VOCATIONAL MATHEMATICS FOR GIRLS

VOCATIONAL MATHEMATICS FOR GIRLS

BY

WILLIAM H. DOOLEY

AUTHOR OF "VOCATIONAL MATHEMATICS" "TEXTILES," ETC.

D. C. HEATH & CO., PUBLISHERS

BOSTON NEW YORK CHICAGO

1 B 7

PREFACE

The author has had, during the last ten years, considerable experience in organizing and conducting intermediate and secondary technical schools for boys and girls. During this time he has noticed the inability of the average teacher in mathematics to give pupils practical applications of the subject. Many teachers are not familiar with the commercial and rule of thumb methods of solving mathematical problems of everyday life. Too often a girl graduates from the course in mathematics without being able to "commercialize" or apply her mathematical knowledge in such a way as to meet the needs of trade, commerce, and home life.

It is to overcome this difficulty that the author has prepared this book on vocational mathematics for girls. He does not believe in omitting the regular secondary school course in mathematics, but offers vocational mathematics as an introduction to the regular course.

The problems have been used by the author during the past few years with girls of high school age. The method of teaching has consisted in arousing an interest in mathematics by showing its value in daily life. Important facts, based upon actual experience and observation, are recalled to the pupil's mind before she attempts to solve the problems.

A discussion of each division of the subject usually precedes the problems. This information is provided for the regular teacher in mathematics who may not be familiar with the subject or the terms used. The book contains samples of problems from all occupations that women are likely to enter, from the textile mill to the home.

The author has received valuable suggestions from his former teachers and from the following: Miss Lilian Baylies Green, Editor *Ladies' Home Journal*, Philadelphia, Pa.; Miss Bessie Kingman, Brockton High School, Brockton, Mass.; Mrs. Ellen B. McGowan, Teachers College, New York City; Miss Susan Watson, Instructor at Peter Bent Brigham Hospital, Boston; Mr. Frank F. Murdock, Principal Normal School, North Adams, Mass.; Mr. Frank Rollins, Principal Bushwick High School, Brooklyn; Mr. George M. Lattimer, Mechanics Institute, Rochester, N. Y.; Mr. J. J. Eaton, Director of Industrial Arts, Yonkers, N. Y.; Dr. Mabel Belt, Baltimore, Md.; Mr. Curtis J. Lewis, Philadelphia, Pa.; Mrs. F. H. Consalus, Washington Irving High School, New York City; Miss Griselda Ellis, Girls' Industrial School, Newark, N. J.; Mr. J. C. Donohue, Technical High School, Syracuse, N. Y.; Mr. W. E. Weafer, Hutchinson-Central High School, Buffalo, N. Y.; The Burroughs Adding Machine Company; The Women's Educational and Industrial Union; the Department of Agriculture, Washington, D. C.; and Reports of Conference of New York State Vocational Teachers.

This preface would not be complete without reference to the author's wife, Mrs. Ellen V. Dooley, who has offered many valuable suggestions and corrected both the manuscript and the proof.

The author will be pleased to receive any suggestions or corrections from any teacher.

CONTENTS

PART I — REVIEW OF ARITHMETIC

PART II — PROBLEMS IN HOMEMAKING

VOCATIONAL MATHEMATICS FOR GIRLS

PART I — REVIEW OF ARITHMETIC

CHAPTER I

Notation and Numeration

A **unit** is one thing; as, one book, one pencil, one inch.

A **number** is made up of units and *tells how many units* are taken.

An **integer** is a whole number.

A single figure expresses a certain number of units and is said to be in the units column. For example, 5 or 8 is a single figure in the units column; 53 is a number of two figures and has the figure 3 in the units column and the figure 5 in the tens column, for the second figure represents a certain number of tens. Each column has its own name, as shown below.

hundred-billions	ten-billions	billions	hundred-millions	ten-millions	millions	hundred-thousands	ten-thousands	thousands	hundreds	tens	units
1	3	8,	6	9	5,	4	0	7,	1	2	5

Reading Numbers. — For convenience in reading and writing numbers they are separated into groups of three figures each by commas, *beginning at the right:*

138,695,407,125.

The first group is 125 units.
The second group is 407 thousands.
The third group is 695 millions.
The fourth group is 138 billions.

The preceding number is read one hundred thirty-eight billion, six hundred ninety-five million, four hundred seven thousand, one hundred twenty-five; or 138 billion, 695 million, 407 thousand, 125.

Roman Numerals

A knowledge of Roman numerals is very important. Dates in buildings and amounts on prescriptions are usually expressed in Roman numerals. They are also used for numbering chapters and dials. The following capital letters, seven in all, are used to express Roman numerals:

I	II	V	X	L	C	D	M
One	Two	Five	Ten	Fifty	100	500	1000

All other numbers are expressed by combining the letters according to the following principles:

1. When a letter is repeated, the value is repeated. Thus, II represents 2; XXX, 30.

2. When a letter of less value is placed after one of greater value, the lesser is added to the greater. Thus, VII, 7 — two added to five.

3. When a letter of less value is placed before one of greater value, the lesser is taken from the greater. Thus, IX, 9 — ten less one.

Read the following Roman numerals according to the above rules:

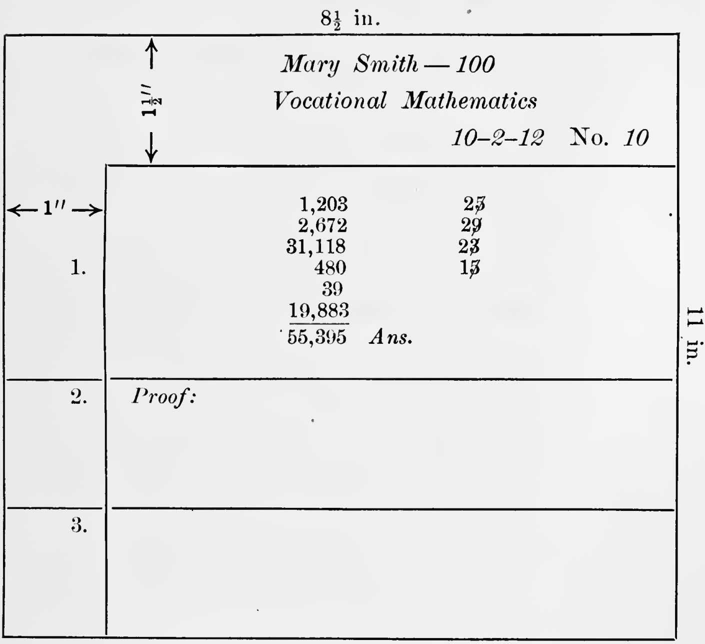
1. III	**9.** XIX	**17.** LXVI
2. XXX	**10.** LXXVII	**18.** MDC
3. CCC	**11.** DCCCVII	**19.** LXXII
4. MMM	**12.** XL	**20.** CCLI
5. VII	**13.** XC	**21.** DCLXVI
6. LXXX	**14.** IX	**22.** DCXIV
7. XXII	**15.** XD	**23.** MDXLVI
8. XVIII	**16.** XM	**24.** MDCCXXIX

Express the following numbers in Roman numerals:

1. 14	**4.** 81	**7.** 281	**10.** 314	**13.** 1837
2. 42	**5.** 73	**8.** 509	**11.** 573	**14.** 1789
3. 69	**6.** 67	**9.** 812	**12.** 874	**15.** 80,003

Standard Mathematics Sheet. — To avoid errors in solving problems the work should be done in such a way as to show each step and to make it easy to check the answer when found. Paper of standard size, $8\frac{1}{2}$ in. by 11 in., should be used. Rule each sheet as in the following diagram, set down each example with its proper number in the margin, and clearly show the different steps required for the solution. To show that the answer obtained is correct, the proof should follow the example.

Standard Mathematics Sheet



The pupil should write or print her name and class, the date when the problem is finished, and the number of the problem on the Standard

Mathematics Sheet. If the question contains several divisions or problems, they should be tabulated — (*a*), (*b*), etc. — at the left of the problems inside the margin line. A line should be drawn between problems to separate them.

Addition

Addition is the process of finding the sum of two or more numbers. The result obtained by this process is called the *sum* or *amount.*

The **sign of addition** is an upright cross, +, called *plus.* The sign is placed between the two numbers to be added.

Thus, 9 inches + 7 inches (read nine inches plus seven inches).

The **sign of equality** is two short horizontal parallel lines, =, and means *equals* or *is equal to.*

Thus, the statement that 8 feet + 6 feet = 14 feet, means that six feet added to eight feet (or 8 feet plus 6 feet) equals fourteen feet.

To find the sum or amount of two or more numbers.

Example. — An agent for a flour mill sold the following number of barrels of flour during the day: 1203, 2672, 31,118, 480, 39, and 19,883 bbl. How many barrels did he sell during the day?

[The abbreviation for barrels is bbl.]

	1,203	2$\cancel{5}$
	2,672	2$\cancel{9}$
	31,118	2$\cancel{3}$
	480	1$\cancel{5}$
	39	
	19,883	
Sum	55,395 bbl.	

The sum of the units column is 3 + 9 + 0 + 8 + 2 + 3 = 25 units, or 20 and 5 more; 20 is tens, so leave the 5 under the units column and add the 2 tens in the tens column. The sum of the tens column is 2 + 8 + 3 + 8 + 1 + 7 + 0 = 29 tens. 29 tens equal 2 hundreds and 9 tens. Place the 9 tens under the tens column and add the 2 hundreds to the hundreds column. 2 + 8 + 4 + 1 + 6 + 2 = 23 hundreds; 23 hundreds are equal to 2 thousands and 3 hundreds. Place the 3 hundreds under the hundreds column and add the 2 thousands to the next column. 2 + 9 + 1 + 2 + 1 = 15 thousands, or 1 ten-thousand and 5 thousands. Add the 1 ten-thousand to the ten-thousands column and the sum is $1 + 1 + 3 = 5$. Write the 5 in the ten-thousands column. Hence, the sum is 55,395 bbl.

TEST. — Repeat the process, beginning at the top of the right-hand column.

Exactness is very important in arithmetic. There is only one correct answer. Therefore it is necessary to be accurate in performing the numerical calculations. A check of some kind should be made on the work. The simplest check is to estimate the answer before solving the problem. If there is a great discrepancy between the estimated answer and the answer in the solution, the work is probably wrong. It is also necessary to be exact in reading the problem.

EXAMPLES

1. Write the following numbers as figures and add them: Seventy-five thousand three hundred eight; seven million two hundred five thousand eight hundred forty-nine.

2. In a certain year the total output of copper from the mines was worth $58,638,277.86. Express this amount in words.

3. Solve the following:

$$386 + 5289 + 53666 + 3001 + 291 + 38 = ?$$

4. The cost of the Panama Canal was estimated in 1912 to be $ 375,000,000. Express this amount in words.

5. A farmer's wife received the following number of eggs in four successive weeks: 692, 712, 684, and 705 eggs. How many eggs were received during the four weeks?

6. A woman buys a two-family house for $ 6511.00. She makes the following repairs: mason-work, $ 112.00; plumbing, $ 146.00; carpenter work, $ 208.00; painting and decorating, $ 319.00. How much does the house cost her?

7. Add the following numbers, left to right:

a. 108, 219, 374, 876, 763, 489, 531, 681, 104;

b. 3846, 5811, 6014, 8911, 7900, 3842, 5879.

8. According to the census of 1910 the population of the United States, exclusive of the outlying possessions, consisted of 47,332,277 males and 44,639,989 females. What was the total population?

9. Wire for electric lights was run around four sides of three rooms. If the first room was 13 ft. long and 9 ft. wide; the second 18 ft. long and 18 ft. wide; and the third 12 ft. long and 7 ft. wide, what was the total length of wire required? Remember that electric lights require two wires.

10. Find the sum:

46 lb. + 135 lb. + 72 lb. + 39 lb. + 427 lb. + 64 lb. + 139 lb.

Subtraction

Subtraction is the process of finding the difference between two numbers, or of finding what number must be added to a given number to equal a given sum. The *minuend* is the number from which we subtract; the *subtrahend* is the number subtracted; and the *difference* or *remainder* is the result of the subtraction.

The **sign of subtraction** is a short horizontal line, –, called *minus*, and is placed before the number to be subtracted.

Thus, 12 – 8 = 4 is read twelve minus (or less) eight equals four.

To find the difference of two numbers.

Example. — A house was purchased for $ 8074.00 twenty-five years ago. It was recently sold at auction for $ 4869.00. What was the loss?

Minuend	$ 8074.00
Subtrahend	$ 4869.00
Remainder	$ 3205.00

Write the smaller number under the greater, with units of the same order in the same vertical line. 9 cannot be taken from 4, so change 1 ten to units. The 1 ten that was changed from the 7 tens makes 10 units, which added to the 4 units makes 14 units. Take 9 from the 14 units and 5 units remain. Write the 5 under the unit column. Since 1 ten was changed from 7 tens, there are 6 tens left, and 6 from 6 leaves 0. Write 0 under the tens column. Next, 8 hundred cannot be taken from 0 hundred, so 1 thousand (ten hundred) is changed from the thousands column. 8 hundred from 10 hundred leave 2 hundred. Write the 2 under the hundreds column. Since 1 thousand has been taken from the 8 thousand, there are left 7 thousand to subtract the 4 thousand from, which leaves 3 thousand. Write 3 under the thousand column. The whole remainder is \$3205.00.

Proof. — If the sum of the subtrahend and the remainder equals the minuend, the answer is correct.

EXAMPLES

1. Subtract 1001 from 79,999.

2. A box contained one gross (144) of wood screws. If 48 screws were used on a job, how many screws were left in the box?

3. What number must be added to 3001 to produce a sum of 98,322?

4. Barrels are usually marked with the gross weight and tare (weight of empty barrel). If a barrel of sugar is marked 329 lb. gross weight and 19 lb. tare, find the net weight of sugar.

5. A box contains a gross (144) of pencils. If 109 are removed, how many remain?

6. A farmer received 1247 quarts of milk in October and 1189 quarts in November. What was the difference?

7. A housewife purchases a \$800.00 baby grand piano for \$719.00. How much does she save?

8. No. 1 cotton yarn contains 840 yards to the pound, while No. 1 worsted yarn contains 560 yards to the pound. What is the difference in length?

9. A young lady saved \$453.00 during five years. She spent \$189.00 on a sea trip. How much remained?

10. 69,221 – 3008 = ?

11. The population of New York City in 1900 was 3,437,202 and in 1910 was 4,766,883. What was the increase from 1900 to 1910?

12. If there are 374,819 wage-earning women in a certain city having a total population of 3,366,416 persons, how many of the residents are not wage-earning women?

13. In the year 1820 only 8385 immigrants arrived in the United States. In 1842, 104,565 immigrants arrived. How many more arrived in 1842 than in 1820?

14. The first great shoemaker settled in Lynn, Mass., in 1636. How many years is it since he arrived in Lynn?

Multiplication

Multiplication is the process of finding the product of two numbers.

Thus, 8×3 may be read 8 multiplied by 3, or 8 times 3, and means 8 added to itself 3 times, or $8 + 8 + 8 = 24$ and $8 \times 3 = 24$.

The numbers multiplied together are called *factors*. The *multiplicand* is the number multiplied; the *multiplier* is the number multiplied by; and the result is called the *product*.

The **sign of multiplication** is an oblique cross, $\times$, which means *multiplied by* or *times*.

Thus, 7×4 may be read 7 multiplied by 4, or 7 times 4.

To find the product of two numbers.

Example. — A certain set of books weighs 24 lb. What is the weight of 17 sets?

Multiplicand	24 lb.
Multiplier	17
	168
	24
Product	408 lb.

Write the multiplier under the multiplicand, units under units, tens under tens, etc. 7 times 4 units equal 28 units, which are 2 tens and 8 units. Place the 8 under the units column. The 2 tens are to be added to the tens product. 7 times 2 tens are 14 tens + the 2 tens are 16 tens, or 1 hundred and 6 tens. Place the 6 tens in the tens column and the 1 hundred in the hundreds column. 168 is a partial product. To multiply by the 1, proceed as before, but as 1 is a ten, write the first number, which is 4 of this partial product, under the tens column, and the next number under the hundreds column, and so on. Add the partial products, and their sum is the whole product, or 408 lb.

EXAMPLES

1. A milliner ordered 58 spools of wire, each spool containing 100 yards. How many yards did she order in all?

2. Each shoe box contains 12 pairs of shoes. How many pairs in 423 boxes?

3. Multiply 839 by 291.

4. A mechanic sent in the following order for bolts: 12 bolts, 6 lb. each; 9 bolts, 7 lb. each; 11 bolts, 3 lb. each; 6 bolts, 2 lb. each; and 20 bolts, 3 lb. each. What was the total weight of the order?

5. Find the product of 1683 and 809.

To multiply by 10, 100, 1000, *etc., annex as many ciphers to the multiplicand as there are ciphers in the multiplier.*

EXAMPLE. — $864 \times 100 = 86{,}400$.

EXAMPLES

Multiply and read the answers to the following:

1. 869×10

2. 1011×100

3. $10{,}389 \times 1000$

4. $11{,}298 \times 30{,}000$

5. $58{,}999 \times 400$

6. $681{,}719 \times 10$

7. $801{,}369 \times 100$

8. 100×500

9. 1000×900

10. $10{,}000 \times 500$

11. $10{,}000 \times 6000$

12. $1{,}000{,}000 \times 6000$

13. $1{,}891{,}717 \times 400$

14. $10{,}000{,}059 \times 78{,}911$

Division

Division is the process of finding how many times one number is contained in another. The *dividend* is the number to be divided; the *divisor* is the number by which the dividend is divided; the *quotient* is the result of the division. When a number is not contained an equal number of times in another number, what is left over is called a *remainder.*

The **sign of division** is $\div$, and when placed between two numbers signifies that the first is to be divided by the second.

Thus, $56 \div 8$ is read 56 divided by 8.

Division is also indicated by writing the dividend above the divisor with a line between.

Thus, $\frac{56}{8}$; this is read 56 divided by 8.

In division we are given a product and one of the factors to find the other factor.

To find how many times one number is contained in another.

EXAMPLE. — A manufacturer desires to distribute a surplus of \$8035.00 among his employees so that each one will receive \$3.00 How many employees will receive \$3.00? How much is left over?

$$\begin{array}{rrl} & 2678 & \textit{Employees} \\ \textit{Divisor} & 3\overline{)8035} & \textit{Dividend} \\ & \underline{6} & \\ & 20 & \\ & \underline{18} & \\ & 23 & \\ & \underline{21} & \\ & 25 & \\ & \underline{24} & \\ \textit{Remainder} & 1 & \end{array}$$

Write the numbers in the manner indicated at the left. 8 thousand is in the thousands column. The nearest 8 thousand can be divided into groups of 3 is 2 (thousand) times, which gives 6 thousand. Write 2 as the first figure in the quotient over 8 in the dividend. Place the 6 (thousand) under the 8 thousand and subtract; the remainder is 2 thousand, or 20 hundred. 3 is contained in 20 hundred 6 hundred times, or 18 hundred and 2 hundred remainder. Write 6 as the next figure in the quotient. Add the 3 tens in the dividend to the 2 hundred, or 20 tens, and 23 tens is the next dividend to be divided. 3 is contained in 23 tens 7 times, or 21 tens with a remainder of 2 tens. Write 7 as the next figure in the quotient. 2 tens, or 20 units, plus the 5 units from the quotient make 25 units. 3 is contained in 25, 8 times. Write 8 as the next figure in the quotient. 24 units subtracted from 25 units leave a remainder of 1 unit. Then the answer is 2678 employees and 1 dollar left over.

PROOF. — Find the product of the divisor and quotient, add the remainder, if any, and if the sum equals the dividend, the answer is correct.

EXAMPLES

1. A strip of sheeting measures 81″ in width. How many pieces 6″ wide can be cut from it? Would there be a remainder?

2. How many pieces 6″ long can be cut from a piece of velvet 62″ long, if no allowance is made for waste in cutting?

3. If the cost of constructing 162 miles of railway was $ 4,561,200, what was the cost per mile?

4. If a job which took 379 hours was divided equally among 25 women, how many even hours would each woman work, and how much overtime would one of the number have to put in to complete the job?

5. The "over-all" dimension on a drawing was 18′ 9″. The distance was to be spaced off into 14-inch lengths, beginning at one end. How many such lengths could be spaced? How many inches would be left at the other end?

6. If a locomotive consumed 18 gallons of fuel oil per mile of freight service, how far could it run with 2036 gallons of oil?

7. If 6 eggs weigh one pound, how many cases each containing 36 eggs could be filled from a stock of 48 lb. of eggs?

8. The American people spend three hundred million dollars every year on shoes, and average three pairs a person. What is the average (wholesale) cost per pair, assuming that there are 91,972,266 people in the United States?

9. The enlisted strength of the army of the United States in 1914 was 91,402 with an upkeep charge of $ 92,076,145.51. What did it cost the United States per man to maintain its standing army that year?

10. Divide 38,910 by 3896.

REVIEW EXAMPLES

1. A farmer's daughter raised on the farm 5 loads of potatoes containing 38 bu., 29 bu., 43 bu., 39 bu., and 29 bu. respectively. She sold 12 bu. to each of three families, and 34 bu. to each of four families. How many bushels were left?

2. Five pieces of cloth are placed end to end. If each piece contains 38 yards, what is the total length?

3. I bought a chair for $3, a mat for $1, a table for $4, and gave in payment a $20 bill. What change did I receive?

4. A teacupful contains 4 fluid ounces. How many teacupfuls in 64 fluid ounces?

5. No. 30 cotton yarn contains 25,200 yards to a pound. How many pounds of yarn in 630,000 yards?

6. The consumption of water in a city during the month of December was 116,891,213 gallons and during January 115,819,729 gallons. How much was the decrease in consumption?

7. An order to a machine shop called for 598 sewing machines each weighing 75 pounds. What was the total weight?

8. If a strip of carpet weighs 4 lb. per foot of length, find the weight of one measuring 16′ 9″ in length.

9. Multiply 641 and 225.

10. Divide 24,566 by 319.

11. An order was given for ties for a railroad 847 miles long. If each mile required 3017 ties, how many ties would be needed?

12. How many gallons of milk are used every day by two hospitals, if one uses 25 gallons per day and the other 6 gallons less?

Factors

The **factors** of a number are the integers which when multiplied together produce that number.

Thus, 21 is the product of 3 and 7 ; hence, 3 and 7 are the factors of 21.

Separating a number into its factors is called *factoring.*

A number that has no factors but itself and 1 is a *prime* number.

The prime numbers up to 25 are 2, 3, 5, 7, 11, 13, 17, 19 and 23.

A prime number used as a factor is a *prime factor.*

Thus, 3 and 5 are prime factors of 15.

Every prime number except 2 and 5 ends with 1, 3, 7, or 9.

To find the prime factors of a number.

Example. — Find the prime factors of 84.

$$\begin{array}{r} 2\overline{)84} \\ 2\overline{)42} \\ 3\overline{)21} \\ 7\overline{)7} \\ 1 \end{array}$$

The prime number 2 divides 84 evenly, leaving the quotient 42, which 2 divides evenly. The next quotient is 21 which 3 divides, giving a quotient 7. 7 divided by 7 gives the last quotient 1 which is indivisible. The several divisors are the prime factors. So 2, 2, 3, and 7 are the prime factors of 84.

Proof. — The product of the prime factors gives the number.

EXAMPLES

Find the prime factors:

1. 63	**4.** 636	**7.** 1155
2. 60	**5.** 1572	**8.** 7007
3. 250	**6.** 2800	**9.** 13104

Cancellation

To reject a factor from a number divides the number by that factor; to reject the same factors from both dividend and divisor does not affect the quotient. This process is called *cancellation.*

This method can be used to advantage in many everyday calculations.

Example. — Divide $12 \times 18 \times 30$ by $6 \times 9 \times 4$.

$$\begin{array}{ll} & \ \ \ \ \ \ \ 1 \\ & 2 \quad \ \cancel{2} \quad 15 \\ \textit{Dividend} & \dfrac{\cancel{12} \times \cancel{18} \times \cancel{30}}{\cancel{6} \times \cancel{9} \times \cancel{4}} = 30 \ \textit{Quotient.} \\ \textit{Divisor} & \\ & 1 \quad 1 \quad \cancel{2} \\ & 1 \end{array}$$

By this method it is not necessary to multiply before dividing. Indicate the division by writing the divisor under the dividend with a line between. Since 6 is a factor of 6 and 12, and 9 of 9 and 18, respectively, they may be cancelled from both divisor and dividend. Since 2 in the dividend is a factor of 4 in the divisor it may be cancelled from both, leaving 2 in the divisor. Then the 2 being a factor of 30 in the dividend, is cancelled from both, leaving 15. The product of the uncancelled factors is 30. Therefore, the quotient is 30.

PROOF. — If the product of the divisor and the quotient equal the dividend, the answer is correct.

EXAMPLES

Indicate and find quotients by cancellation:

1. Divide $36 \times 27 \times 49 \times 38 \times 50$ by $70 \times 18 \times 15$.

2. What is the quotient of $36 \times 48 \times 16$ divided by $27 \times 24 \times 8$?

3. How many pounds of tea at 50 cents a pound must be given in exchange for 15 pounds of butter at 40 cents a pound?

4. There are 16 ounces in a pound; 30 pounds of steel will produce how many horseshoes, if each weighs 6 ounces?

5. Divide the product of 10, 75, 9, and 96 by the product of 5, 12, 15, and 9.

6. I sold 16 dozen eggs at 30 cents a dozen and took my pay in butter at 40 cents a pound; how many pounds did I receive?

7. A dealer bought 16 cords of wood at $4 a cord and sold them for $96; find the gain per cord.

Greatest Common Divisor

The **greatest common divisor** of two or more numbers is the greatest number that will exactly divide each of the numbers.

To find the greatest common divisor of two or more numbers.

EXAMPLE. — Find the greatest common divisor of 90 and 150.

$$90 = 2 \times 3 \times 5 \times 3$$
$$150 = 2 \times 3 \times 5 \times 5$$
$$\textit{Ans.}\ 30 = 2 \times 3 \times 5$$

$$\begin{array}{r|rr} 2 & 90 & 150 \\ \hline 5 & 45 & 75 \\ \hline 3 & 9 & 15 \\ \hline & 3 & 5 \end{array}$$

$$2 \times 3 \times 5 = 30\ \textit{Ans.}$$

First Method

The prime factors common to both 90 and 150 are 2, 3, and 5. Since the greatest common divisor of two or more numbers is the product of their common factors, 30 is the greatest common divisor of 90 and 150.

```
                           90)150(1
                               90
                               60)90(1
                                  60
Greatest Common Divisor           30)60(2
                                     60
```

Second Method

To find the greatest common divisor when the numbers cannot be readily factored, divide the larger by the smaller, then the last divisor by the last remainder until there is no remainder. The last divisor will be the greatest common divisor. If the greatest common divisor is to be found of more than two numbers, find the greatest common divisor of two of them, then of this divisor and the third number, and so on. The last divisor will be the greatest common divisor of all of them.

EXAMPLES

Find the greatest common divisor:

1. 270, 810.
2. 264, 312.
3. 504, 560.
4. 288, 432, 1152.
5. 72, 153, 315, 2187.

Least Common Multiple

The product of two or more numbers is called a **multiple** of each of them; 4, 6, 8, 12 are multiples of 2. The **common**

multiple of two or more numbers is a number that is divisible by each of the numbers without a remainder; 60 is a common multiple of 4, 5, 6.

The **least common multiple** of two or more numbers is *the smallest* common multiple of the number; 30 is the least common multiple of 3, 5, 6.

To find the least common multiple of two or more numbers.

Example. — Find the least common multiple of 21, 28, and 30.

First Method

$$21 = 3 \times 7$$
$$28 = 2 \times 2 \times \cancel{7}$$
$$30 = \cancel{2} \times \cancel{3} \times 5$$

Take all the factors of the first number, all of the second not already represented in the first, etc. Thus,

$$3 \times 7 \times 2 \times 2 \times 5 = 420 \text{ } L.\ C.\ M.$$

Second Method

$$\begin{array}{r|rrr} 2 & 21 & 28 & 30 \\ \hline 3 & 21 & 14 & 15 \\ \hline 7 & 7 & 14 & 5 \\ \hline & 1 & 2 & 5 \end{array}$$

$$2 \times 3 \times 7 \times 1 \times 2 \times 5 = 420 \text{ } L.\ C.\ M.$$

Divide any two or more numbers by a prime factor contained in them, like 2 in 28 and 30. Write 21 which is not divided by the 2 for the next quotient together with the 14 and 15. 3 is a prime factor of 21 and 15 which gives a quotient of 7 and 5 with 14 written in the quotient undivided. 7 is a prime factor of 7 and 14 which gives a remainder of 1, 2; and 5 undivided is written down as before. The product 420 of all these divisors and the last quotients is the least common multiple of 21, 28, and 30.

EXAMPLES

Find the least common multiple:

1. 18, 27, 30.   2. 15, 60, 140, 210.   3. 24, 42, 54, 360.

4. 25, 20, 35, 40.   5. 24, 48, 96, 192.

6. What is the shortest length of rope that can be cut into pieces 32′, 36′, and 44′ long?

Fractions

A **fraction** is one or more equal parts of a unit. If an apple be divided into two equal parts, each part is one-half of the apple, and is expressed by placing the number 1 above the number 2 with a short line between: $\frac{1}{2}$. A fraction always indicates division. In $\frac{1}{2}$, 1 is the dividend and 2 the divisor; 1 is called the *numerator* and 2 is called the *denominator*.

A **common fraction** is one which is expressed by a numerator written above a line and a denominator below. The numerator and denominator are called the *terms of the fraction*.

A **proper fraction** is a fraction whose value is less than 1; its numerator is less than its denominator, as $\frac{3}{4}$, $\frac{5}{8}$, $\frac{6}{7}$, $\frac{11}{12}$. An **improper fraction** is a fraction whose value is 1 or more than 1; its numerator is equal to or greater than its denominator, as $\frac{4}{4}$, $\frac{19}{16}$. A number made up of an integer and a fraction is a **mixed number**. Read with the word *and* between the whole number and the fraction: $4\frac{9}{16}$, $3\frac{7}{8}$, etc.

The *value of a fraction* is the *quotient* of the numerator divided by the denominator.

EXERCISE

Read the following:

1. $\frac{5}{8}$	**3.** $12\frac{1}{2}$	**5.** $5\frac{1}{2}$	**7.** $9\frac{1}{32}$	**9.** $\frac{7}{4}$
2. $\frac{17}{16}$	**4.** $8\frac{1}{2}$	**6.** $6\frac{7}{8}$	**8.** $12\frac{3}{64}$	

Reduction of Fractions

Reduction of fractions is the process of changing their form without changing their value.

To reduce a fraction to higher terms.

Multiplying the denominator and the numerator of the given fraction by the same number does not change the value of the fraction.

EXAMPLE. — Reduce $\frac{5}{8}$ to thirty-seconds.

$$\frac{5}{8}\times\frac{4}{4}=\frac{20}{32}\quad Ans.$$

The denominator must be multiplied by 4 to obtain 32; so the numerator must be multiplied by the same number in order that the value of the fraction may not be changed.

EXAMPLES

Change the following:

1. $\frac{3}{9}$ to 27ths.
2. $\frac{11}{12}$ to 60ths.
3. $\frac{5}{8}$ to 40ths.
4. $\frac{7}{8}$ to 56ths.
5. $\frac{9}{10}$ to 50ths.
6. $\frac{9}{25}$ to 75ths.
7. $\frac{19}{36}$ to 144ths.
8. $\frac{47}{56}$ to 168ths.
9. $\frac{17}{18}$ to 522ds.
10. $\frac{125}{375}$ to 9375ths.

A fraction is said to be in its *lowest terms* when the numerator and the denominator are prime to each other.

To reduce a fraction to its lowest terms.

Dividing the numerator and the denominator of a fraction by the same number does not change the value of the fraction. The process of dividing the numerator and denominator of a fraction by a number common to both may be continued until the terms are prime to each other.

EXAMPLE. — Reduce $\frac{12}{16}$ to fourths.

$$\frac{12}{16}=\frac{3}{4}\quad Ans.$$

The denominator must be divided by 4 to give the new denominator 4; then the numerator must be divided by the same number so as not to change the value of the fraction.

If the terms of a fraction are large numbers, find their greatest common divisor and divide both terms by that.

EXAMPLE. — Reduce $\frac{2166}{2888}$ to fourths.

(1)
```
           2166)2888(1
                2166
G. C. D.         722)2166(3
                     2166
```

(2) $\frac{2166}{2888}=\frac{3}{4}$ *Ans.*

EXAMPLES

Reduce to lowest terms:

1. $\frac{8}{16}$	3. $\frac{1162}{1328}$	5. $\frac{21}{78}$	7. $\frac{300}{800}$	9. $\frac{114}{285}$
2. $\frac{240}{480}$	4. $\frac{14}{16}$	6. $\frac{16}{128}$	8. $\frac{130}{162}$	10. $\frac{112}{1888}$

To reduce an integer to an improper fraction.

Example. — Reduce 25 to fifths.

25 times $\frac{5}{5} = \frac{125}{5}$ *Ans.*

In 1 there are $\frac{5}{5}$. In 25 there must be 25 times $\frac{5}{5}$, or $\frac{125}{5}$.

To reduce a mixed number to an improper fraction.

Example. — Reduce $16\frac{4}{7}$ to an improper fraction.

$16\frac{4}{7}$
7 sevenths
112
4 sevenths
116 sevenths, $= \frac{116}{7}$.

Since in 1 there are $\frac{7}{7}$, in 16 there must be 16 times $\frac{7}{7}$, or $\frac{112}{7}$.
$\frac{112}{7} + \frac{4}{7} = \frac{116}{7}$.

EXAMPLES

Reduce to improper fractions:

1. $3\frac{7}{8}$	3. $17\frac{1}{4}$	5. $13\frac{7}{8}$	7. $359\frac{5}{16}$
2. $16\frac{1}{32}$	4. $12\frac{1}{2}$	6. $27\frac{3}{15}$	8. $482\frac{19}{45}$

9. $25\frac{1}{30}$

10. Reduce 250 to 16ths.

11. Change 156 to a fraction whose denominator shall be 12.

12. In $730 how many fourths of a dollar?

13. Change $12\frac{5}{8}$ to 16ths.

14. Change $24\frac{5}{9}$ to 18ths.

To reduce an improper fraction to an integer or mixed number divide the numerator by the denominator.

Example. — Reduce $\frac{385}{16}$ to an integer or mixed number.

$$\begin{array}{r} 24 \\ 16\overline{)385} \\ \underline{32} \\ 65 \\ \underline{64} \\ 1 \end{array}$$

$24\frac{1}{16}$ *Ans.*

Since $\frac{16}{16}$ equal 1, $\frac{385}{16}$ will equal as many times 1 as 16 is contained in 385, or $24\frac{1}{16}$ times.

EXAMPLES

Reduce to integers or mixed numbers:

1. $\frac{70}{35}$	4. $\frac{3824}{24}$	7. $\frac{807}{27}$	10. $\frac{3075}{25}$
2. $\frac{219}{16}$	5. $\frac{38763}{26}$	8. $\frac{912}{89}$	11. $\frac{89163}{64}$
3. $\frac{3982}{75}$	6. $\frac{360}{39}$	9. $\frac{25000}{100}$	12. $\frac{72}{22}$

When fractions have the same denominator their denominator is called a *common denominator.*

Thus, $\frac{10}{12}$, $\frac{6}{12}$, $\frac{2}{12}$ have a common denominator.

The *smallest common denominator* of two or more fractions is their least common denominator.

Thus, $\frac{10}{12}$, $\frac{6}{12}$, $\frac{2}{12}$ become $\frac{5}{6}$, $\frac{3}{6}$, $\frac{1}{6}$ when changed to their least common denominator.

The common denominator of two or more fractions is a *common multiple* of their denominators.

The least common denominator of two or more fractions is the *least common multiple* of their denominators.

Example. — Reduce $\frac{3}{4}$ and $\frac{5}{6}$ to fractions having a common denominator.

$\frac{3}{4} \times \frac{6}{6} = \frac{18}{24}$

$\frac{5}{6} \times \frac{4}{4} = \frac{20}{24}$

$\frac{3}{4} = \frac{18}{24}$ and $\frac{5}{6} = \frac{20}{24}$

The common denominator must be a common multiple of the denominators 4 and 6, and since 24 is the product of the denominators, it is a common multiple of them. Therefore, 24 is a common denominator of $\frac{3}{4}$ and $\frac{5}{6}$.

To reduce fractions to fractions having the least common denominator.

Example. — Reduce $\frac{2}{3}$, $\frac{5}{6}$, and $\frac{7}{12}$ to fractions having the least common denominator.

$$\begin{array}{r|rrr} 2 & 3 & 6 & 12 \\ \hline 3 & 3 & 3 & 6 \\ \hline & 1 & 1 & 2 \end{array}$$

$2 \times 3 \times 2 = 12$ *L. C. M.*

$\frac{2}{3} = \frac{8}{12}$; $\frac{5}{6} = \frac{10}{12}$; $\frac{7}{12} = \frac{7}{12}$. *Ans.*

The least common denominator must be the least common multiple of the denominators 3, 6, 12, which is 12.

Divide the least common multiple 12 by the denominator of each fraction, and multiply both terms by the quotient. If the denominators should be prime to each other, their product would be their least common denominator.

EXAMPLES

Reduce to fractions having a common denominator:

1. $\frac{1}{3}, \frac{3}{5}$
2. $\frac{3}{4}, \frac{2}{3}$
3. $\frac{5}{8}, \frac{7}{9}$
4. $\frac{5}{7}, \frac{1}{14}, \frac{1}{2}$
5. $\frac{5}{7}, \frac{2}{3}, \frac{2}{5}$
6. $\frac{7}{8}, \frac{5}{6}, \frac{4}{9}$
7. $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \frac{4}{5}$
8. $\frac{1}{5}, \frac{3}{12}, \frac{5}{9}, \frac{7}{8}$

Reduce to fractions having least common denominator:

1. $\frac{6}{5}, \frac{7}{8}, \frac{7}{12}$
2. $\frac{3}{4}, \frac{7}{8}, \frac{5}{16}$
3. $\frac{3}{15}, \frac{4}{21}, \frac{2}{3}$
4. $\frac{4}{5}, \frac{5}{12}, \frac{3}{20}, \frac{5}{60}$
5. $\frac{5}{7}, \frac{3}{2}, \frac{5}{14}, 4$
6. $\frac{4}{5}, \frac{5}{6}, \frac{7}{8}, \frac{5}{9}$
7. Which fraction is larger, $\frac{6}{7}$ or $\frac{7}{8}$?

Addition of Fractions

Only fractions with a common denominator can be added. If the fractions have not the same denominator, reduce them to a common denominator, add their numerators, and place their sum over the common denominator. The result should be reduced to its lowest terms. If the result is an improper fraction, it should be reduced to an integer or mixed number.

EXAMPLE. — Add $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{9}{16}$.

1.
$$\begin{array}{r|rrr} 2 & 4 & 6 & 16 \\ \hline 2 & 2 & 3 & 8 \\ \hline & 1 & 3 & 4 \end{array} \quad 48\ L.\ C.\ M.$$

2. $\frac{3}{4} + \frac{5}{6} + \frac{9}{16} = \frac{36}{48} + \frac{40}{48} + \frac{27}{48} = \frac{103}{48}$. *Ans.*

The least common multiple of the denominators is 48. Dividing this by the denominator of each fraction and multiplying both terms by the quotient give $\frac{36}{48}$, $\frac{40}{48}$, $\frac{27}{48}$. The fractions are now like fractions, and are added by adding their numerators and placing the sum over the common denominator. Hence, the sum is $\frac{103}{48}$, or $2\frac{7}{48}$.

EXAMPLE. — Add $5\frac{3}{5}$, $7\frac{7}{10}$, and $6\frac{7}{15}$.

$$\begin{aligned} 5\tfrac{3}{5} &= 5\tfrac{18}{30} \\ 7\tfrac{7}{10} &= 7\tfrac{21}{30} \\ 6\tfrac{7}{15} &= 6\tfrac{14}{30} \\ & \overline{18\tfrac{53}{30}} = 19\tfrac{23}{30}. \quad \textit{Ans.} \end{aligned}$$

First find the sum of the fractions, which is $\frac{53}{30}$, or $1\frac{23}{30}$. Add this to the sum of the integers, 18. $18 + 1\frac{23}{30} = 19\frac{23}{30}$.

EXAMPLES

1. Find the "over-all" dimension of a drawing if the separate parts measure $\frac{5}{16}''$, $\frac{3}{8}''$, $\frac{1}{2}''$, and $\frac{3}{4}''$, respectively.

2. Find the sum of $\frac{1}{2}$, $\frac{3}{4}$, $\frac{7}{8}$, $\frac{15}{16}$, and $\frac{31}{32}$.

3. Find the sum of $3\frac{3}{3}$, $4\frac{3}{4}$, and $2\frac{1}{16}$.

4. A seam $\frac{3}{16}$ of an inch wide is made on both sides of a piece of cloth 27 inches wide. What is the width after the seams are made?

5. I bought cotton cloth valued at \$ $6\frac{1}{4}$, silk at \$ $13\frac{3}{4}$, handkerchiefs for \$ $2\frac{1}{2}$, and hose for \$ $2\frac{3}{4}$. What was the whole cost?

6. A ribbon was cut into two pieces, one $8\frac{3}{8}''$ and the other $5\frac{9}{16}''$ long. If $\frac{1}{16}''$ was allowed for waste in cutting, what was the length of the ribbon?

7. Three pieces of cloth contain $38\frac{1}{3}$, $12\frac{1}{2}$, and $53\frac{2}{3}$ yards respectively. What is their total length in yards?

8. Add: $10\frac{1}{5}$, $7\frac{2}{7}$, 11, $\frac{14}{35}$.

9. Add: $136\frac{1}{2}$, $184\frac{4}{5}$, $416\frac{1}{4}$, $125\frac{7}{8}$.

Subtraction of Fractions

Only fractions with a common denominator can be subtracted. If the fractions have not the same denominator, reduce them to a common denominator and write the difference of their numerators over the common denominator. The result should be reduced to its lowest terms.

EXAMPLE. — Subtract $\frac{2}{3}$ from $\frac{5}{6}$.

$\frac{5}{6} - \frac{2}{3} = \frac{5}{6} - \frac{4}{6} = \frac{1}{6}$. *Ans.*

The least common denominator of $\frac{5}{6}$ and $\frac{2}{3}$ is 6. $\frac{5}{6} = \frac{5}{6}$, and $\frac{2}{3} = \frac{4}{6}$. Their difference is $\frac{1}{6}$.

EXAMPLE. — From $11\frac{1}{3}$ subtract $5\frac{5}{6}$.

$$\begin{array}{rl} 11\frac{1}{3} = & 10\frac{8}{6} \\ 4\frac{5}{6} = & \underline{4\frac{5}{6}} \\ & 6\frac{3}{6} = 6\frac{1}{2}. \quad \textit{Ans.} \end{array}$$

When the fractions are changed to their least common denominator, they are $11\frac{2}{6} - 4\frac{5}{6}$. $\frac{5}{6}$ cannot be subtracted from $\frac{2}{6}$, hence 1 is taken from 11 units, changed to sixths, and added to the $\frac{2}{6}$, which makes $\frac{8}{6}$. $10\frac{8}{6} - 4\frac{5}{6} = 6\frac{3}{6} = 6\frac{1}{2}$.

EXAMPLES

1. From eleven yards of cloth, $1\frac{3}{4}$ yards were cut for a jacket and $3\frac{7}{8}$ yards for a coat. How many yards were left?

2. From a firkin of butter containing $27\frac{1}{2}$ lb. there were sold $3\frac{7}{8}$ lb. and $11\frac{1}{4}$ lb. How many pounds remained?

3. The sum of two fractions is $\frac{3}{4}$. One of the fractions is $\frac{1}{3}$. Find the other.

4. Laura had \$ $7\frac{1}{2}$ and gave away \$ $2\frac{1}{2}$ and \$ $3\frac{1}{4}$. How much remained?

5. The sum of 2 numbers is $37\frac{1}{2}$ and one of the numbers is $28\frac{3}{8}$. Find the other number.

6. By selling goods for \$ $43\frac{1}{4}$, I lost \$ $27\frac{1}{2}$. What was the cost?

7. A man sells $9\frac{7}{8}$ yards from a piece of cloth containing 34 yds. How many yards remain?

8. Mr. Brown sold goods for \$ $56\frac{3}{10}$, gaining \$ 12. What did they cost?

9. A dealer had 208 tons of coal and sold $92\frac{3}{4}$ tons. How much remained?

10. If I buy a ton of coal for \$ $6\frac{1}{4}$ and sell for \$ $7\frac{1}{2}$, how much do I gain?

14. There were $48\frac{1}{2}$ gallons in the tank. First $4\frac{1}{2}$ gallons were used, then $5\frac{1}{3}$ gallons, and last $2\frac{3}{4}$ gallons. How many gallons were left in the tank?

15. What is the difference between $\frac{9}{17}$ and $\frac{18}{34}$?

16. What is the difference between $32\frac{7}{8}$ and $3\frac{17}{64}$?

17. A piece of dress goods contains 60 yd. If four cuts of $12\frac{1}{2}$, $9\frac{5}{8}$, $18\frac{3}{4}$, and $10\frac{1}{2}$ yd. respectively are made, what remains?

Multiplication of Fractions

To multiply fractions, multiply the numerators together for the new numerator and multiply the denominators together for the new denominator.

Cancel when possible. The word *of* between two fractions is equivalent to the sign of multiplication.

To multiply a mixed number by an integer, multiply the whole number and the fraction separately by the integer then add the products.

To multiply two mixed numbers, change each to an improper fraction and multiply.

Example. — Multiply $\frac{4}{5}$ by $\frac{3}{4}$.

$\frac{4}{5}$ multiplied by $\frac{3}{4}$ is the same as $\frac{3}{4}$ *of* $\frac{4}{5}$. 3 and 5 are prime to each other so that answer is $\frac{3}{5}$. This method of solution is the same as multiplying the numerators together for a new numerator and the denominators for a new denominator. Cancellation shortens the process.

Example. — Find the product of $124\frac{3}{4}$ and 5.

$$\begin{array}{r} 124\frac{3}{4} \\ 5 \\ \hline 3\frac{3}{4} \\ 620 \\ \hline 623\frac{3}{4} \end{array} \quad \textit{Ans.}$$

$5 \times \frac{3}{4} = \frac{15}{4} = 3\frac{3}{4}$

If the fraction and integer are multiplied separately by 5, the result is 5 times $\frac{3}{4} = \frac{15}{4} = 3\frac{3}{4}$, and 5 times $124 = 620$. $620 + 3\frac{3}{4} = 623\frac{3}{4}$.

EXAMPLES

1. William earns $83\frac{1}{3}$ cents a day. How much will he earn in five weeks?

2. One bag of flour costs 75 cents. How much will three barrels cost? A barrel holds 8 bags.

3. From a barrel of flour containing 196 lb., $24\frac{1}{2}$ lb. were taken. At another time $\frac{1}{7}$ of the remainder was taken. How many pounds were left?

4. Multiply $\frac{5}{4}$ of $\frac{3}{9}$ by $\frac{2}{5}$ of $\frac{4}{3}$.

5. Multiply $26\frac{5}{9}$ by $9\frac{1}{3}$.

6. Find the cost of $19\frac{2}{3}$ yd. of cloth at $16\frac{1}{2}$ cents a yard.

7. At \$ $12\frac{1}{2}$ each, how many tables can be bought for \$ 280?

8. I paid \$ $6\frac{3}{4}$ for a barrel of flour and sold it for \$ $\frac{9}{10}$ more. How much did I sell it for?

9. What is the cost of 18 yards of cloth at $15\frac{2}{3}$ cents a yard?

10. If coal cost \$$7\frac{1}{2}$ a ton, how much will $8\frac{1}{4}$ tons cost?

11. Multiply: $32\frac{3}{8}$ by $8\frac{1}{7}$.

Division of Fractions

To divide one fraction by another, invert the divisor and proceed as in multiplication of fractions. Change integers and mixed numbers to improper fractions.

EXAMPLE. — Divide $\frac{4}{5} \times \frac{3}{8}$ by $\frac{5}{6} \times \frac{3}{5}$.

$\frac{4}{5} \times \frac{3}{8} \div (\frac{5}{6} \times \frac{3}{5}) =$

$$\frac{\cancel{4}}{5} \times \frac{3}{\underset{2}{\cancel{8}}} \times \frac{\overset{2}{\cancel{6}}}{\cancel{5}} \times \frac{\cancel{5}}{\cancel{3}} = \frac{3}{5}. \quad \textit{Ans.}$$

The divisor $\frac{5}{6} \times \frac{3}{5}$ is inverted and the result obtained by the process of cancellation.

EXAMPLE. — Divide $3156\frac{3}{4}$ by 5.

$$\begin{array}{l}
\quad 631\frac{7}{20} \quad \textit{Ans.} \\
5)\overline{3156\frac{3}{4}} \\
\underline{30} \\
\;15 \\
\;\underline{15} \qquad 1\frac{3}{4} = \frac{7}{4} \\
\quad 6 \\
\quad \underline{5} \\
\quad 1\frac{3}{4} \qquad \frac{7}{4} \div 5 = \frac{7}{4} \times \frac{1}{5} = \frac{7}{20}
\end{array}$$

When the integer of a mixed number is large, it may be divided as follows: 5 in $3156\frac{3}{4}$, 631 times, with a remainder of $1\frac{3}{4}$. This remainder divided by 5 gives $\frac{7}{20}$, which is placed at the right of the quotient.

EXAMPLE. — Divide 3682 by $5\frac{1}{2}$.

$$\begin{array}{l}
5\frac{1}{2})\ 3682 \\
\underline{2} \qquad\quad \underline{2} \\
11\ )\overline{7364} \\
\qquad 669\frac{5}{11} \quad \textit{Ans.}
\end{array}$$

When the dividend is a large number and the divisor a mixed number, it is useful to remember that multiplying both dividend and divisor by the same number does not change the quotient. In this example we can multiply both dividend and divisor by 2 and then divide as with whole numbers. The quotient is $669\frac{5}{11}$.

A fraction having a fraction for one or both of its terms is called a *complex fraction.*

To reduce a complex fraction to a simple fraction.

EXAMPLE. — Reduce $\dfrac{4\frac{2}{3}}{7\frac{5}{6}}$ to a simple fraction.

$$\frac{4\frac{2}{3}}{7\frac{5}{6}} = \frac{\frac{14}{3}}{\frac{47}{6}} = \frac{14}{3} \div \frac{47}{6} = \frac{14}{3} \times \frac{6}{47} = \frac{28}{47} \quad \textit{Ans.}$$

Change $4\frac{2}{3}$ and $7\frac{5}{6}$ to improper fractions, $\frac{14}{3}$ and $\frac{47}{6}$, respectively. Perform the division indicated with the aid of cancellation and the result will be $\frac{28}{47}$.

EXAMPLES

1. Divide $\frac{41}{64}$ by $\frac{1}{2}$.
2. Divide $\frac{7}{16}$ by $\frac{3}{4}$.
3. Divide $\frac{29}{32}$ by $\frac{1}{4}$.
4. Divide $\frac{7}{8}$ by $\frac{1}{4}$.
5. Divide $\frac{3}{4}$ by $\frac{5}{8}$.
6. $384\frac{3}{5} \div 5 = ?$
7. $296 \div 10\frac{1}{2} = ?$
8. $28{,}769 \div 7\frac{5}{8} = ?$
9. $\dfrac{7\frac{1}{9}}{\frac{16}{27}} = ?$
10. $\dfrac{\frac{1}{4} \text{ of } \frac{7}{8}}{\frac{2}{3} \times \frac{5}{6}} = ?$

REVIEW PROBLEMS IN FRACTIONS

1. Two and one half yards of cloth cost \$ 2.75. What is the price per yard?

2. An $8\frac{1}{2}$-qt. can of milk is bought from a farmer for 60 cents. What is the cost per quart?

3. I paid 56 cents for $\frac{3}{4}$ of a yard of lace. What was the price per yard?

4. A farmer's daughter sold a weekly supply of eggs for \$ 5.70. If she received $28\frac{1}{2}$ cents a dozen, how many dozen did she sell?

5. If a narrow piece of goods, $6\frac{1}{4}$ yd. long, is cut into pieces $6\frac{3}{4}$ inches long, how many pieces can be cut? How much remains? Allow $\frac{1}{4}$ in. for waste.

6. What is the cost of $18\frac{1}{2}$ pounds of crackers at $17\frac{1}{2}$ cents a pound?

7. A gallon (U. S. Standard capacity) contains 231 cubic inches.

a. Give number of cubic inches in $\frac{1}{2}$ gallon.
b. Give number of cubic inches in 1 quart.
c. Give number of cubic inches in 1 pint.
d. Give number of cubic inches in $\frac{1}{2}$ pint.

8. A woman earns \$ $2\frac{1}{2}$ a day. If she spends \$ $1\frac{3}{4}$, how much does she save? How many weeks (six full working days) will it take to save \$ 90?

9. I paid 56 cents for $\frac{3}{4}$ of a yard of lace. What was the price per yard?

10. A furniture dealer sold a table for \$ $14\frac{1}{2}$, a couch for \$ $45\frac{4}{5}$, a desk for \$ $11\frac{3}{4}$, and some chairs for \$ $27\frac{3}{10}$. Find the amount of his sales.

11. A woman had \$ 200. She lost $\frac{1}{5}$ of it, gave away $\frac{1}{2}$ the remainder, and spent \$ $20\frac{3}{4}$. How much had she left?

12. I gave \$ $16\frac{1}{2}$ for 33 yards of cloth. How much did one yard cost?

Drill in the Use of Fractions

Addition

1. $\frac{1}{2}+\frac{1}{2}=?$
2. $\frac{1}{2}+\frac{1}{4}=?$
3. $\frac{1}{2}+\frac{1}{8}=?$
4. $\frac{1}{2}+\frac{1}{16}=?$
5. $\frac{1}{2}+\frac{1}{12}=?$
6. $\frac{1}{2}+\frac{3}{8}=?$
7. $\frac{1}{4}+\frac{1}{12}=?$
8. $\frac{1}{4}+\frac{1}{4}=?$
9. $\frac{1}{4}+\frac{1}{8}=?$
10. $\frac{1}{4}+\frac{1}{16}=?$
11. $\frac{1}{4}+\frac{1}{3}=?$
12. $\frac{1}{4}+\frac{2}{3}=?$
13. $\frac{5}{8}+\frac{1}{2}=?$
14. $\frac{5}{8}+\frac{1}{4}=?$
15. $\frac{5}{8}+\frac{1}{8}=?$
16. $\frac{5}{8}+\frac{1}{16}=?$
17. $\frac{5}{8}+\frac{5}{12}=?$
18. $\frac{5}{8}+\frac{1}{12}=?$
19. $\frac{1}{8}+\frac{1}{12}=?$
20. $\frac{3}{8}+\frac{1}{4}=?$
21. $\frac{1}{8}+\frac{1}{8}=?$
22. $\frac{3}{8}+\frac{1}{16}=?$
23. $\frac{1}{8}+\frac{7}{12}=?$
24. $\frac{1}{8}+\frac{5}{12}=?$
25. $\frac{1}{16}+\frac{5}{12}=?$
26. $\frac{5}{16}+\frac{1}{4}=?$
27. $\frac{1}{16}+\frac{1}{8}=?$
28. $\frac{1}{16}+\frac{1}{16}=?$
29. $\frac{1}{16}+\frac{5}{6}=?$
30. $\frac{1}{16}+\frac{1}{3}=?$
31. $\frac{3}{4}+\frac{1}{2}=?$
32. $\frac{3}{4}+\frac{1}{4}=?$
33. $\frac{3}{4}+\frac{1}{8}=?$
34. $\frac{3}{4}+\frac{1}{16}=?$
35. $\frac{3}{4}+\frac{5}{12}=?$
36. $\frac{3}{4}+\frac{7}{12}=?$
37. $\frac{1}{32}+\frac{1}{2}=?$
38. $\frac{1}{32}+\frac{1}{4}=?$
39. $\frac{1}{32}+\frac{1}{8}=?$
40. $\frac{17}{18}+\frac{8}{9}-?$
41. $\frac{8}{9}+\frac{1}{8}=?$
42. $\frac{7}{8}+\frac{5}{12}=?$
43. $\frac{5}{12}+\frac{5}{6}=?$
44. $\frac{5}{6}+\frac{7}{12}=?$
45. $\frac{7}{12}+\frac{11}{12}=?$
46. $\frac{11}{12}+\frac{5}{18}=?$
47. $\frac{5}{18}+\frac{1}{18}=?$
48. $\frac{1}{9}+\frac{5}{18}=?$
49. $\frac{7}{8}+\frac{1}{2}=?$
50. $\frac{7}{8}+\frac{1}{4}=?$
51. $\frac{7}{8}+\frac{1}{8}=?$
52. $\frac{7}{8}+\frac{1}{16}=?$
53. $\frac{7}{8}+\frac{7}{12}=?$
54. $\frac{3}{8}+\frac{7}{12}=?$

Subtraction

1. $\frac{1}{2}-\frac{1}{2}=?$
2. $\frac{1}{2}-\frac{1}{4}=?$
3. $\frac{1}{2}-\frac{1}{8}=?$
4. $\frac{1}{2}-\frac{1}{16}=?$
5. $\frac{1}{2}-\frac{1}{32}=?$
6. $\frac{1}{2}-\frac{1}{64}=?$
7. $\frac{1}{2}-\frac{1}{40}=?$
8. $\frac{1}{4}-\frac{1}{4}=?$
9. $\frac{1}{4}-\frac{1}{8}=?$
10. $\frac{1}{4}-\frac{1}{16}=?$
11. $\frac{1}{4}-\frac{1}{32}=?$
12. $\frac{1}{4}-\frac{1}{64}=?$
13. $\frac{5}{8}-\frac{1}{2}=?$
14. $\frac{5}{8}-\frac{1}{4}=?$
15. $\frac{5}{8}-\frac{1}{8}=?$
16. $\frac{5}{8}-\frac{1}{16}=?$
17. $\frac{5}{8}-\frac{1}{32}=?$
18. $\frac{5}{8}-\frac{1}{64}=?$
19. $\frac{1}{2}-\frac{3}{8}=?$
20. $\frac{1}{4}-\frac{5}{32}=?$
21. $\frac{1}{8}-\frac{1}{8}=?$

22. $\frac{1}{8} - \frac{1}{16} = ?$
23. $\frac{1}{8} - \frac{1}{32} = ?$
24. $\frac{1}{8} - \frac{1}{64} = ?$
25. $\frac{1}{2} - \frac{3}{16} = ?$
26. $\frac{9}{64} - \frac{1}{16} = ?$
27. $\frac{15}{128} - \frac{1}{16} = ?$
28. $\frac{1}{16} - \frac{1}{16} = ?$
29. $\frac{1}{16} - \frac{1}{32} = ?$
30. $\frac{1}{16} - \frac{1}{64} = ?$
31. $\frac{3}{4} - \frac{1}{2} = ?$
32. $\frac{3}{4} - \frac{1}{4} = ?$
33. $\frac{3}{4} - \frac{1}{8} = ?$
34. $\frac{3}{4} - \frac{1}{16} = ?$
35. $\frac{3}{4} - \frac{1}{32} = ?$
36. $\frac{3}{4} - \frac{1}{64} = ?$
37. $\frac{11}{64} - \frac{1}{32} = ?$
38. $\frac{1}{4} - \frac{7}{32} = ?$
39. $\frac{17}{64} - \frac{1}{32} = ?$
40. $\frac{13}{64} - \frac{1}{32} = ?$
41. $\frac{1}{32} - \frac{1}{32} = ?$
42. $\frac{13}{32} - \frac{1}{64} = ?$
43. $\frac{1}{2} - \frac{15}{64} = ?$
44. $\frac{1}{4} - \frac{3}{64} = ?$
45. $\frac{5}{8} - \frac{1}{64} = ?$
46. $\frac{15}{16} - \frac{1}{64} = ?$
47. $\frac{1}{32} - \frac{1}{64} = ?$
48. $\frac{1}{64} - \frac{1}{64} = ?$
49. $\frac{7}{8} - \frac{1}{2} = ?$
50. $\frac{7}{8} - \frac{1}{4} = ?$
51. $\frac{7}{8} - \frac{1}{8} = ?$
52. $\frac{7}{8} - \frac{1}{16} = ?$
53. $\frac{7}{8} - \frac{1}{32} = ?$
54. $\frac{7}{8} - \frac{1}{64} = ?$

Multiplication

1. $\frac{1}{2} \times \frac{1}{2} = ?$
2. $\frac{1}{2} \times \frac{1}{4} = ?$
3. $\frac{1}{2} \times \frac{1}{8} = ?$
4. $\frac{1}{2} \times \frac{1}{16} = ?$
5. $\frac{1}{2} \times \frac{1}{32} = ?$
6. $\frac{1}{2} \times \frac{1}{64} = ?$
7. $\frac{1}{4} \times \frac{1}{2} = ?$
8. $\frac{1}{4} \times \frac{1}{4} = ?$
9. $\frac{1}{4} \times \frac{1}{8} = ?$
10. $\frac{1}{4} \times \frac{1}{16} = ?$
11. $\frac{1}{4} \times \frac{1}{32} = ?$
12. $\frac{1}{4} \times \frac{1}{64} = ?$
13. $\frac{5}{8} \times \frac{1}{2} = ?$
14. $\frac{5}{8} \times \frac{1}{4} = ?$
15. $\frac{5}{8} \times \frac{1}{8} = ?$
16. $\frac{5}{8} \times \frac{1}{16} = ?$
17. $\frac{5}{8} \times \frac{1}{32} = ?$
18. $\frac{5}{8} \times \frac{1}{64} = ?$
19. $\frac{1}{8} \times \frac{1}{2} = ?$
20. $\frac{1}{8} \times \frac{1}{4} = ?$
21. $\frac{1}{8} \times \frac{1}{8} = ?$
22. $\frac{1}{8} \times \frac{1}{16} = ?$
23. $\frac{1}{8} \times \frac{1}{32} = ?$
24. $\frac{1}{8} \times \frac{1}{64} = ?$
25. $\frac{1}{16} \times \frac{1}{2} = ?$
26. $\frac{1}{16} \times \frac{1}{4} = ?$
27. $\frac{1}{16} \times \frac{1}{8} = ?$
28. $\frac{1}{16} \times \frac{1}{16} = ?$
29. $\frac{1}{16} \times \frac{1}{32} = ?$
30. $\frac{1}{16} \times \frac{1}{64} = ?$
31. $\frac{3}{4} \times \frac{1}{2} = ?$
32. $\frac{3}{4} \times \frac{1}{4} = ?$
33. $\frac{3}{4} \times \frac{1}{8} = ?$
34. $\frac{3}{4} \times \frac{1}{16} = ?$
35. $\frac{3}{4} \times \frac{1}{32} = ?$
36. $\frac{3}{4} \times \frac{1}{64} = ?$
37. $\frac{1}{32} \times \frac{1}{2} = ?$
38. $\frac{1}{32} \times \frac{1}{4} = ?$
39. $\frac{1}{32} \times \frac{1}{8} = ?$
40. $\frac{1}{32} \times \frac{1}{16} = ?$
41. $\frac{1}{32} \times \frac{1}{32} = ?$
42. $\frac{1}{32} \times \frac{1}{64} = ?$
43. $\frac{1}{64} \times \frac{1}{2} = ?$
44. $\frac{1}{64} \times \frac{1}{4} = ?$
45. $\frac{1}{64} \times \frac{1}{8} = ?$
46. $\frac{1}{64} \times \frac{1}{16} = ?$
47. $\frac{1}{64} \times \frac{1}{32} = ?$
48. $\frac{1}{64} \times \frac{1}{64} = ?$
49. $\frac{7}{8} \times \frac{1}{2} = ?$
50. $\frac{7}{8} \times \frac{1}{4} = ?$
51. $\frac{7}{8} \times \frac{1}{8} = ?$
52. $\frac{7}{8} \times \frac{1}{16} = ?$
53. $\frac{7}{8} \times \frac{1}{32} = ?$
54. $\frac{7}{8} \times \frac{1}{64} = ?$

Division

1. $\frac{1}{2} \div \frac{1}{2} = ?$
2. $\frac{1}{2} \div \frac{1}{4} = ?$
3. $\frac{1}{2} \div \frac{1}{8} = ?$
4. $\frac{1}{2} \div \frac{1}{16} = ?$
5. $\frac{1}{2} \div \frac{1}{32} = ?$
6. $\frac{1}{2} \div \frac{1}{64} = ?$
7. $\frac{1}{4} \div \frac{1}{2} = ?$
8. $\frac{1}{4} \div \frac{1}{4} = ?$
9. $\frac{1}{4} \div \frac{1}{8} = ?$
10. $\frac{1}{4} \div \frac{1}{16} = ?$
11. $\frac{1}{4} \div \frac{1}{32} = ?$
12. $\frac{1}{4} \div \frac{1}{64} = ?$
13. $\frac{5}{8} \div \frac{1}{2} = ?$
14. $\frac{5}{8} \div \frac{1}{4} = ?$
15. $\frac{5}{8} \div \frac{1}{8} = ?$
16. $\frac{5}{8} \div \frac{1}{16} = ?$
17. $\frac{5}{8} \div \frac{1}{32} = ?$
18. $\frac{5}{8} \div \frac{1}{64} = ?$
19. $\frac{1}{8} \div \frac{1}{2} = ?$
20. $\frac{1}{8} \div \frac{1}{4} = ?$
21. $\frac{1}{8} \div \frac{1}{8} = ?$
22. $\frac{1}{8} \div \frac{1}{16} = ?$
23. $\frac{1}{8} \div \frac{1}{32} = ?$
24. $\frac{1}{8} \div \frac{1}{64} = ?$
25. $\frac{1}{16} \div \frac{1}{2} = ?$
26. $\frac{1}{16} \div \frac{1}{4} = ?$
27. $\frac{1}{16} \div \frac{1}{8} = ?$
28. $\frac{1}{16} \div \frac{1}{16} = ?$
29. $\frac{1}{16} \div \frac{1}{32} = ?$
30. $\frac{1}{16} \div \frac{1}{64} = ?$
31. $\frac{3}{4} \div \frac{1}{2} = ?$
32. $\frac{3}{4} \div \frac{1}{4} = ?$
33. $\frac{3}{4} \div \frac{1}{8} = ?$
34. $\frac{3}{4} \div \frac{1}{16} = ?$
35. $\frac{3}{4} \div \frac{1}{32} = ?$
36. $\frac{3}{4} \div \frac{1}{64} = ?$
37. $\frac{1}{32} \div \frac{1}{2} = ?$
38. $\frac{1}{32} \div \frac{1}{4} = ?$
39. $\frac{1}{32} \div \frac{1}{8} = ?$
40. $\frac{1}{32} \div \frac{1}{16} = ?$
41. $\frac{1}{32} \div \frac{1}{32} = ?$
42. $\frac{1}{32} \div \frac{1}{64} = ?$
43. $\frac{1}{64} \div \frac{1}{2} = ?$
44. $\frac{1}{64} \div \frac{1}{4} = ?$
45. $\frac{1}{64} \div \frac{1}{8} = ?$
46. $\frac{1}{64} \div \frac{1}{16} = ?$
47. $\frac{1}{64} \div \frac{1}{32} = ?$
48. $\frac{1}{64} \div \frac{1}{64} = ?$
49. $\frac{7}{8} \div \frac{1}{2} = ?$
50. $\frac{7}{8} \div \frac{1}{4} = ?$
51. $\frac{7}{8} \div \frac{1}{8} = ?$
52. $\frac{7}{8} \div \frac{1}{16} = ?$
53. $\frac{7}{8} \div \frac{1}{32} = ?$
54. $\frac{7}{8} \div \frac{1}{64} = ?$

Decimal Fractions

A **power** is the product of equal factors, as $10 \times 10 = 100$. $10 \times 10 \times 10 = 1000$. 100 is the second power of 10. 1000 is the third power of 10.

A **decimal fraction** or **decimal** is a fraction whose denominator is 10 or a power of 10. A common fraction may have any number for its denominator, but a decimal fraction must always have for its denominator 10, or a power of 10. A decimal is written at the right of a period (.), called the decimal point. A figure at the right of a decimal point is called a decimal figure.

$\frac{5}{10} = .5$; $\frac{25}{100} = .25$; $\frac{7}{100} = .07$; $\frac{16}{1000} = .016$.

A **mixed decimal** is an integer and a decimal; as, 16.04.

To *read* a decimal, read the decimal as an integer, and give it the denomination of the right-hand figure. To *write* a decimal, write the numerator, prefixing ciphers when necessary to express the denominator, and place the point at the left. There must be as many decimal places in the decimal as there are ciphers in the denominator.

EXAMPLES

Read the following numbers:

1. .7	**7.** .4375	**13.** .0000054	**19.** 9.999999
2. .07	**8.** .03125	**14.** 35.18006	**20.** .10016
3. .007	**9.** .21875	**15.** .0005	**21.** .000155
4. .700	**10.** .90625	**16.** 100.000104	**22.** .26
5. .125	**11.** .203125	**17.** 9.1632002	**23.** .1
6. .0625	**12.** .234375	**18.** 30.3303303	**24.** .80062

Express decimally:

1. Four tenths.

2. Three hundred twenty-five thousandths.

3. Seventeen thousand two hundred eleven hundred-thousandths.

4. Seventeen hundredths.

5. Fifteen thousandths.

6. Five hundredths.

7. Six ten-thousandths.

8. Eighteen and two hundred sixteen hundred-thousandths.

9. One hundred twelve hundred-thousandths.

10. 10 millionths.

11. 824 ten-thousandths.

12. Twenty-nine hundredths.

13. 324 and one hundred twenty-six millionths.

14. 7846 hundred-millionths.

15. $\frac{15}{100}$, $\frac{289}{100000}$, $\frac{1}{1000000}$, $\frac{1000}{1000}$, $15\frac{5}{1000}$, $500\frac{5}{10}$.

16. $\frac{563}{100000000}$, $\frac{1}{100}$, $\frac{2123}{10000}$, $\frac{3}{10}$, $\frac{28654}{1000000}$.

17. One and one tenth.

18. One and one hundred-thousandth.

19. One thousand four and twenty-nine hundredths.

Reduction of Decimals

Ciphers *annexed* to a decimal do not change the value of the decimal; these ciphers are called decimal ciphers. For each cipher *prefixed* to a decimal, the value is diminished tenfold. The denominator of a decimal — when expressed — is always 1 with as many ciphers as there are decimal places in the decimal.

To reduce a decimal to a common fraction.

Write the numerator of the decimal omitting the point for the numerator of the fraction. For the denominator write 1 with as many ciphers annexed as there are decimal places in the decimal. Then reduce to lowest terms.

EXAMPLE. — Reduce .25 and .125 to common fractions.

$$.25 = \frac{25}{100} = \frac{\overset{1}{\cancel{25}}}{\underset{4}{\cancel{100}}} = \frac{1}{4} \quad \textit{Ans.}$$

Write 25 for the numerator and 1 for the denominator with two 0's, which makes $\frac{25}{100}$; $\frac{25}{100}$ reduced to lowest terms is $\frac{1}{4}$.

$$.125 = \frac{125}{1000} = \frac{\overset{1}{\cancel{125}}}{\underset{8}{\cancel{1000}}} = \frac{1}{8} \quad \textit{Ans.}$$

.125 is reduced to a common fraction in the same way.

EXAMPLE. — Reduce $.37\frac{1}{2}$ to a common fraction.

$$\frac{37\frac{1}{2}}{100} = \frac{\frac{75}{2}}{100} = \frac{\overset{3}{\cancel{75}}}{2} \times \frac{1}{\underset{4}{\cancel{100}}} = \frac{3}{8} \quad \textit{Ans.}$$

$37\frac{1}{2}$ has for its denominator 1 with 00, which equals $\frac{37\frac{1}{2}}{100}$.

This is a complex fraction which reduced to lowest terms is $\frac{3}{8}$.

EXAMPLES

Reduce to common fractions:

1. .09375	**6.** 2.25	**11.** $.16\frac{2}{3}$	**16.** $.87\frac{1}{2}$
2. .15625	**7.** 16.144	**12.** $.33\frac{1}{3}$	**17.** $.66\frac{2}{3}$
3. .015625	**8.** 25.0000100	**13.** $.06\frac{1}{4}$	**18.** $.36\frac{7}{8}$
4. .609375	**9.** 1084.0025	**14.** .140625	**19.** $.83\frac{1}{3}$
5. .578125	**10.** $.12\frac{1}{2}$	**15.** .984375	**20.** $.62\frac{1}{2}$

To reduce a common fraction to a decimal.

Annex decimal ciphers to the numerator and divide by the denominator. Point off from the right of the quotient as many places as there are ciphers annexed. If there are not figures enough in the quotient, prefix ciphers.

The division will not always be exact, *i.e.* $\frac{1}{7} = .142\frac{6}{7}$ or $.142^+$.

EXAMPLE. — Reduce $\frac{3}{4}$ to a decimal.

$$\begin{array}{r} .75 \\ 4\overline{)3.00} \\ \underline{28} \\ 20 \end{array}$$

$$\tfrac{3}{4} = .75$$

EXAMPLES

Reduce to decimals:

1. $\frac{1}{20}$	**6.** $\frac{7}{8}$	**11.** $\frac{1}{80}$	**16.** $\frac{31}{64}$	**21.** $\frac{1}{200}$
2. $\frac{1}{150}$	**7.** $\frac{11}{16}$	**12.** $\frac{1}{250}$	**17.** $16\frac{1}{4}$	**22.** $25.12\frac{1}{2}$
3. $\frac{1}{380}$	**8.** $\frac{15}{32}$	**13.** $\frac{1}{1250}$	**18.** $66\frac{2}{3}$	**23.** $33\frac{1}{3}$
4. $\frac{1}{8}$	**9.** $\frac{7}{32}$	**14.** $12\frac{1}{2}$	**19.** $\frac{15}{20}$	**24.** $\frac{7}{24}$
5. $\frac{3}{4}$	**10.** $\frac{1}{750}$	**15.** $\frac{6}{11}$	**20.** $\frac{5}{9}$	**25.** $\frac{1}{128}$

Addition of Decimals

To add decimals, write them so that their decimal points are in a column. Add as in integers, and place the point in the sum directly under the points above it.

EXAMPLE. — Find the sum of 3.87, 2.0983, 5.00831, .029, .831.

3.87	Place these numbers, one under the other, with decimal points in a column, and add as in addition of integers. The sum of these numbers should have the decimal point in the same column as the numbers that were added.
2.0983	
5.00831	
.029	
.831	
11.83661 *Ans.*	

EXAMPLES

Find the sum:

1. 5.83, 7.016, 15.0081, and 18.3184.
2. 12.031, 0.0894, 12.0084, and 13.984.
3. .0765, .002478, .004967, .0007862, .17896.
4. 24.36, 1.358, .004, and 1632.1.
5. .175, 1.75, 17.5, 175., 1750.
6. 1., .1, .01, .001, 100, 10., 10.1, 100.001.
7. Add 5 tenths; 8063 millionths; 25 hundred-thousandths; 48 thousandths; 17 millionths; 95 ten-millionths; 5, and 5 hundred-thousandths; 17 ten-thousandths.
8. Add $24\frac{3}{4}$, $17\frac{1}{4}$, .0058, $7\frac{1}{8}$, $9\frac{1}{16}$.
9. 32.58, 28963.1, 287.531, 76398.9341.
10. 145., 14.5, 1.45, .145, .0145.

Subtraction of Decimals

To subtract decimals, write the smaller number under the larger with the decimal point of the subtrahend directly under the decimal point of the minuend. Subtract as in integers, and place the point directly under the points above.

EXAMPLE. — Subtract 2.17857 from 4.3257.

4.32570 *Minuend*	Write the lesser number under the greater, with the decimal points under each other. Add a 0 to the minuend, 4.3257, to give it the same denominator as the subtrahend. Then subtract as in subtraction of integers. Write the remainder with decimal point under the other two points.
2.17857 *Subtrahend*	
2.14713 *Remainder*	

EXAMPLES

Subtract:

1. $59.0364 - 30.8691 = ?$
2. $48.7209 - 12.0039 = ?$
3. $.0625 - .03125 = ?$
4. $.00011 - .000011 = ?$
5. $10 - .1 + .0001 = ?$
6. From one thousand take five thousandths.
7. Take 17 hundred-thousandths from 1.2.
8. From $17.37\frac{1}{2}$ take $14.16\frac{1}{8}$.
9. Prove that $\frac{1}{2}$ and .500 are equal.
10. Find the difference between $\frac{384}{1000}$ and $\frac{384}{10000}$.

Multiplication of Decimals

To multiply decimals proceed as in integers, and give to the product as many decimal figures as there are in both multiplier and multiplicand. When there are not figures enough in the product, prefix ciphers.

Example. — Find the product of 6.8 and .63.

6.8	*Multiplicand*
.63	*Multiplier*
204	
408	
4.284	*Product*

6.8 is the multiplicand and .63 the multiplier. Their product is 4.284 with three decimal figures, the number of decimal figures in the multiplier and multiplicand.

Example. — Find the product of .05 and .3.

.05	*Multiplicand*
.3	*Multiplier*
.015	*Product*

The product of .05 and .3 is .015 with a cipher prefixed to make the three decimal figures required in the product.

EXAMPLES

Find the products:

1. $46.25 \times .125$
2. $8.0625 \times .1875$
3. $.015 \times .05$
4. $25.863 \times 4\frac{1}{3}$

5. 11.11×100
6. $.5625 \times 6.28125$
7. $.326 \times 2.78$
8. $.325 \times 12\frac{1}{2}$
9. $.001542 \times .0052$
10. 1.001×1.01

To multiply by 10, 100, 1000, *etc., remove the point one place to the right for each cipher in the multiplier.*

This can be performed without writing the multiplier.

EXAMPLE. — Multiply 1.625 by 100.

$$1.625 \times 100 = 162.5$$

To multiply by 200, *remove the point to the right and multiply by* 2.

EXAMPLE. — Multiply 86.44 by 200.

$$\begin{array}{r} 86.44. \\ 2 \\ \hline 17{,}288 \end{array}$$

EXAMPLES

Find the product of:

1. 1 thousand by one thousandth.
2. 1 million by one millionth.
3. 700 thousands by 7 hundred-thousandths.
4. 3.894×3000
5. $1.892 \times 2000.$

Division of Decimals

To divide decimals proceed as in integers, and give to the quotient as many decimal figures as the number in the dividend exceeds those in the divisor.

EXAMPLE. — Divide 12.685 by .5.

$$\begin{array}{rl} \textit{Divisor}\ .5\overline{)12.685} & \textit{Dividend} \\ 25.37 & \textit{Quotient} \end{array}$$

The number of decimal figures in the quotient, 12.685, exceeds the number of decimal figures in the divisor, .5, by two. So there must be two decimal figures in the quotient.

EXAMPLE. — Divide 399.552 by 192.

2.081 *Quotient*
Divisor 192)399.552 *Dividend*
384
1555
1536
192
192

When the divisor is an integer, the point in the quotient should be placed directly over the point in the dividend, and the division performed as in integers. This may be proved by multiplying divisor by quotient, which would give the dividend.

EXAMPLE. — Divide 28.78884 by 1.25.

23.031+ *Quotient*
Divisor 1.25.)28.78.884 *Dividend*
250
378
375
388
375
134
125
9 *Remainder*

When the divisor contains decimal figures, move the point in both divisor and dividend as many places to the right as there are decimal places in the divisor, which is equivalent to multiplying both divisor and dividend by the same number and does not change the quotient. Then place the point in the quotient as if the divisor were an integer. In this example, the multiplier of both dividend and divisor is 100.

EXAMPLES

Find the quotients:

1. $.0625 \div .125$
2. $315.432 \div .132$
3. $.75 \div .0125$
4. $125 \div 12\frac{1}{2}$
5. $1000 \div .001$
6. $2.496 \div .136$
7. $28000 \div 16.8$
8. $1.225 \div 4.9$
9. $3.1416 \div 27$
10. $8.33 \div 5$

To divide by 10, 100, 1000, *etc., remove the point one place to the left for each cipher in the divisor.*

To divide by 200, *remove the point two places to the left, and divide by* 2.

EXAMPLES

Find the quotients:

1. $38.64 \div 10$
2. $398.42 \div 1000$
3. $1684.32 \div 1000$
4. $1.155 \div 100$
5. $386.54 \div 2000$
6. $865.45 \div 5000$
7. $38.28 \div 400$
8. $2.5 \div 500$
9. $.5 \div 10$
10. $.001 \div 1000$

REVIEW EXAMPLES

1. Add 28.03, .1674, .08309, 7.00091, .1895.
2. Subtract 1.00894 from 13.0194.
3. Multiply 83.74×3.1416.
4. Divide 3.1416 by 8.5.
5. Perform the following calculations: $.7854 \times 35 \times 7.5$.
6. Perform the following calculations:

$$\frac{65.3 \times 3.1416 \times .7854}{600 \times 3.5 \times 8.3}.$$

7. Change the following fractions to decimals:

(*a*) $\frac{1}{20}$, (*b*) $\frac{1}{40}$, (*c*) $\frac{1}{60}$, (*d*) $\frac{1}{120}$, (*e*) $\frac{1}{12}$, (*f*) $\frac{1}{18}$, (*g*) $\frac{1}{24}$.

8. Change the following decimals to common fractions:

(*a*) $.33\frac{1}{3}$, (*b*) .25, (*c*) .125, (*d*) .375, (*e*) $.437\frac{1}{2}$, (*f*) .875.

Parts of 100 or 1000

1. What part of 100 is $12\frac{1}{2}$? 25? $33\frac{1}{3}$?
2. What part of 1000 is 125? 250? $333\frac{1}{3}$?
3. How much is $\frac{1}{5}$ of 100? Of 1000?
4. How much is $\frac{1}{4}$ of 100? Of 1000?
5. What is $\frac{1}{3}$ of 100? Of 1000?

EXAMPLE. — How much is 25 times 24?

100 times 24 = 2400.
25 times 24 = $\frac{1}{4}$ as much as 100 times 24 = 600. *Ans.*

Short Method of Multiplication

To multiply by

25, multiply by 100 and divide by 4;
$33\frac{1}{3}$, multiply by 100 and divide by 3;
$16\frac{2}{3}$, multiply by 100 and divide by 6;
$12\frac{1}{2}$, multiply by 100 and divide by 8;
9, multiply by 10 and subtract the multiplicand;
11, if more than two figures, multiply by 10 and add the multiplicand to the product;
11, if two figures, place the figure that is their sum between them.

$$63 \times 11 = 693 \qquad 74 \times 11 = 814$$

Note that when the sum of the two figures exceeds nine, the one in the tens place is carried to the figure at the left.

EXAMPLES

Multiply by the short process:

1. 81 by 11 = ?
2. 75 by $33\frac{1}{3}$ = ?
3. 128 by $12\frac{1}{2}$ = ?
4. 87 by 11 = ?
5. 19 by 9 = ?
6. 846 by 11 = ?
7. 88 by 11 = ?
8. 19 by 11 = ?
9. 846 by $16\frac{2}{3}$ = ?
10. 68 by $16\frac{2}{3}$ = ?
11. 112 by 11 = ?
12. 37 by 11 = ?
13. 4183 by 11 = ?
14. 364 by $33\frac{1}{3}$ = ?
15. 8712 by $12\frac{1}{2}$ = ?
16. 984 by $16\frac{2}{3}$ = ?
17. 36 by 25 = ?
18. 30 by $333\frac{1}{3}$ = ?

Aliquot Parts of $1.00

The **aliquot parts** of a number are the numbers that are exactly contained in it. The aliquot parts of 100 are 5, 20, $12\frac{1}{2}$, $16\frac{2}{3}$, $33\frac{1}{3}$, etc.

The monetary unit of the United States is the dollar, containing one hundred cents, which are written decimally.

$6\frac{1}{4}$ cents = $\$\frac{1}{16}$	25 cents = $\$\frac{1}{4}$ = quarter dollar
$8\frac{1}{3}$ cents = $\$\frac{1}{12}$	$33\frac{1}{3}$ cents = $\$\frac{1}{3}$
$12\frac{1}{2}$ cents = $\$\frac{1}{8}$	50 cents = $\$\frac{1}{2}$ = half dollar
$16\frac{2}{3}$ cents = $\$\frac{1}{6}$	

10 mills	= 1 cent, ct.	= \$ .01 or \$ 0.01
5 cents	= 1 "nickel"	= \$ .05
10 cents	= 1 dime, *d.*	= \$ .10
10 dimes	= 1 dollar, \$	= \$ 1.00
10 dollars	= 1 eagle, E.	= \$ 10.00

EXAMPLE. — What will 69 pairs of stockings cost at $16\frac{2}{3}$ cents a pair?

69 pairs will cost $69 \times 16\frac{2}{3}$ cts., or $69 \times \$\frac{1}{6} = \frac{69}{6} = \$11\frac{3}{6} = \$11.50$.

EXAMPLE. — At 25¢ a peck, how many pecks of potatoes can be bought for \$ 8.00?

$8 \div \frac{1}{4} = 8 \times \frac{4}{1} = 32$ pecks. *Ans.*

Review of Decimals

1. For work on a job one woman receives \$ 13.75, a second woman \$ 12.45, a third woman \$ 14.21, and a fourth woman \$ 21.85. What is the total amount paid for the work?

2. A pipe has an inside diameter of 3.067 inches and an outside diameter of 3.428 inches. What is the thickness of the metal of the pipe?

3. At $4\frac{1}{2}$ cts. a pound, what will be the cost of 108 boxes of salt each weighing 29 lb.?

4. A dressmaker receives \$ 121.50 for doing a piece of work. She gives \$ 12.25 to one of her helpers and \$ 10.50 to another. She also pays \$ 75.75 for material. How much does she make on the job?

5. An automobile runs at the rate of $9\frac{1}{2}$ miles an hour. How long will it take it to go from Lowell to Boston, a distance of 26.51 miles?

6. A man uses a gallon of gasoline in traveling 16 miles. If a gallon costs 23 cents, what is the cost of fuel per mile?

7. Which is cheaper, and how much, to have a $13\frac{1}{2}$ cents an hour woman take $13\frac{1}{4}$ hours on a piece of work, or hire a $17\frac{1}{2}$ cents an hour woman who can do it in $9\frac{1}{2}$ hours?

8. On Monday 1725.25 lb. of coal are used, on Tuesday 2134.43 lb., on Wednesday 1651.21 lb., on Thursday 1821.42 lb., on Friday 1958.82 lb., and on Saturday 658.32 lb. How many pounds of coal are used during the week?

9. If, in the example above, there were 10,433.91 lb. of coal on hand at the beginning of the week, how much was left at the end of the week?

10. The distance traveled in an automobile is measured by an instrument called a speedometer. A man travels in a week the following distances: 87.5 mi., 49.75 mi., 112.60 mi., 89.7 mi., 119.3 mi., and 93.75 mi. What is the total distance traveled?

11. An English piece of currency corresponding to our five-dollar bill is called a pound sterling and is worth \$4.866$\frac{1}{2}$. How much more is a five-dollar bill than a pound?

12. An alloy is made of copper and zinc. If .66 is copper and .34 is zinc, how many pounds of zinc and how many pounds of copper will there be in a casting of the alloy weighing 98 lb.?

13. A train leaves New York at 2.10 P.M. and arrives in Philadelphia at 4.15 P.M. The distance is 90 miles. What is the average rate per hour of the train?

14. The weight of a foot of $\frac{9}{16}''$ steel bar is 1.08 lb. Find the weight of a 21-foot bar.

15. A steam pump pumps 3.38 gallons of water to each stroke and the pump makes 51.1 strokes per minute. How many gallons of water will it pump in an hour?

16. At $12\frac{1}{2}$ cents per hour, what will be the pay for $23\frac{1}{2}$ days if the days are 10 hours each?

Compound Numbers

A number composed of different kinds of concrete units that are related is a **compound number**: as, 3 bu. 2 pk. 1 qt.

A **denomination** is a name given to a unit of measure or of weight. A number having one or more denominations is also called a **denominate number.**

Reduction is the process of changing a number from one denomination to another without changing its value.

Changing to a lower denomination is called **reduction descending**: as, 2 bu. 3 pk. = 88 qt. Changing to a higher denomination is called **reduction ascending**; as, 88 qt. = 2 bu. 3 pk.

Linear Measure is used in measuring lines or distance

Table

12 inches (in.)	= 1 foot, ft.
3 feet	= 1 yard, yd.
$5\frac{1}{2}$ yards, or $16\frac{1}{2}$ feet	= 1 rod, rd.
320 rods, or 5280 feet	= 1 mile, mi.

1 mi. = 320 rd. = 1760 yd. = 5280 ft. = 63,360 in.

Square Measure is used in measuring surfaces.

Table

144 square inches	= 1 square foot, sq. ft.
9 square feet	= 1 square yard, sq. yd.
$30\frac{1}{4}$ square yards $272\frac{1}{4}$ square feet	= 1 square rod, sq. rd.
160 square rods	= 1 acre, A.
640 acres	= 1 square mile, sq. mi.

1 sq. mi. = 640 A. = 102,400 sq. rd. = 3,097,600 sq. yd.

Cubic Measure is used in measuring volumes or solids.

Table

1728 cubic inches	= 1 cubic foot, cu. ft.
27 cubic feet	= 1 cubic yard, cu. yd.
16 cubic feet	= 1 cord foot, cd. ft.
8 cord feet, or 128 cu. ft.	= 1 cord, cd.

1 cu. yd. = 27 cu. ft. = 46,656 cu. in.

Liquid Measure is used in measuring liquids.

Table

4 gills (gi.)	= 1 pint, pt.
2 pints	= 1 quart, qt.
4 quarts	= 1 gallon, gal.

1 gal. = 4 qt. = 8 pt. = 32 gi.

A gallon contains 231 cubic inches.

The standard barrel is $31\frac{1}{2}$ gal., and the hogshead 63 gal.

Dry Measure is used in measuring roots, grain, vegetables, etc.

Table

2 pints	= 1 quart, qt.
8 quarts	= 1 peck, pk.
4 pecks	= 1 bushel, bu.

1 bu. = 4 pk. = 32 qt. = 64 pints.

The bushel contains 2150.42 cubic inches; 1 dry quart contains 67.2 cu. in. A cubic foot is $\frac{45}{56}$ of a bushel.

Avoirdupois Weight is used in weighing all common articles; as, coal, groceries, hay, etc.

Table

16 ounces (oz.)	= 1 pound, lb.
100 pounds	= 1 hundredweight, cwt.; or cental, ctl.
20 cwt., or 2000 lb.	= 1 ton, T.

1 T. = 20 cwt. = 2000 lb. = 32,000 oz.

The *long ton* of 2240 pounds is used at the United States Custom House and in weighing coal at the mines.

Measure of Time.

Table

60 seconds (sec.)	= 1 minute, min.
60 minutes	= 1 hour, hr.
24 hours	= 1 day, da.
7 days	= 1 week, wk.
365 days	= 1 year, yr.
366 days	= 1 leap year.
100 years	= 1 century.

Counting.

Table

12 things = 1 dozen, doz.
12 dozen = 1 gross, gr.
12 gross = 1 great gross, G. gr.

Paper Measure.

Table

24 sheets = 1 quire	2 reams = 1 bundle
20 quires = 1 ream	5 bundles = 1 bale

Reduction Descending

EXAMPLE. — Reduce 17 yd. 2 ft. 9 in. to inches.

$$
\begin{aligned}
1 \text{ yd.} &= 3 \text{ ft.} \\
17 \text{ yd.} &= 17 \times 3 = 51 \text{ ft.} \\
51 + 2 &= 53 \text{ ft.} \\
1 \text{ ft.} &= 12 \text{ in.} \\
53 \text{ ft.} &= 53 \times 12 = 636 \text{ in.} \\
636 + 9 &= 645 \text{ in.} \quad \textit{Ans.}
\end{aligned}
$$

EXAMPLES

Reduce to lower denominations:

1. 46 rd. 4 yd. 2 ft. to feet.
2. 4 A. 15 sq. rd. 4 sq. ft. to square inches.
3. 16 cu. yd. 25 cu. ft. 900 cu. in. to cubic inches.
4. 15 gal. 3 qt. 1 pt. to pints.
5. 27 da. 18 hr. 49 min. to seconds.

Reduction Ascending

EXAMPLE. — Reduce 1306 gills to higher denominations.

4)1306 gi.
2)326 pt. + 2 gi.
4)163 qt.
40 gal. + 3 qt.
40 gal. 3 qt. 2 gi. *Ans.*

Since in 1 pt. there are 4 gi., in 1306 gi. there are as many pints as 4 gi. are contained times in 1306 gi., or 326 pt. and 2 gi. remainder.

In the same way the quarts and gallons are found. So there are in 1306 gi., 40 gal. 3 qt. 2 gi.

EXAMPLES

Reduce to higher denominations:

1. Reduce 225,932 in. to miles, etc.

2. Change 1384 dry pints to higher denominations.

3. In 139,843 sq. in. how many square miles, rods, etc.?

4. How many cords of wood in 3692 cu. ft.?

5. How many bales in 24,000 sheets of paper?

A **denominate fraction** is a fraction of a unit of weight or measure.

To reduce denominate fractions to integers of lower denominations.

Change the fraction to the next lower denomination. Treat the fractional part of the product in the same way, and so proceed to the required denomination.

Example. — Reduce $\frac{5}{7}$ of a mile to rods, yards, feet, etc.

$\frac{5}{7}$ of 320 rd. $= \frac{1600}{7}$ rd. $= 228\frac{4}{7}$ rd.
$\frac{4}{7}$ of $\frac{11}{2}$ yd. $= \frac{44}{14}$ yd. $= 3\frac{1}{7}$ yd.
$\frac{1}{7}$ of 3 ft. $= 0\frac{3}{7}$ ft.
$\frac{3}{7}$ of 12 in. $= \frac{36}{7}$ in. $= 5\frac{1}{7}$ in.
$\frac{5}{7}$ of a mile $= 228$ rd. 3 yd. 0 ft. $5\frac{1}{7}$ in.

The same process applies to denominate decimals.

To reduce denominate decimals to denominate numbers.

Example. — Reduce .87 bu. to pecks, quarts, etc.

$$\begin{array}{r} .87 \text{ bu.} \\ 4 \\ \hline 3.48 \text{ pk.} \end{array} \qquad \begin{array}{r} .48 \text{ pk.} \\ 8 \\ \hline 3.84 \text{ qt.} \end{array} \qquad \begin{array}{r} .84 \text{ qt.} \\ 2 \\ \hline 1.68 \text{ pt.} \end{array}$$

3 pk. 3 qt. 1.68 pt. *Ans.*

Change the decimal fraction to the next lower denomination. Treat the decimal part of the product in the same way, and so proceed to the required denomination.

EXAMPLES

Reduce to integers of lower denominations:

1. $\frac{5}{6}$ of an acre.
2. .3125 of a gallon.
3. $\frac{3}{7}$ of a ton.
4. .51625 of a mile.
5. Change $\frac{3}{7}$ of a year to months and days.
6. .2364 of a ton.
7. What is the value of $\frac{1}{8}$ of $1\frac{1}{3}$ of a mile?
8. Reduce $\frac{34}{50}$ bu. to integers of lower denominations.
9. .375 of a month.
10. $\frac{9}{14}$ acre are equal to how many square rods, etc.?

Addition of Compound Numbers

EXAMPLE. — Find the sum of 7 hr. 30 min. 45 sec., 12 hr. 25 min. 30 sec., 20 hr. 15 min. 33 sec., 10 hr. 27 min. 46 sec.

hr.	min.	sec.
7	30	45
12	25	30
20	15	33
10	27	46
50	39	34

50 hr. 39 min. 34 sec. *Ans.*

The sum of the seconds = 154 sec. = 2 min. 34 sec. Write the 34 sec. under the sec. column and add the 2 min. to the min. column. Add the other columns in the same way.

Subtraction of Compound Numbers

EXAMPLE. — From 39 gal. 2 qt. 2 pt. 1 gi. take 16 gal. 2 qt. 3 pt. 3 gi.

gal.	qt.	pt.	gi.
39	2	2	1
16	2	3	3
22	3	0	2

22 gal. 3 qt. 2 gi. *Ans.*

As 3 gi. cannot be taken from 1 gi., 4 gi. or 1 pt. are borrowed from the pt. column and added to the 1 gi. Subtract 3 gi. from the 5 gi. and the remainder is 2 gi. Continue in the same way until all are subtracted. Then the remainder is 22 gal. 3 qt. 0 pt. 2 gi.

Multiplication of Compound Numbers

EXAMPLE. — Multiply 4 yd. 2 ft. 8 in. by 8.

yd.	ft.	in.
4	2	8
		8
39	0	4

39 yd. 4 in. *Ans.*

8 times 8 in. = 64 in. = 5 ft. 4 in. Place the 4 in. under the in. column, and add the 5 ft. to the product of 2 ft. by 8, which equals 21 ft. = 7 yd. Add 7 yd. to the product of 4 yd. by 8 = 39 yd.

Division of Compound Numbers

EXAMPLE. — Find $\frac{1}{35}$ of 42 rd. 4 yd. 2 ft. 8 in.

$$
\begin{array}{l}
\quad\;\text{rd.}\quad \text{yd.}\quad \text{ft.}\quad \text{in.}\\
35)42\quad 4\quad 2\quad 8(1 \text{ rd.}\\
\quad\;\underline{35}\\
\quad\;\;7\\
\quad\;\;\underline{5\tfrac{1}{2}}\\
\quad\;\;3\tfrac{1}{2}\\
\quad\;\underline{35\;\;}\\
\quad\;38\tfrac{1}{2}\\
\quad\;\underline{+\,4}\\
35)42\tfrac{1}{2} \text{ yd. } (1 \text{ yd.}\\
\quad\;\underline{35\;\;}\\
\quad\;\;7\tfrac{1}{2}\\
\quad\;\;\underline{3}\\
\quad\;22\tfrac{1}{2} \text{ ft.}\\
\quad\;\underline{12}
\end{array}
\qquad
\begin{array}{l}
35)24\tfrac{1}{2}(0 \text{ ft.}\\
\quad\;\;\underline{12}\\
\quad\;294\\
\quad\;\underline{+\,8}\\
35)302(8\tfrac{22}{35} \text{ in.}\\
\quad\;\underline{280}\\
\quad\;\;\;22
\end{array}
$$

1 rd. 1 yd. $8\frac{22}{35}$ in. *Ans.*

$\frac{1}{35}$ of 42 rd. = 1 rd.; remainder, 7 rd. = $38\frac{1}{2}$ yd.; add 4 yd. = $42\frac{1}{2}$ yd. $\frac{1}{35}$ of $42\frac{1}{2}$ yd. = 1 yd.; remainder, $7\frac{1}{2}$ yd., = $22\frac{1}{2}$ ft. = $24\frac{1}{2}$ ft. $\frac{1}{35}$ of $24\frac{1}{2}$ ft. = 0 ft. $24\frac{1}{2}$ ft. = 294 in.; add 8 in. = 302 in. $\frac{1}{35}$ of 302 in. = $8\frac{22}{35}$ in.

Difference between Dates

EXAMPLE. — Find the time from Jan. 25, 1842, to July 4, 1896.

1896	7	4	
1842	1	25	
54 yr.	5 mo.	9 da.	*Ans.*

It is customary to consider 30 days to a month. July 4, 1896, is the 1896th yr., 7th mo., 4th da., and Jan. 25, 1842, is the 1842d yr., 1st. mo., 25th da. Subtract, taking 30 da. for a month.

Example. — What is the exact number of days between Dec. 16, 1895, and March 12, 1896?

Dec.	15
Jan.	31
Feb.	29
Mar.	12
	87 days. *Ans.*

Do not count the first day mentioned. There are 15 days in December, after the 16th. January has 31 days, February 29 (leap year), and 12 days in March; making 87 days.

EXAMPLES

1. How much time elapsed from the landing of the Pilgrims, Dec. 11, 1620, to the Declaration of Independence, July 4, 1776?

2. Washington was born Feb. 22, 1732, and died Dec. 14, 1799. How long did he live?

3. Mr. Smith gave a note dated Feb. 25, 1896, and paid it July 12, 1896. Find the exact number of days between its date and the time of payment.

4. A carpenter earning $2.50 per day commenced Wednesday morning, April 1, 1896, and continued working every week day until June 6. How much did he earn?

5. Find the exact number of days between Jan. 10, 1896, and May 5, 1896.

6. John goes to bed at 9.15 P.M. and gets up at 7.10 A.M. How many minutes does he spend in bed?

To multiply or divide a compound number by a fraction.

To multiply by a fraction, multiply by the numerator, and divide the product by the denominator.

To divide by a fraction, multiply by the denominator, and divide the product by the numerator.

When the multiplier or divisor is a mixed number, reduce to an improper fraction, and proceed as above.

EXAMPLES

1. How much is $\frac{6}{7}$ of 16 hr. 17 min. 14 sec.?

2. A field contains 10 A. 12 sq. rd. of land, which is $\frac{5}{6}$ of the whole farm. Find the size of the farm.

3. If a train runs 60 mi. 35 rd. 16 ft. in one hour, how far will it run in $12\frac{2}{5}$ hr. at the same rate of speed?

4. Divide 14 bu. 3 pk. 6 qt. 1 pt. by $\frac{7}{8}$.

5. Divide 5 yr. 1 mo. 1 wk. 1 da. 1 hr. 1 min. 1 sec. by $3\frac{2}{5}$.

REVIEW EXAMPLES

1. A time card on a piece of work states that 2 hours and 15 minutes were spent on a skirt, 1 hour and 12 minutes on a waist, 2 hours and 45 minutes on a petticoat, and 1 hour and 30 minutes on a jacket. What was the number of hours spent on all the work?

2. How many parts of a sewing machine, each weighing 14 oz., can be obtained from 860 lb. of metal if nothing is allowed for waste?

3. How many feet long must a dry goods store be to hold a counter 8′ 6″, a bench 14′ 4″, a desk 4′ 2″, and a counter 7′ 5″, placed side by side, if 3′ 3″ are allowed between the pieces of furniture and between the walls and the counters?

4. How many gross in a lot of 968 buttons?

5. Find the sum of 7 hr. 30 min. 45 sec., 12 hr. 25 min. 30 sec., 20 hr. 15 min. 33 sec., 10 hr. 27 min. 46 sec.

6. If a train is run for 8 hr. at the average rate of 50 mi. 30 rd. 10 ft. per hour, how great is the distance covered?

7. A telephone pole is 31 ft. long. If 4 ft. 7 in. are under ground, how high (in inches) is the top of the pole above the street?

8. If 100 bars of iron, each $2\frac{3}{4}'$ long, weigh 70 lb., what is the total weight of 2300 bars?

9. If a cubic foot of water weighs $62\frac{1}{2}$ lb., how many ounces does it weigh?

10. A farmer's wife made 9 pounds 7 ounces of butter and sold it at 41 cents a pound. How much did she receive?

11. A peck is what part of a bushel?

12. A quart is what part of a bushel? of a peck?

13. I have 84 lb. 14 oz. of salt which I wish to put into packages of 2 lb. 6 oz. each. How many packages will there be?

14. If one bottle holds 1 pt. 3 gi., how many dozen bottles will be required to hold 65 gal. 2 qt. 1 pt.?

15. How many pieces $5\frac{1}{2}''$ long can be cut from a rod $16'\ 8''$ long, if $5''$ are allowed for waste?

16. What is the entire length of a railway consisting of five different lines measuring respectively 160 mi. 185 rd. 2 yd., 97 mi. 63 rd. 4 yd., 126 mi. 272 rd. 3 yd., 67 mi. 199 rd. 5 yd., and 48 mi. 266 rd. 5 yd.?

Percentage

Percentage is a process of solving questions of relation by means of hundredths or per cent (%).

Every question in percentage involves three elements: the rate per cent, the base, and the percentage.

The *rate per cent* is the number of hundredths taken.

The *base* is the number of which the hundredths are taken.

The *percentage* is the result obtained by taking a certain per cent of a number.

Since the percentage is the result obtained by taking a certain per cent of a number, it follows that *the percentage is the product of the base and the rate.* The rate and base are always factors, the percentage is the product.

Example. — How much is 8 % of \$ 200?

$$8\% \text{ of } \$200 = 200 \times .08 = \$16. \qquad (1)$$

In (1) we have the three elements: 8 % is the rate, \$200 is the base, and \$16 is the percentage.

Since \$200 $\times$ .08 = \$16, the percentage;
\$16 $\div$ .08 = \$200, the base;
and \$16 $\div$ \$200 = .08, the rate.

If any two of these elements are given, the other may be found:

$$\textit{Base} \times \textit{Rate} = \textit{Percentage}$$
$$\textit{Percentage} \div \textit{Rate} = \textit{Base}$$
$$\textit{Percentage} \div \textit{Base} = \textit{Rate}$$

Per cent is commonly used in the decimal form, but many operations may be much shortened by using the common fraction form.

$1\% = .01 = \frac{1}{100}$	$\frac{1}{2}\% = .00\frac{1}{2}$ or $.005$
$10\% = .10 = \frac{1}{10}$	$33\frac{1}{3}\% = .33\frac{1}{3} = \frac{1}{3}$
$100\% = 1.00 = 1$	$8\frac{1}{4}\% = .08\frac{1}{4} = .0825$
$12\frac{1}{2}\% = .12\frac{1}{2}$ or $.125 = \frac{1}{8}$	$\frac{1}{8}\% = .00\frac{1}{8} = .00125$

There are certain per cents that are used so frequently that we should memorize their equivalent fractions.

$6\frac{1}{4}\% = \frac{1}{16}$	$33\frac{1}{3}\% = \frac{1}{3}$	$66\frac{2}{3}\% = \frac{2}{3}$
$10\% = \frac{1}{10}$	$37\frac{1}{2}\% = \frac{3}{8}$	$75\% = \frac{3}{4}$
$12\frac{1}{2}\% = \frac{1}{8}$	$40\% = \frac{2}{5}$	$80\% = \frac{4}{5}$
$16\frac{2}{3}\% = \frac{1}{6}$	$50\% = \frac{1}{2}$	$83\frac{1}{3}\% = \frac{5}{6}$
$20\% = \frac{1}{5}$	$60\% = \frac{3}{5}$	$87\frac{1}{2}\% = \frac{7}{8}$
$25\% = \frac{1}{4}$	$62\frac{1}{2}\% = \frac{5}{8}$	

EXAMPLES

1. Find 75 % of \$368.
2. Find 15 % of \$412.
3. 840 is $33\frac{1}{3}$ % of what number?
4. 615 is 15 % of what number?
5. What per cent of 12 is 8?

6. What per cent of a foot is 8 inches? 11 inches? 4 inches?

7. A technical high school contains 896 pupils; 476 of the pupils are girls. What per cent of the school is girls?

8. Out of a gross of bottles of mucilage 9 were broken. What was the per cent broken?

Trade Discount

Merchants and jobbers have a price list. From this list they give special discounts according to the credit of the customer and the amount of supplies purchased, etc. If they give more than one discount, it is understood that the first means the discount from the list price, while the second denotes the discount from the remainder.

EXAMPLES

1. What is the price of 200 spools of cotton at $ 36.68 per M. at 40 % off?

2. Supplies from a dry goods store amounted to $ 58.75. If $12\frac{1}{2}$ % were allowed for discount, what was the amount paid?

3. A dealer received a bill amounting to $ 212.75. Successive discounts of 15 %, 10 %, and 5 % were allowed. What was the amount to be paid?

4. 2 % is usually discounted on bills paid within 30 days. If the following are to be paid within 30 days, what will be the amounts due?

a. $ 30.19	*c.* $ 399.16	*e.* $ 1369.99
b. 2816.49	*d.* 489.01	*f.* 918.69

5. Millinery supplies amounted to $ 127.79 with a discount of 40 % and 15 %. What was the net price?

6. What single discount is equivalent to a discount of 45 % and 10 %?

7. What single discount is equivalent to 20 %, and 10 %?

Simple Interest

Money that is paid for the use of money is called **interest.** The money for the use of which interest is paid is called the **principal,** and the sum of the principal and interest is called the **amount.**

Interest at 6 % means 6 % of the principal for 1 year; 12 months of 30 days each are usually regarded as a year in computing interest. There are several methods of computing interest.

EXAMPLE.—What is the interest on $ 100 for 3 years at 6 %?

$$\begin{array}{rl} \$100 & \\ .06 & \\ \hline \$6.00 & \text{interest for one year.} \\ 3 & \\ \hline \$18.00 & \text{interest for 3 years. } Ans. \end{array}$$

Or, $\frac{6}{100} \times \frac{100}{1} \times \frac{3}{1} = \$18.$ *Ans.*

$\$100 + \$18 = \$118$, amount.

$$Principal \times Rate \times Time = Interest.$$

EXAMPLE.— What is the interest on $ 297.62 for 5 yr. 3 mo. at 6 %?

$$\begin{array}{r} \$297.62 \\ .06 \\ \hline \$17.8572 \\ 5\frac{1}{4} \\ \hline 4.4643 \\ 89.2860 \\ \hline \$93.7503 \end{array} \quad \$93.75. \ Ans.$$

Or, $\frac{\overset{3}{\cancel{6}}}{100} \times \frac{\$297.62}{1} \times \frac{21}{\underset{2}{\cancel{4}}} = \frac{\$18750.06}{200} = \$93.75.$

NOTE. — Final results should not include mills. Mills are disregarded if less than 5, and called another cent if 5 or more.

EXAMPLES

1. What is the interest on $ 586.24 for 3 months at 6 %?
2. What is the interest on $ 816.01 for 9 months at 5 %?
3. What is the interest on $ 314.72 for 1 year at 4 %?
4. What is the interest on $ 876.79 for 2 yr. 3 mo. at $4\frac{1}{2}$ %?
5. What is the interest on $ 2119.70 for 6 yr. 2 mo. 13 da. at $5\frac{1}{2}$ %?

The Six Per Cent Method

By the 6 % method it is convenient to find first the interest of \$ 1, then multiply it by the principal.

EXAMPLE. — What is the interest on \$ 50.24 at 6 % for 2 yr. 8 mo. 18 da.?

Interest on \$1 for 2 yr. $= 2 \times \$.06 = \$.12$
Interest on \$1 for 8 mo. $= 8 \times \$.00\frac{1}{2} = .04$
Interest on \$1 for 18 da. $= 18 \times \$.000\frac{1}{6} = .003$
Interest on \$1 for 2 yr. 8 mo. 18 da. \$.163
Interest on \$ 50.24 is 50.24 times \$.163 = \$8.19. *Ans.*

Second Method. — *Interest on any sum for 60 days at 6 % is $\frac{1}{100}$ of that sum and may be expressed by moving the decimal point two places to the left.* The interest for 6 days may be expressed by moving the decimal three places to the left.

EXAMPLE. — What is the interest on \$ 394.50 for 96 days at 6 %?

\$3.9450, interest on \$394.50 for 60 days at 6 %.
1.9725, interest on \$394.50 for 30 days at 6 %.
.3945, interest on \$394.50 for 6 days at 6 %.
\$6.3120, interest on \$394.50 for 96 days at 6 %. *Ans.* \$6.31.

EXAMPLE. — What is the interest on \$ 529.70 for 78 days at 8 %?

\$5.297, interest on \$529.70 for 60 days at 6 %.
1.589, interest on \$529.70 for 18 days (6 days × 3).
\$6.886, interest on \$529.70 for 78 days at 6 %.
8 % = 6 % + $\frac{1}{3}$ of 6 %.
\$6.886 + \$2.295 = \$9.181. *Ans.* \$9.18.

EXAMPLES

Find the interest and amount of the following:

1. \$ 2350 for 1 yr. 3 mo. 6 da. at 6 %.
2. \$ 125.75 for 2 yr. 5 mo. 17 da. at 7 %.
3. \$ 950.63 for 3 yr. 7 mo. 21 da. at 5 %.
4. \$ 625.57 for 2 yr. 8 mo. 28 da. at 8 %.

Exact Interest

When the time includes days, interest computed by the 6% method is not strictly exact, by reason of using only 30 days for a month, which makes the year only 360 days. The day is therefore reckoned as $\frac{1}{360}$ of a year, whereas it is $\frac{1}{365}$ of a year.

To compute exact interest, find the exact time in days, and consider 1 *day's interest as* $\frac{1}{365}$ *of* 1 *year's interest.*

EXAMPLE. — Find the exact interest of $358 for 74 days at 7%.

$358 × .07 = $25.06, 1 year's interest.
74 days' interest is $\frac{74}{365}$ of 1 year's interest.
$\frac{74}{365}$ of $25.06 = $5.08. *Ans.*
Or, $\frac{\$358}{1} \times \frac{7}{100} \times \frac{74}{365} = ?$

EXAMPLES

Find the exact interest of:

1. $324 for 15 da. at 5%.
2. $253 for 98 da. at 4%.
3. $624 for 117 da. at 7%.
4. $620 from Aug. 15 to Nov. 12 at 6%.
5. $153.26 for 256 da. at $5\frac{1}{2}$%.
6. $540.25 from June 12 to Sept. 14 at 8%.

Rules for Computing Interest

The following will be found to be excellent rules for finding the interest on any principal for any number of days.

Divide the principal by 100 and proceed as follows:

2% — Multiply by number of days to run, and divide by 180.
$2\frac{1}{2}$% — Multiply by number of days, and divide by 144.
3% — Multiply by number of days, and divide by 120.
$3\frac{1}{2}$% — Multiply by number of days, and divide by 102.86.

4 % — Multiply by number of days, and divide by 90.
5 % — Multiply by number of days, and divide by 72.
6 % — Multiply by number of days, and divide by 60.
7 % — Multiply by number of days, and divide by 51.43.
8 % — Multiply by number of days, and divide by 45.

Savings Bank Compound Interest Table

Showing the amount of $1, from 1 year to 15 years, with compound interest added semiannually, at different rates.

Per Cent	3	4	5	6	7	8	9
½ year	1 01	1 02	1 02	1 03	1 03	1 04	1 04
1 year	1 03	1 04	1 05	1 06	1 07	1 08	1 09
1½ years	1 04	1 06	1 07	1 09	1 10	1 12	1 14
2 years	1 06	1 08	1 10	1 12	1 14	1 16	1 19
2½ years	1 07	1 10	1 13	1 15	1 18	1 21	1 24
3 years	1 09	1 12	1 15	1 19	1 22	1 26	1 30
3½ years	1 10	1 14	1 18	1 22	1 27	1 31	1 36
4 years	1 12	1 17	1 21	1 26	1 31	1 36	1 42
4½ years	1 14	1 19	1 24	1 30	1 36	1 42	1 48
5 years	1 16	1 21	1 28	1 34	1 41	1 48	1 55
5½ years	1 17	1 24	1 31	1 38	1 45	1 53	1 62
6 years	1 19	1 26	1 34	1 42	1 51	1 60	1 69
6½ years	1 21	1 29	1 37	1 46	1 56	1 66	1 77
7 years	1 23	1 31	1 41	1 51	1 61	1 73	1 85
7½ years	1 24	1 34	1 44	1 55	1 67	1 80	1 93
8 years	1 26	1 37	1 48	1 60	1 73	1 87	2 02
8½ years	1 28	1 39	1 52	1 65	1 79	1 94	2 11
9 years	1 30	1 42	1 55	1 70	1 85	2 02	2 20
9½ years	1 32	1 45	1 59	1 75	1 92	2 10	2 30
10 years	1 34	1 48	1 63	1 80	1 98	2 19	2 41
11 years	1 38	1 54	1 72	1 91	2 13	2 36	2 63
12 years	1 42	1 60	1 80	2 03	2 28	2 56	2 87
13 years	1 47	1 67	1 90	2 15	2 44	2 77	3 14
14 years	1 51	1 73	1 99	2 28	2 62	2 99	3 42
15 years	1 56	1 80	2 09	2 42	2 80	3 24	3 74

EXAMPLES

Solve the following problems by using the tables on page 56:

1. What is the compound interest of $1 at the end of $8\frac{1}{2}$ years at 6 %?

2. What is the compound interest of $1 at the end of 11 years at 6 %?

3. How long will it take $400 to double itself at 5 %, compound interest?

4. How long will it take $580 to double itself at $5\frac{1}{2}$ %, compound interest?

5. How long will it take $615 to double itself at 8 %, simple interest?

6. How long will it take $784 to double itself at 7 %, simple interest?

7. Find the interest of $684 for 94 days at 3 %.

8. Find the interest of $1217 for 37 days at 4 %.

9. Find the interest of $681.14 for 74 days at $4\frac{1}{2}$ %.

10. Find the interest of $414.50 for 65 days at 5 %.

11. Find the interest of $384.79 for 115 days at 6 %.

Ratio and Proportion

Ratio is the relation between two numbers. It is found by dividing one by the other. The ratio of 4 to 8 is $4 \div 8 = \frac{1}{2}$.

The **terms** of the ratio are the two numbers compared. The first term of a ratio is the *antecedent*, and the second the *consequent*. The sign of the ratio is (:). (It is the division sign with the line omitted.) Ratio may also be expressed fractionally, as $\frac{16}{4}$ or 16 : 4; or $\frac{3}{17}$ or 3 : 17.

A ratio formed by dividing the consequent by the antecedent is an *inverse ratio:* 12 : 6 is the inverse ratio of 6 : 12.

The two terms of the ratio taken together form a couplet.

Two or more couplets taken together form a *compound ratio.*

Thus, $2:5 \quad 6:11$

A compound ratio may be changed to a simple ratio by taking the product of the antecedents for a new antecedent, and the product of the consequents for a new consequent; as, $6 \times 2 : 11 \times 5$, or $12 : 55$.

$$\textit{Antecedent} \div \textit{Consequent} = \textit{Ratio}$$
$$\textit{Antecedent} \div \textit{Ratio} = \textit{Consequent}$$
$$\textit{Ratio} \times \textit{Consequent} = \textit{Antecedent}$$

To multiply or divide both terms of a ratio by the same number does not change the ratio.

Thus
$$12 : 6 = 2$$
$$3 \times 12 : 3 \times 6 = 2$$
$$\tfrac{12}{3} : \tfrac{6}{3} = 2$$

EXAMPLES

Find the ratio of

1. $20 : 300$
2. 3 bu. : 3 pk.
3. $2\frac{1}{2} : 16$
4. $12 : \frac{1}{4}$
5. $\frac{1}{2} : \frac{2}{3}$
6. $16 : (?) = \frac{1}{2}$

Fractions with a common denominator have the same ratio as their numerators.

7. $\frac{8}{17} : \frac{16}{17}$, $\frac{28}{75} : \frac{7}{75}$, $\frac{15}{11} : \frac{30}{11}$
8. $\frac{3}{4} : \frac{2}{3}$, $\frac{3}{7} : \frac{5}{8}$, $\frac{2}{3} : \frac{5}{6}$

Proportion

An equality of ratios is a **proportion.**

A **proportion** is usually expressed thus: $4 : 2 :: 12 : 6$, and is read 4 *is to* 2 *as* 12 *is to* 6.

A proportion has four terms, of which the first and third are *antecedents* and the second and fourth are *consequents.* The first and fourth terms are called *extremes,* and the second and third terms are called *means.*

The product of the extremes equals the product of the means.

To find an extreme, divide the product of the means by the given extreme.

To find a mean, divide the product of the extremes by the given mean.

EXAMPLES

Supply the missing term:

1. 1 : 836 : : 25 : ( )
2. 6 : 24 : : ( ) : 40
3. ( ) : 15 : : 60 : 6
4. 10 yd. : 50 yd. : : \$ 20 : (\$)
5. $\$\frac{3}{4} : \$3\frac{3}{4}$: : ( ) : 5

Simple Proportion

An equality of two simple ratios is a *simple proportion.*

Example. — If 12 bushels of charcoal cost \$ 4, what will 60 bushels cost?

12 : 60 : : \$ 4 : (\$)

$\frac{60 \times 4}{12} = \$20.$ *Ans.*

There is the same relation between the cost of 12 bu. and the cost of 60 bu. as there is between the 12 bu. and the 60 bu. \$ 4 is the third term. The answer is the fourth term. It must form a ratio of 12 and 60 that shall equal the ratio of \$ 4 to the answer. Since the third term is less than the required answer, the first must be less than the second, and 12 : 60 is the first ratio. The product of the means divided by the given extreme gives the other extreme, or \$ 20.

EXAMPLES

Solve by proportion:

1. If 150 yd. of edging cost \$ 6, how much will 1200 yd. cost?

2. If 250 pounds of lead pipe cost \$ 15, how much will 1200 pounds cost?

3. If 5 men can dig a ditch in 3 days, how long will it take 2 men?

4. If 4 men can shingle a shed in 2 days, how long will it take 3 men?

5. The ratio of Simon's pay to Matthew's is $\frac{2}{3}$. Simon earns \$ 18 per week. What does Matthew earn?

6. What will $11\frac{3}{4}$ yards of cambric cost if 50 yards cost \$6.75?

7. If it takes $7\frac{1}{2}$ yards of cloth, 1 yard wide, to make a suit, how many yards of cloth, 44 inches wide, will it take to make the same suit?

8. If 21 yards of silk cost \$52.50, what will 35 yards cost?

9. A farm valued at \$5700 is taxed for \$38.19. What should be the tax on property valued at \$28,500?

10. If there are 7680 minims in a pint of water, how many pints are there in 16,843 minims?

11. There are approximately 15 grains in a gram. How many grams in 641 grains?

12. In a velocity diagram a line $3\frac{3}{4}$ in. long represents 45 ft. What would be the length of a line representing 30 ft. velocity?

13. When a post 11.5 ft. high casts a shadow on level ground 20.6 ft. long, a telephone pole nearby casts a shadow 59.2 ft. long. How high is the pole?

14. If 10 grams of silver nitrate dissolved in 100 cubic centimeters of water will form a 10 % solution, how much silver nitrate should be used in 1560 cubic centimeters of water?

15. A ditch is dug in 14 days of 8 hours each. How many days of 10 hours each would it have taken?

16. If in a drawing a tree 38 ft. high is represented by $1\frac{1}{4}''$, what on the same scale will represent the height of a house 47 ft. high?

17. What will be the cost of 21 motors if 15 motors cost \$887?

18. If goods are bought at a discount of 25 % and are sold at the list price, what per cent is gained? (Assume \$1 as the list price.)

18. If a sewing machine sews 26 inches per minute on heavy goods, how many yards will it sew in an hour?

19. If a girl spends 28 cents a week for confectionery, how much does she spend for it in three months?

20. If a pole 8 ft. high casts a shadow $4\frac{1}{2}$ ft. long, how high is a tree which casts a shadow 48 ft. long?

Involution

The product of equal factors is a **power.**

The process of finding powers is **involution.**

The product of two equal factors is the *second power*, or **square**, of the equal factor.

The product of three equal factors is the *third power*, or **cube**, of the factor.

$4^2 = 4 \times 4$ is 4 to the second power, or the square of 4.
$2^3 = 2 \times 2 \times 2$ is 2 to the third power, or the cube of 2.
$3^4 = 3 \times 3 \times 3 \times 3$ is 3 to the fourth power, or the fourth power of 4.

EXAMPLES

Find the powers:

1. 5^3	**3.** 1^4	**5.** $(2\frac{1}{2})^2$	**7.** 9^3
2. 1.1^2	**4.** 25^2	**6.** 2^4	**8.** $.15^2$

Evolution

One of the *equal* factors of a power is a **root.**

One of *two equal* factors of a number is the **square root.**

One of *three equal* factors of a number is the **cube root** of it.

The square root of $16 = 4$. The cube root of $27 = 3$.

The radical sign ($\sqrt{}$) placed before a number indicates that its root is to be found. The radical sign alone before a number indicates the square root.

Thus, $\sqrt{9} = 3$ is read, the square root of $9 = 3$.

A small figure placed in the opening of the radical sign is called the index of the root, and shows what root is to be taken.

Thus, $\sqrt[3]{8} = 2$ is read, the cube root of 8 is 2.

Square Root

The square of a number composed of tens and units is equal to the square of the tens, plus twice the product of the tens by the units, plus the square of the units.

$$tens^2 + 2 \times tens \times units + units^2$$

EXAMPLE. — What is the square root of 1225?

$$\begin{array}{lrl}
 & & 12'25(\underline{30 + 5 = 35} \\
Tens^2,\ 30^2 & = & 900 \\
2 \times tens = 2 \times 30 & = 60 & \underline{\vert\, 325} \\
2 \times tens + units = 2 \times 30 + 5 & = 65 & \underline{\vert\, 325}
\end{array}$$

Separating into periods of two figures each, by a check mark ('), beginning at units, we have 12'25. Since there are two periods in the power, there must be two figures in the root, tens and units.

The greatest square of even tens contained in 1225 is 900, and its square root is 30 (3 tens). Subtracting the square of the tens, 900, the remainder consists of $2 \times$ (tens $\times$ units) + units.

325, therefore, is composed of two factors, units being one of them, and $2 \times$ tens – units being the other. But the greater part of this factor is $2 \times$ tens ($2 \times 30 = 60$). By trial we divide 325 by 60 to find the other factor (units), which is 5, if correct. Completing the factor, we have $2 \times$ tens + units = 65, which, multiplied by the other factor, 5, gives 325. Therefore the square root is $30 + 5 = 35$.

The area of every square surface is the product of two equal factors, length, and width.

Finding the square root of a number, therefore, is equivalent to finding the length of one side of a square surface, its area being given.

1. *Length* $\times$ *Width* = *Area*
2. *Area* $\div$ *Length* = *Width*
3. *Area* $\div$ *Width* = *Length*

SHORT METHOD

EXAMPLE. — Find the square root of 1306.0996.

$$
\begin{array}{r|l}
 & 13'06.09'96\,(\underline{36.14} \\
 & 9 \\
66) & \overline{406} \\
 & 396 \\
721) & \overline{1009} \\
 & 721 \\
7224) & \overline{28896} \\
 & \underline{28896}
\end{array}
$$

Beginning at the decimal point, separate the number into periods of two figures each, pointing whole numbers to the left and decimals to the right. Find the greatest square in the left-hand period, and write its root at the right. Subtract the square from the left-hand period, and bring down the next period for a dividend.

Divide the dividend, with its right-hand figure omitted, by twice the root already found, and annex the quotient to the root, and to the divisor. Multiply this complete divisor by the last root figure, and bring down the next period for a dividend, as before.

Proceed in this manner till all the periods are exhausted.

When 0 occurs in the root, annex 0 to the trial divisor, bring down the next period, and divide as before.

If there is a remainder after all the periods are exhausted, annex decimal periods.

If, after multiplying by any root figure, the product is larger than the dividend, the root figure is too large and must be diminished. Also the last figure in the complete divisor must be diminished.

For every decimal period in the power, there must be a decimal figure in the root. If the last decimal period does not contain two figures, supply the deficiency by annexing a cipher.

EXAMPLES

Find the square root of:

1. 8836

2. 370881

3. 29.0521

4. 46656

5. $\sqrt{\frac{1}{4} \times \frac{1}{9}}$

6. 72.5

7. $.009\frac{9}{16}$

8. 1684.298431

9. $\sqrt{3.532 \div 6.28}$

10. $\sqrt{625 + 1296}$

11. $\frac{1}{\sqrt{9}} \times \frac{\sqrt{9}}{3}$

12. $\frac{3969}{5625}$

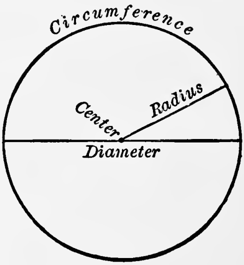
13. What is the length of one side of a square field that has an area equal to a field 75 rd. long and 45 rd. wide?

CHAPTER II

MENSURATION

The Circle

A **circle** is a plane figure bounded by a curved line, called the **circumference**, every point of which is equidistant from the center.



The **diameter** is a straight line drawn from one point of the circumference to another and passing through the center.

The ratio of the circumference to the diameter of any circle is always a constant number, 3.1416+, approximately $3\frac{1}{7}$, which is represented by the Greek letter π (*pi*).

$$C = \text{Circumference}$$
$$D = \text{Diameter}$$
$$C = \pi D$$ [1]

The **radius** is a straight line drawn from the center to the circumference.

Any portion of the circumference is an **arc**.

By drawing a number of radii a circle may be cut into a series of figures, each one of which is called a **sector**. The area of each sector is equal to one half the product of the arc and radius. Therefore the *area of the circle* is equal to one half of the product of the circumference and radius.

[1] See Appendix for explanation and directions concerning the use of formulas.

$$A = C \times \frac{R}{2}$$

$$A = \pi 2\,R \times \frac{R}{2} = \pi R^2$$

In this formula A equals area, $\pi = 3.1416$, and $R^2 =$ the radius squared.

$$A = \tfrac{1}{2}\,D \times \tfrac{1}{2}\,C$$

In this formula D equals the diameter and C the circumference,

or
$$A = \frac{\pi D^2}{4} = \frac{3.1416\ D^2}{4} = .7854\ D^2$$

Example. — What is the area of a circle whose radius is 3 ft.?

$$A = \pi R^2 \qquad A = \frac{\pi D^2}{4}$$

$$A = \pi \times\ 9 \qquad A = \frac{\pi \overset{9}{\cancel{36}}}{\cancel{4}} = \pi\ 9 = 28.27 \text{ sq. ft.} \quad \textit{Ans.}$$

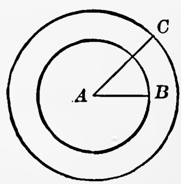
Example. —What is the area of a circle whose circumference is 10 ft.?

$$D = \frac{10}{3.1416} \qquad A = \frac{1}{2} D \times \frac{1}{2} C$$

$$\frac{1}{2} \times \frac{10}{3.1416} \times \frac{1}{2} \times 10 = \frac{25}{3.1416} = 7.1 \text{ sq. ft.} \quad \textit{Ans.}$$

Area of a Ring. — On examining a flat iron ring it is clear that the area of one side of the ring may be found by subtracting the area of the inside circle from the area of the outside circle.

Let $D =$ outside diameter
$d =$ inside diameter
$A =$ area of outside circle
$a =$ area of inside circle



(1) $$A = \frac{D^2\pi}{4} = .7854\ D^2$$

(2) $$a = \frac{d^2\pi}{4} = .7854\ d^2$$

(3) $$A - a = \frac{D^2\pi}{4} - \frac{d^2\pi}{4}$$

Let $B =$ area of circular ring $= A - a$

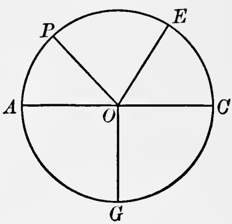
$$B = \frac{D^2\pi}{4} - \frac{d^2\pi}{4} = \frac{\pi}{4}(D^2 - d^2) = .7854\ (D^2 - d^2)$$

Example. — If the outside diameter of a flat ring is 9″ and the inside diameter 7″, what is the area of one side of the ring?

$$B = .7854\ (D^2 - d^2)$$
$$B = .7854\ (81 - 49) = .7854 \times 32 = 25.1328 \text{ sq. in.} \quad Ans.$$

Angles

We make two common uses of angles: (1) to measure a circular movement, and (2) to measure a difference in direction. A circle contains 360°, and the angles at the center of the circle contain as many degrees as their corresponding arcs on the circumference.



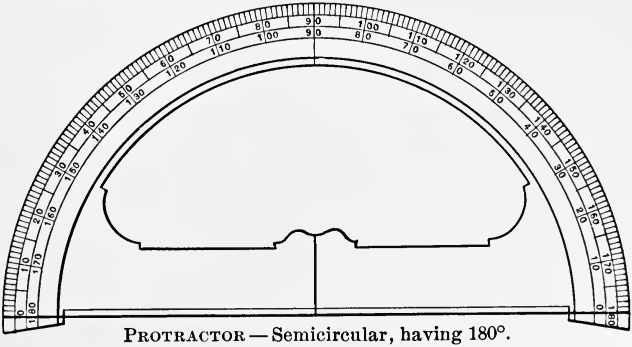
Angle POE has as many degrees as arc PE.

A **right angle** is measured by a quarter of the circumference of the circle, which is 90°.

The angle AOG is a right angle.

The angle AC, made with half the circumference of the circle, is a **straight angle**, and the two right angles, AOG and GOC, which it contains, are **supplementary** to each other. When the sum of two angles is equal to 90°, they are said to be **complementary angles**, and one is the complement of the other. When the sum of two angles equals 180°, they are **supplementary angles**, and one is said to be the **supplement** of the other.

The number of degrees in an angle may be measured by a *protractor.* The distance around a semicircular protractor is



PROTRACTOR — Semicircular, having 180°.

divided into 180 parts, each division measuring a degree. It is used by placing the center of the protractor on the *vertex* and the base of the protractor on one side of the angle to be measured. Where the other side of the angle cuts the circular piece of the protractor, the size of the angle may be read in degrees.

EXAMPLES

1. What is the area of a circular piece of velvet 8″ in diameter?

2. What is the distance around the edge of a hat 6″ in diameter?

3. Name the complements of angles of 30°, 45°, 65°, 70°, 85°.

4. Name the supplements of angles of 55°, 140°, 69°, 98° 44′, 81° 19′.

5. What is the diameter of a wheel that is 12′ 6″ in circumference?

6. What is the area of one side of a flat iron ring 14″ inside diameter and 18″ outside diameter?

7. The wheel of a child's carriage is 30″ in diameter. What is the length of the rubber tire that fits it?

8. How much ribbon is needed to bind the edge of a circular cloth that exactly covers the top of a center table 28″ in diameter?

9. A straw hat measures 30″ around the rim. What is the diameter of the hat?

10. If a circular dining room table measures 12′ 6″ in circumference, what is the greatest distance across the table?

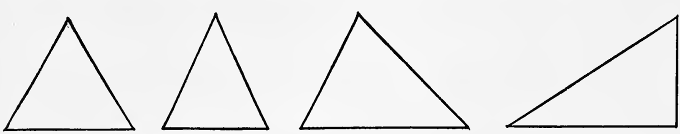
Triangles

A **triangle** is a plane figure bounded by three straight lines. Triangles are classified according to the relative lengths of their sides and the size of their angles.

A triangle having equal sides is called **equilateral.** One having two sides equal is **isosceles.** A triangle having no sides equal is called **scalene.**

If the angles of a triangle are equal, the triangle is **equiangular.**

If one of the angles of a triangle is a right angle, the triangle is a **right triangle.** In a right triangle the side opposite the right angle is called the **hypotenuse** and is the longest side. The other two sides of the right triangle are the legs, and are at right angles to each other.



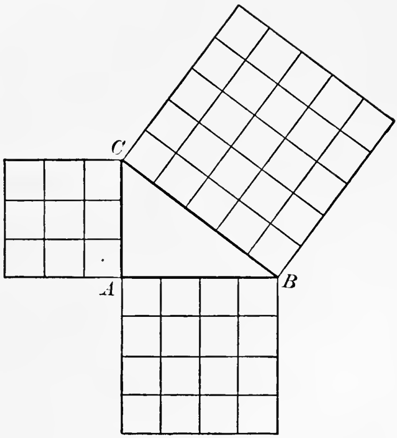
EQUILATERAL ISOSCELES SCALENE RIGHT

Kinds of Triangles

Right Triangles

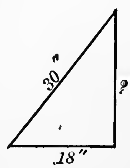
In a right triangle the square of the hypotenuse equals the sum of the squares of the other two sides or legs.

If the length of the hypotenuse and one leg of a right triangle is known, the other side may be found by squaring the hypotenuse and squaring the leg, and extracting the square root of their difference.



Example.—If the hypotenuse of a right angle triangle is 30″ and the base is 18″, what is the altitude?

$$30^2 = 30 \times 30 = 900$$
$$18^2 = 18 \times 18 = 324$$
$$900 - 324 = 576$$
$$\sqrt{576} = 24''. \quad \textit{Ans.}$$



Areas of Triangles

The *area of a triangle* may be found when the length of the three sides is given by adding the three sides together, dividing by 2, and subtracting from this sum each side separately. Multiply the four results together and find the square root of their product.

Example. — What is the area of a triangle whose sides measure 15, 16, and 17 inches, respectively?

$$\begin{array}{r} 15 \\ 16 \\ 17 \\ 2\overline{)48} \\ 24 \end{array}$$

$24 - 15 = 9$
$24 - 16 = 8$
$24 - 17 = 7$

$$\sqrt{24 \times 9 \times 8 \times 7} = \sqrt{12096}$$
$$\sqrt{12096} = 109.98 \text{ sq. in.} \quad \textit{Ans.}$$

Area of a Triangle $= \frac{1}{2}$ *Base* $\times$ *Altitude*

Example. — What is the area of a triangle whose base is 17″ and altitude 10″?

$$A = \frac{1}{\cancel{2}} \times 17 \times \overset{5}{\cancel{10}} = 85 \text{ sq. in.} \quad \textit{Ans.}$$

EXAMPLES

1. A ladder 17 ft. long standing on level ground reached to a window 12 ft. from the ground. If it is assumed that the wall is perpendicular, how far is the foot of the ladder from the base of the wall?

2. Find the area of a triangular piece of cloth having the base 81″ and the height measured from the opposite angle 56″.

3. Find the length of the hypotenuse of a right triangle with equal legs and having an area of 280 sq. in.

4. Find the length of a side of a right triangle with equal legs and an area of 72 sq. in.

5. Find the hypotenuse of a right triangle with a base of 8″ and the altitude of 7″.

6. What is the area of a triangle whose sides measure 12, 19, and 21 inches?

7. What is the altitude of an isosceles triangle having sides 8 ft. long and a base 6 ft. long?

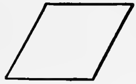
Quadrilaterals

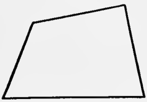
Four-sided plane figures are called **quadrilaterals.** Among them are the *trapezoid, trapezium, rectangle, rhombus, and rhomboid.*


SQUARE


RECTANGLE


RHOMBOID


RHOMBUS


TRAPEZIUM


TRAPEZOID


PARALLELOGRAM

KINDS OF QUADRILATERALS

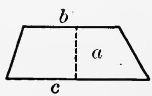
A **rectangle** is a quadrilateral which has its opposite sides parallel and its angles right angles. Its area equals the product of its base and altitude.

$$A = ba$$

A **trapezoid** is a quadrilateral having only two sides parallel. Its area is equal to the product of the altitude by one half the sum of the bases.

$$A = (b + c) \times \tfrac{1}{2} a$$

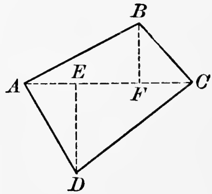
In this formula $c =$ length of longest side
$b =$ length of shortest side
$a =$ altitude



A **trapezium** is a four-sided figure with no two sides parallel. The area of a trapezium is found by dividing the trapezium into triangles by means of a diagonal. Then the area may be found if the diagonal and perpendicular heights of the triangles are known.

Example. — In the trapezium $ABCD$ if the diagonal is 43′ and the perpendiculars 11′ and 17′, respectively, what is the area of the trapezium?

$43 \times \frac{11}{2} = \frac{473}{2} = 236\frac{1}{2}$ sq. ft., area of ABC
$43 \times \frac{17}{2} = \frac{731}{2} = 365\frac{1}{2}$ sq. ft., area of ADC
602 sq. ft., total area
Ans.



To find the areas of irregular figures, draw the longest diagonal and upon this diagonal drop perpendiculars from the vertices of the figure. These perpendiculars will form trapezoids and right triangles whose areas may be determined by the preceding rules. The sum of the areas of the separate figures will give the area of the whole irregular figure.

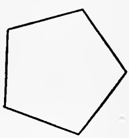
Polygons

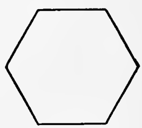
A plane figure bounded by straight lines is a **polygon.** A polygon which has equal sides and equal angles is a **regular polygon.**

The **apothem** of a regular polygon is the line drawn from the center of the polygon perpendicular to one of the sides.

A five-sided polygon is a **pentagon.**

A six-sided polygon is a **hexagon.**


Pentagon


Hexagon

An eight-sided polygon is an **octagon.**

The shortest distance between the opposite sides of a regular hexagon is the perpendicular distance between them, and is equal to the diameter of the inscribed circle.

The diameter of the circumscribed circle is the long diameter of a regular hexagon.

The **perimeter** of a polygon is the sum of all its sides.

The area of a regular polygon equals one half the product of the apothem and the perimeter.

Formula $A = \frac{1}{2}aP$

In this formula $P =$ perimeter

$a =$ apothem

Ellipse

Only the approximate circumference of an ellipse can be obtained.

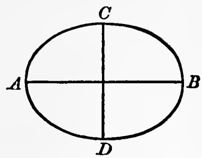
The circumference of an ellipse equals one half the product of the sum of two diameters and π.

If $d_1 =$ major diameter

$d_2 =$ minor diameter

$C =$ circumference

then $C = \frac{d_1 + d_2}{2}\pi$



The *area of an ellipse* is equal to one fourth the product of the major and minor diameters by π.

If $A =$ area

$d_1 =$ major diameter

$d_2 =$ minor diameter

then $A = \pi\frac{d_1 d_2}{4}$

EXAMPLES

1. Find the area of a trapezium if the diagonal is 93′ and the perpendiculars are 19′ and 33′.

2. What is the area of a trapezoid whose parallel sides are 18 ft. and 12 ft., and the altitude 8 ft.?

3. What is the distance around an ellipse whose major diameter is 14″ and minor diameter 8″?

4. In the map of a country a district is found to have two of its boundaries approximately parallel and equal to 276 and 216 miles. If the breadth is 100 miles, what is its area?

5. If the greater and lesser diameters of an elliptical manhole door are 2′ 9″ and 2′ 6″, what is its area?

6. Find the area of a trapezium if the diagonal is 78″ and the perpendiculars 18″ and 27″.

7. The greater diameter of an elliptical funnel is 4 ft. 6 in., and the lesser diameter is 4 ft. What is its area?

8. Find the perimeter of a hexagon having each side 15″ long.

9. What is the area of a pentagon whose apothem is $4\frac{1}{2}''$ and whose side is 5″?

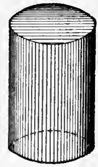
Volumes

The *volume of a rectangular-shaped bar* is found by multiplying the area of the base by the length. If the area is in square inches, the length must be in inches.

The *volume of a cube* is equal to the cube of an edge.

The *contents or volume of a cylindrical solid* is equal to the product of the area of the base by the height.

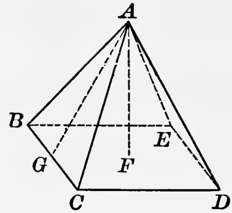
If $S =$ contents or capacity of cylinder
$R =$ radius of base
$H =$ height of cylinder
$\pi = 3.1416^{+}$ or $\frac{22}{7}$ (approx.)
$S = \pi R^2 H$



Example. — Find the contents of a cylindrical tank whose inside diameter is 14″ and height 6′.

$$S = \pi R^2 H$$
$$H = 6' = 72''$$
$$S = \tfrac{22}{7} \times 7 \times 7 \times 72 = 11{,}088 \text{ cu. in.}$$

The Pyramid



The *volume of a pyramid* equals one third of the product of the area of the base and the altitude.

$$V = \tfrac{1}{3}\,ba$$

The *volume of a frustum of a pyramid* equals the product of one third the altitude and the sum of the two bases and the square root of the product of the bases.

$$V = \tfrac{1}{3}\,h(b + b^1 + \sqrt{bb^1})$$

The *surface of a regular pyramid* is equal to the product of the perimeter of the bases and one half the slant height.

$$S = P \times \tfrac{1}{2}\,sh$$

The Cone

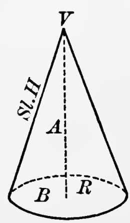
A **cone** is a solid generated by a right triangle revolving on one of its legs as an axis.

The **altitude** of the cone is the perpendicular distance from the base to the apex.

The *volume of a cone* equals the product of the area of the base and one third of the altitude.

$$V = \tfrac{1}{3}\,\pi R^2 H$$

or $$V = .2618\ D^2H$$



Example. — What is the volume of a cone $1\frac{1}{2}''$ in diameter and $4''$ high?

$$\text{Area of base} = .7854 \times \tfrac{9}{4}$$
$$= \frac{7.0686}{4} = 1.7671 \text{ sq. in.}$$
$$V = .2618\,D^2H$$
$$= .2618 \times \tfrac{9}{4} \times 4 = 2.3562 \text{ cu. in.} \quad \textit{Ans.}$$

The *lateral surface of* a *cone* equals one half the product of the perimeter of the base by the slant height.

EXAMPLE. — What is the surface of a cone having a slant height of 36 in., and a diameter of 14 in.?

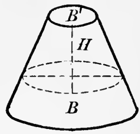
$$\pi = 3\tfrac{1}{7}$$
$$C = \pi D = 14 \times \tfrac{22}{7} = 44''$$
$$\frac{44 \times 36}{2} = 792 \text{ sq. in. } \textit{Ans.}$$

Frustum of a Cone

The **frustum** of a cone is the part of a cone included between the base and a plane or upper base which is parallel to the lower base.

The *volume of a frustum of a cone* equals the product of one third of the altitude and the sum of the two bases and the square root of their product.

When $H =$ altitude
$B^1 =$ upper base
$B =$ lower base
$V = \frac{1}{3} H(B + B^1 + \sqrt{BB^1})$



The *lateral surface of a frustum of a cone* equals one half the product of the slant height and the sum of the perimeters of the bases.

The Sphere

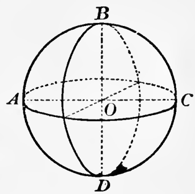
The *volume of a sphere* is equal to

$$V = \frac{4 \pi R^3}{3}$$

where R is the radius.

The *surface of a sphere* is equal to

$$S = 4 \pi R^2$$



The Barrel

To find the cubical contents of a barrel, (1) multiply the square of the largest diameter by 2, (2) add to this product the square of the head diameter, and (3) multiply this sum by the length of the barrel and that product by .2618.

EXAMPLE.—Find the cubical contents of a barrel whose largest diameter is 21″ and head diameter 18″, and whose length is 33″.

$$\begin{array}{lr} 21^2 = 441 \times 2 = & 882 \\ 18^2 = 324 & \underline{324} \\ & 1206 \\ & \underline{33} \\ & 3618 \\ & \underline{3618} \\ & 39798 \end{array}$$

$$V = [(D^2 \times 2) + d^2] \times L \times .2618$$

$$\begin{array}{r} 39798 \\ \underline{.2618} \\ 10419.11 \text{ cu. in.} \end{array}$$

$$\frac{10419.11}{231} = 45.10 \text{ gal.} \quad \textit{Ans.}$$

Similar Figures

Similar figures are figures that have exactly the same shape.

The *areas of similar figures* have the same ratio as the squares of their corresponding dimensions.

EXAMPLE.—If two boilers are 15′ and 20′ in length, what is the ratio of their surfaces?

$$\tfrac{15}{20} = \tfrac{3}{4}, \text{ ratio of lengths}$$

$$\frac{3^2}{4^2} = \frac{9}{16}, \text{ ratio of surfaces}$$

One boiler is $\tfrac{9}{16}$ as large as the other. *Ans.*

The *volumes of similar figures* are to each other as the cubes of their corresponding dimensions.

EXAMPLE.—If two iron balls have 8″ and 12″ diameters, respectively, what is the ratio of their volumes?

$$\tfrac{8}{12} = \tfrac{2}{3}, \text{ ratio of diameters}$$

$$= \tfrac{8}{27}, \text{ ratio of their volumes.} \quad \textit{Ans.}$$

One ball weighs $\tfrac{8}{27}$ as much as the other.

EXAMPLES

1. Find the volume of a rectangular box with the following inside dimensions: $8''$ by $10''$ and $4'$ long.

2. The radius of the small end of a bucket is 4 in. Water stands in the bucket to a depth of 9 in., and the radius of the surface of the water is 6 in. (1) Find the volume of the water in cubic inches. (2) Find the volume of the water in gallons if a cubic foot contains 7.48 gal.

3. What is the volume of a steel cone $2\frac{1}{2}''$ in diameter and $6''$ high?

4. Find the contents of a barrel whose largest diameter is $22''$, head diameter $18''$, and height $35''$.

5. What is the volume of a sphere $8''$ in diameter?

6. What is the volume of a pyramid with a square base, $4''$ on a side and $11''$ high?

7. What is the surface of a wooden cone with a $6''$ diameter and $14''$ slant height?

8. Find the surface of a pyramid with a perimeter of $18''$ and a slant height of $11''$.

9. Find the volume of a cask whose height is $3\frac{1}{2}'$ and the greatest radius $16''$, and the least radius $12''$, respectively.

10. How many gallons of water will a round tank hold which is 4 ft. in diameter at the top, 5 ft. in diameter at the bottom, and 8 ft. deep? (231 cu. in. = 1 gal.)

11. What is the volume of a cylindrical ring having an outside diameter of $6\frac{1}{2}''$, an inside diameter of $5\frac{1}{16}''$, and a height of $3\frac{3}{8}''$? What is its outside area?

12. If 9 tons of wild hay occupy a cube $7' \times 7' \times 7'$, how many cubic feet in one ton of hay?

13. A sphere has a circumference of $8.2467''$. (*a*) What is its area? (*b*) What is its volume?

14. If it is desired to make a conical can with a base 3.5″ in diameter to contain $\frac{1}{2}$ pint, what must the height be?

15. What is the area of one side of a flat ring if the inside diameter is $2\frac{1}{2}''$ and the outside diameter $4\frac{7}{8}''$?

16. There are two balls of the same material with diameters 4″ and 1″, respectively. If the smaller one weighs 3 lb., how much does the larger one weigh?

17. If the inside diameter of a ring is 5 in., what must the outside diameter be if the area of the ring is 6.9 sq. in.?

18. How much less paint will it take to paint a wooden ball 4″ in diameter than one 10″ in diameter?

19. What is the weight of a brass ball $3\frac{1}{2}''$ in diameter if brass weighs .303 lb. per cubic inch?

20. A cube is 19″ on its edge. (*a*) Find its total area. (*b*) Its volume.

21. If a barrel of water contains about 4 cu. ft., what is the approximate weight of the barrel of water? (1 cu. ft. of water weighs 62.5 lb.)

22. A conical funnel has an inside diameter of 19.25″ at the base and is 43″ high inside. (*a*) Find its total area. (*b*) Find its cubical contents.

23. A pointed heap of corn is in the shape of a cone. How many bushels in a heap 10′ high, with a base 20′ in diameter? A bushel contains 2150.42 cu. in.

24. Find the capacity of a rectangular bin 6 ft. wide, 5 ft. 6 in. deep, and 8 ft. 3 in. long.

25. Find the capacity of a berry box with sloping sides 5.1″ by 5.1″ on top, 4.3″ by 4.3″ at the bottom, and 2.9″ in depth.

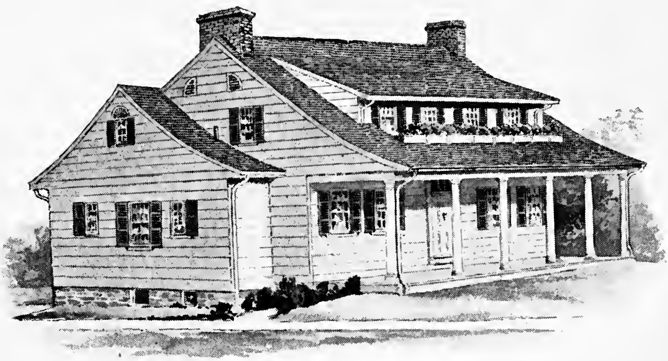
26. Find the capacity of a cylindrical measure 13″ in diameter and 6″ deep.

27. How many tons of nut coal are in a bin 5 ft. wide and 8 ft. long if filled evenly to a depth of 4 ft.? Average nut coal weighs 52 lb. to a cubic foot.

CHAPTER III

INTERPRETATION OF RESULTS

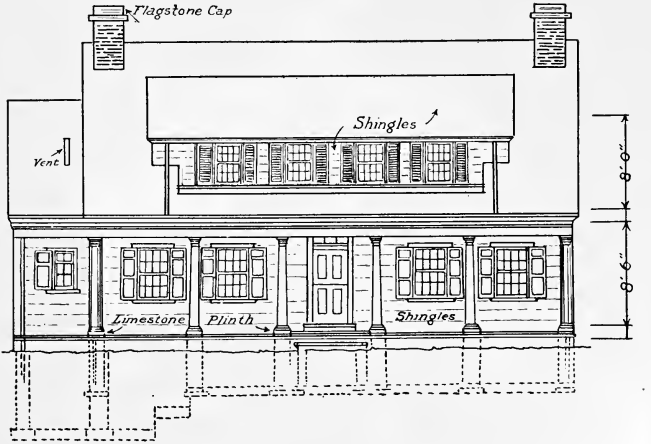
Reading a Blue Print. — Everyone should know how to read a blue print, which is the name given to working plans and drawings with white lines upon a blue background. The blue print is the language which the architect uses to the builder, the machinist to the pattern maker, the engineer to the foreman



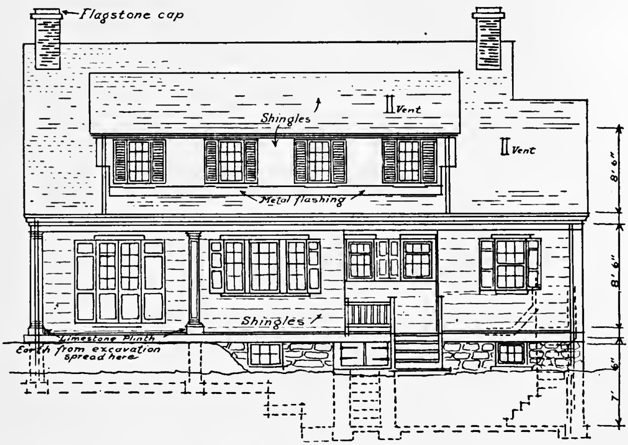
Exterior View of Completed House

of construction, and the designer to the workman. Through following the directions of the blue print the carpenter, metal worker, and mechanic are able to produce the object wanted by the employer and his designer or draftsman.

Blue Print of a House. — An architect, in drawing the plans of a house, usually represents the following views: the exterior views to show the appearance of the house when it is finished; views of each floor, including the basement, to show

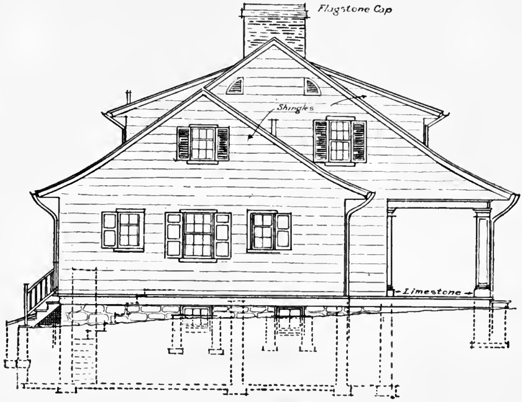


WEST ELEVATION OF HOUSE

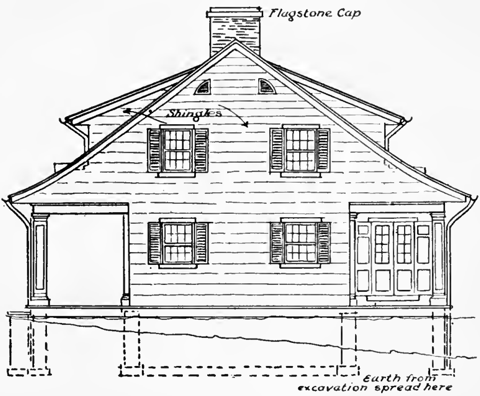


EAST ELEVATION

the location of rooms, windows, doors, and stairs. Detailed plans of sections are drawn for the contractors to show the method of construction.

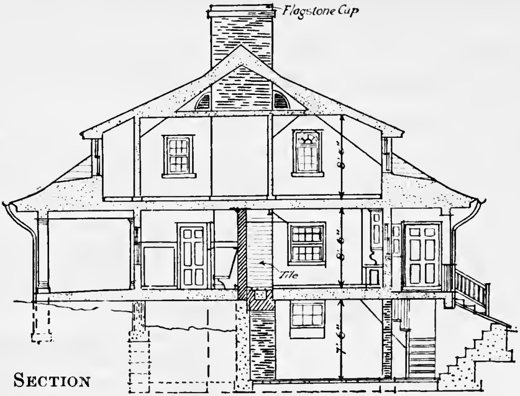


NORTH ELEVATION



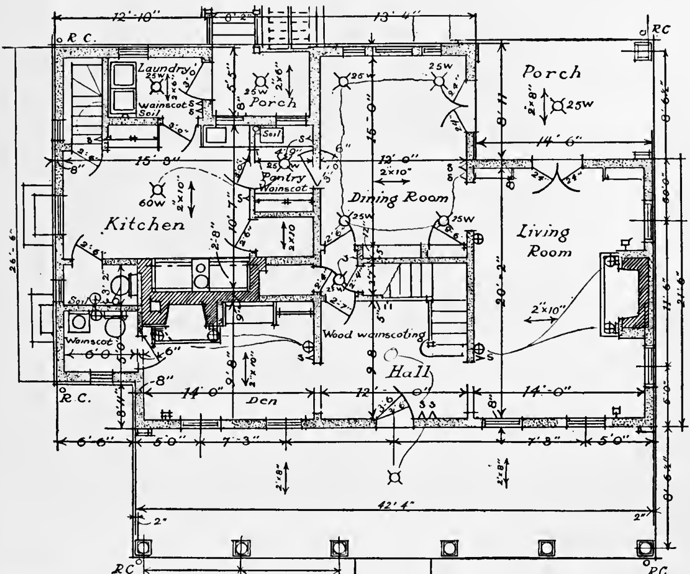
SOUTH ELEVATION

Pupils should be able to form a mental picture of the appearance of a building constructed from any blue print plan set before them. They should have practice in reading the plans of the house and in computing the size of the rooms directly from the blue print.



SECTION

1. What is the height of the rooms on the first floor?
2. What is the height of the rooms on the second floor?
3. What is the height of the cellar, first, and second floors?



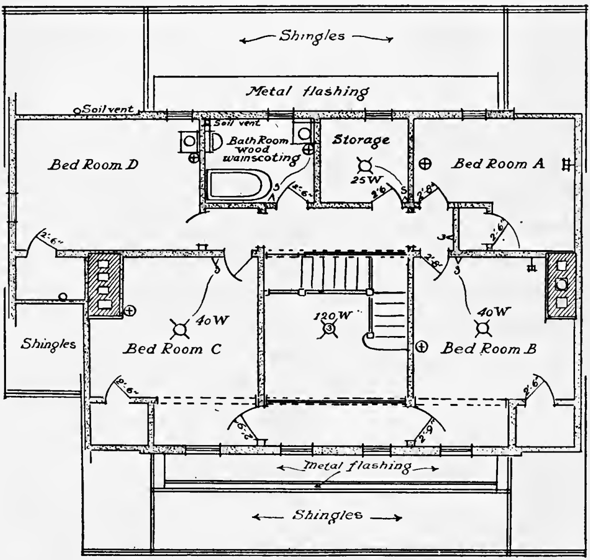
GROUND FLOOR PLAN

1. What is the frontage of the house?

2. What is the depth of the house?

3. What is the length and width of the front porch?

4. What is the length and width of the living room? the dining room? the kitchen?



SECOND FLOOR PLAN

1. What is the size of each of the bedrooms? (Compute with aid of ground floor plan.)

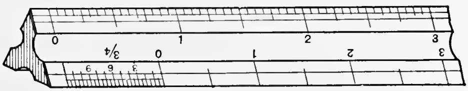
2. What are the dimensions of the bathroom?

3. How large is the storage room?

Two views are usually necessary in every working drawing, one the plan or top view obtained by looking down upon the object, and the other the elevation or front view. When an object is very complicated, a third view, called an end or profile view is shown.

All the information, such as dimensions, etc., necessary to construct whatever is represented by the blue print must be supplied on the drawing. If the blue print represents a machine, it is necessary to show all the parts of the machine put together in their proper places. This is called an assembly drawing. Then there must be a drawing for each part of the building or the machine, giving information as to the size, shape, and number of the pieces. Then if there are interior sections, these must be represented in section drawings.

Drawing to Scale. — As it is impossible to draw most objects full size on paper, it is necessary to make the drawings proportionately smaller. This is done by making all the dimensions of the drawing a certain fraction of the true dimensions of the object. A drawing made in this way is said to be *drawn to scale.*



TRIANGULAR SCALE

The dimensions on the drawing designate the actual size of the object — not of the drawing. If a drawing were made of an iron door 25 inches long, it would be inconvenient to represent the actual size of the door, and the drawing might be made half or quarter the size of the door, but on the drawing the length would read 25 inches.

In making a drawing "to scale," it becomes very tedious to be obliged to calculate all the small dimensions. In order to obviate this work a triangular scale is used. It is a rule with the different scales marked on it. By practice the student will be able to use the scale with as much ease as the ordinary rule.

QUESTIONS AND EXAMPLES

1. Tell what is the scale and the length of the drawing of each of the following:

a. An object 14″ long drawn half size.
b. An object 26″ long drawn quarter size.
c. An object 34″ long drawn one third size.
d. An object 41″ long drawn one twelfth size.

2. If a drawing made to the scale of $\frac{3}{8}'' = 1$ ft. is reduced $\frac{1}{3}$ in size, what will the new scale be?

3. A drawing is made $\frac{1}{8}$ size. If the scale is doubled, how many inches to the foot will the new scale be?

4. On the $\frac{1}{16}''$ scale, how many feet are there in 18 inches?

5. On the $\frac{1}{8}''$ scale, how many feet are there in 26 inches?

6. On the $\frac{1}{4}''$ scale, how many feet are there in 27 inches?

7. If the drawing of a door is made $\frac{1}{3}$ size and the length of the drawing is $8\frac{1}{2}''$, what will it measure if made to scale $3'' = 1$ ft.?

8. What will be the dimensions of the drawing of a banquet hall 582′ by 195′ if it is made to a scale of $\frac{1}{16}'' = 1$ ft.?

Estimating Distances. — Everyone meets occasions in daily life when it is of utmost importance that distance or weight should be correctly estimated.

Few people have a clear conception of even our common standards of measurements. This is due to the fact that the average person has never given the proper attention to them. Improvement will be noticed after a small amount of drill. To illustrate: if the distances of one inch, one foot, one yard, six feet, and ten feet are measured off in a classroom so that an actual view of standard distances is obtained, and then pupils are asked to estimate other and unknown distances, they will estimate with a greater degree of accuracy. Pupils should be able to estimate within $\frac{1}{2}$ inch any distance up to a yard.

The power of estimating longer distances, such as the distance between buildings, across streets, or between streets, may be developed by laying off on a straight road one hundred feet, three hundred feet, and five hundred feet sections, with the proper distance marked on each.

The same plan applies to heights of buildings, etc. Standards of altitude may thus be established.

Pupils should measure in their homes pieces of furniture and wall openings so that they may develop an eye for estimating distances.

1. Estimate the length and width of the schoolroom. Verify this estimate by actual measurement and express the accuracy of your estimate in per cent.

2. Estimate the height and width of the school door. Verify this estimate by actual measurement and express the accuracy of the estimate in per cent.

3. Estimate the width and length of the window panes; the width and length of the window sill.

Estimating Weights. — What is true concerning the advantage of being able to estimate distances applies equally well to weights.

In this, guesswork may be largely eliminated. A little mental figuring on the part of the pupil will usually produce clear results. Weight depends not only on volume but also on the density of the material. Regular blocks of wood are excellent to begin with, and later small spheres and rectangular blocks of different metals afford good material.

1. Select blocks of wood, coal, iron, lead, tin, or copper, and estimate their respective weights.

2. Estimate the weight of a chair.

3. Estimate the weight of different persons.

Methods of Solving Examples. — Every commercial, household, or mechanical problem or operation has two distinct sides: the collecting of data, and the solving of the problem.

The first part, the collecting of data, demands a knowledge of the materials and conditions under which the problem is given, and calls for the exercise of judgment as to the necessary accuracy of the work.

There are three ways by which a problem may be solved:

1. Exact method.

2. Rule of thumb method, by the use of a formula or a rule committed to memory.

3. By means of tables.

The exact method of solving a problem in arithmetic is the one usually taught in school and is the method obtained by analysis. Everyone should be able to solve a problem by the exact method.

The Rule of Thumb Method. — Many of the problems that arise in home, office, and industrial life have been met before, and very careful judgment has been exercised in solving them. As the result of this experience and the tendency to abbreviate and devise shorter methods that give sufficiently accurate results, we find many rule of thumb methods used by the housewife, the storekeeper, the nurse, etc. The exact method would require considerable time and the use of pencil and paper, whereas in cases that are not too complicated the estimates, based on experience or rule, give a quick and accurate result.

In solving problems involving the addition and subtraction of fractions, use the yardstick or tape to carry on the computation. To illustrate: if we desire to add $\frac{1}{3}$ and $\frac{1}{4}$ of a yard, place the thumb over $\frac{1}{3}$ of a yard divisions, then slide (move) the thumb along the divisions corresponding to $\frac{1}{4}$ of a yard, and then read the number of divisions passed over by the thumb. In this case the result is 21 inches.

The Use of Tables. — In the commercial world the tendency is to do everything in the quickest and the most economical way. To illustrate: hand labor is more costly than machine work, so, whenever possible, machine work is substituted for hand labor. The same tendency applies to calculations in the dressmaking shop or the office. The exact methods of doing examples are not the quickest, nor are they more easily understood and performed by the ordinary girl than the shorter methods. Since a great many of the problems in calculation that arise in the daily experiences of the office assistant, the housewife, the dressmaker, the nurse, etc. are about ordinary things and repeat themselves often, it is not necessary to work them anew each time, if, when they are once solved, results are kept on file in the form of tables.

See pages 220, 222, and 254 for tables used in this book.

PART II — PROBLEMS IN HOMEMAKING

CHAPTER IV

THE DISTRIBUTION OF INCOME

THE economic standing of every person in the community depends upon three things: (1) earning capacity, (2) spending ability, and (3) the saving habit. The first regulates the amount of income; the second determines the purchasing power after the amount is earned; the third paves the way to independence.

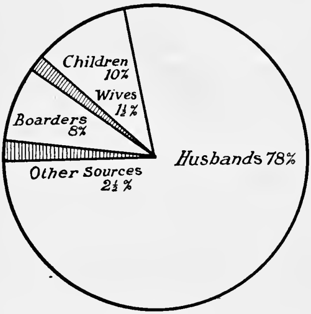
The welfare of every person, whether single or married, depends upon the systematic and careful regulation of each of these three items. No matter how large or small his wages or salary, if he does not spend his money wisely and carefully, or save each week or month a certain per cent of his earnings, a young man or woman is not likely to make a success of life.

A young woman usually has more to do with the spending of money than a young man. The wife is really the spender and the husband the earner in the ordinary home. Therefore, it becomes necessary for every young woman to know how to get one hundred cents out of a dollar. In order to do this, she must know how to distribute the income over such items as rent, food, clothing, incidental expenses due to sickness, pleasure, or self-improvement. The proportion spent for each item should be carefully regulated.

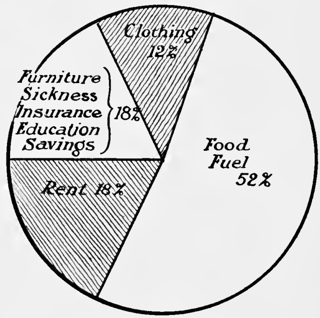
Incomes of American Families

The average family income of both foreign and native born heads is about $ 725 a year; that of families with native born heads alone is about $ 800. Not more than one-fourth have incomes exceeding $ 1000. The daily wages of adult men range from $ 1.50 to $ 5.00. This amounts on the average from $ 450 to $ 1500 a year.

The family, the head of which earns only a few hundred dollars a year, must either be contented with comparatively low standards of living or obtain additional income, either through the labor of children or from boarders or lodgers. The foreign-born workers resort to the labor of children and mothers more than do the native Americans. The second course is quite often adopted so that the average income of workingmen's families is considerably greater than the average earnings of the heads of the families.



INCOMES



EXPENDITURES

Based on Statistics of Twenty-five Thousand Families with an Average Yearly Income of Seven Hundred and Fifty Dollars

EXAMPLES

1. The average workingman's family spends at least two-fifths of its income for food. What per cent is spent for food?

2. If the income of a workingman's family is $ 800, and the amount spent for food is $ 350, what per cent is spent for food?

3. One-fifth of the expenditure of workingmen's families is for rent. What per cent?

4. A family with an income of $ 800 spends $ 12.50 a month for rent. What per cent of the income is spent for rent? Is this too much?

5. A family's income is $ 760. The father contributes $ 601. What per cent of the income is contributed by the father?

6. A family of six has an income of $ 840. The father contributes $ 592, mother $ 112, and one child the balance. What per cent is contributed by the mother and child?

7. A man and wife have an income of $ 971. The husband earns $ 514, the wife keeps boarders and lodgers, and provides the rest of the income. What per cent of the income is contributed by the boarders and lodgers?

Cost of Subsistence

Shelter, warmth, and food demand from two-thirds to three-fourths of the income of most workingmen's families. This leaves for everything else — clothing, furniture, sickness, death, insurance, religion, education, amusements, savings — only one-third or one-fourth of the income. Between $ 200 and $ 250 a year may be considered the usual outlay of workingmen's families for all these purposes combined. It is in these respects that the greatest difference appears between the families of the comparatively poor and the families of the well-to-do. The well-to-do spend not only more in absolute amount, but also a larger proportion of their incomes on these, in general, less absolutely necessary things.

Clothes. — On the average, approximately one-eighth of the income in workingmen's families goes for clothes. To those who keep abreast of the fashions and who dress with some elegance, it may seem quite preposterous that a family of five should spend only $ 100 or less a year for clothing, but multitudes of working-class families are clad with warmth and with decency on such an expenditure.

EXAMPLES

1. If two-thirds of the average workingman's income is spent for shelter, warmth, and food, what per cent is used?

2. A family, receiving an income of $ 847, spends $ 579 for shelter, warmth, and food. What per cent is used?

3. If one-eighth of the income of the average workingmen's family is spent for clothes, what is the per cent?

4. A family receives an income of $ 768, and $ 94 is spent for clothes. What per cent is spent for clothes?

The High Cost of Living

The average cost of living represents the amount that must be expended during a given period by the average family depending on an average income. The maximum or minimum cost, however, is another phase of the problem. It no longer involves the amount of dollars and cents necessary to buy and pay for life's necessaries, but involves questions of home management and housekeeping skill, which cannot be standardized. About 1907 food and other necessities of life began to increase in cost — and this has continued to the present day.

EXAMPLES

1. In 1906 a ton of stove coal cost $ 5.75, and in 1915 $ 8.75. What was the per cent of increase in the cost of coal?

2. In 1907 a suit of clothes cost $ 15. The same suit in 1912 cost $ 19.75. What was the per cent of increase?

3. In 1908 a barrel of flour cost $ 6.10. The same barrel of flour cost in 1914 $ 8.25. What was the per cent of increase?

Division of Income

A girl should always consider her income for the entire year and divide it with some idea of time and relative proportion. If she earns a good salary for only ten months of the year, she must save enough during those months to tide her over the other two. For instance, if a teacher earns $ 60 a month for 10 months of the year, her actual monthly income is $ 50. The milliner, the trained nurse, the actress, and sometimes even the girl working in the mill have the same problem to confront.

No girl has a right to spend nearly all she earns on clothing, neither should she spend too much for amusement. We find from investigations that have been made that girls earning $ 8 or $ 10 a week usually spend about half their income on board and laundry. Girls earning a larger income may pay more for board, but not quite so great a fractional part. In these days, when the cost of living is so high, a girl should consider carefully a position that includes her board and laundry, for in such a position she will be better off financially at the end of the year than her higher salaried sister, who has to pay for the cost of her own living. The housegirl can save about twice as much as the average stenographer.

We find that the average girl needs to spend about one-fifth of her income for clothing. A poor manager will often spend as much as one-third and not be very well dressed at that, because she buys cheap materials, that have to be frequently replaced, and follows every passing fad and style. Choose medium styles and good materials and you will look more richly dressed. Keep the shoes shined, straight at the heel, and the strings fresh. Keep gloves mended, and as clean as possible. If you spend more on clothing than the allotted one-fifth, you will have to go without something else. It may be spending money, or it may be gift or charity money, and quite often it is the bank account that suffers.

Every person should save some part of his income. One never knows when sickness, lack of employment, or ill health may come. Saving money is a habit and one that should be acquired the very first year that a person earns his own living.

EXAMPLES

1. A girl earns $ 12 a week for 42 weeks, and in this time spends $ 144 for clothing. Is she living within the per cent of her income that should be spent for clothing?

2. A salesgirl earns $ 8 a week. She spends $ 98 a year for clothes. Is she living within her income?

3. A girl earns $ 5 a week and pays half of it to her home. She has two car fares and a 14-cent lunch each day. How much should she spend on clothing each year? How much has she for spending money each week? Should she save any money?

4. Which girl is the better off financially, one earning $ 6 a week as a housemaid or one earning $ 7 a week in a store?

Buying Christmas Gifts

Let the gift be something useful. Do not be tempted by the display of fancy Christmas articles, for it is on these that the merchant makes his profit for extra decorations and light. Think of the person for whom you are buying. She may not have the same tastes as you have, so give something that she will like rather than something she ought to like. For instance, a certain girl may be very fond of light hair-ribbons when you know that dark ones would be much more sensible, but at Christmas give the light ones.

The stores always show an extra supply of fancy neckwear. A collar cannot be worn more than three days without becoming soiled, so even 25 cents is too much to pay for something that cannot be cleansed. Over-trimmed Dutch collars and jabots easily rip apart. Choose the plain ordinary ones that you would be glad to wear any day. You see whole counters of handkerchiefs displayed with embroidery, lace, and ruffles. A linen handkerchief, even of very coarse texture, is more suitable.

Be careful also about bright colors, for everything about the store is so gay that ordinary things appear dull, but when you get them out against the white snow, they will be bright enough.

EXAMPLES

1. Shortly before Christmas I purchased $\frac{1}{2}$ doz. handkerchiefs for \$1.50. One month later I purchased the same kind of handkerchiefs at $16\frac{2}{3}$ cents each or 6 for \$1.00. What per cent did I save on the second purchase?

2. I also bought a chiffon scarf for which I paid \$2.25. Early in the fall I saw similar scarfs selling for \$1.50. How much did I lose by not making my purchase at that time? What per cent did I lose?

3. I bought at Christmas two pairs of silk stockings at \$1.50 per pair. If I had purchased the stockings in October they would have cost me $ 1.12½ per pair. How much would I have saved? What per cent would I have saved?

An Expense Account Book

Every person and every family should keep an expense account showing each year's record of receipts and expenditures. A sample form is shown in page 96. Rule sheets in a similar manner for the solution of the problems that follow.

At the end of the year a summary should be made of receipts and disbursements in some such form as the following:

YEARLY SUMMARY

	Receipts		*Disbursements*	
RECEIPTS				
Cash on hand January 1				
Salary, etc.				
Other Income				
DISBURSEMENTS				
Savings and Insurance				
Rent				
Food				
Clothing				
Laundry				
Car fares				
Stamps and Stationery				
Health				
Recreation				
Education				
Gifts, Church, Charity				
Incidentals				
Balance on Hand December 31				
Totals				

Rule similar sheets for the solution of the following problems.

Receipts			Disbursements							From			to		19
Day	Source	Amt.	Total Disbursements	Rent	Food	Clothing	Laundry	Carfares	Health	Recreation	*Education	St'mps and Stationery	Gifts, Ch'r'h, Ch'rity	Savings and Insurance	Incidentals	Details of Disbursements
	Brought for'd															
	Totals															
	Bal. on hand															

* Includes tuition, books, magazines, professional societies.

EXAMPLES

1. A man and wife have an income of $ 1000 a year. The disbursements for the month of October are as follows:

Rent, $ 15	Tooth paste, $ .18
Telephone, 1.45	Provisions, 5.85
Repair on coat, 5.80	Life insurance, 7.40
Gas, .75	Coal, 7.50
Dinner, 1.60	*Outlook* (1 year), 3.00
Stationery, 2.51	Assistance, .60
Fares, .85	Shampoo, .50
Groceries, 10.35	Fares, .60
Fruit, .30	Rubbers, .90
Theater, .50	Soap, .10
Papers, .06	Church, .25
Church, .25	Milk, .56
Milk, .71	Ice, .40
Ice, .45	Papers, .11
Electricity, 1.00	Vase for D., .75
Laundry, .50	Peroxide, .25

Enter the above disbursements in the expense account book. Find the total amount.

What per cent was spent for food? house? clothing? housekeeping? luxuries? savings?

2. The items of expense for the month of January, 1915, are: rent and water, $ 15; operating expense: light and heat, $ 11; food: meats, groceries, $ 30; labor or services, $ 16.65; clothing, $ 15; physician, $ 1; carfares, $ 2.85; books, $ 1.00; amusements, $ 4; cigars, $ 1.00; gifts, $ 1.00; sundry expenses, $ 1.50. Treat as in Ex. 1.

3. A family of two receives an income of $ 1200 a year. They spend per week $ 6.93 for food, $ 3.51 for rent, $ 3.49 for operating expenses, $ 5.81 for contingency. What is the amount for each item per month (4 weeks)? per year (52 weeks)? What is the per cent of each item?

4. A young married woman has an income of $ 1200 a year — $ 100 a month. The following represents the way she spends her income a month:

Savings bank, $ 5.00
Rent, 25.00
Insurance, 5.00
Groceries, 4.70
Meat and fish, 11.15
Milk, 2.79
Clothing, 12.00
Heat and light, 5.00
Laundry and supplies, 2.00
Help, 4.00
Repairs and replenishing, .50
Ice (set aside in the winter months for the summer), $ 0.25
Necessary carfares (the house is located in the country), 2.70
Recreation, 3.00
Avocation, 3.00
Literature, .50
Church and charity, .80
Remembrances, .75
Fire insurance, .09

Enter the above in the expense account book.

How much was left toward the next month's expense? Can you improve on this? What is the per cent for food? Clothing?

5. A girl 14 years of age has cost her parents an amount equal to the following items:

Food, $ 597.16
Clothing, 339.66
Furniture, 88.65
Carfare to school, $ 11.00
Doctor, 70.00
Dentist, 10.00

What is the per cent for each item?

6. A family of seven — three grown people and four children — lived in a southern city on $ 600 — $ 50 per month. The expenses each month were as follows:

House rent, $ 12.00
Groceries, 12.00
Washing, 5.00
Bread, $ 2.50
Beef, 2.50
Vegetables, 2.00

What is the balance for clothing and fuel? What is the per cent of income spent for food? Clothing? Rent? Suggest points of saving.

7. A girl in New York City lives on $ 10 a week. The expenses are as follows:

Board and washing, $ 300.00
Luncheons and carfare, 100.00
Clothing and vacation, $ 95.00
Church and charity, 10.00

How much can she save? What is the per cent for clothing? Incidentals?

Can you suggest any improvements in the distribution of her income?

8. A family of four lives on $ 750 a year. The expenses are as follows:

Rent, $ 180.00
Fuel, 52.00
Meat, oysters, cheese, 95.00
Groceries, including vegetables, butter, eggs, milk, kerosene, soap, etc., $ 241.00
Clothing, about 145.00

How much is left for the savings bank? What per cent for rent? Food? Clothing? Operating expenses?

CHAPTER V

FOOD

SINCE half of the income of the average family is spent for food, it is important that this expenditure should be made intelligently. Experts of the United States Department of Agriculture estimate that the food waste in a great many of the American homes is as high as 20 %. The causes of waste may be classified as follows: Needlessly expensive material, providing little nutrition; failure to select according to season; great amounts thrown away; poor preparation; badly constructed ovens.

If this waste were checked, it would afford an increase in the purchasing power of the income which would appreciably lift the family to a higher plane of efficiency. The efficiency of every person depends upon the energy and constant repair of the body. A woman should know the cost of food and realize what food value she is receiving for her money. It may seem strange, but it is true, that "a Roman feast, a Lenten fast, a Delmonico dinner, and the lunch of the wayside beggar contain the same few elements of nutrition."

The art of cooking can transform the common but nutritious foods into the most appetizing dishes. Further than this, the freshness and attractiveness of the food, the way in which it is served, the surroundings — all affect the appetite and the power to digest. Cost, which must always be considered in the limited income in relation to the nutritive value of food, is influenced by an equally important factor — waste.

The problem of feeding our bodies is primarily a question of supply and demand. Of course, the element of pleasure in eating is a properly normal one, for enjoyment aids digestion. We must, however, eat to live rather than live to eat.

Every motion of the body and every thought in the brain destroy certain tissues. This material must be replaced from the food we eat. The two objects of eating are tissue repair in the adult and tissue repair plus growth in the child. As soon as we realize that these two purposes should determine the character of the food we eat, then we shall know the importance of intelligent instead of haphazard choice of food.

To repair the body means to supply the elements needed to renew the tissues that are worn or destroyed. We can separate the elements of the human body broadly into water, protein, carbohydrates, fats, and ash. Water composes 60 per cent of a normal man's body. In other words, a 200-pound man is composed of only 80 pounds of solids, of which 18 per cent is composed of protein, 15 per cent of fat, 1 per cent of carbohydrates, and 6 per cent of ash.

Water aids digestion and is necessary in the economy of life. Protein is the basis of bone, muscle and other tissues, and essential to the body structure. Fat is an important source of energy in the form of heat and muscular power. Carbohydrates are transformed into fat and are important constituents, though in small proportions in the human body. Ash is composed of potash, soda, and phosphates of lime, and is necessary in forming bone. The diet best fitted to supply all the needs of the healthy human organism must contain a correct proportion of these elements; it is called the balanced ration.

Nutritive Ingredients (or Nutrients) of Food

What has thus far been said about the ingredients of food and the ways in which they are used in the body may be briefly summarized in the following manner:

Food as purchased contains
- Edible portion . . . *e.g.* flesh of meat, yolk and white of eggs, wheat, flour, etc.
  - Water
  - Nutrients
    - Protein
    - Fats
    - Carbohydrates
    - Mineral matters.
- Refuse. *e.g.* bones, entrails, shells, bran, etc.

Uses of Nutrients in the Body

Protein . . . . *e.g.* white (albumen) of eggs, curd (casein) of milk, lean meat, gluten of wheat, etc.	Forms tissue	Repairs tissues. All serve as fuel to yield energy in the forms of heat and muscular power.
Fats . . . . *e.g.* fat of meat, butter, olive oil, oils of corn and wheat, etc.	Are stored in the body as fat	
Carbohydrates . . . . *e.g.* sugar, starch, etc.	Are transformed into fat . .	
Mineral matters (ash) . *e.g.* phosphates of lime, potash, soda, etc.	Share in forming bone, assist in digestion, etc.	

The views thus presented lead to the following definitions: (1) Food is that which, taken into the body, builds tissue or yields energy. (2) The most healthful food is that which best fills the needs of the man. (3) The cheapest food is that which furnishes the largest amount of nutriment at the least cost. (4) The best food is that which is at the same time most healthful and cheapest.

EXAMPLES

Carbohydrates are present in large proportions in all the cereals, bread, and potatoes, and are almost 100 % pure in sugar. There is a widespread notion that starch, which is a fat-producing element, is mostly contained in potatoes, and many people who wish to reduce flesh omit potatoes and substitute rice or larger quantities of bread or cereals. The fact is that the white potato contains only 15 % carbohydrates and the sweet potato 27 %, while rice has 77 % and the breads range from whole wheat bread at 49 % to soda crackers at 73 % and the cereals from oats at 69 % to rye, 78 %.

1. How many ounces of carbohydrates in $\frac{3}{4}$ lb. of white potatoes?

2. Find the number of pounds of carbohydrates in 4 lb. of rice.

3. Find the number of ounces of carbohydrates in a loaf of whole wheat bread ($\frac{3}{4}$ lb.)

4. How many ounces of carbohydrates in a 2 lb. package of Quaker Oats?

5. How many ounces of carbohydrates in 4 oz. of soda crackers?

EXAMPLES

The proportion of ash in foods is small, and as the body requires 6 per cent, we must be sure to supply it in the food. Salt cod has the largest proportion, 25 per cent, and we find it in good quantities in butter, dried beef, smoked herring, and bacon.

Of the proteins, lean meat is the one most easily digested and assimilated. Curiously enough, dried beef has the largest proportion of protein of any flesh meat, 30 per cent, while next in range are leg of lamb, beef steak, roast beef, and fowl, with about 18 per cent.

Let us note the protein value of fish. Smoked herring, despised by many, contains 36 per cent of protein, salt cod and canned salmon 21 per cent, and perch, halibut, mackerel, and fresh cod average 18 per cent, equal in food value per pound to the best beef and fowl. The peanut has 27 per cent of its weight protein, and peanut butter 29 per cent.

Fat is found in large proportion in nuts, especially in walnuts, which contain 63 per cent, and cocoanuts 57 per cent. Bacon contains 67 per cent of fat, and butter 85 per cent.

1. If a man weighs 189 pounds, how many pounds of water in his weight? How many pounds of solids? How many pounds of fat? protein? carbohydrates?

2. How many ounces of protein in a pound and a half dried beef?

3. Give the number of ounces of protein in a pound fowl.

4. Give the number of ounces of protein in $1\frac{1}{4}$ lb. of herring.

5. How many ounces of fat in $1\frac{1}{2}$ lb. of shelled walnuts?

Kitchen Weights and Measures

Correct measurements are absolutely necessary to insure successful results in cooking.

Sift flour, meal, powdered sugar and soda before measuring. Many articles settle hard or in lumps and should be stirred and pulverized before measuring.

Measure all materials level full, leveling with knife. Do not pack powdered articles. Butter, lard, etc., should be packed in measure and leveled.

A half spoonful should be taken lengthwise and not crosswise.
A quarter spoonful should be taken by dividing a half crosswise.
A third spoonful is obtained by dividing twice crosswise.

Equivalents	To Make One Pound
3 teaspoons equal 1 tablespoon.	4 cups flour.
4 tablespoons equal $\frac{1}{4}$ cup.	$2\frac{5}{6}$ cups corn meal.
2 cups equal 1 pint.	$2\frac{2}{3}$ cups oatmeal.
2 pints equal 1 quart.	6 cups rolled oats.
4 quarts equal 1 gallon.	$4\frac{1}{3}$ cups rye meal.
4 cups flour equal 1 lb.	2 cups rice.
2 cups sugar equal 1 lb.	2 cups granulated sugar.
16 tablespoons dry ingredients equal 1 cup.	$2\frac{2}{3}$ cups brown sugar.
	$2\frac{3}{4}$ cups powdered sugar.
12 tablespoons liquid equal 1 cup.	$3\frac{1}{2}$ cups confectioner's sugar.
	2 cups butter.
	2 cups chopped meat.
	$4\frac{1}{3}$ cups ground coffee.

t. is the abbreviation for teaspoonful; and *tb.*, for tablespoonful.

EXAMPLES

1. How many teaspoons in 4 tablespoons?
2. How many tablespoons in $\frac{3}{4}$ cup?
3. How many cups are equivalent to 5 pints?
4. Give the number of tablespoons in a pint.
5. Give the number of teaspoons in 3 quarts and 1 pint.
6. A cup of flour weighs how many ounces? What part of a pound?
7. How many cups will 56 tablespoons of baking soda fill?
8. A pint of liquid contains how many tablespoons?
9. A cup of sugar weighs how many ounces?
10. Two cups of corn meal is what part of a pound?

11. Give the weight in ounces and fractions of a pound of the following quantities: —

(*a*) 1 cup of butter.
(*b*) 1 cup of rice.
(*c*) 3 cups chopped meat.
(*d*) 1 cup of coffee.
(*e*) 1 cup of conf. sugar.
(*f*) 1 cup of powdered sugar.
(*g*) 1 cup of brown sugar.
(*h*) 1 cup of rye meal.
(*i*) 1 cup of oatmeal.

12. What is the cost of each of the following:

(*a*) 1 cup of oatmeal at 5 cts. a pound?
(*b*) 2 cups of sugar at 5 lbs. for 33 cts.?
(*c*) $2\frac{1}{2}$ cups of rice at 5 cts. a pound?
(*d*) $\frac{1}{3}$ cup of milk at 8 cts. a quart?
(*e*) $\frac{3}{4}$ cup of butter at 35 cts. a pound?
(*f*) 2 eggs at 38 cts. a dozen?
(*g*) $\frac{1}{5}$ peck of potatoes at 72 cts. a bushel?
(*h*) $3\frac{1}{2}$ level teaspoons of sugar at 8 cts. a pound?
(*i*) $\frac{1}{6}$ cup of vinegar at 9 cts. a quart.

Cost of Food

In order to calculate the cost of food it is necessary to know price per pound, price per cupful, and even price per teaspoonful. The price should be calculated to three decimal places and the results tabulated as follows:

Cost per pound or quart.
Number of cupfuls in pound or quart.
Cost per cupful.
Cost per tablespoonful.
Cost per teaspoonful.

When it is once calculated the data may be used from day to day in calculating the cost of food.

EXAMPLES

1. What is the cost per teaspoonful of cocoa at 38 cents a pound? (4 cups in a pound.)

2. What is the cost of a third of a cup of powdered sugar at 10 cents a pound? ($2\frac{3}{4}$ cups in a pound.)

3. What is the cost of a tablespoonful of cream at 23 cents a pint?

4. What is the cost of 2 teaspoonfuls of sugar at $6\frac{1}{2}$ cents a pound? (2 cups in a pound.)

5. What is the cost of 6 nuts at 20 cents a pound? (29 walnuts in a pound.)

6. What is the cost of 6 tablespoons of coffee at 35 cents a pound? ($4\frac{1}{3}$ cups of coffee in a pound.)

7. What is the cost of 3 slices of toast at 5 cents a loaf? (10 slices in a loaf.)

8. What is the cost of a pat of butter at 38 cents a pound? (16 pats of butter in a pound.)

9. What is the cost of an ordinary serving of cornflakes at 10 cents a pound? (15 servings in a pound.)

10. What is the cost of a serving of cream ($\frac{3}{8}$ of cup) at 24 cents a pint?

11. What is the cost of an ordinary serving of macaroni at 12 cents a pound? (11 servings to the pound.)

12. What is the cost of a serving of cheese at 20 cents a pound? (9 servings in a pound.)

13. What is the cost of a serving of cabbage salad if cabbage is 3 cents a pound and two servings in a pound? (A tablespoonful of salad dressing of equal parts of oil and vinegar. Oil is 25 cents a half pint. Vinegar is 10 cents a quart.)

14. What is the cost of a serving of stewed apricots at 18 cents a pound? (A half pound of sugar at 7 cents is added to the apricots. Nine servings in a pound.)

15. What is the cost of an ordinary serving of mashed potatoes at 25 cents a half peck? (A teaspoonful of milk at 8 cents a quart to each serving. A half pat of butter at 37 cents a pound, sixteen pats in a pound. Twenty-one servings in a half peck.)

16. What is the cost of a serving of grape jelly ($\frac{1}{2}$ oz.) at 13 cents a pound?

Girls should know how to make out a tabulation of standard food materials, the current price for such material at the local stores, and the cost of quantities commonly used in cooking, as one cup or one tablespoonful. They should, in addition, know how to take common recipes that are used in cooking classes and reckon the cost. This will aid in reckoning the cost of meals and arranging them economically. In a like manner, the cost of meals for one day and for one week may be calculated to see how near they are living within their income.

EXAMPLES

1. A supper consisting of the following is served for 14 people: codfish in tomato sauce, cereal muffins, cookies, and tea. What is the cost per person if the codfish costs 30 cents, the muffins 24 cents, the cookies 34 cents, the tea 10 cents, and fuel 5 cents?

2. What is the cost per person for the following meal when 14 are served? The meal consists of milk toast, stewed prunes with lemon, chocolate layer cake, and tea. The milk toast costs 25 cents, the prunes 25 cents, the cake 50 cents, the tea 10 cents, and fuel 10 cents.

3. In a pound of rolled oats, costing 8 cents, there are 4 cups. What is the cost of a serving ($\frac{1}{4}$ cup) of rolled oats?

4. In a package of cream of wheat costing 14 cents there are $4\frac{1}{2}$ cups. One eighth of a cup is necessary for a serving. What is the cost of a serving?

5. Compute the cost of a cup of white sauce from the following recipe:

1 cup milk	milk, 9c a quart
$4\frac{1}{2}$ t. flour	flour, 5c a pound
$4\frac{1}{2}$ t. butter	butter, 39c a pound
$\frac{1}{4}$ t. salt	salt 1c a cup

6. A dinner consisting of mashed potatoes, peas, rib roast, rolls, jelly, fruit salad, krummel torte, coffee, cream and sugar is served for six. What is the cost per person? Estimate portions from amounts given.

Dishes	Amounts
Mashed potatoes	$\frac{1}{5}$ pk. potatoes at 45c per pk.
	$1\frac{1}{2}$ cups milk at 2c per cup
	3 tablespoons butter at 40c per lb.
Peas	6 tablespoons or $\frac{1}{4}$ can at 13c per can
Rib roast	$\frac{2}{5}$ of 4-lb. roast at 28c per lb.
Gravy	3 cups flour at $.1\frac{1}{2}$c per cup
Rolls	$\frac{1}{3}$ cup milk at 2c per cup
	3 tablespoons sugar, 2 tablespoons butter, $\frac{2}{3}$ yeast cake at 2c
Jelly	$\frac{1}{2}$ glass at 10c per glass
Apple and	3 apples at 8c per doz.
grape salad	$\frac{1}{2}$ lb. grapes at 10c per lb.
Saratoga flakes	$\frac{1}{4}$ package at 15c per package
Salad dressing	$\frac{1}{6}$ cup vinegar at 8c per qt.
	1 egg at 30c per doz.
	3 tablespoons sugar at 7c per lb.
	1 tablespoon butter at 40c per lb.
Krummel Torte	$\frac{1}{3}$ package dates at 10c per package
	$\frac{3}{8}$ cup nuts at 70c per lb., 3 cups per lb.
	$1\frac{1}{2}$ eggs at 30c per doz.
	$\frac{1}{2}$ pt. whipping cream for torte as well as for coffee at 15c $\frac{1}{2}$ pt.
Coffee	6 tablespoons at 34c per lb.
Sugar	3 teaspoons
Sugar total	7 tablespoons = $\frac{7}{16}$ cup at 7c per lb.
Butter total	6 tablespoons = $\frac{3}{8}$ cup at 40c per lb.

7. The following breakfast and luncheon were served for six. What was the cost of each meal per person?

Dishes	Amount per Person
Orange	1 medium-sized, 30c a doz.
Toast	2 thin slices, $\frac{1}{2}$c a slice
Butter	1 ordinary pat, $\frac{1}{2}$c
Egg	1 medium-sized, 3c
Corn flakes	1 ordinary serving, .2c
Cream	$\frac{3}{8}$ cup, 15c $\frac{1}{2}$ pt.
Sugar	$3\frac{1}{2}$ level teaspoons, 7c lb.
Coffee	$2\frac{1}{2}$ tb. at 34c per lb
	Luncheon
Macaroni	Ordinary serving, 4c
and cheese	$\frac{3}{4}$ cu. in., .02c
Cabbage salad	Large serving, .02c
Cooked dressing	1 tablespoon, .00$\frac{1}{2}$c
Stewed apricots	1 serving, 2c
Doughnut	1 large, 1c
Milk	1 cup, 3c

8. The following dinner was served for six. What is the cost per person?

Dishes	Amount per Person
Rib roast, Brown gravy	Fairly large serving, 9c
Butter	Ordinary pat, $\frac{1}{2}$c
Mashed potatoes	Ordinary serving, $\frac{1}{2}$c
Peas	Very small, $\frac{1}{2}$c
Jelly	Very small, 1c
Buns	2 buns, 1c apiece
Apple and	$\frac{1}{2}$ apple, $\frac{1}{2}$c
grape salad	$\frac{1}{2}$ oz. of grapes, 1c
Cooked dressing	1 tablespoon, $\frac{1}{2}$c
Saratoga flakes	3 portions, 10c a pkg. (12 portions)
Krummel Torte	
Dates	6 dates, 10c a lb. (30 dates in a lb.)
Nuts	6 nuts, 18c a lb. (22 nuts in a lb.)
Whipping cream	1 tablespoon, 15c $\frac{1}{2}$ pt.
Sugar	2 teaspoons, 7c a lb.
Cream	1 tablespoon, 25c a pt.

9. The recipe for potato soup for a family of man, wife, and two children is:

3 large potatoes	2 tb. flour
1 qt. milk	$1\frac{1}{2}$ t. salt
2 slices onion	dash pepper
3 tb. butter	1 t. chopped parsley

a. What is the recipe for five men, two women, and three children (consider a child's diet one-half a man's diet, and a woman's equal to a man's)? *b.* What is the recipe for one person (adult)?

10. The recipe for a vegetable soup for a family of husband, wife, and two children is:

Beef, 1 lb.	$1\frac{1}{2}$ qt. water
Bones, 1 lb.	5 tb. butter
$\frac{1}{4}$ cup carrot	1 tb. finely chopped parsley
$\frac{1}{4}$ cup turnip	salt
$1\frac{1}{2}$ cups potato	pepper
$\frac{1}{2}$ onion	

a. What is the recipe for a family of three men, two women, and a child? *b.* What is the recipe for a child?

11. The recipe for sour-milk biscuits for a family of husband, wife, and two children is:

$2\frac{1}{2}$ c. flour	1 tb. fat (lard or butter)
1 t. salt	1 c. sour milk, or $\frac{1}{2}$ c. sour milk
$\frac{1}{2}$ t. soda	$\frac{1}{2}$ c. water

a. What is the recipe for a man, wife, two boarders, and five children? *b.* What is the recipe for one adult?

Food Values

The heating value of food is measured by the amount of heat given off when burned. The food taken into the human system is oxidized slowly in order to give us the ability to do work;

the number of heat units that food is capable of giving a body represents the quantity of energy the food will provide.

There are two units for measuring heat: the English and metric unit. The English unit is called a Calorie, and it represents the quantity of heat necessary to raise a pound of water four degrees on the Fahrenheit scale. The metric unit is also called a calorie and is the amount of heat necessary to raise a gram of water one degree on the Centigrade scale. The English unit is called a large Calorie and is represented by the large letter C while the metric unit is called a small calorie and is represented by the small letter c.

All scientific experiments are conducted in the metric system, while our measurements in daily life are in the English system. It is only necessary to know the English unit, which is used in this book.

The United States Department of Agriculture

The Department Bulletin No. 28 gives the fuel value of foods. It may be well to know how the fuel value is determined. To illustrate: What is the fuel value of flour? Careful experiments by the Department of Agriculture show that flour is composed of 10.6 % protein, 1.1 % fat, and 76.5 % carbohydrates. Other experiments have shown that:

1 gram of protein yields 4100 Calories (C)
1 gram of fat yields 9300 Calories (C)
1 gram of carbohydrates yields 4100 Calories (C)
or 1 ounce of protein yields 113 Calories (C)
1 ounce of fat yields 255 Calories (C)
1 ounce of carbohydrates yields 113 Calories (C)

Then each ounce of flour contains

0.106 ounce protein
0.011 ounce fat
0.763 ounce carbohydrates

Since each ounce of protein yields 113 C, 0.106 oz. will yield 113×0.106, or 11.98 C. 0.011 oz. of fat will yield 255×0.011, or 2.81 C. 0.763 oz. of carbohydrates will yield 0.763×113, or 86.22 C.

EXAMPLES

1. Rice contains 6 % protein, 79.5 % carbohydrates, and 0.7 % fat. What is the fuel value of 3 oz. rice?

2. Milk contains 4 % protein, 5 % carbohydrates, and 4 % fat. What is the fuel value of 8 oz. milk?

3. Beans contain 23.1 % protein, 57 % carbohydrates, and 2 % fat. What is the fuel value of 5 oz. beans?

4. Chicken contains 24.4 % protein and 2 % fat. What is the fuel value of 7 oz. chicken?

5. Pork (shoulder) contains 16 % protein and 32.8 % fat. What is the fuel value of 2 lb. pork?

6. Butter contains 0.6 % protein, 0.5 % carbohydrates, and 85 % fat. What is the fuel value of $\frac{1}{2}$ lb. butter?

7. Eggs contain 14.9 % protein and 10.5 % fat. What is the fuel value of 7 oz. eggs?

8. Cornmeal contains 9.2 % protein, 70.6 % carbohydrates, and 3.8 % fat. What is the fuel value of 3 lb. cornmeal?

9. English walnuts contain 16.6 % protein, 63.4 % carbohydrates, and 16.1 % fat. What is the fuel value of $\frac{3}{4}$ lb. nuts?

It is clear that a balanced ration need not be an expensive one. The amount of heat required by the body varies from 2000 to 3500 calories approximately, dependent upon age, occupation, and sex. A family of a working man, wife, and three children under sixteen years of age requires 12,000 total calories, 1200 to 1800 of protein, or from 10 to 25 % of the total amount required. The quantity of food taken at each meal may vary, provided the total quantities each day reach the standard required. Some authorities suggest about four-twelfths for breakfast, three-twelfths for luncheon, and five-twelfths for dinner.

There are two defects in American diet. First, we fail to have a balanced ration and, second, we think that the richer the food the more nourishing it is, and that its goodness is in proportion to the hours spent in its preparation.

The protein is the most valuable and expensive part of the food supply and it is wise to have a list of proteins so that one can substitute the lesser for the more expensive. Protein, of which we need 18 %, is found more generally in fish than in meat, and the inexpensive peanut is an appetizing substitute; fat, of which we need 15 %, can be had from the fat of all meats, and carbohydrates are better obtained from potatoes than from rich cakes, confectionery, and jellies. We are indebted to modern inventions for a wide list of cooked and partially cooked foods which have economized the time of the busy housewife and which have enriched our breakfast table beyond that of other nations. The breakfast cereals and the grains from which they are made, white bread, potatoes, sugar, butter, and other fats may be classed as carbohydrates, while meat, fish, eggs, milk, cheese, peas, beans, and cabbage are some of the representatives of the protein group. These carbohydrates and nitrogenous substances are not wholly such, but are more or less a mixture of other things.

Making Up Menus

In making up menus it is necessary to have them balance evenly. One should not have too much fat one day, too much starch the next, etc. The menus for each day should hold part of each kind of food, one meat (fish or eggs), one fat, one starch, one tonic vegetable, and one laxative vegetable or fruit.

The summer menus must be compiled most carefully, for too much fat or too much meat tends to heat the body at an excessive rate and should therefore be avoided.

Of the different food materials which are palatable, nutritious, and otherwise suited for nourishment, we should select those that furnish the largest amounts of available nutrients at the lowest cost. To do this it is necessary to take into account not only the price per pound, quart, or bushel of the different materials, but also the kinds and amounts of the actual nutrients they contain and their fitness to meet the demands of the body for nourishment. The cheapest food is that which supplies the most nutriment for the least money. The most economical food is that which is cheapest and at the same time best adapted to the needs of the user.

There are various ways of comparing food materials with respect to the relative cheapness or expensiveness of their nutritive ingredients. The best way of estimating the relative pecuniary economy of different food materials is found in a comparison of the quantities of nutrients and energy which can be obtained for a given sum, say 10 cents, at current prices. This is illustrated in the table which follows :

Comparative Cost of Digestible Nutrients and Energy in Different Food Materials at Average Prices

[It is estimated that a man at light to moderate muscular work requires about 0.23 pounds of protein and 3050 Calories of energy per day.]

Kind of Food Material	Price per Lb.	Cost of 1 Lb. Protein[1]	Cost of 1,000 Calories Energy (a)	Amount for 10 Cents: Total weight of food material	Protein	Fat	Carbohydrates	Energy
	Cents	Dollars	Cents	Lbs.	Lbs.	Lbs.	Lbs.	Calories
Beef, sirloin	25	1.60	25	0.40	0.06	0.06	—	410
Do	20	1.28	20	.50	.08	.08	—	515
Do	15	.96	15	.67	.10	.11	—	685
Beef, round	16	.87	18	.63	.11	.08	—	560
Do	14	.76	16	.71	.13	.09	—	630
Do	12	.65	13	.83	.15	.10	—	740
Beef, shoulder clod	12	.75	17	.83	.13	.08	—	595
Do	9	.57	13	1.11	.18	.10	—	795
Beef, stew meat	5	.35	7	2	.29	.23	—	1,530
Beef, dried, chipped	25	.98	32	.40	.10	.03	—	315
Mutton chops, loin	16	1.22	11	.63	.08	.17	—	890
Mutton, leg	20	1.37	22	.50	.07	.07	—	445
Do	16	1.10	18	.63	.09	.09	—	560
Roast pork, loin	12	.92	10	.83	.11	.19	—	1,035
Pork, smoked ham	22	1.60	13	.45	.06	.14	—	735
Do	18	1.30	11	.56	.08	.18	—	915
Pork, fat salt	12	6.67	3	.83	.02	.68	—	2,950
Codfish, dressed, fresh	10	.93	46	1	.11	—	—	220
Halibut, fresh	18	1.22	38	.56	.08	.02	—	265
Cod, salt	7	.45	22	1.43	.22	.01	—	465
Mackerel, salt, dressed	10	.74	9	1	.13	.20	—	1,135
Salmon, canned	12	.57	13	.83	.18	.10	—	760
Oysters, solids, 50 cents per quart	25	4.30	111	.40	.02	—	.01	90
Oysters, solids, 35 cents per quart	18	3.10	80	.56	.03	.01	.02	125

[1] The cost of 1 pound of protein means the cost of enough of the given material to furnish 1 pound of protein, without regard to the amounts of the other nutrients present. Likewise the cost of energy means the cost of enough material to furnish 1000 Calories, without reference to the kinds and proportions of nutrients in which the energy is supplied. These estimates of the cost of protein and energy are thus incorrect in that neither gives credit for the value of the other.

Comparative Cost of Digestible Nutrients and Energy in Different Food Materials at Average Prices — (*Continued*)

Kind of Food Material	Price per Lb.	Cost of 1 Lb. Protein	Cost of 1000 Calories Energy (a)	Amount for 10 Cents: Total weight of food material	Protein	Fat	Carbohydrates	Energy
	Cents	*Dollars*	*Cents*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Calories*
Lobster, canned	18	1.02	46	.56	.10	.01	—	225
Butter	20	20.00	6	.50	.01	.40	—	1,705
Do	25	25.00	7	.40	—	.32	—	1,365
Do	30	30.00	9	.33	—	.27	—	1,125
Eggs, 36 cents per doz.	24	2.09	39	.42	.05	.04	—	260
Eggs, 24 cents per doz.	16	1.39	26	.63	.07	.06	—	385
Eggs, 12 cents per doz.	8	.70	13	1.25	.14	.11	—	770
Cheese	16	.64	8	.63	.16	.20	.02	1,185
Milk, 7 cents per quart	3½	1.09	11	2.85	.09	.11	.14	885
Milk, 6 cents per quart	3	.94	10	3.33	.11	.13	.17	1,030
Wheat flour	3	.31	2	3.33	.32	.03	2.45	5,440
Do	2½	.26	2	4	.39	.04	2.94	6,540
Corn meal, granular	2½	.32	2	4	.31	.07	2.96	6,540
Wheat breakfast food	7½	.73	4	1.33	.13	.02	.98	2,235
Oat breakfast food	7½	.53	4	1.33	.19	.09	.86	2,395
Oatmeal	4	.29	2	2.50	.34	.16	1.66	4,500
Rice	8	1.18	5	1.25	.08	—	.97	2,025
Wheat bread	6	.77	5	1.67	.13	.02	.87	2,000
Do	5	.64	4	2	.16	.02	1.04	2,400
Do	4	.51	3	2.50	.20	.03	1.30	3,000
Rye bread	5	.65	4	2	.15	.01	1.04	2,340
Beans, white, dried	5	.29	3	2	.35	.03	1.16	3,040
Cabbage	2½	2.08	22	4	.05	.01	.18	460
Celery	5	6.65	77	2	.02	—	.05	130
Corn, canned	10	4.21	23	1	.02	.01	.18	430
Potatoes, 90 cents per bu.	1½	1.00	5	6.67	.1	.01	.93	1,970
Potatoes, 60 cents per bu.	1	.67	3	10	.15	.01	1.40	2,950
Potatoes, 45 cents per bu.	¾	.50	3	13.33	.20	.01	1.87	3,935
Turnips	1	1.33	8	10	.08	.01	.54	1,200
Apples	1½	5.00	8	6.67	.02	.02	.65	1,270
Bananas	7	10.00	27	1.43	.01	.01	.18	370
Oranges	6	12.00	40	1.67	.01	—	.13	250
Strawberries	7	8.75	47	1.43	.01	.01	.09	215
Sugar	6	—	3	1.67	—	—	1.67	2,920

EXAMPLES

1. What is the most economical part of beef for a soup?
2. What is the most economical part of mutton for boiling?
3. What is the most economical part of pork for a roast?
4. Is fresh or salt codfish more economical?
5. What is the fuel value of 3 oz. oatmeal?
6. What is the fuel value of 3 oz. rice?
7. What is the fuel value of 4 oz. strawberries?
8. What is the fuel value of 6 oz. milk?

EXAMPLES

Since several hundred Calories are required each day for a person's diet, it is most convenient in computing meals to think of our foods in 100-Calorie portions. Therefore it is desirable to know how to compute this portion and tabulate it for future reference.

1. 42 qt. of milk give 36,841 Calories. What is the weight of a 100-C portion?

2. $3\frac{1}{2}$ lb. of flour give 1610.5 Calories. What is the weight of a 100-C portion?

3. $\frac{1}{2}$ lb. of dates give 393.75 Calories. What is the weight of a 100-C portion?

4. If $\frac{3}{4}$ of a cup of flaked breakfast food gives approximately 100 C, what is the food value of 1 lb.?

5. If $\frac{1}{8}$ of a cup of skimmed milk gives approximately 100 C, what is the food value of 1 qt.?

6. A teaspoonful of fat gives 100 C. What is the food value of 1 lb. lard?

7. If $\frac{1}{4}$ of a medium-sized egg gives a food value of 100 C, what is the food value of an egg?

8. 4 thin slices of bacon (1 oz.) give a food value of 100 C. What is the food value of 9 lb. of bacon?

9. If $\frac{3}{4}$ oz. of sweet chocolate has a food value of 100 C, what is the food value of $\frac{1}{2}$ lb.?

10. Ten large pears have the value of 100 C, which is the same as for 2 doz. raisins. What is the food value of a single raisin?

11. Find the individual cost of feeding the following families per week and per day. Find the number of Calories per individual per day. (Arrange results in a column as suggested.)

Family	No. in Family	Total Cost	Total Calories
A	5	$ 13.60	86224
B	7	15.06	99928.64
C	3	11.21	101966.75
D	3	5.68	33744.14
E	7	15.01	130557.04
F	6	12.89	93456.34
G	7	17.77	11063.91
H	4	11.86	90891.3
I	4	10.23	50490
J	6	16.47	69385.9
K	8	10.37	112197.3
L	6	16.08	930262
M	7	30.89	86006.8
N	14	32.91	141517
O	6	12.31	85582.8

Economical Use of Meat

It is important to reduce waste by using as much as possible of the bone, fat, and trimmings, not usually served with the meat. If nothing better can be done with them, the bones and trimmings are profitably used in the soup kettle, and the fat can be saved for cooking to be used in place of more expensive butter and lard. The bits of meat not served with the main dish, or remaining after the first serving, may be seasoned and recooked in many palatable ways. Or they can be combined with vegetables, pie crust, or other materials, thus extending the meat flavor over a large quantity of less expensive food.

Different kinds and cuts vary considerably in price. Sometimes the cheaper cuts contain a larger proportion of refuse than the more expensive, and the apparent cost is really more than the actual cost of the more edible portion. Aside from this advantage, that of the more expensive cuts lies in the tenderness and flavor, rather than in the nutritive value. Tenderness depends on the character of the muscle fibers and connective tissues of which the meat is composed. Flavor depends partly on the fat present in the tissues, but mainly on nitrogenous bodies known as extractives, which are usually more abundant or of more agreeable flavor in the more tender parts of the animal. The heat of cooking dissolves the connective tissues of tough meat and in a measure makes it more tender, but heat above the boiling point or even a little lower tends to change the texture of muscle fibers. Hence tough meats must be carefully cooked at low heat long applied in order to soften the connective tissue. For this purpose the fireless cooker may be used to great advantage.

Steers and Beef

Steers are bought from the farmer by the hundredweight (cwt.). They are inspected and then weighed. After they are killed and dressed, they are washed several times and sent to the cooler. The carcass must be left in the cooler several days before it can be cut. It is then divided into eight standard cuts and each piece weighed separately.

Sixty per cent of the meat used in this country is produced in the Federally inspected slaughtering and packing houses, of which there are nearly 900, located in 240 cities.

EXAMPLES

1. A steer weighing 1093 lb. was purchased for $ 7.42 per cwt. What was paid for him?

2. The live weight of a steer is 1099 lb.; the dressed weight 641 lb. What is the difference? What is the percentage of beef in the animal?

3. A steer with a dressed weight of 677 lb. was cut into the following parts: two ribs weighing 61 lb. each, 2 loins 103 lb., 2 rounds 154 lb., and suet 21 lb. What was the percentage of each part to the total amount?

4. A steer with a dressed weight of 644 lb. was sold at \$10.51 per cwt. What was paid?

5. If the value of ribs is 18¢, loins $18\frac{1}{4}$¢, rounds $9\frac{3}{4}$¢, what is the value of cuts in problem 3?

6. A housewife buys $8\frac{3}{4}$ lb. of meat every Monday, $9\frac{1}{2}$ lb. on Wednesday, and $10\frac{1}{2}$ lb. on Saturday. What is the total amount of meat purchased in a week?

7. The live weight of a low-grade steer was 947 lb. and dressed weight 475 lb. What is the per cent of dressed to live weight? What did the steer sell for at $6\frac{1}{2}$ cts. live weight? What was the selling price per cwt.?

8. A high-grade steer weighed live weight 1314 lb. and dressed weight 897 lb. What is the per cent of dressed to live weight? What did the steer sell for at 9 cts. a pound live weight? What was the selling price per cwt.? Note the difference in the price between low- and high-grade steers due to the fact that the latter have a greater proportion of the higher priced cuts.

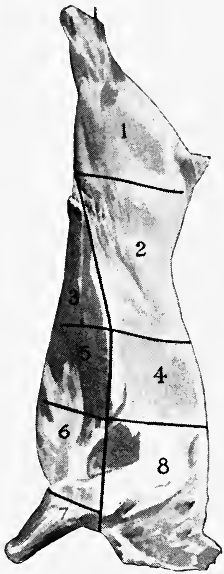
9. A steer was killed weighing 632 lb. and sold for \$10.38 cwt. *a.* What was the selling price? *b.* What was the average price per pound? *c.* What was the percentage of each cut to total value? *d.* What was the total value of each cut?

Cuts	Weight	Price per Pound (Wholesale)
2 Ribs	58 lb.	\$.17
2 Loins	100	$.18\frac{1}{2}$
2 Rounds	150	$.09\frac{3}{4}$
2 Chucks	160	.08
2 Flanks	30	$.05\frac{1}{2}$
2 Shanks	26	.05
2 Briskets	32	$.08\frac{1}{2}$
Navel End	46	.05
Neck Piece	8	$.01\frac{3}{4}$
2 Kidneys	2	.05
Suet	20	.08
	632 lb.	

Cuts of Beef

The cuts of beef differ with the locality and the packing house. The general method of cutting up a side of beef is illustrated in the following figure.

STANDARD BEEF CUTS — CHICAGO STYLE



1 — *Round*

Rump Roast
Round Steak
Corned Beef
Hamburger Steak
Dried Beef
Shank — Soup Bone

2 — *Loin*

Sirloin Steak
Porterhouse Steak
Club Steak
Beef Tenderloin

3 — *Flank*

Flank Steak
Hamburger Steak
Corned Beef

4 — *Ribs*

Rib Roasts

5 — *Navel End*

Short Ribs
Corned Beef
Soup Meat

6 — *Brisket*

Corned Beef
Soup Meat
Pot Roast

7 — *Fore Shank*

Soup Bone

8 — *Chuck*

Shoulder Steak
Shoulder Roast
Pot Roast
Stews

STANDARD PORK CUTS — CHICAGO STYLE

1 — *Short-cut Ham*
Ham

2 — *Picnic Ham*
or California Ham

3 — *Boston Butt*
Pickled Pork
Pork Shoulder
Pork Steak

4 — *Clear Plate*
Dry Salt or Barrel Pork

5 — *Belly*
Bacon
Spare Ribs
Brisket Bacon
Salt Pork

6 — *Loin*
Pork Roast
Pork Chops
Pork Tenderloin

7 — *Fat Back*
Paprika Bacon
Dry Salt Fat Backs
Barrel Pork

EXAMPLES

Hogs are usually killed when nine or ten months old. The weight is 75% to 80% of live weight. The method of cutting up a side of pork differs considerably from that employed with other meats. A large portion of the carcass of a dressed pig consists of almost clear fat. This furnishes the cuts which are used for salt pork and bacon.

1. A hog weighed at the end of 9 months 249 lb. When he was killed and dressed, he weighed 203 lb. What was the per cent of dressed to live weight?

2. A hog weighing 251 lb. was sold for $8\frac{1}{2}$ cents live weight. When he was dressed, he weighed 204 lb. What should he sell for per cwt. (dressed) in order to cover the price of purchase?

3. Sugar-cured hams and bacons are made by rubbing salt into the pieces and placing a brine solution of the following proportions over them in a barrel, before smoking them: 8 lb. salt, 21 lb. brown sugar, 2 oz. saltpeter in four gallons of water for every 100 lb. of meat. What percentage of the solution is salt? Sugar? (Consider a pint of water equal to a pound.)

4. Sausages are made by mixing pork trimmings from the ham with fat and spices, and placing in casings. If 3 lb. of ham are added to 1 lb. fat pork, what is the percentage of lean pork?

STANDARD MUTTON CUTS — CHICAGO STYLE

1 — *Leg*
- Leg of Mutton
- Mutton Chops

2 — *Loin*
- Loin Roast
- Mutton Chops

3 — *Hotel Rack*
- Rib Chops
- Crown Roast

4 — *Breast*
- Mutton Stew

5 — *Chuck*
- Shoulder Roast
- Stew
- Shoulder Chops

EXAMPLES

1. A butcher buys 169 sheep at \$5.75 a head. He sells them so as to receive on the average \$$6.12\frac{1}{2}$ for each. What does he gain?

2. A market man bought 19 dressed sheep for $81.75. What was the average price?

3. A sheep weighed 138 lb. live weight and 72 lb. dressed. What was the per cent of dressed to live weight?

4. A dressed sheep when cut weighed as follows:

Leg	23.1 lb. each	Neck	3.4 lb.	Breast	8.2 lb.
Loin	18.4 lb. each	Shoulder	5.1 lb. each	Shank	5.3 lb. each
Ribs	15.3 lb. each				

What was the total dressed weight? What was the percentage of each cut to the dressed weight?

Length of Time Required to Cook Mutton

Boiling

Mutton, per pound	15 minutes

Baking

Mutton, leg, rare, per pound . . .	10 minutes
Mutton, leg, well done, per pound .	15 minutes
Mutton, loin, rare, per pound . .	8 minutes
Mutton, shoulder, stuffed, per pound	15 minutes
Mutton, saddle, rare, per pound . .	9 minutes
Lamb, well done, per pound . . .	15 minutes

Broiling

Mutton chops, French	8 minutes
Mutton chops, English	10 minutes

EXAMPLES

Give the fraction of an hour required

(*a*) To boil mutton (2 lb.).
(*b*) To bake leg of mutton (3 lb.).
(*c*) To bake loin of mutton (4 lb.).
(*d*) To broil mutton chops (French).
(*e*) To broil mutton chops (English).
(*f*) To bake shoulder of mutton (5 lb.).

Fish is a very economical kind of food. It can be obtained fresh at a reasonable figure in seacoast towns.

1. During the year 1913, 170,000,000 lb. of fish were brought into Boston, and sold for $7,000,000. What was the average price per pound?

2. If 528,000,000 lb. of fish were caught in the waters of New England during the year 1913, it would represent one-quarter of the catch of the entire country. What is the catch of the entire country?

3. A pound of smoked ham at 24 cents contains 16 % protein, while a pound of haddock at 7 cents contains 18 % protein. How much more protein in a pound of haddock than in a pound of ham? (In ounces.)

4. For the same value, how much more protein can you purchase in the haddock than in the ham?

5. A pound of pork chops at 25 cents contains 17 % protein; a pound of herring at 8 cents contains 19 %. How much more protein is there in the pound of herring than in the pork chops?

6. For the same value, how much more protein can be purchased in the pound of herring than in pork chops?

7. A pound of sirloin steak at 30 cents gives the same amount of protein as the pork chops in example 6. For the same value how much more protein can be obtained from haddock than from the steak? What per cent of protein per pound in haddock? Use data in Example 3.

8. If fish can be purchased at any time at not over 12 cents per pound, and meats at not less than 20 cents per pound, what is the per cent of saving by buying fish?

9. If 5.3 % of the total expenses for foodstuffs is for fish, and 22 % of the family earnings goes for food, what is the amount spent for each? Family income $894.

Economical Marketing

The most economical way to purchase food is to buy in bulk. Fancy packages with elaborate labels must be paid for by the consumer. All realize the convenience of package goods, the saving in cost of preparation and cooking and the ease with which they are kept clean and wholesome, but the additional expense is enormous, in some instances as high as 300 %.

EXAMPLES

1. If the retail price of dried beef is 50 cents a pound, how much more per pound do I pay for dried beef, when I purchase a package weighing $3\frac{1}{2}$ oz. for 18 cents? What per cent more do I pay?

2. Wheat costs the farmer or producer $1\frac{1}{2}$ cents per pound. I purchase a package of wheat preparation weighing 5 oz. for 10 cents. How much more do I pay for wheat per pound than it costs to produce it? What per cent more do I pay?

3. Good apples cost $ 2.75 per barrel. If I purchase a peck for 50 cents, at what rate am I paying for apples per barrel? (A standard apple barrel contains $2\frac{1}{2}$ bushels.) How much would I save a peck, if a few families in the neighborhood joined me in purchasing a barrel?

4. Codfish retails at 17 cents a pound. A group of families sent one of their members to the wharf and she purchased for 60 cents a codfish weighing 6 lb. How much was saved per pound? What per cent?

5. Print butter is molded by placing a quantity of tub butter in a mold. If the tub butter costs 34 cts. a pound and the print butter 42 cts. a pound, how much cheaper (per cent) is the tub butter than print butter? Does it afford the same nourishment?

6. A pint can of evaporated milk costs 10 cents and contains the food element of $2\frac{1}{2}$ quarts of fresh milk at 8 cents a quart. What is the saving per quart of milk?

Every housewife should possess the following articles in the kitchen so as to be able to verify everything she buys:

1 good 20-lb. scale	1 dry quart measure
1 peck measure	1 liquid quart measure
1 half-peck measure	60-inch steel tape
1 quarter peck measure	8-oz. graduate

The above should be tested and "sealed" by the Superintendent of Weights and Measures. Check the goods bought and see if weight and volume agree with what was ordered.

EXAMPLES

1. If a gallon contains 231 cu. in., how many cubic inches are there in a quart?

2. If a bushel contains 2150.42 cu. in., how many cubic inches are there in a dry quart?

3. If a half-bushel basket or box, heaping measure, must contain five-eighths bushel, stricken[1] measure, how many cubic inches does the basket contain?

4. A box 12 by 14 by 16 inches when stricken full will hold a heaping bushel. How many cubic inches in the box?

5. A dealer often sells dry commodities by liquid measure. If a quart of string beans were sold by liquid measure for 15 cts., how much would the customer lose? What is the difference in per cent between liquid and dry quart measure?

6. A grocer sold a peck of apples to a housewife. As he was about to place the apples in the basket, the woman called his attention to the fact that the measure was not "heaping." He placed four more apples in the measure. When she reached home she counted 24 apples. What would have been the per cent loss if she had not called his attention to the measure?

[1] Stricken measure is measure that is not heaped, but even full.

7. A "five-pound" pail of lard was found to weigh 4 lb. 11 oz. What per cent was lost to the customer?

8. A package (supposed to be a pound) sold for 12 cents and was found to weigh $14\frac{1}{2}$ ounces. How much did the consumer lose?

9. A quart of ice cream was bought for 40 cents. The box was found to be $12\frac{1}{2}\%$ short. How much did the consumer lose?

10. A girl bought a quart of berries for ten cents. The box was found to contain 54.5 cu. in. How much was lost?

11. A pound of print butter cost 39 cents and was found to weigh $14\frac{1}{2}$ ounces. How much did the consumer lose?

CHAPTER VI

PROBLEMS ON THE CONSTRUCTION OF A HOUSE

Most people live either in a flat or a house. Each has its advantages and its disadvantages. The work of a flat is all on one floor; there are no stairs, halls, cellars, furnaces, and sidewalks to care for, and when the building is heated by steam, there is only the kitchen fire or a gas range to look after. These are the advantages and they reduce the work of the home to very simple proportions.

Then, too, it is possible to find comfortable flats at a moderate price in a neighborhood where it would be impossible to build a small house. However, in these flats some of the rooms are not well lighted and ventilated, and one is dependent upon the janitor for many services which are not always pleasantly performed, though fees are constantly expected. The long flights of stairs are a great drawback, because people will not go out as much as they should, on account of the exhausting climb on their return.

The small house, in country or city, brings more healthful mental and physical surroundings than the flat. Perfect ventilation, light, sunshine, and freedom from all petty restrictions give a more vigorous tone to body and mind. If the house is in the suburbs and there is some land with it, where a few vegetables and flowers can be cultivated, it has an added charm and blessing in the form of healthful outdoor work: furnace, cellar, and grounds for the husband's share; house, from garret to cellar, for the wife's share. In a flat a man can escape nearly all duties about the house, but in the little house he must bear his share.

If one lives in the suburbs, the time and money spent in going to and from the city is quite an item, but the cheaper rent usually more than balances the traveling expense. A person should not pay over 25 % of income for rent. In case a person receives an income of $1500 or over, and has a savings bank deposit of about $1500, it is usually better to purchase a house than to rent. Money may be borrowed from either the coöperative bank or the savings bank.

The total rent of a house a year should be at least 10 % of the value of the house and land: 6 % represents interest on the investment, and 4 % covers taxes and depreciation. In a flat the middle floor should cost approximately 10 % more than the first floor, and the top 10 % less than the first floor.

EXAMPLES

1. A single house and land cost $2800. What should be considered the rent per year?

2. A two-family house cost $5600. (*a*) What should be the rent per month? (*b*) What should be the rent of each flat?

3. A three-family house costs $6500. What should be the rent of each floor?

4. A family desires to build a cottage-style, gambrel roof house containing seven rooms, bath, reception hall, cemented cellar, and small storage attic. It is finished inside with North Carolina pine and has hard-pine floors, fir doors, open plumbing, two coats of plaster, furnace heat, and electric light. The first floor has three rooms and a reception hall. The second floor has three chambers, bath, and sewing room over the hall. The architect finds that the cost of materials in the summer and late fall varies as follows:

Item	Summer	Amount saved by building in the Fall
Mason work	$200	$16.00
Brick and cement	90	7.20
Lumber	500	60.00
Finish	125	12.50
Plumbing	225	22.50
Heat (furnace)	100	10.00
Paint and paper	200	20.00
Plastering	200	16.00
Electric wiring	40	3.20
Electric light fixtures	40	4.00
Labor (carpenters)	450	
Profit to contractor	213	27.52

(*a*) What is the total cost in each case? (*b*) What is the difference in per cent? What is the per cent difference in each item?

Economy of Space

Many persons who build houses, barns, and other buildings do not understand the fundamental fact that there is more space in a square building than in a long one, and that the further they depart from the square form the more their building will cost in proportion to its size. For instance, a building 20′ by 20′ has 400 square feet of floor space and requires 80 feet of outside wall, while one 10′ by 40′ will, with the same floor space, require 100 feet of wall. Accordingly more material and work will be required for the longer one.

In many cases, of course, there are objections to having a building square. The longer building, for instance, gives more wall space and more light, and these may be desired items. The roof and floor items are about the same in either case.

Preparation of Wood for Building Purposes

In winter the forest trees are cut and in the spring the logs are floated down the rivers to sawmills, where they are sawed into boards of different thicknesses. To square the log, four slabs are first sawed off. After these slabs are off, the remainder is sawed into boards.

As soon as the boards or planks are sawed from the logs, they are piled on prepared foundations in the open air to season. Each layer is separated from the one above by a crosspiece, called a strip, in order to allow free circulation of air about each board to dry it quickly and evenly. If lumber were piled up without the strips, one board upon another, the ends of the pile would dry and the center would rot. This seasoning or drying out of the sap usually requires several months.

Wood that is to be subject to a warm atmosphere has to be artificially dried. This artificially dried or kiln-dried lumber has to be dried to a point in excess of that of the atmosphere in which it is to be placed after being removed from the kiln. This process of drying must be done gradually and evenly or the boards may warp and then be unmarketable.

Definitions

Board Measure. — *A board one inch or less in thickness is said to have as many board feet as there are square feet in its surface.* If it is more than one inch thick, the number of board feet is found by multiplying the number of square feet in its surface by its thickness measured in inches and fractions of an inch.

The number of board feet = length (in feet) × width (in feet) × thickness (in inches).

Board measure is used for plank measure. A plank 2″ thick, 10″ wide, and 15′ long, contains twice as many square feet (board measure) as a board 1″ thick of the same width and length.

Boards are sold at a certain price per hundred (C) or per thousand (M) board feet.

The term **lumber** is applied to pieces not more than four inches thick; **timber** to pieces more than four inches thick; but a large amount taken together often goes by the general name of *lumber*. A piece of lumber less than an inch and a half thick is called a **board** and a piece from one inch and a half to four inches thick is called a **plank**.

Rough Stock is lumber the surface of which has not been dressed or planed.

The standard lengths of pieces of lumber are 10, 12, 14, 16, 18 feet, etc.

EXAMPLES

1. How many board feet in a board 1 in. thick, 15 in. wide, and 15 ft. long?

2. How many board feet of 2-inch planking will it take to make a walk 3 feet wide and 4 feet long?

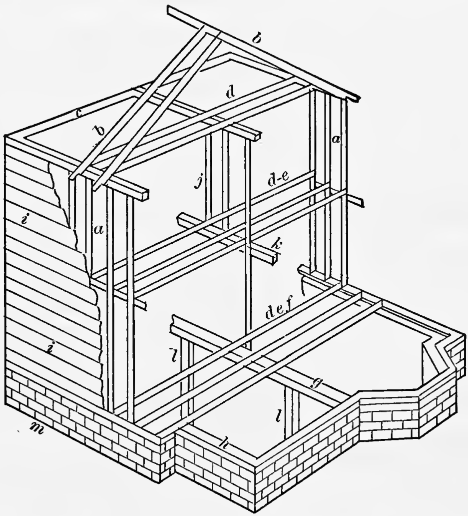
3. A plank 19′ long, 3″ thick, 10″ wide at one end and 12″ wide at the other, contains how many board feet?

4. Find the cost of 7 2-inch planks 12 ft. long, 16 in. wide at one end, and 12 in. at the other, at $0.08 a board foot.

5. At $12 per M, what will be the cost of 2-inch plank for a 3 ft. 6 in. sidewalk on the street sides of a rectangular corner lot 56 ft. by 106 ft. 6 in.?

Frame and Roof

After the excavation is finished and the foundation laid, the construction of the building itself is begun. On the top of the foundation a large timber called a **sill** is placed. The timbers running at right angles to the front sill are called **side sills**. The sills are joined at the corners by a half-lap joint and held together by spikes.



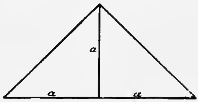
a. Outside studding	*de*. Second-floor joists	*i*. Sheathing
b. Rafters	*def*. First-floor joists	*j*. Partition studs
c. Plates	*g*. Girder or cross sill	*k*. Partition heads
d. Ceiling joists	*h*. Sills	*l*. Piers

The walls of the building are framed by placing corner posts 4″ by 6″ on the four corners. Between these corner posts there are placed smaller timbers called **studding**, 2″ by 4″, 16″ apart. Later the laths, 4′ long, are nailed to this studding. The upright timbers are often mortised into the sills at the bottom. When these uprights are all in position, a timber, called **a plate**, is placed on the top of them and they are spiked together.

On the top of the plate is placed the roof. The principal timbers of the roof are the **rafters**. Different roofs have a different **pitch** or **slope** — that is, form different angles with the plate. To obtain the desired pitch the carpenter uses the steel square.

A roof with one half pitch means that the height of the ridge of the roof above the level of the plate is equal to one half the width of the building.

This illustrates a roof with one-half pitch.



EXAMPLES

Give the height of the ridge of the roof above the level of the plate of the following building:

	Pitch	Width of Building
1.	One-half	32′
2.	One-fourth	40′
3.	One-third	36′
4.	One-sixth	48′

Building Materials

Besides wood many materials enter into the construction of buildings; among these are mortar, cement, stone, bricks, marble, slate, etc.

Mortar is a paste formed by mixing lime with water and sand in the correct proportions. (Common mortar is generally made of 1 part of lime to 5 parts of sand.) It is used to hold bricks, etc., together, and when stones or bricks are covered with this paste and placed together, the moisture in the mortar evaporates and the mixture "sets" by the absorption of the carbon dioxide from the air. Mortar is strengthened by adding cow's hair when it is used to plaster a house; in such mortar there is sometimes half as much lime as sand.

Plaster is a mixture of a cheap grade of gypsum (calcium sulphate), sand, and hair. When the plaster is mixed with water, the water combines with the gypsum and the minute crystals in forming interlace and cause the plaster to "set."

When masons plaster a house, they estimate the amount of work to be done by the square yard. Nearly all masons use the following rule: Calculate the total area of walls and ceilings and deduct from this total area one-half the area of openings such as doors and windows. A bushel of mortar will cover about 3 sq. yd. with two coats.

EXAMPLE. — How many square yards of plastering are necessary to plaster walls and ceiling of a room 28′ by 32′ and 12′ high?

Areas of the front and back walls are	$28 \times 12 \times 2 =$	672 sq. ft.
Areas of the side walls are	$32 \times 12 \times 2 =$	768 sq. ft.
Area of the ceiling is	$28 \times 32 =$	896 sq. ft.
		2336 sq. ft.

$$2336 \text{ sq. ft.} = \tfrac{2336}{9} \text{ sq. yd.} = 259\tfrac{5}{9} \text{ sq. yd.}$$

260 sq. yd. *Ans.*

EXAMPLES

1. What will it cost to plaster a wall 10 ft. by 13 ft. at $ 0.30 per square yard?

2. What will it cost to plaster a room 28′ 6″ by 32′ 4″ and 9′ 6″ high, at 29 cents a square yard, if one-half its area is allowed for openings and there are two doors 8′ by $3\frac{1}{2}$′ and three windows 6′ by 3′ 3″?

3. What will it cost to plaster an attic 22′ 4″ by 16′ 8″ and 9′ 4″ high, at a cost of 32 cents a square yard?

Bricks used in Building

Brickwork is estimated by the thousand, and for various thicknesses of wall the number required is as follows:

$8\frac{1}{4}$-inch wall, or 1 brick in thickness, 14 bricks per superficial foot.
$12\frac{3}{4}$-inch wall, or $1\frac{1}{2}$ bricks in thickness, 21 bricks per superficial foot.
17-inch wall, or 2 bricks in thickness, 28 bricks per superficial foot.
$21\frac{1}{2}$-inch wall, or $2\frac{1}{2}$ bricks in thickness, 35 bricks per superficial foot.

EXAMPLES

From the above table solve the following examples:

1. How much brickwork is in a 17″ wall (that is, 2 bricks in thickness) 180′ long by 6′ high?

2. How many bricks in an $8\frac{1}{4}''$ wall, $164'\ 6''$ long by $6'\ 4''$?

3. How many bricks in a $17''$ wall, $48'\ 3''$ long by $4'\ 8''$?

4. How many bricks in a $21\frac{1}{2}''$ wall, $36'\ 4''$ long by $3'\ 6''$?

5. How many bricks in a $12\frac{3}{4}''$ wall, $38'\ 3''$ long by $4'\ 2''$?

6. At \$19 per thousand find the cost of bricks for a building $48'$ long, $31'$ wide, $23'$ high, with walls $12\frac{3}{4}''$ thick. There are 5 windows ($7' \times 3'$) and 4 doors ($4' \times 8\frac{1}{2}'$).

To estimate the number of bricks in a wall it is customary to find the number of cubic feet and then multiply by 22, which is the number of bricks in a cubic foot with mortar.

7. How many bricks are necessary to build a partition wall $36'$ long, $22'$ wide, and $18''$ thick?

8. How many bricks will be required for a wall $28'\ 6''$ long, $16'\ 8''$ wide, and $6'\ 5''$ high?

9. How many cubic yards of masonry will be necessary to build a wall $18'\ 4''$ long and $12'\ 2''$ wide and $4''$ thick?

10. At \$19 per thousand, how much will the bricks cost to build an $8\frac{1}{4}''$, or one-brick wall, $28'\ 4''$ long and $8'\ 3''$ high?

11. At \$20.50 per thousand, how much will the bricks cost to build a $12\frac{3}{4}''$ wall, $52'\ 6''$ long and $14'\ 8''$ high?

12. A house is $45' \times 34' \times 18'$, the walls are 1 foot thick, the windows and doors occupy 368 cu. ft.; how many bricks will be required to build the house?

13. What will it cost to lay 250,000 bricks, if the cost per thousand is \$8.90 for the bricks; \$3 for mortar; laying, \$8; and staging, \$1.25?

Stonework

Stonework, like brickwork, is measured by the cubic foot or by the perch ($16\frac{1}{2}' \times 1\frac{1}{2}' \times 1'$) or cord. Practical men usually consider 24 cubic feet to the perch and 120 cubic feet to the cord. The cord and perch are not much used.

The usual way is to measure the distance around the cellar on the outside for the length. This includes the corners twice, but owing to the extra work in making corners this is considered proper. No allowance is made for openings unless they are very large, when one-half is deducted.

The four walls may be considered as one wall with the same height.

EXAMPLE. — If the outside dimensions of a wall are 44′ by 31′, 10′ 6″ high and 8″ thick, find the number of cubic feet.

$$\begin{array}{r} 44 \\ \underline{31} \\ 75 \\ \underline{2} \\ 150 \text{ ft. length.} \end{array} \qquad \overset{\overset{25}{\cancel{75}}}{\cancel{150}} \times \frac{21}{\cancel{2}} \times \frac{\overset{2}{\cancel{8}}}{\underset{\cancel{4}}{\cancel{12}}} = 1050 \text{ cu. ft.} \quad \textit{Ans.}$$

Cement

Some buildings have their columns and beams made of concrete. Wooden forms are first set up and the concrete is poured into them. The concrete consists of Portland cement, sand, and broken stone, usually in the proportion of 1 part cement to 2 parts sand and 4 parts stone. The average weight of this mixture is 150 pounds per cubic foot. After the concrete has "set," the wooden boxes or forms are removed.

Within a few years twisted steel rods have been placed in the forms and the concrete poured around them. This is called reënforced concrete and makes a stronger and safer combination than the whole concrete. It is used in walls, sewers, and arches. It takes a long time for the concrete to reach its highest compressive and tensile strength.

Cement is also used for walls and floors where a waterproof surface is desired. When the cement "sets," it forms a layer like stone, through which water cannot pass. If the cement is inferior or not properly made, it will not be waterproof and water will pass through it and in time destroy it.

EXAMPLES

1. If one bag (cubic foot) of cement and one bag of sand will cover $2\frac{2}{3}$ sq. yd. one inch thick, how many bags of cement and of sand will be required to cover 30 sq. yd. $2\frac{1}{2}''$ thick?

2. How many bags of cement and of sand will be required to lay a foundation 1″ thick on a sidewalk 20′ by 8′?

3. How many bags of cement and of sand will it take to cover a walk, 34′ by 8′ 6″, $\frac{3}{4}$″ thick?

4. If one bag of cement and two of sand will cover $5\frac{1}{3}$ sq. yd. $\frac{3}{4}$″ thick, how much of each will it take to cover 128 sq. ft.?

5. How much of a mixture of one part cement, two parts sand, and four parts cracked stone will be needed to cover a floor 28′ by 32′ and 8″ deep? How much of each will be used?

Shingles

Shingles for roofs are figured as being 16″ by 4″ and are sold by the thousand. The widths vary from 2″ upward. They are put in bundles of 250 each. When shingles are laid on the roof of a building, they overlap so that only part of each is exposed to the weather.

EXAMPLES

1. How much will it cost for shingles to shingle a roof 50 ft. by 40 ft., if 1000 shingles are allowed for 125 sq. ft. and the shingles cost $ 1.18 per bundle?

2. Find the cost of shingling a roof 38 ft. by 74 ft., 4″ to the weather, if the shingles cost $ 1.47 a bundle, and a pound and a half of cut nails at 6 cents a pound are used with each bundle.

3. How many shingles would be needed for a roof having four sides, two in the shape of a trapezoid with bases 30 ft. and 10 ft., and altitude 15 ft., and two (front and back) in the shape of a triangle with base 20 ft. and altitude 15 ft.? (1000 shingles will cover 120 sq. ft.)

Slate Roofing

In order to make the exterior of a house fireproof the roof should be tile or slate. Slates make a good-looking and durable roof. They are put on, like shingles, with nails. Estimates for slate roofing are made on 100 sq. ft. of the roof.[1]

The following are typical data for building a slate roof:

A square of No. 10 × 20 Monson slate costs about \$8.35.
Two pounds of galvanized nails cost \$0.16 per pound.
Labor, \$3 per square.
Tar paper, at $2\frac{3}{4}$ cents per pound, $1\frac{1}{2}$ lb. per square yard.

EXAMPLES

Using the above data, give the cost of making slate roofs for the following:

1. What is the cost of laying a square of slate?
2. What is the cost of laying slate on a roof 112′ by 44′?
3. What is the cost of laying slate on a roof 156′ by 64′?
4. What is the cost of laying slate on a roof 118′ by 52′?
5. What is the cost of laying slate on a roof 284′ by 78′?

Clapboards

Clapboards are used to cover the outside walls of frame buildings. Most clapboards are 4′ long and 6″ wide. They are sold in bundles of twenty-five. Three bundles will cover 100 square feet if they are laid 4″ to the weather.

To find the number of clapboards required to cover a given area, find the area in square feet and divide by $1\frac{1}{3}$. Allowance may be made for openings by deducting from area.

EXAMPLES

1. How many clapboards will be required to cover an area of 40 ft. by 30 ft.?

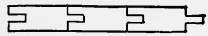
2. How many clapboards will be necessary to cover an area of 38′ by 42′ if 56 sq. ft. are allowed for doors and windows?

3. How many clapboards will a barn 60 ft. by 50 ft. require if 10% is allowed for openings and the distance from foundation to the plate is 17 ft. and the gable 10 ft. high?

[1] Called a square.

Flooring

Most floors in houses are made of oak, maple, birch, or pine. This flooring is grooved so that the boards fit closely together without cracks between them.



The accompanying figure shows the ends of pieces of matched flooring. Matched boards are also used for ceilings and walls. In estimating for matched flooring enough stock must be added to make up for what is cut away from the width in matching. This amount varies from $\frac{1}{2}''$ to $\frac{3}{4}''$ on each board according to its size. Some is also wasted in squaring ends, cutting up, and fitting to exact lengths. A common floor is made of unmatched boards and is usually used as an under floor. Not more than $\frac{1}{4}''$ per board is allowed for waste.

EXAMPLE. — A room 12 ft. square is to have a floor laid of unmatched boards $1\frac{1}{2}''$ wide; one-third is to be added for waste. What is the number of square feet in the floor? What is the number of board feet required for laying the floor?

$12 \times 12 = 144$ sq. ft. = area.
144. *Ans.*

$144 \times \frac{1}{3} = 48$
$\underline{144}$
192 board measure for unmatched floor.
192. *Ans.*

EXAMPLES

1. How much $\frac{7}{8}$ in. matched flooring 3″ wide will be required to lay a floor 16 ft. by 18 ft.? One-fourth more is allowed for matching and 3 % for squaring ends.

2. How much hard pine matched flooring $\frac{7}{8}''$ thick and $1\frac{1}{2}''$ wide will be required for a floor $13' 6'' \times 14' 10''$? Allow $\frac{1}{3}$ for matching and add 4 % for waste.

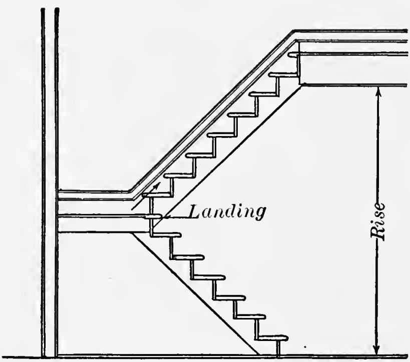
3. An office floor is 10′ 6″ wide at one end and 9′ 6″ wide at the other (trapezoid) and 11′ 7″ long. What will the material cost for an unmatched maple floor $\frac{7}{8}''$ thick and $1\frac{1}{2}''$ wide at $ 60 per M, if 4 sq. ft. are allowed for waste?

4. How many square feet of sheathing are required for the outside, including the top, of a freight car 34′ long, 8′ wide, and $7\frac{1}{2}'$ high, if $37\frac{1}{2}\%$ covers all allowances?

5. In a room 50′ long and 20′ wide flooring is to be laid; how many feet (board measure) will be required if the stock is $\frac{7}{8}'' \times 3''$ and $\frac{1}{4}$ allowance for waste is made?

Stairs

The perpendicular distance between two floors of a building is called the **rise** of a flight of stairs. The width of all the steps is called the **run**. The perpendicular distance between steps is called the **width of risers**. **Nosing** is the slight projection on the front of each step. The board on each step is the **tread**.



STAIRS

To find the number of stairs necessary to reach from one floor to another: Measure the rise first. Divide this by 8 inches, which is the most comfortable riser for stairs. The run should be $8\frac{1}{2}$ inches or more to allow for a tread of $9\frac{3}{4}$ inches with a nosing of $1\frac{1}{4}$ inches.

EXAMPLE. — How many steps will be required, and what will be the riser, if the distance between floors is 118 inches?

$$118 \div 8 = 14\tfrac{3}{4} \text{ or 15 steps.}$$
$$118 \div 15 = 7\tfrac{13}{15} \text{ inches each riser.} \quad \textit{Ans.}$$

EXAMPLES

1. How many steps will be required, and what will be the riser, (*a*) if the distance between floors is 8′? (*b*) If the distance is 9 feet?

2. How many steps will be required, and what will be the riser, (*a*) if the distance between floors is 12′? (*b*) If the distance is 8′ 8″?

Lathing

Laths are thin pieces of wood, 4 ft. long and $1\frac{1}{2}$ in. wide, upon which the plastering of a house is laid. They are usually put up in bundles of one hundred. They are nailed $\frac{3}{8}$ in. apart and fifty will cover about 30 sq. ft.

EXAMPLES

1. At 30 cents per square yard what will it cost to lath and plaster a wall 12 ft. by 15 ft.?

2. At 45 cents per square yard what will it cost to lath and plaster a wall 18 ft. by 16 ft.?

3. What will it cost to lath and plaster a room (including walls and ceiling) 16 ft. square by 12 ft. high, allowing 34 sq. ft. for windows and doors, at 40 cents per square yard?

4. What will it cost to lath and plaster the following rooms at $41\frac{1}{2}$ cents per square yard?

a. $16' \times 14' \times 11'$ high with a door $8' \times 2\frac{1}{2}'$ and 2 windows $2\frac{1}{2}' \times 5'$.
b. $18' \times 15' \times 11'$ high with a door $10' \times 3'$ and 4 windows $2\frac{1}{2}' \times 5'$.
c. $20' \times 18' \times 12'$ high with a door $11' \times 3'$ and 4 windows $2\frac{1}{2}' \times 4'$.
d. $28' \times 32' \times 16'$ high with a door $10' \times 3'$ and 4 windows $3' \times 5'$.
e. $28' \times 30' \times 15'$ high with a door $10' \times 3'$ and 3 windows $3' \times 5'$.

Painting

Paint, which is composed of dry coloring matter or pigment mixed with oil, drier, etc., is applied to the surface of wood by means of a brush to preserve the wood. The paint must be composed of materials which will render it impervious to water, or rain would wash it from the exterior of houses. It should thoroughly conceal the surface to which it is applied. The unit of painting is one square yard. In painting wooden houses two coats are usually applied.

It is often estimated that one pound of paint will cover 4 sq. yd. for the first coat and 6 sq. yd. for the second coat. Some allowance is made for openings; usually about one-half the area of openings is deducted, for considerable paint is used in painting around them.

Table

1 gallon of paint will cover on concrete . . .	300 to 375 superficial feet
1 gallon of paint will cover on stone or brick work	190 to 225 superficial feet
1 gallon of paint will cover on wood	375 to 525 superficial feet
1 gallon of paint will cover on well-painted surface or iron	600 superficial feet
1 gallon of tar will cover on first coat . . .	90 superficial feet
1 gallon of tar will cover on second coat . .	160 superficial feet

EXAMPLES

1. How many gallons of paint will it take to paint a fence 6′ high and 50′ long, if one gallon of paint is required for every 350 sq. ft.?

2. What will be the cost of varnishing a floor 22′ long and 16′ wide, if it takes a pint of varnish for every four square yards of flooring and the varnish costs $2.65 per gallon?

3. What will it cost to paint a ceiling 36′ by 29′ at 21 cents per square yard?

4. What will be the cost of painting a house which is 52′ long, 31′ wide, 21′ high, if it takes one gallon of paint to cover 300 sq. ft. and the paint costs $ 1.65 per gallon? (House has a flat roof.)

Papering

Wall paper is 18″ wide and may be bought in single rolls 8 yards long or double rolls 16 yards long. When you get a price on paper, be sure that you know whether it is by the single or double roll. It is usually more economical to buy a double roll. There is considerable waste in cutting and matching paper, hence it is difficult to estimate the exact amount.

A fraction of a roll is not sold, — there are various rules provided. The border, called **frieze**, is usually sold by the yard.

Find the perimeter of the room in feet, and divide this by the width of the paper (which is 18″ or $1\frac{1}{2}'$). The quotient obtained equals the number of strips of paper required. Then divide the length of the roll by the height of the room in order to obtain the number of strips in the roll. The number of rolls required is found by dividing the strips in the room by the strips in the roll.

Another rule is: Find the perimeter of the room in yards, multiply that by 2, and you have the number of strips. Find the length of each strip. How many whole strips can you cut from a double roll? How many rolls will it take? To allow for doors and windows deduct 1 yard from the perimeter for each window and each door.

EXAMPLES

1. A paper hanger is asked to paper a square room 18′ by 18′ with a door and three windows. The door is 3′ by 7′ and the windows 2′ by 4′. How many double rolls of paper will he use? (Consider all rooms 9′ high.)

2. How much paper will be required to paper a room 18′ by 14′?

3. How much paper will be required to paper a room 18′ 6″ by 16′ 4″ with 2 doors and 2 windows?

4. How much will it cost to paper a room 19′ 6″ by 16′ 4″ with 2 doors and 2 windows. The paper costs 49¢ a roll to place it on the wall.

Taxes

Find out where the money comes from to support the schools, police, library, etc. in your city or town. How is it obtained? What is real estate? What is personal property? What is a poll tax? A tax is the sum of money assessed on persons and property to defray the expenses of the community.

The tax rate is usually expressed as so many dollars per thousand of valuation, generally between $ 10 and $ 20. In some places it is expressed as a certain number of mills on $ 1 or cents on $ 100.

The tax rate, or the amount on each thousand dollars of property, is determined by dividing the whole tax by the number of thousand dollars of taxable property in the community. To illustrate:

In a certain community the whole tax is $ 1,942,409.73. The taxable property is $ 97,945,162.00.

$$\frac{\$\,1,942,409.73}{97,945} = \$\,19.83.$$

EXAMPLES

1. If the tax rate is $ 21.85, what are the taxes paid by a family of women owning property worth $ 16,000?

2. What is the tax on $ 34,697 in your town or city?

3. A man owns real estate worth $ 84,313, and has personal property worth $ 16,584. What is his tax bill, if the tax rate is $ 1.75 per hundred and a poll tax is $ 2?

4. A dwelling house is valued at $ 8500 and the tax rate is $ 17.52 per thousand. What is the tax?

5. What is the tax on a house valued at $ 3500, if the tax rate is $ 23.45?

6. The taxable property of a city is $ 97,945,162.00; and the expenses (taxes) necessary to run the city are $ 1,900,136.14. Obtain the tax rate.

United States Revenue

The town or city derives revenue from taxes levied on real and personal property. The county and state derive part of their revenue from a tax imposed upon the towns and cities. The United States government derives a great part of its revenue from a tax placed on tobacco and liquor sold within its boundaries and from a tax, called customs duties, imposed upon articles imported from other countries.

Some articles are admitted into the country free; these are said to be on the free list. The others are subject to one or both of the following duties: a duty placed on the weight or quantity of an article without regard to value (called *specific* duty), or a duty based upon the value of the article (expressed in per cent and called *ad valorem* duty).

When goods are received into this country, they are examined by an officer (called a customs officer). The goods are accompanied by a written statement of the quantity and value (called manifest or invoice).

Sometimes the goods are liquid, and in this case the weight of the barrel (called tare) must be subtracted from the total weight to obtain the net weight on which duty is imposed.

In case bottles are broken and liquids have escaped, due allowance must be made before imposing duty. This is called *leakage* or *breakage*.

EXAMPLES

1. What is the duty on bronze worth $ 8760 at 45 %?

2. What is the duty on goods valued at $ 3115 at 35 %?

3. What is the duty on 3843 sq. ft. of plate glass, duty $ 0.09 per square foot?

4. What is the duty on jewelry valued at $ 8376 at 40 %?

5. What is the duty on cotton handkerchiefs valued at $ 834 at 45 %?

6. What is the duty on woolen knit goods valued at $ 1643, 41 cts. per pound plus 50 %?

7. What is the duty on rugs (Brussels), 120 yards, 27″ wide, invoiced at $ 1.80 a yard, at 29 cts. per square yard and 45 % ad valorem?

CHAPTER VII

COST OF FURNISHING A HOUSE

When about to furnish a house, one of the first things to consider is the amount of money to be devoted to the purpose. This amount should depend on the income. A person with a salary of $1000 a year should have saved at least $250 toward the equipment of his home before starting house-keeping. This is sufficient to purchase the essentials of a simply furnished apartment or small house.

After one has lived in the house for a short time, it will be easy to study the possibilities and necessities of each room, and as time, opportunity, and money permit, one can add such other things as are needed. In this way the purchase of undesirable and inharmonious articles may be avoided.

There are many different styles and grades of furniture. The cost depends upon the kind of wood used, and the care with which it is put together and finished. The most inexpensive furniture is not the cheapest in the end. It is made of inferior wood and with so little care that it is neither durable nor attractive. The medium grades are generally made of birch, oak, or willow, are durable, and may be found in styles that are permanently satisfactory. The best grades are made of mahogany and other expensive woods, and those whose income consists only of wages or a salary cannot usually afford to buy more than a few pieces of this kind.

Furniture that is well made, of good material, and free from striking peculiarities of design and of decoration is chosen by all people of good taste and good judgment.

Furnishing the Hall

The only furniture necessary for the vestibule is a rack for umbrellas. The walls should be painted with oil paint in some warm color, and the floor should be tiled or covered with inlaid linoleum in tile or mosaic design. If the vestibule serves also as the only hall, it should contain a rug, a small table or chair, and a mirror. A panel of filet lace is suitable to use across the glass in the front door.

Through the front door one gets one's first impression of the occupants of the house. The furnishings of the hall should therefore be carefully chosen. It is a passageway rather than a room, and requires very little furniture. The walls may be done in a landscape paper, if one wishes to make the room appear larger, or in plain colonial yellow, if a bright effect is desired. If the size of the hall will permit, it is best to furnish it as a reception room; it may be made an attractive meeting place for the family and friends; but if it is one of the narrow passages so often found in city houses, one must be content with the regulation hall stand, or a mirror and a narrow table, and possibly one chair.

PRICE LIST OF HALL FURNITURE

	Cottage Furniture in Oak or Birch Stained any Color	Colonial Designs Reproduced in Oak or Birch	Colonial Designs Reproduced in Oak — Gloss Enamel	Colonial Designs Reproduced in Oak — Rubbed Enamel	Colonial Designs Reproduced in Real Mahogany	Hand-made Furniture in Oak	Willow Furniture
Umbrella rack .	$ 1.25	$6.00	$7.25	$8.50	$10.00	$5.00	$7.50
Table	3.75	6.75	8.25	9.75	20.00	10.00	37.50
Mirror . . .	3.00	3.00	3.40	3.75	30.00	7.50	
Straight chair .	2.75	4.50	5.50	6.50	25.00	6.50	8.00
Chest	13.50	13.50	16.50	19.50	50.00	40.00	
Sofa					50.00	35.00	16.00
Tall clock . .	60.00	60.00			150.00		75.00
Settle	18.00	18.00	22.50	27.00	32.00	32.00	21.00
Telephone stand	6.75	6.75	8.25	9.75	10.50	5.50	15.00
Clothes rack .	3.50	3.50	4.15	4.90	5.00	7.00	8.25

EXAMPLES

1. What is the complete cost of furnishing a hall with willow furniture?

2. Compare the cost of furnishing a hall with mahogany or birch.

3. If a family receives an income of $1400 a year and lives in a single cottage house, what kind of furniture should be selected? What should the cost not exceed for the hall furniture?

4. A hall was furnished with the following articles. What did it cost? What kind of furniture was probably purchased?

Seat, $11.85	Rug, $9.85
Mirror, $2.15	China umbrella stand, $2.10
Table, $2.20	Table cover (one yard of felt), $1.15
Two chairs, $7.40	Pole, $2.20

With hardwood or stained floors the furnishing and care of a house are much simplified. If one must have carpets, the colors should be neutral. The best quality of Canton or Japanese matting is satisfactory; it is a yard wide and costs fifty cents a yard. Next to matting, the most sanitary and economical carpet is good body Brussels. It wears well, and the dust does not get under it. A cheap, loosely woven matting or woolen carpet is always unsatisfactory.

Floor Coverings

In selecting floor coverings there are several important considerations. The design and quality should be governed by the treatment the rug will necessarily have.

Hall

A hall rug or carpet will receive hard wear; therefore, the quality should be good. A small all-over symmetrical design in two tones of one color or in several harmonizing colors will show dust and wear less than a plain surface would do.

Rag rug, machine made, 3 by 6 feet	$2.18
Hand-woven rag rug, 3 by 6 feet	7.50
Scotch wool rug, 3 by 6 feet	4.00
Hand-woven wool rug, 3 by 6 feet	6.00
East India drugget, 3 by 6 feet	8.00
Saxony, 3 by 6 feet	9.00
Brussels rug, 3 by 6 feet	9.00
Oriental rug, 3 by 6 feet	35.00

Living Room

In a living room the floor covering will be worn all over equally. Since there is always a variety of colors and forms in a living room, it is well to keep the floor covering as plain as possible. A rug with a plain center and a darker border of the some color is excellent in this room, particularly if the walls or hangings are figured. If they are plain, the rug or carpet may have a small, indefinite figure. If several domestic rugs are used in the same room, they should be exactly alike in design and color. If small Oriental rugs are used, they will, of course, differ in design, but they should be as nearly as possible in the same tone.

Good Living-room Rugs

Crex or grass rug, 9 by 12 feet	$8.50
Rag rugs, 9 by 12 feet	$10.00 to 45.00
Scotch wool rug, 9 by 12 feet	$14.50 to 25.00
Brussels, 9 by 12 feet	32.75
Hand-woven wool rug, 9 by 12 feet	36.00
East India drugget, 9 by 12 feet	43.00
Saxony, 9 by 12 feet	50.00
Oriental, 9 by 12 feet	200.00 up

Dining Room

A dining-room rug gets very hard wear in spots. It should, therefore, be selected in as good quality as one can afford. It is not well to have a perfectly plain rug in a dining room, as a plain surface shows crumbs and spots too readily. There is no objection to having a dining-room floor quite bare, if the floor is well finished. Inlaid linoleum also makes an excellent floor covering for a dining room that receives very hard usage.

The best coverings for this room are:

Crex ingrain rug, 9 by 12 feet	$8.50
Rag rug, 9 by 12 feet	$10.00 to 45.00
Brussels, 9 by 12 feet	32.75
East India drugget, 9 by 12 feet	36.00
Saxony, 9 by 12 feet	50.00
Oriental, 9 by 12 feet	200.00 up

Bedroom and Sewing Room

On account of the lint which accumulates in bedrooms, it is a good plan to keep the space under the beds bare, so that it may be dusted every day. Small rugs laid where most needed are more hygienic in sleeping rooms than are large rugs and carpets. Plain Chinese matting makes a clean floor covering when the boards are not in good condition. Although it is in good taste to use a carpet or one large rug in a bedroom, the preference lies among the following:

Small rag rugs, 3 by 6 feet	$1.75
Oval braided rag rugs, 3 by 6 feet	2.50
East India drugget, 3 by 6 feet	8.00
Saxony, 3 by 6 feet	8.00
Oriental, 3 by 6 feet	35.00

EXAMPLES

1. A family has an income of $1400. They buy a Brussels rug $3' \times 6'$ for $9. Are they extravagant?

2. How much cheaper is a crex rug, 9 by 12 feet, than a Brussels the same size? What per cent cheaper?

3. A dining-room rug is purchased for $49.75. What kind of a rug is it? Is it suitable for a family with an income of $2500?

4. An oval braided rag rug $3' \times 6'$ costs $2.50 and will last twice as long as a small rag rug that costs $1.75 for the bedroom. Which is more economical to purchase? How much more economical is it?

The Living Room

In houses or apartments of but five or six rooms there is usually but one living room. This room should represent the tastes which the members of the family have in common. The first requisite of such a room is that it should be restful. It is, therefore, advisable to use a wall covering that is plain in effect. Tan is good in a room that is inclined to be dark; gray-green or gray itself in a very bright living room. One large rug in two tones of one color, preferably the same color as the walls, is better than a figured rug for this room.

Chairs are an important part of the furnishing of a living room. It is well to have comfortable armchairs, upholstered in plain material, or willow chairs with cushions of chintz, if this material is used as curtains. A roomy table with a good reading lamp is essential, while open bookshelves, a writing desk or table, a sofa, a sewing table, and a piano are all appropriate furnishings for this room.

A Harmoniously Furnished Living Room

The curtains may be of figured materials, such as chintz or cretonne. Plain scrim or net curtains may be used over curtains of plain-colored material or of chintz simply to give the necessary warmth and color to the sides of the room. Valances are used to reduce the apparent height of a window and to give a low cozy look to the room. Plants are always appropriate to use in sunny windows, and pictures of common interest, framed in polished wood or dull gilt frames, help to make the living room attractive. Use very little bric-a-brac. Nothing which does not actually contribute to the beauty of the room should be allowed to find a place there.

Price List of Living-room Furniture

	Cottage Furniture in Oak or Birch Stained any Color	Colonial Designs Reproduced in Oak or Birch	Colonial Designs in Oak — Painted in Gloss Enamel	Colonial Designs Reproduced in Real Mahogany	Hand-made Furniture in Oak	Library Furniture	Willow Furniture
Table	\$4.50	\$15.00	\$17.00	\$50.00	\$35.00	\$59.00	\$12.00
Chair	17.00	22.50	25.00	45.00	30.50	50.00	12.75
Sofa				55.00	68.00	100.00	23.50
Armchair . . .		20.00		38.00	32.00	65.00	9.75
Desk chair . .	2.75	6.75	7.75	15.00	4.75	15.00	8.25
Desk	9.75	19.50	21.75	90.00	28.00	90.00	37.50
Bookcase . . .	9.00	9.00	11.25	100.00	25.00	100.00	13.50
Sewing table . .	5.00	5.00	6.00	17.00	18.50		13.50
Tea table . . .	1.50	1.50	2.00	35.00	12.00		7.25
Footstool . . .	2.25	3.75	3.00	6.00	4.50	6.00	5.25
Wood box or rack		5.00		5.00	5.00	5.00	3.50
Magazine stand .	6.00	6.75	8.25	10.00	8.50	8.50	12.75
Piano	200.00	250.00		450.00	450.00		
Music cabinet .	6.75	6.75	8.25	28.00	10.00		

Stoves { Gas, \$5.00; Coal, 17.00 } Wood . . \$15.00; Wood or coal 25.50 Franklin grate or andirons, wood or coal \$35.00

EXAMPLES

1. How much more will it cost to furnish a living room with library furniture than with willow furniture?

2. How much more will it cost to furnish a living room with hand-made oak furniture than with colonial designs in oak?

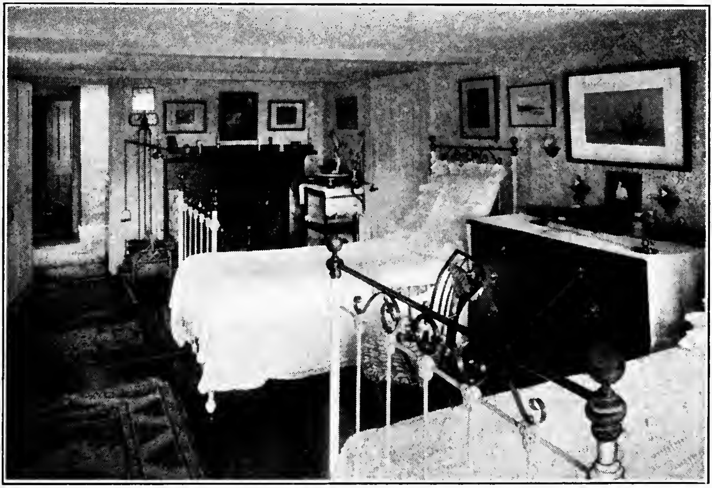
3. A living room was furnished with the following furniture. Ascertain from the price list what kind of furniture it is.

Large round table and small table, \$ 7.95
Six chairs and couch, \$ 51.15
Bookcase or shelves, \$ 9.85
Curtains and shades for three windows, \$ 6.15
Rug and draperies, \$ 34.15
Incidentals, \$ 24.65

What is the cost?

The Bedroom

When one stops to think that about one-third of one's life is spent in sleep, it is easy to understand that the first requisite in the furnishing of the bedroom is that it be fresh and clean.



A Comfortable Bedroom

Unless the room must be used as a study or sitting room in the daytime, the amount of furniture should be reduced as much as possible. The necessary pieces are a bed, a dressing case which should be generous in drawers and mirror, a washstand, a toilet set, towel-rack, one easychair and one plain one, a small table, a rug, and window shades. If space and money permit, a couch is desirable. Naturally, a writing desk, bookshelves, and pictures all add to the attractiveness of such a room. If one cannot have bare floors, the next best thing is good matting. A woolen carpet is not desirable for a sleeping room. All draperies should be of materials that will hold neither dust nor odor.

The bed is the most important article in the room. The springs and mattress should be firm enough to support all parts of the body when it is in a horizontal position.

The walls should be light in color and the woodwork white if possible. The furniture also may be white, although dull-finished mahogany in colonial designs, with small rugs on the floor, makes a charming bedroom. One set of draw curtains, of figured chintz if the walls are plain, and of plain-colored material if the walls have a small figure, is enough for each window.

The furnishings of a young girl's bedroom should be carried out in her favorite color, and to the usual bedroom furniture should be added a desk, lamp, worktable, and bookshelves.

The bedroom for a growing boy should be his own sitting room and study as well; a place where he can entertain his friends, do his studying, and develop his hobbies. The walls, hangings, couch cover, etc., should be very plain, as a boy usually has a collection of trophies which need the plainest sort of a background in order to prevent the room from looking cluttered. Instead of the usual bed he should have an iron-framed couch, which in the daytime may be made up with a plain dark cover with cushions, to be used as a couch. A chiffonier, an armchair, bookshelves, writing table, and one or two small rugs will complete the furnishings of the boy's bedroom.

EXAMPLES

1. Sheets should be of ample length and breadth. The finished sheets should be nearly three yards long. How many inches long?

2. The supply of bedroom linen, blankets, and counterpanes for a small house is as follows:

12 sheets @ \$0.85	4 pairs blankets @ \$8.00
12 pillow cases @ \$.40	2 counterpanes @ \$2.50
24 towels @ \$0.50	

What is the total cost?

PRICE LIST OF BEDROOM FURNITURE

	Cottage Furniture in Oak or Birch Stained any Color	Colonial Designs Reproduced in Oak or Birch	Colonial Designs Reproduced in Oak — Gloss Enamel	Colonial Designs Reproduced in Oak — Rubbed Enamel	Colonial Designs Reproduced in Real Mahogany	Hand-made Furniture in Oak	Willow Furniture
Bed	$9.75	$16.50	$18.75	$21.00	$55.00	$30.00	$56.00
Mattress	3.35 to 16.00	16.00 to 25.00	16.00 to 25.00	16.00 to 25.00	36.00	36.00	36.00
Box spring	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Crib (iron)	12.75	12.75	12.75	12.75	12.75	12.75	
Crib mattress	3.75	9.00	9.00	9.00	9.00	9.00	
Pillows (pair)	1.25	2.10	2.10	2.10	6.00	5.25	5.25
Bureau	9.75	22.50	25.00	27.50	75.00	50.00	67.50
Washstand	1.50	2.00	2.75	3.50	6.00 (enamel iron)	10.00	
Dressing table	9.00	12.57	14.25	15.75	55.00	26.00	48.00
Chiffonier (no mirror)	9.00	12.00	14.25	16.50	100.00 (high-boy)	39.00	60.00
Chair	2.75	4.50	5.25	6.00	10.00	6.50	8.00
Rocking chair	2.75	6.75	7.75	8.75	9.00	6.50	8.25
Waist box	Home-made	2.50	3.50	4.50	20.00	16.00	4.50
Desk	4.50	9.75	10.75	11.75	60.00	20.00	28.50
Armchair		6.75	7.75	8.75	24.00	8.00	7.50
Couch	5.00 (iron frame)	13.25 (box)			60.00	50.00	25.00
Bookshelves	Home-made	9.00	10.50	12.00	(built in)	21.50	13.50
Cheval glass	11.25	15.50	16.50	18.00	50.00	25.00	

Stoves { Gas, $5.00; Coal, 17.00   Wood . . . $15.50; Wood or coal 25.50   Franklin grate or andirons, wood or coal . $35.00

3. If a person spends one-third of a life in a bedroom, how many hours a day are spent in the bedroom?

4. A bedroom is furnished with the following furniture:

Enameled bedstead with springs, $7.50
A dressing case, $15.00
A plain wooden table to be used as washstand, $1.00
A small table $2.00
Chair, $2.00
Mattress, $5.00
Rug, $3.00
Dimity for draping bed, washstand and two windows, twenty-one yards, $3.15
Enameled cloth for washstand, $.55
Two pillows, $4.00
Toilet set, $3.00
Shades for two windows, $1.00
Towel rack, $.75

What is the total cost?

5. What will it cost to furnish a bedroom with simple cottage furniture as provided above?

6. What will it cost to furnish a bedroom with the good grade of oak furniture in gloss enamel? What is the least income a family should have in order to buy this furniture?

7. What will it cost to furnish a bedroom with real mahogany furniture? What is the least income one should have in order to buy this furniture?

The Dining Room

The dining room does not require a great deal of furniture, but what there is should be of the most substantial kind. Mahogany and oak are the woods to be preferred. The table should be broad, stand well, with the legs so placed that they will not interfere with the comfort of any one seated at the table. The chairs should be well made, with broad, deep seats and high, straight backs. Unless one can afford the right kind of a sideboard it is better to purchase a sideboard table in simple design. A piece of Japanese matting in the center of the dining room floor is quite satisfactory when the floor is stained.

The room in which the family assembles several times each day to enjoy its meals together should be the most cheerful room in the house.

An Attractive Dining Room

Because there is so much attractive blue-and-white china in use, many persons want dining rooms with blue walls. This is usually a mistake, as blue used in large quantities absorbs the light and makes a room gloomy, particularly on dark days and at night. By using colonial yellow on the walls, with hangings, rug, and decorative china in blue and white, one has an almost ideal arrangement. There are many charming landscape and foliage papers on the market which, used without pictures against them, but with bulbs or plants blooming on the windowsills and with hangings of plain, semitransparent, colored material make most delightful rooms.

Plate rails or racks reduce the apparent height of an over-high ceiling. It is better to use a simple flat molding than to crowd a plate rail full of inharmonious objects.

Ugly glass domes on lamps are being replaced by silk ones with deep silk fringe or, better still, the center light is abandoned in favor of side wall fixtures in all of the rooms. Candles, prettily shaded, are used on the table at night, with a jar of flowers or fruit as a centerpiece.

EXAMPLES

1. What will the following cottage dining-room furniture cost? (Include the items given in the price list below.)

2. What will the following oak dining-room furniture cost?

3. What will the following real mahogany dining-room furniture cost?

PRICE LIST OF DINING-ROOM FURNITURE

	Cottage Furniture in Oak or Birch Stained any Color	Colonial Designs Reproduced in Oak or Birch	Colonial Designs Reproduced in Oak — Gloss Enamel	Colonial Designs Reproduced in Oak — Rubbed Enamel	Colonial Designs Reproduced in Real Mahogany	Hand-made Furniture in Oak	Willow Furniture
Table	$9.00	$30.00	$10.50	$12.00	$85.00	$21.00	$16.00
Chair	2.75	4.50	5.50	6.50	10.00	6.50	8.25
Armchair . . .	2.75	6.75	7.75	8.75	15.00	10.00	
Serving table . .	8.25	9.00	10.50	12.75	35.00	18.00	28.00
Buffet	18.00	27.50	21.00	24.00	125.00	34.00	82.50
China closet . .	15.00	30.00	34.50	39.00	60.00	45.00	
Serving table on wheels . . .	16.75	16.75	30.50	34.00	27.00	27.00	24.00
Screen	3.75	5.00	4.50	5.25	25.00	20.00	
High chair . .	2.50	2.50	4.15	5.50	10.00	9.00	8.00

Stoves { Gas, $5.00; Coal, 17.00 } Wood . . . $15.50; Wood or coal 25.00; Franklin grate or andirons, wood or coal . . $35.00

4. What will it cost to furnish a home on a moderate scale with china of the following amounts and kinds:

$\frac{1}{2}$ dozen soup plates (to be used for cereals also) . .	$2.35
$\frac{1}{2}$ dozen dinner plates	2.25
1 dozen lunch plates (used also for breakfast and for salads)	3.85
$\frac{1}{2}$ dozen dessert plates	1.60

$\frac{1}{2}$ dozen bread-and-butter plates	\$0.70
$\frac{1}{2}$ dozen coffee cups and saucers	3.30
$\frac{1}{2}$ dozen tea cups and saucers	2.80
$\frac{1}{2}$ dozen after-dinner coffee cups and saucers	2.35
1 teapot	1.90
1 coffee pot	2.00
1 covered hot-milk jug or chocolate pot	2.60
1 large cream pitcher	.70
1 small platter or chop platter	2.50
3 odd plates for cheese, butter, etc.	.95
Covered dish	2.80
$\frac{1}{2}$ dozen egg cups	1.50

5. What will it cost to furnish a home on a moderate scale with glass, colonial period, of the following amounts and kinds:

$\frac{1}{2}$ dozen tumblers	\$0.50
$\frac{1}{2}$ dozen sherbet glasses	.35
$\frac{1}{2}$ dozen dessert plates	1.25
$\frac{1}{2}$ dozen finger bowls	.75
Sugar bowl and cream pitcher	.50
Dish for lemons	.50
Dish for nuts	.25
Pitcher	.50
Candlesticks	.65
Vinegar and oil cruets	.50
Berry dish	.25
$\frac{1}{2}$ dozen iced-tea glasses	.75
$\frac{1}{2}$ dozen individual salt cellars	.60

6. What will it cost to furnish a home on a moderate scale with silver, pilgrim pattern, of the following amounts and kinds:

1 dozen teaspoons	\$14.00
$\frac{1}{2}$ dozen dessert spoons (used for soup also)	9.50
4 tablespoons	9.50
1 dozen dessert forks (used also for breakfast, lunch, salad, pie, fruit, etc.)	19.00
$\frac{1}{2}$ dozen dessert knives	11.00

$\frac{1}{2}$ dozen table knives with steel blades and ivoroid handles	$2.00
Carving set to match steel knives	4.00
$\frac{1}{2}$ dozen table forks	12.00
2 fancy spoons for jellies, bonbons, etc. ($1.50 each)	3.00
2 fancy forks for olives, lemons, etc. ($1.50 each)	3.00
$\frac{1}{2}$ dozen after-dinner coffee spoons	5.00
$\frac{1}{2}$ dozen bouillon spoons	8.00
$\frac{1}{2}$ dozen butter spreaders	1.50
1 gravy ladle	4.75
Saltspoon	.20
Sugar tongs	2.25

7. What will it cost to furnish a home on a moderate scale with silver-plated ware of the following amounts and kinds:

Covered vegetable dish (cover may be used as a dish by removing handle)	$10.00
Platter	11.50
Pitcher	12.00
Coffee pot	12.50
Toast rack	4.50
Small tray	6.50
Sandwich plate	6.00
Silver bowl	9.00
Egg steamer	8.00
Bread or fruit tray	5.50
Tea strainer	1.00
Candlesticks, each	3.75

Household Linen

The quality of linen in every household should be the best that one can possibly afford. The breakfast runners and napkins are to be made by hand, of unbleached linen such as one buys for dish towels. With insets of imitation filet lace these are very attractive, durable, and easy to launder.

1. What is the cost of supplying the following amount of table and bed linen for a couple with an average income of $1400, who are about to begin housekeeping?

Table Linen

2 dozen 22-inch napkins, at $3.00 a dozen.
2 dozen 12-inch luncheon napkins, at $4.50 a dozen.
(Luncheon napkins at $1.00 a dozen if made by hand of coarse linen.)
2 two-yard square tablecloths, at $1.25 a yard.
Two-yard square asbestos or cotton flannel pad for table, at $1.00.
½ dozen square tea cloths, $12.00.
½ dozen table runners for breakfast, at $2.40.
1 dozen white fringed napkins, at $1.20.
4 tray covers, at 65 cts.
1 dozen finger-bowl doilies, at $3.00.
1 dozen plate doilies, at $3.00.

Bed Linen

4 sheets (extra long) for each bed, at $1.10.
4 pillow cases for each pillow, at 20 cts.
1 mattress protector for each bed, with one extra one in the house, at $1.50.
2 spreads for each bed, at $2.50.
1 down or lamb's-wool comforter for each bed, at $6.
1 pair of blankets for each bed, with 2 extra pairs in the house, at $8.
½ dozen plain huckaback towels for each person, at 25 cts.
3 bath towels for each person, at 30 cts.
½ dozen washcloths for each person, at 11 cts.
1 bath mat in the bathroom, 2 in reserve, at $1.50.

The Sewing Room

Even in a small house there is sometimes an extra room which may be fitted up as a sewing room in such a way as to be very convenient and practical, and at the same time so attractive as to serve occasionally as an extra bedroom. This room should be kept as light as possible and should be so furnished that it may easily be kept clean.

EXAMPLE

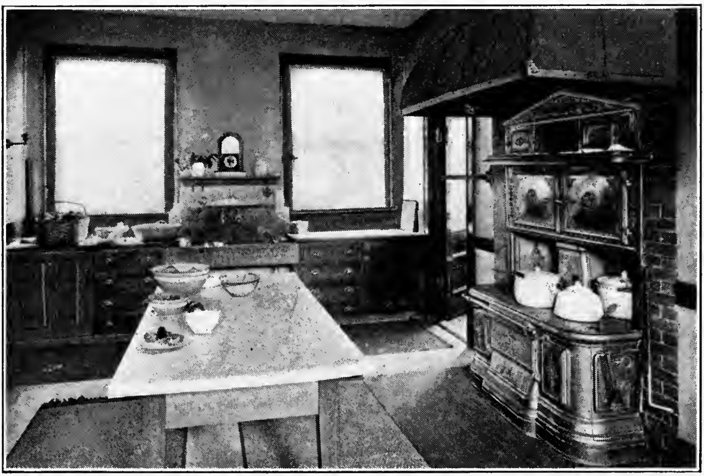
1. What will it cost to furnish a sewing room with the following articles?

Sewing machine with flat top to be used as a dressing table	$20.00
Chair	1.25
Box couch	13.25
Chiffonier	9.00

Mirror against a door	$11.25
Low rocking-chair without arms	1.50
Cutting table, box underneath ; tilt top to be used	6.75
Clothes tree	3.38

The Kitchen

The room in which the average housekeeper spends the greater part of her time is usually the least attractive room in the house, whereas it should be made — and we learn by visiting foreign kitchens that it may be made — a picturesque setting for one of the finest arts — the art of cookery.



A CONVENIENT KITCHEN

The woodwork should be light in color, the walls should be painted with oil paint, or covered with washable material, this also in a light color. A limited number of well-made, carefully selected utensils will be found more useful than a large supply purchased without due consideration as to their real value and the need of them. Of course, the style of living and the size of the family must to some extent control the number, size, and kind of utensils that are required in each kitchen. As in all the other furnishings, the beginner will do well to purchase only the essential articles until time demonstrates the need of others.

EXAMPLES

1. What will it cost to furnish your kitchen?[1]

Stoves — Gas	\$2.50, \$10.00, \$30.00
Blue-flame kerosene	10.25
Coal, wood, gas	86.00
Coal and wood	49.75
Small electric	33.00
Table	\$2.10; \$9.00 (drop leaf); \$11.25 (white enamel on steel)
Chair	\$1.87, \$6.75
Ice chest	\$7.00, \$15.00, \$40.00 (white enamel)
Kitchen cabinet	\$28.00, \$29.00 (white enamel on steel)
Linoleum	60c. square yard, printed; \$1.60 square yard, inlaid

2. What will the following small kitchen furnishings cost?

Small-sized ironing board	\$0.35
Small glass washboard	.35
Clothesline and pins	.59
2 irons, holder and stand	.70
2-gallon kerosene can	.45
Small bread board	.15
Rack for dish towels	.10
6 large canisters	.60
Wooden salt box	.10
1 iron skillet	.30
1 double boiler	1.00
Dish drainer	.25
2 dish mops	.10
Wire bottle washer	.10
Small rolling pin	.10
Chopping machine	1.10
Large saucepan	.30
3 graduated copper, enameled or nickel handled dishes	.50
2 covered earthenware or enameled casseroles	1.50
2 pie plates enameled	.20
Alarm clock	1.00
Small covered garbage pail	.35
Scrubbing brush	.20
Broom and brushes	.60
1 quart ice-cream freezer	1.75
Roller for towel	.10
Bread box	.50
4 small canisters	.40
2 sheet-iron pans to use as roasting pans	.20
Dishpan (fiber)	.50
Plate scraper	.15
Soap shaker	.10
Vegetable brush	.05
Muffin tins	.25
Granite soup kettle	.45
3 graduated small saucepans	.30
Glass butter jar	.35
6 popover or custard cups	.30
Soap dish	.25
Knives, forks, egg beater, lemon squeezer, etc.	5.50
Sink strainer, brush, and shovel	.50
Galvanized-iron scrub pail	.30

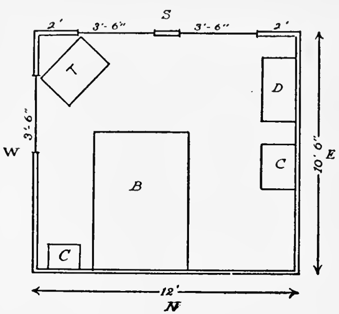
[1] Consider income of family and size of kitchen.

EXAMPLES IN LAYING OUT FURNITURE

Considerable practice should be given in laying out furniture according to scale.

1. A bedroom 12′ × 10′ 6″ faces the south, and has 2 windows, 3′ 6″ wide, 1 window, 3′ 6″, two feet from corner of west side; and a door 3′ wide two feet from east wall. This room is to contain the following furniture:

1 bed, 6′ 6″ × 4′	1 table, 2′ 6″ × 3′
1 dresser, 3′ × 1′6″	2 chairs, 1′ 6″ × 2′



SOLUTION

Draw a plan showing the most artistic arrangement of furniture. Scale $\frac{1}{8}'' = 1'$.

2. A dining room 15′ × 18′ faces the east, and has two windows 3′ 6″ wide on the east side, 2 windows 3′ 6″ on the north side, folding doors 6′ wide in the center, on the south side. Draw a plan and place the following furniture in it in the most artistic manner:

1 dining table, 5′ in diameter	6 chairs, 2′ × 1′ 6″
1 buffet, 4′ × 2′	Scale, $\frac{1}{8}'' = 1'$

3. A living room 15′ × 18′ faces the north and has 2 windows 3′ 6″ wide on the north side, 2 windows 3′ 6″ on the west side, and folding doors on the south side. Draw a plan and place the following furniture in the most artistic manner:

1 settee	2 easy-chairs
1 table	2 rockers
1 desk and chair	Scale $\frac{1}{8}'' = 1'$

4. A kitchen 12′ × 10′ 6″ faces the south and has 2 windows 3′ 6″ wide on the south side, 1 on the west side, two feet from the north corner, a door 3′ wide, two feet from the northeast corner that leads into the dining room. Draw a plan and place the furniture in proper places:

1 kitchen range
1 sink
2 set tubs
1 table
2 chairs
Scale $\frac{1}{8}'' = 1'$

REVIEW EXAMPLES

1. A living room was fitted out with the furniture in the list below. What kind of furniture is it? What is the cost?

Large round table and small table, \$8.00
Six chairs and couch, \$50.00
Bookcase or shelves, \$10.00
Curtains and shades for three windows, \$6.30
Rug and draperies, \$34.00
Incidentals, \$25.00

2. A hall was furnished with the following articles. What was the total cost? What kind of furniture was used?

Seat, \$12.00
Mirror, \$2.00
Table, \$2.00
Two chairs, \$7.50
Rug, \$10.00
Umbrella stand, \$2.00
Table cover, \$1.00
Pole, \$3.00

3. A family of seven — three grown people and four children — lived in a southern city on \$600 a year. The monthly expense was as follows:

House rent, \$12.00
Groceries, \$12.00
Washing, \$5.00
Bread, \$3.50
Beef, \$3.50
Vegetables, \$3.00

What is the balance from the monthly income of \$50 for clothing and fuel?

4. What is the cost of the following kitchen furniture?

1 kitchen chair, \$1.25
1 table, \$1.50
1 broom, 50 cents
Kitchen utensils, \$8.50

5. What is the cost of the following living-room furniture? How much income should a family receive to buy this furniture?

Overstuffed chair, $12.50
2 willow chairs, $6 each
1 willow stool, $4.25
1 rag rug, $9.50
1 newspaper basket, $2.25
12 yards of cretonne, 35 cents a yard
1 green pottery lamp bowl, $3.00
1 wire shade frame, 50 cents
7 yards of linen, at 50 cents a yd.
10 yards of cotton fringe, at 5 cents a yd.
6 yards of net, at 25 cents a yd.
Table, 48 by 30 inches, $7.00

6. What is the cost of the following bedroom furniture? How much income should a family have to buy this furniture?

1 bed spring, $3.50
1 single cotton mattress, $4.25
1 chiffonier, $6.50
1 dressing table, $2.25
1 mirror, $2.75
1 armchair, $4.00
1 rag rug, $3.25
2 pillows, 75 cents each
1 bed pillow, $1.00
10 yards of white Swiss, at 25 cents a yd.
8 yards of pink linen, at 50 cents a yd.
1 comfortable, $4.25
Sheets and blankets for one bed, $6.00
3 yards of cretonne, at 35 cents a yd.

7. What is the cost of the following bedroom furniture? How much income should a family have to warrant buying this furniture?

2 white iron beds, at $4.25 each
2 single springs, at $2.50 each
2 cotton mattresses, at $4.25 each.
2 bed pillows, at $1.00 each
1 dressing table, $5.50
1 white desk, $6.75
1 chiffonier, $6.50
1 dressing-table mirror, $3.25
1 chiffonier mirror, $1.50
1 rag rug, $3.25
1 wastepaper basket, .50
11 yards of cretonne, at 35 cents a yd.
5 yards of yellow sateen, at 25 cents a yd.
2 comfortables, at $4.25 each
10 yards of cream sateen, at 25 cents a yd.
15 yards of cotton fringe, at 5 cents a yd.
1 willow chair, $6.00
1 cushion, 75 cents
4 yards of net, at 25 cents a yd.
Sheets and blankets for two beds, $12.00
1 dressing table chair, $4.50

8. What is the cost of the following dining-room furniture? What income should one receive to buy this furniture?

6 dining-room chairs, $4.50	10 yards of cretonne, at 35 cents a yd.
1 dining table, $6.75	One wire shade frame, 50 cents
1 serving table, $6.25	Table linen, $8.00
1 rag rug, $9.50	Silverware, $7.50
1 set of dishes, $9.75	1 willow tray, $3.25

HEAT AND LIGHT

Value of Coal to Produce Heat

Several different kinds of coal are used for fuel. Some grades of the same coal give off more heat in burning than others. The heating value of a coal may be determined in three ways: (1) by chemical analysis to determine the amount of carbon; (2) by burning a definite amount in a calorimeter (a vessel immersed in water) and noting the rise in temperature of the water; (3) by actual trial in a stove or under a steam boiler. The first two methods give a theoretical value; the third gives the real result under the actual conditions of draft, heating surface, combustion, etc.

The coal generally used for household purposes in the Eastern states comes from the anthracite fields of Pennsylvania. This coal, as shipped from the mines, is divided into several different grades according to size. The standard screening sizes of one of the leading coal-mining districts are as follows:

Broken, through $4\frac{1}{2}''$ round	Pea, through $\frac{3}{4}''$ square
Egg, through $2\frac{3}{4}''$ square	Buckwheat, through $\frac{1}{2}''$ square
Stove, through $2''$ square	Rice, through $\frac{3}{8}''$ round
Nut, through $1\frac{3}{8}''$ square	Barley, through $\frac{1}{4}''$ round

The last three sizes given above are too small for household use and are usually purchased for generating steam in large power-plant boilers.

Coke is used to some extent in localities where it can be obtained at a reasonable price in sizes suitable for domestic purposes. The grades of coke generally used for this purpose are known as nut and pea. The use of coke in the household has one principal objection. It burns up quickly and the fires, therefore, require more attention. This is due to the fact that a given volume of coke weighs less and therefore contains less heat than other fuel occupying the same space in the stove or furnace.

The chief qualities which determine the value of domestic coal are its percentage of ash and its behavior when burned. Coal may contain an excessive amount of impurities such as stone and slate, which may be easily observed by inspection of the supply. The quality of domestic coke depends entirely upon the grade of coal from which it has been made, and may vary as much as 100 % in the amount of impurities contained.

Aside from the chemical characteristics of domestic coal, the most important factor to consider in selecting fuel for a given purpose is the size which will best suit the range or heater. This depends on the amount of grate surface, the size of the fire-box, and the amount of draft.

EXAMPLES

1. Hard coal of good quality has at least 90 % of carbon. How much carbon in 9 tons of hard coal?

2. A common coal hod holds 30 pounds of coal. How many hods in a ton?

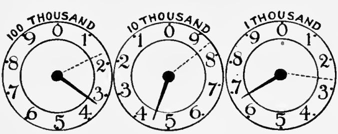
3. If coal sells for $8.25 in June and for $9.00 in January, what per cent is gained by buying it in June rather than in January? When is the most economical time to buy coal?

4. The housewife buys kerosene by the gallon. If the price per gallon is 13 cts. and five gallons cost 55 cts., what is the per cent gained by buying in 5-gallon can lots?

5. If kerosene sells for $4.60 a barrel, what is the price per gallon by the barrel? What per cent is gained over single gallons at 13 cts. retail? What is the most economical way to buy kerosene? (A barrel contains 42 gallons.)

How to Read a Gas Meter[1]

1. Each division on the right-hand circle denotes 100 feet; on the center circle 1000 feet; and on the left-hand circle 10,000 feet. Read from left-hand dial to right, always taking the figures which the hands have passed, viz.: The above dials register 3, 4, 6, adding



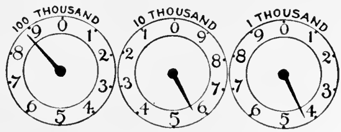
[1] Gas is measured in cubic feet.

two ciphers for the hundreds, making 34,600 feet registered. To ascertain the amount of gas used in a given time, deduct the previous register from the present, viz.:

Register by above dials	34,600
Register by previous statement	18,200
Given number of feet registered	16,400

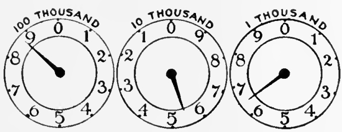
16,400 feet @ 90 cts. per 1000 costs what amount?

2. If a gas meter at the previous reading registered 82,700 feet, and to-day the dials read as follows,

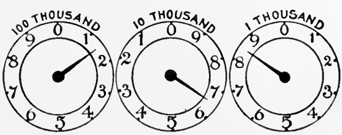


what is the cost of the gas at 95 cts. per 1000?

3. What is the cost of the gas used during the month from the reading on this meter, if the previous reading was 6100 feet? The rate is $ 1.00 per 1000 cu. ft. less ten per cent, if paid before the 12th of the month. Give two answers.



4. What is the cost of gas registered by this meter at 85 cts. per 1000 cu. ft.?



How to Read an Electric Meter

(See the subject of the electricity in the Appendix)

There are three terms used in connection with electricity which it is important to understand; namely, the **volt**, the **ampere**, and the **watt** or **kilowatt**.

(1) The **volt** is the unit of Electromotive Force or electrical pressure. It is the pressure necessary to force a current of one ampere through a resistance of one *ohm.*

(2) The unit of electric current strength is the **ampere**. It

is the amount of current flowing through a resistance of one *ohm* under a pressure of one volt.

(3) The **watt** is the unit of electrical power; it is the product of volts (of electromotive force) and current (amperes) in the circuit, when their values are respectively one volt and one ampere. That is to say, if we have an electrical device operated at 3 amperes, on a line voltage of 115 volts, the amount of current consumed is equal to $115 \times 3 = 345$ watts, which, if operated continuously for one hour, will register on the electric meter as 345 watt hours, or .345 kilowatt hours (a **kilowatt hour** being equal to 1000 watt hours).

All electrically operated devices are stamped with the ampere and voltage rating. This stamping may be found on the name-plate or bottom of the device. By multiplying the voltage of the circuit upon which the device is to be operated by the amperes as found stamped on the device, we can quickly determine the wattage consumption of the latter, as explained under the definition of the watt, and as shown above. The line voltage which is most extensively supplied by Electric Lighting companies in this country is 115 volts, and where this voltage is in operation, the devices are stamped for voltage thus: V. 110–125. This means that the device may be used on a circuit where the voltage does not drop below 110 volts or rise above 125 volts. By operating a device with the above stamping on a circuit of 106 volts the life of the device would be very much longer, but the results desired from it would be secured much more slowly. Again, if the same device were used on a circuit operating at 130 volts, the life of the device would be very short, although the results desired from it would be brought about much more quickly. Before attempting to operate an electrically heated or lighted device, if in doubt about the voltage of the circuit, it is best to call upon the Electric Company with which you are doing business and ask the voltage of their lines.

Incandescent electric lamps, while known to the average user as lamps of a certain "candle-power," are all labeled with their proper wattage consumption. Mazda lamps, suitable for household use and obtainable at all lighting companies, are made in 15, 25, 40, 60, and 100 watt sizes. For commercial use, lamps of 1000 watts and known as the nitrogen-filled lamps are on the market. Nitrogen lamps are made in sizes of 200 watts and upwards.

The rate by which current consumed for lighting and small heating is figured in some cities is known as the "sliding scale rate," and current is charged for each month, as follows:

The first 200 kw. hrs. used @ 10¢ per kilowatt hour.
The next 300 kw. hrs. used @ 8¢ per kilowatt hour.
The next 500 kw. hrs. used @ 7¢ per kilowatt hour.
The next 1000 kw. hrs. used @ 6¢ per kilowatt hour.
The next 3000 kw. hrs. used @ 5¢ per kilowatt hour.
All over 5000 kw. hrs. used @ 4¢ per kilowatt hour.

Less 5% discount, if bill is paid within 15 days from date of issue.

Under the sliding-scale rate the more electricity that is consumed, the cheaper it becomes. But it is also readily seen that the customer who uses a large amount of electricity pays in exactly the same way as the small consumer pays for his consumption.

If a person uses less than 200 kw. hrs. per month, he pays for his consumption at the rate of 10¢ per kilowatt hour; if he uses 201 kw. hrs. of electricity per month, he pays for his first 200 kw. hrs. at the first step, namely 10¢, and for the remaining 1 kw. hr. he pays 8¢ per kilowatt hour.

If a meter reads "1000 kw. hrs.," the bill is not figured at 6¢ direct, but must be figured step by step as shown in the examples below.

For convenience in figuring, the amount of power used by various electrically operated devices is given in the following table. By figuring the cost of each per hour, it will be seen that these electric servants work very cheaply.

Apparatus	Watts used	What is Cost per Hour[1]
(*a*) Disk stove	200	?
(*b*) 6 lb. iron	440	?
(*c*) Air heater, small	1000	?
(*d*) Toaster-stove	500	?
(*e*) Heating pad	55	?
(*f*) Sewing-machine motor	50 (average)	?
(*g*) 25 watt (16 c p.) lamp	25	?
(*h*) Chafing dish	500	?
(*i*) Washing-machine motor	200 (average)	?

Example. — Suppose a customer in one month used 6120 kilowatt hours of electricity, what is the amount of his bill

[1] Based on 10 cents per kilowatt hour.

with 5 % deducted if the bill is paid within the discount period of 15 days from date of issue?

SOLUTION. —	6120 kw. hrs.	= total amount used.
First	200 kw. hrs. @ 10 ¢ =	$ 20.00
	5920	
Next	300 kw. hrs. @ 8 ¢ =	24.00
	5620	
Next	500 kw. hrs. @ 7 ¢ =	35.00
	5120	
Next	1000 kw. hrs. @ 6 ¢ =	60.00
	4120	
Next	3000 kw. hrs. @ 5 ¢ =	150.00

We have now figured for 5000 kw. hrs., and as our rate states that all over 5000 kw. hrs., is figured at 4 ¢ per kilowatt hours, we have

1120 kw. hrs. @ 4 ¢ = $ 44.80
$ 333.80 = gross bill

Assuming that the bill is paid within the given discount period, we deduct 5 % from the

gross bill, which equals $ 16.69
$ 317.11 = net bill

EXAMPLES

1. A customer uses in one month 300 kw. hr. of electricity. What is the amount of his bill if 5 % is deducted for payment within 15 days?

2. What is the amount of bill, with 5 % deducted, for 15 kw. hr. of electricity?

An electric meter is read in the same way that a gas meter is read. In deciding the reading of a pointer, the pointer before it (to the right) must be consulted. Unless the pointer to the right has reached or passed zero, or, in other words, completed a revolution, the other has not completed the division upon which it may appear to rest. Figure 1 reads 11 kw. hrs., as the pointer to the extreme right has made one complete revolution, thus advancing the second pointer to the first digit and has itself passed the first digit on its dial.

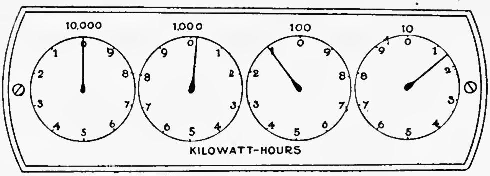


FIG. 1.—READING 11 KW. HRS.

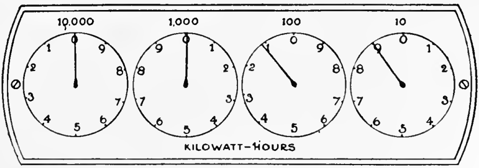


FIG. 2.—WHAT IS THE READING?

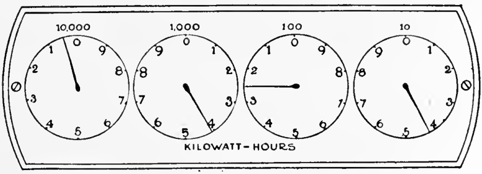


FIG. 3.—READING 424 KW. HRS.

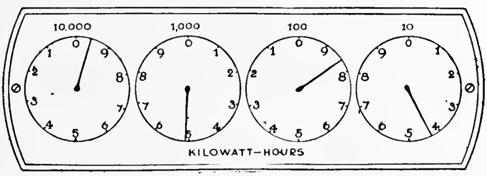


FIG. 4.—WHAT IS THE READING?

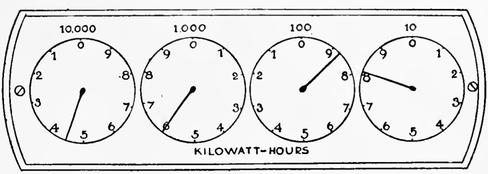


FIG. 5.—WHAT IS THE READING?

1. What is the cost of electricity in Fig. 1, using the rates on page 171?

2. What is the cost of electricity in Fig. 2, using the rates on page 171, with the discount?

3. What is the cost of electricity in Fig. 3, using the rates on page 171, with the discount?

EXAMPLES

1. What is the cost of maintaining ten 25-watt Mazda lamps, burning 30 hours at 10 cents per kw. hr.?

2. What will it cost to run a sewing machine by a motor (50 watts) for 15 hours at 9 cents per kw. hr.?

3. A 6-lb. electric flatiron is marked 110 V. and 4 amperes. What will it cost to use the iron for 20 hours at 8 cents per kw. hr.?

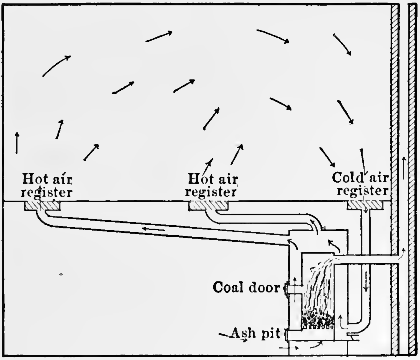
4. An electric washing machine is marked 110 V. and 2 amperes. What will it cost to run it 15 hours at $8\frac{1}{2}$ cents per kw. hr.?

5. An electric toaster stove is marked 115 volts and $3\frac{1}{2}$ amperes. What will it cost to run it for a month (thirty breakfasts) 15 hours at $8\frac{3}{4}$ cents per kw. hr.? If a discount of 5% is allowed for prompt payment, what is the net amount of the bill?

Methods of Heating

Houses are heated by hot air, hot water, or steam. In the hot-water system of heating, hot water passes through coils of pipes from the heater in the basement to radiators in the rooms. The water is heated in the boiler, and the portion of the fluid heated expands and is pushed upward by the adjacent colder water. A vertical circulation of the water is set up and the hot water passes from the boiler to the radiators and gives off its heat to the radiators, which in turn give it off to the surrounding air in the room. The convection currents carry heat through the room and at the same time provide for ventilation.

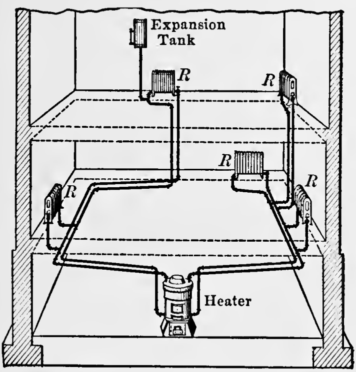
In the hot-air method the heat passes from the furnace through openings in the floor called registers. This method frequently fails to heat a house uniformly because there is no way for the air in certain rooms to escape so as to permit fresh and heated air to enter.



Hot Air Heating System

Steam heating consists in allowing steam from a boiler in the basement to circulate through coils or radiators. The steam gives off its heat to the radiators, which in turn give it off to the surrounding air.

Room-heating Calculations



Hot Water Heating System

In order to insure comfort and health, every housewife should be able to select an efficient room-heating appliance, or be able to tell whether the existing heating apparatus is performing the required service in the most economical manner. In order to do this, it is necessary to know how to determine the requirements for individual room heating.

For Steam Heating

Allow 1 sq. ft. of radiator surface for each
80 cu. ft. of volume of room.
13 sq. ft. of *exposed* wall surface.
3 sq. ft. of *exposed* glass surface (single window).
6 sq. ft. of *exposed* glass surface (double window).

For Hot-water Heating

Add 50 per cent to the amount of radiator surface obtained by the above calculation.

For Gas Heaters having no Flue Connection

Allow 1 cu. ft. of gas per hour for each
215 cu. ft. of volume of room.
35 sq. ft. of *exposed* wall surface.
9 sq. ft. of *exposed* glass surface (single window).
18 sq. ft. of *exposed* glass surface (double window).

The results obtained must be further increased by one or more of the following factors if the corresponding conditions are present.

Northern exposure	1.3
Eastern or western exposure	1.2
Poor frame construction	2.5
Fair frame	2.0
Good frame or 12-inch brick	1.2
Room heated in day time only	1.1
Room heated only occasionally	1.3–1.4
Cold cellar below or attic above	1.1

Example. — How much radiating surface, for steam heating, is necessary to heat a bathroom containing 485 cu. ft.? The bathroom is on the north side of the house.

$\frac{485}{80} = 6\frac{1}{16}$ sq. ft. of radiating surface

$6\frac{1}{16} \times 1.3 = \frac{97}{16} \times \frac{13}{10} = 7\frac{141}{160}$ sq. ft.

$6\frac{1}{16} + 7\frac{141}{160} = 6\frac{10}{160} + 7\frac{141}{160} = 13\frac{151}{160}$ sq. ft. or approx. 14 sq. ft. *Ans.*

EXAMPLES

1. How much radiating surface, for steam heating, is required for a bathroom $12' \times 6' \times 10'$ on an eastern exposure?

2. How much radiating surface, for hot-water heating, is required for the bathroom in example 1?

3. How large a gas heater should be used for heating the bathroom in example 1?

4. (*a*) How much radiating surface is required for steam heating, in a living room $18' \times 16\frac{1}{2}' \times 10'$, with three single windows $2' \times 5\frac{1}{2}'$? The room is exposed to the north.

(*b*) How much radiating surface for hot-water heating?

(*c*) How much gas should be provided to heat the room in example (*a*)?

5. (*a*) How much radiating surface is required for steam heating a bedroom $19' \times 17' \times 11'$ with two single windows $2' \times 5\frac{1}{2}'$? The house is of poor frame construction.

(*b*) How much radiating surface for hot-water heating?

(*c*) How much gas should be provided to heat room in example (*a*)?

CHAPTER VIII

THRIFT AND INVESTMENT

It is not only necessary to increase your earning capacity, but also to develop systematically and regularly the saving habit. A dollar saved is much more than two dollars earned. For a dollar put at interest is a faithful friend, earning twenty-four hours a day, while a spent dollar is like a lost friend — gone forever. Histories of successful men show that fortune's ladder rests on a foundation of small savings; it rises higher and higher by the added power of interest. The secret of success lies in regularly setting aside a fixed portion of one's earnings, for instance 10 %; better still, 10 % for a definite object, such as a home or a competency.

In every community one will find various agencies by which savings can be systematically encouraged and most successfully promoted. These institutions promote habits of thrift, encourage people to become prudent and wise in the use of money and time. They help people to buy or build homes for themselves or to accumulate a fund for use in an emergency or for maintenance in old age.

Banks

Working people should save part of their earnings in order to have something for old age, or for a time of sickness, when they are unable to work. This money is deposited in banks — savings, National, coöperative, and trust companies.

National Banks

National banks pay no interest on small deposits, but give the depositor a check book, which is a great convenience in business. National banks require that a fixed sum should be left on deposit, $ 100 or more, and some of them charge a certain amount each month for taking care of the money.

Trust Companies

Trust companies receive money on deposit and allow a customer to draw it out by means of a check. They usually pay a small interest on deposits that maintain a balance over $ 500.

Coöperative Banks

When a person takes out shares in a coöperative bank, he pledges himself to deposit a fixed amount each month. If he deposits $ 5, he is said to have five shares. No person is permitted to have more than twenty-five shares. The rate of interest is much higher than in other banks, and when the shares mature, which is usually at the end of about eleven years, all the money must be taken out. Many people build their home through the coöperative bank, for, like every other bank, it lends money. When a person borrows money from a coöperative bank, he has to give a mortgage on real estate as security, and must pay back a certain amount each month.

Savings Banks

The most common form of banking is that carried on by the *Savings Bank*. People place their money in a savings bank for safe keeping and for interest. The bank makes its money by lending at a higher interest than it pays its depositors. There is a fixed date in each bank when money deposited begins to draw interest. Some banks pay quarterly and some semi-annually. At different times banks pay different rates of interest; and often in the same community there are different rates of interest paid by different banks.

Every bank is obliged to open its books for inspection by special officers who are appointed for that work. If these men did their work carefully and often enough, there would be almost no chance of loss in putting money in a bank. Banks fail when they lend money to too many people who are unable to pay it back.

EXAMPLES

(Review interest on page 50)

1. I place $ 400 in a savings bank that pays 4 % on Jan. 1, 1916. Money goes on interest April 1 and at each successive quarter. How much money have I to my credit at the beginning of the third quarter?

2. A man with a small business places his savings, $ 1683,

in a trust company so he can pay his bills by check. The bank pays 2 % for all deposits over $ 500. He draws checks for $ 430 and $ 215 within a few days. At the end of a month he will receive how much interest?

3. Practically 10 % of the entire population of the United States, including children, have savings-bank accounts. If the population is 92,818,726, how many people have savings bank deposits?

4. On April 1, 1910, a woman deposited $ 513 in a savings bank which pays 4 % interest. Interest begins April 1 and at each succeeding quarter. Dividends are declared Jan. 1 and July 1. What is the total amount of her deposit at the present date?

The savings bank is not adapted to the needs of those with large sums to place at interest. It is a place where small sums may be deposited with absolute safety, earn a modest amount, and be used by the depositor at short notice. The savings bank lends money on mortgages and receives about 5 %. It pays its depositor either $3\frac{1}{2}$ % or 4 %. The difference goes to pay expenses and to provide a surplus fund to protect depositors.

The question may be asked, "Why cannot the ordinary depositor lend his money on mortgages and receive 5 %?" He can, if he is willing to assume the risk. When you receive 4 % interest, you are paying 1% to $1\frac{1}{2}$ % in return for absolute safety and freedom from the necessity of selecting securities.

Mortgages

A mortgage is the pledging of property as a security for a debt. Mr. Allen owns a farm and wants some money to buy cattle for it. He goes to Mr. Jones and borrows $ 1000 from him, and Mr. Jones requires him to give as surety a mortgage on his farm. That is, Mr. Allen agrees that if he does not pay back the $ 1000, the farm, or such part as is necessary to cover the debt, shall belong to Mr. Jones.

Under present law, if a man wishes to foreclose a mortgage, — that is, compel its payment when due, — he cannot take the property, but it must be sold at public auction. From the money received at the sale the man who holds the mortgage receives his full amount, and anything that is left belongs to the man who owned the property.

Notes

A promissory note is a paper signed by the borrower promising to repay borrowed money. Notes should state value received, date, the amount borrowed (called the face), the rate, to whom payable, and the time and place of payment. Notes are due at the expiration of the specified time.

The rate of interest varies in different parts of the country. The United States has to pay about 2 %. Savings banks pay 3 % or 4 %. Individuals borrowing on good security pay from 4 % to 6 %.

In order to make the one who loans the money secure, the borrower, called the maker of the note, often has to get a friend to indorse or sign this note. The indorser must own some sort of property and if, at the end of six months or the time specified, the maker cannot pay the note, he is notified by written order, called a protest, and may, later, be called upon to repay the note.

A man is asking a great deal when he asks another man to sign a note for him. Unless you have more money than you need, it is better business policy to refuse the favor.

Always be sure that you know exactly what you are signing and that you know the responsibility attached. If you are a stenographer or a clerk in an office, you will often be called upon to witness a signature and then to sign your own name to prove that you have witnessed it. Always insist upon reading enough of the document to be sure that you know just what your signature means.

EXAMPLES

1. My house is worth $4000 and the bank holds a mortgage on it for one-half its value. They charge 5 % interest, which must be paid semi-annually. How much do I pay each time?

2. A bank holds a mortgage of $2500 on a house. The interest is 5 % payable semi-annually. How much is paid for interest at the end of three years?

3. A man buys property worth $3000. He gives a $2000 mortgage and pays $5\frac{1}{2}$ % interest. What will be the interest on the mortgage at the end of the year? Suppose he does not pay the interest, how long can he hold the property?

Different Kinds of Promissory Notes

$______ Montgomery, Ala.________________191

__________after date for value received_____promise

to pay to the order of____________________________

____________________________________Dollars

at Mechanics National Bank.

No.________ Due______________ ____________________

A Common Note

$______ St. Paul, Minn.________________19

__________after date for value received we jointly and

severally promise to pay to the order of________________

____________________________________Dollars

at Mechanics National Bank.

____

No.________ Due______________ ____________________

Joint Note

$ -------- Fall River, Mass. ----------------- 191

----------------------*after date for value received*.------

promise to pay to the order of The Mechanics National Bank of Fall River, Mass. --- Dollars, at said Bank, and interest for such further time as said principal sum or any part thereof shall remain unpaid at the rate of------per cent per annum, having deposited with the said Mechanics National Bank, as General Collateral Security, for the payment of any of------liabilities to said Bank due, or to become due, direct or indirect, joint or several, individual or firm, now or hereafter contracted or incurred, at the option of said Bank, the following property, viz.:

----

and------hereby authorize said Bank or its assigns to sell and transfer said property or any part thereof without notice, at public or private sale, at the option of said Bank or its assigns, on the non-payment of any of the liabilities aforesaid, and to apply the proceeds of said sale or sales, after deducting all the expenses thereof, interest, all costs and charges of enforcing this pledge and all damages, to the payment of any of the liabilities aforesaid, giving_______credit for any balance that may remain. Said Bank or its assigns shall at all times have the right to require the undersigned to deposit as general collateral security for the liabilities aforesaid, approved additional securities to an amount satisfactory to said Bank or its assigns, and_______ hereby agree to deposit on demand (which may be made by notice in writing deposited in the post office and addressed to_______at_______last known residence or place of business) such additional collateral. Upon_______ failing to deposit such additional security, the liabilities aforesaid shall be deemed to be due and payable forthwith, anything hereinbefore or elsewhere expressed to the contrary notwithstanding, and the holder or holders may immediately reimburse themselves by public or private sale of the security aforesaid; and it is hereby agreed that said Bank or any of its officers, agents, or assigns may purchase said collateral or any part thereof at such sale. In case of any exchange of or addition to the above described collateral, the provisions hereof shall apply to said new or additional collateral.

COLLATERAL NOTE

4. On Jan. 2, 1915, Mr. Lewis gave his note for \$2400, payable on Feb. 27, with interest at 6%. On Feb. 2, he paid \$600. How much was due Mar. 2, 1915?

SOLUTION.—In the case of notes running for less than a year, exact days are counted; from Jan. 2 to Feb. 2 is 31 days.

Interest Jan. 2 to Feb. 2, 31 days,

	\$12.00	for 30 days
	.40	for 1 day
	\$12.40	31 days

Amount due Feb. 2, \$2400 + 12.40 = \$2412.40.
\$2412.40 − 600 = \$1812.40.

Interest Feb. 2 to March 2, 28 days,

	\$6.0413	20 days
	1.8124	6 days
	.6041	2 days
	\$8.4578	or \$8.46
		1812.40
Amount due March 2,		\$1820.86 *Ans.*

Money lenders may discount their notes at banks and thus obtain their money before the note comes due. But the banks, in return for this service, deduct from the full amount of the note interest at a legal rate on the full amount for such time as remains between the day of discount and the day when the note comes due.

To illustrate: A man has a note for \$600 due in three months at 6% interest. At the end of a month he presents the note at a bank and returns the difference between the amount at maturity, \$609, and the interest on \$609 for two months, the remaining time, at legal rate 6%, \$6.09 or \$609 – 6.09 = \$602.91.

5. On June 1, 1914, Mr. Smith gives his note for \$1200, payable on demand with interest at 6%. The following payments are made on the note: Aug. 1, 1914, \$140; Oct. 1, 1914, \$100; Dec. 1, 1914, \$100; and Feb. 1, 1914, \$160. How much was due May 1, 1915?

6. A merchant buys paper amounting to \$945. He gives his note for this amount, payable in three months at 6%. The paper dealer desires to turn the note into cash immediately. He therefore discounts it at the bank for 6%. How much does he receive?

Stocks

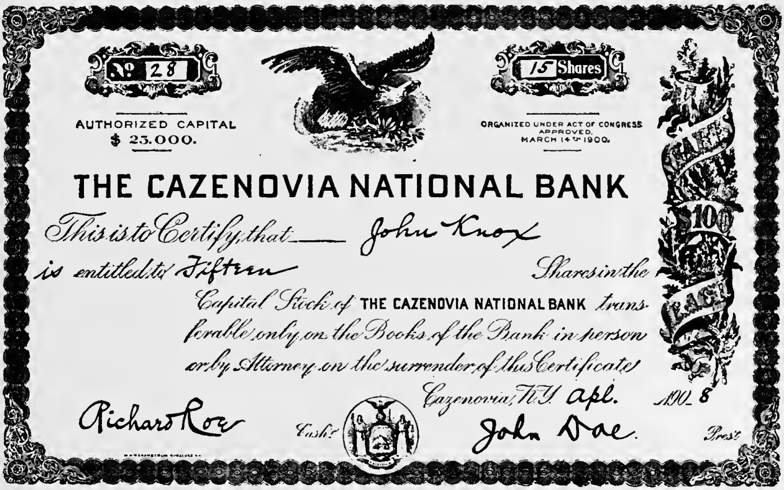
It often happens that one man or a group of men desire to engage in a business that requires more money than they alone are able or willing to invest in it. They obtain more money by organizing a stock company, in which they themselves buy as many shares as they choose, and then they induce others to pay for enough more shares to make up the capital that is needed or authorized for the business.

A **stock company** consists of a number of persons, organized under a general law or by special charter, and empowered to transact business as a single individual. The **capital stock** of a company is the amount named in its charter. A **share** is one of the equal parts into which the capital stock of a company is divided (generally \$100).

The **par value** of a share of stock is its original or face value; the **market value** of a share of stock is the price for which the share will sell in the market. The market values of leading stocks vary from day to day, and are quoted in the daily papers; *e.g.* "N. Y. C., 131" means that the stock of the New York Central R. R. Co. is selling to-day at \$131 a share.

Dividends are the net profits of a stock company divided among the stockholders according to the amount of stock they own.

Stock companies often issue two kinds of stock, namely: **preferred stock**, which consists of a certain number of shares on which dividends are paid at a fixed rate, and **common stock**, which consists of the remaining shares, among which are apportioned whatever profits there are remaining after payment of the required dividends on the preferred stock.



No. 28 | 15 Shares

AUTHORIZED CAPITAL $ 25.000.

ORGANIZED UNDER ACT OF CONGRESS APPROVED, MARCH 14th 1900.

THE CAZENOVIA NATIONAL BANK

This is to Certify, that John Knox is entitled to Fifteen Shares in the Capital Stock of THE CAZENOVIA NATIONAL BANK transferable only on the Books of the Bank in person or by Attorney on the surrender of this Certificate.

Cazenovia, N.Y. Apl. 1908

Richard Roe Cash'r. John Doe Prest.

CERTIFICATE OF STOCK

Stocks are generally bought and sold by brokers, who act as agents for the owners of the stock. Brokers receive as their compensation a certain per cent of the **par value** of the stock bought or sold. This is called brokerage. The usual brokerage is $\frac{1}{8}\%$ of the par value; *e.g.* if a broker sells 10 shares of stock for me, his brokerage is $\frac{1}{8}\%$ of \$1000, or \$1.25.

EXAMPLE. — What is the cost of 20 shares of No. Butte $30\frac{1}{2}$?

$\$30\frac{1}{2} + \$\frac{1}{8}$[1] $= \$30\frac{5}{8}$, cost of 1 share.

$\$30\frac{5}{8} \times 20 = \$600 + \$12\frac{1}{2} = \$612.50$, total cost.

[1] $\frac{1}{8}$ of 1% of \$100 = $\frac{1}{8}$ of \$1, broker's charge per share.

EXAMPLES

1. The par value of a certain stock is $100. It is quoted on the market at $$87\frac{1}{2}$. What is the difference in price per share between the market value and the par value?

2. What is the cost of 40 shares of Copper Range at 53?

3. What is the cost of 53 shares of Calumet and Hecla at 680?

4. I have 50 shares of Anaconda. How much shall I receive if I sell at $66\frac{1}{2}$?

5. I buy 60 shares of Anaconda at $66\frac{1}{2}$. It pays a quarterly dividend of $1.50. What interest am I receiving on my money?

Bonds

Corporations and national, state, county, and town governments often need to borrow money in order to meet extraordinary expenditures. When a corporation wishes to borrow a large sum of money for several years, it usually mortgages its property to a person or bank called a trustee. The amount of the mortgage is divided into parts called **bonds**, and these are sold to investors. The interest on the bonds is at a fixed rate and is generally payable semi-annually. Shares of stock represent the property of a corporation, while bonds represent debts of the corporation; stockholders are owners of the property of the corporation, while bondholders are its creditors.

Bonds of large corporations whose earnings are fairly stable and regular, like steam railroads, street railways, and electric power and gas plants, whose property must be employed for public necessities regardless of the ability of the managers, are usually good investments. Well-secured bonds are safer than stocks, as the interest on the bonds must be paid regardless of the condition of the business.

For the widow who is obliged to live on the income from a moderate amount of capital, it is better to invest in bonds and farm mortgages than in stock.

A SAMPLE BOND

EXAMPLES

1. A man put $200 in the Postal Savings Bank and received 2 % interest. What would have been the difference in his income for a year if he had taken it to a savings bank that paid $3\frac{1}{2}$ %?

2. A widow had a principal of $18,000. She placed it in a group of savings banks that paid $3\frac{3}{4}$ %. The next year she purchased farm mortgages and secured $5\frac{1}{2}$ %. What was the difference in her income for the two years?

3. Two sons were left $15,000 each. One placed it in first-class bonds paying $5\frac{1}{4}$ %. The other placed it in savings banks and averaged $4\frac{1}{4}$ %. What was the difference in income per year?

Fire Insurance

Household furniture, books, apparel, etc., can be insured at a low rate. While it will not make a man less careful in protecting his home from fire, it will make him more comfortable in the thought that if fire should come, the family will not be left without the means of clothing themselves and refurnishing the house. One of the first duties then, after the home is established, is to secure insurance.

Insurance companies issue a policy for 1, 3, or 5 years. There is an advantage in buying a policy for more than one year, for on the 3- or 5-year policy there is a saving of about 20 % in premiums. Rules of percentage apply to problems in insurance.

Example. — A house worth $8400 is insured for its full value at 28 cents per $100. What is the cost of premium?

Solution.

$8400 is the value of the policy or base.
28 cents is the rate of premium or rate.
The premium or interest is the amount to be found.
84 × $0.28 = $23.52, premium.

EXAMPLES

1. Find the insurance upon a dwelling house valued at $3800 at $2.80 per $1000 if the policy is on 80 % of the value of the house.

2. Mr. Jones takes out $800 insurance on his automobile at 2%. What is the cost of the premium?

3. The furniture in one tenement of a three-family house is valued at $1000. What premium is paid, if it is insured at the rate of 1% for 5 years?

4. If the premium on the same furniture in a two-family house in a different city is $7.50, what is the rate, expressed in per cent?

Life Insurance

Every industrious and thrifty person lays aside a certain amount regularly for old age or future necessities, or in case of death to provide sufficient amount for the support of the family. This is usually done by taking out life insurance from a corporation called an insurance company. This corporation is obliged to obtain a charter from the state, and is regularly inspected by a proper state officer.

The *policy* or *contract* which is made by the company with the member, fixing the amount to be paid in the event of his death, is called a *life insurance policy*, and the person to whom the amount is payable is termed the *beneficiary*. The contribution to be made by the member to the common fund, as stipulated in the policy, is termed the *premium*, and is usually payable in yearly, half-yearly, or quarterly installments.

There are different kinds of insurance policies: the simplest is the ordinary life policy. Before entering into a contract of this kind, it is necessary to fix the amount of the premium, which must be large enough to enable the company to meet the necessary expense of conducting the business and to accumulate a fund sufficient to pay the amount of the policy when the latter matures by the death of the insured.

Making the Premium. — If it were known to a certainty just how long the policy holder would live, anyone could compute the amount of the necessary premium. Let us suppose, for illustration, that the face of the policy is $1000, and that the policyholder will live just twenty years. Let us assume that the business is conducted without expense, and that the premiums are all to be invested at interest from date of payment. We do not know to a certainty what rate of interest can be earned during the whole period, and we shall therefore assume one that we can safely depend upon, say three per cent. A yearly payment of $36.13 invested at three per cent compound interest will amount to $1000 in twenty years.

No. 213649 **$5000**

The North Star Mutual Life Insurance Company

In Consideration of the application for this Policy, a copy of which is attached hereto and made a part hereof, and in further consideration of the payment of

One Hundred Thirty-eight $\frac{65}{100}$ Dollars,

the receipt whereof is hereby acknowledged, and of the Annual payment of a like sum to the said Company, on or before the First day of January in every year during the continuance of this Policy, promises to pay at its office in Milwaukee, Wisconsin, unto Mary Doe, Beneficiar y, Wife of John Doe the Insured, of Des Moines in the State of Iowa subject to the right of the Insured, hereby reserved, to change the Beneficiary or Beneficiaries the sum of Five Thousand Dollars,

upon receipt and approval of proof of the death of said Insured while this Policy is in full force, the balance of the year's premium, if any, and any other indebtedness on account of this Policy being first deducted therefrom; provided, however, that if no Beneficiary shall survive the said Insured, then such payment shall be made to the executors, administrators or assigns of the said Insured.

In Witness Whereof, THE NORTH STAR MUTUAL LIFE INSURANCE COMPANY, at its office in Milwaukee, Wisconsin, has by its President and Secretary, executed this contract, this *First* day of *January* one thousand nine hundred and *sixteen.*

S. A. Hawkins, Secretary. *L. H. Perkins*, President.

ORDINARY LIFE INSURANCE POLICY

If it were certain that the policyholder would live just twenty years, and that his premiums would earn just three per cent interest, and that the business could be conducted without expense, the necessary premium would be $36.13. But there are certain other contingencies that should be provided for; such as, for example, a loss of invested funds, or a failure to earn the full amount of three per cent interest.

To meet these expenses and contingencies something should be added to the premium. Let us estimate as sufficient for this purpose the sum of $7. This will make the gross yearly premium $43.13, the original payment ($36.13) being the net premium, while the amount added thereto for expenses, etc. ($7.00), is termed the *loading.*

The *net premium* is the amount which is mathematically necessary for the creation of a fund sufficient to enable the company to pay the policy in full at maturity. The loading is the amount added to the net premium to provide for expenses and contingencies. The net premium and loading combined make up the *gross premium*, or the total amount to be paid each year by the insured.

Mortality Tables. — Although it is impossible, as in the illustration given above, to predict in advance the length of any individual life, there is a law governing the mortality of the race by which we may determine the average lifetime of a large number of persons of a given age. We cannot predict in what year the particular individual will die, but we may determine with approximate accuracy how many out of a given number will die at any specified age. By means of this law it becomes possible to compute the premium that should be charged at any given age with almost as much exactness as in the example given, in which the length of life remaining to the individual was assumed to be just twenty years.

Let us suppose, for example, that observations cover a period of time sufficient to include the history of 100,000 lives. Of these, you will find a certain number dying at the age of thirty, a larger number at the age of forty, and so on at the various ages, the extreme limit of life reached being in the neighborhood of one hundred years. The mortuary records of other groups of 100,000, living where conditions are practically the same, would give approximately the same results — the same number of deaths at each age in 100,000 born. The variation would not be great, and the larger the number of lives under observation, the nearer the number of deaths at the several ages by the several records would approach to uniformity.

In this manner *mortality tables* have been constructed which show how many in any large number of persons born, or starting at a certain age, will live to age thirty, how many to age forty, how many to any other age, and likewise the number that will die at each age, with the average lifetime remaining to those still alive. The insurance companies from these tables construct tables of premiums, varying according to the amount and kind of insurance and the age at which the policy is taken out.

Kinds of Policies. — An *endowment policy* is essentially for persons who must force themselves to save. It is an expensive form of insurance, but one that affords the young man or woman an incentive for saving, and that matures at a time when the individual has, as a result of long experience, better opportunities to make profitable investments. This policy also has a larger loan value than any other, and this sometimes becomes an advantage to the young person. However, the chief advantage of the endowment policy is its incentive to save.

A *limited payment policy*, such as the *twenty-payment life*, appeals most directly to those who desire to pay for life insurance only within the productive period of their life. This policy should attract the young man who is uncertain of an income after a given period, or who does not wish insurance premiums to be a burden upon him after middle life. Out of the relatively large and certain income of his early productive years he pays for his insurance. This policy also appeals to the man of middle age who has neglected to purchase life insurance but who wishes to buy it and pay for it before he becomes actually old.

The Annuity

An *annuity* is a specific sum of money to be paid yearly to some designated person. The one to whom the money is to be paid is termed the *annuitant.* If the payment is to be made every year until the annuitant dies, it is termed a *life annuity.* For example, a life insurance company or other financial institution, in consideration of the payment to it of a specified amount, say $ 1000, will enter into a contract to pay a designated annuitant a stated sum, say $ 70, on a specified day in every year so long as the annuitant continues to live. The latter may live to draw his annuity for many years, until he has received in aggregate several times the original amount paid by him, or he may die after having collected but a single payment. In either case, the contract expires and the annuity terminates with the death of the annuitant.

The amount of the yearly income or annuity which can be purchased with $ 1000 will depend, of course, upon the age of the annuitant. That sum will buy a larger income for the man of seventy than for one of fifty-six, for the reason that the former has, on the average, a much shorter time yet to live. The net cost of an annuity, that is, the net amount to be paid in one sum, and which is termed the *value of the annuity*, is not a matter of estimate, but, like the life insurance premium, is determined by mathematical computation, based upon the mortality table. The process is quite as simple as the computation of the single premium.

Many men who insure their lives choose a form of policy under which the beneficiary, instead of receiving the full amount of the insurance at the death of the insured, is paid an annuity for a period of years or throughout life. The amount of annuity paid in such cases is exactly equal to the amount that could be bought for a sum equal to the value of the policy when it falls due.

EXAMPLES

1. A young man at 26 years of age takes out a straight life policy of $ 1000, for which he pays $ 17.03 a year as long as he lives, and his estate receives $ 1000 at his death. If he dies at 46 years of age, how much has he paid in? How much more than he has paid does his estate receive then?

2. Another young man at the same age takes out a twenty-payment life policy and pays $ 24.85 for twenty years. At the end of the twenty years, how much has he paid in? Does he receive anything in return at the end of the twenty years?

3. Another form of insurance, called an endowment, is taken out by another young man at twenty-six years of age. He pays $ 41.94 a year. At the end of twenty years he receives $ 1000 from the insurance company. How much has he paid in? Where is the difference between these two amounts?

Exchange

Exchange is the process of making payment at a distant place without the risk and expense of sending money itself. Funds may be remitted from one place to another in the same country in six different ways: Postal money order, express money order, telegraphic money order, bank draft, check, and sight draft.

The largest amount for which one can obtain a postal money order is $ 100. It is drawn up by the postmaster after an application has been duly made out.

An express money order is similar to a postal money order, but may be drawn for any number of dollars at the same rate as the post office order. This is issued at express offices.

A telegraphic money order is an order drawn by a telegraph agent at any office, instructing the agent at some other office to pay the person named in the message the sum specified. The rates are high, and in addition one must pay the actual cost of sending the telegram according to distance and number of words.

A bank draft is an order written by one bank directing another bank to pay a specified sum of money to a third party. This order looks much like a check.

A check is an order on a bank to pay the sum named and deduct the amount from the deposit of the person who signs the check.

A sight draft is an order on a debtor to pay to a bank the sum named by the creditor who signs the draft.

Foreign exchange is a system for transmitting money to another country. By this means the people of different countries may pay their debts.

The most common methods of foreign exchange for an ordinary traveler are letters of credit or travelers' cheques.

A letter of credit is a circular letter issued by a banking house to a person who desires to travel abroad. The letter directs certain banks in foreign countries to furnish the traveler such sums as he may require up to the amount named in the letter.

Fees For Money Orders

Domestic Rates

When payable in Bahamas, Bermuda, British Guiana, British Honduras, Canada, Canal Zone, Cuba, Martinique, Mexico, Newfoundland, The Philippine Islands, The United States Postal Agency at Shanghai (China), and certain islands in the West Indies, listed in the register of money order offices.

For Orders from	
\$00.01 to \$2.50	3 cents
From \$2.51 to \$5	5 cents
From \$5.01 to \$10	8 cents
From \$10.01 to \$20	10 cents
From \$20.01 to \$30	12 cents
From \$30.01 to \$40	15 cents
From \$40.01 to \$50	18 cents
From \$50.01 to \$60	20 cents
From \$60.01 to \$75	25 cents
From \$75.01 to \$100	30 cents

International Rates

When payable in Asia, Austria, Belgium, Bolivia, Chile, Costa Rica, Denmark, Egypt, France, Germany, Great Britain and Ireland, Greece, Honduras, Hongkong, Hungary, Italy, Japan, Liberia, Luxemburg, Netherlands, New South Wales, New Zealand, Norway, Peru, Portugal, Queensland, Russia, Salvador, South Australia, Sweden, Switzerland, Tasmania, Union of South Africa, Uruguay, and Victoria.

For Orders from	
$ 00.01 to $ 10	10 cents
From $ 10.01 to $ 20	20 cents
From $ 20.01 to $ 30	30 cents
From $ 30.01 to $ 40	40 cents
From $ 40.01 to $ 50	50 cents
From $ 50.01 to $ 60	60 cents
From $ 60.01 to $ 70	70 cents
From $ 70.01 to $ 80	80 cents
From $ 80.01 to $ 90	90 cents
From $ 90.01 to $ 100	1 dollar

Rates for Money Transferred by Telegraph

The Western Union charges for the transfer of money by telegraph to its offices in the United States the following:

First: For $ 25.00 or less	25 cents
$ 25.01 to $ 50.00	35 cents
$ 50.01 to $ 75.00	60 cents
$ 75.01 to $ 100.00	85 cents

For amounts above $ 100.00 add (to the $ 100.00 rate) 25 cents per hundred (or any part of $ 100.00) up to $ 3000.00.

For amounts above $ 3000.00 add (to the $ 3000.00 rate) 20 cents per hundred (or any part of $ 100.00).

Second: To the above charges are to be added the tolls for a fifteen word message from the office of deposit to the office of payment.

Express rates are the same as postal rates.

EXAMPLES

1. A young woman in California desires to send $ 20 to her mother in Maine. What is the most economical way to send it, and what will it cost?

2. A young lady, traveling in this country, finds that she needs money immediately. What is the quickest and most economical way for her to obtain \$ 275 from her brother who lives 1000 miles distant?

3. A merchant in Boston buys a bank draft of \$ 3480 for Chicago. The bank charges $\frac{1}{8}$ of 1 % for exchange. How much must he pay the bank?

4. A domestic in this country sends to her mother in Ireland 5 pounds for a Christmas present. What will it cost her, if \$ 4.865 = £ 1? A commission of $\frac{1}{2}$ of 1 % is charged.

Claims

If a person traveling by boat, electric or steam railway is injured by an accident which is the fault of the company, it is bound to repair the financial loss. The company is not responsible for the carelessness of passengers or for the action of the elements. When an accident occurs, the injured persons are interviewed by a claim agent, whom all large companies employ, and he offers to settle with you for a certain amount. If you are not satisfied with this amount, you may put in your claim and the case goes to court, where you may lose or win according to the decision of the jury. When a wreck occurs on a railroad, a claim agent and a doctor are brought to the scene as soon as possible. They take the name and address of each person in the accident and try to settle the case at once, because it is expensive to go to court and the newspaper notoriety injures the reputation of the company. If you are not seriously hurt, the claim agent tries to persuade you to sign a paper which relieves the company from any responsibility forever after. For instance, in a collision you seem to be only shaken up, not injured. The claim agent perhaps offers to pay you \$ 25. You think that is an easy way to get \$ 25, so you take it, but in turn you must sign a paper which states that the company has settled in full with you for any claim that you may have against it for that accident. Now it may prove later that you have an internal injury which you did not realize at the time, and that an operation costing \$ 500 is necessary. Can you compel the company to pay the bill? People who are not hurt at all in an accident and to whom the claim agent offers nothing are also asked to sign a paper relieving the company from all responsibility. *Do not sign such a paper.* The company cannot compel you to, you gain nothing by it, and may lose much if it proves later that you are internally injured.

EXAMPLES

1. A woman was riding in an electric car that collided with another. She was cut with flying glass and was obliged to hire a servant for four weeks at \$8. Doctor's bills amounted to \$24.50, medicine, etc., \$8.75. She settled at the time of the accident for \$50. Did she lose or gain?

2. A man working in a mill was injured in an elevator accident. The insurance company paid his wages and medical bills for 8 weeks at \$13.50 per week. A year later he was out of work for three weeks for the same injury and did not receive any compensation. Would it have been better for him to have settled for \$100 at the beginning?

3. A saleslady tripped on a staircase and sprained her ankle. She was out of work for two weeks and two days at \$8.75 per week. Her medical supplies cost \$9.75. She settled for \$45. How much did she gain?

PART III — DRESSMAKING AND MILLINERY

CHAPTER IX

PROBLEMS IN DRESSMAKING

THE yardstick is much used for measuring cloth, carpets, and fabrics. The yardstick is divided into halves, quarters, and eighths. Dressmakers should know the fractional equivalents of yards in inches and the fractional equivalents of dollars in cents.

It is wise to buy to the nearest eighth of a yard unless the cost per yard is so small that an eighth would cost as much as a quarter.

EXAMPLES

1. Give the equivalent in inches of the following:

(*a*) 1 yd.	(*f*) $4\frac{5}{8}$ yd.	(*k*) $\frac{1}{3}$ yd.
(*b*) $2\frac{1}{2}$ yd.	(*g*) $6\frac{7}{8}$ yd.	(*l*) $\frac{1}{9}$ yd.
(*c*) $1\frac{1}{4}$ yd.	(*h*) $1\frac{1}{6}$ yd.	(*m*) $\frac{1}{12}$ yd.
(*d*) $2\frac{1}{8}$ yd.	(*i*) $1\frac{3}{4}$ yd.	(*n*) $\frac{1}{18}$ yd.
(*e*) $3\frac{3}{8}$ yd.	(*j*) $\frac{1}{6}$ yd.	(*o*) $\frac{3}{16}$ yd.

2. A piece of cloth is 12 yd. long. How many pieces are needed for 16 aprons requiring $1\frac{1}{2}$ yd. each?

3. A piece of lawn cloth is 28 yd. long. How many pieces are needed for 20 aprons requiring $1\frac{3}{4}$ yd. each?

4. Give the value in cents of the following fractions of a dollar:

(*a*) $\frac{15}{16}$	(*e*) $\frac{13}{16}$	(*i*) $\frac{5}{16}$	(*m*) $\frac{3}{16}$
(*b*) $\frac{1}{4}$	(*f*) $\frac{5}{8}$	(*j*) $\frac{3}{8}$	(*n*) $\frac{1}{16}$
(*c*) $\frac{1}{2}$	(*g*) $\frac{7}{8}$	(*k*) $\frac{9}{16}$	(*o*) $\frac{1}{3}$
(*d*) $\frac{11}{16}$	(*h*) $\frac{7}{16}$	(*l*) $\frac{7}{10}$	(*p*) $\frac{3}{4}$

5. If 16″ is cut from $1\frac{5}{8}$ yd. of cloth, how much remains?

6. If $\frac{7}{8}$ of a yard of lawn is cut from a piece 40 in. long, what part of a yard is left?

7. I bought $9\frac{3}{4}$ yd. of silk for a dress. If $1\frac{3}{8}$ yd. remained, how much was used?

8. A towel is 33 inches long and and a dishcloth 13 inches.

(*a*) Find the length of both. (Allow $\frac{1}{2}$″ for each hem.)
(*b*) Find the number of yards used for both.
(*c*) Find the number of inches used by a class of 24.
(*d*) Find the number of yards used by a class of 24.
(*e*) Find the cost per pupil at 6 cts. per yard.
(*f*) Find the cost for a class of 24 at 6 cts. per yard.

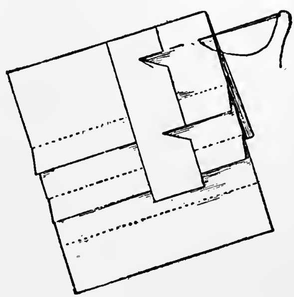
9. If it took 72 yards of material for a dishcloth and towel for two classes of 24 (48 in all), find the amount used by each pupil.

10. If $45\frac{5}{6}$ yards of material were used for a class of 42, find the amount used by each pupil.

11. (*a*) Reduce 75 inches to yards. (*b*) Find the number of inches in $3\frac{1}{2}$ yards. (*c*) From $2\frac{3}{4}$ yards cut 40 inches.

Tucks

A **tuck** is a fold in the cloth for the purpose of shortening garments or for trimming or decoration. A tuck takes up twice its own depth; that is, a 1″ tuck takes up 2″ of cloth.



MEASURING FOR TUCKS FROM FOLD TO FOLD

EXAMPLES

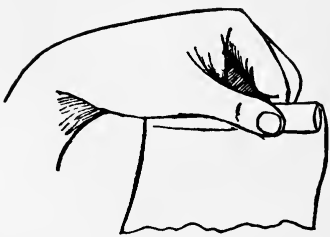
1. Before tucking, a piece of goods was $\frac{5}{6}$ yd. long; after tucking, it was $\frac{2}{3}$ yd. long. How many $\frac{1}{8}$″ tucks were made?

2. How much lawn is taken up in 3 groups of tucks, the first group containing 6 one-inch tucks, the second group 6 one-half-inch tucks, and the third group 12 one-eighth-inch tucks?

3. A piece of muslin 29 inches wide was tucked and when returned to the teacher was only 14 inches wide. How many $\frac{1}{4}''$ tucks were made in it?

4. Before tucking, a piece of goods was $\frac{3}{4}$ yd. long; after tucking, it was $\frac{1}{2}$ yd. long. How many $\frac{1}{8}''$ tucks were made?

Hem



HEM TURNED

A **hem** on a piece of cloth is an edge turned over to form a border or finish. In making a hem an edge must always be turned to prevent fraying; except for very heavy or very loosely woven cloth this is usually $\frac{1}{4}''$. For an inch hem you would have to allow $1\frac{1}{4}''$.

EXAMPLES

1. I wish to put three $\frac{1}{2}''$ tucks in a skirt which is to be 40″ long. How long must the skirt be cut to allow for the tucks and $3\frac{1}{2}''$ hem?

2. My cloth for a ruffle is 10″ deep. It is to have a $1\frac{1}{2}''$ hem, and five $\frac{1}{8}''$ tucks. How long will it be when finished?

3. If a girl can hem $2\frac{1}{2}$ inches in five minutes, how long will she take to hem 2 yards?

4. At the rate of $\frac{3}{4}$ of an inch per minute, how long will it take a girl to hem 2 yards? 10 yards?

5. At the rate of $5\frac{1}{2}$ inches per ten minutes, how long will it take to hem $3\frac{1}{4}$ yards?

6. A girl can hem 3 inches in five minutes. How much in an hour?

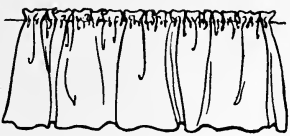
7. How long will she take to hem 90 inches?

8. At 6 cents per hour, how much can she earn by hemming 190 inches?

9. How long will it take a girl to hem $2\frac{1}{4}$ yards if she can hem $5\frac{1}{2}$ inches in ten minutes?

Ruffle

A **ruffle** is a strip of cloth gathered in narrow folds on one edge and used for the trimming or decoration. Different proportions of material are allowed according to the use to which it is to be put. For the ordinary ruffle at the bottom of a skirt, drawers, apron, etc., allow once and a half. Once and a quarter is enough to allow for trimming for a corset cover or for other places where only a scant ruffle is desirable. A plaiting requires three times the amount.



RUFFLE

EXAMPLES

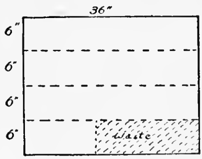
1. How much hamburg would you buy to make a ruffle for a petticoat which measures 3 yd. around, if once and a half the width is necessary for fullness?

2. How much lace $2\frac{1}{2}$ inches wide would you buy to have plaited for sleeve finish, if the sleeve measures 8 inches around the wrist — allowing three times the amount for plaiting?

3. A skirt measuring $3\frac{1}{4}$ yd. around is to have two 5-inch ruffles of organdie flouncing. Allowing twice the width of skirt for lower ruffle, and once and three quarters for the upper one, how much flouncing would you buy, and what would be the cost at \$ .87$\frac{1}{2}$ per yard for organdie?

4. How deep must a ruffle be cut to be 6″ deep when finished, if there is to be a $1\frac{1}{4}$″ hem on the bottom and three $\frac{1}{8}$″ tucks above the hem?

5. How deep a ruffle can be made from a strip of lawn 16″ deep, if a 2″ hem is on the bottom and above it three $\frac{1}{4}$″ tucks?



6. How many yards of cloth 36″ wide are needed for $3\frac{1}{2}$ yd. of ruffling which is to be cut 6″ deep?

7. How many widths for ruffling can be cut from 4 yd. of lawn 36″ wide, if the ruffle is 6″ finished, and has a $\frac{3}{4}$″ hem and five $\frac{1}{8}$″ tucks?

NOTE. — Allowance must be made for joining a ruffle to a skirt, usually $\frac{1}{4}$″.

8. How deep must a ruffle be cut to be 5″ deep when finished, if there is to be a $1\frac{1}{4}$″ hem on the bottom, and five $\frac{1}{8}$″ tucks above the hem?

9. How many yards of ruffling are needed for a petticoat $2\frac{1}{4}$ yd. around the bottom?

EXAMPLES IN FINDING COST OF MATERIALS

1. What is the cost of hamburg and insertion for one pair of drawers?

32 in. around each leg.
Hamburg at 16 cents a yard.
Insertion at 15 cents a yard.

2. What is the cost of hamburg and insertion for one pair of drawers?

36 in. around each leg.
Hamburg at $18\frac{1}{2}$ cents a yard.
Insertion at $16\frac{1}{2}$ cents a yard.

3. What is the cost of hamburg and insertion for a petticoat?

5 yd. around.
Hamburg at 25 cents a yard.
Insertion at 15 cents a yard.

4. What is the cost of hamburg and insertion for a petticoat?

$5\frac{1}{2}$ yd. around.
Hamburg at $27\frac{1}{2}$ cents a yard.
Insertion at $16\frac{1}{2}$ cents a yard.

5. What is the cost of trimming for a corset cover?

38 in. around top.
13 in. around armhole.
Lace at 10 cents a yard.

6. What is the cost of trimming for a corset cover?

41 in. around top.
$13\frac{1}{2}$ in. around armhole.
Lace at $12\frac{1}{2}$ cents a yard.

7. What is the cost of lace for neck and sleeves at $12\frac{1}{2}$ cents a yard?

Neck, 13 in., sleeves, 8 in.

8. What is the cost of lace for neck and sleeves at 15 cents a yard?

Neck, 14 in., sleeves, $8\frac{1}{2}$ in.

9. What is the cost of a petticoat requiring $2\frac{1}{2}$ yd. longcloth at $12\frac{1}{2}$ cents a yard, and $2\frac{1}{4}$ yd. hamburg at $15\frac{1}{2}$ cents a yard?

10. What is the cost of a petticoat requiring $2\frac{3}{4}$ yd. longcloth at $13\frac{1}{2}$ cents a yard, and $2\frac{1}{2}$ yd. hamburg at $15\frac{1}{2}$ cents a yard?

11. What is the cost of a nightdress requiring $3\frac{1}{2}$ yd. of cambric at 25 cents a yard and 3 skeins of D. M. C. embroidery cotton which sells at 5 cents for 2 skeins, and $1\frac{1}{2}$ yd. $\frac{1}{2}$-inch ribbon at 9 cents a yard?

12. What is the cost of the following material for a corset cover?

$1\frac{1}{4}$ yd. longcloth at 15 cents a yard.
$2\frac{1}{4}$ yd. hamburg at 8 cents a yard.
6 buttons at $12\frac{1}{2}$ cents a dozen.

13. What is the cost of the following material for a skirt?

7 yd. silk at 79 cents a yard.
$1\frac{1}{2}$ yd. lining at 35 cents a yard.

14. What is the cost of the following material for a corset cover?

$1\frac{1}{2}$ yd. longcloth at 15 cents a yard.
$2\frac{1}{4}$ yd. hamburg at $8\frac{1}{2}$ cents a yard.
4 buttons at $12\frac{1}{2}$ cents a dozen.

15. What is the cost of the following material for a corset cover?

$1\frac{1}{2}$ yd. longcloth at $16\frac{1}{2}$ cents a yard.
$2\frac{3}{4}$ yd. hamburg at $25\frac{1}{2}$ cents a yard.
$2\frac{3}{4}$ yd. insertion at $19\frac{1}{2}$ cents a yard.
4 buttons at 15 cents a dozen.

16. What is the cost of the following material for a corset cover?

$1\frac{1}{8}$ yd. longcloth at $14\frac{1}{2}$ cents a yard.
$1\frac{3}{4}$ yd. hamburg at $17\frac{1}{2}$ cents a yard.

17. What is the cost of the following material for a skirt?

$7\frac{1}{2}$ yd. silk at $83\frac{1}{2}$ cents a yard.
$1\frac{1}{2}$ yd. lining at $37\frac{1}{2}$ cents a yard.

18. Find the cost of a corset cover that requires

1 yd. cambric at $12\frac{1}{2}$ cents a yard.
$\frac{3}{4}$ yd. bias binding at 2 cents a yard.
$\frac{1}{3}$ doz. buttons at 12 cents a dozen.
$1\frac{3}{4}$ yd. lace at 10 cents a yard.
$\frac{1}{4}$ spool thread at 5 cents a spool.

19. Find the cost of an apron that requires

1 yd. lawn at $12\frac{1}{2}$ cents a yard.
$2\frac{1}{2}$ yd. lace at 10 cents a yard.
$\frac{1}{4}$ spool thread at 5 cents a spool.

20. Find the cost of a nightgown containing

$3\frac{1}{2}$ yd. cambric at $12\frac{1}{2}$ cents a yard.
2 yd. lace at 5 cents a yard.
3 yd. ribbon at 3 cents a yard.
$\frac{1}{2}$ spool thread at 5 cents a spool.

21. Find the cost of drawers containing

2 yd. cambric at $12\frac{1}{2}$ cents a yard.
$1\frac{1}{2}$ yd. finishing braid at 5 cents a yard.
$\frac{1}{4}$ spool thread at 5 cents a spool.
2 buttons at 10 cents a dozen.

22. What is the cost of a waist made of the following?

$2\frac{5}{8}$ yd. shirting, 32 inches wide, at 23 cents a yard.
Sewing cotton, buttons, and pattern, 25 cents.

23. What is the cost of $7\frac{1}{8}$ yd. chiffon faille, 36 inches wide, at $1.49 a yard?

24. How many yards of ruffling are needed for 1 dozen aprons if each apron is one yard wide and half the width of the apron is added for fullness?

25. How many pieces of lawn 36 inches wide are needed for the ruffle for one apron? For eight aprons?

26. A skirt measures $2\frac{1}{2}$ yards around the bottom. How much material is needed for ruffling if the material is one yard wide and ruffle is to be cut 7 inches wide?

27. How deep would you cut a cambric ruffle that when finished will measure $12\frac{1}{2}''$, including the hamburg edge which measures $4''$, two clusters of 5 tucks $\frac{1}{8}''$ deep, and allowing $1'$ for making?

28. Find the cost of a poplin suit made of the following:

Silk poplin, 40 inches wide: $5\frac{1}{2}$ yards, at $1.79 a yard.
Satin facing for collar, revers, and cuffs, 21 inches wide: 1 yard, at $1.25 a yard.
Coat lining, 36 inches wide: $2\frac{5}{8}$ yards, at $1.50 a yard.
Buttons, braid, sewing silk, two patterns, $.64.

Cloths of Different Widths

There are in common use cloths of several different widths and at various prices. It is often important to know which is the most economical cloth to buy. This may be calculated by finding the cost per square yard, 36″ by 36″. To illustrate: which is less expensive, broadcloth 56″ wide, at \$2.25 per yard, or 50″ wide, at \$1.75 per yard?

$$\frac{36 \times \cancel{36}}{56 \times \cancel{36}} \times 2.25 = \$1.44\tfrac{9}{14} \text{ per square yard.}$$
$$\frac{36 \times \cancel{36}}{50 \times \cancel{36}} \times 1.75 = \$1.26 \text{ per square yard.}$$

EXAMPLES

Find the cost per square yard and the relative economy in purchasing:

(*a*) Prunella, 46″ wide, at \$1.50 a yard.
Prunella, 44″ wide, at \$1.35 a yard.

(*b*) Serge, 54″ wide, at \$1.25 a yard.
Poplin, 42″ wide, at \$1.00 a yard.

(*c*) Serge, 42″ wide, at 49 cents a yard.
Serge, 37″ wide, at 39 cents a yard.

(*d*) Shepherd check, 54″ wide, at \$1.75 a yard.
Shepherd check, 52″ wide, at \$1.50 a yard.
Shepherd check, 42″ wide, at \$1.00 a yard.

(*e*) Taffeta, 19″ wide, at 89 cents a yard.
Taffeta, 36″ wide, at \$1.25 a yard.

(*f*) Cashmere, 42″ wide, at \$1.00 a yard.
Nuns veiling 44″ wide, at 75 cents a yard.

(*g*) Cheviot, 57″ wide, at \$1.50 a yard.
Diagonal, 54″ wide, at \$2.00 a yard.

(*h*) Messaline, 26″ wide, at 59 cents a yard.
Messaline, 36″ wide, at \$1.25 a yard.

PROBLEMS IN TRADE DISCOUNT

Illustrative Example.—A dressmaker bought $ 125 worth of material, receiving 6 % discount for cash. She sold the material for 20 % more than the original price. What was the gain?

Solution. —	$ 125.00 original price	$125.00
	.06	7.50
	$ 7.50 discount	$ 117.50 price paid for material.
	5 | $ 125 original cost	$ 150.00 selling price
	$ 25 20 % gain	117.50 price paid
	$ 150 selling price	$ 32.50 gain. *Ans.*

EXAMPLES

1. A dressmaker bought 25 yd. of hamburg at 50 cents per yard, receiving 6 % discount for cash. She then sold the hamburg to her customers at 60 cents per yard. What was the price paid for hamburg, and what per cent did she make?

2. A dressmaker bought $ 325 worth of goods, receiving 6 % discount for cash. She sold the goods for 25 % more than the original price. What was the gain?

3. A milliner bought $ 200 worth of ribbons, velvets, and flowers, receiving 5 % discount for cash. She then sold the materials for 30 % more than the original price. What was the gain?

REVIEW EXAMPLES

1. A dressmaker bought 30 yd. of silk at $ 1.25 per yard. She received a discount of 10 %. She sold the silk for $ 1.39 per yard. How much did she gain on the 30 yards?

2. A merchant bought 50 yd. of lawn at $12\frac{1}{2}$ cents a yard, and received a discount of 6 % for cash. How much did the lawn cost?

3. A piece of crinoline containing 45 yd. was bought for $ 18. It was made into dress models of 5 yd. each. What was the cost of the crinoline in each model?

4. A dressmaker bought $175 worth of silk, receiving 6 % discount for cash. She sold the silk for 25 % more than the original price. What was the gain per cent?

5. A dressmaker bought $24\frac{3}{4}$ yd. of silk, at $1.10 per yard. From it she made three dresses, and had $13\frac{3}{8}$ yd. left. How much did the silk for one dress cost?

6. Find the cost of 36 yd. of valenciennes lace at $7\frac{1}{2}$ cents a yard, 12 yd. of insertion at $6\frac{1}{2}$ cents a yard, and 12 yd. of beading at 7 cents a yard. What is the net cost, when 2 % discount is given?

7. How many lingerie shirtwaists, each containing $2\frac{3}{4}$ yd., can be made from 49 yd. of batiste? What is the cost of material for one waist, if the whole piece cost $9.80, less 5 % discount?

8. A dressmaker bought $2\frac{1}{2}$ yd. of crepe at 29 cents a yard, for a shirtwaist, 3 yd. of beading at $12\frac{1}{2}$ cents a yard, 6 crochet buttons at 35 cents a dozen. What did the material for the waist cost?

9. A woman bought $9\frac{1}{2}$ yd. of foulard silk, at $1.10 a yard, for a dress, $1\frac{3}{4}$ yd. of net at $1.50 a yard, and $\frac{3}{4}$ yd. of plain silk at $1.25 a yard. What was the cost of material?

10. A dressmaker bought 50 yd. of taffeta silk for $45.00. She sold $8\frac{1}{2}$ yd. to one customer for $1.25 a yard, $15\frac{1}{2}$ yd. at $1.00 a yard to another customer, and the remainder at cost. What did she gain on the entire piece? What was the gain per cent?

11. Two and one-half yards of cloth cost $2.75. What was the price per yard?

12. A dressmaker bought 50 yd. of handmade lace abroad and paid $75 for it. She paid 60 % duty on the lace and sold it at a gain of $33\frac{1}{3}$ %. What was the selling price per yard?

13. A dressmaker bought 20 yd. of foulard silk at 90 cents a yard. She received 6 % discount. She sold it for $10\frac{1}{2}$ % more than the original price. How much did she gain on the sale? What per cent did she gain?

14. A dressmaker bought the following materials for a customer: $4\frac{1}{2}$ yd. of broadcloth at \$2.75 a yard, $6\frac{1}{2}$ yd. of silk at \$3.75 a yard, $2\frac{1}{2}$ yd. of trimming at \$2.50 a yard. She received a dressmaker's discount of 6 %, and 5 % discount for cash payment. What did she pay for the materials? She charged the retail price for them. How much did she gain? What per cent?

15. A dressmaker bought a $7\frac{1}{2}$-yd. remnant of broadcloth for \$22.50. She sold 6 yd. to a customer at \$3.50 a yard, but the remainder could not be sold. Did she gain or lose? What per cent?

16. A dressmaker bought in France three 15-yd. pieces of dress silk at $25\frac{1}{2}$ cents a yard. After paying 60 % duty on them, she sold two pieces to one customer at 48 % gain, and the third piece to another customer at 35 % gain. What was the gain on the three pieces?

17. A dressmaker furnished the materials for a lingerie dress and charged \$25 for it. For the materials she paid the following: 10 yd. of dimity at 45 cents a yard, $12\frac{1}{2}$ yd. Cluny insertion at 25 cents a yard, findings, \$2. If she charged \$12 for making, how much did she gain on the material? Make a bill for the same and receipt it.

18. The materials for a dress cost a dressmaker \$14.50. She sold them for 10 % more than cost and charged \$15 for making. She paid her helper 20 % of the amount received. What was the gain per cent?

19. If it takes $6\frac{1}{2}$ yards of cloth 52 inches wide to make a dress, how many yards of cloth 22 inches wide will be needed to make the same dress?

20. A dressmaker agreed to make a dress for a customer for \$25. She paid 2 assistants \$1.25 a day each for $3\frac{1}{2}$ days of work. The dress was returned for alterations, and the assistants were paid for one more day's work. How much did the dressmaker receive for her own work?

21. A dressmaker bought \$1.50 worth of silk, receiving 6 % discount for cash. She sold the silk for 40 % more than the original price. What was the gain per cent?

22. A dressmaker has an order for three summer dresses, for which $31\frac{1}{2}$ yd. of batiste are needed. She can buy three remnants of $10\frac{1}{2}$ yd. each for 25 cents a yard, or she can buy a piece of 35 yd. for 25 cents a yard and receive 4 % discount for cash. Which is the better plan?

23. (*a*) How many inches in $\frac{3}{4}$ yd.? (*b*) How many inches in $\frac{1}{8}$ yd.? (*c*) How many inches in $\frac{3}{8}$ yd.? (*d*) How many inches in $\frac{5}{8}$ yd.? (*e*) How many inches in $\frac{7}{8}$ yd.? (*f*) How many inches in $\frac{2}{3}$ yd.? (*g*) How many inches in $\frac{5}{6}$ yd.?

24. Find the cost of each of the above lengths in lace at \$.$12\frac{1}{2}$ a yard.

25. Find the cost of $4\frac{1}{3}$ yd. of lace at \$1.95 per piece (one piece = 12 yd.).

26. A dressmaker bought 2 pieces of white lining taffeta, one piece 42 yd. and another $48\frac{7}{8}$ yd., at \$.$42\frac{1}{2}$ a yard. What was the total cost?

27. A piece of crinoline containing $42\frac{1}{2}$ yd. that cost \$1.70 a yard was made into dress models of $8\frac{1}{2}$ yd. each. What was the cost of the crinoline in each model?

28. What is the cost of a child's petticoat containing:

$2\frac{1}{4}$ yd. longcloth at 15 cents a yard,
$1\frac{3}{4}$ yd. hamburg at 19 cents a yard,
$1\frac{1}{2}$ yd. insertion at 15 cents a yard?

29. What is the cost of two petticoats requiring for one:

$2\frac{3}{4}$ yd. longcloth at 19 cents a yard,
3 yd. hamburg at 25 cents a yard,
$2\frac{1}{4}$ yd. insertion at 19 cents a yard?

30. What is the cost of a petticoat requiring:

3 yd. longcloth at $12\frac{1}{2}$ cents a yard,
$3\frac{1}{4}$ yd. hamburg at 17 cents a yard?

31. What is the total cost of the following?

Wedding gloves, \$2.75.
Slippers and stockings, \$5.00.
Six undervests, at 19 cents each.
Six pairs of stockings, at $33\frac{1}{3}$ cents a pair.
Two pairs of shoes, at \$5.00 a pair.
One pair of rubbers, 75 cents.
One pair long silk gloves, \$2.00.
One pair of long lisle gloves, \$1.00.
Two pairs of short silk gloves, \$1.00.
Veils and handkerchiefs, \$5.00.
Two hats, \$10.00.
Corsets, \$3.00.
Wedding veil of 3 yards of tulle, 2 yards wide, at 89 cents a yard.

32. What is the cost of the following material for a top coat?

Cotton corduroy, 32 inches wide: $4\frac{7}{8}$ yards at 75 cents a yard.
Lining, 36 inches wide: $4\frac{7}{8}$ yards at \$1.50 a yard.
Buttons, sewing silk, pattern, 27 cents.
Velvet for collar facing, $\frac{1}{4}$ yard, at \$1.50 a yard.

33. What is the cost of the following dressmaking supplies?

$\frac{7}{8}$ yard of China silk, 27 inches wide, at 49 cents a yard (for the lining).

$1\frac{3}{4}$ yard of mousseline de soie interlining 40 inches wide, at 80 cents a yard.

$\frac{5}{8}$ yard of all-over lace 36 inches wide, at \$1.48 for front and lower back.

$\frac{1}{2}$ yard of organdie at \$1.00, 32 or more inches wide, for collar and vest.

Sewing silk, hooks and eyes, pattern, at 32 cents.

34. What is the cost of the following?

Cotton gabardine, 36 inches wide: $5\frac{3}{4}$ yards at 39 cents a yard.
Sewing cotton, braid, buttons, pattern, at 35 cents.

35. Which of the following fabrics is the most economical to buy?

Crepe meteor, 44″ wide, at $3.25 a yard.
Faille Française, 42″ wide, at $3.00.
Charmeuse, 40″ wide, at $2.25.
Louisine, 38″ wide, at $2.00.
Armure, 20″ wide, at $1.50.
Satin duchesse, 21″ wide, at $1.25.

MILLINERY PROBLEMS

1. What would a hat cost with the following trimmings?

$1\frac{1}{2}$ yd. velvet, at $2.50 a yard.
$\frac{1}{3}$ yd. satin for facing, at $1.98 a yard.
2 feathers, at $5.50 each.
Frame and work, at $2.50.

Make out a bill. (See lesson on Invoice, Chapter XI, page 243.)

2. A leghorn hat cost $6.98. Four bunches of fadeless roses at $2.98, 2 bunches of foliage at $.98, and $1\frac{1}{2}$ yd. of velvet ribbon at $1.49 were used for trimming. The milliner charged 75 cents for her work. How much did the hat cost?

3. A milliner used the following trimmings on a child's bonnet:

1 piece straw braid, at $1.49.
2 yd. maline, at 25 cents a yard.
4 bunches flowers, at 69 cents each.
4 bunches foliage, at 49 cents each.
Work, at $2.00.

What was the total cost of the hat? Make out a bill and receipt it.

4. An old lady's bonnet was trimmed with the following:

3 yd. silk, at $ 1.50 a yard.
1 piece of jet, $ 3.00.
2 small aigrettes, at $ 1.50 each.
Ties, 75 cents.
Work, $ 1.50.

How much did the finished bonnet cost?

5. What was the total cost of a hat with the following trimmings?

2 pieces straw braid, at $ 2.50 each.
2 yd. velvet ribbon, at 98 cents a yard.
5 flowers, at 59 cents.
4 foliage, at 49 cents.
Frame and work, at $ 2.50.

6. A milliner charged $ 2.00 for renovating an old hat. She used 2 yd. satin at $ 1.50 a yard and charged $ 2.25 for an ornament. How much did the hat cost?

7. The following trimmings were used on a child's hat:

3 yd. velvet, at $ 1.50 a yard.
8 yd. lace, at 15 cents a yard.
2 bunches buds, at 49 cents a bunch.
Work, $ 2.00.

How much did the hat cost?

8. A milliner charged $ 6.00 for renovating three feathers, $ 2.50 for a fancy band, $ 4.75 for a hat, and 75 cents for work. How much did the customer pay for her hat?

9. A lady bought a hat with the following trimmings:

2 yd. satin, at $ 1.75 a yard.
2 bunches grapes, at $ 1.59 a bunch.
$2\frac{1}{2}$ yd. ribbon, at 69 cents a yard.
Work, 75 cents.

How much did the hat cost?

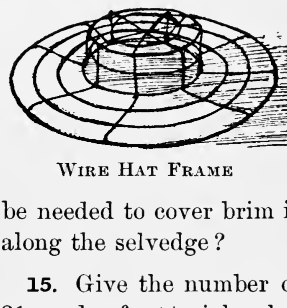
10. What would a hat cost with the following trimmings?

2 pieces straw braid, at $1.98 each.
3 yd. ribbon, at 89 cents a yard.
Fancy feather, $6.98.
Frame and work, $2.50.

11. Estimate the cost of a hat using the following materials:

$2\frac{1}{4}$ yd. plush, at $2.25 a yard.
2 yd. ribbon, at 25 cents a yard.
$\frac{5}{8}$ yd. buckram, at 25 cents a yard.
$\frac{1}{2}$ yd. tarlatan, at 10 cents a yard.
1 band fur, 75 cents.
Foliage, 10 cents.
Labor, $2.00.

12. If the true bias from selvedge to selvedge is about $\frac{1}{2}$ longer than the width of the goods, how many bias strips must be cut from velvet 18″ wide in order to have a three-yard bias strip?



Wire Hat Frame

13. The edge of a hat measures 45 inches in circumference; the velvet is 16 inches wide. How many bias strips of velvet would it take to fit the brim?

14. What amount of velvet would be needed to cover brim if each strip cut measured $\frac{3}{8}$ of a yard along the selvedge?

15. Give the number of $13\frac{1}{2}$-in. strips that can be cut from $3\frac{1}{2}$ yards of material; also the number of inches of waste.

16. How many $22\frac{1}{2}$-in. strips can be cut from $2\frac{1}{2}$ yd. of material?

17. What length bias strip can be made from $1\frac{1}{8}$ yd. of silk, each strip 1 yd. 10 in. long and $1\frac{1}{8}$ in. wide?

18. How many six-petal roses can be made from 1 yard of velvet 18 inches wide, each petal cut 3 inches square?

19. Estimate the total cost of roses, if velvet is \$ 1.50 a yard, centers 18 cents a dozen, sprays 12 cents a dozen, stemming 6 cents a yard, using $\frac{1}{3}$ of a yard for each flower.

20. Find the cost of one flower; the cost of $\frac{1}{3}$ of a dozen flowers, using the figures given above.

21. What amount of velvet will be needed to fit a plain-top facing and crown of hat, width of brim 5 inches, diameter of headsize $7\frac{3}{4}$ inches, diameter of crown $15\frac{1}{2}$ inches, allowing $8\frac{1}{2}$ inches on brim for turning over edges?

22. If the circumference of the brim measures 56 inches, what amount of silk will it take for a shirred facing made of silk 22 inches wide, allowing twice around the hat for fullness, and also allowing 1 inch on depth of silk for casings?

23. At the wholesale rate of eight frames for one dollar, what is the cost of five dozen frames? of twelve dozen?

24. A milliner had $2\frac{1}{2}$ dozen buckram frames at \$ 3.60 a dozen. She sold $\frac{2}{3}$ of them at 75 cents each, but the others were not sold. Did she gain or lose and what per cent?

25. Flowers that were bought at \$ 5.50 a dozen bunches were sold at 75 cents a bunch. What was the gain on $1\frac{1}{2}$ dozen bunches?

26. A milliner bought ten rolls of ribbon, ten yards to the roll, for \$ 8.50. Ten per cent of the ribbon was not salable. The remainder was sold at 19 cents a yard. How much was the gain? what per cent?

27. A piece of velvet containing twelve yards was bought for \$ 28.20 and sold for \$ 2.75 per yard. How much was gained on the piece?

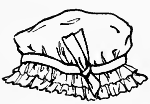
28. A thirty-six yard piece of maline cost \$ 7.02 and was sold at 29 cents a yard. One yard was lost in cutting. How much was gained on the piece?

29. Find cost of a velvet hat requiring

$1\frac{1}{2}$ yd. of velvet, at $1.50 a yard.
$\frac{3}{4}$ yd. of fur band, at $4.00 a yard.
1 feather ornament, at $3.00.
Hat frame, 50 cents.
Edge wire, 10 cents.
Taffeta lining, 25 cents.
Making, $2.50.

30. A milliner charged $8.37 for a hat. She paid 37 cents for the frame, $2.80 for the trimming, and $1.50 for labor. What was the per cent profit?

31. A child's hat of organdie has two ruffles edged with valenciennes lace. The lower ruffle is 3″ wide; the upper ruffle,



$2\frac{1}{2}$″. $2\frac{3}{4}$ yd. lace edging cost $12\frac{1}{2}$ cents a yard, 2 yd. of 3″ ribbon cost 25 cents a yard, $1\frac{1}{8}$ yd. of organdie cost 25 cents a yard, the hat frame cost 35 cents, and the lining cost 10 cents. Find the total cost.

32. How much velvet at $2.00 a yard would you buy to put a snap binding on a hat that measures 43″ around the edge? Should the velvet be bias or straight?

CHAPTER X

CLOTHING

SINCE about one eighth of the income in the average workingman's family is spent for clothing, this is a very important subject. The housewife purchases the linen for the house and her own wearing apparel. It is not uncommon for her to have considerable to say about the clothing of the men, particularly about the underclothing. Therefore she should know something about what constitutes a good piece of cloth, and be able to make an intelligent selection of the best and most economical fabric for a particular purpose. The cheapest is not always the best, although it is in some cases.

All kinds of cloth are made by the interlacing (weaving) of the sets of thread (called *yarn*). The thread running lengthwise is the strongest and is called the *warp*. The other thread is called the *filling*. Such fabrics as knitted materials and lace are made by the interlacing of a single thread. Threads (yarn) are made by lengthening and twisting (called *spinning*) short fibers. Since the fibers vary in such qualities as firmness, length, curl, and softness, the resulting cloth varies in the same way. This is the reason why we have high-grade, medium-grade, and low-grade fabrics.

The principal fabrics are wool, silk, mohair, cotton, and flax (linen).

The consumer is often tempted to buy the cheaper fabrics and wonders why there is such a difference in price. This difference is due in part to the cost of raw material and in part to the care in manufacturing. For example, raw silk costs from $1.35 to $5.00 a pound, according to the nature and quality of the silk. The cost of preparing the raw silk averages about 55 cents a pound, according to the nature of the twist, which is regulated by the kind of cloth into which it is to enter. The cost of dyeing varies from 55 cents to $1.50 a pound. Weavers are paid from 2 to 60 cents a yard for weaving, the price varying according to the desirability of the cloth.

When we compare the relative values of similar goods produced by different manufacturers, there are a few general principles by which good construction can easily be determined. The density of a fabric is determined by the number of warp yarn and filling yarn to the inch. This is usually determined by means of a magnifying glass with a $\frac{1}{4}''$ opening. To illustrate: If there are 36 threads in the filling and 42 threads in the warp to $\frac{1}{4}''$, what is the density of the cloth to the inch?

SOLUTION. —

$36 \times 4 = 144$ threads in the filling.
$42 \times 4 = 168$ threads in the warp.

EXAMPLES

1. A 25-cent summer undervest (knitted fabric) will outwear two of the flimsy 15-cent variety in addition to retaining better shape. What is the gain, in wear, over the 15-cent variety?

2. A 50-cent undervest will outwear three of the 25-cent variety. What is gained by purchasing the 50-cent style?

3. A cotton dress for young girls, costing 75 cents ready made, will last one season. A similar dress of better material costs 94 cents, but will last two seasons. Why is the latter the better dress to buy? What is gained?

4. A linen tablecloth (not full bleached) costing $1.04 a yard, will last twice as long as a bleached linen at $1.25 a yard. Which is the better investment?

5. A sheer stocking at 50 cents will wear just half as long as a thicker stocking at 35 cents. What is gained in wear? What kind of stockings should be selected for wear?

SHOES

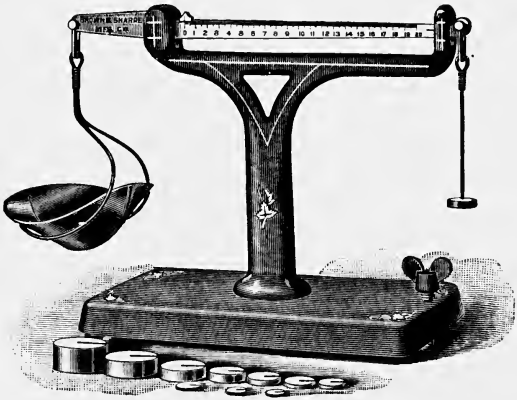
Our grandfathers and grandmothers wore handmade shoes, and wore them until they had passed their period of usefulness. At that time the consumption of leather did not equal its production. But, since the appearance of machine-made shoes, different styles are placed on the market at different seasons to correspond to the change in the style of clothing, and are often discarded before they are worn out. Thus far we have not been able to utilize cast-off leather as the shoddy mill uses cast-off wool and silk. The result is that the demand for leather is above the production; therefore, as in the case of textiles, substitutes must be used. In shoe materials there is at present an astonishing diversity and variety of leather and its substitutes. Every known leather from kid to cowhide is used, and such textile fabrics as satins, velvets, and serges have rapidly grown in favor, especially in the making of women's and children's shoes. Of course, we must bear in mind that for wearing qualities there is nothing equal to leather. In buying a pair of shoes we should try to combine both wearing qualities and simple style as far as possible.

EXAMPLE

1. A pair of shoes at $ 1.75 was purchased for a boy. The shoes required 80 cents worth of mending in two months. If a $3.00 pair were purchased, they would last three times as long with 95 cents worth of mending. How much is gained by purchasing a $ 3.00 pair of shoes?

YARNS

Worsted Yarns. — All kinds of yarns used in the manufacture of cloth are divided into sizes which are based on the relation between weight and length. To illustrate: Worsted yarns are made from combed wools, and the size, technically called the *counts*, is based upon the number of lengths (called *hanks*) of 560 yards required to weigh one pound.



Roving or Yarn Scales

These scales will weigh one pound by tenths of grains or one seventy-thousandth part of one pound avoirdupois, rendering them well adapted for use in connection with yarn reels, for the numbering of yarn from the weight of hank, giving the weight in tenths of grains to compare with tables.

Thus, if one hank weighs one pound, the yarn will be number one counts, while if 20 hanks are required for one pound, the yarn is the 20's, etc. The greater the number of hanks necessary to weigh one pound, the higher the counts and the finer the yarn. The hank, or 560 yards, is the unit of measurement for all worsted yarns.

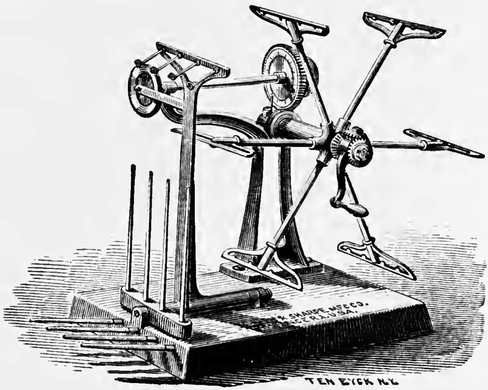
Length for Worsted Yarns

No.	Yards per Lb.	No.	Yards per Lb.	No.	Yards per Lb.	No.	Yards per Lb.
1	560	5	2800	9	5040	13	7280
2	1120	6	3360	10	5600	14	7840
3	1680	7	3920	11	6160	15	8400
4	2240	8	4480	12	6720	16	8960

Woolen Yarns.— In worsted yarns the fibers lie parallel to each other, while in woolen yarns the fibers are entangled.

This difference is due entirely to the different methods used in working up the raw stock.

In woolen yarns there is a great diversity of systems of grading, varying according to the districts in which the grading is done. Among the many systems are the English *skein*, which differs in various parts of England; the Scotch *spyndle;* the American *run;* the Philadelphia *cut;* and others. In these lessons the run system will be used unless otherwise stated. This is the system used in New England. The run is based upon 100 yards per ounce, or 1600 yards to the pound. Thus, if 100 yards of woolen yarn weigh one ounce, or if 1600 yards weigh one pound, it is technically termed a No. 1 run; and if 300 yards weigh one ounce, or 4800 yards weigh one pound, the size will be No. 3 run. The finer the yarn, or the greater the number of yards necessary to weigh one pound, the higher the run.



YARN REEL

For reeling and measuring lengths of cotton, woolen, and worsted yarns.

LENGTH FOR WOOLEN YARNS (RUN SYSTEM)

No.	Yards per Lb.	No.	Yards per Lb.	No.	Yards per Lb.	No.	Yards per Lb.
$\frac{1}{8}$	200	1	1600	2	3200	3	4800
$\frac{1}{4}$	400	$1\frac{1}{4}$	2000	$2\frac{1}{4}$	3600	$3\frac{1}{4}$	5200
$\frac{1}{2}$	800	$1\frac{1}{2}$	2400	$2\frac{1}{2}$	4000	$3\frac{1}{2}$	5600
$\frac{3}{4}$	1200	$1\frac{3}{4}$	2800	$2\frac{3}{4}$	4400		

Raw Silk Yarns. — For raw silk yarns the table of weights is:

16 drams = 1 ounce
16 ounces = 1 pound
256 drams = 1 pound

The unit of measure for raw silk is 256,000 yards per pound. Thus, if 1000 yards — one skein — of raw silk weigh one dram, or if 256,000 yards weigh one pound, it is known as 1-dram silk, and if 1000 yards weigh two drams, the yarn is called 2-dram silk; hence the following table is made:

1-dram silk = 1000 yards per dram, or 256,000 yards per lb.
2-dram silk = 1000 yards per 2 drams, or 128,000 yards per lb.
4-dram silk = 1000 yards per 4 drams, or 64,000 yards per lb.

Drams per 1000 Yards	Yards per Pound	Yards per Ounce
1	256,000	16,000
$1\frac{1}{4}$	204,800	12,800
$1\frac{1}{2}$	?	?
$1\frac{3}{4}$	146,286	9143
2	128,000	8000
$2\frac{1}{4}$	113,777	7111
$2\frac{1}{2}$	102,400	6400
$2\frac{3}{4}$	93,091	5818
3	?	?
$3\frac{1}{4}$	78,769	4923
$3\frac{1}{2}$	73,143	4571

Linen Yarns. — The sizes of linen yarns are based on the *lea* or cuts per pound and the pounds per spindle. A cut is 300 yards and a spindle 14,000 yards. A continuous thread of several cuts is a hank, as a 10-cut hank, which is $10 \times 300 = 3000$ yards per hank. The number of cuts per pound, or the leas, is the number of the yarn, as 30's, indicating $30 \times 300 = 9000$ yards per pound. Eight-pound yarn means that a spindle weighs 8 pounds or that the yarn is 6-lea $(14,400 \div 8) \div 300 = 6$.

Cotton Yarns. — The sizes of cotton yarns are based upon the system of 840 yards to 1 hank. That is, 840 yards of cotton yarn weighing 1 pound is called No. 1 counts.

Spun Silk. — Spun silk yarns are graded on the same basis as that used for cotton (840 yards per pound), and the same rules and calculations that apply to cotton apply also to spun silk yarns.

Two or More Ply Yarns. — Yarns are frequently produced in two or more ply; that is, two or more individual threads are twisted together, making a double twist yarn. In this case the size is given as follows:

2/30's means 2 threads of 30's counts twisted together, and 3/30's would mean 3 threads, each a 30's counts, twisted together.

(The figure before the line denotes the number of threads twisted together, and the figure following the line the size of each thread.)

Thus when two threads are twisted together, the resultant yarn is heavier, and a smaller number of yards are required to weigh one pound.

For example: 30's worsted yarn equals 16,800 yd. per lb., but a two-ply thread of 30's, expressed 2/30's, requires only 8400 yards to the pound, or is equal to a 15's; and a three-ply thread of 30's would be equal to a 10's.

When a yarn is a two-ply, or more than a two-ply, and made up of several threads of equal counts, divide the number of the single yarn in the required counts by the number of the ply, and the result will be the equivalent in a single thread.

To Find the Weight in Grains of a Given Number of Yards of Worsted Yarn of a Known Count

Example. — Find the weight in grains of 125 yards of 20's worsted yarns.

No. 1's worsted yarn = 560 yards to a lb.
No. 20's worsted yarn = 11,200 yards to a lb.
1 lb. worsted yarn = 7000 grains.

If 11,200 yards of 20's worsted yarn weigh 7000 grains, then $\frac{125}{11,200}$ of $7000 = \frac{125}{11,200} \times 7000 = \frac{625}{8} = 78.125$ grains.

NOTE. — Another method: Multiply the given number of yards by 7000, and divide the result by the number of yards per pound of the given count.

$$125 \times 7000 = 875,000.$$
$$1 \text{ pound } 20\text{'s} = 11,200.$$
$$875,000 \div 11,200 = 78.125 \text{ grains. } \quad \textit{Ans.}$$

To Find the Weight in Grains of a Given Number of Yards of Cotton Yarn of a Known Count

EXAMPLE. — Find the weight in grains of 80 yards of 20's cotton yarn.

$$\text{No. 1's cotton} = 840 \text{ yards to a lb.}$$
$$\text{No. 20's cotton} = 16,800 \text{ yards to a lb.}$$
$$1 \text{ lb.} = 7000 \text{ grains.}$$
$$1 \text{ yd. } 20\text{'s cotton} = \frac{7000}{16,800} \text{ grains.}$$
$$80 \text{ yd. } 20\text{'s cotton} = \frac{7000}{16,800} \times 80 = \frac{700}{21} = 33.33 \text{ grains. } \quad \textit{Ans.}$$

It is customary to solve examples that occur in daily practice by rule.

The rule for the preceding example is as follows:

Multiply the given number of yards by 7000 and divide the result by the number of yards per pound of the given count.

$$80 \times 7000 = 560,000.$$
$$560,000 \div (20 \times 840) = 33.33 \text{ grains. } \quad \textit{Ans.}$$

NOTE. — 7000 is always a multiplier and 840 a divisor.

To find the weight in ounces of a given number of yards of cotton yarn of a known count, multiply the given number of yards by 16, and divide the result by the yards per pound of the known count.

To find the weight in pounds of a given number of yards of cotton yarn of a known count, divide the given number of yards by the yards per pound of the known count.

To find the weight in ounces of a given number of yards of woolen yarn (run system), divide the given number of yards by the number of runs, and multiply the quotient by 100.

NOTE. — Calculations on the run basis are much simplified, owing to the fact that the standard number (1600) is exactly 100 times the number of ounces contained in 1 pound.

EXAMPLE. — Find the weight in ounces of 6400 yards of 5-run woolen yarn.

$$6400 \div (5 \times 100) = 12.8 \text{ oz.} \quad \textit{Ans.}$$

To find the weight in pounds of a given number of yards of woolen yarn (run system) the above calculation may be used, and the result divided by 16 will give the weight in pounds.

To find the weight in grains of a given number of yards of woolen yarn (run system), multiply the given number of yards by 7000 (the number of grains in a pound) and divide the result by the number of yards per pound in the given run, and the quotient will be the weight in grains.

EXAMPLES

1. How many ounces are there (*a*) in 6324 grains? (*b*) in $34\frac{1}{2}$ pounds?

2. How many pounds are there in 9332 grains?

3. How many grains are there (*a*) in $168\frac{1}{2}$ pounds? (*b*) in 2112 ounces?

4. Give the lengths per pound of the following worsted yarns: (*a*) 41's; (*b*) 55's; (*c*) 105's; (*d*) 115's; (*e*) 93's.

5. Give the lengths per pound of the following woolen yarns (run system): (*a*) $9\frac{1}{4}$'s; (*b*) 6's; (*c*) 19's; (*d*) 17's; (*e*) $1\frac{1}{2}$'s.

6. Give the lengths per pound of the following raw silk yarns: (*a*) $1\frac{1}{2}$'s; (*b*) 3's; (*c*) $3\frac{3}{4}$'s; (*d*) 20's; (*e*) 28's.

7. Give the lengths per ounce of the following raw silk yarns: (*a*) $4\frac{1}{2}$'s; (*b*) $6\frac{1}{2}$'s; (*c*) 8's; (*d*) 9's; (*e*) 14's.

8. What are the lengths of linen yarns per pound: (*a*) 8's; (*b*) 25's; (*c*) 32's; (*d*) 28's; (*e*) 45's?

9. What are the lengths per pound of the following cotton yarns: (*a*) 10's; (*b*) 32's; (*c*) 54's; (*d*) 80's; (*e*) 160's?

10. What are the lengths per pound of the following spun silk yarns: (*a*) 30's; (*b*) 45's; (*c*) 38's; (*d*) 29's; (*e*) 42's?

11. Make a table of lengths per ounce of spun silk yarns from 1's to 20's.

12. Find the weight in grains of 144 inches of 2/20's worsted yarn.

13. Find the weight in grains of 25 yards of 3/30's worsted yarn.

14. Find the weight in ounces of 24,000 yards of 2/40's cotton yarn.

15. Find the weight in pounds of 2,840,000 yards of 2/60's cotton yarn.

16. Find the weight in ounces of 650 yards of $1\frac{1}{2}$-run woolen yarn.

17. Find the weight in grains of 80 yards of $\frac{1}{2}$-run woolen yarn.

18. Find the weight in pounds of 64,000 yards of 5-run woolen yarn.

Solve the following examples, first by analysis and then by rule:

19. Find the weight in grains of 165 yards of 35's worsted.

20. Find the weight in grains of 212 yards of 40's worsted.

21. Find the weight in grains of 118 yards of 25's cotton.

22. Find the weight in grains of 920 yards of 18's cotton.

23. Find the weight in pounds of 616 yards of $16\frac{1}{2}$'s woolen.

24. Find the weight in grains of 318 yards of 184's cotton.

25. Find the weight in grains of 25 yards of 30's linen.

26. Find the weight in pounds of 601 yards of 60's spun silk.

27. Find the weight in grains of 119 yards of 118's cotton.

28. Find the weight in grains of 38 yards of 64's cotton.

29. Find the weight in grains of 69 yards of 39's worsted.

30. Find the weight in grains of 74 yards of 40's worsted.

31. Find the weight in grains of 113 yards of $1\frac{1}{4}$'s woolen.

32. Find the weight in grains of 147 yards of $1\frac{3}{4}$'s woolen.

33. Find the weight in grains of 293 yards of 8's woolen.

34. Find the weight in grains of 184 yards of $16\frac{1}{2}$'s worsted.

35. Find the weight in grains of 91 yards of 44's worsted.

36. Find the weight in grains of 194 yards of 68's cotton.

37. Find the weight in pounds of 394 yards of 180's cotton.

38. Find the weight in pounds of 612 yards of 60's cotton.

39. Find the weight in grains of 118 yards of 44's linen.

40. Find the weight in pounds of 315 yards of 32's linen.

41. Find the weight in grains of 84 yards of 25's worsted.

42. Find the weight in grains of 112 yards of 20's woolen.

43. Find the weight in grains of 197 yards of 16's woolen.

44. Find the weight in grains of 183 yards of 18's cotton.

45. Find the weight in grains of 134 yards of 28's worsted.

46. Find the weight in grains of 225 yards of 34's linen.

47. Find the weight in pounds of 369 yards of 16's spun silk.

48. Find the weight in pounds of 484 yards of 18's spun silk.

To Find the Size or the Counts of Cotton Yarn of Known Weight and Length

Example. — Find the size or counts of 84 yards of cotton yarn weighing 40 grains.

Since the counts are the number of hanks to the pound,

$$\frac{7000}{40} \times 84 = 14{,}700 \text{ yd. in 1 lb.}$$
$$14{,}700 \div 840 = 17.5 \text{ counts.} \quad \textit{Ans.}$$

RULE. — Divide 840 by the given number of yards; divide 7000 by the quotient obtained; then divide this result by the weight in grains of the given number of yards, and the quotient will be the counts.

$$840 \div 84 = 10.$$
$$7000 \div 10 = 700.$$
$$700 \div 40 = 17.5 \text{ counts.} \quad \textit{Ans.}$$

To Find the Run of a Woolen Thread of Known Length and Weight

EXAMPLE. — If 50 yards of woolen yarn weigh 77.77 grains, what is the run?

$$1600 \div 50 = 32.$$
$$7000 \div 32 = 218.75.$$
$$218.75 \div 77.77 = 2.812\text{-run yarn.} \quad \textit{Ans.}$$

RULE. — Divide 1600 (the number of yards per pound of 1-run woolen yarn) by the given number of yards; then divide 7000 (the grains per pound) by the quotient; divide this quotient by the given weight in grains and the result will be the run.

To Find the Weight in Ounces for a Given Number of Yards of Worsted Yarn of a Known Count

EXAMPLE. — What is the weight in ounces of 12,650 yards of 30's worsted yarn?

$$12{,}650 \times 16 = 202{,}400.$$
$$202{,}400 \div 16{,}800 = 12.047 \text{ oz.} \quad \textit{Ans.}$$

RULE. — Multiply the given number of yards by 16, and divide the result by the yards per pound of the given count, and the quotient will be the weight in ounces.

To Find the Weight in Pounds for a Given Number of Yards of Worsted Yarn of a Known Count

EXAMPLE. — Find the weight in pounds of 1,500,800 yards of 40's worsted yarn.

1,500,800 ÷ 22,400 = 67 lb. *Ans.*

RULE. — Divide the given number of yards by the number of yards per pound of the known count, and the quotient will be the desired weight.

EXAMPLES

1. If 108 inches of cotton yarn weigh 1.5 grains, find the counts.

2. Find the size of a woolen thread 72 inches long which weighs 2.5 grains.

3. Find the weight in ounces of 12,650 yards of 2/30's worsted yarn.

4. Find the weight in ounces of 12,650 yards of 40's worsted yarn.

5. Find the weight in pounds of 1,500,800 yards of 40's worsted yarn.

6. Find the weight in pounds of 789,600 yards of 2/30's worsted yarn.

7. What is the weight in pounds of 851,200 yards of 3/60's worsted yarn?

8. If 33,600 yards of cotton yarn weigh 5 pounds, find the counts of cotton.

Buying Yarn, Cotton, Wool, and Rags

Every fabric is made of yarn of definite quality and quantity. Therefore, it is necessary for every mill man to buy yarn or fiber of different kinds and grades. Many small mills buy cotton, wool, yarn, and rags from brokers who deal in these commodities. The prices rise and fall from day to day according to the law of demand and supply. Price lists giving the quotations are sent out weekly and sometimes daily by agents as the prices of materials rise or fall. The following are quotations of different grades of cotton, wool, and shoddy, quoted from a market list:

Quantity	Price per Lb.
8103 lb. white yarn shoddy (best all wool)	$0.485
3164 lb. white knit stock (best all wool)	.365
2896 lb. pure indigo blue	.315
1110 lb. fine dark merino wool shoddy	.225
410 lb. fine light merino woolen rags	.115
718 lb. cloakings (cotton warp)	.02
872 lb. wool bat rags	.035
96 lb. 2/20's worsted (Bradford) yarn	.725
408 lb. 2/40's Australian yarn	1.35
593 lb. 1/50's delaine yarn	1.20
987 lb. 16-cut merino yarn (50 % wool and 50 % shoddy)	.285
697 lb. carpet yarn, 60 yd. double reel, wool filling	.235

Find the total cost of the above quantities and grades of textiles.

EXAMPLES

1. The weight of the fleece on the average sheep is 8 lb. Wyoming has at least 4,600,000 sheep; what is the weight of wool raised in a year in this state?

2. A colored man picks 155 lb. of cotton a day; how much cotton will he pick in a week (6 days)?

3. The average yield is 558 lb. per acre; how much cotton will be raised on a farm of 165 acres?

4. The standard size of a cotton bale in the United States is 54 × 27 × 27 inches; what is the cubical contents of a bale?

5. In purchasing cotton an allowance of 4 % is made for tare. How much cotton would be paid for in 96 bales, 500 lb. to each bale?

6. Broadcloth was first woven in 1641. How many years has it been in use?

7. The length of "Upland" cotton varies from three-fourths to one and one-sixteenth inches. What is the difference in length from smallest to largest?

8. If a sample of 110 lb. of cotton entered a mill and 68 lb. were made into fine yarn, what is the per cent of waste?

9. If a yard of buckram weighs 1.8 ounces, how many yards to the pound?

10. If a calico printing machine turns out 95 fifty-yard pieces a day, how many are printed per hour in a ten-hour day?

11. If a sample of linen weighing one pound and a half absorbs 12 % moisture, what is the weight after absorption?

12. A piece of silk weighing 3 lb. 4 oz. is "weighted" 175% ; what is the total weight?

13. If the textile industry in a certain year pays out $ 500,000,000 to 994,875 people, what is the wage per capita?

14. How much dyestuff, etc., will be required to dye 5 lb. of cotton by the following receipt?

6 % brown color, afterwards treated with

1.5 % sulphate of copper,
1.5 % bichromate of potash,
3 % acetic acid.

15. How many square yards of cloth weighing 8 oz. per sq. yd. may be woven from 1050 lb. of yarn, the loss in waste being 5 per cent?

16. A piece of union cloth has a warp of 12's cotton and is wefted with 30's linen yarn, there being the same number of threads per inch in both warp and weft; what percentage of cotton and what of linen is there in the cloth?

17. A sample of calico 3 in. by 4 in. weighs 30 grains. What is the weight in pounds of a 70-yard piece, 36 in. wide?

18. 4 yd. of a certain cloth contains 2 lb. of worsted at 67 cents a pound and $1\frac{1}{4}$ lb. of cotton at 18 cents a pound. Each is what per cent of the total cost of material?

19. A bale of worsted weighing 75 lb. loses 8 oz. in reeling off; what is the per cent of loss?

20. If Ex. 19 worsted gains 0.45 lb. to the 75 lb. bale in dyeing, what is the per cent of gain?

21. This 75 lb. cost $ 50.25 and it lost 4 oz. in the fulling mill, what was the value of the part lost?

22. The total loss is what per cent of the original weight? What is its value at 67 cents a pound?

PART IV — THE OFFICE AND THE STORE

CHAPTER XI

ARITHMETIC FOR OFFICE ASSISTANTS

Every office assistant should be quick at figures — that is, should be able to add, subtract, multiply, and divide accurately and quickly. In order to do this one should practice addition, subtraction, multiplication, and division until all combinations are thoroughly mastered.

An office assistant should make figures neatly so that there need be no hesitation or uncertainty in reading them.

Rapid Calculations

Add the following columns and check the results. Compare the time required for the different examples.

1.	2.	3.	4.	5.
27	37	471	568	1,039
12	20	295	284	579
8	11	194	187	381
18	20	327	341	668
12	16	287	272	559
8	12	191	184	375
8	16	237	193	430
8	9	194	156	350
7	12	169	166	335
11	15	247	232	479
12	13	194	180	374
2	3	27	25	52
12	17	253	240	493
11	14	241	212	453
12	20	355	367	722
12	14	244	222	466
8	11	93	79	172
10	15	208	213	421
		233		

6.	**7.**	**8.**	**9.**	**10.**
7	7	159	152	311
2	5	60	78	138
4	7	111	88	199
6	10	173	121	294
4	6	112	84	196
4	4	88	76	164
4	5	104	83	187
4	6	96	104	200
4	7	120	97	217
8	9	144	123	267
4	5	60	101	161
4	5	73	92	165
8	10	186	176	362
4	4	64	75	139
4	6	114	113	227
4	4	89	88	177
6	7	91	80	171
8	9	204	170	374
4	13	175	166	341
4	4	73	77	150
4	7	119	127	246
4	5	84	103	187
8	11	177	165	342
6	8	156	136	292
3	4	94	61	155
12	18	310	293	603
8	12	191	189	380
8	13	268	198	466
2	2	17	17	34
4	8	122	137	259
8	9	193	185	378
1	1	4	6	10
1	1	9	15	24
1	2	16	16	32
1	1	11	15	26
1	2	34	44	78
1	2	27	34	61
1	2	26	53	79
1	2	36	41	76
1	2	17	10	27
1	2	38	22	60

11. $162.24	**12**. $37,000.00	**13**. $31.25	**14**. $8,527.08	**15**. $630.33
266.45	300,000.00	73.70	2,907.31	408.32
277.56	410,000.00	2.00	3,262.68	399.99
12,171.44	82,000.00	4 25	8,096.90	28.00
17.72		.89	9,359.21	644.15
6.00	51,000.00	31.15	2,177.30	18,000.00
33.15	40,000.00	3.20	8,385.50	32.85
23.65		16.75	7,229.20	154.65
3.18	34,500.00	4.51	8,452.38	
82.35			3,066.34	1,758.13
517.50	17,000.00	2,665.76	5,236.32	25.00
1128.13			6,147.42	639.24
36.00	15,500.00	3.20	4,443.88	
2.60		30.00	3,386.72	79.90
4.00	5,500.00		3,927.78	1,143.00
289.22	1,000.00	29.12	4,797.46	
265.50			2,612.00	727.00
17.82	70,500.00	1.00	2,476.31	141.33
199.87		33.27	3,705.00	
2314.76	10,000.00	19.09	6,417.42	3,091.72
2.40	12,500.00	720.00	1,574.50	1,049.95
9.25	1,500.00	28.80	3,121.97	166.64
55.80	300.00	96.00	120.00	
494.03		3.41	26,146.93	1,483.84
18.00	800.00	5.00	51.397.19	657.62
1.55	50.00	7.37	99.55	1,416.68
3.15	100.00	3.60	3,605.93	135.50
2.55	200.00		22,830.14	208.33
4,010.92	250.00	9.08	85,706.13	42.84
126.45	300.00		36,361.19	362.25
2.25		4.50	39,056.23	234.47
152.70	2,000.00		30,000.00	31.50
10.25		35.84	179,346.77	49.76
3.62	1,000.00		3,375.31	150.22
4.00		2.00	12,638.85	2.64
111.10	1,200.00	3.50	30,992.76	2.40
324.83		11.06	179,346.77	22.50
302.10	114,350.00	.74	3,375.31	8.92
345.04	40,000.00	7.25	12,638.85	176.91
301.10	120,000.00	6.00	30,992.76	11.30
1.20	9,476.00	3.00	16,503.48	17.00

16.	**17.**	**18.**	**19.**
$437.58	$81.33	$144.40	$61.45
2.75	31.66	15.00	14.50
1.40	9.91	1,124.04	1.80
70.06	20.00	110.59	2.00
3.54	23.25	44.83	24.17
396.89	129.99	318.40	272.90
33.00	9.01	22.35	5.13
18.24	208.01	757.00	482.09
6.75	150.98	674.37	.50
68.70		14.50	220.50
1.53	10.60	27.30	36.60
9.20		280.00	6.50
.90	3.60	83.78	.32
98.95	2.50	36.90	216.60
117.13	31.00	245.00	40.00
192.71	91.87	481.30	542.25
58.43	18.97		57.96
2.11	25.49	59.35	53.07
2.92		3.75	2.54
43.34	8.14	1,863.74	36.08
5.80		155.70	21.25
108.81	22.38	1,076.82	
1.75	6.47	8,699.46	449.85
10.10	132.28	4,437.97	
3.25	4.00	391.00	394.48
881.69	3.00	72.00	
82.80	24.00	35.00	85.12
.75	10.00	310.49	47.90
3.00	10.40	1,078.50	31.68
26.50		.85	49.50
19.04	37.70	77.91	39.76
2.24		64.43	17.21
19.50	2.20	158.26	
2,676.35		185.99	1.50
25.25	2.40		6.00
.70		53.49	8.62
36.53	2.50	7.50	3.85
3.60	1.70	5.05	23.65
3.00	2.00	7.60	259.00
168.66	.70	2.00	701.47
67.60	92.00	11.50	3,148.00

Horizontal Addition

Reports, invoices, sales sheets, etc., are often written in such a way as to make it necessary to add figures horizontally. In adding figures horizontally, it is customary to add from left to right and check the answer by adding from right to left.

EXAMPLES

Add the following horizontally:

1. $38 + 76 + 49 =$
2. $11 + 43 + 29 =$
3. $27 + 57 + 15 =$
4. $34 + 16 + 23 =$
5. $47 + 89 + 37 =$
6. $53 + 74 + 42 =$
7. $94 + 17 + 67 =$
8. $79 + 37 + 69 =$
9. $83 + 49 + 74 =$
10. $19 + 38 + 49 =$

Add the following and check by adding the horizontal and vertical totals:

11.
$$\begin{array}{l} 36 + 74 + 19 + 47 = \\ 29 + 63 + 49 + 36 = \\ \quad\ + \quad\ + \quad\ + \quad\ = \end{array}$$

12.
$$\begin{array}{l} 74 + 34 + 87 + 27 = \\ 37 + 19 + 73 + 34 = \\ \quad\ + \quad\ + \quad\ + \quad\ = \end{array}$$

13.
$$\begin{array}{l} 178 + 74 + 109 + 83 = \\ 39 + 111 + 381 + 127 = \\ \qquad + \qquad + \qquad + \qquad = \end{array}$$

14.
$$\begin{array}{l} 217 + 589 + 784 = \\ 309 + 611 + 983 = \\ \qquad + \qquad + \qquad = \end{array}$$

15.

$$\begin{aligned} 1118 + 3719 + 8910 &= \\ 3001 + 5316 + 6715 &= \\ + \quad\quad + \quad\quad &= \end{aligned}$$

Add the following and check by adding horizontal and vertical totals. Compare the time required for the different examples.

16.

$702,000	$14,040	$370,000	$6,475.00	$1,072,000	$20,515.00
525,000	10,500	20,000	350.00	565,000	11,300.00
1,267,500	25,350	447,250	7,826.88	1,724,750	33,401.88
333,000	6,660	340,000	5,950.00	833,000	16,022.50
380,000	7,600	351,000	6,142.50	790,000	15,070.00
1,077,000	21,540	50,000	875.00	1,127,000	22,415.00
702,000	14,040	370,000	6,475.00	1,072,000	20,515.00
525,000	10,500	20,000	350.00	565,000	11,300.00
1,264,500	25,290	447,250	7,826.87	1,721,750	33,341.87
333,000	6,660	200,000	3,500.00	693,009	13,572.50
355,000	7,100	348,000	6,090.00	758,000	14,427.50
1,072,000	21,440	50,000	875.00	1,122,000	22,315.00

17.

318,143	28,760	9.04	491.86	189.54	77,751,393
295,187	18,363	6.22	498.23	188.74	78,426,000
300,789	23,398	7.95	479.80	187.88	75,180,746
279,735	22,290	7.97	511.43	187.24	79,864,039
302,737	28,699	9.48	523.55	187.80	82,001,180
302,338	22,149	7.33	578.00	188.83	91,025,879
341,085	27,765	8.14	554.30	192.87	89,161,101
335,775	24,080	7.17	534.23	192.13	85,603,137
311,739	20,356	6.53	521.79	192.17	83,627,195
335,350	21,299	6.35	524.17	192.76	84,266,576
281,481	18,032	6.41	500.09	194.89	81,283,747
305,370	20,865	6.83	496.12	196.06	81,122,570

18.

380,782,151	451,880,223	520,781,017	389,692,401	1,743,135,792
452,491,808	480,722,907	537,837,574	481,528,491	1,952,580,780
71,709,667	28,842,684	17,056,557	91,836,090	209,444,988
1,585	600	317	1,907	1,102
283,448,988	282,640,795	326,233,015	291,835,151	1,184,157,949
6,264	5,879	6,066	6,061	6,068
97,333,163	169,239,428	194,548,002	97,857,250	558,977,843

19.	3,200,000	17,000,000	28,000,000	7,000,000	55,700,000
	27,200,000	25,000,000	31,400,000	23,000,000	106,600,000
			6,100,000		6,100,000
	850,000	65,100,000	64,200,000	12,300,000	142,450,000
		3,500,000	12,000,000		15,500,000
		625,000	5,200,000	2,900,000	8,725,000
	1,416,353	7,263,712	2,000,000	11,866,463	22,546,528
	565,907	542,539	443,392	415,531	1,967,359
	3,500,000	11,200,000	13,200,000	7,400,000	35,300,000
	12,500,000	2,500,000	3,500,000	2,600,000	21,100,000

20.	29,000,000	22,500,000	14,200,000	16,600,000	82,300,000
	13,500,000	10,200,000	9,600,000	8,600,000	41,900,000
	327,998	330,915	508,266	358,262	1,525,441
	1,122,905	1,222,262	1,296,344	1,317,004	4,958,515
	2,400,000	1,100,000	1,650,000	1,800,000	6,950,000
	1,500,000	850,000	900,000	900,000	4,150,000
	250,000	305,000	350,000	300,000	1,205,000

Add the following decimals and check the answer:

21.	21.51	35.21	36.17	20.32	28.30
	18.91	12.42	5.95	20.95	14.56
	15.85	6.00	3.17	19.07	11.02

22.	44.33	73.15	71.59	14.36	8.15
	43.20	47.14	126.04	85.05	70.42
	93.35	80.13	31.15	62.51	49.17
	49.17	29.37	47.25	31.10	206.38
	37.59	47.25	35.59	50.47	73.26

23. On the following page is an itemized list of investments.

What is the total amount of investments?
What is the average rate of interest?

Review Interest, page 50.

List of Investments Held by the Sinking Funds of Fall River, Mass. January 1, 1913

Name	Rate	Maturity	Amount
City of Boston Bonds	$3\frac{1}{2}$	July 1, 1939	$15,000
City of Cambridge Bonds	$3\frac{1}{2}$	Nov. 1, 1941	25,000
City of Chicago Bonds	4	Jan. 1, 1921	27,500
City of Chicago Bonds	4	Jan. 1, 1922	100,000
City of Los Angeles Bonds	$4\frac{1}{4}$	June 1, 1930	50,000
City of So. Norwalk Bonds	4	July 1, 1930	23,000
City of So. Norwalk Bonds	4	Sept. 1, 1930	22,000
City of Taunton Bonds	4	June 1, 1919	39,000
Town of Revere Note	4.35 disc.	Aug. 13, 1913	10,000
Boston & Albany R. R. Bonds	4	May 1, 1933	57,000
Boston & Albany R. R. Bonds	4	May 1, 1934	57,000
Boston Elevated R. R. Bonds	4	May 1, 1935	50,000
Boston Elevated R. R. Bonds	$4\frac{1}{2}$	Oct. 1, 1937	68,000
Boston Elevated R. R. Bonds	$4\frac{1}{2}$	Nov. 1, 1941	50,000
Boston & Lowell R. R. Bonds	4	April 1, 1932	16,000
Boston & Maine R. R. Bonds	$4\frac{1}{2}$	Jan. 1, 1944	150,000
Boston & Maine R. R. Bonds	4	June 10, 1913	20,000
C. B. & Q. R. R. Bonds (Ill. Div.)	4	July 1, 1949	50,000
C. B. & Q. R. R. Bonds (Ill. Div.)	$3\frac{1}{2}$	July 1, 1949	55,000
Chi. & N. W. R. R. Bonds	7	Feb. 1, 1915	92,000
Chi. & St. P., M. & O. R. R. Bonds	6	June 1, 1930	20,000
Cleveland & Pittsburg R. R. Bonds	$4\frac{1}{2}$	Jan. 1, 1942	35,000
Cleveland & Pittsburg R. R. Bonds	$4\frac{1}{2}$	Oct. 1, 1942	10,000
Fitchburg R. R. Bonds	$3\frac{1}{2}$	Oct. 1, 1920	50,000
Fitchburg R. R. Bonds	$3\frac{1}{2}$	Oct. 1, 1921	20,000
Fitchburg R. R. Bonds	$4\frac{1}{2}$	May 1, 1928	50,000
Fre. Elk. & Mo. Val. R. R. Bonds	6	Oct. 1, 1933	85,000
Great Northern R. R. Bonds	$4\frac{1}{4}$	July 1, 1961	25,000
Housatonic R. R. Bonds	5	Nov. 1, 1937	46,000
Louis. & Nash. R. R. Bonds (N. O. & M.)	6	Jan. 1, 1930	20,000
Louis. & Nash. R. R. Bonds (St. L. Div.)	6	March 1, 1921	5,000
Louis. & Nash. R. R. Bonds (N. & M.)	$4\frac{1}{2}$	Sept. 1, 1945	10,000
Louis. & Nash. R. R. Bonds	5	Nov. 1, 1931	35,000
Mich. Cent. R. R. Bonds	5	March 1, 1931	37,000
Mich. Cent. R. R. Bonds (Kal. & S. H.)	2	Nov. 1, 1939	50,000

24. What is total amount of the following water bonds? What is the average rate of interest?

Water Bonds of Fall River, Mass.

Date of Issue	Rate	Term	Maturity	Amount
June 1, 1893	4	30 years	June 1, 1923	$75,000
May 1, 1894	4	30 years	May 1, 1924	25,000
Nov. 1, 1894	4	29 years	Nov. 1, 1923	25,000
Nov. 1, 1894	4	30 years	Nov. 1, 1924	25,000
May 1, 1895	4	30 years	May 1, 1925	25,000
June 1, 1895	4	30 years	June 1, 1925	50,000
Nov. 1, 1895	4	30 years	Nov. 1, 1925	25,000
May 1, 1896	4	30 years	May 1, 1926	25,000
Nov. 1, 1896	4	30 years	Nov. 1, 1926	25,000
April 1, 1897	4	30 years	April 1, 1927	25,000
Nov. 1, 1897	4	30 years	Nov. 1, 1927	25,000
April 1, 1898	4	30 years	April 1, 1928	25,000
Nov. 1, 1898	4	30 years	Nov. 1, 1828	25,000
May 1, 1899	4	30 years	May 1, 1929	50,000
Aug. 1, 1899	4	30 years	Aug. 1, 1929	150,000
Nov. 1, 1899	$3\frac{1}{2}$	30 years	Nov. 1, 1929	175,000
Feb. 1, 1900	$3\frac{1}{2}$	30 years	Feb. 1, 1930	100,000
May 1, 1900	$3\frac{1}{2}$	30 years	May 1, 1930	20,000
April 1, 1901	$3\frac{1}{2}$	30 years	April 1, 1931	20,000
April 1, 1902	$3\frac{1}{2}$	30 years	April 1, 1932	20,000
April 1, 1902	$3\frac{1}{2}$	30 years	April 1, 1932	50,000
Dec. 1, 1902	$3\frac{1}{2}$	30 years	Dec. 1, 1932	50,000
April 1, 1903	$3\frac{1}{2}$	30 years	April 1, 1933	20,000
Feb. 1, 1904	$3\frac{1}{2}$	30 years	Feb. 1, 1934	175,000
May 2, 1904	4	30 years	May 2, 1934	20,000

SUBTRACTION

Drill Exercise

1. 33	**2.** 35	**3.** 37	**4.** 38	**5.** 36	**6.** 32	**7.** 26
7	9	8	9	7	4	9

8. 42	**9.** 49	**10.** 46	**11.** 43	**12.** 41
17	18	19	16	15

13. 45 17	**14.** 44 17	**15.** 364 126	**16.** 468 329	**17.** 566 328

18. 661 324	**19.** 363 127	**20.** 465 228	**21.** 362 129
22. 865,900 697,148	**23.** 891,000 597,119	**24.** 200,000 121,314	**25.** 30,071 28,002
26. 581,300 391,111	**27.** 481,111 310,010	**28.** 681,900 537,349	**29.** 868,434 399,638
30. 753,829 537,297	**31.** 394,287 277,469	**32.** 567,397 297,719	**33.** 487,196 311,076
34. 291,903 187,147	**35.** $ 835.00 119.00	**36.** $ 1100.44 835.11	**37.** $ 2881.44 1901.33
38. $ 3884.59 1500.45	**39.** $ 4110.59 1744.43	**40.** $ 2883.40 1918.17	**41.** $ 3717.17 1999.18

42. $ 1911.84 1294.95	**43.** $ 2837.73 1949.94	**44.** $ 5887.93 4999.99

MULTIPLICATION

Drill Exercise

By inspection, multiply the following numbers:

1. 1600×900.	**11.** 80×11.
2. 800×740.	**12.** 79×11.
3. 360×400.	**13.** 187×11.
4. 590×800.	**14.** 2100×11.
5. 1700×1100.	**15.** 2855×11.
6. 1900×700.	**16.** 84×25.
7. $788,000 \times 600$.	**17.** 116×50.
8. $49,009 \times 400$.	**18.** 288×25.
9. $318,000 \times 4000$.	**19.** 198×25.
10. $988,000 \times 50,000$.	**20.** 3884×25.

Review rules on multiplication, pages 8–9.

BILLS (Invoices)

When a merchant sells goods (called *merchandise*), he sends a bill (called an *invoice*) to the customer unless payment is made at the time of the sale. This invoice contains an itemized list of the merchandise sold and also the following:

The place and date of the sale.

The terms of the sale (usually in small type) — cash or a number of days' credit. Sometimes a small discount is given if the bill is paid within a definite period.

The quantity, name, and price of each item is placed on the same line. The entire amount of each item, called the *extension*, is placed in a column at the right of the item.

Discounts are deducted from the bill, if promised.

Extra charges, such as cartage or freight, are added after taking off the discount.

Make all Checks payable to Union Coal Company of Boston

We handle only highest grades of Anthracite and Bituminous Coals

UNION COAL COMPANY
40 CENTER STREET

BRANCH EXCHANGE TELEPHONE
CONNECTING ALL WHARVES AND OFFICES

SOLD TO L. T. Jones,
5 Whitney St.,
Mattapan, Mass.

BOSTON, Sept. 3, 1914.

6000 lb.	Stove Coal	7.00	$21.00
4000 "	Nut	7.25	14.50
			35.50

REC'D PAYMENT
SEPT. 28, 1914
UNION COAL CO.
Per A. A. Smith.

When the amount of the bill or invoice is paid, the invoice is marked.

Received payment,
Name of firm.
Per name of authorized person.

This is called receipting a bill.

Ledger

Whenever an invoice is sent to a customer, a record of the transaction is made in a book called a *ledger*. The pages of this book are divided into two parts by means of red or double lines. The left side is called the debit and the right side the credit side. At the top of each ledger page the name of a person or firm that purchases merchandise is recorded. The record on this page is called the *account* of the person or firm. When the person or firm purchases merchandise, it is recorded on the debit side. When merchandise or cash is received, it is recorded on the credit side. The date, the amount, and the word *Mdse.* or cash is usually written.

We *debit* an account when it receives value, and *credit* an account when it delivers value.

E. D. REDINGTON

1917						*1917*					
Jan.	*2*	*Cash*	*109*	*1000*		*Jan.*	*1*	*Acc't to Perkins*	*114*	*810*	*58*
		Note, 60 ds.	*114*	*1500*			*2*	*Mdse.*	*100*	*3057*	*50*
	9	*Page's Order*	*115*	*575*			*10*	"	*100*	*575*	
	25	*Cash*	*109*	*500*			*22*	*Order to Jenness*	*115*	*375*	
	27	*Mdse.*	*93*	*157*	*50*			*688.05*		*4818*	*08*
	31	*Browne's Acc.*	*115*	*397*	*53*						
				4130	*03*						

Specimen Ledger Page

A summary of the debits and credits of an account is called a *statement*. The difference between the debits and credits represents the standing of the account. If the debits are greater than the credits, the customer named on the account owes the merchant. If the credits are greater than the debits, then the merchant owes the customer.

EXAMPLES

Balance the following accounts:

BLANEY, BROWN & CO.

1917					*1917*				
Jan. 14	*Cons't #1*	177	669	98	*Jan.* 6	*Mdse.*	171	1303	75
	" *Co. #1*	179	386	25	30	*Dft. favor Dutton*	180	900	
28	" " *#1* 53.23	179	1200	75					

LUDWIG & LONG

1917					*1917*				
Jan. 6	*Cons't #2*	177	1939	50	*Jan.* 6	*Cash*	172	1000	
20	" *#2* 327.50	177	1327	50	15	"	172	939	50
					28	"	172	1000	

CHARLES N. DUTTON

1917					*1917*				
Jan. 7	*Mdse.*	168	651	88	*Jan.* 9	*Ship't Co. #2*	177	856	67
12	*Cash*	173	1000		24	*Cons't #2* 208.51	176	4699	09
20	"	173	2000						
29	*Ship't Co. #1*	179	795	37					
30	*Dft. on Blaney, B.*	180	900						

D. K. REED & SON

1917					*1917*				
Jan. 8	*Cons't #1*	*177*	*525*	*42*	*Jan. 8*	*Note at 60 ds.*	*180*	*525*	*42*
17	*Mdse.*	*170*	*202*	*50*	*17*	*Cash*	*172*	*202*	*50*
26	*Cons't #1*	*177*	*243*	*75*					
	" Co. #1	*179*	*206*						

PROFIT AND LOSS

(Review Percentage on pages 50–56)

A merchant must sell merchandise at a higher price than he paid for it in order to have sufficient funds at the end of the transaction to pay for clerk hire, rent, etc. Any amount above the purchasing price and its attendant expenses is called *profit;* any amount below purchasing price is called *loss.*

A merchant must be careful in figuring his profit. He must have a set of books so arranged as to show what caused either an increase or reduction in the profits.

There are certain special terms used in considering profit and loss. The first cost of goods is called the *net* or *prime* cost. After the goods have been received and unpacked, and the freight, cartage, storage, commission, etc. paid, the cost has been increased to what is called *gross* or *full* cost. The total amount received from the sale of goods is called *gross selling price.* The sum of expenses connected with the sale of goods subtracted from the gross selling price is called the net selling price. A merchant gains or loses according as the net selling price is above or below the gross cost.

There are two methods of computing gain or loss, each based on the rules of percentage. In the first method, the gross cost is the *base*, the per cent of gain or loss the *rate*, the gain or loss the *percentage.* The second method considers the selling price the base and will be explained in detail later.

EXAMPLES

1. Make extensions after deducting discounts and give total:

Credit not allowed on goods returned without our permission

PETTINGELL-ANDREWS COMPANY

ELECTRICAL MERCHANDISE

General Offices and Warerooms

156 to 160 PEARL STREET and 491 to 511 ATLANTIC AVENUE

Terms: 30 Days Net

NEW YORK, Nov 17 1911

SOLD TO City of Lowell School Dept., Lowell, Mass.

SHIPPED TO Same Lowell Industrial School, Lowell, Mass.

SHIPPED BY B & L 11/14/11 OUR REG. NO. 3786

ORDER REC'D 11/13/11 REELS COILS BUNDLES CASES BBLS.

Quantity Ordered	Quantity Shipped	ORDER NO. 78158 REG. NO. 52108		PRICE		
1	1	#4 Comealong #11293	Ea	4 00 15%		
1	1	#14492 16″ Extension Bit	Ea	2 00 50%		
36	36	2 oz cans Nokorode Soldering Paste	Doz	2 00 50%		
15	15	#8020 Cutouts	Ea	36 40%		
2	2	#322 H & H Snap Sws	Ea	76 30%		
125	125	#9395 Porc Sockets	Ea	30 45%		
125	125	#1999 Fuseless Rosettes	Ea	08 45%		
100	100	O C Ball Adjusters for Lp Cord	M	7 00		
50	50	$\frac{1}{8}$″ Skt Bushings	C	50		
200	200	Pr #43031 Std #328 #1 Single Wire Cleats	M Pr	26 68 40%		
200	200	Pr #43033 Single Wire Cleats	M Pr	40 00 40%		
2	2	Lb White Exemplar Tape	Lb	45		

2. Make extensions on the following items and give total:

Goods are Charged for the Convenience of Customers and Accounts are Rendered Monthly

R. A. McWHIRR CO.

DEPARTMENT STORE

FALL RIVER, MASS.

A. A. MILLS, Pres't & Treas.
J. H. MAHONEY, Supt.
R. S. THOMPSON, Sec'y.

Purchases for Fall River Technical High School

September, 1913 City

No. Order Number 719

DATE	ARTICLES		AMOUNTS	DAILY TOTAL	CREDITS
Sept 4	2 Doz C Hangers	90			
	2 " Skirt "	45			
5	120 Long Cloth	15			
	$34\frac{3}{8}$ Cambric	$5\frac{1}{2}$			
6	522 B Cambric	18			
	100 B Nainsook	16			
	24 Doz Kerr L Twist	120			
	8 Doz Tape Measures	25			
	84 " W Thread	51			
	1 10/12 Doz Tape	25			
9	1 Gro Tambo Cotton	520			
	$\frac{1}{2}$ Doz Bone Stillettos	46			
	$\frac{1}{2}$ " Steel "	46			
	40 Paper Needles	$3\frac{1}{2}$			
	20 " "	$3\frac{1}{2}$			
	2 Doz M Plyers	600			
	2 Boxes Edge Wire	125			
	12 " Even Tie Wire	180			
	24 " Brace "	225			
	2 " Lace "	160			
	2 Pk Ribbon	125			
	2 Rolls Buckram	90			
	48 Yd Cape Net	15			
13	100 Crinoline	5			
	125 "	5			

3. Make extensions on the following items and give total:

Goods are Charged for the Convenience of Customers and Accounts are Rendered Monthly

R. A. McWhirr Co.

DEPARTMENT STORE

FALL RIVER, MASS.

A. A. MILLS, Pres't & Treas.
J. H. MAHONEY, Vice-Pres't.
R. S. THOMPSON, Sec'y.

Purchases for Fall River Public Buildings
September, 1913 City

No. For Technical High School

Date	Articles		Amounts	Daily Total	Credits
Sept 4	1 Dinner Set	1700			
	100 Knives	9			
	100 Forks	9			
	100 D Spoons	10			
	100 Tea Spoons	09			
	1 Doz Glasses	90			
	$8\frac{1}{3}$ Doz Tumblers	45			
	$8\frac{1}{3}$ " Bowls	96			
	54 Crash	$11\frac{1}{2}$			
	$7\frac{1}{4}$ "	$11\frac{1}{2}$			
	50 "	$3\frac{1}{2}$			
	$\frac{1}{2}$ Doz Napkins	270			
	$\frac{1}{2}$ " "	415			
	2 Table Cloths	360			
12	120 Crash	$11\frac{1}{2}$			
15	2 Stock Pots	325			
	1 Lemon Squeezer	14			
	1 Doz Teaspoons	500			
	1 Butter Spreader	75			
	$\frac{1}{2}$ Doz Forks	625			

EXAMPLE. — A real estate dealer buys a house for \$4990 and sells it to gain \$50. What is the per cent of gain over cost?

SOLUTION. — $\frac{5\not{0}}{499\not{0}} \times 100 = \frac{500}{499} = 1\frac{1}{499}\%$. *Ans.*

DRILL EXERCISE

Find per cent of gain or loss:

	Cost	*Gain*		*Cost*	*Loss*
1.	\$1660	\$175	**6.**	\$6110	\$112
2.	\$1845	\$135	**7.**	\$5880	\$65
3.	\$1997.75	\$412.50	**8.**	\$3181.10	\$108.75
4.	\$2222.50	\$319.75	**9.**	\$7181.49	\$213.60
5.	\$3880.11	\$610.03	**10.**	\$3333.19	\$28.90

EXAMPLES

1. A dealer buys wheat at 91 cents a bushel and sells to gain 26 cents. What is the per cent of gain?

2. A farmer sold a bushel of potatoes for 86 cents, and gained 20 cents over the cost. What was the per cent of gain?

3. Real estate was sold for \$19,880 at a profit of \$3650. What was the per cent of gain?

4. A provision dealer buys smoked hams at 19 cents a pound and sells them at 31 cents a pound. What is the per cent of gain?

5. A grocer buys eggs at 28 cents a dozen and sells them at 35 cents a dozen. What is the per cent gain?

6. A dealer buys sewing machines at \$22 each and sells them at \$40. What is the per cent gain?

7. A dealer buys an automobile for \$972 and sells it for \$1472 and pays \$73.50 freight. What is the per cent gain?

Drill Exercise

Find the per cent gain or loss on both cost and selling price:

	Cost	*Selling Price*		*Cost*	*Selling Price*
1.	$ 1200	$ 1500	6.	$ 2475	$ 2360
2.	$ 1670	$ 1975	7.	$ 1650	$ 1490
3.	$ 2325	$ 2980	8.	$ 4111.50	$ 2880.80
4.	$ 4250.50	$ 5875.75	9.	$ 4335.50	$ 4660.60
5.	$ 3888.80	$ 4371.71	10.	$ 2880.17	$ 2551.60

REVIEW EXAMPLES

1. A dealer buys 46 gross of spools of cotton at $ 11.12. He sells them at 5 cents each. What is his profit? What is the per cent of gain on cost? on selling price?

2. Hardware supplies were bought at $ 119.75 and sold for $ 208.16. What is the per cent of gain on cost and on selling price?

3. A grocer pays $ 840 f.o.b. Detroit for an automobile truck. The freight costs him $ 61.75. What is the total cost of automobile truck? What per cent of the total cost is freight?

4. A dry goods firm buys 900 yards of calico at 5 cents a yard, and sells it at 9 cents. What is the profit? What per cent of cost and selling price?

5. A grocer buys a can ($8\frac{1}{2}$ qt.) of milk for 55 cents and sells it for 9 cents a quart. What is the per cent of gain?

EXAMPLES

1. A dealer sold a piano at a profit of $ 115, thereby gaining 18 % on cost. What was the selling price?

Solution. — If $ 115 = 18 % of cost, which is 100 %,

$1\,\% = \frac{115}{18} = 6.3889$

$100\,\% = \$\,638.89$ cost

Adding 115.00 profit

$ 753.89 selling price.

2. A dealer sold furniture at a profit of \$98. What was the cost of the furniture, if he sold to gain 35 %?

3. A coal dealer buys coal at the wharf and sells it to gain \$2 per ton. What is the cost per ton if he gains 31 %?

4. A shoe jobber buys a lot of shoes for \$1265 and sells to gain 26 %. What is the selling price?

5. An electrician buys a motor for \$48 and sells it to gain 18 %. What is the selling price?

6. A pair of shoes was sold to gain 26 %, giving the shoe dealer a profit of 97 cents. What was the cost price? What was the selling price?

FORMULAS

$$\text{Gain or loss} = \text{Cost} \times \text{rate of gain or loss}$$

$$\text{Cost} = \frac{\text{Gain or loss}}{\text{Rate of gain or rate of loss}}$$

$$\text{Selling Price} = \text{Cost}\ (100\,\% + \text{rate of gain})\ \text{or}\ (100\,\% - \text{rate of loss})$$

$$\text{Cost} = \frac{\text{Selling Price}}{100\,\% + \text{rate of gain}}\ \text{or}\ \frac{\text{Selling Price}}{100\,\% - \text{rate of loss}}$$

Drill Exercise

Find the selling price in each of the following problems:

Sold to Lose	*Cost*	*Sold to Gain*	*Cost*
1. $16\frac{2}{3}$ %	\$96	6. 37 %	\$250
2. 20 %	\$115	7. 33 %	\$644.50
3. 30 %	\$48	8. 41 %	\$841.75
4. 19 %	\$112.50	9. 29 %	\$108.19
5. $20\frac{1}{2}$ %	\$187.75	10. $22\frac{1}{2}$ %	\$237.75

COMPUTING PROFIT AND LOSS

Second Method. — Many merchants find that it is better business practice to figure per cost profit on the selling price rather than on the cost price. Many failures in business can be traced to the practice of basing profits on cost. We must bear in mind that no comparison can be made between per cents of profit or cost until they have been reduced to terms of the same unit value or to per cents of the same base.

To illustrate: It costs \$100 to manufacture a certain article. The expenses of selling are 22 %. For what must it sell to make a net profit of 10 %? Most students would calculate \$132, taking the first cost as the basis of estimating cost of sales and net profit. The average business man would say that the expenses of selling and cost should be quoted on the basis of the selling price.

SOLUTION. — Expenses of selling = 22 %
Profit = 10 %
32 % on selling price.

∴ Cost on \$ 100 = 68 % selling price.
100 % = \$ 147 selling price.

EXAMPLE 1. — An article costs \$ 5 and sells for \$ 6. What is the percentage of profit? *Ans.* $16\frac{2}{3}$ %.

Process. — Six dollars minus \$5 leaves \$1, the profit. One dollar divided by \$6, decimally, gives the correct answer, $16\frac{2}{3}$ %.

EXAMPLE 2. — An article costs \$ 3.75. What must it sell for to show a profit of 25 % ? *Ans.* \$ 5.

Process. — Deduct 25 from 100. This will give you a remainder of 75, the percentage of the cost. If \$3.75 is 75 %, 1 % would be \$3.75 divided by 75 or 5 cents, and 100 % would be \$5. Now, if you marked your goods, as too many do, by adding 25 % to the cost, you would obtain a selling price of about \$4.69, or 31 cents less than by the former method.

EXAMPLES

1. What is the percentage of profit, if an article costs \$ 8.50 and sells for \$ 10?

2. What is the percentage of profit on an automobile that cost \$ 810 and sold for \$ 1215?

3. An article costs \$ 840. What must I sell it for to gain 30 %?

4. A case of shoes is bought for \$30. For what must I sell them to gain 25%?

Table for Finding the Selling Price of any Article

Cost to do Business	Net Per Cent Profit Desired																				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**20**	**25**	**30**	**35**	**40**	**50**
15%	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	65	60	55	50	45	35
16%	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	64	59	54	49	44	34
17%	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	63	58	53	48	43	33
18%	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	62	57	52	47	42	32
19%	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	61	56	51	46	41	31
20%	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	60	55	50	45	40	30
21%	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	59	54	49	44	39	29
22%	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	58	53	48	43	38	28
23%	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	57	52	47	42	37	27
24%	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	56	51	46	41	36	26
25%	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	55	50	45	40	35	25

The percentage of cost of doing business and the profit are figured on the selling price.

Rule

Divide the cost (invoice price with freight added) by the figure in the column of "net rate per cent profit desired" on the line with per cent it cost you to do business.

Example. — If a wagon cost \$60.00
Freight 1.20
\$61.20

You desire to make a net profit of . . . . 5 per cent
It costs you to do business . . . . 19 per cent
Take the figure in column 5 on line 19, which is 76.

```
76)$61.2000($80.52, the selling price.
   608
     400
     380
      200
      152
```

Solve the following examples by table:

1. I bought a wagon for \$84.00 f.o.b. New York City. Freight cost \$1.05. I desire to sell to gain 8%. If the cost to do business is 18%, what should be the selling price?

2. I buy goods at \$97 and desire a net profit of 7%. It costs 16% to do business. What should be my selling price?

3. Hardware supplies are purchased for \$489.75. If it costs 23% to do the business, and I desire to make a net profit of 11%, for what must I sell the goods?

EXAMPLES

1. I bought 15 cuts of cloth containing $40\frac{1}{2}$ yd. each, at 7 cents a yd., and sold it for 9 cents a yd. What was the gain?

2. A furniture dealer sold a table for \$14.50, a couch for \$45.80, a desk for \$11.75, and some chairs for \$27.30. Find the amount of his sales.

3. Goods were sold for \$367.75 at a loss of \$125. Find the cost of the goods.

4. Goods costing \$145.25 were sold at a profit of \$28.50. For how much were they sold?

5. A woman bought $4\frac{1}{2}$ yards of silk at \$1.80 per yard, and gave in payment a \$10 bill. What change did she receive?

6. I bought 25 yards of carpet at \$2.75 per yard, and 6 chairs at \$4.50 each, and gave in payment a \$100 bill. What change should I receive?

TIME SHEETS AND PAY ROLLS

Office assistants must tabulate the time of the different employees and compute the individual amount due each week. In addition, they must know the number of coins and bills of different denominations required so as to be able to place the exact amount in each envelope. This may be done by making out the following pay roll form.

FORM USED TO DETERMINE THE NUMBER OF DIFFERENT DENOMINATIONS

No. Persons	Amt. Rec'd	$10	$5	$2	$1	50¢	25¢	10¢	5¢	1¢
2	13.50	2		2	2	2				
3	9.85		3	6		3	3	3		
4	7.48		4	4			4	8		12
2	9.18		2	4				2	2	6
Total Number Coins		2	9	16	2	5	7	13	2	18

TIME CARD

Week Ending .... 191..

No.

NAME

....

DAY	MORNING IN	MORNING OUT	AFTERNOON IN	AFTERNOON OUT	LOST OR OVERTIME IN	LOST OR OVERTIME OUT	TOTAL
Mon							
Tue							
Wed							
Thu							
Fri							
Sat							
Sun							

Total Time .... Hrs.

Rate ....

Total Wages for Week $ ....

FORM USED TO SEND TO THE BANK FOR THE MONEY FOR PAY ROLL

MEMORANDUM OF

CASH FOR PAY ROLL

WANTED BY

....

.... 19...

Twenties		
Tens		
Fives		
Twos		
Ones		
Halves		
Quarters		
Dimes		
Nickels		
Pennies		
Total		

TABLE OF WAGES[1]

To find the amount due at any rate from 30 cents to 55 cents per hour, look at the column containing the number of hours and the amount will be shown. Time and a half is counted for overtime on regular working days, and double time for Sundays and holidays.

Hours	Rate per Hr.	Reg. Time	Overtime	Dbl. Time	Rate per Hr.	Reg. Time	Overtime	Dbl. Time	Rate per Hr.	Reg. Time	Overtime	Dbl. Time
½...	$0 30	$0 15	$0 22½	$0 30	$0 32½	$0 16¼	$0 24⅜	$0 32½	$0 45	$0 22½	$0 33¾	$0 45
1...	30	30	45	60	32½	32½	48¾	65	45	45	67½	90
2...	30	60	90	1 20	32½	65	97½	1 30	45	90	1 35	1 80
3...	30	90	1 35	1 80	32½	97½	1 46¼	1 95	45	1 35	2 02½	2 70
4...	30	1 20	1 80	2 40	32½	1 30	1 95	2 60	45	1 80	2 70	3 60
5...	30	1 50	2 25	3 00	32½	1 62½	2 43¾	3 25	45	2 25	3 37½	4 50
6...	30	1 80	2 70	3 60	32½	1 95	2 92½	3 90	45	2 70	4 05	5 40
7...	30	2 10	3 15	4 20	32½	2 27½	3 41¼	4 55	45	3 15	4 72½	6 30
8...	30	2 40	3 60	4 80	32½	2 60	3 90	5 20	45	3 60	5 40	7 20
9...	30	2 70	4 05	5 40	32½	2 92½	4 38¾	5 85	45	4 05	6 07½	8 10
10...	30	3 00	4 50	6 00	32½	3 25	4 87½	6 50	45	4 50	6 75	9 00
½...	$0 47½	$0 23¾	$0 35⅝	$0 47½	$0 50	$0 25	$0 37½	$0 50	$0 55	$0 27½	$0 41¼	$0 55
1...	47½	47½	71¼	95	50	50	75	1 00	55	55	82½	1 10
2...	47½	95	1 42½	1 90	50	1 00	1 50	2 00	55	1 10	1 65	2 20
3...	47½	1 42½	2 13¾	2 85	50	1 50	2 25	3 00	55	1 65	2 47½	3 30
4...	47½	1 90	2 85	3 80	50	2 00	3 00	4 00	55	2 20	3 30	4 40
5...	47½	2 37½	3 56¼	4 75	50	2 50	3 75	5 00	55	2 75	4 12½	5 50
6...	47½	2 85	4 27½	5 70	50	3 00	4 50	6 00	55	3 30	4 95	6 60
7...	47½	3 32½	4 98¾	6 65	50	3 50	5 25	7 00	55	3 85	5 77½	7 70
8...	47½	3 80	5 70	7 60	50	4 00	6 00	8 00	55	4 40	6 60	8 80
9...	47½	4 27½	6 41¼	8 55	50	4 50	6 75	9 00	55	4 96	7 42½	9 90
10...	47½	4 75	7 12½	9 50	50	5 00	7 50	10 00	55	5 50	8 25	11 00

EXAMPLES

1. Find the amount due a carpenter who has worked 8 hours regular time and 2 hours overtime at 55 cents per hour.

[1] Similar tables may be constructed for other rates.

2. A plasterer worked on Sunday from 8 to 11 o'clock. If his regular wages are 45 cents per hour, how much will he receive?

3. A machinist's regular wage is 55 cents an hour. How much money is due him for working July 4th from 8–12 A.M. and 1–4.30 P.M.?

4. A plumber works six days in the week; every morning from 7.30 to 12 M.; three afternoons from 1 to 4.30 P.M.; two afternoons from 1 to 5.30; and one from 1 until 6 P.M. What will he receive for his week's wages at 50 cents per hour?

WAGES OF EMPLOYEES

Superintendent	$1,200.00 per annum
Matron	700.00 per annum
Nurses, 2 at	45.00 per month
Nurses, 1 at	40.00 per month
Nurses, 3 at	35.00 per month
Attendant	6.00 per week
Cook	12.00 per week
Assistant cook	1.00 per day
Kitchen maid	6.00 per week
Ward maids, 4 at	6.00 per week
Waitresses, 2 at	6.00 per week
Laundress	8.00 per week
Washwomen, 2 at	6.00 per week
Janitors, 1 day and 1 night	16.00 per week
Barber	6.00 per week

5. Find the total of coins and bills of all different denominations necessary to make up the weekly pay roll (52 weeks = a year) of the above. Assume full time for a week. Make out the currency memorandum for bank.

6. Find the total of coins and bills of the different denominations necessary to make up the following pay roll:

$47\frac{1}{2}$ hours, at 30 cents.
48 hours, at 45 cents.
48 hours, at $47\frac{1}{2}$ cents.
46 hours, at $32\frac{1}{2}$ cents.

7. Make a pay roll memorandum for the following pay roll:

48 at $42\frac{1}{2}$, 39 at 45, $46\frac{1}{2}$ at $48\frac{1}{2}$.

TEMPORARY LOANS

The following is a statement of the temporary loans of a New England city negotiated during the year, — amount, time, rates.

Date	Amount of Loan	Time		Rate of Interest	Amount of Interest
		Months	Days		
Feb. 28	$50,000		243	2.76	
Feb. 28	25,000		243	2.76	
Feb. 28	25,000		243	2.76	
June 6	100,000	5		3.25	
June 19	25,000		126	3.52	
June 19	25,000		126	3.52	
June 19	25,000		126	3.52	
June 19	25,000		126	3.52	
July 3	25,000		124	3.55	
July 3	25,000		124	3.55	
July 3	25,000		124	3.55	
July 3	25,000		124	3.55	
July 3	25,000		124	3.55	
July 3	25,000		124	3.55	
Aug. 14	25,000	2		4.	
Aug. 20	25,000		80	4.07	
Aug. 20	25,000		80	4.07	
Aug. 20	25,000		80	4.07	
Aug. 20	25,000		80	4.07	
Sept. 4	25,000		40	4.	
Sept. 4	25,000		40	4.	
Sept. 4	16,000		40	4.	

Write in a column after each loan, as suggested above, the amount of interest on each loan for the time and at the rate.

CHAPTER XII

ARITHMETIC FOR SALESGIRLS AND CASHIERS

The majority of employees in a department store are salesgirls. It may be well to describe briefly the method of operation of such a store and to indicate what part a salesgirl has in it.

A department store is a combination of a number of distinct stores or departments under one roof and general management. It is organized in this way for the purpose of economy. Each department is conducted as a separate store, and is in charge of a buyer, who both buys and plans the sales for his department. His department is charged for rent, according to its location, and must also pay for overhead charges.

The buyer in charge of each department has under him salesgirls or saleswomen, who sell the goods. Each salesgirl has a book containing sales slips in duplicate and a card to show the amount of sales.

The sales slip shows the name and address of the purchaser if the merchandise is to be sent to the customer's home. In the case of a charge account a special form of sales slip is used. The name and quality of the article purchased are written in large space and the amount extended to the right. The amount of money received from the purchaser is placed at the top of the sales slip.

A carbon copy of each sales slip is made. The carbon copy is given to the customer and the original is sent with the money to the cashier. It is then used to tabulate data in regard to sales, etc.

J. H. EMERSON CO.

8606 *Dallas, Tex.,* -----19--

Name ---------------------------

Address ---------------------------

SOLD BY---------- DEPT AM'T REC'D------

Pur. by 1

Send this Slip to Cashier 1 before you wrap Goods. Enter Sale on Record Sheet first

Am't Rec'd	Sold by	Am't of Sale
8606	1	

SALESMAN'S VOUCHER

In Case of Error Please Return Goods and Bill

J. H. EMERSON CO.

8606 *Dallas, Tex.,* -----19--

Name ---------------------------

Address ---------------------------

SOLD BY---------- DEPT AM'T REC'D------

Pur. by

Customers will please report any failure to deliver bill with goods

This Slip must go in Customer's Parcel. Violation of this Rule is cause for Instant Dismissal

1

DEPARTMENT-----------

SALESMAN ------------------------------ DATE----------------

	Cash Sales	Charge Sales		Cash Sales	Charge Sales
1				Forward	
2			10		
3			11		
4			12		
5			13		
6			14		
7			15		
8			16		
9			17		

Salesgirls should be able to do a great many calculations at sight. This ability comes only through practice.

EXAMPLES

Find the amount of the following:

1. 10 yd. percale at $12\frac{1}{2}$ cents.
2. 12 yd. voile at $16\frac{2}{3}$ cents.
3. 27 yd. silesia at $33\frac{1}{3}$ cents.
4. 50 yd. serge at $1.50.
5. 28 yd. mohair at $1.25.
6. 48 yd. organdie at $37\frac{1}{2}$ cents.
7. $91\frac{1}{2}$ yd. gingham at 10 cents.
8. 112 yd. calico at $4\frac{1}{2}$ cents.
9. 36 yd. galatea at 15 cents.
10. 11 yd. lawn at 19 cents.
11. 64 yd. dotted muslin at $62\frac{1}{2}$ cents.
12. 24 yd. gabardine at $1.75.
13. 18 yd. poplin at 29 cents.
14. 16 yd. hamburg at 15 cents.
15. 12 yd. lace at $87\frac{1}{2}$ cents.
16. 19 yd. val lace at 9 cents.
17. 26 yd. braid at 25 cents.
18. 48 dz. hooks and eyes at 12 cents.
19. 19 yd. cambric at 15 cents.
20. 18 pc. binding at 16 cents.
21. 6 yd. canvas at 24 cents.
22. 56 yd. linen at $62\frac{1}{2}$ cents.
23. 18 yd. albatross at $1.50.
24. 22 yd. silk at $2.25.

PROBLEMS

1. I bought cotton cloth valued at \$ 6.25, silk at \$ 13.75, handkerchiefs for \$ 2.50, and hose for \$ 2.75. What was the whole cost?

2. Ruth saved \$ 15.20 one month, \$ 20.75 a second month, and the third month \$ 4.05 more than the first and second months together. How much did she save in the three months?

3. Goods were sold for \$ 367.75, at a loss of \$ 125. Find the cost of the stock.

4. Goods costing \$ 145.25 were sold at a profit of \$ 28.50. For how much were they sold?

5. A butcher sold $8\frac{3}{4}$ pounds of meat to one customer, $9\frac{1}{2}$ pounds to a second, to the third as much as the first plus $1\frac{1}{4}$ pounds, to a fourth as much as to the second. How many pounds did he sell?

6. Edith paid \$ 42.75 for a dress, one-half as much for a cloak, and \$ 7.25 for a hat. How much did she pay for all?

7. A merchant sold four pieces of cloth; the first piece contained 24 yards, the second 32 yards, the third 16 yards, and the fourth five-eighths as many yards as the sum of the other three. How many yards were sold?

8. From a piece of cloth containing $65\frac{3}{8}$ yards, there were sold $23\frac{1}{4}$ yards. How many yards remained?

9. A merchant sold goods for \$ 528.40 and gained \$ 29.50. Find the cost.

10. From 11 yards of cloth, $3\frac{3}{4}$ were cut for a coat, and $6\frac{7}{8}$ yards for a suit. How many yards remained?

11. I bought 15 cuts of cloth containing $40\frac{1}{2}$ yards each at 7 cents a yard and sold it for 9 cents a yard. What was the gain?

12. What is the cost of $13\frac{1}{2}$ yards of silk at \$ 3.75 per yard?

13. What is the cost of $16\frac{1}{2}$ yards of broadcloth at \$ 2.25 per yard?

14. What is the cost of 3 pieces of cloth containing $12\frac{3}{4}$, $14\frac{1}{4}$, and $15\frac{1}{2}$ yards at $12\frac{1}{2}$ cents per yard?

15. What will $5\frac{1}{8}$ yards of velvet cost at \$ 2.75 per yard?

16. What is the cost of three-fourths of a yard of crêpe de chine at \$ 1.75 per yard?

17. A saleslady is paid \$ 1.00 per day for services and a bonus of 2 % on all sales over \$ 50 per week. If the sales amount to \$ 175 per week, what will be her salary?

18. At \$ $1.33\frac{1}{3}$ a yard, how much will 15 yards of lace cost?

19. At \$ $1.16\frac{2}{3}$ a yard, how much will 9 yards of silk cost?

20. At \$ $1.12\frac{1}{2}$ per yard, how much will 6 yards of velvet cost?

21. At $33\frac{1}{3}$ cents each, find the cost of 101 handkerchiefs.

22. A salesgirl sold $14\frac{1}{2}$ yards of gingham at 25 cents, 9 yards of cotton at $12\frac{1}{2}$ cents, $10\frac{1}{2}$ yards of Madras at 35 cents. Amount received, \$ 10. How much change will be given to the customer?

23. Sold $6\frac{1}{2}$ yards of cheviot at \$ 1.10, $5\frac{3}{8}$ yards of silk at \$ 1.25, $9\frac{1}{2}$ yards of velveteen at 98 cents. Amount received, \$ 25.00. How much change will be given to the customer?

24. Sold $11\frac{1}{2}$ yards of Persian lawn at \$ 1.95, $6\frac{5}{8}$ yards of dimity at 25 cents, $12\frac{1}{8}$ yards of linen suiting at 75 cents. Amount received, \$ 40. How much change will be given to the customer?

25. Sold $9\frac{1}{2}$ yards of Persian lawn at \$ $1.37\frac{1}{2}$, $5\frac{1}{8}$ yards of cheviot at \$ 1.25, 15 yards of cotton at $12\frac{1}{2}$ cents. Amount received, \$ 30. How much change will be given to the customer?

26. Sold 7 yards of muslin at 25 cents, $12\frac{1}{2}$ yards of lining at 11 cents, $6\frac{5}{8}$ yards of lawn at \$ 1.50, 7 yards of suiting at 75 cents. Amount received, \$ 20. How much change will be given to the customer?

27. Sold 16 yards of velvet at \$ 2.25, $14\frac{1}{2}$ yards of suiting at 48 cents, 23 yards of cotton at 15 cents, $6\frac{3}{8}$ yards of dimity at 24 cents, $7\frac{1}{2}$ yards of ribbon at 25 cents. Amount received, \$ 50. How much change will be given to the customer?

28. At $12\frac{1}{2}$ cents a yard, what will $8\frac{3}{4}$ yards of ribbon cost?

29. At \$ 2.50 a yard, what will 2.8 yards of velvet cost?

30. If it takes $5\frac{1}{9}$ yards of cloth for a coat, $3\frac{1}{6}$ yards for a jacket, and $\frac{1}{2}$ a yard for a vest, how many yards will it take for all?

31. I gave \$ 16.50 for 33 yards of cloth. How much did one yard cost?

32. Mary went shopping. She had a \$ 20 bill. She bought a dress for \$ 9.50, a pair of gloves for \$ .75, a fan for \$ .87, two handkerchiefs for \$ .37 each, and a hat for \$ 4.50. How much money had she left?

33. Emma's dress cost \$ 11.25, and Mary's cost $\frac{2}{3}$ as much. How much did Mary's cost? How much did both cost?

34. What is the cost of $16\frac{3}{4}$ yards of silk at \$ 2.75 a yard?

35. What is the cost of $14\frac{1}{8}$ yards of cambric at 42 cents a yard?

36. If $5\frac{1}{2}$ yards of calico cost 33 cents, how much must be paid for $14\frac{5}{8}$ yards?

37. One yard of sheeting cost $22\frac{1}{2}$ cents. How many yards can be bought for \$ 15.15?

38. From a piece of calico containing $33\frac{7}{8}$ yards there have been sold at different times $11\frac{3}{4}$, $7\frac{5}{8}$, and $1\frac{1}{2}$ yards. How many yards remain?

39. I bought $16\frac{1}{2}$ yards of cloth for \$ $3\frac{2}{3}$ per yard, and sold it for \$ $4\frac{1}{4}$ per yard. What was the gain?

40. A merchant has three pieces of cloth containing, respectively, $28\frac{3}{4}$, $35\frac{1}{2}$, and $41\frac{5}{8}$ yards. After selling several yards from each piece, he finds that he has left in the three pieces 67 yards. How many yards has he sold?

ARITHMETIC FOR CASHIER

How to Make Change. — Every efficient cashier or saleslady makes change by adding to the amount of the sale or purchase enough change to make the sum equal to amount presented. The change should be returned in the largest denominations possible.

To illustrate: A young lady buys dry goods to the amount of \$ 1.52. She gives the saleslady a \$ 5 bill. What change should she receive?

The saleslady will say: \$ 1.52, \$ 1.55, \$ 1.65, \$ 1.75, \$ 2.00, \$ 4.00, \$ 5.00. That is, \$ 1.52 + \$ .03 = \$ 1.55; \$ 1.55 + \$ .10 = \$ 1.65; \$ 1.65 + \$ .10 = \$ 1.75; \$ 1.75 + \$ .25 = \$ 2.00; \$ 2.00 + \$ 2.00 = \$ 4.00; \$ 4.00 + \$ 1.00 = \$ 5.00.

EXAMPLES

1. What change should be given for a dollar bill, if the following purchases were made?

a. \$ .87	*c.* \$ .43	*e.* \$ .20
b. \$ .39	*d.* \$ .51	*f.* \$ .23

2. What change should be given for a two-dollar bill, if the following purchases were made?

a. \$ 1.19	*d.* \$ 1.57	*g.* \$ .63
b. \$ .89	*e.* \$ 1.42	*h.* \$ .78
c. \$ 1.73	*f.* \$ 1.12	*i.* \$ .27

3. What change should be given for a five-dollar bill, if the following purchases were made?

a. $3.87	*d.* $2.81	*g.* $1.93
b. $2.53	*e.* $3.74	*h.* $.17
c. $4.19	*f.* $4.29	*i.* $.47

4. What change should be given for a ten-dollar bill, if the following purchases were made?

a. $8.66	*d.* $6.23	*g.* $3.16
b. $9.31	*e.* $5.29	*h.* $2.29
c. $7.42	*f.* $4.18	*i.* $1.74

5. What change should be given for a twenty-dollar bill, if the following purchases were made?

a. $18.46	*c.* $17.09	*e.* $8.01
b. $19.23	*d.* $12.03	*f.* $6.27

CHAPTER XIII

CIVIL SERVICE

ALMOST every government position open to women has to be obtained through an examination. In most cases Arithmetic is one of the subjects tested. It is wise to know not only the subject, but also the standards of marking, and for this reason some general rules on this subject follow.

Marking Arithmetic — Civil Service Papers

1. On questions of addition, where sums are added across and the totals added, for each error deduct $16\frac{2}{3}$ %.

2. For each error in questions containing simple multiplication or division, as a single process, deduct 50 % ; as a double process, deduct 25 %.

3. In questions involving fractions and problems other than simple computation, mark as follows :

(*a*) Wrong process leading to incorrect result, credit 0.

(*b*) For inconvenient or complex statement, process, or method, giving right result, deduct from 5 to 25 %.

(*c*) If the answer is correct but no work is shown, credit 0.

(*d*) If the answer is correct and the process is clearly indicated, but not written in full, deduct 25 %.

(*e*) If no attempt is made to answer, credit 0.

(*f*) If the operation is incomplete, credit in proportion to the work done.

(*g*) For the omission of the dollar sign ($) in final result or answer, deduct 5.

(*h*) In long division examples, to be solved by decimals, if the answer is given as a mixed number, deduct 25.

4. For questions on bookkeeping and accounts, mark as follows :

(*a*) For omission of total heading, deduct 25 ; for partial omission, a commensurate deduction.

(*b*) For every misplacement of credits or debits, deduct 25.

(*c*) For every omission of date or item, deduct 10.
(*d*) For omissions or misplacement of balance, deduct 25.

NOTE. — Hard and fast rules are not always applicable because the importance of certain mistakes differs with the type of example. Before a set of examples is marked, the deductions to be made for various sorts of errors are decided upon by the examiners. In general, examples in arithmetic for high-grade positions are marked on practically the same basis as clerical arithmetic. Arithmetic in lower-grade examinations, such as police and fire service and the like, is marked about 60 % easier than clerical.

CIVIL SERVICE EXAMPLES

(Give the work in full in each example.)

1. Multiply 83,849,619 by 11,079.

2. Subtract 16,389,110 from 48,901,001.

3. Divide 18,617.03 by .717.

4. At $ 0.37 per dozen, how many dozen eggs can be bought for $ 33.67 ?

5. What would 372 pounds of corn meal cost if 4 lb. cost 12 cents ?

6. If a man bought 394 cows for $ 23,640 and sold 210 for $ 14,700, what was the profit on each cow ?

7. What is the net amount of a bill for $ 93.70, subject to a discount of $37\frac{1}{2}$ % ?

8. How many pints in a measure containing 14,784 cubic inches ?

9. What number exceeds the sum of its fourth, fifth, and sixth by 23 ?

10. If a man's yearly income is $ 1600, and he spends $ 25 a week, how much can he save in a year ?

11. What will $16\frac{2}{3}$ pounds of butter cost at 34 cents a pound ?

12. How many hogs can be bought for $ 1340 if each hog averages 160 pounds and costs 9 cents a pound ?

13. How many tons of coal can be bought for $ 446.25, if each ton costs $ 8.75 ?

14. A young lady can separate 38 letters per minute. If a letter averages $6\frac{1}{2}$ ounces, how many pounds of mail does she handle in an hour?

15. Multiply $53\frac{7}{8}$ by $9\frac{3}{5}$ and divide the product by $2\frac{1}{2}$. (Solve decimally.)

16. Roll matting costs $73\frac{1}{2}$ cents per sq. yd. What will be the cost of 47 rolls, each roll 60 yd. long and 36 in. wide?

17. A man paid \$5123.25 for 27 mules and sold them for \$6500. How much did he gain by the transaction?

18. A wheel measures 3′ 7″ in diameter. What is the distance around the tire?

19. A bricklayer earns 70 cents an hour. If he works 129 days, 8 hours a day, and spends \$50 a month, how much does he save a year?

20. A rectangular courtyard is 48′ 5″ long and 23′ 7″ wide. How many square yards is it in area?

21. How many days will it take a ship to cross the Atlantic Ocean, 2970 miles, if the vessel sails at the rate of 21 miles an hour?

22. Eleven men bought 7 tracts of land with 22 acres in each tract. How many acres will each man have?

23. A merchant sends his agent \$10,228 to buy goods. What is the value of the goods, after paying \$28 for freight and giving the agent 2% for his commission?

24. If milk costs 6 cents a quart, and you sold it for 9 cents a quart, and your profit for the milk was \$48, how many quarts of milk did you sell?

25. A traveler travels $11\frac{3}{4}$ miles a day for 8 days. How many more miles has he yet to travel if the journey is 134 miles?

26. What is the net amount of a bill for \$29.85, subject to a discount of $16\frac{2}{3}$%?

27. Add across, placing the totals in the spaces indicated; then add the totals and check:

					TOTALS
8,431	17,694	18,630	91	707	
5,912	305	3,777	871	8,901	
6,801	29,006	5,891	30	16,717	
5,008	10,008	7,771	144	9,001	
13,709	10,999	39	1,113	3,444	

28. Divide 37,818.009 by .0391.

29. A pile of wood is 136 ft. long, 8 ft. wide, and 6 ft. high, and is sold for $4.85 per cord, which is 20 % more than the cost. What is the cost of the pile?

30. Add the following column and from the sum subtract 81,376,019:

80,614,304
68,815,519
32,910,833
54,489,605
96,315,809
75,029,034
21,201,511

31. A man bought 128 gal. cider at 23 cents a gallon; he sold it for 28 cents a gallon. How much did he make?

32. A laborer has $48 in the bank. He is taken sick and his expenses are $7.75 a day. How many days will his fund last?

33. In paving a street $1\frac{3}{4}$ mi. long and 54 ft. wide, how many bricks 9 in. long and 4 in. wide will be required?

34. Find the simple interest on $841.37 for 2 yr. 3 mo. 17 da. at 5 %.

35. Find the simple interest on $367.49 for 1 yr. 7 mo. 19 da. at 4 %.

SPECIMEN ARITHMETIC PAPERS

Clerks, Messengers, etc.

Rapid Computation

1. Add these *across*, placing the totals in the spaces indicated; then add the totals:

						Totals
15,863	3,175	368	51,461	35,196	27,368	
7,242	82,463	24,175	52,837	3,724	51,493	
68,317	58,417	41,582	4,738	16,837	5,281	
52,683	26,364	73,642	25,164	42,525	70,463	
1,475	18,572	7,368	15,726	71,394	62,958	

2. Multiply 82,473,659 by 9874. Give the work in full. **3.** From 68,515,100 subtract 24,884,574. Give the work in full. **4.** Divide 29,379.7 by .47. Give the work in full. **5.** What is the net amount of a bill for \$19.20, subject to a discount of $16\frac{2}{3}$ %? Give the work in full.

Arithmetic

1. How many times must 720 be added to 522 to make 987,642? Give the work in full. **2.** If the shadow of an upright pole 9 ft. high is $8\frac{1}{2}$ ft. long, what is the height of a church spire which casts a shadow 221 ft. long? Give the work in full. **3.** How many sods, each 8 in. square, will be required to sod a yard 24 feet long and 10 feet 8 inches wide? Give the work in full. **4.** A retired merchant has an income of \$25 a day, his property being invested at 6 %. What is he worth? Give the work in full. **5.** Find the principal that will yield \$38.40 in 1 yr. 6 mo. at 4 % simple interest. Give the work in full. **6.** If the time past noon increased by 90 minutes equals $\frac{5}{11}$ of the time from noon to midnight, what time is it? Give the work in full. **7.** A merchant deducts 20 % from the marked price of his goods and still makes a profit of 16 %. At what advance on the cost are the goods marked? Give the work in full. **8.** If a grocer sells a tub of butter at 22 cents a pound, he will gain 168 cents, but if he sells it at 17 cents a pound, he will lose 112 cents. Find (*a*) the weight of the butter and (*b*) the cost per pound. Give the work in full. **9.** The product of four factors is 432. Two of the factors are 3 and 4. The other two factors are equal. What are the equal factors? Give the work in full.

Stenographer-Typewriter

1. From what number can 857 be subtracted 307 times and leave a remainder of 49? Give the work in full.

2. What number exceeds the sum of its fourth, fifth, sixth, and seventh parts by 101? Give the work in full.

3. A sells to B at 10 % profit; B sells to C at 5 % profit; if C paid $ 5336.10, what did the goods cost A? Give the work in full.

4. Find the simple interest of $ 297.60 for 3 yr. 1 mo. 15 da. at 6 %. Give the work in full.

5. A man sold $\frac{1}{4}$ of his farm to B, $\frac{2}{3}$ of the remainder to C, and the remaining 60 acres to D. How many acres were in the farm at first? Give the work in full.

Sealers of Weights and Measures

(Review Weights and Measures, pages 43, 276)

1. A measure under test is found to have a capacity of 332.0625 cu. in. What is its capacity in gallons, quarts, etc.? Give the work in full.

2. How many quarts, dry measure, would the above measure hold? Give the work in full, carrying the answer to four decimal places.

3. What is the equivalent of 175 lb. troy in pounds avoirdupois? Give the work in full. 1 av. lb. = 7000 grains.

4. How many grains in 12 lb. 15 oz. avoirdupois? Give the work in full.

5. Reduce 15 lb. 10 oz. 20 grains avoirdupois to grains troy weight. Give the work in full.

6. What part of a bushel is 2 pecks and 3 pints? Give the work in full and the answer both as a decimal and as a common fraction.

7. What will 10 bushels 3 pecks and 4 quarts of seed cost at $ 2.10 per bushel? Give the work in full.

8. What part of a troy pound is 50 grains, expressed both decimally and in the form of a common fraction?

9. A strawberry basket was found to be 65.2 cubic inches in capacity. (*a*) How many cubic inches short was it? (*b*) What percentage of a full quart did it contain? Give the work in full.

10. In testing a spring scale it was found that in weighing 22 lb. of correct test weights on same, the scale indicated 22 lb. $10\frac{1}{2}$ oz. What was the percentage of error in this scale at this weight? Give the work in full.

Visitor

1. A certain "home" had at the beginning of the year $ 693.07, and received during the year donations amounting to $ 1322.48. The expenses for the year were: salaries, $387.25; printing, etc., $175; supplies, $651.15; rent, $104.25 heat, etc., $ 75; interest, $ 100; miscellaneous, $ 72.83. Find the cash on hand at the end of the year. Give the work in full.

2. Of the 72,700 persons relieved in a certain state at public expense in the year ending March 31, 1912, 76 % were aided locally, and the remainder by the state. Find the number relieved by the state. Give the work in full.

3. There was spent in state, city, and town public poor relief in Massachusetts in one year the sum of $ 3,539,036. The number of beneficiaries was 72,700. What was the average sum spent per person? Give the work in full.

4. Of the 72,900 persons aided by public charity in this state in a certain year $\frac{99}{100}$ were classed as sane. Of the remainder, $\frac{4}{9}$ were classed as insane, $\frac{1}{3}$ as idiotic, and the rest as epileptic. How many epileptics received public aid? Give the work in full.

PART V — ARITHMETIC FOR NURSES

CHAPTER XIV

A NURSE should be familiar with the weights and measures used in dispensing medicines. There are two systems used — the English, based on the grain, and the Metric system, based on the meter.

APOTHECARIES' WEIGHT

(Troy Weight)

20 grains (gr.)	= 1 scruple	(℈)
3 ℈	= 1 dram	(ʒ) = 60 gr.
8 ʒ	= 1 ounce	(℥) = 24 ℈ = 480 gr.
12 ℥	= 1 pound	(℔) = 96 ʒ = 288 ℈ = 5760 gr.

The number of units is often expressed by Roman numerals written after the symbols. (See Roman Numerals, p. 2.)

EXAMPLES

1. How many grains in iv scruples?
2. How many grains in iii drams?
3. How many grains in iv ounces?
4. How many scruples in ℔ i?
5. How many grains in ℔ iii?
6. How many drams in ℔ iv?
7. How many grains in ʒ ii?
8. How many scruples in ℥ v?
9. How many drams in ℥ vii?
10. How many ounces in ℔ viii?

11. Salt ℥ i will make how many quarts of saline solution, gr. xc to qt. 1?

12. How many drams of sodium carbonate in 10 powders of Seidlitz Powder? Each powder contains gr. xl.

APOTHECARIES' FLUID MEASURE

60 minims (m)	= 1 fluid dram = (f ʒ).
8 f ʒ	= 1 fluid ounce (f ℥).
16 f ℥	= 1 pint (O) = 128 f ʒ = 7680 m.
8 O	= 1 gallon (C) = 128 f ℥ = 1024 f ʒ.

EXAMPLES

1. How many minims in f ʒ iv?

2. How many minims in f ℥ iii?

3. How many fluid drams in 1 O?

4. How many minims in 5 pints?

5. How many pints in 8 gallons?

6. How many fluid drams in O ii?

7. How many minims in f ℥ viii?

8. How many fluid drams in C vii?

9. How many pints in C v?

10. How many minims in f ℥ ix?

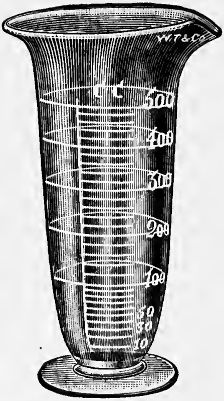
11. If the dose of a solution is m xxx and each dose contains $\frac{1}{30}$ gr. strychnine, how much of the drug is contained in f ℥ i of the solution?

12. ʒ ii of a solution contains gr. i of cocaine. How much cocaine is given when a doctor orders m x of the solution?

Approximate Measures of Fluids

(With Household Measures)

An ordinary teaspoonful is supposed to hold 60 minims of pure water and is approximately equal to a fluid dram. A



A GRADUATE.

drop is ordinarily considered equivalent to a minim, but this is only approximately true in the case of water. The specific gravity, shape, and surface from which the drop is poured influence the size. In preparing medicines to be taken internally, minims should never be measured out as drops. There are minim droppers and measures for this purpose.

A level teaspoonful of either a fluid or solid preparation is equal to a dram. Level spoonfuls are always considered in measurements.

1 teaspoonful	= 1 fluid dram.
1 dessertspoonful	= 2 fluid drams.
1 tablespoonful	= 4 fluid drams or $\frac{1}{2}$ fluid ounce.
1 wineglassful	= 2 fluid ounces.
1 teacupful	= 6 fluid ounces.
1 tumblerful	= 8 fluid ounces.

EXAMPLES

1. How many dessertspoonfuls in 8 fluid ounces?
2. How many wineglassfuls in 2 tumblerfuls?
3. How many tablespoonfuls in 3 fluid drams?
4. How many teaspoonfuls in 5 fluid ounces?
5. How many teacupfuls in 4 fluid drams?
6. How many dessertspoonfuls in 6 fluid drams?
7. How many teaspoonfuls in 1 gallon?
8. How many drops of water in 1 quart?
9. How many teaspoonfuls in 3 ounces?
10. How many minims in 3 pints?

11. What household measure would you use to make a solution, ʒ i to a pint?

12. Read the following apothecaries' measurements and give their equivalents:

a. ʒ iv.
b. gr. v.
c. O ii.
d. ℥ ii.
e. ℥ ij.
f. ʒ ss.[1]
g. O iv.
h. ʒ ii.
i. ℥ iv.
j. ℥ ss.

Metric System of Weights and Measures

(Review Metric System in Appendix.)

The metric system of weights and measures is used to a great extent in medicine. The advantage of this system over the English is that, in preparing solutions, it is easy to change weights to volumes and volumes to weights without the use of common fractions.

In medicine the gramme (so written in prescriptions to avoid confusion with the dram) and the milligramme are the chief weights used.

1 gramme	= wt. of 1 cubic centimeter (cc.) of water at 4° c.
1000 grammes	= 1 kilogram or "kilo."
1 kilogram of water	= 1000 cc. = 1 liter.

Conversion Factors

1 gramme	= 15.4 or approx. 15 grains.
1 grain	= 0.064 gramme.
1 cubic centimeter	= 15 minims.
1 minim	= 0.06 cc.
1 liter	= 1 quart (approx.).

The liter and cubic centimeter are the principal units of volume used in medicine.

[1] ss means one-half.

A micro-millimeter is used in measuring microscopical distances. It is $\frac{1}{10}$ mm. and is indicated by the Greek letter μ.

To convert cc. into minims multiply by 15.
To convert grammes into drams divide by 4.
To convert cc. into ounces divide by 30.
To convert minims into cc. divide by 15.
To convert grains into grammes divide by 15.
To convert fluid drams into cc. multiply by 4.
To convert drams into grammes multiply by 4.

1 grain	= 0.064 gramme.
2 grains	= 0.1 gramme.
5 grains	= 0.3 gramme.
8 grains	= 0.5 gramme.
10 grains	= 0.6 gramme.
15 grains	= 1 gramme.
1 milligramme	= 0.0154 grain.

Review Troy (apothecary) and avoirdupois weights, pages 43 and 276.

EXAMPLES

1. A red corpuscle is 8 μ in diameter. Give the diameter in a fraction of an inch.

2. A microbe is $\frac{1}{25000}$ inch in diameter. What part of a millimeter is it?

3. Another form of microbe is $\frac{1}{60000}$ of an inch in diameter. What part of a millimeter is it?

4. A bottle holds 48 cc. What is the weight of water in the bottle when it is filled?

5. How many liters of water in a vessel containing 4831 grams of water?

6. Give the approximate equivalent in English of the following:

a. 48 grammes
b. 3.6 kilograms
c. 3.5 liters
d. 8 kilos
e. 3.9 grammes
f. 53 milligrammes

7. Give the approximate equivalents in the metric system of the following:

a. 39 grains
b. 4 drams
c. 7 fluid drams
d. 47 ℔
e. 13 quarts
f. 2 gallons
g. 39 minims
h. 8321 grains

Approximate Equivalents between Metric and Household Measures

1 teaspoonful	=	4 cc. or 4 grams of water.
1 dessertspoonful	=	8 cc. or 8 grams of water.
1 tablespoonful	=	15+ cc. or 15+ grams of water.
1 wineglassful	=	60 cc. or 60 grams of water.
1 teacupful	=	180 cc. or 180 grams of water.
1 glassful	=	240 cc. or 240 grams of water.

EXAMPLES

(Give approximate answers.)

1. What is the weight of two glassfuls of water in the metric system?

2. What is the weight of a gallon of water in the metric system?

3. What is the weight of three liters of water in the English system?

4. What is the volume of four ounces of water in the metric system?

5. What is the volume of twelve cubic centimeters of water in the English system?

6. What is the volume of f ℥ iii in the metric system?

7. What is the volume of eighty grammes of water?

8. What is the weight of 360.1 cc. of water?

9. What is the volume of 4 kilos of water?

10. What is the weight of 6.1 liters of water?

11. With ordinary household measures how would you obtain the following: 5 gm., m xv, 1.5 L., 25 cc., ℥ ii, f ℥ ss?

METRIC SYSTEM

EXAMPLES

1. Change the following to milligrammes:
8 gm., 17 dg., 13 gm.

2. Change the following to grammes:
13 mg., 29 dg., 7 dg., 21 mg.

3. Add the following:
11 mg., 18 dg., 21 gm., 4.2 gm.

Express answer in grammes.

4. Add the following:
25 mg., 1.7 gm., 9.8 dg., 21 mg.

Express answer in milligrammes.

5. The dose of atropine is 0.4 mg. What fraction of a gramme is necessary to make 25 cc. of a solution in which 1 cc. contains the dose?

6. Give the equivalent in the metric system of the following doses:

a. Extract of gentian, gr. $\frac{1}{10}$.
b. Tincture of quassia, ʒ i.
c. Tincture of capsicum, m iii.
d. Spirits of peppermint, ʒ i.
e. Cinnamon spirit, m x.
f. Oil of cajuput, m xv.
g. Extract of cascara sagrada, gr. v.
h. Fluid extract of senna, ʒ ii.
i. Agar agar, ℥ ss.

7. Give the equivalent in the English system of the following doses:

a. Ether, 1 cc.
b. Syrup of ipecac, 4 cc.
c. Compound syrup of hypophosphites, 4 cc.

d. Pancreatin, 0.3 gm.
e. Zinc sulphate, 2 gm.
f. Copper sulphate, 0.2 gm.
g. Castor oil, 30 cc.
h. Extract of rhubarb, 0.6 gm.
i. Purified aloes, 0.5 gm.

DOSES

Since all drugs are harmful or poisonous in sufficiently large quantities, it is necessary to know the least amount needed to produce the desired change in the body — the minimum dose. This has been ascertained by careful and prolonged experiments. Similar experiments have told us the largest amount of drug that one can take without producing dangerous effect — the maximum dose.

On the average, children under 12 years of age require smaller doses than adults. To determine the fraction of an adult dose of a drug to give to a child, let the child's age be the numerator, and the sum of the child's age plus twelve be the denominator of the fraction. For infants under one year, multiply the adult dose by the fraction $\frac{\text{age in months}}{150}$.

To illustrate: How much of a dose should be given to a child of four?

Age of child = 4.
Age of child + 12 = 16.
Fraction of dose $\frac{4}{16} = \frac{1}{4}$. *Ans.* $\frac{1}{4}$ of a dose.

EXAMPLES

1. What is the fraction of a dose to give to a child of 8?
2. What is the fraction of a dose to give to a child of 6?
3. What is the fraction of a dose to give to a child of 3?
4. What is the fraction of a dose to give to a child of 10?

5. If the normal adult dose of aromatic spirits of ammonia is 1 dram, what is the dose for a child of 7?

6. If the normal adult dose of castor oil is one-half ounce, what is the dose for a child of 6?

7. If the normal adult dose of epsom salts is 4 drams, what is the dose for a child of 4?

8. If the normal adult dose of strychnine sulphate is $\frac{1}{20}$ gr., what is the dose for a child of 8?

9. If the normal adult dose of ipecac is 15 grains, what is the dose for a child of 11?

10. If the normal adult dose of aromatic spirits of ammonia is 4 grammes, what is the dose for a child of 5 months?

11. If the normal adult dose of ipecac is 1 gramme, what is the dose for a child 10 months old?

12. The normal adult dose of strychnine sulphate is 3.2 mg. How much should be given to a child 2 years old?

STRENGTH OF SOLUTIONS

A nurse should know about the strength of substances used in treating the sick. Most of these substances are drugs which are prepared according to formulas given in a book called a *Pharmacopœia*. Preparations made according to this standard are called official preparations, and often have the letters U. S. P. written after them to distinguish them from patented preparations prepared from unknown formulas.

Drugs are applied in the following forms: solutions, liniments, oleates, cerates, powders, lozenges, plasters, ointments, etc.

An infusion is a liquid preparation of the drug made by extracting the drug with boiling water. The strength of an infusion is 5% of the drug, unless otherwise ordered by the physician.

The strength of a solution may be written as per cent or in the form of a ratio. A 10 % solution means that in every 100 parts by weight of water or the solvent there are 10 parts by weight of the substance. This may be written in form of a fraction — $\frac{10}{100}$ or $\frac{1}{10}$. In other words, for every ten parts of solvent there is one part of substance. Since a fraction may be written as a ratio, it may be called a solution of one to ten, written thus, 1 : 10.

EXAMPLES

1. Express the following per cents as ratios: 5 %, 20 %, 2 %, 0.1 %, 0.01 %.

Since per cent represents so many parts per hundred, a ratio may be changed to per cent by putting it in the form of a fraction and multiplying by 100. The quotient is the per cent.

2. Express the following in per cents: 1 : 4, 1 : 3, 1 : 6, 1 : 15, 1 : 25, 1 : 40.

3. Arrange the following solutions in the order of their strength: 3 %, 8 %, 24 %, 6 %, 1 : 10, 1 : 14, 1 : 50, 40 %, 1 : 45, 50 %.

4. Express the strength of the following solutions as per cents, and in ratios.

a. 80 ounces of dilute alcohol contains 40 ounces of absolute alcohol.

b. 6 pints of dilute alcohol contains two pints of absolute alcohol.

5. Change the following ratios into per cents: 1 : 18, 1 : 20, 1 : 5, 1 : 35, 1 : 100. Arrange in order, beginning with the highest.

6. Change the following per cents to ratios: 33 %, 12 %, 15 %, .5 %, 1 %.

7. Is it possible to make an 8 % solution from 4 %? Explain.

8. Express the following strengths in terms of ratio:

a. 25 cc. of alcohol in 100 cc. solution.

b. 5 pints of alcohol in 3 qts.

c. f ℥ i contains f ʒ iii.

9. Express the following strengths in terms of per cent:

a. 50 cc. of solution containing 5 cc. of peroxide of hydrogen.

b. f ℥ iii of dilute alcohol containing ʒ ii of pure alcohol.

How to Make Solutions of Different Strengths from Crude Drugs or Tablets of Known Strengths

Exact Method

Illustrative Example. — How much water will be necessary to dissolve 5 gr. of powdered bichloride of mercury to make a solution of 1 part to 2000?

Since the whole powder is dissolved,

1 part is 5 gr.
2000 parts = 10,000 grains.
480 gr. = 1 oz.
32 oz. = 1 qt.

$\frac{10000}{480} = 20\frac{5}{6}$. Approx. 21 oz. or $1\frac{1}{3}$ pints of water should be used to dissolve it.

The above example may be solved by proportion, when x = no. oz. of water necessary to dissolve powder; then wt. of powder : drug : : x : water.

$$\frac{5}{480} : 1 :: x : 2000.$$

$$x = \frac{5 \times 2000}{480} = \frac{125}{6} = 20\tfrac{5}{6} \text{ oz.} \quad \text{Approx. 21 oz.}$$

EXAMPLES

Solve the following examples by analysis and proportion:

1. How much water will be required to dissolve 5 gr. of powdered corrosive sublimate to make a solution of 1 part to 1000?

2. How much water will be required to dissolve a $7\frac{1}{2}$-grain tablet of corrosive sublimate to make a solution 1 part to 2000?

ILLUSTRATIVE EXAMPLE. — How much of a 40 % solution of formaldehyde should be used to make a pint of 1 : 500 solution?

480 minims = 1 oz.
7680 minims = 1 pint.

$\frac{7680}{500} = 15\frac{9}{25}$ minims = amt. of pure formaldehyde necessary to make a pint of 1 : 500.

Since the strength of the solution is 40 %, $15\frac{9}{25}$ minims represents but $\frac{40}{100}$ or $\frac{2}{5}$ of the actual amount necessary. Therefore, the full amount of 40 % solution is obtained by dividing by $\frac{2}{5}$.

$$\frac{\overset{192}{\cancel{384}}}{\underset{5}{\cancel{25}}} \times \frac{5}{\cancel{2}} = \frac{192}{5} = 38\tfrac{2}{5} \text{ minims to a pint.}$$

To Determine the Amount of Crude Drug Necessary to Make a Certain Quantity of a Solution of a Given Strength

To illustrate: To make a gallon of 1 : 20 carbolic acid solution, how much crude carbolic acid is necessary?

$1 : 20 :: x : 1$ gal.
$1 : 20 :: x : 8$ pints or 128 ounces.
$20x = 128$ ounces.
$x = 6\frac{2}{5}$ ounces crude carbolic acid.

EXAMPLES

1. How much crude boric acid is necessary to make 6 pints of 5 % boric acid?

$5 : 100 :: x : 6$ pts.
$5 : 100 :: x : 576$ drams.
$100x = 2880$.
$x = 28.8$ drams.

2. How much crude boric acid is necessary to make 2 quarts of 1 : 18 boric acid?

3. How much crude drug is necessary to make f℥iii of 2% cocaine?

4. How many $7\frac{1}{2}$-grain tablets are necessary to make 2 gallons of 1 : 1000 bichloride of mercury?[1]

5. How much crude drug is necessary to make O vi of 1 : 20 phenol solution?

6. How much crude drug is necessary to make O vii of 1 : 500 bichloride of mercury?

7. How much crude drug is necessary to make O iii of 1 : 10 chlorinated lime?

Hypodermic Doses

Standard strong solutions and pills are kept on hand in a hospital and from these weaker solutions are made as required by the nurse for hypodermic use. This is done by finding out what part the required dose is of the tablet or solution on hand. The hypodermic dose is not administered in more than 25 or less than 10 minims. The standard pill or solution is dissolved or diluted in about 20 minims and the fractional part, corresponding to the dose, is used for injection.

To illustrate: A nurse is asked to give a patient $\frac{1}{200}$ gr. strychnine. She finds that the only tablet on hand is $\frac{1}{30}$ gr. How will she give the required dose?

$$\frac{1}{200} \div \frac{1}{30} = \frac{1}{200} \times 30 = \frac{3}{20}.$$

The required dose is $\frac{3}{20}$ of the stock pill. Therefore she dissolves the pill in 80 minims of water and administers 12 minims. The reason for dissolving in 80 rather than in 20 minims is to have the hypodermic dose not less than 10 minims.

EXAMPLES

1. Express the dose, in the illustrative example, in the metric system.

[1] Hospitals usually use 1 tablet for a pint of water to make 1 : 1000 solution.

2. How would you give a dose $\frac{1}{60}$ gr. strychnine sulphate from stock tablet $\frac{1}{30}$ gr.?

3. How would you give gr. $\frac{1}{30}$, if only $\frac{1}{20}$ grain were on hand?

4. How would you give gr. $\frac{1}{10}$, if only $\frac{1}{6}$-grain tablets were on hand?

5. How would you give gr. $\frac{1}{30}$, if only $\frac{1}{60}$-grain tablets were on hand?

6. How would you give gr. $\frac{1}{60}$, if only $\frac{1}{100}$-grain tablets were on hand?

7. How would you give gr. $\frac{1}{150}$ of atropine sulphate, if only $\frac{1}{120}$-grain tablets were on hand?

8. How would you give gr. $\frac{1}{60}$ of apomorphine hydrochloride if only $\frac{1}{10}$-grain tablets were on hand?

To Estimate a Dose of a Different Fractional Part of a Grain from the Prepared Solution

Nurses are often required to give a dose of medicine of a different fractional part of a grain from the drug they have.

To illustrate: Give a dose of $\frac{1}{25}$ gr. of strychnine when the only solution on hand is one containing $\frac{1}{30}$ gr. in every 10 minims.

Since $\frac{1}{30}$ grain is contained in 10 minims,
1 grain or $30 \times \frac{1}{30}$ grain is contained in 300 minims.
Then, $\frac{1}{25}$ of a grain is $\frac{1}{25}$ of $300 = \frac{1}{25} \times 300 = 12$ m.

EXAMPLES

1. What dose of a solution of 60 minims containing $\frac{1}{32}$ gr. will be given to get $\frac{1}{100}$ gr.?

2. Reckon quickly and accurately how much of a tablet gr. $\frac{1}{8}$ should be given to have the patient obtain a dose gr. $\frac{1}{10}$.

3. What dose of a solution of m x containing gr. $\frac{1}{8}$ morphine sulphate will be given to give gr. $\frac{1}{6}$?

4. What dose of a solution of m xx containing gr. $\frac{1}{30}$ strychnine sulphate will be given to give gr. $\frac{1}{60}$?

5. What dose of a solution of 1 cc. containing 0.1 cc. of the fluid extract of nux vomica will be given to give 0.06 cc.?

To Obtain a Definite Dose from a Stock Solution of Definite Strength

To illustrate: To give a patient a $\frac{1}{25}$-grain dose when the stock solution has a strength of 1%.

1 % solution means that each drop of the solution contains $\frac{1}{100}$ part or $\frac{1 \text{ gr.}}{100}$ of strychnine.

$\frac{1}{25}$ gr. is contained in as many drops as $\frac{1}{100}$ is contained in it.

$$\frac{1}{25} \div \frac{1}{100} = \frac{1}{25} \times 100 = 4.$$

Therefore 4 drops of the 1 % solution contains $\frac{1}{25}$ gr.

EXAMPLES

1. To give $\frac{1}{50}$ gr. strychnine from 2 % solution.

2. To give $\frac{1}{25}$ gr. strychnine from solution containing in ten minims $\frac{1}{20}$ gr.

3. To give 3 gr. of caffeinic sodium benzoate from a 25 % solution.

4. To give $\frac{1}{200}$ gr. of atropine from 1 % solution.

5. To give $\frac{1}{150}$ gr. of strychnine from $\frac{1}{2}$ % solution.

6. To give $\frac{1}{40}$ gr. atropine from solution containing in ten minims $\frac{1}{30}$ gr.

Temperature

The temperature of the body is due to the combined activity of all its various systems but is regulated chiefly by the skin and circulatory system. It remains very nearly constant in the normal person, in spite of the variations of the outdoor temperature. A variation of more than one degree from the normal temperature, that is, above $99\frac{1}{2}°$ F. or below $97\frac{1}{2}°$ F., may be regarded as a sign of a disease. The temperature is obtained by means of a small thermometer — called a clinical thermometer. See Appendix, page 337, for description of the different thermometers.

Temperature readings are usually expressed in the Fahrenheit scale, but scientific data gathered in laboratories are expressed according to the Centigrade scale. Therefore, we should be able to change readings from one scale to another.

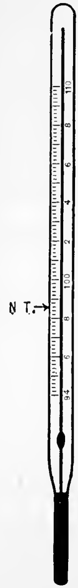
Fahrenheit readings may be obtained by adding 32° to $\frac{9}{5}$ of the Centigrade reading. This rule may be abbreviated into a formula as follows:

$$F = \tfrac{9}{5}C + 32°,$$

where F = Fahrenheit reading,
C = Centigrade reading.

Centigrade readings may be obtained by subtracting 32° from the Fahrenheit and taking $\frac{5}{9}$ of the remainder. This may be abbreviated into a formula as follows:

$$C = \tfrac{5}{9}(F - 32°).$$



CLINICAL THERMOMETER

EXAMPLES

1. Albumin is coagulated by heat at 155° F. What is the degree Centigrade?

2. When milk is heated above 170° F., the albumin coagulates and forms a scum on the milk. To what degree on Centigrade scale does this correspond?

3. Egg albumin (white of egg) coagulates at 138° F. At what degree on the Centigrade scale?

4. Milk is pasteurized by bringing milk in the bottle to a temperature of 165° F. To what degree on the Centigrade scale?

5. "Gentle heat" is a term used to denote the temperature between 32° to 38° C. What are the corresponding degrees on the Fahrenheit scale?

Baths

(Change the following temperatures to Centigrade scale.)

A bath with a temperature between 33° and 65° F. is known as a *cold* bath.

A bath with a temperature between 65° and 75° F. is known as a *cool* bath.

A bath with a temperature between 75° and 85° F. is known as a *temperate* bath.

A bath with a temperature between 85° and 92° F. is known as a *tepid* bath.

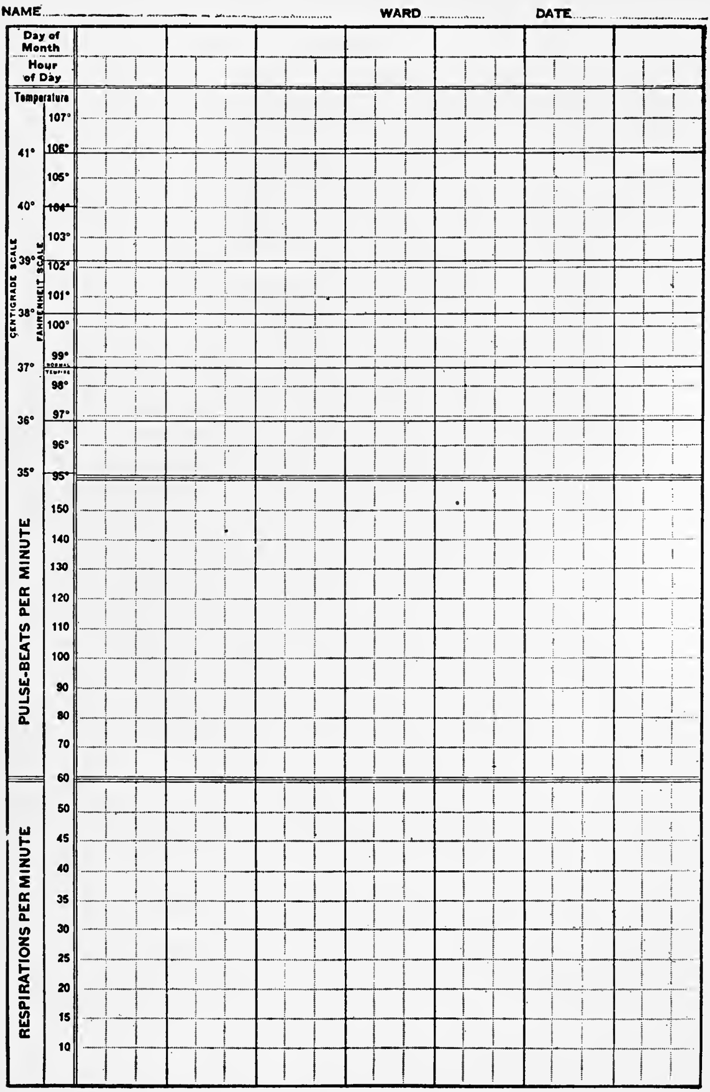
A bath with a temperature between 92° and 98° F. is known as a *warm* bath.

A bath with a temperature between 98° and 112° F. is known as a *hot* bath.

Medical Chart (Graph)

(See Graphs in the Appendix.)

In order to follow the condition of a patient from day to day, the temperature, the pulse beats, and respirations are recorded morning and night on a special ruled chart. The name of the patient is placed on each chart.


NAME
WARD
DATE
Day of Month
Hour of Day
Temperature
CENTIGRADE SCALE
FAHRENHEIT SCALE
41°
40°
39°
38°
37°
36°
35°
107°
106°
105°
104°
103°
102°
101°
100°
99°
98°
97°
96°
95°
PULSE-BEATS PER MINUTE
150
140
130
120
110
100
90
80
70
60
RESPIRATIONS PER MINUTE
50
45
40
35
30
25
20
15
10

EXAMPLES

Chart the following case of pneumonia:

	Morning	*Evening*
2 day	102°	104°
3 day	102.6°	105°
4 day	102.4°	104.2°
5 day	102.4°	103.6°
6 day	102.4°	104°
7 day	102.4°	104.4°
8 day	101.8°	103°
9 day	102.9°	104°
10 day	102°	102.8°
11 day	98.4°	98.5°
12 day	97.4°	98.2°
13 day	97.4°	98.2°
14 day	98.2°	98.4°

PROBLEMS IN HOUSEHOLD CHEMISTRY

Bacteria are low forms of vegetable and animal life, and some are capable of producing disease.

Chemicals that are employed to destroy bacteria are known as *germicides.* Those which limit the growth or destructive power of bacteria are called *antiseptics. Deodorants* remove or neutralize unpleasant odors.

1. Bacteria multiply in all temperatures between 2° and 70° C. What are the temperatures in the Fahrenheit scale within which bacteria will grow?

2. Creolin is used as a germicide and deodorant for offensive wounds in solutions of from 2 to 5 %. The creolin must never be added to water over 98° C., as its strength is impaired. What is the corresponding temperature on the Fahrenheit scale?

3. The most important medium or preparation for growing bacteria is nutrient bouillon. It is made of the following:

Meat extract	5 grams
Peptone	10 grams
Salt	5 grams
Water	1 liter

What per cent of each?

4. A sugar bouillon culture is used for artificially cultivating bacteria. It is made by adding 1 % of glucose to nutrient bouillon. How many grams of glucose to a liter of solution?

5. Carbolic acid is bought by hospitals in a 95 % solution and diluted as required. A solution of carbolic acid 1 : 20 is used to destroy germs. How much 95 % solution will be required to make 5 gallons 1 : 20?

6. 1 : 1000 solution means how many grams to the gallon?

7. A normal salt solution is made by dissolving 9 grams of salt to the quart. How many teaspoonfuls to the quart? How many grains to the quart?

8. What is the ratio of a pure drug? What is the percentage of purity of a pure drug?

9. If I desire to make a lotion of 1 : 1000 corrosive sublimate, how much of the substance would be added and how much water used?

10. How much water and corrosive sublimate are required for a gallon of the following strengths?

a. 1 : 2000.	*d.* 1 : 20,000.
b. 1 : 4000.	*e.* 1 : 100,000.
c. 1 : 10,000.	*f.* 1 : 150,000.

11. A saturated solution of boric acid may be made by dissolving ʒ v to pint (O i) of water. What is the per cent of the saturated solution?

12. A saturated solution of $KMnO_4$ may be made by dissolving ℥ i to O i? What is the per cent?

13. How much of the saturated solution should be added to water O i to make 1 % solution?

Water Analysis

Every nurse should be able to interpret a biological and chemical analysis of water.

Terms used in Chemical and Bacteriological Reports

The following brief explanation of the terms used in chemical and bacteriological examinations of water is given in order that the reports of analyses of samples may be clearly understood. As the quantities to be obtained by analyses are usually very small, they are ordinarily expressed in parts per million (p. p. m.), and always by weight.

Turbidity of water is caused by fine particles such as clay, silt, and microscopic organisms.

Sediment is self-explanatory. The amount and nature of the sediment are usually noted.

Color is measured by comparing the sample with artificial standards made by dissolving certain salts in distilled water, or sometimes with colored glass disks. The color of large lakes is usually below 0.10.

Odor. This requires no explanation.

Residue on Evaporation, or *Total Solids*, indicates the total solid matter, both organic and inorganic, in 1,000,000 parts of water. The determination is made by placing about 100 grams of water in a platinum dish and weighing the whole accurately. The water is then evaporated to dryness by moderate heat and the dish again weighed; the difference between this and the weight of the empty dish gives the total solids in the water. The dish is then heated red hot, to burn out the organic matter, when the weight of the remaining ash gives the inorganic or fixed solids. The loss on ignition, sometimes reported, is a measure of the organic solids.

Ammonia. Ammonia in water indicates the presence of organic matter in an advanced stage of decay, and although the amount is small, it affords a valuable indication of what is going on in the water. It is determined in two forms, called "free" and "albuminoid."

Free Ammonia is that which has actually been set free in the water in the process of decay of organic matter, while *Albuminoid Ammonia* is that which has not yet been set free, but which is liable to be freed under the action of the oxygen in the water. The sum of the two gives an indication of the total amount of organic matter in the water.

Water which has 0.05 p. p. m. of free ammonia is probably pure, while if it has more than 0.1 p. p. m., it is perhaps dangerous. A low figure for albuminoid ammonia is 0.05 p. p. m., and a high one is 0.50.

Chlorine in water usually represents sodium chloride, or common salt. It may be due to sewage pollution or to nearness to the ocean. It is always found in natural waters, the normal amount decreasing from the seacoast inland. If the amount exceeds 20 p. p. m., it may cause corrosion in boilers and plumbing fixtures. Properly interpreted, the chlorine content is one of the most useful indexes of the extent of sewage pollution.

Nitrogen is usually determined in the form of nitrates and nitrites, the former being the final result of decomposition, while the latter is the incomplete result of the same action. If an analysis shows the ammonia to be low and the nitrates high, it indicates that the water has become completely purified, while the reverse indicates that the decaying process is going on and the water is dangerous. In good drinking water the nitrates may be as high as 1 or 2 p. p. m., while the nitrites, if present, are practically always a sign of pollution.

Oxygen Consumed. This is the amount of oxygen absorbed by the water from potassium permanganate. As the oxygen is absorbed by the organic matter present in the water, the amount consumed gives a measure of the amount of impurities contained in it. Less than 1 p. p. m. indicates probable purity, while as high as 4 or 5 p. p. m. indicates danger in drinking water.

Hardness. A water is said to be "hard" when it contains in solution the carbonates and sulphates of calcium or magnesium. When a hard water is used for washing, these salts have to be decomposed by soap before a lather can be formed. In boilers, a hard water forms scale. Hardness is expressed by the number of parts of calcium carbonate in 1,000,000 parts of water. Rain water has a hardness of about 5, and river waters of from 50 to 100.

Iron may be troublesome in a water used for domestic purposes if it is present in quantities greater than 0.3 to 0.5 p. p. m.

Alkalinity or *Temporary Hardness* is that part of the total hardness which is due to carbonates removable by boiling, thus causing the formation of scale. For purposes of softening water for boiler use, it is necessary to know both the total hardness and the alkalinity.

Bacteria. While it is obvious that the quality of a water of turbid appearance and unpleasant odor is suspicious, it does not follow that it is dangerous, nor is a water which is entirely free from color and odor necessarily a safe drinking water, for epidemics of typhoid have been caused by such. The bacteriological examination of water, by which the number of bacteria present in one cubic centimeter (1 cc.) is determined, is therefore an important part of an analysis.

As a general statement, it may be said that fresh water containing less than 100 bacteria per cc. is pure, that water containing 500 bacteria per cc. should be viewed with suspicion, and that water containing 1000 bacteria per cc. is undoubtedly contaminated. In considering these figures with relation to a water supply, it must be remembered that all natural surface waters contain some bacteria and that, except where there is pollution, the greater part of them are absolutely harmless.

The bacteria are so small that they may be seen only with the aid of a high-powered microscope. In order to count them a culture jelly of gelatine, albumin, and extract of beef is prepared and 1 cc. of the water is thoroughly mixed with 10 cc. of the culture jelly, a small measured portion of this mixture then being poured in a thin layer on a sterilized plate to harden. Each bacterium eats and multiplies to such an extent that in about forty-eight hours a visible colony is produced. From a count of these colonies within a measured area of the plate the number of bacteria in the original 1 cc. of water is determined.

Different species of bacteria may be detected by the use of different media for development, or they may be found by further examination with the microscope. The well-known colon bacillus (*B. coli*), which, although harmless itself, is an indication of sewage pollution, is detected by the gas which it produces in a closed tube. As *B. coli* are found in practically all warm-blooded animals and sometimes in fish and elsewhere, the finding of a few in large samples of water, or their occasional discovery in small samples, is of no special significance; but if they are found in a larger proportion in small samples and in considerable numbers in larger ones, sewage pollution is indicated.

EXAMPLES

1. If a bacterium multiplies tenfold every half hour in a person's mouth, how many will be produced in twenty-four hours?

2. A sample of water contains 0.24 parts per million of free ammonia. How many parts per 100,000?

3. A sample of water contains 1.1 parts per million of iron. How many parts per 100,000?

4. A sample of water contains 10 parts per million of lime. How many parts per 10,000?

EXAMPLES ON ANALYSES OF WATER

(Parts in 100,000)

	Residue on Evaporation			Ammonia				Chlorine	Nitrogen as		Oxygen Consumed	Hardness	Iron
					Albuminoid								
	Total	Loss on Igni-tion	Fixed	Free	Total	In Solu-tion	In Sus-pen-sion		Nitrates	Nitrites			
a.	4.00	1.65	2.35	.0026	.0190	.0156	.0034	.72	.0030	.0001	.31	1.3	.0160
b.	4.65	2.00	2.65	.0028	.0172	.0148	.0024	.68	.0030	.0000	.28	1.3	.0080
c.	3.85	1.15	2.70	.0014	.0148	.0130	.0018	.68	.0000	.0000	.31	1.1	.0080
d.	4.20	1.50	2.70	.0052	.0140	.0128	.0012	.71	.0000	.0000	.32	1.1	.0050
e.	4.15	1.35	2.80	.0018	.0170	.0152	.0018	.71	.0000	.0000	.26	1.0	.0080
f.	5.00	1.75	3.25	.0014	.0162	.0142	.0020	.73	.0000	.0000	.36	1.0	.0120
g.	4.35	1.60	2.75	.0020	.0178	.0150	.0028	.70	.0010	.0001	.24	1.3	.0080
h.	4.10	1.15	2.95	.0018	.0162	.0136	.0026	.71	.0010	.0001	.24	1.3	.0100

1. Give the number of parts of free ammonia in 10,000 in *a.*

2. Give the number of parts of nitrates in 10,000 in *b.*

3. Give the number of parts of nitrites in 10,000 in *d.*

REVIEW EXAMPLES

1. Give the number of cubic centimeters of water you would measure out to get the following:

a. 70 gm. *b.* 11 kg. *c.* 0.4 gm. *d.* 61 mg.

2. How much would the following amounts of water weigh?

a. 9 l. *b.* 4.7 cc. *c.* $\frac{1}{2}$ l. *d.* 48 cc.

3. If the dose of aromatic spirits of ammonia is 30 minims, what is the dose for a child 6 years old?

4. Give the approximate equivalents in household measures of the following:

a. 7 drams
b. 36 grams
c. 4 ounces
d. 90 minims
e. 12 fluid ounces
f. 3 fluid drams

5. Give the approximate equivalents in household measures of the following:

a. 1500 cc. *c.* 3 liters *e.* 1 gramme
b. 11 cc. *d.* 0.003 grain *f.* 0.008 gramme

6. How many grammes in 3 ounces of 1 % solution?

7. How many drams in 1 gallon of 1 : 50 solution?

8. How many grammes in a liter of 10 % solution?

9. How many grammes in 5 liters of 1 : 25 solution?

10. How many teaspoonfuls of pure carbolic acid in a gallon of 1 % solution?

11. How many drops (minims) of carbolic acid in a quart of 1 : 1000 solution?

12. A basin of rain water has a temperature of 94° F. Give the equivalent on the Centigrade scale.

13. A cool bath registers a temperature of 26° C. Give the equivalent on the Fahrenheit scale.

14. A dose of ipecac is 20 to 30 grammes. What is the dose for a child of seven years?

15. A dose of 1 : 500 solution means how many grammes to a quart?

16. Given a 5 % solution of silver nitrate, how would you make a gallon of 1 : 5000 solution?

17. How would you make a gallon of 3 % solution of acetic acid from the pure acid?

18. How would you make two quarts of 5 % solution of carbolic acid from pure acid? (Consider pure acid 95 %.)

19. A 1 : 50 solution is used for disinfecting wounds. How would you make a gallon of this fluid from standard solution? (Consider standard strength about 40 %.)

20. A 2 % solution of boric acid is used for eye and ear irrigations. How much boric acid will be necessary to make a quart of the solution?

21. Give the approximate equivalents of metric and apothecaries' measures of the following:

a. 31 cc.	*d.* 50 minims
b. $\frac{1}{100}$ gram	*e.* 5 pints
c. 1.5 gram	*f.* 101 cc.

22. If the pharmacy nurse buys 3 oz. of trional, how many powders of 10 grains each can she make?

23. The dose of the tincture of opium is 0.5 cc.; 10 cc. of the tincture contains 1 gm. of opium; 12 % of opium is morphine. How many milligrams of morphine in one dose of the tincture?

24. *a.* Convert the following to milligrams: 5 dg. and 0.27 gm.
b. Convert the following to grams: 483 dg. and 7 mg.

25. How much alcohol (15 % strength) will be necessary to make a quart of alcohol containing 80 % volume of absolute alcohol? 66 %? 37 %? 75 %?

26. If lactic acid is composed of 75 % of absolute acid, how much absolute acid in a pound of the official preparation?

27. Diluted alcohol contains 41.5 % absolute alcohol. How much absolute alcohol in a gallon of dilute alcohol?

28. The dose of morphine sulphate is 0.008 gm. What is the dose for a baby 7 months old?

29. The dose of camphorated tincture of opium (paregoric) is f ʒ i. What is the dose for a baby 6 months old?

30. Hands and arms are often disinfected by washing in a solution of permanganate of potash (two ounces to four quarts of water) followed by immersion in a solution of oxalic acid (eight ounces to four quarts of water). What is the percentage of each?

31. Adhesive iodoform gauze is made by saturating sterilized gauze in the following solution:

Iodoform	22 grams
Resin	10 grams
Glycerine	5 cc.
Alcohol	26 cc.

(Consider specific gravity of alcohol and glycerine as 1.) What per cent of each? Give quantity in English system.

32. How much of each ingredient should be used in preparing a pound of the following mass?

Zinc oxide	5 parts
Gelatine	5 parts
Glycerine	12 parts
Water	10 parts

33. What per cent of the following solution is atropine sulphate?

Atropine sulphate	$1\frac{1}{4}$ gr.
Water	$\frac{1}{2}$ fluid ounce

34. What amount of carbolic acid crystals is used to make 4 oz. of 3 % carbolized petrolatum?

35. What per cent of the following solution is boric acid?

Boric acid	18 gr.
Water	1 oz.

36. How much bichloride of mercury is required to make 1 qt. of a 1 : 25,000 solution?

37. How much potassium permanganate will be necessary to make a pint of a 1 : 1000 solution?

PART VI — PROBLEMS ON THE FARM

CHAPTER XV

EVERY young person who lives on the farm has more or less to do with the bookkeeping and the arithmetic connected with the selling of the eggs, milk, and other products. Very few of the men on the farm have the time or the inclination to do this work, and it is usually performed by the wife or daughter.

EXAMPLES

1. I sold 16 dozen eggs at 30 cents a dozen and took my pay in butter at 40 cents a pound. How many pounds did I receive?

2. A dealer bought 16 cords of wood at $ 4 a cord and sold it for $ 96. Find the gain.

3. Three men bought a farm. Henry paid $ 1135.75, Philip $ 2400.25, and Carl as much as Henry and Philip. Find the value of the farm.

4. A farmer divided his farm as follows: to his elder son he gave $257\frac{3}{9}$ acres, to his younger son $200\frac{5}{12}$ acres, and to his wife as many acres as to his two sons. How many acres in the farm?

5. One farm contains $287\frac{3}{5}$ acres and another $244\frac{1}{4}$ acres. Find the difference between them.

6. One bin contains $165\frac{1}{3}$ bushels of grain and the other bin $184\frac{5}{12}$ bushels. How many bushels more does the larger bin contain than the smaller?

7. From a farm of $375\frac{1}{4}$ acres, $84\frac{3}{10}$ acres were sold. How many acres remained?

8. A farmer owning $57\frac{3}{8}$ acres of land sold $28\frac{1}{2}$ acres and afterwards bought $14\frac{1}{4}$ acres. How many acres did he then own?

9. A farm contained 132 acres, one-eighth of which is woodland, one-sixth is pasture, and the remainder is cultivated. What part of the farm is cultivated? How many acres are cultivated?

10. From four trees, $14\frac{2}{3}$ barrels of apples were gathered. One man bought $5\frac{1}{8}$ bbl., another $3\frac{1}{8}$ bbl. How many barrels remained?

11. I owned two-fifths of a farm and sold three-fourths of my share for $ 1350. Find value of the whole farm.

12. I bought 5 loads of potatoes containing $33\frac{1}{2}$ bushels, $27\frac{3}{4}$ bushels, $40\frac{1}{2}$ bushels, $35\frac{1}{2}$ bushels, and $29\frac{1}{4}$ bushels. I sold $12\frac{3}{4}$ bushels to each of three men, and $25\frac{1}{2}$ bushels to each of four men. How many bushels were left?

13. If two-thirds of a farm costs $ 2480, what is the cost of the farm?

14. Mr. Thomas bought 168 sheep at $ 5.50 a head. He sold three-sevenths of them at $ 6 a head, and the remainder at $ 7 a head. Find the gain.

15. A farm is divided into four lots. The first contains $30\frac{7}{10}$ acres, the second $42\frac{11}{16}$ acres, the third $35\frac{3}{20}$ acres, the fourth $28\frac{4}{5}$ acres. How many acres in the farm?

16. A farmer sold sheep for $ 62.50, cattle for $ 102.60, a horse for $ 125.75, and a plow for $ 18.25. How much did he receive?

17. Farmer Blake raised 114 bushels of apples and $73\frac{3}{4}$ bushels of pears. How many more bushels of apples than pears did he raise?

18. A farmer paid $ 78 for a cow, $ 165 for a horse. How much more did the horse cost than the cow?

19. Mr. Borden has $450\frac{7}{10}$ acres of woodland and sells $304\frac{3}{4}$ acres. How much has he left?

20. Mr. Sherman bought ten acres of land at $ 65 an acre and sold it for $ 24.60 an acre. How much did he lose?

21. A's farm contains $265\frac{5}{8}$ acres, B's $43\frac{3}{10}$ acres. What is the difference in the size of their farms?

22. Mr. Grover had 110 acres of land, and sold $7\frac{9}{16}$ acres. How many acres had he left?

23. Mr. Dean sold one-third of his farm to one man, one-fourth to another, and one-eighth to another. What part had he left?

24. I paid $ 365.75 for a horse, and sold him for four-fifths of what he cost. What was the loss?

25. How many bushels of grain can be put into 16 bags, if they hold $2\frac{3}{4}$ bushels each?

26. A farmer carries 35 bushels of apples to market. What is half this load worth at 75 cents a bushel?

27. I paid $76.50 for 18 sheep. What was the average price?

28. Mr. Platt gave 435 acres of land to his sons, giving each $72\frac{1}{2}$ acres. How many sons had he?

29. If $4\frac{1}{2}$ bushels of potatoes were bought for $ 3.60, how many bushels can be bought for $ 10.80 at the same price per bushel?

30. Mr. White paid $ 16.25 for $2\frac{1}{2}$ cords of wood. How many cords could he buy for $ 74.75 at the same price per cord?

31. A father divided 183 acres of land equally among his sons, giving to each $45\frac{3}{4}$ acres. How many sons had he?

FARM MEASURES

(Review Mensuration and Table of Measures.)

1. If a bushel of shelled corn contains $1\frac{1}{4}$ cubic feet, how many bushels in a bin $8' \times 4' \times 2'\ 6''$?

2. A bushel of ear corn contains $2\frac{1}{2}$ cubic feet. How many bushels in a crib $10' \times 4'\ 3'' \times 2'\ 4''$?

3. A ton of tame hay contains 512 cubic feet. How many tons in a space $14' \times 12' \times 13'$?

4. A ton of wild hay contains 343 cubic feet. How many tons in a space $28'\ 6'' \times 18'\ 9'' \times 13'\ 5''$?

5. A bushel of potatoes contains $1\frac{1}{3}$ cubic feet. How many bushels in a bin $8'\ 6'' \times 7'\ 5'' \times 9'\ 3''$ filled with potatoes?

6. How many bushels of corn on the ear in a pointed heap $12' \times 8'$ and $6'$ high?

7. How many bushels of corn in a circular crib with a diameter $12'\ 6''$ and a height $8'$?

8. How many gallons of water in a rectangular trough $6'\ 3'' \times 2'\ 6'' \times 3'\ 4''$? (Consider a gallon $\frac{1}{8}$ cubic foot.)

9. How many acres in 694 sq. rods?

10. A 60-acre piece of land, half a mile across, is $6'\ 8''$ higher on one side than the other. How much of a fall (grade) to the rod?

11. How many bushels of corn in a rectangular crib with sloping sides $16'$ long, $7'$ high and $4'\ 6''$ wide at the bottom and $6'\ 8''$ wide at the top?

ENSILAGE PROBLEMS

1. A farmer with the purpose of filling his silo with corn began the preparation of one acre of land for planting: 8 loads of stable fertilizer were used in dressing the land. What is the average number of square rods a load will fertilize?

2. The field was plowed in a day. Mr. A receives, when working for others, 20 cents per hour for his horses and 15 cents per hour for his own work. How much is his time worth for the day of 10 hours?

3. Mr. A paid $ 12 for his plow and two extra points. The regular price without extras was $ 10.50. Mr. A broke a plow point on a rock. How much was the loss?

4. It took three-fifths as long to harrow the field (see example 2) as to plow it. If the work was begun at 7 o'clock in the morning, at what time would the corn piece be harrowed? (Noon hour from 12 M. to 1 P.M.)

5. Mr. A bought seed corn at $ 1.25 per bushel. What did the seed cost, 12 quarts being the amount used?

6. He bought 4 one-hundred-pound bags of fertilizer at $ 1.40 per hundred. How much did the fertilizer cost?

7. Mr. A is agent for Bradley fertilizers and receives a commission of 10 % on what he sells for the company. How much must he sell to receive a commission equal to the cost of fertilizer used on his own corn piece, and also the expense of hauling from the railroad station, which amounted to $ 2.50?

8. Mr. A hires a man to plant his corn with a horse planter. He pays $ 2 for the planting, which is at the rate of 30 ¢ per hour. How long did it take?

9. Mr. A cultivated his corn three times, each time requiring about 8 hours. Besides this he and his hired man spent 3 days hoeing the corn once. Which was more expensive, the hoeing or the cultivating? How much?

10. The corn was planted June 1st. It was ready for cutting September 1st. Some of the stalks had grown to a height of 6 ft. What was the average weekly growth?

11. Mr. A's silo is rectangular, 10 ft. long, 10 ft. wide, and 20 ft. deep. The floor is cemented. How many sq. yd. of cement in the floor?

12. If the lumber is 1 inch thick, how many board feet in one thickness of the walls?

13. How many cubic feet of ensilage will the silo hold? How many cubic feet below the level of the barn floor, which is 5 ft. higher than the cemented floor of the silo?

14. How many bushels of the cut and compressed corn stalks must have been produced on the acre of land to fill the space?

15. On September 1st a gang of men helped Mr. A fill the silo. Two men worked in the field cutting down the stalks at \$ 1.50 per day each. Two men hauled to the barn with teams at \$ 3 per day each. Two men, a cutting machine, and horses for power cost \$ 7. One man leveled corn in the silo at \$ 1.50 per day. What did Mr. A pay these men for the work of the day? The next day the men with the cutting machine, one man with a team, and the man for the silo worked two hours to finish the work. Add this expense to that of the previous day.

16. A week later the ensilage had settled 8 feet and Mr. A filled the space with surplus corn. He and a helper hoisted it with a pulley in a two-bushel basket. How many times must he fill the basket?

17. The mass was left to the fermenting process for two months. When Mr. A opens the silo, he begins feeding regularly to his 10 cows, giving each one-half bushel twice a day. At this rate when will the silo be emptied? When should the ensilage be even with the barn floor?

18. It is estimated that 1 ton of ensilage is equal in value to one-third of a ton of hay. If ensilage weighs 50 pounds per bushel, how many pounds of hay equal a feed of ensilage?

19. How many tons of hay is the ensilage worth? What is the value at \$ 15 per ton?

20. Does it pay the farmer to raise ensilage?

NOTE. — Ensilage could not be used as a substitute for hay, but is excellent as a milk producer when fed in moderate quantities. Cows like it better than hay.

DAIRY PRODUCE

Milk is graded according to the amount of cream (fat) in it. In addition to cream, it contains casein (cheese), milk sugar, and about 84 % water. Milk is usually sold by the farmer by weight and the per cent cream.

To illustrate: A sample of milk from a large can weighing 50 lb. contains 4 % cream. The large can contains 2 lb. of butter fat.

EXAMPLES

1. A sample of milk from a cooler containing $48\frac{1}{2}$ lb. tested $3\frac{3}{4}$ % butter fat. How much butter fat in the cooler?

2. A cow gives $3\frac{1}{4}$ gallons of milk per day. If a gallon weighs $8\frac{5}{8}$ lb., what is the weight of milk per day? per week? per month?

3. If the milk in example 2 contains 4.7 per cent of cream, how much butter fat does it yield per week? per month?

4. If butter fat is worth 26 cents a pound, how much is obtained per week from the butter fat in example 3? How much per month?

5. Another cow gives $3\frac{1}{8}$ gallons of milk a day that tests 4.6 % butter fat. Is it more profitable to keep this cow or the one in examples 2 and 3, and by how much?

6. Skim milk from the butter fat is usually sold to feed the pigs at $5\frac{1}{4}$ cents a gallon. Is it cheaper to sell milk at $5\frac{1}{2}$ cents a quart or to make butter and sell it at 26 cents a pound and give the skim milk to the pigs?

PROBLEMS ON EQUIPPING A COÖPERATIVE CHEESE FACTORY

Seventy-three farmers came together, and after the election of officers it was decided that a stock company of seventy-three shares should be formed, and each member bought a share at the rate of $75. Part of the money was used to erect a cheese factory, and the rest was deposited in a bank and drawn out as it was needed to run the business until the sale of the products should be sufficient to supply money for carrying on the business and paying a small per cent on the money invested by each man. The following are the items of expense:

Half acre of land at $0.03 a square foot.
The building cost $2000 for material and work.
Three large vats, $50 each; 4% discount.
A Babcock tester $30; $2\frac{1}{2}$% discount.
A small engine, belts, etc., $53.85.
Whey trough and leads, $54; 4% discount.
Cheese press, $28; 3% discount.
Rennet, salt, coloring, wood, cheesecloth, boiler, and piping, $15.
Boxes, acid for test, etc., $57; 3% commission.
Scales, weights, and weighing can, $27.85.
A year's salary to the cheese maker, $520.
The money left after these expenses was put at 3% interest.

PROBLEMS

1. How much money was put into the business?

2. How much did the cheese maker average a week?

3. What was the cost of the land?

4. The man who sold the boiler and piping and also the engine and belt to the company received 6% commission. What did he receive for his sales?

5. The man who bought the whey trough, the leads, and the large vats received the discount as his commission. How much did he receive?

6. How much did the company that sold the whey trough, leads, and vats receive?

7. How much did the buying company pay out for the whey trough, leads, and vats?

8. An agent sold the tester; his commission was 5 %. How much did he receive?

9. How much did the tester cost the company?

10. The man who bought the press and material received 3 % commission. How much did the press and materials cost the company?

11. How much did it cost to buy the land, build the factory, and equip the plant?

12. How much was left at interest?

13. How much would the interest be for 3 years 6 months and 16 days?

14. What is the interest for one year?

15. What per cent of the whole investment is this interest?

16. What per cent of the whole was left at interest?

PROBLEMS ON POULTRY

One hen has to have five square feet of room in the house.
It costs about ten cents a month to feed one hen.
One dozen eggs sell on the average for 30 cents.
One hen lays about 100 eggs per year.
Broilers are sold at 25 cents a pound.
Hens are sold for 15 cents a pound.
An incubator costing $20 holds 150 eggs.
Setting eggs cost $1.00 a dozen.
Brooders cost $7.50.
A small chicken coop costs $8.00.
One hen costs 60 cents.
Little chickens 1 week old cost 10 cents.
Chicken wire, 6 ft. wide, costs $4\frac{1}{2}$ cents per foot.

PROBLEMS

1. How large would the floor of my poultry house have to be for 30 chickens? for 50? 80? 200?

2. If I have a poultry house the floor of which is 30 ft. by 50 ft., how many chickens can I put in it?

3. How much will it cost to keep the chickens one month? one year?

4. If I have one hen, how much does it cost me to feed her one year? Suppose she lays 90 eggs, how much will I receive for them? Does it pay me to keep the hen?

5. Suppose I sold 25 broilers, 12 weighing 3 lb., 5 weighing 5 lb., and the rest an average of 4 lb. How much would I receive for them? If I had kept them 14 weeks, how much would they have cost me? Would I gain or lose in keeping them? How much?

6. If I bought an incubator for $20, a brooder for $7.50, a chicken coop for $8, and 150 eggs to put into the incubator, how much did I pay in all?

7. If from the 150 eggs only 139 were hatched and lived, how much would I receive for the little chickens when I sold them?

8. Suppose I had a chicken yard 100 by 250 ft. How many feet of wire would I need to fence it in? How much would it cost me to put wire around it?

9. How many eggs would I receive from 60 hens in one year? If I sold all from 40 hens, how much would I receive for them?

10. If I bought 50 little chickens, kept them 16 weeks, and then sold them, each weighing on the average 3 lb., how much profit did I make on them?

POULTRY RAISING

1. A man wishes to build and stock a henhouse for \$ 125. If he has \$ 75, how much will he have to borrow? How much interest will he have to pay for 1 year at 5 %?

2. If he pays \$ 20 for labor, three times as much for material, one-fourth as much for apparatus as for material, how much will he have left? How many hens could he buy with the remainder if each hen cost 50 cents?

3. If it cost \$ 1 per year to keep one hen, how much would it cost to keep all of his hens for 1 year? for 5 years?

4. If each hen lays 100 eggs a year, how many eggs would they yield in one year? how many dozen?

5. If he sold 400 dozen at 25 cents per dozen, how much would he receive for them?

6. If he sold the remaining dozen "for setting" at 50 cents a dozen, how much would he receive for these? How much did he receive for all his eggs?

7. If it cost him the above amount to keep the hens for a year, how much did he gain from selling his eggs?

8. If, from 100 dozen eggs sold for "setting," 9 chickens were hatched from each dozen, how many chickens were hatched in all?

9. If it cost him 27 cents to raise one broiler, how much would it cost to raise all the chickens for broilers?

10. If for each pair of broilers he received \$ 1.50, how much would his entire stock net him?

11. After considering the cost of raising the broilers and the price received for them, what was his profit?

12. After he had paid his interest, what was his net profit?

REVIEW EXAMPLES

1. A crib of corn is 12′ wide, 34′ long, and has an average depth of 11′ of corn in it. How many bushels?

2. How many bushels of oats in a bin 12′ wide, 12′ long, 18′ deep?

3. A freight car is $8' \times 32' \times 11'$. If it is filled $3\frac{3}{4}'$ deep with apples for the cider mill, how many bushels in the car?

4. At 26 cents a barrel, what is the car of apples worth? ($2\frac{1}{2}$ bu. = 1 bbl.)

5. A field of hay is 88 rods long and 64 rods wide. How much is it worth at $ 98 an acre?

6. A cow gives $3\frac{3}{4}$ gallons of milk a day. The milk tests 4.2 % butter fat. At 27 cents a pound for butter, and 5 cents a quart for skim milk, how much is obtained a week from this cow?

7. A flock of 200 hens averaged 135 eggs a year, and at the end of four years were sold for $10\frac{1}{2}$ cents a pound, the average weight being $6\frac{1}{4}$ lb. If the cost of feed for a year is $ 27.05 for the whole flock, what is the average gain per hen?

8. A man receives $ 35 a month. How much per hour, if the month contains 26 working days of 10 hours a day?

9. What is the cost of $963\frac{1}{4}$ bushels of oats at 47 cents per bushel?

10. If I buy 125 bushels of corn at $41\frac{2}{3}$ cents per bushel and sell it at $52\frac{1}{2}$ cents a bushel, how much do I gain?

APPENDIX

METRIC SYSTEM

The metric system is used in nearly all the countries of Continental Europe and among scientific men as the standard system of weights and measures. It is based on the **meter** as the unit of length. The meter is supposed to be one ten-millionth part of the length of the meridian passing from the equator to the poles. It is equal to about 39.37 inches. The unit of weight is the **gram**[1] which is equal to about one thirtieth of an ounce. The unit of volume is the **liter**, which is a little larger than a quart.

Measures of Length

10 millimeters (mm.)	= 1 centimeter	cm.
10 centimeters	= 1 decimeter	dm.
10 decimeters	= 1 meter	m.
10 meters	= 1 dekameter	Dm.
10 dekameters	= 1 hektometer	Hm.
10 hektometers	= 1 kilometer	Km.

Measures of Surface (not Land)

100 square millimeters (mm.)	= 1 square centimeter	sq. cm.
100 square centimeters	= 1 square decimeter	sq. dm.
100 square decimeters	= 1 square meter	sq. m.

Measures of Volume

1000 cubic millimeters (mm.)	= 1 cu. centimeter	cu. cm.
1000 cubic centimeters	= 1 cubic decimeter	cu. dm.
1000 cubic decimeters	= 1 cubic meter	cu. m.

[1] The gram is the weight of one cubic centimeter of pure distilled water at a temperature of 39.2° F.; the kilogram is the weight of 1 liter of water; the metric ton is the weight of 1 cubic meter of water.

Measures of Capacity

10 milliliters (ml.)	= 1 centiliter	cl.
10 centiliters	= 1 deciliter	dl.
10 deciliters	= 1 liter [1]	l.
10 liters	= 1 dekaliter	Dl.
10 dekaliters	= 1 hektoliter	Hl.
10 hektoliters	= 1 kiloliter	Kl.

Measures of Weight

10 milligrams (mg.)	= 1 centigram	cg.
10 centigrams	= 1 decigram	dg.
10 decigrams	= 1 gram	g.
10 grams	= 1 dekagram	Dg.
10 dekagrams	= 1 hektogram	Hg.
10 hektograms	= 1 kilogram	Kg.
1000 kilograms	= 1 ton	T.

Metric Equivalent Measures

Measures of Length

1 meter	= 39.37 in. = 3.28083 ft. = 1.0936 yd.
1 centimeter	= .3937 inch
1 millimeter	= .03937 inch, or $\frac{1}{25}$ inch nearly
1 kilometer	= .62137 mile
1 foot	= .3048 meter
1 inch	= 2.54 centimeters = 25.4 millimeters

Measures of Surface

1 square meter	= 10.764 sq. ft. = 1.196 sq. yd.
1 square centimeter	= .155 sq. in.
1 square millimeter	= .00155 sq. in.
1 square yard	= .836 square meter
1 square foot	= .0929 square meter
1 square inch	= 6.452 square centimeters = 645.2 square millimeters

Measures of Volume and Capacity

1 cubic meter	= 35.314 cu. ft. = 1.308 cu. yd. = 264.2 gal.
1 cubic decimeter	= 61.023 cu. in. = .0353 cu. ft.
1 cubic centimeter	= .061 cu. in.

[1] The liter is equal to the volume occupied by 1 cubic decimeter.

1 liter	= 1 cubic decimeter = 61.023 cu. in. = .0353 cu. ft. = 1.0567 quarts (U. S.) = .2642 gallon (U. S.) = 2.202 lb. of water at 62° F.
1 cubic yard	= .7645 cubic meter
1 cubic foot	= .02832 cubic meter = 28.317 cubic decimeters = 28.317 liters
1 cubic inch	= 16.387 cubic centimeters
1 gallon (British)	= 4.543 liters
1 gallon (U. S.)	= 3.785 liters

Measures of Weight

1 gram	= 15.432 grains
1 kilogram	= 2.2045 pounds
1 metric ton	= .9842 ton of 2240 lb. = 19.68 cwt. = 2204.6 lb.
1 grain	= .0648 gram
1 ounce avoirdupois	= 28.35 grams
1 pound	= .4536 kilogram
1 ton of 2240 lb.	= 1.016 metric tons = 1016 kilograms

Miscellaneous

1 kilogram per meter = .6720 pound per foot
1 gram per square millimeter = 1.422 pounds per square inch
1 kilogram per square meter = .2084 pound per square foot
1 kilogram per cubic meter = .0624 pound per cubic foot
1 degree centigrade = 1.8 degrees Fahrenheit
1 pound per foot = 1.488 kilograms per meter
1 pound per square foot = 4.882 kilograms per square meter
1 pound per cubic foot = 16.02 kilograms per cubic meter
1 degree Fahrenheit = .5556 degree centigrade
1 Calorie (French Thermal Unit) = 3.968 B. T. U. (British Thermal Unit)
1 horse power = 33,000 foot pounds per minute = 746 watts
1 watt (Unit of Electrical Power) = .00134 horse power = 44.24 foot pounds per minute
1 kilowatt = 1000 watts = 1.34 horse power = 44,240 foot pounds per minute

Table of Metric Conversion

To change meters to feet	multiply by	3.28083
feet to meters	multiply by	.3048
square feet to square meters . . .	multiply by	.0929
square meters to square feet . . .	multiply by	10.764

To change square centimeters to square inches	multiply by	.155
square inches to square centimeters	multiply by	6.452
inches to centimeters	multiply by	2.54
centimeters to inches	multiply by	.3937
grams to grains	multiply by	15.43
grains to grams	multiply by	.0648
grams to ounces	multiply by	.0353
ounces to grams	multiply by	28.35
pounds to kilograms	multiply by	.4536
kilograms to pounds	multiply by	2.2045
liters to quarts	multiply by	1.0567
liters to gallons	multiply by	.2642
gallons to liters	multiply by	3.78543
liters to cubic inches	multiply by	61.023
cubic inches to cubic centimeters	multiply by	16.387
cubic centimeters to cubic inches	multiply by	.061
cubic feet to cubic decimeters or liters	multiply by	28.317
kilowatts to horse power	multiply by	1.34
calories to British Thermal Units	multiply by	3.968

EXAMPLES

1. Change 8 m. to centimeters; to kilometers.

2. Reduce 4 Km., 6 m., and 2 m. to centimeters.

3. How many square meters of carpet will cover a floor which is 25.5 feet long and 24 feet wide?

4. (*a*) Change 6.5 centimeters into inches.
   (*b*) Change 48.3 square centimeters into square inches.

5. A cellar 18 m. × 37 m. × 2 m. is to be excavated; what will it cost at 13 cents per cubic meter to do the work?

6. How many liters of capacity has a tank containing 5.2 cu. m.?

7. What is the weight in grams of 31 cc. of water?

8. Give the approximate value of 36 millimeters in inches.

9. Change 84.9 square meters into square feet.

10. Change 23.6 liters to cubic inches.

11. Change 7.3 m. to millimeters; to centimeters; to kilometers.

12. Reduce 9.8 m. to kilometers; to centimeters; to millimeters.

13. What is the difference in millimeters between 2.7 m. and 48.1 mm.?

14. What part of a kilometer is 1.8 mm.?

15. What part of a meter is 1.3 cm.?

16. How many square centimeters are there in 26 square kilometers?

17. How many square meters in 4 rectangular gardens, 3.4 Dm. long and 85.7 dm. wide?

18. How many cubic meters in a wall 43 m. long, 8.4 dm. high, and 69 cm. wide?

19. Reduce 869.7 cg. to milligrams; to kilograms; to grams.

20. What is the weight in grams of 48.7 cc. of water? What is the weight in kilograms of 43.9 l. of water?

21. Mercury weighs 13.6 times as much as water; what is the weight of 87.5 cc. of mercury? Of 5 l. of mercury?

22. A tank is 7.9 m. by 4.3 m. by 3.1 m. How many grams of water will it hold?

23. What is the weight of 874 cc. of copper, the density of which is 89 g. per cubic centimeter?

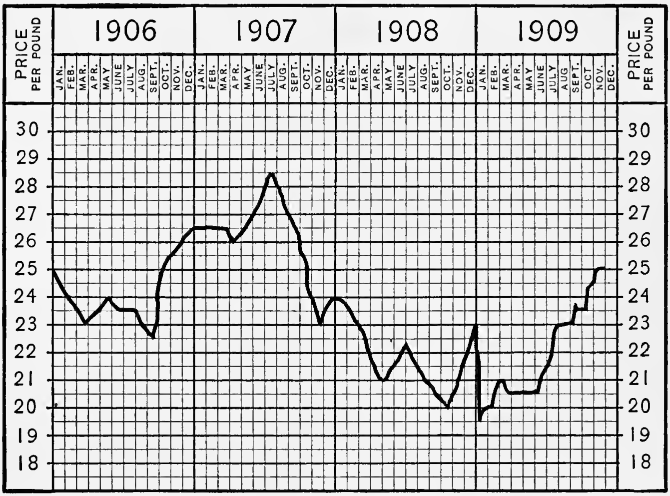
24. What is the capacity of a bottle that holds 5 kg. of alcohol, the density of which is 0.8 g. per cubic centimeter?

25. What is the weight in grams of 56.8 cc. of alcohol? What is the weight in kilograms of 7 l. of alcohol?

26. What part of a liter is 1.7 cc.?

GRAPHS

A SHEET of paper, ruled with horizontal and vertical lines that are equally distant from each other, is called a sheet of cross-section, or coördinate, paper. Every tenth line is very distinct so that it is easy for one to measure off the horizontal and vertical distances without the aid of a ruler. Ruled or



GRAPH SHOWING THE VARIATION IN PRICE OF COTTON YARN FOR A SERIES OF YEARS

coördinate paper is used to record the rise and fall of the price of any commodity, or the rise and fall of the barometer or thermometer.

Trade papers and reports frequently make use of coördinate paper to show the results of the changes in the price of commodities. In this way one can see at a glance the changes and condition of a certain commodity, and can compare these with the results of years or months ago. He also can see from the slope of the curve the rate of rise or fall in price.

If similar commodities are plotted on the same sheet, the effect of one on the other can be noted. Often experts are able to prophesy with some certainty the price of a commodity for a month in advance. The two quantities which must be employed in this comparison are time and value, or terms corresponding to them.

The lower left-hand corner of the squared paper is generally used as an initial point, or origin, and is marked O, although any other corner may be used. The horizontal line from this corner, taken as a line of reference or axis, is called the *abscissa.* The vertical line from this corner is the other axis, and is called the *ordinate.*

Equal distances on the *abscissa* (horizontal line) represent definite units of time (hours, days, months, years, etc.), while equal distances along the *ordinate* (vertical line) represent certain units of value (cost, degrees of heat, etc.).

By plotting, or placing points which correspond to a certain value on each axis and connecting these points, a line is obtained that shows at every point the relationship of the line to the axis.

EXAMPLES

1. Show the rise and fall of temperature in a day from 8 A.M. to 8 P.M., taking readings every hour.

2. Show the rise and fall of temperature at noon every day for a week.

3. Obtain stock quotation sheets and plot the rise and fall of cotton for a week.

4. Show the rise and fall of the price of potatoes for two months.

5. Show a curve giving the amount of coal used each day for a week.

FORMULAS

Most technical books and magazines contain many formulas. The reason for this is evident when we remember that rules are often long and their true meaning not comprehended until they have been reread several times. The attempt to abbreviate the length and emphasize the meaning results in the formula, in which whole clauses of the written rule are expressed by one letter, that letter being understood to have throughout the discussion the same meaning with which it started.

To illustrate: One of the fundamental laws of electricity is that the quantity of electricity flowing through a circuit (flow of electricity) is equal to the quotient (expressed in amperes) obtained by dividing the electric motive force (pressure, or expressed in volts, voltage) of the current by the resistance (expressed in ohms).

One unfamiliar with electricity is obliged to read this rule over several times before the relations between the different parts are clear. To show how the rule may be abbreviated,

Let $I =$ quantity of electricity through a wire (amperes)

$E =$ pressure of the current (volts)

$R =$ resistance of the current (ohms)

Then $I = E \div R = \frac{E}{R}$

It is customary to allow the first letter of the quantity to represent it in the formula, but in this case I is used because the letter C is used in another formula with which this might be confused.

Translating Rules into Formulas

The area of a trapezoid is equal to the sum of the two parallel sides multiplied by one half the perpendicular distance between them.

We may abbreviate this rule by letting

$A =$ area of trapezoid
$L =$ length of longest parallel side
$M =$ length of shortest parallel side
$N =$ length of perpendicular distance between them

Then $A = (L + M) \times \frac{N}{2}$, or

$$A = (L + M)\frac{N}{2}*$$

The area of a circle is equal to the square of the radius multiplied by 3.1416. When a number is used in the formula it is called a constant, and is sometimes represented by a letter. In this case 3.1416 is represented by the Greek letter π (pi).

Let $A =$ area of circle
$R =$ radius of circle

Then $A = \pi \times R^2$, or (the multiplication sign is usually left out between letters)

$$A = \pi R^2$$

Thus we see that a formula is a short and simple way of stating a rule. Any formula may be written or expressed in words and is then called a rule. The knowledge of formulas and of their use is necessary for nearly every one engaged in the higher forms of mechanical or technical work.

* When two or more quantities are to be multiplied or divided or otherwise operated upon by the same quantity, they are often grouped together by means of parentheses ( ) or braces { }, or brackets [ ]. Any number or letter placed before or after one of these parentheses, with no other sign between, is to multiply all that is grouped within the parentheses. In the trapezoid case above, $\frac{N}{2}$ is to multiply the sum of L and M, hence the parentheses. To prevent confusion, different signs of aggregation may be used for different combinations in the same problem.
For instance,

$$V = \frac{1}{3}\pi H\left[\frac{3}{2}(r^2 + r'^2) + \frac{H^2}{2}\right] \text{ which equals}$$

$$V = \tfrac{1}{2}\pi H(r^2 + r'^2) + \tfrac{1}{6}\pi H^3$$

EXAMPLES

Abbreviate the following rules into formulas:

1. One electrical horse power is equal to 746 watts.

2. One kilowatt is equal to 1000 watts.

3. The number of watts consumed in a given electrical circuit, such as a lamp, is obtained by multiplying the volts by the amperes.

4. The number of volts equals the watts divided by the amperes.

5. Number of amperes equals the watts divided by the volts.

6. The horse power of an electric machine is found by multiplying the number of volts by the number of amperes and dividing the product by 746.

7. The speed at which a body travels is equal to the ratio between the distance traveled and the time which is required.

8. To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by 0.434.

9. The amount of gain in a business transaction is equal to the cost multiplied by the rate of gain.

10. The selling price of a commodity is equal to the cost multiplied by the quantity 100 % plus the rate of gain.

11. The selling price of a commodity is equal to the cost multiplied by the quantity 100 % minus the rate of loss.

12. The interest on a sum of money is equal to the product of the principal, time (expressed as years), and the rate (expressed as hundredths).

13. The amount of a sum of money may be obtained by adding the principal to the quantity obtained by multiplying the principal, the time (as years), and the rate (as hundredths).

14. To find the length of an arc of a circle: Multiply the diameter of the circle by the number of degrees in the arc and this product by .0087266.

15. To find the area of a sector of a circle: Multiply the number of degrees in the arc of the sector by the square of the radius and by .008727; or, multiply the arc of the sector by half its radius.

Translating Formulas into Rules

In order to understand a formula, it is necessary to be able to express it in simple language.

1. One of the simplest formulas is that for finding the area of a circle, $A = \pi R^2$

Here A stands for the area of a circle,
R for the radius of the circle.
π is a constant quantity and is the ratio of the circumference of a circle to its diameter. The exact value cannot be expressed in figures, but for ordinary purposes is called 3.1416 or $3\frac{1}{7}$.

Therefore, the formula reads, the area of a circle is equal to the square of the radius multiplied by 3.1416.

2. The formula for finding the area of a rectangle is

$$A = L \times W$$

Here A = area of a rectangle
L = length of rectangle
W = width of rectangle

The area of a rectangle, therefore, is found by multiplying the length by the width.

EXAMPLES

Express the facts of the following formulas as rules:

1. Electromotive force or voltage of electricity delivered by a current, when current and resistance are given:

$$E = RI$$

2. For the circumference of a circle, when the length of the radius is given:

$$C = 2\pi R \text{ or } \pi D$$

3. For the area of an equilateral triangle, when the length of one side is given:

$$A = \frac{a^2\sqrt{3}}{4}$$

4. For the volume of a circular pillar, when the radius and height are given:

$$V = \pi R^2 h$$

5. For the volume of a square pyramid, when the height and one side of the base are given:

$$V = \frac{a^2 h}{3}$$

6. For the volume of a sphere, when the diameter is given:

$$V = \frac{\pi D^3}{6}$$

7. For the diagonal of a rectangle, when the length and breadth are given:

$$D = \sqrt{L^2 + b^2}$$

8. For the average diameter of a tree, when the average girth is known:

$$D = \frac{G}{\pi}$$

9. For the diameter of a ball, when the volume of it is known.

$$D = \sqrt[3]{\frac{6v}{\pi}}$$

10. The diameter of a circle may be obtained from the area by the following formula:

$$D = 1.1283 \times \sqrt{A}$$

11. The number of miles in a given length, expressed in feet, may be obtained from the formula

$$M = .00019 \times F$$

12. The number of cubic feet in a given volume expressed in gallons may be obtained from the formula

$$C = .13367 \times G$$

13. Contractors express excavations in cubic yards; the number of bushels in a given excavation expressed in yards may be obtained from the formula

$$C = .0495 \times Y$$

14. The circumference of a circle may be obtained from the area by the formula

$$C = 3.5446 \times \sqrt{A}$$

15. The area of the surface of a cylinder may be expressed by the formula $A = (C \times L) + 2\,a$

When $C =$ circumference
$L =$ length
$a =$ area of one end

16. The surface of a sphere may be expressed by the formula

$$S = D^2 \times 3.1416$$

17. The solidity of a sphere may be obtained from the formula

$$S = D^3 \times .5236$$

18. The side of an inscribed cube of a sphere may be obtained from the formula

$S = R \times 1.1547,$ where $S =$ length of side,
$R =$ radius of sphere.

19. The solidity or contents of a pyramid may be expressed by the formula

$$S = A \times \frac{F}{3}, \qquad \text{where } A = \text{area of base,}$$
$$F = \text{height of pyramid.}$$

20. The length of an arc of a circle may be obtained from the formula

$$L = N \times .017453\, R, \qquad \text{where } L = \text{length of arc,}$$
$$N = \text{number of degrees,}$$
$$R = \text{radius of circle.}$$

21. The loss in a transaction may be expressed by the formula

$$L = c \times r, \qquad \text{where } L = \text{loss,}$$
$$c = \text{cost,}$$
$$r = \text{rate of loss.}$$

22. The rate of loss in a transaction may be expressed by the formula

$$\frac{L}{c} = r.$$

23. The cost of a commodity may be expressed by the formula

$$c = \frac{S}{100 + r}, \qquad \text{where } S = \text{selling price,}$$
$$c = \text{cost,}$$
$$r = \text{rate.}$$

24. The volume of a sphere when the circumference of a great circle is known may be determined by the formula

$$V = \frac{C^3}{6\pi^2}.$$

25. The diameter of a circle the circumference of which is known may be found by the formula

$$D = \frac{C}{\pi}.$$

26. The area of a circle the circumference of which is known may be found by the formula

$$A = \frac{C^2}{4\,\pi}$$

Coefficients and Similar Terms

When a quantity may be separated into two factors, one of these is called the *coefficient* of the other; but by the coefficient of a term is generally meant its numerical factor.

Thus, $4\,b$ is a quantity composed of two factors 4 and b; 4 is a coefficient of b.

Similar terms are those that have as factors the same letters with the same exponents.

Thus, in the expression, $6\,a$, $4\,b$, $2\,a$, $5\,ab$, $5\,a$, $2\,b$. $6\,a$, $2\,a$, $5\,a$ are similar terms; $4\,b$, $2\,b$ are similar terms; $5\,ab$ and $6\,a$ are not similar terms because they do not have the same letters as factors. $3\,ab$, $5\,ab$, $1\,ab$, $8\,ab$ are similar terms. They may be united or added by simply adding the letters to the numerical sum, $17\,ab$.

In the following, $8\,b$, $5\,b$, $3\,ab$, $4\,a$, ab, and $2\,a$, $8\,b$ and $5\,b$ are similar terms; $3\,ab$ and ab are similar terms; $4\,a$ and $2\,a$ are similar terms; $8\,b$, $3\,ab$, and $4\,a$ are dissimilar terms.

In addition the numerical coefficients are algebraically added; in subtraction the numerical coefficients are algebraically subtracted; in multiplication the numerical coefficients are algebraically multiplied; in division the numerial coefficients are algebraically divided.

EXAMPLES

State the similar terms in the following expressions:

1. $5\,x$, $8\,ax$, $3\,x$, $2\,ax$.

2. $8\,abc$, $7\,c$, $2\,ab$, $3\,c$, $8\,ab$, $9\,abc$.

3. $2\,pq$, $5\,p$, $8\,q$, $2\,p$, $3\,q$, $5\,pq$.

4. $4\,y$, $5\,yz$, $2\,y$, $15\,z$, $5\,z$, $2\,yz$.

5. $18\,mn$, $6\,m$, $5\,n$, $4\,mn$, $2\,m$.

6. $15\,abc$, $2\,abc$, $4\,abc$, $2\,ab$, $3\,ab$.

7. $8\,x$, $6\,x$, $13\,xy$, $5\,x$, $7\,y$.

8. $7\,y$, $2\,y$, $2\,xy$, $3\,y$, $2\,xy$.

9. $2\,\pi$, $5\,\pi r^2$, $\frac{\pi}{2}$, πr^2, $2\,\pi r$.

Equations

A statement that two quantities are equal may be expressed mathematically by placing one quantity on the left and the other on the right of the equality sign (=). The statement in this form is called an equation.

The quantity on the left hand of the equation is called the left-hand member and the quantity on the right hand of the equation is called the right-hand member.

An equation may be considered as a balance. If a balance is in equilibrium, we may add or subtract or multiply or divide the weight on each side of the balance by the same weight and the equilibrium will still exist. So in an equation we may perform the following operations on each member without changing the value of the equation:

We may add an equal quantity or equal quantities to each member of the equation.

We may subtract an equal quantity or equal quantities from each member of the equation.

We may multiply each member of the equation by the same or equal quantities.

We may divide each member of the equation by the same or equal quantities.

We may extract the square root of each member of the equation.

We may raise each member of the equation to the same power.

The expression, $A = \pi R^2$ is an equation. Why?

If we desire to obtain the value of R instead of A we may do so by the process of transformation according to the above rules. To obtain the value of R means that a series of operations must be performed on the equation so that R will be left on one side of the equation.

(1) $A = \pi R^2$

(2) $\frac{A}{\pi} = R^2$ (Dividing equation (1) by the coefficient of R^2.)

(3) $\sqrt{\frac{A}{\pi}} = R$ (Extracting the square root of each side of the equation.)

Methods of Representing Operations

Multiplication

The multiplication sign ($\times$) is used in most cases. It should not be used in operations where the letter (x) is also to be employed.

Another method is as follows:

$$2 \cdot 3 \quad a \cdot 6 \quad 2a \cdot 3b \quad 4x \cdot 5a$$

This method is very convenient, especially where a number of small terms are employed. Keep the dot above the line, otherwise it is a decimal point.

Where parentheses, etc., are used, multiplication signs may be omitted. For instance, $(a + b) \times (a - b)$ and $(a + b)(a - b)$ are identical; also, $2 \cdot (x - y)$ and $2(x - y)$.

The multiplication sign is very often omitted in order to simplify work. To illustrate, $2a$ means 2 times a; $5xyz$ means $5 \cdot x \cdot y \cdot z$; $x(a - b)$ means x times $(a - b)$, etc.

A number written to the right of, and above, another (x^4) is a sign indicating the special kind of multiplication known as involution.

In multiplication we add exponents of similar terms.

Thus,
$$x^2 \cdot x^3 = x^{2+3} = x^5$$
$$abc \cdot ab \cdot a^2b = a^4b^3c$$

The multiplication of dissimilar terms may be indicated.

Thus,
$$a \cdot b \cdot c \cdot x \cdot y \cdot z = abcxyz.$$

Division

The division sign ($\div$) is used in most cases. In many cases, however, it is best to employ a horizontal line to indicate division. To illustrate, $\frac{a + b}{x - y}$ means the same as $(a + b) \div (x - y)$ in simpler form. The division sign is *never* omitted.

A root or radical sign ($\sqrt{3}$, $\sqrt[4]{x^2}$) is a sign indicating the special form of division known as evolution.

In division, we subtract exponents of similar terms.

Thus,
$$x^3 \div x^2 = \frac{x^3}{x^2} = x^{3-2} = x$$
$$a^4b^2c^3 \div a^2bc^2 = \frac{a^4b^2c^3}{a^2bc^2} = a^2bc.$$

The division of dissimilar terms may be indicated.

Thus,
$$(abc) \div xyz = \frac{abc}{xyz}.$$

Substituting and Transposing

A formula is usually written in the form of an equation. The left-hand member contains only one quantity, which is the quantity that we desire to find. The right-hand member contains the letters representing the quantity and numbers whose values we are given either directly or indirectly.

To find the value of the formula we must (1) substitute for every letter in the right-hand member its exact numerical value, (2) carry out the various operations indicated, remembering to perform all the operations of multiplication and division before those of addition and subtraction, (3) if there are any parentheses, these should be removed, one pair at a time, inner parentheses first. A minus sign before a parenthesis means that when the parenthesis is removed, all the signs of the terms included in the parenthesis must be changed.

Find the value of the expression

$$3\,a + b\,(2\,a - b + 18), \text{ where } a = 5,\ b = 3.$$

Substitute the value of each letter. Then perform all addition or subtraction in the parentheses.

$$3 \times 5 + 3(10 - 3 + 18)$$
$$15 + 3(28 - 3)$$
$$15 + 3(25)$$
$$15 + 75 = 90$$

EXAMPLES

Find the value of the following expressions:

1. $2A \times (2 + 3A) \times 8$, when $A = 10$.

2. $8a \times (6 - 2a) \times 7$, when $a = 7$.

3. $8b + 3c + 2a(a + b + c) - 8$, when $a = 9$; $b = 11$; $c = 13$.

4. $8(x + y)$, when $x = 9$; $y = 11$.

5. $13(x - y)$, when $x = 27$; $y = 9$.

6. $24y + 8z(2 + y) - 3y$, when $y = 8$; $z = 11$.

7. $Q(6M + 3N) + 2O$, when $M = 4$, $N = 5$, $Q = 6$, $O = 8$.

8. Find the value of X in the formula $X = \dfrac{3(MN + P)}{P - M}$, when $M = 11$, $N = 9$, $P = 28$.

9. $x = \dfrac{8(n + m)}{P - Q}$, when $n = 5$, $m = 6$, $P = 8$, $Q = 7$.

10. Find the value of T in the equation

$$T = \frac{8(x + y) + 7(x + y)}{(x + y)(x - y)}, \text{ when } x = 7,\ y = 6.$$

11. $3a + 4(b - 2a + 3c) - c$, when $a = 4$, $b = 6$, $c = 2$.

12. $5p - 8q(p + r - S) - q$, when $p = 5$, $q = 7$, $r = 9$, $S = 11$.

13. $S^2 + t^2 - p^2 - 3(S + t + p)$, when $p = 5$, $S = 8$, $t = 9$.

14. $a^2 - b^3 + c^2$, when $a = 9$, $b = 6$, $c = 4$.

15. $(a + b)(a + b - c)$, when $a = 2$, $b = 3$, $c = 4$.

16. $(a^2 - b^2)(a^2 + b^2)$, when $a = 8$, $b = 4$.

17. $(c^3 + d^3)(c^3 - d^3)$, $c = 9$, $d = 5$.

18. $\sqrt{a^2 + 2ab + b^2}$, when $a = 7$, $b = 8$.

19. $\sqrt[3]{c^3 - 61}$, when $c = 5$.

PROBLEMS

Solve the following problems by first writing the formula from the rule on page 326, and then substituting for the answer.

1. How many electrical horse power in 4389 watts?

2. How many kilowatts in 2389 watts?

3. (*a*) Give the number of watts in a circuit of 110 volts and 25 amperes.

(*b*) How many electrical horse power?

4. What is the voltage of a circuit if the horse power is 2740 watts and the quantity of electricity delivered is 25 amperes?

5. What is the resistance of a circuit if the voltage is 110 and the quantity of electricity is 25 amperes?

6. What is the pressure per square inch of water 87 feet high?

7. What is the capacity of a cylinder with a base of 16 square inches and 6 inches high? (Capacity in gallons is equal to cubical contents obtained by multiplying base by the height and dividing by 231 cubic inches.)

8. What is the length of a 30° arc of a circle with 16″ diameter?

9. What is the area of a sector which contains an arc of 40° in a circle of diameter 18″?

10. What is the amount of $ 800 at the end of 5 years at 5 %?

11. What is the amount of gain in a transaction, when a man buys a house for $ 5000 and gains 10 %?

12. What is the selling price of an automobile that cost $ 895, if the salesman gained 33 %?

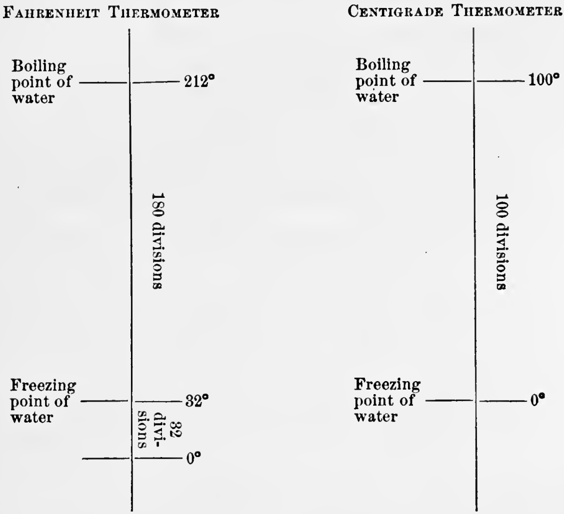
13. What is the capacity of a pail 14″ (diameter of top), 11″ (diameter of bottom), and 16″ in height?

14. What is the area of an ellipse with the greatest length 16″ and the greatest breadth 10″?

Interpretation of Negative Quantities

The quantity or number -12 has no meaning to us according to our knowledge of simple arithmetic, but in a great many problems in practical work the minus sign before a number assists us in understanding the different solutions.

To illustrate:



On the Centigrade scale the freezing point of water is marked 0°. Below the freezing point of water on the Centigrade scale all readings are expressed as minus readings.

$-30°$ C means thirty degrees below the freezing point. In other words, all readings, in the direction below zero are expressed as $-$, and all readings above zero are called $+$. Terms are quantities connected by a plus or minus sign. Those preceded by a plus sign (when no sign precedes a quantity plus is understood) are called positive quantities, while those connected by a minus sign are called negative quantities.

Let us try some problems involving negative quantities. Find the corresponding reading on the Fahrenheit scale corresponding to $-18°$ C.

$$F = \tfrac{9}{5}\,C + 32°$$
$$F = \tfrac{9}{5}(-18°) + 32°$$

Notice that a minus quantity is placed in parenthesis when it is to be multiplied by another quantity.

$$F = -\tfrac{162}{5}° + 32° = -32\tfrac{2}{5}° + 32°\,;\ F = -\tfrac{2}{5}°.$$

The value $-\frac{2}{5}°$ is explained by saying it is $\frac{2}{5}$ of a degree below zero point on Fahrenheit scale.

Let us consider another problem. Find the reading on the Centigrade scale corresponding to $-40°$ F.

Substituting in the formula, we have

$$C = \tfrac{5}{9}(-40° - 32°) = \tfrac{5}{9}(-72°) = -40°.$$

Since subtracting a negative number is equivalent to adding a positive number of the same value, and subtracting a positive number is equivalent to adding a negative number of the same value, the rule for subtracting may be expressed as follows: Change the sign of the subtrahend and proceed as in addition.

For example, 40 minus -28 equals 40 plus 28, or 68.
40 minus $+28$ equals 40 plus -28, or 12.
-40 minus $+32$ equals -40 plus $-32 = -72$.

(Notice that a positive quantity multiplied by a negative quantity or a negative quantity multiplied by a positive quantity always gives a negative product. Two positive quantities multiplied together will give a positive product, and two negative quantities multiplied together will give a positive product.) To illustrate:

$$5 \text{ times } 5 = 5 \times 5 = 25$$
$$5 \text{ times } -5 = 5 \times (-5) = -25$$
$$(-5) \text{ times } (-5) = +25$$

In adding positive and negative quantities, first add all the positive quantities and then add all the negative quantities together. Subtract the smaller from the larger and prefix the same sign before the remainder as is before the larger number.

For example, add:

$$2a,\ 5a,\ -6a,\ 8a,\ -2a$$
$$2a + 5a + 8a = 15a;\ -6a - 2a = -8a$$
$$15a - 8a = 7a$$

EXAMPLES

Add the following terms:

1. $3x,\ -x,\ 7x,\ 4x,\ -2x$.
2. $6y,\ 2y,\ 9y,\ -7y$.
3. $9ab,\ 2ab,\ 6ab,\ -4ab,\ 7ab,\ -5ab$.

Multiplication of Algebraic Expressions

Each term of an algebraic expression is composed of one or more factors, as, for example, $2ab$ contains the factors 2, a, and b. The factors of a term have, either expressed or understood, a small letter or number in the upper right-hand corner, which states how many times the quantity is to be used as a factor. For instance, ab^2. The factor a has the exponent 1 understood and the factor b has the exponent 2 expressed, meaning that a is to be used once and b twice as a factor. ab^2 means, then, $a \times b \times b$. The rule of algebraic multiplication by terms is as follows: Add the exponents of all like letters in the terms multiplied and use the result as exponent of that letter in the product. Multiplication of unlike letters may be expressed by placing the letters side by side in the product.

For example:

$$2ab \times 3b^2 = 6ab^3$$
$$4a \times 3b = 12ab$$

Algebraic or literal expressions of more than one term are multiplied in the following way: begin with the first term to the left in the multiplier and multiply every term in the multiplicand, placing the partial products underneath the line. Then repeat the same operation, using the second term in the multiplier. Place similar products of the same factors and degree (same exponents) in same column. Add the partial products.

Thus, $a + b$ multiplied by $a - b$.

$$\begin{array}{l} a + b \\ \underline{a - b} \\ a^2 + ab - b^2 \\ \underline{\quad\ - ab \qquad} \\ a^2 \qquad\quad - b^2 \end{array}$$

Notice the product of the sum and difference of the quantities is equal to the difference of their squares.

EXAMPLES

1. Multiply $a + b$ by $a + b$.

State what the square of the sum of the quantities equals.

2. Multiply $x - y$ by $x - y$.

State what the square of the difference of the quantities equals.

3. Multiply $(p + q)(p - q)$.
4. Multiply $(p + q)(p + q)$.
5. Multiply $(r + s)(r - s)$.
6. Multiply $(a \pm b)(a \pm b)$.
7. Multiply $(x - y)(x - y)$.
8. $(x + y)^2 = ?$
9. $(x - y)^2 = ?$
10. $(x + y)(x - y) = ?$

USEFUL MECHANICAL INFORMATION

There are certain mechanical terms and laws that every girl should know and be able to apply to the labor-saving devices and machines that are used in the home to-day.

Time and Speed

Two important terms are *time* and *speed.* Speed is the name given to the time-rate of change of position. That is,

$$\text{Speed} = \frac{\text{Change of position or distance}}{\text{Time taken}}.$$

EXAMPLES

1. A train takes 120 seconds to go one mile; what is its speed in miles per hour?

One hour contains 60 minutes, 1 minute contains 60 seconds, then 1 hour contains

$$60 \times 60 = 3600 \text{ seconds.}$$

If the train goes one mile in 120 seconds, in one second it will go $\frac{1}{120}$ of a mile and in 3600 seconds it will go

$$3600 \times \tfrac{1}{120} = 30 \text{ miles per hour. } \textit{Ans.}$$

2. At the rate of 80 seconds per mile, how fast is a train moving in miles per hour?

In a second it will move $\frac{1}{80}$ of a mile; in 3600 seconds it will move 3600 times as much.

3. At the rate of 55 miles an hour, how many seconds will it require to travel between mile-posts?

4. A watch shows 55 seconds between mile-posts; what is the speed in miles per hour?

5. What number of seconds between mile-posts will correspond to a speed of 40 miles an hour?

6. The rim of a fly-wheel is moving at the rate of one mile a minute. How many feet does it move in a second?

7. If a train continues to travel at the rate of 44 feet a second, how many miles will it travel in an hour?

8. If a train travels at the rate of 3.87 miles in 6 minutes, how many miles an hour is it traveling?

Motion and Momentum

Many interesting facts about the motion of bodies can be understood by the aid of a knowledge of the laws of motion and momentum.

A body acted upon by some force,[1] such as steam or electricity, starts slowly, increasing its speed under the action of the force. To illustrate: — when an electric car starts, we often experience a heavy jarring; this is due to the fact that the seat starts before our body, and the seat pushes us along. There is a tendency of bodies to remain in a state of rest or motion, which is called **inertia**, that is, the inability of a body itself to change its position, to stop itself if moving, or to start if at rest.

The **momentum** of a body is defined as the quantity of motion in a body, and is the product of the mass[2] and the velocity in feet per second (speed).

Example. To find the momentum of a body 9 pounds in weight, when moving with the velocity of 75 feet per second.

If the mass of the body upon which the force acts is given in pounds, and the velocity in seconds, the force will be given in foot-pounds.

Mass		Velocity		Momentum
9	×	75	=	675 foot-pounds.

[1] Force is that which tends to produce motion.

[2] Mass is the quantity of matter in a body.

We may abbreviate this rule by allowing letters to stand for quantities. Let the mass be represented by M and the velocity by V.

EXAMPLES

1. What is the momentum of a car weighing 15 tons, moving 12 miles per hour?

2. What is the momentum of a motor-car weighing 3 tons, moving 26 miles per hour?

3. What is the momentum of a person weighing 135 pounds, moving 5 miles per hour?

4. A truck weighing 4 tons has a momentum of 520,000 foot-pounds. At what speed is it moving?

Work and Energy

Work is the overcoming of resistance of any kind. *Energy* is the ability to do work. Work is measured in a unit called a *foot-pound.* It is the work done in raising one pound one foot in one second. One *horse power* is 33,000 foot-pounds in one minute.

EXAMPLES

1. A woman lifts a package weighing 15 lb. from the floor to a shelf 5 ft. above the floor in two seconds. How many foot-pounds of force does she use?

2. How much work does a woman weighing 130 pounds do in climbing a 13-story building in 20 minutes? Each story is 16′ high.

3. If an engine is rated at 5 H. P.,[1] how much work will it do in 8 seconds? in 3 minutes?

[1] Remember that 1 H. P. means 33,000 ft.-lb. in one minute.

4. Find the horse power developed by a locomotive when it draws at the rate of 31 miles per hour a train offering a resistance of 130,000 lb.

Machines

Experience shows that it is often possible to use our strength to better advantage by means of a contrivance called a *machine.* Every home-maker is interested in labor-saving devices.

The mechanical principles of all simple machines may be resolved into those of the *lever*, including the *wheel* and *axle* and *pulley*, and the *inclined plane*, to which belong the *wedge* and *screw.*

In all machines there is more or less *friction.*[1] The work done by the acting force always exceeds the actual work accomplished by the amount that is transformed into heat. The ratio of the useful work to the total work done by the acting force is called the efficiency of the machine.

$$\text{Efficiency} = \frac{\text{Useful work accomplished}}{\text{Total work expended}}.$$

Levers. — The efficiency of simple levers is very nearly 100 % because the friction is so small as to be disregarded.

Inclined Planes. — In the inclined plane the friction is greater than in the lever, because there is more surface with which the two bodies come in contact; the efficiency is somewhere between 90 % and 100 %.

Pulleys. — The efficiency of the commercial block and tackle with several movable pulleys varies from 40 % to 60 %.

Jack Screw. — In the use of the jack screw there is necessarily a very large amount of friction so that the efficiency is often as low as 25 %.

[1] Friction is the resistance which every material surface offers to the sliding or moving of any other surface upon it.

EXAMPLES

1. Mention some instances in which friction is of advantage.

2. If 472 foot-pounds of work are expended by a dredge in raising a load, and only 398 pounds of useful work are accomplished, what is the efficiency of the dredge?

3. If 250 foot-pounds of work are expended at one end of a lever, and 249 pounds of useful work are accomplished, what is the efficiency of the lever?

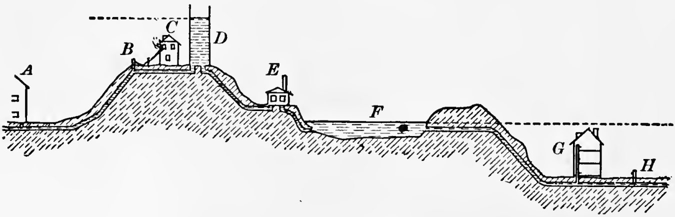
4. If 589 foot-pounds of work are expended in raising a body on an inclined plane, and only 584 pounds of useful work are accomplished, what is the efficiency of the inclined plane?

5. If 844 foot-pounds of work are expended in raising a body by means of pulleys and only 512 pounds of useful work are accomplished, what is the efficiency of the pulley?

Water Supply

The question of the water supply of a city or a town is very important. Water is usually obtained from lakes and rivers which drain the surrounding country. If a lake is located in a section of the surrounding country higher than the city (which is often located in a valley), the water may be obtained from the lake, and the pressure of the water in the lake may be sufficient to force it through the pipes into the houses. But in most cases a reservoir is built at an elevation as high as the highest portion of the town or city, and the water is pumped into it. Since the reservoir is as high as the highest point of the town, the water will flow from it to any part of the town. If houses are built on the same hill with the reservoir, a standpipe, which is a steel tank, is erected on this hill and the water is pumped into it.

Water is conveyed from the reservoir to the house by means of iron pipes of various sizes. It is distributed to the different parts of the house by small lead, iron, or brass pipes. Since water exerts considerable pressure, it is necessary to know how to calculate the exact pressure in order to have pipes of proper size and strength.



WATER SUPPLY

The distribution of water in a city during 1912 is as follows:

MONTHS	GALLONS PER MONTH	GALLONS PER DAY	ESTIMATED NO. OF CONSUMERS	POPULATION	GALLONS PER DAY FOR EACH CONSUMER	GALLONS PER DAY FOR EACH INHABITANT
January	157,866,290	5,092,461	114,651	115,401		
February	147,692,464	5,092,844				
March	146,933,054	4,739,776				
April	143,066,067	4,768,869				
May	161,177,486	5,199,274				
June	176,479,354	5,882,645				
July	189,063,250	6,098,815				
August	179,379,566	5,786,438				
September	169,394,758	5,646,492				
October	176,067,571	5,679,599				
November	153,484,712	5,116,157				
December	151,976,208	4,902,458				

What is the number of gallons per day for each consumer? What is the number of gallons per day for each inhabitant?

EXAMPLES

1. Water is measured by means of a meter. If a water meter measures for five hours 760 cubic feet, how many gallons does it indicate?

NOTE. — 231 cubic inches = 1 gallon.

2. If a water meter registered 1845 cubic feet for 3 days, how many gallons were used?

3. A tank holds exactly 12,852 gallons; what is the capacity of the tank in cubic feet?

4. A tank holds 3841 gallons and measures 4 feet square on the bottom; how high is the tank?

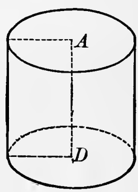
Rectangular Tanks. — To find the contents in gallons of a square or rectangular tank, multiply together the length, breadth, and height in feet; multiply the result by 7.48.

l = length of tank in feet
b = breadth of tank in feet
h = height of tank in feet
Contents = lbh cubic feet $\times$ 7.48 = 7.48 lbh gallons

(NOTE. — 1 cu. ft. = 7.48 gallons.)
If the dimensions of the tank are in inches, multiply the length, breadth, and height together, and the result by .004329.

5. Find the contents in gallons of a rectangular tank having inside dimensions (*a*) $12' \times 8' \times 8'$; (*b*) $15'' \times 11'' \times 6''$; (*c*) $3'\,4'' \times 2'\,8'' \times 8''$; (*d*) $5'\,8'' \times 4'\,3'' \times 3'\,5''$; (*e*) $3'\,8'' \times 3'\,9'' \times 2'\,5''$.

Cylindrical Tank. — To find the contents of a cylindrical tank, square the diameter in inches, multiply this by the height in inches, and the result by .0034.



d = diameter of cylinder
h = height of cylinder
Contents = d^2h cubic inches $\times$ .0034 = d^2h .0034 gallons

6. Find the capacity in gallons of a cylindrical tank (*a*) 14″ in diameter and 8′ high; (*b*) 6″ in diameter and 5′ high;

(*c*) 15″ in diameter and 4′ high; (*d*) 1′ 8″ in diameter and 5′ 4″ high; (*e*) 2′ 2″ in diameter and 6′ 7″ high.

Inside Area of Tanks. — To find the area, for lining purposes, of a square or rectangular tank, add together the widths of the four sides of the tank, and multiply the result by the height. Then add to the above the area of the bottom. Since the top is usually open, we do not line it. In the following problems find the area of the sides and bottom.

7. Find the amount of zinc necessary to line a tank whose inside dimensions are 2′ 4″ × 10″ × 10″.

8. Find the amount of copper necessary to line a tank whose inside dimensions are 1′ 9″ × 11″ × 10″, no allowance made for overlapping.

9. Find the amount of copper necessary to line a tank whose inside dimensions are 3′ 4″ × 1′ 2″ × 11″, no allowance for overlapping.

10. Find the amount of zinc necessary to line a tank 2′ 11″ × 1′ 4″ × 10″.

Capacity of Pipes

Law of Squares. — The areas of similar figures vary as the squares of their corresponding dimensions.

Pipes are cylindrical in shape and are, therefore, similar figures. The areas of any two pipes are to each other as the squares of the diameters.

Example. — If one pipe is 4″ in diameter and another is 2″ in diameter, their ratio is $\frac{16}{4}$, and the area of the larger one is, therefore, 4 times the smaller one.

EXAMPLES

1. How much larger is a section of 5″ pipe than a section of 2″ pipe?

2. How much larger is a section of $2\frac{1}{2}$″ pipe than a section of 1″ pipe?

3. How much larger is a section of 5″ pipe than a section of 3″ pipe?

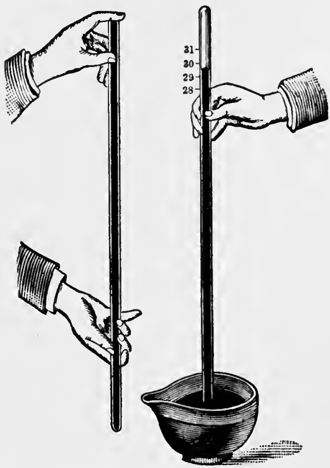
Atmospheric Pressure

The atmosphere has weight and exerts pressure. The pressure is greatest at sea level, because here the depth of the atmosphere is greatest. In mathematics the pressure at sea level is taken as the standard. Men have learned to make use of the principles of atmospheric pressure in such devices as the pump, the barometer, the vacuum, etc.

Atmospheric pressure is often expressed as a certain number of "atmospheres." The pressure of one "atmosphere" is the weight of a column of air, one square inch in area.

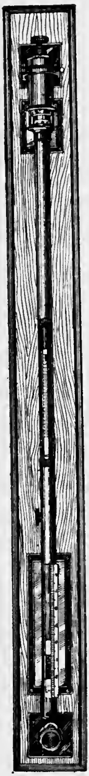
At sea level the average pressure of the atmosphere is approximately 15 pounds per square inch.

The pressure of the air is measured by an instrument called a barometer. The barometer consists of a glass tube, about 31½ inches long, which has been entirely filled with mercury (thus removing all air from the tube) and inverted in a vessel of mercury.



Barometer Tube

The space at the top of the column of mercury varies as the air pressure on the surface of the mercury in the vessel increases or decreases. The pressure is read from a graduated scale which indi-


Barometer

cates the distance from the surface of the mercury in the vessel to the top of the mercury column in the tube.

QUESTIONS

1. Four atmospheres would mean how many pounds?

2. Give in pounds the following pressures: 1 atmosphere; $\frac{1}{2}$ atmosphere; $\frac{3}{4}$ atmosphere.

3. If the air, on the average, will support a column of mercury 30 inches high with a base of 1 square inch, what is the pressure of the air? (One cubic foot of mercury weighs 849 pounds.)

Water Pressure

When water is stored in a tank, it exerts pressure against the sides, whether the sides are vertical, oblique, or horizontal. The force is exerted perpendicularly to the surface on which it acts. In other words, every pound of water in a tank, at a height above the point where the water is to be used, possesses a certain amount of energy due to its position.

It is often necessary to estimate the energy in the tank at the top of a house or in the reservoir of a town or city, so as to secure the needed water pressure for use in case of fire. In such problems one must know the perpendicular height from the water level in the reservoir to the point of discharge. This perpendicular height is called the *head*.

Pressure per Square Inch. — To find the pressure per square inch exerted by a column of water, multiply the head of water in feet by 0.434. The result will be the pressure in pounds.

The pressure per square inch is due to the weight of a column of water 1 square inch in area and the height of the column. Therefore, the pressure, or weight per square inch, is equal to the weight of a foot of water with a base of 1 square inch multiplied by the height in feet. Since the weight of a column of water 1 foot high and having a base of 1 square inch is 0.434 lb., we obtain the pressure per square inch by multiplying the height in feet by 0.434.

EXAMPLES

What is the pressure per square inch of a column of water (*a*) 8′ high? (*b*) 15′ 8″ high? (*c*) 30′ 4″ high? (*d*) 18′ 9″ high? (*e*) 41′ 3″ high?

Head. — To find the *head* of water in feet, if the pressure (weight) per square inch is known, multiply the pressure by 2.31.

Let p = pressure

h = height in feet

Then $p = h \times 0.434$ lb. per sq. in.

$$h = \frac{p}{0.434} = \frac{1}{0.434} \times p = 2.31\,p$$

EXAMPLES

Find the head of water, if the pressure is (*a*) 49 lb. per sq. in.; (*b*) 88 lb. per sq. in.; (*c*) 46 lb. per sq. in.; (*d*) 28 lb. per sq. in.; (*e*) 64 lb. per sq. in.

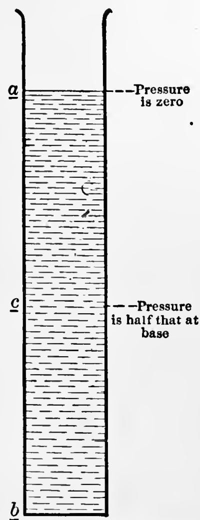
Lateral Pressure. — To find the lateral (sideways) pressure of water upon the sides of a tank, multiply the area of the submerged side, in inches, by the pressure due to one half the depth.

Example. — A tank 18″ long and 12″ deep is full of water. What is the lateral pressure on one side?

length × depth
18″ × 12″ = 216 square inches = area of side
depth
1′ × 0.434 = .434 lb. pressure at the bottom of the tank
0 = pressure at top

2).434 lb.
.217 lb. average pressure due to one half the depth of the tank

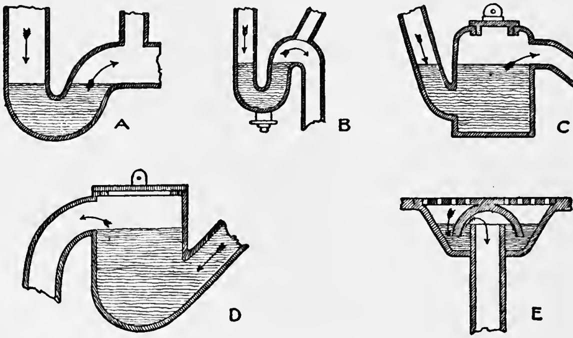
.217 × 216 = 46.872 pounds = pressure on one side of the tank



Lateral Pressure

Water Traps

The question of disposing of the waste water, called sewage, is of great importance. Various devices may be used to prevent odors from the sewage entering the house. In order to prevent the escape of gas



Water Traps

from the outlet of the sewer in the basement of a house or building, a device called a trap is used. This trap consists of a vessel of water placed in the waste pipe of the plumbing fixtures. It allows the free passage of waste material, but prevents sewer gases or foul odors from entering the living rooms. The vessels holding the water have different forms; (see illustration). These traps may be emptied by back pressure or by siphon. It is a good plan to have sufficient water in the trap so that it will never be empty. All these problems belong to the plumber and involve more or less arithmetic.

To determine the pressure which the seal of a trap will resist:

Example. — What pressure will a $1\frac{1}{2}$-inch trap resist?

If one arm of the trap has a seal of $1\frac{1}{2}$ inches, both arms will make a column twice as high, or 3 inches. Since a column of water 28 inches in height is equivalent to a pressure of 1 pound, or 16 ounces, a column of water 1 inch in height is equivalent to a pressure of $\frac{1}{28}$ of a pound, or $\frac{16}{28} = \frac{4}{7}$ ounces, and a column of water 3 inches in height is equivalent to $3 \times \frac{4}{7} = \frac{12}{7} = 1.7$ ounces.

Therefore, a $1\frac{1}{2}$-inch trap will resist 1.7 ounces of pressure.

EXAMPLES

1. What back pressure will a $\frac{3}{4}$-inch seal trap resist?
2. What back pressure will a 2-inch seal trap resist?
3. What back pressure will a $2\frac{1}{2}$-inch seal trap resist?
4. What back pressure will a $4\frac{1}{2}$-inch seal trap resist?
5. What back pressure will a 5-inch seal trap resist?

Water Power

When water flows from one level to another, it exerts a certain amount of energy, which is the capacity for doing work. Consequently, water may be utilized to create power by the use of such means as the water wheel, the turbine, and the hydraulic ram.

Friction, which must be considered when one speaks of water power, is the resistance which a substance encounters when moving through or over another substance. The amount of friction depends upon the pressure between the surfaces in contact.

When work is done a part of the energy which is put into it is naturally lost. In the case of water this is due to the friction. All the power which the water has cannot be used to advantage, and *efficiency* is the ratio of the useful work done by the water to the total work done by it.

Efficiency. — To find the work done upon the water when a pump lifts or forces it to a height, multiply the weight of the water by the height through which it is raised.

Since friction must be taken into consideration, the useful work done upon the water when the same power is exerted will equal the weight of the water multiplied by the height through which it is raised, multiplied by the efficiency of the pump.

Example. — Find the power required to raise half a ton (long ton, or 2240 lb.) of water to a height of 40 feet, when the efficiency of the pump is 75 %.

$$\text{Total work done} = \textit{weight} \times \textit{height} \times \textit{efficiency counter}$$
$$1120 \times 40 \times \tfrac{100}{75} = 59{,}733.3 \text{ ft. lb.}$$
$$\text{H. P. required} = \frac{59{,}733.3}{33000} = 1.8. \quad \textit{Ans.}$$

EXAMPLES

1. Find the power required to raise a cubic foot of water 28′, if the pump has 80 % efficiency.[1]

2. Find the power required to raise 80 gallons of water 15′, if the pump has 75 % efficiency.

3. Find the power required to raise 253 gallons of water 18′, if the pump has 70 % efficiency.

4. Find the power required to raise a gallon of water 16′, if the pump has 85 % efficiency.

5. Find the power required to raise a quart of water 25′, if the pump has 70 % efficiency.

Density of Water

The mass of a unit volume of a substance is called its *density*. One cubic foot of pure water at 39.1° F. has a mass of 62.425 pounds; therefore, its density at this temperature is 62.425, or approximately 62.5. At this temperature water has its greatest density. With a change of temperature, the density is also changed.

With a rise of temperature, the density decreases until at 212° F., the boiling point of water, the weight of a cubic foot of fresh water is only 59.64 pounds.

When the temperature falls below 39.1° F., the density of water decreases until we find the weight of a cubic foot of ice to be but 57.5 pounds.

[1] Consider the time 1 minute in all power examples where the time is not given.

EXAMPLES

1. One cubic foot of fresh water at 62.5° F. weighs 62.355 lb., or approximately 62.4 lb. What is the weight of 1 cubic inch? What is the weight of 1 gallon (231 cubic inches)?

2. What is the weight of a gallon of water at 39.1° F.?

3. What is the weight of a gallon of water at 212° F.?

4. What is the weight of a volume of ice represented by a gallon of water?

5. What is the volume of a pound of water at ordinary temperature, 62.5° F.?

Specific Gravity

Some forms of matter are heavier than others, *i.e.* lead is heavier than wood. It is often desirable to compare the weights of different forms of matter and, in order to do this, a common unit of comparison must be selected. Water is taken as the standard.

Specific Gravity is the ratio of the mass of any volume of a substance to the mass of the same volume of pure water at 4° C. or 39.1° F. It is found by dividing the weight of a known volume of a substance in liquid by the weight of an equal volume of water.

EXAMPLE. — A cubic foot of wrought iron weighs about 480 pounds. Find its specific gravity.

NOTE. — 1 cu. ft. of water weighs 62.425 lb.

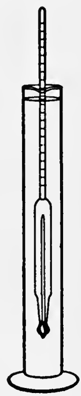
$$\frac{\text{Weight of 1 cu. ft. of iron}}{\text{Weight of 1 cu. ft. of water}} = \frac{480}{62.425} = 7.7. \quad \textit{Ans.}$$

To find Specific Gravity. — To find the specific gravity of a solid, weigh it in air and then in water. Find the difference between its weight in air and its weight in water, which will be the buoyant force on the body, or the weight of an equal volume of water. Divide the weight of the solid in air by its buoyant force, or the weight of an equal volume of water, and the quotient will be the specific gravity of the solid.

Tables have been compiled giving the specific gravity of different solids, so it is seldom necessary to compute it.

The specific gravity of liquids is very often used in the industrial world, as it means the "strength" of a liquid. In the carbonization of raw wool, the wool must be soaked in sulphuric acid of a certain strength. This acid cannot be bought except in its concentrated form (sp. gr. 1.84), and it must be diluted with water until it is of the required strength.

The simplest way to determine the specific gravity of a liquid is with a *hydrometer*. This instrument consists of a closed glass tube, with a bulb at the lower end filled with mercury. This bulb of mercury keeps the hydrometer upright when it is immersed in a liquid. The hydrometer has a scale on the tube which can be read when the instrument is placed in a graduate of the liquid whose specific gravity is to be determined.



But not all instruments have the specific gravity recorded on the stem. Those most commonly in use are graduated with an impartial scale.

In England, Twaddell's scale is commonly employed, and since most of the textile mill workers are English, we find the same scale in use in this country. The Twaddell scale bears a marked relation to specific gravity and can be easily converted into it.

Another scale of the hydrometer is the Beaume, but these readings cannot be converted into specific gravity without the use of a complicated formula or reference to a table.

Hydrometer Scale	Formula for Converting into S. G.
1. Specific gravity hydrometer	Gives direct reading
2. Twaddell	$\text{S. G.} = \frac{(.5 \times N) + 100}{100}$
3. Beaume	$\text{S. G.} = \frac{146.3}{146.3 - N}$

N = the particular degree which is to be converted.

Example. — Change 168 degrees (Tw.) into S. G.

$$\frac{(.5 \times 168) + 100}{100} = 1.84. \quad \textit{Ans.}$$

Another formula for changing degrees Twaddell scale into specific gravity is: $\frac{(5 \times N) + 1000}{1000}$ = specific gravity.

In Twaddell's scale, 1° specific gravity = 1.005
2° specific gravity = 1.010
3° specific gravity = 1.015

and so on by a regular increase of .005 for each degree.

To find the degrees Twaddell when the specific gravity is given, multiply the specific gravity by 1000, subtract 1000, and divide by 5. *Formula:*

$$\frac{(\text{S. G.} \times 1000) - 1000}{5} = \text{degrees Twaddell}$$

Example. — Change 1.84 specific gravity into degrees Twaddell,

$$\frac{(1.84 \times 1000) - 1000}{5} = 168 \text{ degrees Twaddell}$$

EXAMPLES

1. What is the specific gravity of sulphuric acid of 116° Tw.?
2. What is the specific gravity of acetic acid of 86° Tw.?
3. What is the specific gravity of a liquid of 164° Be.?
4. What is the specific gravity of a liquid of 108° Be.?
5. What is the specific gravity of a liquid of 142° Tw.?

Heat

Heat Units. — The unit of heat used in the industries and shops of America and England is the *British Thermal Unit* (*B. T. U.*) and is defined as the quantity of heat required to raise one pound of water through a temperature of one degree Fahrenheit. Thus the heat required to raise 5 lb. of water through 15 degrees F. equals

$5 \times 15 = 75$ British Thermal Units (B. T. U.)

Similarly, to raise 86 lb. of water through $\frac{1}{2}$° F. requires

$86 \times \frac{1}{2} = 43$ B. T. U.

The unit used on the Continent and by scientists in America is the metric system unit, a *calorie.* This is the amount of heat necessary to raise 1 gram of water 1 degree Centigrade.

EXAMPLES

1. How many units (B. T. U.) will be required to raise 4823 lb. of water 62 degrees?

2. How many B. T. U. of heat are required to change 365 cubic feet of water from 66° F. to 208° F.?

3. How many units (B. T. U.) will be required to raise 785 lb. of water from 74° F. to 208° F.?

(Consider one cubic foot of water equal to $62\frac{1}{2}$ lb.)

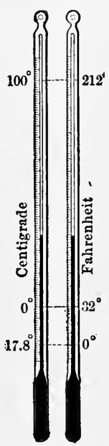
4. How many B. T. U. of heat are required to change 1825 cu. ft. of water from 118° to 211°?

5. How many heat units will it take to raise 484 gallons of water 12 degrees?

6. How many heat units will it take to raise 5116 gallons of water from 66° F. to 198° F.?

Temperature

The ordinary instruments used to measure temperature are called thermometers. There are two kinds — Fahrenheit and Centigrade. The Fahrenheit thermometer consists of a cylindrical tube filled with mercury with the position of the mercury at the boiling point of water marked 212, and the position of mercury at the freezing point of water 32. The intervening space is divided into 180 divisions. The Centigrade thermometer has the position of the boiling point of water 100 and the freezing point 0. The intervening space is divided into 100 spaces. It is often necessary to convert the Centigrade scale into the Fahrenheit scale, and Fahrenheit into Centigrade.



THERMOMETERS

To convert F. into C., subtract 32 from the F. degrees and multiply by $\frac{5}{9}$, or divide by 1.8, or C. = (F. − 32°) $\frac{5}{9}$, where C. = Centigrade reading and F. = Fahrenheit reading.

To convert C. to F., multiply C. degrees by $\frac{9}{5}$ or 1.8 and add 32°.

$$F = \frac{9\,C}{5} + 32^\circ$$

Example. — Convert 212 degrees F. to C. reading

$$\frac{5(212^\circ - 32^\circ)}{9} = \frac{5(180^\circ)}{9} = \frac{900^\circ}{9} = 100^\circ \text{ C.}$$

Example. — Convert 100 degrees C. to F. reading.

$$\frac{9 \times 100^\circ}{5} + 32^\circ = \frac{900^\circ}{5} + 32^\circ = 180^\circ + 32^\circ = 212^\circ \text{ F.}$$

If the temperature is below the freezing point, it is usually written with a minus sign before it: thus, 15 degrees below the freezing point is written -15°. In changing -15° C. into F. we must bear in mind the minus sign.

Thus, $F = \frac{9\,C}{5} + 32^\circ \qquad F = \frac{-15^\circ \times 9}{5} + 32^\circ = -27^\circ + 32^\circ = 5^\circ$

Example. — Change -22° F. to C.

$$\text{C.} = \tfrac{5}{9}\,(\text{F.} - 32)$$
$$\text{C.} = \tfrac{5}{9}\,(-22^\circ - 32^\circ) = \tfrac{5}{9}\,(-54^\circ) = -30^\circ$$

EXAMPLES

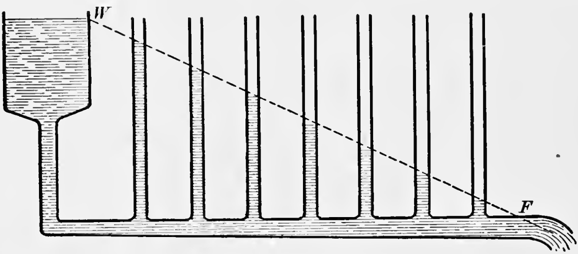
1. Change 36° F. to C.
2. Change 89° F. to C.
3. Change 289° F. to C.
4. Change 350° F. to C.
5. Change 119° C. to F.
6. Change 225° C. to F.
7. Change 380° C. to F.
8. Change 415° C. to F.
9. Change 580° C. to F.

Latent Heat

By latent heat of water is meant that heat which water absorbs in passing from the liquid to the gaseous state, or that heat which water discharges in passing from the liquid to the solid state, without affecting its own temperature. Thus, the temperature of boiling water at atmospheric pressure never rises above 212 degrees F., because the steam absorbs the excess of heat which is necessary for its gaseous state. Latent heat of steam is the quantity of heat necessary to convert a pound of water into steam of the same temperature as the steam in question.

COMMERCIAL ELECTRICITY

Amperes. — What electricity is no one knows. Its action, however, is so like that of flowing water that the comparison is helpful. A current of water in a pipe is measured by the amount which flows through the pipe in a second of time, as one gallon per second. So a current of electricity is measured



WATER ANALOGY OF FALL OF POTENTIAL

by the amount which flows along a wire in a second, as one *coulomb* per second, — a coulomb being a unit of measurement of electricity, just as a gallon is a unit of measurement of water. The rate of flow of one coulomb per second is called one *ampere.* The rate of flow of five coulombs per second is five amperes.

Volts. — The quantity of water which flows through a pipe depends to a large extent upon the pressure under which it flows. The number of amperes of electricity which flow along a wire depends in the same way upon the pressure behind it.

The electrical unit of pressure is the *volt.* In a stream of water there is a difference in pressure between a point on the surface of the stream and a point near the bottom. This is called the *difference* or *drop* in level between the two points. It is also spoken of as the pressure head, "head" meaning the difference in intensity of pressure between two points in a body of water, as well as the intensity of pressure at any point. Similarly the pressure (or voltage) between two points in an electric circuit is called the *difference* or *drop* in pressure or the *potential.* The *amperes* represent the amount of electricity flowing through a circuit, and the *volts* the pressure causing the flow.

Ohms. — Besides the pressure the resistance of the wire helps to determine the amount of the current: — the greater the resistance, the less the current flowing under the same pressure. The electrical unit of resistance is called an *ohm.* A wire has a resistance of one ohm when a pressure of one volt can force no more than a current of one ampere through it.

Ohm's Law. — The relation between current (amperes), pressure (volts), and resistance (ohms) is expressed by a law known as *Ohm's Law.* This is the fundamental law of the study of electricity and may be stated as follows:

An electric current flowing along a conductor is equal to the pressure divided by the resistance.

$$\textit{Current}\text{ (amperes)} = \frac{\textit{Pressure}\text{ (volts)}}{\textit{Resistance}\text{ (ohms)}}$$

Letting $I =$ amperes, $E =$ volts, $R =$ ohms,

$$I = E \div R \text{ or } I = \frac{E}{R}$$

$$E = IR$$

$$R = \frac{E}{I}$$

Example. — If a pressure of 110 volts is applied to a resistance of 220 ohms, what current will flow?

$$I = \frac{E}{R} = \frac{110}{220} = \frac{1}{2} = .5 \text{ ampere.} \quad \textit{Ans.}$$

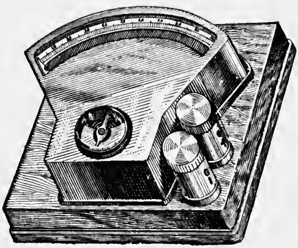
EXAMPLE.—A current of 2 amperes flows in a circuit the resistance of which is 300 ohms. What is the voltage of the circuit?

$$IR = E$$
$$2 \times 300 = 600 \text{ volts.} \quad \textit{Ans.}$$

EXAMPLE.—If a current of 12 amperes flows in a circuit and the voltage applied to the circuit is 240 volts, find the resistance of the circuit.

$$\frac{E}{I} = R \quad \frac{240}{12} = 20 \text{ ohms.} \quad \textit{Ans.}$$

Ammeter and Voltmeter.—Ohm's Law may be applied to a circuit as a whole or to any part of it. It is often desirable to know how much current is flowing in a circuit without calculating it by Ohm's Law. An instrument called an *ammeter* is used to measure the current. This instrument has a low resistance so that it will not cause a drop in pressure. A *voltmeter* is used to measure the voltage. This instrument has high resistance so that a very small current will flow through it, and is always placed *in shunt*, or parallel (see p. 235) with that part of the circuit the voltage of which is to be found.



AMMETER

EXAMPLE.—What is the resistance of wires that are carrying 100 amperes from a generator to a motor, if the drop or loss of potential equals 12 volts?

Drop in voltage $= IR$	$I = 100$ amperes
Drop in volts $= 12$	$R =$? ohms
$R = \frac{E}{I}$	$R = \frac{12}{100} = 0.12$ ohm. *Ans.*

EXAMPLE.—A circuit made up of incandescent lamps and conducting wires is supplied under a pressure of 115 volts.

The lamps require a pressure of 110 volts at their terminals and take a current of 10 amperes. What should be the resistance of the conducting wires in order that the necessary current may flow?

Drop in conducting wires $= 115 - 110 = 5$ volts
Current through wires $=$ 10 amperes

$$R = \frac{E}{I} = \frac{5}{10} = 0.5 \text{ ohm resistance.} \quad \textit{Ans.}$$

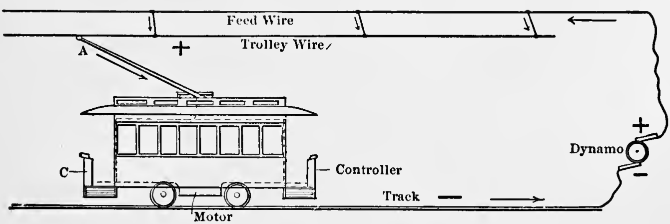
EXAMPLES

1. How much current will flow through an electromagnet of 140 ohms' resistance when placed across a 100-volt circuit?

2. How many amperes will flow through a 110-volt lamp which has a resistance of 120 ohms?

3. What will be the resistance of an arc lamp burning upon a 110-volt circuit, if the current is 5 amperes?

4. If the lamp in Example 3 were to be put upon a 150-volt circuit, how much additional resistance would have to be put into it in order that it might not take more than 5 amperes?



Electric Road System

5. In a series motor used to drive a street car the resistance of the field equals 1.06 ohms; the current going through equals 30 amperes. What would a voltmeter indicate if placed across the field terminals?

6. If the load upon the motor in Example 5 were increased so that 45 amperes were flowing through the field coils, what would the voltmeter then indicate?

INDEX