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THE PUBLIC SCHOOL
MENTAL ARITHMETIC

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UNIVERSITY OF TORONTO

THE PUBLIC SCHOOL

MENTAL ARITHMETIC

BASED ON

McLELLAN AND DEWEY'S "PSYCHOLOGY OF NUMBER"

BY

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PREFACE

IT has recently been stated by a well-known college professor that "boys enter college or training school at eighteen, after having spent from one sixth to one fourth of their entire school life in studying mathematics. Yet they know very little mathematics. In their examination the asking of even three questions shows that they haven't the dimmest idea of what it is all about." This statement, if true, does not prove—as the professor seems to think it does—the justice of the Hamiltonian onslaught on mathematical study. It simply proves that the prevailing methods of teaching arithmetic are radically wrong. The serious defects in existing methods are mainly due to the fact that they take no account of the real nature of number, and of how the child's mind works in grasping the concepts of number and numerical relations. In other words, arithmetic has never been "psychologized." If there is a science of education and rational methods founded upon it, there must be a psychology of arithmetic, a psychology of language, etc. The one-sided theory that education is concerned only with fitting the child for existing civilization has made

the so-called "practical" aims and methods dominant in school work. These methods are, and ever must be, essentially defective, inasmuch as they are founded on a half truth; they take no account of the powers and capacities of the individual who is to be made an effective instrument in maintaining and perfecting this civilization into which he is born. The individual, indeed, lives and moves and has his being in society, and therefore there is a social side to education. Sociology must have something to say on the problem of education. But, on the other hand, society lives and moves and has its being only through the development of the individual; that is to say, education has its psychological side. While the social side, the idea of fitting the individual to play his part in existing civilization, may give a standard for the development of the powers and capacities of the individual, and may point out the subject-matter to be used in this development, it does not show how this development of powers, this adaptation, is to be secured. In other words, sociology indicates *what* is to be done with the individual, but fails to show *how* it is to be done. This is a question of psychology. The meaning of this is that we must have both a psychology of the individual mind and a psychology of the subjects through which it is to be developed.

On this principle the "Public School Arithmetic," the "Primary Public School Arithmetic," and the

“Public School Mental Arithmetic” have been prepared. It is believed that, by direct teaching and helpful suggestion, these books will, in some degree, contribute to the growth of a rational, and therefore economical, method of teaching. At all events, the series differs from all other text-books in being based on the Psychology of Number.

This “Mental Arithmetic” completes the series and completes the *method*. In the methods of the schools—speaking generally—the ignoring of mental arithmetic or the teaching of it in a haphazard, and therefore ineffective, way contributes very largely to the present unsatisfactory results, viz. “little mathematics and less training of logical faculty.” Mental arithmetic, systematically taught from a rationally prepared text-book, is the life and soul of rational method. There is constant adaptation to the normal mental action of the child. During the lesson the teacher is in vital touch with the child’s mind; sees the child’s personal self-activity in the making of images and in controlling their movements. There is hence the least possible waste for both teacher and pupil. The teacher takes care of the image, and then the concept takes care of itself. From long and varied experience, both in teaching the subject and inspecting the teaching of others, it is firmly held that, compared with “written” arithmetic alone, mental arithmetic, if systematically taught, will produce at least twice the KNOWLEDGE

and twice the POWER in a given time. The distinguishing features of the book are:

1. It is not a book of puzzles for ingenious analysis or of "conundrums"—to use a favorite question-begging epithet—for the exercise of a nimble fancy, but a book of ideas and principles for easy mastery by rational method. The subject-matter and the method are one.

2. Like the two books for written arithmetic, the "Mental Arithmetic" is based on the idea that number is the tool of measurement, and that measurement takes its rise in human activity satisfying human needs. Therefore all the processes have meaning for the pupil. They are connected with his own experience. The child, in the first lesson and in all lessons, is always learning with what he has learned; a primary idea unifying all and throwing light on all. This means that there is continuity. The very first question looks towards the very last. Every "new rule" deepens interest; for it is but common-sense application of a certain numerical *habit* to slightly novel conditions—to the acquisition of a new, but related, habit.

3. It keeps constantly in view the value of the image—imaging quantity and quantity relations. There is constant appeal to the child's imagination, and not merely to abstract reasoning power.

4. The important idea of "balance or equation" is frequently stated—made familiar to the pupil—

for the insight which it gives into the problem and its solution. This idea of balance, which results from measurement, is present in every problem in arithmetic. Its recognition by the pupil is essential to the economical solution of the problem. See "Psychology of Number," p. 41.

5. There is constant insistence on the clear apprehension and statement of the elements of the question. This is fundamental in the intelligent handling of problems; and the teacher should frequently test the pupil to see if, after reading the problem, he knows what is in it, and to train him to pay careful attention to what he reads.

6. From the gradual psychological development of the subject the *method* is given in the *presentation of the matter*. Matter and method and process of education are correlated. The teacher has not to trouble himself with books and articles on methods and devices. Every principle and process is presented as the natural movement of the mind demands. The best methods are followed by the best results; for matter, method, and results are a unity.

7. Number concepts are of gradual growth. The book is constructed to promote in the best way this normal growth. To secure this with the greatest certainty and economy all the questions and problems in the book are original.

It is hoped that the teacher will find the language which Dr. Dewey has used in characterizing "The

Primary Public School Arithmetic" equally applicable to the Mental Arithmetic. He says, "It would be difficult, if not impossible, to make a book which would start more fully from what is within the natural range of children's experience and capacity. The book clearly represents in every lesson a careful study of children as well as of arithmetic. In addition to this the development of the subject-matter is so carefully thought out, the transition from one topic to another so thoroughly attended to, that I believe the book, in the hands of a reasonably good teacher, will not only give thorough knowledge of all the numerical combinations and principles employed in this period of school life, but, what is even more important, will develop a number sense, a capacity to understand and apply intelligently what is learned. I can easily believe that this book will make a delight to many children of what otherwise would be a bugbear."

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MENTAL ARITHMETIC



QUANTITY — UNIT — NUMBER

Lesson 1

1. Make a mental picture of a line 12 in. long and also of a *unit of measure* 3 in. long. How many times will the 3-in. unit measure the *quantity* 12 in.?

2. The *number* 4 obtained in example 1 is 4 what? 4 units of 3-in. in what?

3. This number 4 is often called the *ratio* of 12 in. to 3 in. What is the ratio of 12 in. to 4 in.?

4. What part of 12 in. is equal to 3 in.? $\frac{1}{4}$ is often called the *ratio* of 3 in. to 12 in. What is the ratio of 4 in. to 12 in.?

5. Find the number of 3-in. units of length in each of these quantities: 15 in.; 2 ft.; 30 in.; 1 yd.; 1 ft. 6 in.; 2 ft. 3 in. What is the ratio of each of these quantities to the unit? Of the unit to each quantity?

6. In question 5 how did you find the number of 3-in. units in each quantity?

7. How would you find the number of 2-in. units in a given quantity? Of 3-in. units? Of 4-in. units? Of units of any length?

8. Find the number of 2-in. units in each of these quantities: 14 in.; 1 ft. 8 in.; 24 in.; 2 ft. 6 in.; 1 yd. 4 in.; 1 yd. 1 ft.

9. In questions 10-15 name the *quantity* and the *unit* in each case. How will you find the number of units in each quantity?

10. Into how many hair ribbons, each 9 in. long, can you divide a piece 36 in.?

11. A can contains 12 qt. of milk. How many pitchers, each containing 3 pt., can be filled with its contents?

12. A furnace burns on the average 5 T. of coal a month. In how many months will it burn 40 T.?

13. How many pounds of sugar at 6¢ a lb. will cost 48¢? How many pounds of sugar at 5¢ a lb. will cost \$2?

14. How many barrels of flour at \$5 a bbl. will cost \$45?

15. How many pounds of raisins at 8¢ a lb. will cost 56¢?

16. In questions 10-15 the number that you found in each case was the number of what? This number is often called the ratio of the quantity to the unit.

17. How many widths of carpet 3 ft. wide are needed to carpet a room 6 yd. wide? In terms of what unit must you express both the quantity 6 yd. and the unit 3 ft. before dividing?

18. How many strips of paper 2 ft. wide are needed to cover the walls of a room whose perimeter is 20 yd.?

19. How many quarts of milk at 6¢ a qt. will cost \$1.80?

20. In the following examples what numbers express the measurements?

QUANTITY	UNIT	QUANTITY	UNIT
\$45	\$5	2 lb.	4 oz.
20 da.	5 da.	10 qt. 1 pt.	3 pt.
$\frac{1}{2}$ hr.	6 min.	4 yd. 2 ft.	2 ft.
\$4	2 dimes	3 gal. 3 qt.	5 qt.
2 bu.	8 qt.	16 sq. in.	2-in. square

21. What is the ratio of each quantity in example 20 to its own unit? What is the ratio of the unit to the quantity?

22. A man earns \$15 a week and spends \$11. In how many weeks will he save \$136? What is the unit here?

23. Two boats travel up a river at the rate of 12 and 9 mi. per hour, respectively. If they start together, when will the faster be 36 mi. ahead?

24. A farmer's wife sold 10 lb. of butter at 24¢ a lb. and with the proceeds bought sugar at 5¢ a lb. How many pounds did she buy? What is the quantity here?

25. A man travels 12 hr. at the rate of 4 mi. an hr. and returns to the starting-point at the rate of 6 mi. an hr. How long does it take him to return?

Lesson 2

1. Make a mental picture of a line 18 in. long divided into 3 equal parts. How long is the unit of measure that divides it into 3 parts?

2. What unit would divide it into 6 parts? 2 parts? 9 parts?

3. Find the units that divide each of these quantities into 4 parts: 20 in.; 1 ft. 4 in.; $\$24$; 1 bu.; 1 bu. 8 qt.; 2 doz. oranges.

4. In question 3 how did you find the value of the unit in each case?

5. How would you find the size of the unit dividing a quantity into 4 parts? 5 parts? 6 parts? Into any number of parts?

6. In questions 7-13 name the *quantity* and the *number* in each case. How will you find the value of each unit?

7. If 3 lb. of coffee cost 96¢ , what is the price of 1 lb.?

8. A freight train runs 72 mi. in 4 hr. What is the average speed per hr.?

9. If 2 gal. of milk is worth 48¢, what is 1 qt. worth?

10. If the cost of fencing one side of a field 8 rd. long is \$44, what is the cost per rd.? Per yd.?

11. Nine yards of cloth cost \$2.16; find the price per yd.

12. I sold 10 cd. of wood at \$6 a cord, and with the proceeds bought 12 bbl. of flour. What was the cost per bbl.?

13. A rectangle 8 in. long and 9 in. wide is cut into 6 equal rectangles. What is the area of each?

14. In the following examples find the units of measurement:

QUANTITY	NUMBER	QUANTITY	NUMBER
24 h.	6	$8 \times 25¢$	40
$4 \times 9¢$	12	\$20	$3 + 1$
$30 \times \$8$	40	1 lb. 6 oz.	11
300 bu.	10	66 yd.	4
\$1.08	9	3 bu.	6

15. State what each number in example 14 is the ratio of. In example 14 what is $\frac{1}{6}$, $\frac{1}{12}$, etc., the ratio of?

16. How long is the line that is measured 5 times by the unit 6 in.?

17. I fill a pail by emptying into it a 2-qt. measure full of water 6 times. How much water does the pail hold?

18. In examples 16 and 17 how did you find the whole quantity? When you are given the *number* and *unit* how do you find the *quantity*?

19. In examples 20–23 name the *number* and the *unit* in each case.

20. Find the cost of 7 lb. of oatmeal at 4¢ a lb.

21. A farmer sold 4 horses at \$80 apiece. What did he receive for them?

22. Two men separate, one walking west at the rate of 3 mi. an hour, the other east at 5 mi. an hr. How far apart will they be in 9 hr.?

23. Two boys ride along the same road in the same direction. The first rides 9 mi. an hr. and the second 7 mi. How far apart will they be in 3 hr. after the faster passes the slower?

24. In the following examples find the quantities measured by the numbers and the units:

NUMBER	UNIT	NUMBER	UNIT
6	4 sq. ft.	6	\$.20
$1\frac{1}{2}$	8¢	6	3 for 5¢
3	42 mi.	2 doz.	3¢ apiece
5	3 tens	8	2 mi. + 3 mi.
5 tens	3	7	9 mi. – 6 mi.

25. Quantity \div Unit = ? Quantity \div Number = ?
 Number \times Unit = ?

ADDITION

Lesson 3

1. A line 8 in. long is divided into two parts. What can the lengths of these parts be?

2. A line is made up of parts 4 in., 5 in., and 6 in. long. What is the length of the line?

3. Eight is how much less than 10? 5 is how much greater than 2? Why is $8 + 5 = 10 + 3$?

4. $8 + 6 = 10 + ? = ?$ $7 + 9 = 10 + ? = ?$

5. As in question 4 add the following :

5	6	4	6	7	5	3	6	4	5
6	6	7	7	7	7	8	8	8	8
—	—	—	—	—	—	—	—	—	—
7	8	2	9	4	8	6	7	5	3
8	8	9	9	9	9	9	9	9	9
—	—	—	—	—	—	—	—	—	—

6. Memorize the sum of :

2	3	4	5	3	4	5	6	4	5
9	8	7	6	9	8	7	6	9	8
—	—	—	—	—	—	—	—	—	—
6	5	6	7	6	7	7	8	8	7
7	9	8	7	9	8	9	8	9	6
—	—	—	—	—	—	—	—	—	—

The STATEMENT OF BALANCE for example 7 is:

The sum spent = $5\phi + 9\phi$.

Give the *statement of balance* for each of the following examples of this lesson as you solve them.

7. Miriam paid 5ϕ for street car fare and spent 9ϕ for a yard of ribbon. What did she spend altogether?

8. A man spent \$8 for a coat and \$4 for a vest. What did both cost him?

9. Ethel spent 6ϕ for apples and 9ϕ for oranges. How much did she spend in all?

10. A lady paid \$7 for a lounge and \$5 for a chair. What did both cost?

11. A grocer buys pineapples at 9ϕ apiece and sells them at a gain of 4ϕ each. Find the selling price.

12. Add 4 to 6, 9, 3, 7, 8, 5, 6, 4, 7, 6, 9.

13. Add 7 to 8, 6, 3, 5, 4, 8, 9, 7, 2, 5, 9.

14. Add 5 to 2, 8, 4, 9, 8, 7, 5, 9, 6, 8, 7.

15. Add 9 to 7, 4, 9, 6, 3, 9, 8, 5, 2, 4, 1.

16. Add 3 to 5, 7, 9, 6, 4, 5, 7, 3, 6, 9, 8.

17. Add 8 to 5, 9, 7, 5, 6, 2, 8, 6, 9, 7, 4.

18. Add 6 to 9, 5, 8, 7, 4, 8, 5, 7, 4, 9, 6.

STATEMENT OF BALANCE

The weight = 4 times 2 lb. + 3 lb.

19. What is the weight of 4 2-lb. cans of corn and 3 lb. of cheese?

20. What is the cost of 2 spools of thread at 4ϕ apiece and a paper of needles at 5ϕ ?

21. What must I pay for a paper of pins at 7ϕ and 2 bunches of tape at 4ϕ apiece?

22. Add 5 to each of these numbers.

(a) 6, 26, 66, 73, 36, 96, 87, 16, 49, 56.

(b) 3, 32, 13, 63, 43, 88, 53, 24, 73, 93.

(c) 8, 68, 46, 28, 58, 38, 77, 18, 86, 98.

(d) 4, 54, 14, 44, 69, 84, 94, 73, 29, 34.

(e) 7, 17, 38, 57, 24, 87, 65, 97, 46, 77.

(f) 5, 25, 34, 65, 75, 96, 15, 45, 57, 89.

(g) 9, 49, 19, 28, 34, 59, 99, 79, 88, 69.

(h) If to any number ending in 9 you add 5, in what figure does the sum end?

23. Add in turn each of the following numbers to the numbers given in question 22:

2, 6, 3, 7, 1, 9, 4, 10, 8.

24. Saturday Helen had 58ϕ in the Penny Savings and Monday she put in 7ϕ more. How much had she then?

25. I paid $\$36$ for a gold watch, $\$9$ for a chain, and $\$5$ for a gold ring. Find the total cost.

Lesson 4

Give the statement of balance in each example.

1. I paid 98ϕ for a Dewey sailor suit and 8ϕ for a flag. Find the cost of both.

2. Find the cost of 2 yd. of ribbon at 12¢ a yd. and 1 yd. of cambric at 9¢.

3. A man earns \$15 a week, the older of his two sons \$7, and the younger \$6. Find their total weekly earnings.

4. Add the following :

8	4	6	9	7	8
5	9	8	4	8	9
<u>47</u>	<u>53</u>	<u>75</u>	<u>87</u>	<u>76</u>	<u>94</u>

5. 8	9	4	6	5	2
6	7	6	7	8	9
<u>72</u>	<u>37</u>	<u>53</u>	<u>88</u>	<u>43</u>	<u>94</u>

6. Find the cost of 8 bunches of firecrackers at 4¢ apiece and 5 cents' worth of punk.

7. I walked 3 mi. to the railway station, travelled 58 mi. by train, and rode 6 mi. from the station to my destination. Find the total distance.

8. What is the sum of 9 and 6? 19 and 6? 6 and 29? 16 and 9? 9 and 38? 6 and 69? 86 and 9? 9 and 56?

9. What is the sum of 49, 4, 8? 5, 62, 4? 6, 48, 7? 3, 58, 9? 7, 25, 6? 6, 78, 8? 9, 78, 6?

10. Peoria is 55 mi. north of Springfield. How far apart are two places, one 6 mi. north of Peoria and the other 8 mi. south of Springfield?

11. I paid 5¢ for a basket, 59¢ for a tub, and 10¢ for a tin cup. Find the total cost.

12. A milkman delivers milk to five families that take 3 qt. a day, and to four families taking 2 qt. a day. How much milk do these nine families buy each day?

13. A boy riding his bicycle at the rate of 8 mi. an hour goes from A to B in 2 hr., from B to C in 3 hr., and from C to D in 2 hr. How far is it from A to D?

14. I paid 5 ten-dollar bills and 1 five-dollar bill for a rug. What did it cost?

15. I bought an organ, giving for it 6 ten-dollar bills, 3 one-dollar bills, and half a dollar. What did it cost?

16. A lady gave for a piano 4 fifty-dollar bills, 4 ten-dollar bills, and a five-dollar bill. What did it cost her?

17. For my hat I paid a two-dollar bill, 3 dimes, and a nickel. What did the hat cost?

18. A lady preserved 4 2-qt. jars of cherries, 5 2-qt. jars of pears, and 3 2-qt. jars of peaches. How many quarts of fruit did she preserve?

19. What quantity is represented by the sum of 3, 2, 4, the unit of measure being \$1? \$10? \$100? 2 mi.? 2 A.?

20. What distance is represented by 4 units of 100 mi. each, 3 units of 10 mi., and 2 units of 1 mi.?

21. James gave 6 dimes and a nickel for a history and 8¢ for a block of paper. Find what all cost.

22. Richard had 9 marbles, Harry 43, and Thomas 7. How many had all three?

23. A farmer sold 2 horses for \$100 each, a cow for \$20, and a sheep for \$5. What did he get for all?

24. A thermometer registers 8° below zero. This is how many degrees below the freezing point?

25. I paid 59¢ for a walking stick, the price of which had been reduced 25¢. Find the original price.

Lesson 5

1. Find the sum of the following:

32 and 20, 64 and 30, 86 and 30,
75 and 60, 97 and 50, 58 and 80.

2. Find the sum of 58 and 34.

NOTE. $58 \text{ and } 30 = 88$; $88 \text{ and } 4 = 92$.

As in example 2, find the sum of the following:

3. 43 and 25, 26 and 73, 41 and 16,
57 and 32, 68 and 32, 38 and 56.

4. 37 and 65, 68 and 29, 43 and 39,
84 and 49, 94 and 48, 55 and 77.

5. 69 and 74, 85 and 58, 39 and 96,
77 and 26, 28 and 93, 42 and 89.

6. 55 and 36, 78 and 57, 96 and 91,
85 and 69, 43 and 99, 88 and 33.

7. A man paid \$67 for a bicycle for himself and \$25 for one for his son. Find the cost of both.

8. A farmer who owned 76 A. of land bought an adjoining piece containing 24 A. Find the size of his farm after the purchase.

9. A field is 66 rd. long and 48 rd. wide. How far does a person go in walking from one corner of the field to the opposite corner if he walks along the edge of the field?

10. If there are 39 pupils in the first grade and 44 in the second, how many pupils are there in the two grades?

11. A man lost \$23 by selling his horse for \$98. Find what the horse cost him.

12. A cow is tied to a stake with a rope 44 ft. long. A second cow is tied with a rope 7 yd. longer. Find the length of the second rope.

13. A merchant bought cloth at 98¢ a yd. and sold it at a gain of 25¢ a yd. Find the selling price.

14. A milkman had two cans, one holding 8 gal. and the other 26 qt. Find the total capacity of both cans.

15. Winifred gave \$.96 for a geography and $\frac{1}{2}$ as much for a reader. What did both cost?

16. After taking 2 doz. lemons out of a box there remained 19 in the box. How many were in the box at first?

17. A farmer sold a cow for \$35 and 7 lambs at \$4 each. What was the total selling price?

18. One winter morning the thermometer in the schoolroom registered 49° . In an hour the temperature increased 19° . What did the thermometer then register ?

19. What is the distance from Chicago to Milwaukee, if, after travelling 57 mi. from Chicago, I still have 23 mi. further to go to reach Milwaukee ?

20. A rope was cut into two pieces. If the shorter piece was 5 yd. 1 ft. and the longer 45 ft., how many feet long was the rope ?

21. How many quarts of oats are there in a bin containing 2 bu. 28 qt.? How many pounds ?

22. A field is 42 rd. long and 28 rd. wide. How many rods of fencing are required to enclose it ?

23. A bicycle dealer who had 88 bicycles in stock received a shipment of 4 doz. more. How many did he then have in stock ?

24. Find the number of hours in 2 da. 17 hr. Find the number of sheets of paper in 2 quires 12 sheets.

25. I paid 25 units of \$100 each for a lot and built a house on it at a cost of 36 units of \$100 each. Find the total cost.

Lesson 6

1. Find the sum of 28 and 34; of 62 and 45. Find the sum of 48 and 27; of 75 and 89.

2. Find the sum of 56 and 17; 73 and 68; 56, 17, 68. How do you find the sum of three numbers like 56, 17, 68? Find the sum of 45, 24, 53.

3. Find the sum of the following numbers: 120, 32; 140, 53; 134, 65; 128, 76; 184, 78; 256, 89.

4. Find the sum of: 25, 32, 69; 48, 36, 63; 77, 56, 99; 91, 84, 32; 67, 97, 83; 54, 69, 27.

5. A lady pays \$17 for a bedstead, \$61 for a dresser, and \$21 for a washstand. Find the entire cost.

6. A dealer bought three carloads of coal. The first weighed 24 T., the second 22 T., and the third 19 T. Find the total amount.

7. The sides of a triangular field are respectively 36 rd., 45 rd., and 53 rd. Find its perimeter.

8. Monday a grocer sold goods to the value of \$56, Tuesday to the value of \$62, and Wednesday to the value of \$47. Find his sales for the first half of the week.

9. A horse cost \$125 and the harness \$16. What was the cost of both?

10. An arithmetic cost 35¢, a history 27¢ more. Find the cost of the history. Of both.

11. A grocer paid \$47 for sugar and \$28 more than that amount for flour. What did both cost him?

12. A man began business with 38 thousand dollars and in ten years cleared 58 thousand dollars. How much was he then worth?

13. How many days are there in the three spring months? In the three summer months? In the three winter months?

14. A fruit dealer sold 6 oranges for 15¢, 9 others for 24¢, and a dozen of another kind for 45¢. How many oranges did he sell and what did he get for them?

15. State how you solved examples 5-14. State how you will solve the remaining examples in this lesson.

16. A young man earns \$7 a week, his older brother \$4 more, and his father \$6 more than the older brother. What do all three earn a week?

17. A man paid \$52 for a buggy and $\frac{1}{2}$ as much more for a horse. Find the cost of both.

18. If I paid 25 hundred dollars for one lot, 18 hundred dollars for another, and 22 hundred dollars for a third lot, what was the entire cost?

19. How many nickels are there in three piles of which the first contains 23, the second 16, and the third 11. What is their value in dollars and cents?

20. If it was 15 min. after 9 o'clock 17 min. ago, what time will it be in 24 min.?

21. A young man entered the navy 16 yr. ago at the age of 25. How old will he be 12 yr. from now?

22. A farmer divided his farm among his three sons, giving to the eldest 85 A., to the second son 76 A., and to the youngest 68 A. What was the size of his farm?

23. A merchant bought clothes at \$15 a suit and overcoats at \$12 apiece, and sold them at an advance of \$5 each. What must a customer pay for a suit of clothes and an overcoat?

24. A dealer bought lemons at 25¢ a dozen, and oranges at 35¢ a dozen. If he sold them so as to gain 10¢ a dozen, what did he receive for a dozen of each?

25. Three children buy a hammock. The first contributes 75¢, the second 69¢, and the third 41¢. What did the hammock cost?

SUBTRACTION

Lesson 7

STATEMENT OF BALANCE

Ex. 1. The other part = 9 in. - 5 in.

Ex. 2. The quantity left = 3 gal. - 3 qt.

Give the statement of balance for each example in this lesson as you work it.

1. A string 9 in. long is cut into two parts one of which is 5 in. long. How long is the other part?

2. From a can containing 3 gal. of milk 3 qt. are poured out. How many quarts are left in the can?

3. If 2 gal. of milk are poured into an empty can that will hold 15 qt., how many quarts are needed to fill it?

4. In examples 2 and 3 the quantities to be subtracted are not expressed in terms of the same unit. Explain this statement. What must be done with quantities expressed in terms of different units before you can find their difference?

5. A boy has 8 nickels and buys 6 oranges at a nickel each. Find how many cents he has left.

6. Two boys were playing a game of marbles. If one of them got 7 out of 15, how many did the other get?

7. A piece 2 ft. 3 in. long is cut from a rope 6 ft. 11 in. long. Find the length of the other piece.

8. If in paying for a pair of shoes that cost \$6 I gave the clerk 2 five-dollar bills, what change should I receive back?

9. A lady has 7 2-qt. jars of fruit. If her family eats 1 qt. a da. for 6 da., how many jars of fruit will she have at the end of that time?

10. If the perimeter of an oblong is 18 in. and the length 5 in., what is the width?

11. Two vessels going in opposite directions are 17 mi. apart one hour after they pass each other. If one is going 8 mi. an hour, what is the rate of the other?

12. A post 12 ft. long is 4 ft. below ground. How long is the part above ground?

13. From a piece of cloth 5 yd. long a piece 6 ft. long is cut. How many feet of cloth are left?

14. I paid 2 dimes for a collar and got back a nickel in change. What did the collar cost me?

15. I paid 16¢ for a pound of butter, giving three different coins in payment. What were they?

16. A merchant buys berries for 5¢ a box and sells them at the rate of 2 for 15¢. Find his gain on two boxes. On a crate of 16 boxes.

17. A boy picked 8 qt. of berries in two days. If he picked 3 qt. 1 pt. the first day, how much did he pick the second day?

18. From a line that is 6 times the measuring unit I cut off a part that is 4 times as long as the measuring unit. How many inches long is the remainder, the unit being 3 in.?

19. A horse which travels at the rate of 8 mi. an hour goes from A to B in 3 hr., and from B to C in 5 hr. How much farther is it from B to C than from A to B?

20. What quantity is the difference between 11 and 7, the unit of measure being 2 in.? \$2? 3 ft.? 4 qt.? \$10?

21. How much greater are 2 units of \$5 than 3 units of \$2. What is the ratio of this difference to \$2? Of \$2 to this difference?

22. A piece of cloth 3 ft. long and 2 ft. wide is cut from a square yard of cloth. How many square feet in the remainder?

23. I ordered half a pound of cheese and received 10 oz. This was how many ounces more than were ordered?

24. If a man sleeps 7 hr. a day, he sleeps how much less than half the time?

Lesson 8

1. Subtract 4 from each of the following :
 - (a) 6, 16, 26, 38, 46, 56, 69, 76, 81, 96.
 - (b) 13, 33, 12, 63, 43, 88, 53, 24, 73, 93.
 - (c) 8, 68, 46, 28, 58, 38, 77, 18, 86, 98.

(d) 4, 54, 14, 44, 63, 84, 94, 72, 24, 34.

(e) 7, 17, 38, 57, 23, 87, 61, 97, 46, 77.

(f) 10, 20, 33, 60, 74, 90, 41, 80, 72, 50.

(g) 5, 25, 34, 65, 75, 96, 15, 45, 57, 89.

(h) 11, 51, 63, 21, 31, 41, 93, 82, 61, 71.

(l) 9, 49, 19, 28, 34, 59, 99, 79, 88, 69.

(m) 12, 32, 64, 92, 82, 41, 49, 52, 72, 22.

(n) If from any number ending in 2 you subtract 4, in what figure does the difference end? Apply a similar question to each part of example 1.

2. Subtract in turn, where possible, each of the following numbers from those given in example 1 :

2, 6, 3, 7, 1, 9, 5, 10, 8.

3. Harry takes a step 34 in. long and John 5 in. shorter. How far does John step?

4. Robert can jump 6 ft. high and James 7 in. less. How high can James jump?

5. I took 21 min. to walk to the depot and then found that I was 5 min. late for the train. How long before train time did I leave home?

6. Two boys run a race of 100 yd. When the first completes the course the second is 7 yd. behind. How far did he run?

7. If it is 8 min. after 9 o'clock, how long before it will be 10 o'clock.

8. A man paid \$25 for an overcoat and a pair of shoes. If the shoes cost \$6, what did the overcoat cost?

9. A lady buys a quire of paper and then writes 7 letters, using a sheet a letter. How much paper has she left?

10. Out of a class of 43 pupils 9 are absent. How many are present?

11. A thermometer that registered 72° fell 5° . What did it then register?

12. A grocer sold a peck of beans, taking them out of a bushel basket. If the basket was full of beans, how many quarts were left in it?

13. Subtract 2 from each of these numbers :

(a) 8, 13, 7, 18, 16, 9, 23, 11, 5, 14, 18.

(b) 27, 46, 19, 38, 51, 84, 17, 20, 67, 42, 59.

(c) 10, 37, 18, 63, 24, 12, 26, 15, 74, 18, 30.

(d) 15, 18, 34, 21, 45, 82, 83, 36, 29, 13, 36.

(e) 121, 132, 105, 143, 137, 183, 149, 158.

14. Subtract in turn, where possible, each of the following numbers from those given in example 13 :

3, 6, 1, 7, 4, 9, 8, 10, 5.

15. A man earns \$54 a month, and saves \$9 a month. How much does he spend?

16. From 12 tens subtract 8 tens. From 26 hundred subtract 9 hundred.

17. Out of 4 doz. eggs half a dozen were found to be broken. How many eggs were whole?

18. Subtract 30 from each of these numbers :

45, 67, 81, 93, 76, 124, 159, 116, 142, 138.

19. Subtract in turn, where possible, each of the following numbers from those given in example 18 :

20, 60, 40, 70, 10, 90, 80, 50, 100.

20. Subtract 28 from 76.

NOTE. $76 - 20 = 56$; $56 - 8 = 48$.

21. Subtract 34 from 56; 23 from 49; 42 from 73; 15 from 68; 52 from 95; 63 from 99.

22. There are 45 pupils in a class of whom 21 are boys. How many girls are there ?

23. If the freezing-point is 32° , how much above the freezing-point is the temperature when the thermometer registers 67° ?

24. A man is 59 yr. of age and his son 23 yr. How much older is the father than the son ?

25. In a race between two bicyclists the faster has gone 59 mi. and the slower 47 mi. How far is he behind ?

Lesson 9

1. Subtract 48 from 92; 68 from 84; 37 from 78; 58 from 96; 32 from 61; 54 from 82; 33 from 71; 46 from 65.

2. Find the difference between 45 and 80; 67 and 91; 23 and 56; 76 and 95; 16 and 82; 43 and 88; 54 and 29; 70 and 22.

3. Subtract each of the following numbers from 100 :

62, 37, 24, 81, 98, 56, 73, 45, 19.

4. Subtract each of these quantities from \$1.20 : 87¢, 69¢, 43¢, 25¢, 72¢, 56¢, 92¢, 18¢.

5. Find the difference in cents on subtracting 48¢ from \$1.25 ; 76¢ from \$1.50 ; 89¢ from \$1.67 ; \$1.25 from \$1.74 ; \$3.48 from \$5.

6. The following bargains were advertised in a Chicago paper. Find the reduction in price in each case.

1. Pillow covers 12¢, reduced from 40¢.
2. Pillows 23¢, reduced from 75¢.
3. Silk 89¢, reduced from \$1.50.
4. Silk crepons \$1.50, reduced from \$2.25.
5. Wool checks \$1.38, reduced from \$3.50.
6. Silk waists \$1.98, reduced from \$4.
7. Umbrellas 59¢, reduced from \$1.25.
8. Parasols 89¢, reduced from \$2.50.
9. Bicycle skirts, \$2.75, reduced from \$5.
10. Bicycle suits, \$2.48, reduced from \$5.
11. Fancy ribbon 46¢, reduced from \$1.
12. Black silks 62¢, reduced from \$1.25.
13. Silkaline 18¢, reduced from 50¢.
14. Portières \$2.25, reduced from \$6.
15. Lace curtains 80¢, reduced from \$2.

7. A drover bought 60 sheep from three farmers. If he bought 18 from the first and 16 from the second, how many did he buy from the third ?

8. A man who has \$75 in the bank deposits \$36 more, and shortly after withdraws \$48. How much still remains in the bank ?

9. A and B start from two places 99 mi. apart and travel toward each other. The first day A goes 38 mi. and B 25 mi. How far are they then apart? How far is A from B's starting-place? How far is B from A's starting-place?

10. A and B start from two places 85 mi. apart and travel in the same direction. The first day A travels 48 mi. and B 27 mi. How far are they then apart? How far is A from B's starting-place? How far is B from A's starting-place? Show that there are two solutions to this example.

11. Mr. Stevens paid \$68 for one horse and \$75 for another, and sold them both for \$160. Find his gain.

12. A farmer sold two bags of apples for \$1.50. With this money he bought a hoe for 32¢, a rake for 45¢, and a spade with the remainder. What did the spade cost?

13. A merchant sells cloth at \$1.25. He lowers the price 39¢, thus losing 12¢ a yd. Find what the cloth cost him a yard.

14. A boy shot an arrow 34 yd. up the road and another down the road 45 yd. His brother brought them to him. How far did he have to walk?

15. A merchant sells silk at \$2.50 a yd. He lowers the price 75¢ and then sells at 18¢ above cost. Find what the silk cost him a yard.

MULTIPLICATION

Lesson 10

1. Review the multiplication table, page 134.
2. What unit of area is used to measure the area of an oblong 9 in. by 6 in.? Of a table 3 ft. by 2 ft.? Of the floor of a room 6 yd. by 5 yd.? Of a farm? Of a section of land 6 mi. long and 4 mi. wide?
3. Find the area of each oblong given in example 2.
4. Find the area of the floor of each of the rooms whose dimensions are, respectively: 5 yd., 4 yd.; 8 yd., 7 yd.; 11 yd., 9 yd.; 12 yd., 10 yd.
5. How do you find the number of units of area in an oblong?
6. A garden bed 6 ft. long and 4 ft. wide is surrounded by a walk 1 ft. wide. What is the entire area of the bed and walk?
7. A flower garden is surrounded by a walk 2 ft. wide. The length of the walk and garden is 12 ft. and their width 10 ft. Find the area of the garden.
8. Find the number of square inches in each of the stamped linen squares whose sides are, respectively, 5, 7, 9, and 12 in.

9. A rug occupies the centre of a square room and its sides are everywhere 2 ft. from the wall. If the length of the rug is 8 ft., what is the area of the room?

10. How long is a township? How wide? What is its area?

11. What is the difference in area between an 8-in. square and 8 sq. in.? Between a square whose side contains 6 units of length and an oblong containing 6 units of area?

12. A township contains a forest 3 mi. long and 2 mi. wide, the rest being divided into farms. How many square miles of farm land are there in the township?

13. A grass plot 10 ft. square has in the centre a square flower bed whose side is 4 ft. Find how many square feet of grass are in the plot.

14. In a room 14 ft. long and 12 ft. wide is a rug whose sides are everywhere 2 ft. from the wall. Find its area.

Reduce to lower denominations:

15. 8 yd. 2 ft.; 4 yd. 1 ft.; 12 yd. 2 ft.; 9 yd. 2 ft.; 13 yd. 1 ft.; 20 yd. 2 ft. How do you reduce yards and feet to feet?

16. 6 ft. 3 in.; 10 ft. 8 in.; 4 ft. 6 in.; 9 ft. 2 in.; 7 ft. 11 in.; 12 ft. 6 in. How do you reduce feet and inches to inches?

17. 4 sq. yd. 6 sq. ft.; 6 sq. yd. 7 sq. ft.; 12 sq. yd. 4 sq. ft.; 9 sq. yd. 5 sq. ft.; 7 sq. yd. 8 sq. ft.; 12 sq. yd. 3 sq. ft. How do you reduce square yards and square feet to square feet?

18. 8 qt. 1 pt.; 12 qt. 1 pt.; 7 gal. 3 qt.; 9 gal. 2 qt.; 4 gal. 6 pt.; 12 gal. 4 pt.

19. 6 bu. 3 pk.; 10 bu. 2 pk.; 9 pk. 1 qt.; 11 pk. 2 qt.; 13 bu. 1 pk.; 8 pk. 7 qt.

20. 4 wk. 3 da.; 8 wk. 5 da.; 12 wk. 4 da.; 5 hr. 40 min.; 4 hr. 18 min.; 7 min. 35 sec.

21. 5 dimes 6¢; 9 dimes 3¢; 12 dimes 5¢; 6 m. 4 dm.; 8 m. 7 dm.; 11 m. 8 dm.

22. Find the perimeter of the rooms whose dimensions are respectively: 5 yd., 4 yd.; 8 yd., 6 yd.; 12 yd., 8 yd.; 22 ft., 18 ft.

23. How do you find the perimeter of a room? Find the perimeter of a room 8 yd. long and 7 yd. wide. If this room is 3 yd. high, find the area of its four walls.

24. Find the area of the four walls of a room 18 ft. long, 12 ft. wide, and 9 ft. high. How do you find the area of the four walls of a room?

25. How many square feet of wall will a roll of wall paper 8 yd. long and 18 in. wide cover?

26. If the width of a farm is measured by 4 units and its length by 6 units, how many units in its perimeter?

Lesson 11

In examples 1 and 2 the *statements of balance* are :

The weekly profit = $6 \times \$15$.

The quantity of provisions = the rations of 6 men for 12 da.

As you solve the examples of this lesson, give the statements of balance.

1. A merchant averages a profit of \$15 a day. How much is that a week ?

2. A quantity of provisions will last 6 men 12 da. How long will it last 1 man ?

3. If 8 men can do a piece of work in 9 da., how long will it take 2 men to do it ?

4. If 7 men can do a piece of work in 4 da., how many men can do it in 2 da. ?

5. If two men start from the same place and travel in opposite directions, one at the rate of 4 mi. an hr. and the other at the rate of 5 mi. an hr., how far apart will they be in 3 hr. ?

6. How far apart will the men in example 5 be in 8 hr. if they travel in the same direction ?

7. Two men start 60 mi. apart and travel toward each other at the rate of 3 mi. an hr., the other at the rate of 4 mi. an hr. How far apart will they be in 6 hr. ?

8. How far apart will the men in example 7 be in 6 hr. if they travel in the same direction ? Show that there are two solutions.

9. I bought 7 T. of coal at \$6 a ton, and handed in payment 5 ten-dollar bills. How much change should I receive?

10. For how much must I sell 6 bicycles that cost \$28 each to gain \$45? Statement of balance: the selling price = the cost + the gain.

11. A farmer sold 8 sheep at \$6 each and 5 lambs at \$3 each. How much did he get for them all?

12. A tailor has a piece of cloth containing 25 yd. If he should use 13 yd. and sell the remainder at \$5 a yd., what would he receive for it?

13. A and B, travelling toward each other, met in 12 hr. How far apart were their starting-points if A travelled 9 mi. an hr. and B 8?

14. I bought 38 cows for \$35 each, and sold them for \$43 each. Find my profit.

15. A man bought a horse for \$90, paid \$3 a week for his expenses, and received \$5 a week for his work. At the end of 8 wk. he sold him for \$80. Did he gain or lose by the whole transaction, and how much?

16. If a man travels from his home 10 hr. at 6 mi. an hr., and then returns at the rate of 7 mi. an hr. for 5 hr., how far is he then from home?

17. What is the cost of a 5-lb. pail of butter at 19¢ a lb., and 2 lb. of coffee at 35¢ a lb.?

18. A man drives 4 mi. to the station, rides on the train for 3 hr. at 33 mi. an hr., and then drives from the depot into the country a distance of 8 mi. What is the entire distance?

19. A crate of raspberries holds 24 pt. boxes. How many quarts is this and what is a crate worth at 6¢ a pint box?

20. What is the cost of 2 crates of currants at 90¢ a crate, 2 crates of black raspberries at 75¢ a crate, and a crate of red raspberries at a \$ 1.05?

21. How long will it take a lady to look over 2 crates of black raspberries containing 16 qt. boxes each, if she can do 2 boxes in 9 min.?

22. A grocer buys soap at \$2.15 per box of 60 bars and sells it at 5¢ a bar. Find his gain on a dozen boxes.

23. What will 4 rows of wire fencing cost for a lot 100 ft. long and 50 ft. wide at 6¢ a yard?

24. A certain map is drawn so that 4 mi. is represented by 1 in. On this map a certain district is a square whose side is 2 in. What is its area?

Lesson 12

1. In terms of what unit is the volume of a prism 4 in. long, 3 in. wide, and 2 in. thick expressed? What is its volume?

2. Find the volumes of prisms of the following dimensions :

LENGTH	WIDTH	THICKNESS	LENGTH	WIDTH	THICKNESS
6 in.	5 in.	4 in.	8 ft.	4 ft.	4 ft.
8 in.	6 in.	4 in.	10 ft.	8 ft.	7 ft.
7 in.	5 in.	3 in.	4 yd.	3 yd.	2 yd.

How many cubic inches in a brick 8 in. by 4 in. by 2 in.?

3. A gallon of water will just fill a tin box 11 in. long, 7 in. wide, and 3 in. deep. How many cubic inches in a gallon?

4. A cubic yard of earth is a wagon load. How many loads of earth will it take to make an excavation 18 ft. long, 12 ft. wide, and 6 ft. deep?

5. How many cubic inches in a 2-in. cube? 3-in.? 4-in.? 5-in.? 6-in.? 7-in.? 8-in.? 9-in.? 10-in.?

6. A cubic foot of water weighs 1000 oz. A tank 6 ft. long, 2 ft. wide, and 2 ft. deep contains how many ounces?

7. The distance between two points, measured with a yardstick 1 in. too long, is found to be 6 yd. What is the actual distance?

8. The length of a room, measured with a yardstick 1 in. too short, is found to be 8 yd. What is the actual length?

9. Name two factors of 15, 18, 24, 28. Multiply 36 by 15, using the two factors of 15 as multipliers. Multiply similarly 36 by 18, 24, and 28 respectively.

10. Why is it correct in order to multiply a number by 5 to annex zero and divide by 2?

By this method multiply the following numbers by 5:

36, 45, 78, 96, 124, 256.

11. Find the cost of cementing the floor of a cellar 21 ft. long and 18 ft. wide at 15¢ a sq. yd.

12. Find the cost of digging a cellar 5 yd. long, 4 yd. wide, and 2 yd. deep at 24¢ a cu. yd.

13. If 3 ft. is the unit of length, what is the unit of area? If the measuring unit is a line 3 in. long, find the area of an oblong whose dimensions are 6 and 4 times the measuring unit.

14. What is the cost of 2 lb. 8 oz. of butter at 16¢ a lb.?

15. An electric car makes 15 trips a day, carrying on the average 20 passengers a trip at 5¢ a fare. How much did it earn in 1 mo. of 30 da.?

16. Why is it correct, in order to multiply a number by 25, to annex two zeros and divide by 4?

By this method multiply the following numbers by 25:

24, 18, 35, 27, 25, 19.

17. I bought 19 chickens at 25¢ apiece. What change should I get out of a five-dollar bill?

18. A merchant bought 10 bu. of peaches at \$1.75 a bu., and 1 bu. being spoiled, he sold the remainder at \$2 a bu. Find his gain or loss.

19. A lady bought a remnant of silkline containing $3\frac{1}{2}$ yd., and a remnant of ribbon containing $5\frac{1}{2}$ yd. of ribbon. The price of each was 12¢ a yd., find the cost.

20. From a piece of cloth containing 32 yd. there were sold at different times 11 yd., 8 yd., and 9 yd. The remainder was put on the remnant counter to sell at 25¢ a yd. Find the selling price.

21. A lady gave her little girl a dollar bill with which to buy a 2-lb. roll of butter at 22¢ a lb., and 1 lb. of coffee at 35¢ a lb. What change did she bring home to her mother if she was allowed to buy 5¢ worth of candy?

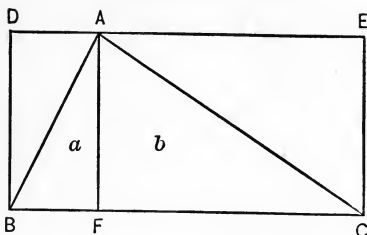
22. A city store advertises 7¢ muslin at 3¢ a yd. and 25¢ lace curtains at 10¢ a yd. A lady buys 4 yd. of the latter and 6 yd. of the former. How much less does she pay than if she had bought them at the regular price?

23. If 6 bbl. of flour cost \$33, what will 24 bbl. cost at the same rate?

24. If 1 pt. of maple syrup costs 12¢, what will 1 gal. cost at the same rate?

25. How many feet in 1 rod? 2 rods? 20 rods? Wire fencing is sold at \$4.90 per bale of 20 rd., or at 2¢ per ft. How much is saved by buying 20 rd. by the bale instead of by the foot?

Lesson 13



1. The triangle a is what part of the oblong $AFBD$? The triangle b is what part of the oblong $AFCE$? The triangle ABC (i.e. $a+b$) is what part of the oblong $DBCE$?

2. To find the area of a triangle multiply one-half the measure of its base by that of its altitude. Memorize this rule.

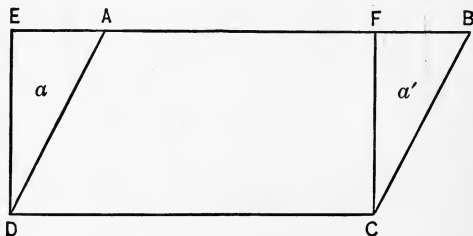
3. If ABC represents a triangle whose base BC is 8 in. and altitude AF is 4 in., what is the area of the triangle represented? Draw the triangle.

4. Find the areas of the following triangles :

BASE	ALTITUDE	BASE	ALTITUDE
10 in.	6 in.	2 ft.	1 ft. 8 in.
16 in.	12 in.	2 ft. 4 in.	1 ft. 10 in.
18 ft.	10 ft.	3 yd. 1 ft.	4 yd.
24 ft.	22 ft.	4 yd. 2 ft.	5 yd. 1 ft.
36 yd.	20 yd.	3 yd.	10 in.
80 yd.	60 yd.	4 rd.	8 yd.

5. What is the area of a triangular garden bed whose base is 2 yd. and altitude 1 yd. 2 ft.?

6. The gable end of a barn measures 20 ft. and the perpendicular distance from the ridge of the barn to the base is 11 ft. How many square feet of lumber does it contain?



7. Which is greater the triangle a or a' ? Which is greater the parallelogram $ABCD$ or the rectangle $EFCD$?

8. How do you find the area of a rectangle such as $EFCD$? Of a parallelogram such as $ABCD$?

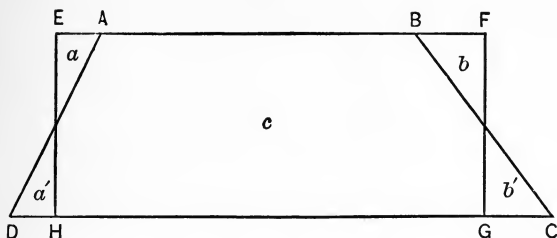
9. *To find the area of a parallelogram multiply the measure of the base (CD) by the measure of the altitude (CF).* Memorize this rule.

10. Find the areas of the following parallelograms:

BASE	ALTITUDE	BASE	ALTITUDE
8 ft.	6 ft.	16 rd.	12 rd.
12 yd.	8 yd.	24 mi.	20 mi.

Base = 9 units of length. Altitude = 4 units of length.

11. Name three pairs of factors of 20. Give the base and altitude of three parallelograms whose area in each case is 20 sq. in.



12. Name the two parallel sides of the *trapezoid ABCD*. Which is larger, the triangle a or a' ? b or b' ?

13. If you add the triangles a' and b' to the large central figure c , you get what figure? If you add the triangles a and b to the central figure c , what figure do you get? Which is larger the trapezoid *ABCD* or the rectangle *EFGH*?

14. Show by actually measuring that GH is one-half the sum of AB and CD . AB and CD are called the *bases* of the trapezoid *ABCD*.

15. *To find the area of a trapezoid multiply the measure of one-half the sum of its bases or parallel sides by the measure of its altitude.* Memorize this rule.

16. The lengths of the parallel sides of a trapezoid are 12 ft. and 8 ft. and its altitude is 5 ft. Find its area.

17. Find the areas of these trapezoids:

BASES		ALTITUDE	BASES		ALTITUDE
11 in.,	9 in.	7 in.	1 ft. 7 in.,	1 ft. 3 in.	10 in.
14 ft.,	8 ft.	6 ft.	5 yd. 2 ft.,	2 yd. 1 ft.	3 yd.
12 ft.,	9 ft.	4 ft.	2 yd. 1 ft.,	1 yd. 2 ft.	2 ft.
13 ft.,	10 ft.	8 ft.	4 yd. 2 ft.,	3 yd. 1 ft.	5 ft.

18. The border of a rug consists of 4 equal trapezoids whose bases are 10 ft. and 6 ft. If the width of the border is 2 ft., find its area.

19. In each corner of the centrepiece of a rug is a trapezoid whose parallel sides are 13 in. and 9 in. and whose altitude is 14 in. Find their area.

20. In the centre of a rug is a hexagon which can be divided into two equal trapezoids whose bases are 2 ft. and 1 ft., and altitude 1 ft. 4 in. Find its area.

21. How do you find the area of a rectangle? Triangle? Parallelogram? Trapezoid?

DIVISION

Lesson 14

In the following examples give the statements of balance :

1. What must 8 mi. be multiplied by to give 72 mi.? If a boy travels 72 mi. on a bicycle at the rate of 8 mi. an hr., how many hours is he travelling?

2. 6 is one factor of 42, what is the other? If 6 lb. of dates cost 42¢, what is the price per lb.?

3. At 5¢ a lb. how many pounds of sugar can you buy for 80¢?

4. A horse trotted 48 mi. in 6 hr. How many miles an hour did he average?

5. In the preceding four questions name the given quantity, the measuring unit, and the number of units in the quantity.

6. Reduce to quarts: 18 pt.; 25 pt.; 36 pt.; 43 pt.; 57 pt.; 128 pt.; 141 pt.

7. Find the number of strips of carpet each 2 ft. wide required to carpet a room 16 ft. wide; 20 ft. wide; 26 ft. wide; 17 ft. wide.

8. Reduce to yards: 42 ft.; 96 ft.; 105 ft.; 141 ft.; 186 ft.; 204 ft.; 167 ft.; 343 ft.; 196 ft.

9. How many strips of carpet each 3 ft. wide will be required to carpet a room 24 ft. wide? 33 ft. wide? 20 ft. wide?

10. Reduce to gallons: 28 qt.; 37 qt.; 56 qt.; 86 qt.; 107 qt.; 260 qt.

11. Find the number of school weeks in 20 school days. In 35 da. In 100 da. In 200 da.

12. If a man works 6 days a week, in how many weeks will he work 96 da.? 150 da.? 192 da.? 222 da.? 264 da.?

13. Reduce to weeks: 84 da.; 98 da.; 126 da.; 175 da.; 240 da.; 365 da.

14. Reduce to pecks: 40 qt.; 58 qt.; 72 qt.; 125 qt.; 197 qt.; 215 qt.; 288 qt.

15. Reduce to square yards: 81 sq. ft.; 108 sq. ft.; 164 sq. ft.; 200 sq. ft.; 243 sq. ft.

16. Reduce to dimes: 80¢; 120¢; 93¢; 168¢; 248¢; 290¢; 312¢; 415¢.

17. Reduce to meters: 40 dm.; 70 dm.; 82 dm.; 94 dm.; 99 dm.; 100 dm.

18. How many yards in 1 rod? Measure off 1 rd. in the schoolroom. Measure this distance again with a unit half a yard in length. Count the number of half-yards in 1 rd. How many?

19. What is the number of rods in 33 half-yd.? 66 half-yd.? 88 half-yd.?

20. Divide by 11: 75; 92; 132; 189; 210; 265; 331; 484.

21. Reduce to feet: 72 in.; 89 in.; 117 in.; 169 in.; 254 in.; 288 in.

22. How many dozen are there in 60 units? 93 units? 384 units?

23. State how you reduce a quantity expressed in pints to quarts. Quarts to gallons. Quarts to pecks. Inches to feet. Feet to yards. Square feet to square yards. Days to weeks. Cents to dimes.

Lesson 15

1. What must 5 lb. be multiplied by to get 40 lb.? 40 lb. of butter is packed into pails each containing 5 lb. How many?

2. 4 is one factor of 36, what is the other? If 4 yd. of ribbon cost 36¢, what is the price per yd.?

3. A pail contains 9 qt. of water. How many quarts will be left in the pail after 8 pt. are taken out?

4. What will a dozen oranges cost at the rate of 3 for 10¢?

5. How many lemons can I buy for 50¢ at the rate of 4 for 10¢?

6. A man travels 18 mi. at the rate of 6 mi. an hr., and returns immediately at the rate of 9 mi. an hr. How many hours is he gone?

7. A man drove to the city in 3 hr. at the rate of 8 mi. an hr., remained 2 hr. to transact business, and returned at the rate of 6 mi. an hr. How long was he gone?

8. A dairyman traded 4 horses worth \$90 apiece for cows worth \$30 apiece. How many cows did he get?

9. If 3 lb. of rice cost 24 ¢, what will 2 lb. cost?

10. I select the cheaper of two rugs, one of which costs \$48 and the other \$66. With the difference in price, how many chairs can I buy at \$6 apiece?

11. A room is 10 yd. 2 ft. long. How many steps will a boy take in walking the length of the room if he steps 2 ft. each time?

12. A room is 12 ft. wide. How many strips of carpet each 2 ft. wide are needed to carpet it? How many yards of carpet are needed if the room is 15 ft. long?

13. A room is 15 ft. wide and 18 ft. long. How many yards of carpet are needed to carpet it, if the carpet is 3 ft. wide, the carpet running lengthwise?

14. A room is 20 ft. wide and 24 ft. long. How many yards of carpet are needed to carpet it, if the carpet is 2 ft. wide, the carpet running lengthwise?

15. If two 5-lb. pails of butter cost \$1.05, what will 20 lb. cost?

16. If 6 bu. of corn cost \$3, what will 30 bu. cost?

17. What is the cost of 12 boxes of berries at 3 for 25 ¢?

18. A farmer's wife sold to a grocer 8 lb. of butter at 18 ¢ a lb. and took in exchange raisins at 12 ¢ a lb. How many pounds of raisins did she get?

19. A man divided 3 lb. 8 oz. of candy equally among 4 children. How many ounces did each get?

20. Some workmen work 9 hr. a day at 24¢ an hour. They demand the same daily wages for an 8-hr. day. How much would that be per hour?

21. What is the cost of 5 qt. 1 pt. of milk at 24¢ a gal.?

22. To how many customers does a milkman sell 8 gal. 1 qt. of milk if he sells 3 pt. to each customer?

23. I bought 7 chickens giving for them a \$2 bill and receiving in change 25¢. What did they cost apiece?

24. A grocer buys 6 baskets of peaches at 30¢ a basket. He uses two baskets and sells the remainder for what all cost him. Find the selling price of each basket.

25. Find the number of strips of paper in a room 20 ft. long and 18 ft. wide, the paper being 2 ft. wide.

Lesson 16

1. Find the weight of an iron bar 5 yd. 1 ft. long of which 2 ft. weigh 13 lb.

2. A block of stone is 10 in. long, 8 in. wide, and 6 in. thick. Find its weight if 5 cu. in. weigh 1 lb.

3. A grocer bought a crate of red raspberries (24 pt.) at 5¢ a pint. He kept some for his own use and sold the remainder at 6¢ a pint box for what all cost. How many boxes did he keep for his own use?

4. An express train takes 5 hr. 25 min. to travel 225 mi. If it makes stops of 5 min. each at 3 different places and one stop of 10 min., find the average rate at which the train goes.

5. A railway train travels at the rate of 2 mi. in 3 min. What is its rate per hour?

6. If 8 yd. of ribbon cost 96¢, what will 3 yd. 1 ft. cost at the same rate?

7. What number measures the area of an oblong containing 24 sq. in., the unit being 1 sq. in. If its length is 6 in., what number measures its length, the unit being 1 in. What number measures its width? What is its width?

8. How do you find the width of an oblong when its area and length are given?

9. Find the width of the oblongs given in the first two columns, and the length of those given in the last two:

AREA	LENGTH	AREA	WIDTH
30 sq. in.	6 in.	70 sq. yd.	5 yd.
48 sq. ft.	8 ft.	264 sq. yd.	11 yd.
63 sq. yd.	9 yd.	36 sq. mi.	6 mi.
8 sq. yd.	12 ft.	96 sq. mi.	8 mi.

10. A strip of carpet containing 6 sq. yd. is 2 ft. wide. How long is it?

11. The area of the ceiling and floor of a room 24 ft. long is 96 sq. yd. What is its width?

12. Into how many parts each 2 in. long can a line 8 in. long be divided? 6 in. long? Into how many 2-in. squares can an oblong 8 in. long and 6 in. wide be divided?

13. An oblong is 36 in. long and 24 in. wide. Into how many 3-in. squares can it be divided? 4-in. squares? 6-in. squares? 8-in. squares? 12-in. squares? Square feet?

14. How many tiles, each 6 in. square, are needed for a piece of tiling 5 ft. long and 1 ft. 6 in. wide?

15. A 10-in. cube can be cut into how many 5-in. cubes? How many 2-in. cubes?

16. A cubic foot can be cut into how many 3-in. cubes? How many 4-in. cubes?

17. How many pasteboard boxes, each edge of which is 8 in., can be packed into a box 3 ft. 4 in. long, 2 ft. 8 in. wide, and 2 ft. deep, inside measurement?

18. A farmer got 256 bu. of wheat off a field containing 8 A. What is the yield per acre worth at 90¢ a bushel?

19. How long will it take a boy to go a bicycle trip of 336 mi., riding 8 mi. an hr. for 7 hr. a day?

20. On what day will two boys finish a bicycle trip of 648 mi., riding 9 mi. an hr. for 6 hr. a day and resting on Sunday, if they start on Wednesday? If they start on Monday?

21. Two boys travel in opposite directions at the rate of 3 and 4 mi. an hr. In how many hours after parting will they be 56 mi. apart?

22. Divide \$40 between two brothers so that the older gets \$3 for every \$2 that the younger gets. What is the unit that measures \$40? What number arises from the measurement? How many \$3?

23. A farmer divided a farm of 160 A. between his two sons, giving the older 5 A. for every 3 A. he gave the younger. Find the share of each.

24. If, in example 23, the farmer gave his younger son \$2000 in order to give him as much as the older son, what was the farm worth per acre?

25. I gave \$1.20 for a pound of coffee and a pound of tea. If the tea cost three times as much as the coffee, find the cost of each.

Lesson 17

Before solving these problems let different pupils contribute what they can to their solution.

1. A man bought an equal number of pigs and sheep for \$81. Each pig cost \$3 and each sheep \$4. How many of each did he buy?

2. In example 1 name the whole quantity and the unit of measure. Name both in example 3.

3. A merchant sold cloth at \$2 a yd., and twice as much at \$3 a yd., the whole amounting to \$216. How many yards of each kind did he sell?

4. A merchant sold silk at \$4 a yd., and three times as much at \$2 a yd., the whole amounting to \$90. How many yards of each kind did he sell?

5. A grocer mixed 5 lb. of tea worth 40¢ a lb. with 3 lb. worth 80¢ a lb. What is the mixture worth a pound?

6. The expense of carpeting a room was \$45; but if the breadth had been 3 ft. less, the expense would have been \$40. Find the breadth of the room.

7. The expense of carpeting a room was \$14.40; but if 20¢ more a yard had been paid for the carpet, the cost would have been \$19.20. Find the number of yards of carpet.

8. How much water must be mixed with 30 gal. of wine at \$3 a gal. in order to make it worth \$2 a gal.?

9. Divide \$56 among 2 men and 3 women, giving each man twice as much as each woman.

10. State how you solved each of the above examples.

11. Find the wages due a workman who has worked 45 hr. at \$1.80 a day of 9 hr. each.

12. If 3 T. of coal are worth \$18, and 8 T. are given for 12 thousand shingles, how much are the shingles a thousand?

13. If 20 A. of land are bought for \$600, how much per acre must they be sold for that the purchaser may double his money?

14. I divide 33 marbles between two boys, giving one 9 more than the other. How many will each have?

15. Into how many townships can a tract of land 18 mi. square be divided, a township being 6 mi. square.

16. A rectangle is 12 in. long and 6 in. wide. How many times is it greater than a triangle whose base is 6 in. and altitude 4 in.

17. Give three pairs of factors of 18. Give the dimensions of three rectangles of different shape, the area of each of which is 18 sq. in.

18. Give the dimensions of as many rectangles as you can whose area is 24 sq. in.; 20 sq. in.; 36 sq. in.; 48 sq. in.; 60 sq. in.

SQUARE ROOT

Lesson 18

1. What is the product of 4 and 4? Of 6 and 6?
Of 8 and 8?

2. How many units of area in a square whose side contains 4 units of length? 6 units of length? 8 units of length?

3. What is the length of the side of a square containing 16 units of area? 36 units of area? 64 units of area?

4. We say that the square of 4 is 16 ($4^2 = 16$), and that the square root of 16 is 4 ($\sqrt{16} = 4$).
 $6^2 = ?$ $\sqrt{36} = ?$ $8^2 = ?$ $\sqrt{64} = ?$

5. Find the square of each number from 1 to 12 inclusive, and commit to memory.

6. What is the square root of 25? 81? 4? 121? 1? 9? 144? 16? 64? 49? 36? 100?

7. What is the side of a square flower bed that contains 16 sq. ft.? The perimeter of a square room containing 25 sq. yd.?

8. A man drives around a square township containing 36 square miles at the rate of 8 mi. an hour. How long does it take him? Give the statement of balance in this and the following questions. (The number of hours = the perimeter \div 8 mi.)

9. Two boys race on bicycles. They start together, and the first goes around a square block containing 36 sq. mi. at the rate of 10 mi. an hour, and the second around a square block containing 49 sq. mi. at the rate of 12 mi. an hour. Who comes in first, and by how many minutes?

10. If two squares whose sides are respectively 3 in. and 4 in. were cut up and placed in the form of a square, what would be the length of its side?

11. If an 8-in. square were cut out of a 10-in. square, how large a square could be made out of the remainder?

12. Find the length of the side of a chicken coop in the form of a square containing 13 sq. yd. 4 sq. ft.

13. Find the squares of 13, 14, 15, 16, 17, 18, 19, 20, and 25, and memorize your results.

14. What is the square root of 225? 169? 289? 400? 900? 3600? 256? 196? 625? 361?

15. A city playground contains 675 sq. yd. and is 3 times as long as it is broad. Find its length and breadth.

16. A lady bought ribbon, paying as many cents a yard as she bought yards. The whole cost was \$1.96. How many yards did she buy, and at what price per yard?

17. Draw two lines respectively 3 in. and 4 in. long at right angles. Join the other end of these lines. Measure the line thus drawn. How long

is it? The length of this *hypotenuse* (5 in.) of the right triangle can be found from 3 and 4 without measuring. How? Test your method in other right triangles.

18. *To find the hypotenuse of a right triangle, square the measures of the lengths of its base and altitude. Take the square root of their sum.*

19. Find the hypotenuse of a right triangle whose base is 8 ft. and altitude 6 ft.

20. Find the diagonals of an oblong field whose sides are 15 rd. and 8 rd.

21. What is the base of a right triangle whose hypotenuse is 13 ft. and altitude 5 ft.?

22. The top of a ladder 15 ft. long rests against the side of a building 12 ft. from the ground. How far is its foot from the wall?

23. A square rug contains 256 sq. ft. If it is put in the centre of a square room 6 yd. long, how far is its edge from the wall?

24. Find the length of the longest straight line that can be drawn on the floor of a room 20 ft. long and 15 ft. wide.

25. A rug 8 ft. by 6 ft. lies in the centre of a room 16 ft. by 12 ft. How far is the corner of the rug from the corner of the room?

26. An oblong containing 4 3-in. squares is equal in area to how many 2-in. squares? 25 4-in. squares are equal in area to how many 5-in. squares?

GREATEST COMMON MEASURE AND LEAST COMMON MULTIPLE

Lesson 19

1. Name all the units of length that will exactly measure a line 12 in. long and also a line 18 in. long.
2. Name the largest unit that will exactly measure both lines.
3. What is the greatest common measure of the following quantities: 15 ft., 25 ft.; 16 yd., 24 yd.; 35 mi., 56 mi.; 36 gal., 63 gal.; 28 qt., 40 qt.; 77 bu., 56 bu.; 24 lb., 104 lb.
4. What is the largest measure that can be used to measure the capacity of two cans which contain 28 qt. and 36 qt.? In this and the following examples give the statements of balance. (The largest measure = the G. C. M. of 28 qt. and 36 qt.)
5. What is the length of the longest board that can be used to build a fence around a garden 64 ft. long and 40 ft. wide?
6. What is the largest unit of money that can be used to pay each of two debts, one of \$60 and the other of \$100?

7. A farmer has 39 bu. of wheat and 45 bu. of corn, which he puts into sacks of equal size without mixing the two kinds of grain. How many bushels must each sack contain in order to be as large as possible, and how many sacks were there of each kind?

8. What is the greatest common measure of 42 and 54? 44 and 72? 63 and 98? 75 and 85?

9. Prove, in the case of the numbers given in example 8, that the greatest common measure of two numbers will also divide their sum or difference.

10. A rectangular piece of tiling 1 yd. 1 ft. 6 in. long and 2 ft. wide is made of square tiles. Find the largest possible tile that can be used and the number that will be required.

11. On attempting to divide 39 marbles between several boys there were 4 left over. If there had been 58, there would have been 3 left over. How many boys were there?

12. What is the shortest distance that will exactly contain the units 4 in. and 5 in.? 3 in. and 7 in.? 4 in. and 6 in.? 6 in. and 8 in.? 9 in. and 12 in.? 10 in. and 15 in.? 20 in. and 30 in.?

13. Two bells toll at intervals of 5 sec. and 6 sec. respectively, and begin to toll at the same instant. When will they next toll together?

14. What is the least number of acres that will admit of being divided into farms of 60 A. or 80 A. each?

15. Arthur can ride around a two-mile block in 12 min. and Cecil in 10 min. If they start together, when will they be together again? How many times will each go round the block in the time?

16. What is the least sum of money with which I can buy sheep at \$6 apiece or cows at \$26?

17. Find the least sum of money with which you can buy an exact number of a dozen lemons or bananas at 20¢ and 15¢ a dozen respectively.

18. What is the least number which, when divided by 6 or 7, leaves 3 as remainder in each case?

19. Find the least number which, when divided by 4, 6, or 8, leaves 2 as remainder in each case.

20. The fore and hind wheels of a carriage are 9 ft. and 12 ft. in circumference. Find the least number of revolutions of each that will bring them to the same relative position as at starting.

21. Find the L. C. M. of the denominators of the following fractions :

$$\frac{1}{2}, \frac{1}{3}; \frac{2}{3}, \frac{1}{4}; \frac{2}{3}, \frac{5}{6}; \frac{3}{5}, \frac{1}{3}; \frac{2}{3}, \frac{7}{9}; \frac{3}{7}, \frac{8}{21}; \frac{5}{12}, \frac{1}{18}.$$

22. What is the least number of parts into which the primary unit 1 yd. must be divided in order that both $\frac{1}{3}$ yd. and $\frac{1}{4}$ yd. may be expressed by a whole number of parts? How many parts in each case?

23. As in example 22, give the least number of parts into which the primary unit must be divided

and the number of parts equal to the given quantities in the following: $\frac{1}{9}$ yd., $\frac{1}{4}$ yd.; $\frac{1}{4}$ ft., $\frac{1}{5}$ ft.; $\frac{2}{3}$ lb., $\frac{1}{4}$ lb.; $\frac{3}{4}$ gal., $\frac{1}{8}$ gal.; $\frac{2}{7}$ bu., $\frac{3}{5}$ bu.; $\$ \frac{1}{8}$, $\$ \frac{5}{6}$.

24. Solve as in example 23: $\frac{2}{3}$ da., $\frac{1}{8}$ da.; $\frac{1}{6}$ yr., $\frac{1}{7}$ yr.; $\frac{5}{9}$ wk., $\frac{1}{8}$ wk.; $\frac{2}{3}$ hr., $\frac{3}{4}$ hr.; $\frac{5}{6}$ min., $\frac{6}{7}$ min.; $\frac{5}{6}$ mo., $\frac{5}{9}$ mo.

25. Solve as in example 23: $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{6}$; $\frac{1}{2}$, $\frac{2}{3}$, $\frac{5}{6}$; $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{5}$; $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$; $\frac{1}{2}$, $\frac{1}{6}$, $\frac{1}{7}$; $\frac{3}{4}$, $\frac{11}{12}$, $\frac{7}{8}$.

FRACTIONS

Lesson 20

1. If on measuring a certain unknown quantity with a unit 1 ft. in length I count 5 units in the quantity, then I know that the quantity is 5 ft. Similarly, if I measure another quantity with a unit 2 ft. in length and count 4 units in the quantity, I know that it is 4 (2 ft.). If I measure a third quantity with a unit $\frac{1}{4}$ ft. in length and count 3 units in the quantity, then I know that it is 3 times the unit $\frac{1}{4}$ ft. or $\frac{3}{4}$ ft. Thus when a measured quantity is denoted by the expression $\frac{3}{4}$ ft., the measuring unit is $\frac{1}{4}$ ft. and the number of units in the quantity is 3.

Let actual work be done in measuring unknown quantities with fractional units.

2. I measured a quantity with the unit $\frac{1}{6}$ ft. and counted 5 units. What was the quantity?

3. Name the quantities which, when measured by the following units, give the numbers indicated:

UNIT	NUMBER	UNIT	NUMBER
$\frac{1}{9}$ yd.	4	$\frac{1}{6}$ hr.	7
$\frac{1}{12}$ ft.	7	$\frac{1}{7}$ gal.	4
$\frac{1}{8}$ mi.	3	$\frac{1}{5}$ bu.	3
$\frac{1}{12}$ lb.	11	$\frac{1}{8}$ T.	13
$\frac{1}{4}$ lb.	5	$\frac{1}{6}$ doz.	9

4. I measured the quantity of milk in a pitcher with a measure containing $\frac{1}{2}$ qt., and in so doing filled it 5 times. Find the quantity of milk in the pitcher.

5. I measured a distance and found it equal to $\frac{3}{4}$ ft. What unit did I use and how often did I measure?

6. In each of the following quantities name the measuring unit and give the number of units that measure the quantity: $\frac{3}{4}$ ft.; $\frac{5}{8}$ yd.; $\frac{2}{7}$ gal.; $\frac{7}{9}$ sq. yd.; $\frac{11}{20}$ A.; $\frac{6}{13}$ cd.; $\frac{1}{2}$ sq. mi.; $\frac{7}{15}$ T.

7. What is the measuring unit for the quantity $\frac{5}{6}$ ft.? Into how many parts do we think of the primary unit, 1 ft., as being divided to give the measuring unit $\frac{1}{6}$ ft.?

8. Name the primary units indicated by the following quantities and state into how many parts we think of them as being divided in order to give the measuring units: $\frac{2}{3}$ ft.; $\$ \frac{9}{10}$; $\frac{6}{11}$ lb.; $\frac{7}{8}$ sq. yd.; $\frac{9}{10}$ cu. yd.; $\frac{8}{5}$ A.; $\frac{1}{7}$ yr.; $\frac{4}{5}$ mo. Name the measuring unit in each case.

9. Find $\frac{1}{2}$ of \$10; $\frac{1}{3}$ of 9 lb.; $\frac{1}{4}$ of 16 mi.; $\frac{1}{2}$ of 19 hr.; $\frac{1}{3}$ of 28 T.; $\frac{1}{4}$ of 37 A.

10. How do you find $\frac{1}{2}$ of a quantity? (Divide the quantity by 2.) How do you find $\frac{1}{3}$ of a quantity? $\frac{1}{4}$? $\frac{1}{5}$? $\frac{1}{6}$? $\frac{1}{7}$? $\frac{1}{8}$? $\frac{1}{9}$? $\frac{1}{10}$? $\frac{1}{11}$? $\frac{1}{12}$?

11. Find the fractions, given in example 10, of these quantities: \$30; 24 mi.; 45 yr.; 66 A.; 42¢.

12. Find $\frac{2}{3}$ of \$12; $\frac{3}{4}$ of 20¢; $\frac{2}{5}$ of 25¢; $\frac{5}{6}$ of 24 hr.; $\frac{4}{7}$ of 28 da.

13. How do you find $\frac{2}{3}$ of a quantity? (Divide the quantity by 3 and multiply by 2.) How do you find $\frac{3}{4}$ of a quantity? $\frac{2}{5}$? $\frac{5}{6}$? $\frac{4}{7}$? How do you find any fraction of a quantity?

14. Find $\frac{5}{6}$ of 18; $\frac{6}{7}$ of 49; $\frac{5}{8}$ of 72; $\frac{7}{9}$ of 54; $\frac{3}{10}$ of 80; $\frac{8}{11}$ of 88; $\frac{5}{12}$ of 48.

15. Can you find a fraction of a quantity by multiplying it by the numerator and dividing the product by the denominator? Find in two ways the value of $\frac{2}{3}$ of \$12; $\frac{3}{4}$ of \$8; $\frac{5}{6}$ of \$18; $\frac{4}{7}$ of \$14.

16. By the method given in example 15, find the value of the following: $\frac{2}{3}$ of 7; $\frac{3}{4}$ of 11; $\frac{2}{5}$ of 12; $\frac{5}{6}$ of 10, $\frac{3}{7}$ of 15; $\frac{5}{8}$ of 20; $\frac{4}{9}$ of 13; $\frac{3}{10}$ of 23.

17. If I cut a piece of string 48 in. long into halves, what will be the length of each piece? If into thirds? Into fourths? Fifths? Sixths? Sevenths? Eighths?

In examples 18 to 28 give the statements of balance.

18. A boy had 30 words in his spelling lesson and spelled correctly $\frac{5}{6}$ of them. How many did he spell correctly?

19. A man is 32 yr. old, and his wife $\frac{3}{4}$ as old. What is her age?

20. James rode 28 mi. on his bicycle in $2\frac{1}{2}$ hr., and Harry $\frac{3}{4}$ as far. How far did Harry ride?

21. During the month of April a commercial traveller was away from home $\frac{5}{6}$ of the time. How many days was he away?

22. A merchant bought cloth for 60¢ a yard and sold it for $\frac{6}{5}$ of the cost. Find the selling price.

23. A man earns \$20 a week, and his son $\frac{2}{5}$ as much. Find the sum of their earnings.

24. A man whose salary is \$30 a week pays $\frac{1}{6}$ of it for rent and $\frac{2}{5}$ of it to meet other expenses. How much does he spend a week and how much does he save?

25. A man who earns \$32 a week spends $\frac{1}{8}$ of it for meat and $\frac{1}{7}$ of the remainder for groceries. How much does he spend each week for meat and groceries.

26. A horse which cost \$98 was sold for $\frac{6}{7}$ of the cost price. Find the loss on selling.

27. A house is sold for \$2400, and $\frac{3}{4}$ of that sum is paid down. How much remains unpaid?

28. What actual coins and how many of each kind are equal, respectively, to $\frac{3}{4}$, $\frac{7}{10}$, and $\frac{9}{20}$ of \$1?

Lesson 21

1. Find $\frac{1}{2}$ of \$12; $\frac{2}{3}$ of \$12; $\frac{1}{3}$ of \$12; $\frac{3}{5}$ of \$12; $\frac{1}{4}$ of \$12; $\frac{4}{5}$ of \$12; $\frac{1}{6}$ of \$12; $\frac{6}{6}$ of \$12.

2. Which is greater $\frac{2}{2}$ or $\frac{3}{3}$ or $\frac{4}{4}$ or $\frac{6}{6}$ of \$12? Of any quantity?

3. Show that $\frac{2}{2} = \frac{3}{3} = \frac{4}{4} = \frac{5}{5} = \frac{6}{6} = \frac{10}{10} = \frac{12}{12} = \frac{15}{15}$
 $\frac{20}{20} = \frac{30}{30} = \frac{60}{60}$ by taking these fractions of \$60.

4. What is $\frac{5}{5}$ of a quantity equal to? How can you write a fraction that is equal to 1?

5. How many hours are there in $\frac{1}{2}$ da.? $\frac{2}{4}$ da.? $\frac{3}{6}$ da.? $\frac{4}{8}$ da.?

6. What is meant by saying that $\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{4}{8}$?

7. $\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{4}{8} = \frac{5}{10} = \frac{6}{12} = \frac{7}{14} = \frac{8}{16} = \frac{9}{18} = \frac{10}{20}$.

What is the relation between the denominator of a fraction and the numerator in order that a fraction may be equal to $\frac{1}{2}$?

8. How many inches are there in $\frac{1}{3}$ yd.? $\frac{2}{6}$ yd.? $\frac{3}{9}$ yd.? $\frac{4}{12}$ yd.? Name ten fractions each equal to $\frac{1}{3}$.

9. Name fractions equal to $\frac{1}{4}$; $\frac{1}{5}$; $\frac{1}{6}$; $\frac{1}{7}$; $\frac{1}{8}$; $\frac{1}{9}$; $\frac{1}{10}$; $\frac{1}{11}$; $\frac{1}{12}$.

10. What change can be made in the numerator and denominator of such a fraction as $\frac{1}{4}$ without altering its value?

11. $\frac{2}{3}$ yd. = ? in. $\frac{4}{6}$ yd. = ? in. $\frac{6}{9}$ yd. = ? in.
 $\frac{8}{12}$ yd. = ? in. $\frac{12}{18}$ yd. = ? in. $\frac{24}{36}$ yd. = ? in. Name five fractions each equal to $\frac{2}{3}$.

12. What change can be made in the numerator and denominator of such a fraction as $\frac{2}{3}$ without altering its value?

13. By what process is $\frac{2}{3}$ changed to $\frac{8}{12}$ or $\frac{12}{18}$?
 By what process is $\frac{6}{9}$ or $\frac{24}{36}$ changed to $\frac{2}{3}$?

14. $\frac{3}{4}$ da. = ? hr. $\frac{6}{8}$ da. = ? hr. $\frac{9}{12}$ da. = ? hr
Name five fractions each equal to $\frac{3}{4}$.

15. Show that $\frac{2}{5} = \frac{4}{10} = \frac{6}{15} = \frac{8}{20} = \frac{12}{30}$ by finding the number of minutes in each of these fractions of an hour.

16. Name five fractions equal to each of the following: $\frac{3}{5}$, $\frac{4}{5}$, $\frac{5}{6}$, $\frac{2}{7}$, $\frac{3}{8}$, $\frac{7}{9}$, $\frac{9}{10}$.

17. When we use the expression $\frac{2}{3}$ yd., we think of 1 yd. as divided into how many parts? When we change $\frac{2}{3}$ yd. to $\frac{8}{12}$ yd., we think of each of these parts as divided into how many parts?

18. Why can you multiply both terms of a fraction by the same number without changing the value of the fraction?

19. 1 yd. is equal to how many halves of a yard? How many thirds of a yard? Fourths? Fifths? Sixths?

20. 1 ft. is equal to how many fourths of a foot? 2 ft. is equal to how many thirds of a yard?

21. Express \$1 as 4ths of a dollar; \$5 as 4ths; 6 yd. as 3rds; 2 ft. as 12ths; 8 gal. as 4ths. In each case name the measuring unit of the quantity expressed as a fraction. Name this unit also as an actual unit in common use.

22. Express 8 wk. as 7ths of a week; 6 yr. as 12ths; 10 da. as 24ths; 5 min. as 60ths; 9 pk. as 8ths; 11 bu. as 4ths.

23. In each example in the preceding question name the direct measuring unit as an actual unit of measure in common use.

24. What is $\frac{3}{4}$ of 24 equal to? If 1 yd. is divided into 24 equal parts, into how many parts is $\frac{3}{4}$ yd. divided? $\frac{3}{4}$ yd. = $\frac{?}{24}$ yd.

25. Reduce $\frac{3}{4}$ lb. to 12ths; $\frac{5}{8}$ lb. to 16ths; $\frac{3}{7}$ qt. to 21sts; $\frac{4}{9}$ da. to 36ths; $\$ \frac{2}{3}$ to 15ths; $\frac{3}{5}$ hr. to 30ths.

26. Express as fractions with 100 as denominator: $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, $\frac{4}{5}$, $\frac{1}{10}$, $\frac{7}{10}$, $\frac{9}{10}$, $\frac{1}{3}$, $\frac{2}{3}$, $\frac{1}{6}$, $\frac{5}{6}$, $\frac{1}{7}$, $\frac{1}{8}$, $\frac{1}{9}$.

Lesson 22

1. Reduce the following to their lowest terms: $\frac{6}{8}$ ft.; $\frac{4}{6}$ yd.; $\frac{8}{12}$ mi.; $\frac{16}{20}$ da.; $\frac{12}{16}$ hr.; $\frac{15}{35}$ bu.; $\frac{12}{27}$ pk.

2. Reduce to their lowest terms: $\frac{9}{15}$, $\frac{14}{22}$, $\frac{20}{48}$, $\frac{15}{18}$, $\frac{24}{39}$, $\frac{16}{28}$. How do you reduce a fraction to its lowest terms?

3. Reduce to their lowest terms:

$$\frac{36}{60}, \frac{33}{51}, \frac{42}{54}, \frac{78}{87}, \frac{24}{99}, \frac{63}{84}.$$

4. From a rope 30 yd. long I cut off 20 yd. for a clothes-line. What part of the whole piece was cut off?

5. Express as a fraction of 2 doz.:

4, 6, 3, 8, 10, 9, 12, 15, 20, 30, 36.

6. Express as a fraction of a peck:

1 qt., 4 qt., 2 qt., 6 qt., 8 qt., 9 qt., 12 qt., 14 qt.

7. Express as a fraction of an hour: 20 min., 15 min., 40 min., 60 min., 45 min., 80 min., 90 min.

8. Express as a fraction of a bushel :
8 qt., 24 qt., 28 qt., 16 qt., 36 qt., 48 qt., 80 qt.

9. Express as a fraction of 2 ft. 6 in.: 10 in., 6 in., 9 in., 15 in., 20 in., 24 in., 30 in., 36 in., 45 in.

10. What part of a mile is 220 yd.? 880 yd.? 440 yd.? 176 yd.? 160 yd.? 480 yd.? What part of an acre is 484 sq. yd.? 121 sq. yd.? 242 sq. yd.? 968 sq. yd.? 605 sq. yd.?

11. If \$6 is used as a measure of \$12, what number expresses the measurement? If \$6 is used as a measure of \$6, what is the number? If \$6 is used as a measure of \$3, what is the number? What is the ratio of \$3 to \$6?

12. If 8 lb. is used as a measure of 48 lb., what number expresses the measurement? Of 32 lb.? 16 lb.? 8 lb.? 4 lb.? 6 lb.? 2 lb.?

13. Frank had 32 marbles and gave 12 of them to his brother. What part of them did he give away? What part did he keep?

14. A dealer sold a bicycle which cost him \$40 at an advance of \$25. The gain was what part of the cost?

15. Of a farm of 90 A., 40 A. are in wheat, 25 A. in oats, 15 A. in corn, and the remainder in pasture. What part of the farm is devoted to each purpose?

16. I paid 12¢ for berries, 14¢ for peas, and 10¢ for beans. What part of whole sum was paid for each?

17. At 64¢ a yd., how much cloth can I buy for 48¢?

18. At 20¢ a quire, what part of a quire of paper can I buy for 15¢? How many sheets?

19. A man walks a certain distance in 6 hr. What part of it does he walk in 2 hr.? In 3 hr.? In 4 hr.? In 1 hr.? In $\frac{1}{2}$ hr.? In $\frac{1}{4}$ hr.?

20. I had \$30 and spent $\frac{1}{2}$ of it for an overcoat and $\frac{1}{3}$ of it for a bicycle suit. What was the cost of both? This is what part of \$30?

21. The smaller of two numbers is 16 and their sum 40. Their difference is what part of their sum?

22. On $\frac{1}{4}$ of a field containing 12 A. I sowed oats; on $\frac{2}{3}$ of the remainder wheat. What part of the field did I sow in wheat?

23. A pipe will fill a tank containing 300 gal. in 10 hr.; a second pipe will fill it in 5 hr. How many gallons will enter the tank in 1 hr. if both pipes are open? This is what part of the capacity of the tank?

24. A can do a piece of work measured by 20 units in 4 hr., and B in 5 hr. How many units of work will they do in 1 hr., working together? This is what part of the whole work?

25. A sum of money is divided between A and B so that A gets twice as much as B. What part of the money does each get? If the money is \$63, what does each get?

26. I bought 2 bu. of plums put up in 4 boxes of equal size, each of which was divided into two equal parts. What part of a bushel did each part contain? What part of half a bushel?

Lesson 23

1. \$240 was divided between A and B, so that B received three times as much money as A. How many units represent the entire sum? A receives what part? B what part? How much in each case?

2. \$180 was divided among A, B, and C. B received twice as much as A, and C as much as A and B together. What part of the money did each receive? How many dollars?

3. In one corner of an oblong 8 in. by 3 in. is drawn an oblong 3 in. by 2 in. The small oblong occupies what part of the area of the large one?

4. At a recent election 150 votes were cast in favor of the successful candidate and 120 for his opponent. The majority was what part of the whole number of votes?

5. A 3-in. square is what part of a 6-in. square?

6. A 3-in. cube is what part of a 6-in. cube?

7. A bookcase, 6 ft. high and 4 ft. wide, is put at one end of a room 12 ft. wide and 9 ft. high. What part of the wall space does it occupy?

8. A rug consists of a centre piece 4 ft. square and a border 2 ft. wide. What part of the whole rug is the centre piece? The border is what part?

9. A tablecloth 10 ft. long is folded under 2 ft. The part folded under is what fraction of what is needed for a tablecloth?

10. How often will a line 6 in. long measure a line 18 in. long? 3 is often called the *ratio* of 18 in. to 6 in.

11. What part of a line 18 in. is equal to a line 6 in. long? $\frac{1}{3}$ is often called the *ratio* of 6 in. to 18 in.

12. What is the ratio of 20 in. to 5 in.? Of 5 in. to 20 in.?

13. What is the ratio of 6 A. to 24 A.? If 24 A. of land cost \$720, what will 6 A. cost at the same rate?

14. If 20 bu. of wheat cost \$16, what will 4 bu. cost at the same rate?

15. The ratio of the value of a purse to the money in it is $\frac{1}{6}$. If there is \$12 in the purse, what is the value of the purse?

16. Give the multiplication table of 4. Name numbers of which 4 is the ratio. Of which $\frac{1}{4}$ is the ratio.

17. Give numbers of which the ratio is $5, \frac{1}{5}$; $6, \frac{1}{6}$; $7, \frac{1}{7}$; $\frac{1}{8}$; $\frac{1}{9}$; $\frac{1}{10}$; $\frac{1}{11}$; $\frac{1}{12}$.

18. What is the ratio of the cost of 5 yd. of ribbon to that of 15 yd.? If 15 yd. of ribbon cost \$1.83, what will 5 yd. cost at the same rate?

19. What is the ratio of 3 in. to 4 in.? Of 4 in. to 3 in.? Of 3 in. to 8 in.? Of 8 in. to 3 in.?

20. What is the ratio of a line 3 2-in. long to a line 4 2-in. long? Of a line 3 3-in. long to a line 4 3-in. long? Of a line made up of 3 units of any length to a line made up of 4 units of the same kind? Of 4 units to 3 units?

21. What is the longest unit that will exactly measure lines 12 in. long and 20 in. long? How many times in each case? What is the ratio of 12 in. to 20 in.? Of 20 in. to 12 in.?

22. What is the ratio of 12 ft. to 20 ft.? Of \$12 to \$20? Of \$20 to \$12? Of 20 da. to 12 da.? Of 12 da. to 20 da.?

23. If a boy earns \$30 in 20 da., what part of \$30 will he earn in 12 da.? How much?

24. If 12 yd. of cloth cost \$21, what fraction of \$21 will 20 yd. cost? How much?

What is the largest unit that will exactly measure the following quantities, and what is the ratio in each case?

25. 18 bu., 27 bu.; 27 bu., 18 bu.; 24 bu., 32 bu.; 20 bu., 30 bu.; the cost of 30 bu. of potatoes to that of 42 bu.; of 42 bu. to that of 30 bu.

26. If 42 bu. of potatoes cost \$28, what will 30 bu. cost at the same rate?

27. \$28, \$35; \$48, \$72; \$45, \$25; \$25, \$45; \$54, \$42; of the number of days it will take to earn \$81 to the number it will take to earn \$99.

28. If a man earns \$99 in 66 da., in how many days will he earn \$81?

29. 24 yd., 30 yd.; 8 qt., 4 gal.; 6 qt., 2 pk.; 2 sq. yd., 20 sq. ft.; 36 sheets, 2 quires.

30. Find the gear of each of the following 28-in. wheel bicycles, in which the number of teeth in the front and rear sprockets is given:

Front sprocket = 24, 17, 20, 25, 19, 22, 27.

Rear sprocket = 8, 7, 8, 9, 8, 8, 9.

Lesson 24

1. What is the ratio of the cost of 6 qt. of berries to that of 2 qt.? At 2 qt. for 15¢, what will 6 qt. of blackberries cost?

2. What is the ratio of 24 lb. to 36 lb.? Of 36 lb. to 24 lb.? Which ratio do you use to solve the following question: If 24 lb. of coffee cost \$8, what will 36 lb. cost?

3. What is the ratio of the length of the shadow cast by a boy 4 ft. tall to that cast by a man 6 ft. tall? A man 6 ft. tall casts a shadow 9 ft. long. How long is the shadow cast by a boy 4 ft. tall?

4. Will it take 2 men longer or shorter to do a piece of work than 8 men? In what ratio? If 2 men can do a piece of work in 20 da., in how many days can 8 men do it?

5. Will it take more or fewer rolls of wall paper 18 in. wide to cover the walls of a room than of paper 22 in. wide? In what ratio? If 9 rolls of wall paper 22 in. wide are needed to paper a room, how many rolls 18 in. would have been needed?

6. What is the ratio of 16 oz. to 24 oz.? Of 24 oz. to 16 oz.? The carpet on a certain room weighs 24 oz. to the yard, and its entire weight is 45 lb. What would a carpet for the same room weigh if made out of carpet weighing 16 oz. to the lb.?

7. It costs \$9.60 to carpet a room with hemp carpet at 24¢ a yd. What would it cost with carpet at 15¢ a yd.?

8. The moulding for a room costs \$1.98 at 3¢ a ft. What would it cost at 4¢ a ft.?

9. I paid \$27 for a hat and a suit of clothes. If the suit cost 8 times as much as the hat, find the cost of both.

10. Imagine a line $2\frac{1}{4}$ ft. long. With 1 ft. as the measuring unit, can you count the number of parts? (No.) With $\frac{1}{4}$ ft. as the measuring unit, what number of parts can you count? (9.) Expressed in terms of the smaller unit, we have $2\frac{1}{4}$ ft. = $\frac{9}{4}$ ft.

11. With the following quantities and the given units, what number of parts can you count?

QUANTITY	UNIT	NUMBER
$4\frac{1}{3}$ ft.	$\frac{1}{3}$ ft.	?
$6\frac{2}{5}$ yd.	$\frac{1}{5}$ yd.	?
$3\frac{5}{6}$ da.	$\frac{1}{6}$ da.	?
$8\frac{3}{4}$ hr.	$\frac{1}{4}$ hr.	?
$6\frac{3}{8}$ bu.	$\frac{1}{8}$ bu.	?

Express each quantity in terms of the smaller unit.

12. Express each of these quantities in terms of the smaller unit: $8\frac{1}{4}$ mi., $6\frac{2}{3}$ A., $4\frac{2}{5}$ sq. mi., $3\frac{3}{7}$ sq. yd., $12\frac{3}{4}$ gal., $16\frac{2}{3}$ da.

13. In reducing $8\frac{3}{7}$ to an improper fraction, is it more convenient to think of 8 or of 7 as the multiplier? Reduce to improper fractions: $4\frac{1}{7}$, $3\frac{3}{7}$, $5\frac{5}{7}$, $1\frac{6}{7}$, $8\frac{6}{7}$, $6\frac{2}{7}$.

14. Reduce the following to improper fractions: $6\frac{3}{4}$, $8\frac{5}{6}$, $2\frac{8}{9}$, $4\frac{5}{9}$, $9\frac{3}{5}$, $1\frac{8}{9}$, $7\frac{1}{3}$, $14\frac{2}{7}$, $33\frac{1}{3}$, $16\frac{2}{3}$, $12\frac{1}{2}$, $11\frac{1}{9}$, $8\frac{1}{3}$.

15. Among how many children can you divide \$ $8\frac{3}{4}$ equally, if each child receives \$ $\frac{1}{4}$?

16. How many boxes of candy, each containing half a pound, can be put up from $8\frac{1}{2}$ lb.?

17. How many weeks will $3\frac{2}{3}$ T. of coal last a furnace that burns on the average $\frac{1}{3}$ T. a week?

18. How often is 5 contained in 19 and with what remainder? If you measure a line $1\frac{9}{5}$ ft. long with a foot rule, how often could you measure an exact number of feet? The remainder would be what part of a foot?

19. The expression $1\frac{9}{5}$ ft. denotes a quantity made up of 19 units each equal to $\frac{1}{5}$ ft. The expression $3\frac{4}{5}$ ft. denotes the *same quantity* divided into 3 parts, each equal to the *primary unit* 1 ft., and the remaining part divided into 4 parts, each equal to the direct measuring unit of the fraction; viz. $\frac{1}{5}$ ft.

20. Have you a clearer idea of the value of a quantity when expressed as $1\frac{9}{5}$ ft. or as $3\frac{4}{5}$ ft.?

21. Express the following quantities in terms of the primary units and the direct measuring units: $\frac{9}{4}$ ft., $\frac{28}{5}$ yd., $\frac{37}{8}$ mi., $\frac{100}{7}$ lb., $\frac{49}{6}$ T., $\$ \frac{84}{12}$, $\$ \frac{49}{5}$, $\frac{80}{11}$ A., $\frac{27}{4}$ A.

22. Name the two units of measurement in each quantity in example 21.

Reduce to integers and proper fractions :

23. $\frac{48}{11}$, $\frac{83}{9}$, $\frac{99}{6}$, $\frac{78}{12}$, $\frac{57}{9}$, $\frac{86}{4}$.

24. $\frac{100}{3}$, $\frac{200}{9}$, $\frac{100}{7}$, $\frac{25}{2}$, $\frac{25}{3}$, $\frac{50}{3}$.

25. $\frac{171}{8}$, $\frac{95}{6}$, $\frac{121}{9}$, $\frac{103}{12}$, $\frac{96}{9}$.

Lesson 25

1. Find the sum of: 2 in. and 3 in.; $\frac{2}{6}$ ft. and $\frac{3}{6}$ ft.; $\frac{3}{8}$ pk. and $\frac{4}{8}$ pk.; $\frac{4}{9}$ sq. yd. and $\frac{3}{9}$ sq. yd.; $\frac{2}{7}$ wk. and $\frac{5}{7}$ wk. How can you add $\frac{3}{8}$ and $\frac{4}{8}$?

2. Can you add $\frac{1}{2}$ ft. and $\frac{1}{4}$ ft. as you added the quantities in example 1? Why not?

3. To what unit must you reduce 2 gal. before you can add it to 3 qt.? 5 ft. before you can add it to 6 in.?

4. To what must you reduce $\frac{1}{2}$ before you can add it to $\frac{1}{4}$? $\frac{1}{2} + \frac{1}{4} = ?$ $\frac{1}{2} - \frac{1}{4} = ?$

5. $\frac{1}{2}$ of 12 = ? $\frac{1}{3}$ of 12 = ? $\frac{2}{3}$ of 12 = ? $\frac{3}{4}$ of 12 = ?
 $\frac{1}{6}$ of 12 = ? $\frac{3}{4}$ of 12 = ?

6. Reduce the following fractions to 12ths: $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{3}$, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{1}{6}$, $\frac{5}{6}$. How do you find the numerator when you reduce $\frac{3}{4}$ to 12ths? (Take $\frac{3}{4}$ of 12.)

7. Reduce to 10ths: $\frac{1}{2}$, $\frac{2}{2}$, $\frac{1}{5}$, $\frac{4}{5}$, $\frac{3}{5}$, $\frac{2}{5}$.

8. Reduce to 15ths: $\frac{1}{3}$, $\frac{2}{5}$, $\frac{2}{3}$, $\frac{4}{5}$, $\frac{4}{3}$, $\frac{6}{5}$.

9. Reduce to 16ths: $\frac{1}{2}$, $\frac{3}{8}$, $\frac{1}{4}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$.

10. Reduce to 18ths: $\frac{1}{3}$, $\frac{5}{6}$, $\frac{2}{9}$, $\frac{2}{3}$, $\frac{1}{6}$, $\frac{7}{9}$.

11. Reduce to 20ths: $\frac{1}{2}$, $\frac{3}{2}$, $1\frac{1}{2}$, $\frac{4}{5}$, $1\frac{2}{5}$, $\frac{7}{5}$, $\frac{3}{10}$, $1\frac{1}{2}$, $1\frac{9}{10}$.

12. Reduce to 24ths: $\frac{5}{6}$, $\frac{2}{3}$, $1\frac{1}{2}$, $\frac{3}{4}$, $\frac{5}{8}$, $1\frac{1}{2}$, $1\frac{1}{3}$, $1\frac{7}{8}$, $1\frac{3}{4}$, $1\frac{5}{6}$.

13. Reduce to 30ths: $\frac{1}{2}$, $1\frac{1}{3}$, $\frac{2}{3}$, $\frac{3}{5}$, $1\frac{2}{5}$, $\frac{5}{6}$, $\frac{9}{10}$, $1\frac{3}{5}$.

14. What is the least common denominator of the fractions $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$? Reduce them to equivalent fractions having this least common denominator for their common denominator.

Reduce to equivalent fractions having for their common denominator the least common denominator of the given fractions :

15. $\frac{1}{2}, \frac{1}{3}, \frac{1}{6}, \frac{1}{12}$; $1\frac{1}{2}, \frac{2}{3}, \frac{5}{6}, \frac{4}{9}$.

16. $\frac{1}{5}, \frac{3}{10}, \frac{2}{3}, \frac{5}{6}$; $\frac{3}{4}, 1\frac{1}{3}, \frac{5}{6}, \frac{3}{8}$.

17. $\frac{1}{4}, \frac{1}{7}, \frac{1}{2}, \frac{3}{4}$; $\frac{3}{5}, \frac{1}{6}, \frac{2}{15}, \frac{3}{10}$.

18. $2\frac{1}{2}, 1\frac{1}{3}, 1\frac{3}{4}, \frac{5}{6}$; $\frac{5}{8}, 1\frac{3}{4}, \frac{1}{16}, \frac{5}{12}$.

19. A piece of land containing $\frac{3}{4}$ A. is divided into lots each containing $\frac{1}{8}$ A. Find the number of lots and their selling price at \$800 each.

20. Pepper is sold in bottles each containing $\frac{1}{8}$ lb. How many of these bottles will contain $2\frac{3}{4}$ lb.?

21. How many tins each containing $\frac{1}{4}$ lb. of mustard will contain all together $2\frac{1}{2}$ lb.?

22. A charity organization divided 5 bbl. of flour among several families, giving each family $\frac{1}{4}$ bbl. How many families received help?

23. I spent \$ $\frac{3}{5}$ in buying collars at \$ $\frac{1}{10}$ each. How many collars?

24. A grocer sold $3\frac{1}{2}$ bbl. of flour in $\frac{1}{4}$ bbl. sacks at \$2 each. Find the total selling price.

25. A girl works a problem in arithmetic on the average in $\frac{1}{10}$ hr. How many will she work at this rate in $1\frac{1}{2}$ hr.?

ADDITION AND SUBTRACTION OF FRACTIONS

Lesson 26

1. What is the sum of $\frac{1}{2}$ and $\frac{1}{3}$? $\frac{1}{2}$ and $\frac{1}{6}$? $\frac{1}{5}$ and $\frac{1}{4}$?
 $\frac{1}{2}$ and $\frac{1}{5}$? $\frac{1}{3}$ and $\frac{1}{4}$?

2. What is the sum of $\frac{1}{3}$ and $\frac{1}{7}$? $\frac{1}{4}$ and $\frac{1}{6}$? $\frac{1}{6}$ and $\frac{1}{8}$?
 $\frac{1}{7}$ and $\frac{1}{6}$? $\frac{1}{6}$ and $\frac{1}{9}$?

3. A man whose lot contained $\frac{1}{2}$ A. bought an adjoining piece that contained $\frac{1}{4}$ A. How much did he then have?

4. A can do $\frac{1}{5}$ of a piece of work in an hour, and B $\frac{1}{6}$ of it. How much can they do in one hour working together?

5. Find the difference between $\frac{1}{3}$ and $\frac{1}{5}$; $\frac{1}{4}$ and $\frac{1}{7}$;
 $\frac{1}{4}$ and $\frac{1}{8}$; $\frac{1}{5}$ and $\frac{1}{9}$; $\frac{1}{6}$ and $\frac{1}{9}$; $\frac{1}{4}$ and $\frac{1}{12}$; $\frac{1}{8}$ and $\frac{1}{9}$.

6. Bought $\frac{1}{2}$ bbl. of flour. How much was left after using $\frac{1}{6}$ bbl.?

7. What is the difference between $\frac{1}{4}$ of my age and $\frac{1}{5}$ of it? If this is 2 yr., how old am I? If 6 mo., how old am I?

8. What is the sum of

$\frac{1}{4}$ and $\frac{3}{8}$?	$\frac{4}{5}$ and $\frac{1}{6}$?	$\frac{2}{3}$ and $\frac{1}{6}$?
$\frac{3}{4}$ and $\frac{5}{6}$?	$\frac{2}{3}$ and $\frac{5}{6}$?	$\frac{2}{3}$ and $\frac{1}{12}$?
$\frac{3}{4}$ and $\frac{2}{3}$?	$\frac{3}{7}$ and $\frac{3}{4}$?	$\frac{1}{2}$ and $\frac{2}{3}$?
$\frac{7}{12}$ and $\frac{2}{5}$?	$\frac{2}{5}$ and $\frac{3}{10}$?	$\frac{5}{9}$ and $\frac{1}{6}$?

9. Find the difference between the fractions in example 8.

10. If $\frac{1}{5}$ of the cost of a hat was 20 ¢, what did the hat cost?

11. If $\frac{2}{3}$ of the value of a house is \$1200, what is $\frac{1}{3}$ of its value? What is $\frac{3}{8}$ of its value? What is the house worth?

12. If $\frac{3}{4}$ of the size of a farm is 75 A., what is $\frac{1}{4}$ of its size? How many acres in the farm?

13. If $\frac{5}{6}$ of a boy's weight is 45 lb., how much does he weigh? What is your divisor here? Your multiplier? With the fractions $\frac{5}{8}$, $\frac{3}{4}$, $\frac{9}{10}$, $\frac{5}{7}$, respectively, what would your divisors and multipliers be?

14. The sum of $\frac{1}{3}$ and $\frac{1}{2}$ of a boy's weight is what part of it? If this is 60 lb., how much does the boy weigh?

15. A man invested $\frac{1}{4}$ of his money in business and $\frac{1}{3}$ of it in real estate. What part of his money did he invest in both? If this was \$14,000, how much money had he?

16. $1 - \frac{3}{4} = ?$ $1 - \frac{2}{5} = ?$ $1 - \frac{5}{7} = ?$ $1 - \frac{7}{8} = ?$
 $1 - \frac{5}{9} = ?$ $2 - \frac{5}{9} = ?$ $1 - \frac{5}{12} = ?$ $2 - \frac{2}{3} = ?$ $3 - \frac{1}{16} = ?$

17. A tailor cut off $\frac{2}{5}$ of a piece of cloth to make a suit of clothes. If 6 yd. are left in the piece, how many did it contain at first?

18. A cistern was $\frac{4}{9}$ full of water, and during a rain filled up $\frac{1}{3}$ more. The water was then 2 ft. from the top. How deep is the cistern?

19. The trunk of a tree was cut into three parts. The first contained $\frac{1}{3}$ of the length, the second $\frac{1}{4}$, and the third part was 20 ft. long. How long was the trunk?

20. A merchant sold cloth at 45¢ a yd., gaining $\frac{1}{4}$ of the cost. The selling price was what fraction of the cost? What was the cost per yard?

In examples 21–27 give the statements of balance.

21. A merchant sold apples at 60¢ a bushel, gaining $\frac{1}{3}$ of the cost. Find the cost.

22. A boy lost $\frac{1}{4}$ of his marbles and has 30 left. How many had he at first?

23. A man divides his lot into two parts, one of which, containing $\frac{3}{5}$ of the entire lot, he keeps for himself. The other part, which has a frontage of 100 ft., he sells. What is the frontage of the entire lot?

24. Two boys ran a race, and when the winner had reached the goal, the second boy, who was 10 yd. behind, had run $\frac{9}{10}$ of the whole distance. How long was the course?

25. Three boys ran a race, and when the winner reached the goal the second boy had run $\frac{8}{9}$ of the whole distance, and the third boy, who was 2 yd. behind him, had run $\frac{7}{8}$ of the whole distance. How long was the course?

26. The torrid zone extends $23\frac{1}{2}^\circ$ on each side of the equator. How many degrees wide is it?

27. How many degrees from the north pole to the equator? The frigid zone extends $23\frac{1}{2}^\circ$ from the north pole, and the torrid zone $23\frac{1}{2}^\circ$ north from the equator? Find the number of degrees in the north temperate zone.

Lesson 27

1. What is the sum of 3 and 2? Of $\frac{1}{2}$ and $\frac{1}{3}$?
Of $3\frac{1}{2}$ and $2\frac{1}{3}$?

2. Find the sum of the following :

$$2\frac{2}{5} \text{ and } 3\frac{1}{2}$$

$$3\frac{5}{6} \text{ and } \frac{1}{2}$$

$$4\frac{1}{4} \text{ and } 2\frac{2}{3}$$

$$4\frac{3}{8} \text{ and } 5\frac{3}{4}$$

$$3\frac{2}{3} \text{ and } 4\frac{1}{2}$$

$$2\frac{4}{9} \text{ and } 3\frac{5}{6}$$

$$2\frac{3}{4} \text{ and } 1\frac{2}{3}$$

$$4\frac{2}{3} \text{ and } 1\frac{4}{5}$$

$$2\frac{1}{6} \text{ and } 1\frac{1}{4}$$

$$2\frac{1}{2} \text{ and } 3\frac{4}{7}$$

$$4\frac{2}{5} \text{ and } 7\frac{2}{3}$$

$$\frac{5}{9} \text{ and } 2\frac{3}{4}$$

How do you add two fractions?

3. Find the difference between the following :

$$2\frac{3}{5} \text{ and } 1\frac{1}{2}$$

$$3\frac{5}{6} \text{ and } 1\frac{1}{2}$$

$$3\frac{2}{3} \text{ and } 2\frac{1}{4}$$

$$5\frac{3}{4} \text{ and } 4\frac{3}{8}$$

$$2\frac{3}{4} \text{ and } 2\frac{2}{3}$$

$$3\frac{4}{7} \text{ and } 1\frac{2}{9}$$

4.	$\frac{3}{2} - \frac{2}{3} = ?$	$1\frac{1}{2} - \frac{2}{3} = ?$
	$\frac{5}{8} - \frac{3}{4} = ?$	$1\frac{2}{3} - \frac{3}{4} = ?$
	$1\frac{1}{5} - \frac{1}{2} = ?$	$1\frac{3}{5} - \frac{2}{3} = ?$
	$6 = 1 + ?$	$6\frac{3}{5} - \frac{2}{3} = ?$
	$4\frac{1}{2} - \frac{3}{4} = ?$	$5\frac{1}{6} - \frac{1}{2} = ?$
	$7\frac{2}{3} - 4\frac{3}{4} = ?$	$8\frac{2}{5} - 4\frac{5}{6} = ?$

5. How do you find the difference between two such fractions as $8\frac{2}{5}$ and $4\frac{5}{6}$?

6. Find the difference between the following :

$4\frac{3}{7}$ and $\frac{7}{9}$	$4\frac{4}{5}$ and $3\frac{2}{3}\frac{2}{5}$
12 and $6\frac{9}{14}$	$6\frac{1}{2}$ and $5\frac{3}{4}$
$36\frac{1}{2}$ and $24\frac{5}{8}$	$3\frac{1}{2}$ and $2\frac{3}{10}$
$4\frac{1}{4}$ and $2\frac{3}{8}$	$12\frac{5}{7}$ and $8\frac{2}{5}$

7. Find the sum of the following :

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

8.	$\frac{1}{2} + \frac{1}{3} - \frac{1}{4} = ?$	$2\frac{1}{2} + 4\frac{1}{5} - 4\frac{1}{4} = ?$
	$\frac{1}{2} + \frac{3}{4} - \frac{1}{3} = ?$	$1\frac{1}{3} - 1\frac{1}{4} + 3\frac{1}{3} = ?$
	$\frac{1}{2} + \frac{1}{6} - \frac{1}{4} = ?$	$2\frac{1}{6} + 2\frac{1}{5} - 2\frac{1}{10} = ?$
	$\frac{1}{5} - \frac{3}{10} + \frac{1}{4} = ?$	$4\frac{3}{4} - 2\frac{1}{3} - 1\frac{1}{2} = ?$

9. A boy who had $\$4\frac{1}{4}$ earned $\$2\frac{3}{5}$ more. How many dollars did he then have?

10. A dress was made from two remnants, one containing $4\frac{7}{8}$ yd., and the other $8\frac{3}{4}$ yd. How many yards did the dress contain?

11. Two brothers gathered hickory nuts. The older gathered $2\frac{5}{6}$ bu., and the younger $2\frac{1}{4}$ bu. How many bushels did they gather together?

12. A lady is $48\frac{3}{4}$ yr. old, and her husband is $5\frac{1}{2}$ yr. older. Find his age.

13. A boy travelled $39\frac{5}{8}$ mi. on his bicycle and the next day $36\frac{3}{4}$ mi. How much farther did he travel the first day than the second?

14. What fraction subtracted from the sum of $\frac{1}{2}$ and $\frac{7}{8}$ will leave 1 for remainder?

15. A farmer divided a portion of his farm among his three sons, giving to the two oldest $\frac{1}{3}$ each, and to the youngest $\frac{1}{4}$ of it. What part of his farm did he divide. If this was 165 A., how large was his farm? What was each son's share?

16. Two boys contributed $\frac{1}{3}$ and $\frac{1}{4}$, respectively, toward the expenses of an outing. The third boy, who contributed the remainder, put in 75¢. What did the outing cost and what did each contribute?

17. A number is larger by 50 than $\frac{2}{3}$ of it. Find the number.

18. A man paid a debt in four payments. At first he paid $\frac{1}{2}$, then $\frac{1}{6}$, then $\frac{2}{9}$ of it, and finally \$500. Find the original debt and the amount of each payment.

19. My furnace burns $12\frac{5}{6}$ T. of coal during the winter, and my neighbor's $8\frac{3}{4}$ T. How much more does it cost me for coal than my neighbor, if coal is \$6 a ton?

20. A bicyclist travelling at the rate of 8 mi. an hour goes around a quadrilateral section of country of which the sides are $6\frac{1}{4}$ mi., $5\frac{1}{2}$ mi., $3\frac{3}{4}$ mi., and $6\frac{1}{2}$ mi. How long is he gone if he is delayed a quarter of an hour on the road?

21. If a certain number is increased by $\frac{2}{3}$ of itself the sum will equal 75. Find the number.

22. At the rate of 8 mi. an hour how far will a boy ride in two trips, one lasting $3\frac{3}{4}$ hr., and the other $4\frac{7}{8}$ hr., if he stops $\frac{1}{4}$ hr. during each trip?

23. The difference in weight between two parcels is $3\frac{1}{8}$ lb., and the lighter parcel weighs $12\frac{5}{16}$ lb. What is the weight of the heavier? Of both?

24. Divide $10\frac{1}{2}$ lb. of sugar into two parcels, one of which shall be $1\frac{1}{2}$ lb. heavier than the other.

25. What fraction must be added to the sum of $\frac{1}{3}$ and $\frac{1}{2}$ that their sum may be $\frac{8}{9}$?

MULTIPLICATION AND DIVISION OF FRACTIONS

Lesson 28

1. Find the cost of 10 yd. of cloth at $\$ \frac{3}{5}$ a yd. Name the *number*, the *unit*, and the *quantity*.

2. Find the cost of $\frac{3}{4}$ yd. of silk at $\$ 8$ a yd. Name the *number*, the *unit*, and the *quantity*.

3. In taking $\frac{3}{4}$ of a number is it better to divide by 4 and then multiply by 3, or to multiply first by 3 and then divide by 4? Test in these questions :

$$\frac{3}{4} \text{ of } 20 = ?$$

$$\frac{3}{4} \text{ of } 15 = ?$$

$$\frac{3}{4} \text{ of } 7 = ?$$

$$\frac{3}{4} \text{ of } 13 = ?$$

$$\frac{3}{4} \text{ of } 32 = ?$$

$$\frac{3}{4} \text{ of } 48 = ?$$

Find the cost of :

4. 10 lb. sugar at $5\frac{1}{2}$ ¢ a lb.

6 bu. potatoes at $\$ \frac{3}{5}$ a bu.

5 baskets melons at $\$ \frac{7}{20}$ a basket.

5. $\frac{1}{2}$ doz. 5-lb. jars butter at $\$ 1\frac{1}{10}$ each.

$\frac{3}{4}$ yd. cloth at $\$ 2$ a yd.

2 doz. yd. towelling at $\$ \frac{1}{8}$ a yd.

Find the weight of :

6. 8 yd. carpet at $1\frac{1}{2}$ lb. a yd.; $1\frac{1}{4}$ lb.; $1\frac{1}{16}$ lb.;

$1\frac{3}{16}$ lb.; $\frac{1}{16}$ lb.

7. 8 double rolls of wall paper at $1\frac{3}{4}$ lb. each; 6 double rolls; 12; 7; 9; 10.

8. 3 spoons at $\frac{1}{2}$ oz. each; 5 at $\frac{2}{3}$ oz. each; $\frac{3}{4}$ doz. at $\frac{5}{6}$ oz. each; $\frac{2}{3}$ doz. at $1\frac{2}{3}$ oz. each.

9. Half a dozen teaspoons, each $4\frac{7}{8}$ in. long are placed end to end; how long a line do they make? How long if each is $5\frac{1}{2}$ in. long? $5\frac{3}{4}$ in.?

10. How many ounces of pure silver in a dozen tablespoons weighing $1\frac{2}{3}$ oz. each, $\frac{3}{4}$ fine?

11. Reduce to inches: $\frac{2}{3}$ ft.; $1\frac{1}{2}$ ft.; $2\frac{1}{3}$ ft.; $3\frac{3}{4}$ ft.; $\frac{4}{7}$ ft.; $\frac{5}{9}$ ft.; $1\frac{5}{6}$ ft.

12. Reduce to yards: 2 rd.; 4 rd.; 6 rd.; 5 rd.; 9 rd.; 10 rd.; 12 rd.

13. Reduce to feet: 2 rd.; 6 rd.; 3 rd.; 10 rd.; 12 rd.

14. Reduce to quarts: $1\frac{3}{4}$ gal.; $\frac{3}{8}$ gal.; $1\frac{7}{8}$ gal.; $2\frac{1}{2}$ gal.; $3\frac{5}{16}$ gal.; $14\frac{3}{32}$ gal.

15. Reduce to square feet: $\frac{2}{3}$ sq. yd.; $\frac{7}{9}$ sq. yd.; $\frac{4}{5}$ sq. yd.; $2\frac{1}{3}$ sq. yd.

16. Reduce to ounces avoirdupois: $\frac{1}{2}$ lb.; $\frac{3}{4}$ lb.; $\frac{7}{8}$ lb.; $2\frac{1}{4}$ lb.; $5\frac{1}{2}$ lb.

17. What is the area of a table 3 ft. long and $2\frac{1}{2}$ ft. wide?

18. Find the areas of the floors of the following rooms:

LENGTH	WIDTH	LENGTH	WIDTH
8 yd.	$6\frac{3}{4}$ yd.	10 yd.	$7\frac{5}{6}$ yd.
9 yd.	$7\frac{2}{3}$ yd.	12 yd.	$8\frac{3}{4}$ yd.
7 yd.	$5\frac{1}{3}$ yd.	9 yd.	$6\frac{7}{8}$ yd.

19. Find the areas of the walls of the following rooms :

PERIMETER	HEIGHT	PERIMETER	HEIGHT
60 ft.	8 ft. 6 in.	80 ft.	10 ft. 4 in.
80 ft.	9 ft. 9 in.	90 ft.	9 ft. 4 in.

20. The base of a triangle is 12 ft. and the altitude 6 ft. 6 in. Find its area. (See p. 35, ex. 2.)

21. Reduce $2\frac{2}{3}$ and $4\frac{1}{2}$ to improper fractions.

$$\frac{1}{3} \text{ of } 4\frac{1}{2} = ? \quad 8 \times \frac{3}{2} = ? \quad 2\frac{2}{3} \times 4\frac{1}{2} = ?$$

22. How do you find the product of two numbers like $2\frac{2}{3}$ and $4\frac{1}{2}$?

23. Find the value of :

$$1\frac{1}{2} \times 3\frac{1}{3}$$

$$3\frac{3}{4} \times 1\frac{3}{5}$$

$$1\frac{2}{7} \times 9\frac{1}{3}$$

$$2\frac{2}{5} \times 4\frac{1}{6}$$

$$\frac{2}{5} \times \frac{4}{3}$$

$$7\frac{1}{3} \times 2\frac{2}{11}$$

$$\frac{2}{3} \times \frac{5}{7}$$

$$\frac{3}{4} \times \frac{5}{6}$$

$$2\frac{4}{7} \times 5\frac{1}{4}$$

$$8\frac{3}{4} \times 4\frac{4}{5}$$

24. Find the value of :

$$3\frac{3}{4} \times 5\frac{1}{3}$$

$$1\frac{3}{4} \times 2\frac{1}{2}$$

$$18\frac{1}{3} \times 3\frac{3}{5}$$

$$12 \times 1\frac{2}{5}$$

$$2\frac{3}{4} \times 6\frac{2}{3}$$

$$13\frac{1}{3} \times 4\frac{1}{5}$$

$$\frac{1}{4} \text{ of } \frac{2}{3} \text{ of } 12$$

$$\frac{3}{5} \text{ of } \frac{5}{8} \text{ of } 24$$

$$\frac{2}{3} \text{ of } \frac{5}{6} \text{ of } 36$$

$$4\frac{1}{2} \text{ of } \frac{4}{5} \text{ of } 15$$

$$\frac{2}{7} \text{ of } 4\frac{2}{3} \text{ of } 27$$

$$\frac{3}{5} \text{ of } 6\frac{1}{4} \text{ of } 8$$

25. If a man earns \$ $2\frac{3}{5}$ a day, how much will he earn in $3\frac{3}{4}$ da.?

26. Find the volume of a rectangular slab of granite $4\frac{1}{2}$ ft. long, $2\frac{1}{2}$ ft. wide, and $1\frac{1}{3}$ ft. thick.

27. What is the weight in pounds and ounces of a square piece of floor oil cloth $1\frac{1}{2}$ yd. long, weighing $3\frac{1}{2}$ lb. to the square yard?

28. What is the weight of a mat 27 in. wide, 48 in. long, which weighs $2\frac{1}{2}$ lb. to the square yard?

Lesson 30

1. If 1 bu. of corn is worth $\$ \frac{3}{5}$, what is $\frac{2}{3}$ bu. worth?

2. What will $5\frac{1}{3}$ T. of coal cost at $\$ 5\frac{1}{4}$ a ton?

3. What will a 5-gal. can of kerosene cost at $12\frac{1}{2}$ ¢ a gal.?

4. How many square miles are there in a section of country $4\frac{1}{2}$ mi. long and $2\frac{2}{3}$ mi. wide?

5. A piece of park is in the form of a triangle. If its base is $7\frac{1}{5}$ rd. and its altitude $6\frac{2}{3}$ rd., what is its area? (See Lesson 13, example 2.)

6. A lot in the form of a trapezoid is $9\frac{1}{2}$ rd. wide in front and $6\frac{1}{2}$ rd. wide in the back. If its depth is $10\frac{1}{4}$ rd., what is its area? (See Lesson 13, example 15.)

7. How far will a person travel in $5\frac{1}{2}$ hr. at $5\frac{1}{2}$ mi. an hr.?

8. How many yards in 1 rd.? How many square yards in 1 sq. rd.?

9. At $\$ \frac{3}{4}$ a yd., what part of a dollar will $\frac{5}{8}$ yd. cost?

10. A farmer can plough a field in 18 hr. What part of it can he plough in 2 hr.? In $3\frac{3}{5}$ hr.? In 2 hr. 15 min.? In 6 hr. 45 min.?

11. If $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{1}{2}$ of a board 20 ft. long is cut off, what length of board is left?

12. How much greater is $\frac{2}{11}$ of $2\frac{2}{5}$ rd. than 1 yd.?

13. Texas is $4\frac{2}{3}$ times as large as Illinois, and Illinois is $2\frac{1}{4}$ as large as West Virginia. How many times as large as West Virginia is Texas? What part of Texas is as large as West Virginia?

14. If Michigan is $\frac{10}{7}$ as large as California and Oklahoma is $\frac{2}{3}$ as large as Michigan, compare the area of Oklahoma with that of California.

15. If the population of the District of Columbia is $\frac{2}{3}$ that of Rhode Island, how many people live in the District of Columbia for every 99 who live in Rhode Island?

16. If the population of Utah is $\frac{1}{2}$ that of Colorado, and that of Colorado $\frac{1}{5}$ that of Michigan, how many people live in Utah for every 100 who live in Michigan? How many people in Michigan for every 100 in Utah?

17. The Mackenzie River is $\frac{1}{2}$ as long as the Amazon, and the Rio Grande $\frac{9}{10}$ as long as the Mackenzie. How long is the Rio Grande, the Amazon being 4000 mi. in length?

18. I bought a house and lot and paid $\frac{3}{4}$ of the cost price in cash? If this was \$3600, what was the cost price?

19. A man sold his horse, gaining $\frac{2}{7}$ of the cost price. If his gain was \$24, what did the horse cost him?

20. A man owned a $\frac{2}{3}$ interest in a factory and sold $\frac{3}{5}$ of his share. What part of the factory did he sell and what part did he keep?

21. A man invested $\frac{3}{7}$ of his money in a house. What part of his money was left? If he invested $\frac{1}{2}$ of this remainder in business, what part of his money did he invest in business? If this was \$2400, how much money had he at first?

22. A man spent $\frac{6}{11}$ of his money for a farm and $\frac{3}{5}$ of the remainder for cattle. If he paid \$1800 for the cattle, how much money had he at first?

23. A merchant bought goods to the amount of \$360, but he got $\frac{1}{3}$ off as a merchant, and then $\frac{1}{10}$ off the remainder by paying cash. What did the goods cost him?

24. A wholesale merchant sold goods amounting to \$600, but he deducted $\frac{1}{4}$ of the amount of the bill and then threw off $\frac{1}{10}$ of the remainder for cash. Find the net selling price.

25. A wholesale merchant threw off $\frac{1}{4}$ of the amount of a bill and then $\frac{1}{5}$ of the remainder, and the bill then amounted to \$300. What was the original bill?

26. A piece of cloth when measured with a yardstick that is $\frac{3}{8}$ in. too long seems to be $10\frac{2}{3}$ yd. long. How many inches longer than that is it? How many yd., ft., and in. long is it?

Lesson 31

1. Into how many parts, each 2 ft. long, can you divide a line 6 ft. long? $6 \text{ ft.} \div 2 \text{ ft.} = ?$

2. Imagine a line 1 ft. long divided into parts each $\frac{1}{3}$ ft. long. How many parts? $1 \text{ ft.} \div \frac{1}{3} \text{ ft.} = ?$

3. $1 \text{ ft.} \div \frac{1}{4} \text{ ft.} = ?$ $1 \text{ ft.} \div \frac{1}{6} \text{ ft.} = ?$

$1 \text{ ft.} \div \frac{1}{5} \text{ ft.} = ?$ $1 \text{ ft.} \div \frac{1}{8} \text{ ft.} = ?$

4. $1 \text{ lb.} \div \frac{1}{2} \text{ lb.} = ?$ $1 \text{ T.} \div \frac{1}{9} \text{ T.} = ?$

$1 \text{ A.} \div \frac{1}{8} \text{ A.} = ?$ $1 \text{ bu.} \div \frac{1}{10} \text{ bu.} = ?$

5. Into how many lots, each equal to $\frac{1}{6}$ A., can you divide 1 A.?

6. A society distributed 1 T. of coal to several families, giving to each $\frac{1}{8}$ T. How many families were there?

7. Into how many parts, each $\frac{1}{3}$ ft. long, can you divide a line 1 ft. long? 4 ft. long? 6 ft.?

$6 \text{ ft.} \div \frac{1}{3} \text{ ft.} = ?$ $4 \text{ ft.} \div \frac{1}{4} \text{ ft.} = ?$

$8 \text{ yd.} \div \frac{1}{5} \text{ yd.} = ?$ $9 \text{ hr.} \div \frac{1}{3} \text{ hr.} = ?$

$7 \text{ gal.} \div \frac{1}{7} \text{ gal.} = ?$ $5 \text{ bu.} \div \frac{1}{12} \text{ bu.} = ?$

8. A five-gallon can of maple syrup is emptied into jars, each containing $\frac{1}{4}$ gal. Find the number of jars.

Name the quantity, the unit, and the number.

9. A girl, working problems in arithmetic, did 2 in every $\frac{1}{4}$ hr. How many did she do in 2 hr.?

10. Into how many parts, each $\frac{1}{3}$ ft. long, can you divide a line 6 ft. long? How many of these 18 parts make $\frac{2}{3}$ ft.? How many parts, each equal to $\frac{2}{3}$ ft., can you count in these 18 parts.

$$6 \text{ ft.} \div \frac{2}{3} \text{ ft.} = ?$$

$$4 \text{ ft.} \div \frac{2}{3} \text{ ft.} = ?$$

11. In the first example in question 10 by what did you multiply 6 to get 18? By what did you divide 18 to get 9? Is it correct to divide by 2 first, and then multiply by 3? Which gives the smaller numbers?

12. How do you divide a whole number by a fraction?

13. Find the quotient in each of the following :

$$6 \text{ ft.} \div \frac{3}{4} \text{ ft.}$$

$$\$4 \div \$\frac{2}{5}$$

$$8 \text{ ft.} \div \frac{2}{3}$$

$$10 \text{ yd.} \div \frac{2}{3} \text{ yd.}$$

$$\$8 \div \$\frac{4}{3}$$

$$20 \text{ yd.} \div \frac{4}{5}$$

$$6 \text{ lb.} \div \frac{3}{5} \text{ lb.}$$

$$\$10 \div \$\frac{5}{6}$$

$$14 \text{ lb.} \div \frac{7}{8}$$

$$4 \text{ T.} \div \frac{4}{7} \text{ T.}$$

$$\$12 \div \$\frac{3}{4}$$

$$18 \text{ T.} \div \frac{9}{10}$$

$$10 \text{ A.} \div \frac{5}{2} \text{ A.}$$

$$\$14 \div \$3\frac{1}{2}$$

$$20 \text{ A.} \div 3\frac{1}{3}$$

14. How many strips of Brussels carpet $\frac{3}{4}$ yd. wide are needed to carpet a room 6 yd. wide? If this room is 8 yd. long, how many yards of carpet will be needed for the room, provided there is no waste in matching? How many yards will be needed if there is a waste of $\frac{1}{2}$ yd. on each strip in matching?

15. How many strips of hemp carpet $\frac{8}{9}$ yd. wide are needed to carpet a room 8 yd. wide? If the room is 10 yd. long, how many yards of carpet are needed for it?

16. What part of a yard is 18 in.? How many widths of wall paper 18 in. wide will be needed to paper a room whose perimeter is 20 yd.? A room whose perimeter is 90 ft.?

17. What part of a yard is 22 in.? How many widths of wall paper 22 in. wide will be needed to paper a room 6 yd. long and 5 yd. wide?

$$18. \quad 6 \div \frac{2}{3} = ? \qquad 8 \div \frac{4}{5} = ? \qquad \frac{6}{7} \times \frac{2}{3} = ?$$

$$\frac{6}{5} \div \frac{2}{3} = ? \qquad \frac{8}{15} \div \frac{4}{5} = ? \qquad \frac{6}{7} \div \frac{3}{2} = ?$$

How do you divide one fraction by another?

$$19. \quad \frac{1}{3} \div \frac{4}{5} = ? \qquad \frac{6}{5} \div \frac{3}{10} = ? \qquad \frac{2}{9} \div \frac{5}{7} = ?$$

$$\frac{1}{2} \div \frac{3}{4} = ? \qquad \frac{8}{9} \div \frac{4}{7} = ? \qquad 2\frac{1}{2} \div 1\frac{10}{17} = ?$$

$$\frac{3}{5} \div \frac{2}{7} = ? \qquad \frac{3}{8} \div \frac{6}{11} = ? \qquad 3\frac{1}{3} \div 1\frac{2}{3} = ?$$

$$\frac{7}{8} \div \frac{1}{2} = ? \qquad \frac{7}{10} \div 2\frac{1}{2} = ? \qquad 5\frac{2}{5} \div 7\frac{1}{5} = ?$$

What is the ratio of $\frac{1}{2}$ to $\frac{2}{3}$? Of $1\frac{1}{3}$ to $2\frac{2}{5}$? Of $2\frac{1}{3}$ to $1\frac{5}{9}$?

$$\begin{array}{lll}
 20. & 3\frac{1}{7} \div 5\frac{1}{2} = ? & 3\frac{1}{4} \div 5\frac{1}{5} = ? & 6\frac{2}{5} \div 2\frac{2}{3} = ? \\
 & 4\frac{2}{3} \div 3\frac{1}{2} = ? & 2\frac{3}{4} \div 5\frac{1}{2} = ? & 7\frac{7}{8} \div 2\frac{1}{4} = ? \\
 & 1\frac{3}{4} \div 1\frac{2}{5} = ? & 9\frac{1}{3} \div 1\frac{1}{14} = ? & 1\frac{5}{6} \div 2\frac{2}{3} = ?
 \end{array}$$

What is the ratio of $4\frac{1}{8}$ to $5\frac{1}{2}$? Of 6 to $16\frac{1}{2}$? $1\frac{2}{3}$ to $4\frac{4}{9}$?

21. How many rods in 22 yd.? In 33 yd.? Reduce to the fraction of a rod: $2\frac{3}{4}$ yd., $1\frac{5}{6}$ yd., $3\frac{1}{8}$ yd., $7\frac{1}{3}$ yd., $1\frac{1}{2}$ yd.

22. Reduce to the fraction of a foot: $2\frac{2}{5}$ in., $7\frac{1}{5}$ in., $3\frac{3}{4}$ in., $6\frac{6}{7}$ in., $2\frac{2}{3}$ in.

23. Reduce to the fraction of a yard: 1 ft. 6 in.; 2 ft. 3 in.; 2 ft. 6 in.

24. Reduce to fractions of 100: $11\frac{1}{9}$, $9\frac{1}{11}$, $14\frac{2}{7}$, $22\frac{2}{9}$, $44\frac{4}{9}$, $55\frac{5}{9}$, $33\frac{1}{3}$, $66\frac{2}{3}$, $6\frac{1}{4}$, $6\frac{2}{3}$.

25. Barbed wire weighs $1\frac{1}{16}$ lb. to the rod. How long is a roll of wire weighing $8\frac{1}{2}$ lb.?

26. A double roll of wall paper weighs $1\frac{3}{4}$ lb. How many double rolls weigh $17\frac{1}{2}$ lb.?

27. If carpet weighs 20 oz. to the yard, how many yards of carpet will weigh $32\frac{1}{2}$ lb.?

28. How many silver dessert spoons weighing 15 oz. per doz. will weigh $3\frac{1}{3}$ lb.?

29. How many silver spoons, each $5\frac{3}{4}$ in. long, placed end to end will make a line 5 ft. 9 in. long?

Lesson 32

In examples 1 and 2 the statements of balance are :

(1) The rate = 27 mi. \div $2\frac{1}{4}$

Or $2\frac{1}{4}$ times the rate = 27 mi.

(2) The actual distance = 12 yd. $- 1\frac{2}{8}$ in.

Give the statements of balance for the following examples in this lesson.

1. A bicyclist rode 27 mi. in 2 hr. 15 min. What was his rate in miles per hour?

2. If a yard measure is $\frac{1}{8}$ in. too short, what is the actual distance between two points which is found by this measure to be 12 yd. ?

3. After pumping out 360 gal. of water from a cistern, $\frac{5}{8}$ of the water still remained. How many gallons did the cistern contain at first?

4. After selling 400 bu. of wheat, a farmer had $\frac{3}{5}$ of his crop left. How many bushels remained unsold?

5. What part of a mile is 440 yd.? 30 sec. is what part of 1 min.? Of 1 hr.? A train travels 440 yd. in 30 sec. This is at the rate of how many miles an hour?

6. Railway fencing costs \$5.50 a rod. What is the cost of 1 yd. of fencing? Of 2 mi.?

7. Find the number which is 35 more than the sum of $\frac{1}{3}$ and $\frac{1}{5}$ of it. Prove your answer correct.

8. If to a certain number its $\frac{1}{2}$ and $\frac{1}{3}$ be added, the sum will be 66. Find the number. Prove your answer correct.

9. A man paid out $\frac{2}{5}$ of the money in his pocket to settle a grocery bill, $\frac{2}{3}$ of the remainder to settle a meat bill. If he had \$9 left, how much money had he at first? Prove your answer correct.

10. A lady spent $\frac{3}{7}$ of the money in her purse for a jacket, and $\frac{1}{4}$ of the remainder for a hat. If the jacket cost \$12 more than the hat, how much money did the purse contain at first? Prove your answer correct.

11. One-fifth of the number of pupils in a high school are in the highest class, and $\frac{2}{3}$ of the remainder in the lowest class. If there are 5 more pupils in the middle than in the highest class, how many pupils are in the school? Prove your answer correct.

12. A man bought a house and lot; $\frac{1}{3}$ of their value was equal to 4 times the cost of repairs. The total cost was \$2600. Find the cost of the house and lot.

13. If gun metal is composed of 11 parts of copper to 2 parts of tin, how many pounds of each in 65 lb. of gun metal?

14. A room is $\frac{1}{3}$ again as long as it is wide. If its perimeter is 84 ft., what are its dimensions?

15. The Hudson River is $\frac{1}{3}$ as long as the Red River, and the Potomac is $\frac{7}{8}$ as long as the Hudson. The Potomac River is 350 mi. in length. How long is the Red River?

16. The Connecticut River, which is 450 mi. long, is $\frac{1}{4}$ shorter than the Cumberland, and the Cumberland $\frac{1}{3}$ as long as the Nelson. How long is the Nelson River?

17. A man invested $\frac{5}{8}$ of his money in business, but it having proved a failure he sold it for $\frac{2}{5}$ of what he invested in it. If his loss was \$2700, how much money had he at first?

18. A man left $\frac{1}{3}$ of his property to his wife, $\frac{1}{3}$ of the remainder to his daughter, and the rest to his son. What was the share of each, and what was the property worth if the son received \$6000 more than the daughter?

19. A man earns three times as much as his oldest son, and the oldest son earns twice as much as his brother. What part of the family income does each earn? If this is \$45 a week, what are the weekly earnings of each?

20. A speculator sold wheat at the rate of 30 bu. for \$25, and by doing so lost $\frac{1}{6}$ of the cost price. What did the wheat cost him per bu.?

21. What is the ratio of the cost of $1\frac{3}{7}$ T. of coal to that of $3\frac{1}{3}$ T.? If $3\frac{1}{3}$ T. of coal cost \$21, what will $1\frac{3}{7}$ T. cost?

22. I sold a horse for \$60 and thereby lost $\frac{1}{4}$ of the cost price. What should I have sold it for to gain $\frac{1}{5}$ of the cost?

23. A boy bought 3 doz. eggs for his mother at 12¢ a doz., and with the remainder, which was $\frac{2}{5}$ of the money she gave him, he bought oranges at 4¢ each. How many oranges did he buy?

24. Three farms join each other. The first contains $\frac{4}{5}$ as much as the second, and the second $\frac{3}{4}$ as much as the third. The third farm contains 120 A. How large is the first farm?

25. I traded a $\frac{2}{3}$ interest in a grocery store for a $\frac{3}{5}$ interest in a general store. If the grocery store was valued at \$9000, what was the value of the general store?

DECIMALS

Lesson 33

1. In the expression \$6.37 the 6 is 6 what? The 3 is 3 what? What part of a dollar? The 7 is 7 what? What part of a dollar? The 37 is 37 what? What part of a dollar?

2. In the expression \$2.19 what part of a dollar is the 1? The 9? The 19?

3. Read as dollars and as hundredths of a dollar: \$4.29, \$6.37, \$2.15, \$8.05, \$8.99, \$.76, \$.26, \$.06, \$.09.

4. Read the following expressions:
3.45 T., 2.96 mi., 7.15 A., 6.43 yr., .37 da., .89 hr., .07 hr., .08 gal., 3.06 gal., 5.01 bu., 3.18, .64, 3.50, .04, .02.

Give the *place value* of each figure in the above example.

5. Read the following expressions:
3.146 lb., 4.293 T., 8.141 A., 5.16 A., 8.028 T., 3.006 da., .456 da., .75 hr., .005 bu., .003 gal., 4.568 mi., 3.333, 4.593, .063, .008, .06, .006.

Give the place value of each figure in the above example.

6. Read the following expressions :
 .292, 6.04, .6, .64, .645, .6457, .64572, .6, .06,
 .006, .0006, .0054, 94.3006, .0016, 7.24732, 3.0306,
 12.47025, .42819, .00328, .8216, 3.1416, 2150.42,
 39.371.

7. Reduce to common fractions in their lowest terms : .5, .6, .20, .25, .75, .80, .125, .375, .625, .875.

8. A farmer sold .8 of his flock of 325 sheep. How many did he sell? Give the statements of balance for this and the following examples.

9. A farmer gave .375 of his farm of 200 A. to his son. How many acres did he keep?

10. A merchant sold cloth at an advance of .125 of the cost and gained 21 ¢ a yd. What did a customer pay for 10 yd.?

11. Reduce to common fractions in their lowest terms : $.33\frac{1}{3}$, $.66\frac{2}{3}$, $.16\frac{2}{3}$, $.14\frac{2}{7}$, $.12\frac{1}{2}$, $.37\frac{1}{2}$, $.62\frac{1}{2}$, $.87\frac{1}{2}$, $.11\frac{1}{9}$, $.22\frac{2}{9}$, $.44\frac{4}{9}$, $.55\frac{5}{9}$, $.77\frac{7}{9}$, $.88\frac{8}{9}$, $.6\frac{2}{3}$, $.6\frac{1}{4}$, $.08\frac{1}{8}$. Commit these results to memory.

12. A man withdrew $.44\frac{4}{9}$ of the money he had in a bank to invest it in business. There still remained in the bank \$8500. How much did he withdraw?

13. A merchant sent $.06\frac{2}{3}$ of a piece of cloth, which originally contained 45 yd. and sold at 50 ¢ a yd., to the remnant counter, reducing the price .5. What was the piece marked to sell at?

14. A merchant bought goods from a wholesale house for which he received a bill for \$480 less $.33\frac{1}{3}$ and $.06\frac{1}{4}$ for cash. Find the cash amount of the bill.

15. $.66\frac{2}{3}$ of a piece of ribbon was sold to one customer and $.16\frac{2}{3}$ of it to another. The remainder sold for 36ϕ at 12ϕ a yard. Find the number of yards in the piece at first.

16. Reduce to hundredths: $\frac{1}{5}, \frac{1}{4}, \frac{3}{4}, \frac{1}{3}, \frac{2}{3}, \frac{2}{5}, \frac{3}{5}, \frac{4}{5}, \frac{1}{6}, \frac{5}{6}, \frac{1}{7}, \frac{1}{8}, \frac{3}{8}, \frac{5}{8}, \frac{7}{8}, \frac{1}{9}, \frac{2}{9}, \frac{4}{9}, \frac{5}{9}, \frac{7}{9}, \frac{8}{9}, \frac{1}{10}, \frac{1}{11}, \frac{1}{12}, \frac{1}{15}, \frac{1}{16}$. Commit these results to memory.

17. What part of 1 yd. is 1 ft.? How many hundredths? What part of 1 ft. is 1 in.? How many hundredths?

18. Express your answers to the following questions in tenths or hundredths. What part of 1 gal. is 1 qt.? Of 1 bu. is 2 pk.? Of 1 pk. is 1 qt.? Of 1 lb. avoird. is 1 oz.? Of 1 lb. troy is 1 oz.? Of $.25$ of 1 yr. is 1 mo.? Of 1 da. is 4 hr.? Of $.16\frac{2}{3}$ of 1 quire is $.33\frac{1}{3}$ of a dozen sheets of paper? Of 1 rd. is 1 yd.? Of 1 sq. yd. is 1 sq. ft.? Of the side of a square containing 25 sq. in. is the side of a square containing 16 sq. in.?

19. Carpet bought at 56ϕ a yd. is sold for 70ϕ a yd. What is the gain as a fraction of the cost? How many hundredths?

20. A grocer bought tea at 60ϕ a lb., and sold it for 72ϕ a lb. How many hundredths of the cost did he gain?

21. Bought pencils at 30¢ a dozen and sold them at 4¢ each. What is the gain on each dollar invested?

22. A laboring man earns $\$270$ in 240 da. at $\$1.50$ a day. How many days does he work out of every 100 da.?

23. A person invested $.33\frac{1}{3}$ of his money in real estate and $.44\frac{4}{9}$ of it in business. He had $\$1200$ left. What was the amount of each investment?

24. A grocer sold $.16\frac{2}{3}$ of his stock of eggs for 24¢ a doz., $.5$ of it for 22¢ a doz., and the remainder 18¢ a doz. Find the average price per doz.

25. The stock in a drygoods store was damaged $.33\frac{1}{3}$ of its value by fire. If the stock was worth $\$9000$, what was the loss of one of the partners who had a $\frac{3}{5}$ interest in the business?

COMPOUND QUANTITIES

Lesson 34

In the following examples give the statements of balance :

1. Find the quantity measured by the number 6 and the unit 1 gal. 2 qt.

2. Mark off the space occupied by a cord. How many cords in a pile of cordwood 24 ft. long and 4 ft. high? 24 ft. long and 8 ft. high? What is the cost of the latter pile at \$4 a cord?

3. How many acres in 1 sq. mi.? What part of a square mile is a farm of 160 A.? If this farm is in the form of a square, what is the length of its side?

4. How long will it take to walk around the farm in example 3 at the rate of 3 mi. an hr.?

5. How might such expressions as the following arise by acts of measurement: 2 rd. 3 yd.; 3 bu. 1 pk.; 4 gal. 2 qt. 1 pt.; 5 lb. 6 oz.; 2 T. 400 lb.; 3 yr. 2 mo.; 4 hr. 26 min., 3 doz. 6?

6. What part of 1 yd. is 2 ft.? 6 in.? 2 ft. 6 in.? Find the weight of an iron bar 5 yd. 2 ft. 6 in. long if 1 yd. weighs 15 lb.

7. How many pecks in 1 bu.? A farmer sowed 5 pk. of oats on a field and raised 16 bu. 1 pk. What is the yield per peck of seed? per bushel?

8. A train travels at the rate of $\frac{1}{4}$ mi. in 30 sec. What is its rate per hour?

9. What is the value of £1 in dollars and cents? A gentleman in New York places £100 to his credit in London. What will it cost him, exchange being quoted at \$4.87?

10. A cubic foot of water weighs 1000 oz. How many pounds? 20 cu. ft. of water weigh what part of a ton?

11. Apples are bought at \$2 a bbl. of $2\frac{1}{2}$ bu., and sold at 30¢ a pk. What is the gain per bbl.? What would the gain be if 1 pk. in each barrel were spoiled?

12. How many square rods in 1 A.? What is the value of a triangular piece of land whose base is 32 rd. and altitude 15 rd. at \$60 an acre? (p. 35.)

13. How much ink will it take to fill the ink-wells in a room containing 48 single desks, if each well holds $\frac{1}{4}$ gill?

14. How many pounds does 1 bu. of wheat weigh? What is the cost of 2 bu. 15 lb. of wheat at 84¢ a bu.?

15. How many square chains in 1 A.? What is the selling price of a piece of land 20 ch. long and 16 ch. wide at \$90 an acre?

16. A fruit dealer bought a bushel of apples for \$1.50, and sold them at the rate of 3 for 5¢. How much did he gain if there were 240 apples in the bushel?

17. How many loads of earth were removed to make a cellar 15 ft. long, 12 ft. wide, and 6 ft. deep?

18. How many lead pencils in a dozen boxes if each contains $\frac{1}{2}$ gross?

19. When apples are selling at 40¢ a peck, what profit is made by the seller who buys them at \$1.20 a bushel?

20. What will the lumber cost for a tight board fence 250 ft. long and 4 ft. high at \$2 per C?

21. A square rug $2\frac{1}{2}$ yd. long costs \$5; what is the price per square yard?

22. A bottle of sachet powder weighs 6 oz. What is the least number of bottles that weigh an exact number of pounds?

23. How many pounds of silver will make 240 teaspoons, $\frac{3}{4}$ fine, if a dozen spoons weigh 6 oz.?

24. Each of the two sides of a roof is 50 ft. long and 24 ft. wide. What is the cost of iron roofing to cover this roof at \$2.50 per square of 100 sq. ft.?

25. How many 4-in. cubes can be cut from a block of wood 1 ft. 8 in. long, 1 ft. wide, and 8 in. thick, no allowance being made for waste?

26. Find the weight in pounds of 12 doz. silver tablespoons weighing 20 oz. per doz. Of 12 yd. of carpet weighing 20 oz. each.

Lesson 35

1. Find the value of the quantity measured by the number 8 according as the unit is 2 ft. 6 in. or 2 bu. 6 pk.

2. What are the dimensions of a cord? Find the value of a pile of cordwood 32 ft. long and 6 ft. high at \$ 3.50 a cord.

3. What part of a rod is 1 ft.? $5\frac{1}{2}$ ft.? 22 ft.? The driving wheel of a locomotive, which is 22 ft. in circumference, turns 90 times in 1 min. Through how many rods does it draw the train in 1 min.?

4. What part of a mile is 40 rd.? 120 rd.? 160 rd.? 280 rd.? A train runs 120 rd. in 1 min. How many miles is that an hour?

5. How many rods in 1 mi.? How many yards? feet? A horse trotted 1 mi. in 2 min. 56 sec. Taking his stride at 5 yd., how many times a second did his feet touch the ground?

6. What part of an hour is 18 min.? 36 min.? 45 min.? 48 min.? 54 min.? A horse travels 24 mi. in 2 hr. 24 min. What is the rate per hour?

7. Reduce $\frac{2}{3}$ of \$ 48 to a decimal of \$ 80.

8. How many shillings in £ 1? £ 15? £ 1 16s.? £ 3 4s.? £ 2 17s.? How many ounces of gold are worth £ 27 if .6 oz. is worth £ 2 14s.?

9. How do you find the perimeter of an oblong field? How many rods of wire fencing will it take to enclose a field 40 rd. long and 25 rd. wide, there being 5 rows of wire?

10. What will the wire cost at \$2 per spool of 100 lb., if wire fencing weighs 1 lb. to the rod?

11. What part of a yard is 18 in.? How many strips of wall paper 18 in. wide will be required to paper a room 20 ft. long and 16 ft. wide, no allowance being made for waste in matching?

12. If the room in the previous example is 12 ft. high, how many double rolls of paper will be needed for the room, and what will be its weight? (A double roll weighs $1\frac{3}{4}$ lb. and is 16 yd. long.)

13. State clearly and briefly how you solved each of the foregoing examples in this lesson. State how you will solve each of the following examples in this lesson.

14. What are the factors of 231? I buy molasses put up in a tin dish 10'' by 7'' by $2\frac{1}{2}$ in. What part of a gallon do I get?

15. Give the table of Troy weight. Find the weight in pounds of one dozen silver teaspoons weighing $\frac{2}{3}$ oz. each. Find their cost at 50¢ each if 3 initials are engraved on each spoon at a charge of $1\frac{1}{2}$ ¢ a letter.

16. A man paid 96¢ for 1 lb. of tea, but on weighing it found that it was $\frac{1}{2}$ oz. too light. What should he have paid for it?

17. What is 1 ft. board measure? A lot 250 ft. long and 150 ft. wide is to be surrounded by a close board fence 5 ft. high. What will the lumber cost at \$13 per M?

18. A watch gains 3 sec. in 12 hr. In how many days will it gain 5 min.?

19. How many acres in 1 sq. mi.? $\frac{1}{4}$ sq. mi.? $\frac{3}{4}$ sq. mi.? How many square miles in a strip of land 20 mi. long and $\frac{1}{5}$ mi. wide? 20 mi. long and $\frac{1}{60}$ mi. wide? How many acres in the last strip?

20. What part of 1 mi. is 880 yd.? 88 yd.? 22 yd.? 176 yd.?

A railway company pays \$20 an acre for a strip of land 44 yd. wide and 20 mi. long. Find the entire cost.

21. Name the months that have 30 days; 31 days. A note drawn on Aug. 27 is due Oct. 15. How many days has it to run?

22. A note due Dec. 8, 1898, was discounted Oct. 16. Find the number of days between the day of discount and the day on which the note is due.

23. Through how many degrees does the sun pass in 1 hr.? How do you change longitude expressed in time to longitude expressed in degrees?

24. A man travels until his watch is 2 hr. 4 min. fast. Does he travel east or west, and through how many degrees?

25. How many square chains in 1 A.? How many links in a chain?

What is the value of land 24 ch. 50 l. long and 20 ch. wide at \$60 an acre?

26. Two clocks are together at Monday noon; one loses 10 sec. and the other gains 20 sec. a day. In how many days will one be 10 min. ahead of the other? On what day of the week?

Lesson 36

1. How many pounds of flour are there in a sack containing $\frac{1}{2}$ bbl.? $\frac{1}{4}$ bbl.?

2. How many grains in 1 lb. Avoir.? In 1 lb. Apothecaries'? Do druggists use Avoirdupois or Apothecaries' weight in buying drugs? In selling drugs?

3. A druggist buys 1 lb. of quinine for \$4 and uses it to make 2 gr. quinine pills which he sells at 30¢ a hundred. How much does he gain?

4. Give the table of Apothecaries' liquid measure. How many minims, or drops, will fill a teaspoon? A physician prescribes a 4 oz. bottle of medicine to be taken in teaspoonful doses three times a day. How many days will it last if a teaspoon holds 60 drops?

5. What does 1 cu. ft. of water weigh? How many pounds do 8 cu. ft. of water weigh? What part of a ton?

A cylindrical column of water whose base is 4 sq. ft. and height 8 ft. weighs how many tons?

6. How many board feet in 8 scantlings 12 ft. by 4 in. by 3 in.?

7. Find the cost of 5 bu. 3 pk. 2 qt. of nuts at \$1.28 a bu.?

8. How many hours of daylight are there on Aug. 18, the sun rising at 5.10 A.M.?

9. How many sheets in a quire? Quires in a ream? A stationer pays \$1.56 a ream for letter paper and sells it at 15¢ a quire. How much does he gain on 1 ream? This is what part of the cost?

10. Show by measuring that the circumference of a circle (plate, etc.) is about $3\frac{1}{7}$ times the diameter. How many feet will a bicycle having a 28-in. wheel go in making 12 revolutions?

11. How often does the unit 88 ft. measure the quantity 1 mi.?

How many revolutions will a 28-in. bicycle wheel make in going 1 mi.? Also the pedal, the gear being 3?

12. What is the ratio of the weight of 1 lb. of brass to that of 1 lb. of gold? How many pounds of gold weigh as much as 72 lb. of brass?

13. If 14 yd. of cloth 30 in. wide will make a dress, how many yards of cloth 28 in. wide will be needed to make another dress of the same size?

14. An ingrain rug 30 in. by 54 in. cost 50¢. What was the price per square yard?

15. A man rowed 4 miles down stream in 40 min., and back again up stream in 1 hr. Find his rate of rowing per hour down stream, up stream, in still water, and also the rate of the current.

16. If paint brushes that cost 4¢ each cost $\frac{5}{8}$ as much when bought by the dozen, what is the cost of 6 doz.?

17. The border of an oblong Moquette carpet is $22\frac{1}{2}$ in. wide. How much longer is the perimeter of the border on the outside than on the inside?

18. In the centre of a square room 12 yd. on a side is a square rug covering $\frac{4}{9}$ of the floor. Find the length of its side.

19. If 6 double rolls of wall paper 18 in. wide are needed to paper a room, how many double rolls of 22-in. paper would paper a room of the same wall area?

20. What is the ratio of the side of a 6-in. square to that of a 9-in. square? Of the perimeter? Of the area?

21. What is the ratio of the side of a square rug $1\frac{1}{4}$ yd. long to that of a square rug $1\frac{1}{2}$ yd. long? Of the perimeter? Of the area?

22. If the larger rug in example 21 costs \$1.44, what will the smaller rug cost at the same rate per square yard?

23. A stationer buys lead pencils at 90¢ per half gross, and sells them at the rate of 2 for 5¢. Find his gain on 1 gross.

24. How many quarts in 1 bu.? If a horse eats 1 pk. 3 qt. of oats in 1 da., in how many days will it eat 6 bu.?

25. A township 6 mi. square is divided into how many sections? What is the area of one section in square miles? In acres? A farmer who owns $\frac{1}{4}$ of a section of land has how many acres in his farm? If his farm is in the form of a square, what is the distance around it?

26. 25 bu. of grain occupy 32 cu. ft. A bin 8 ft. by 4 ft. by 4 ft. contains 3200 lb. of grain. Find the weight of 1 bu. of this grain. What kind of grain is it?

PERCENTAGE

Lesson 37

1. A quantity divided into thirds is measured by 3 units. By how many units is a quantity measured that is divided into fourths? Into fifths? Fortieths? Sixtieths? Hundredths?

2. A quantity considered in percentage is measured by 100 units, $\frac{1}{4}$ of the quantity by $\frac{1}{4}$ of 100 or 25 units. Thus $\frac{1}{4}$ of a quantity is 25 hundredths or 25 per cent (25 %) of it.

3. What per cent of a quantity is $\frac{1}{2}$ of it? $\frac{1}{5}$? $\frac{1}{10}$? $\frac{1}{20}$? $\frac{2}{5}$? $\frac{3}{4}$?

4. What is meant by saying that $\frac{1}{2} = 50\%$? $\frac{1}{4} = 25\%$? $\frac{1}{5} = 20\%$?

5. Express the following fractions in per cent :

(a) $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, $\frac{4}{4}$; $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, $\frac{4}{5}$, $\frac{5}{5}$; $\frac{1}{10}$, $\frac{3}{10}$, $\frac{7}{10}$, $\frac{9}{10}$; $\frac{1}{20}$, $\frac{3}{20}$, $\frac{9}{20}$, $\frac{11}{20}$; $\frac{1}{25}$, $\frac{3}{25}$, $\frac{13}{25}$, $\frac{24}{25}$.

(b) $\frac{1}{3}$, $\frac{2}{3}$, $\frac{3}{3}$; $\frac{1}{6}$, $\frac{5}{6}$; $\frac{1}{8}$, $\frac{3}{8}$, $\frac{5}{8}$, $\frac{7}{8}$; $\frac{1}{9}$, $\frac{2}{9}$, $\frac{4}{9}$, $\frac{5}{9}$, $\frac{7}{9}$, $\frac{8}{9}$; $\frac{1}{11}$; $\frac{1}{12}$; $\frac{1}{15}$; $\frac{1}{16}$.

6. What is the ratio of 1 qt. to 1 gal.? What per cent is 1 qt. of 1 gal.? What is the ratio of 1 ft. to 1 yd.? What per cent is 1 ft. of 1 yd.?

7. What per cent is 1 pt. of 1 qt.? 1 dime of \$1? 1 da. of 1 wk.? 1 in. of 1 ft.? 1 ft. of 1 fathom? 1 sq. ft. of 1 sq. yd.? 1 sq. ch. of 1 A.? 1 oz. of 1 lb. Avoir.? 1 oz. of 1 lb. Troy? 1 qt. of 1 pk.? 1 sh. of £1?

8. What per cent is 2 in. of 1 ft.? 1 yd. of 1 rd.? A 3-ft. square of 1 sq. yd.? A 2-ft. square of a 3-ft. square? 8 oz. of $2\frac{1}{2}$ lb. Avoir.? 30 min. of 2 hr.? 4 units of 2 doz.? 1 dm. of 1 m.? 1 qr. of 1 rm.? 77 cu. in. of 1 gal.? 1 rd. of 1 ch.?

9. What is the ratio of \$3 to \$4? What per cent is \$3 of \$4? What is the ratio of \$200 to \$600? What per cent is \$200 of \$600?

10. What per cent of \$2 is 50¢? Of \$64 is \$24? Of 84¢ is 14¢? Of 48¢ is 6¢? Of \$56 is \$49? Of \$225 is \$45? Of \$2500 is \$400? Of \$5.28 is \$1.32? Of \$5 is \$2.45? Of \$3 is \$1.25? Of \$1 is 59¢?

11. Memorize the following table :

20 % = $\frac{1}{5}$	$33\frac{1}{3}$ % = $\frac{1}{3}$	50 % = $\frac{1}{2}$	$22\frac{2}{9}$ % = $\frac{2}{9}$
40 % = $\frac{2}{5}$	$66\frac{2}{3}$ % = $\frac{2}{3}$	$62\frac{1}{2}$ % = $\frac{5}{8}$	$16\frac{2}{3}$ % = $\frac{1}{6}$
60 % = $\frac{3}{5}$	$12\frac{1}{2}$ % = $\frac{1}{8}$	75 % = $\frac{3}{4}$	$8\frac{1}{3}$ % = $\frac{1}{12}$
80 % = $\frac{4}{5}$	25 % = $\frac{1}{4}$	$87\frac{1}{2}$ % = $\frac{7}{8}$	$6\frac{2}{3}$ % = $\frac{1}{15}$
100 % = 1	$37\frac{1}{2}$ % = $\frac{3}{8}$	$11\frac{1}{9}$ % = $\frac{1}{9}$	$6\frac{1}{4}$ % = $\frac{1}{16}$

What is meant by saying that $6\frac{1}{4}$ % = $\frac{1}{16}$?

In the following examples give the statements of balance :

12. A grocer bought tea at 75¢ a lb., and sold it at a gain of 15¢ a lb. What is the ratio of the gain to the cost? What per cent of the cost did he gain?

13. A merchant bought flour at \$6 a bbl., and sold it for \$7.50 a bbl. Find his gain per cent.

14. Bought cloth at 80 ¢ a yd., and sold it for 70 ¢ a yd. Find the loss per cent.

15. At the end of the season the following articles were advertised in the Chicago papers as marked down in price. Find in each case the rate per cent of reduction :

1. Tan shoes from \$5 to \$3.75.
2. Leather belts from 15 ¢ to 5 ¢.
3. Couches from \$15 to \$10.
4. Screen doors from \$1 to 29 ¢.
5. Window screens from 25 ¢ to 10 ¢.
6. Rockers from \$2.50 to \$1.70.
7. Handkerchiefs from 15 ¢ to 9 ¢.
8. Sheeting unbleached from 6 ¢ to 3 ¢.
9. Bicycles from \$25 to \$16.50.
10. Boys' bicycles from \$20 to \$14.50.
11. Bicycle shoes from \$2.50 to \$1.25.
12. Shoes from \$3 to \$1.85.
13. Veils from \$5 to \$2.25.
14. Dress skirts from \$8 to \$5.75.
15. Bookcases from \$12.50 to \$7.
16. Towels from 15 ¢ to $12\frac{1}{2}$ ¢.
17. Towels from 50 ¢ to 35 ¢.
18. Towels from \$75 ¢ to 50 ¢.

19. Curtains from \$ $2\frac{1}{4}$ to \$ $1\frac{1}{4}$
20. Skirts from 40 ¢ to 25 ¢.
21. Blankets from \$ 5 to \$ $3\frac{3}{4}$.
22. Comforters from \$ 4 to \$ 2.98.
23. Comforters from \$ $3\frac{1}{2}$ to \$ $2\frac{1}{2}$.
24. Laces from \$ $1\frac{1}{2}$ to 25 ¢.
25. Jackets from \$ 20 to \$ $7\frac{1}{2}$.

Lesson 38

What fractions in their lowest terms are equivalent to the following per cents ?

1. 1 %, 2 %, 4 %, 5 %, 20 %, 25 %, 50 %, 60 %, 100 % ?

2. 75 %, 45 %, 36 %, 90 %, 18 %, 32 %, 56 % ?

3. $12\frac{1}{2}$ %, $62\frac{1}{2}$ %, $87\frac{1}{2}$ %, $37\frac{1}{2}$ %, $33\frac{1}{3}$ %, $66\frac{2}{3}$ % ?

4. $16\frac{2}{3}$ %, $83\frac{1}{3}$ %, $8\frac{1}{3}$ %, $11\frac{1}{9}$ %, $14\frac{2}{7}$ %, $6\frac{2}{3}$ %, $6\frac{1}{4}$ % ?

5. $9\frac{1}{11}$ %, $44\frac{4}{9}$ %, $5\frac{5}{9}$ %, $88\frac{8}{9}$ %, $27\frac{7}{9}$ % ?

6. 100 %, 120 %, 125 %, 225 %, 350 %, 475 % ?

7. A lot which cost \$600 was sold at a gain of 40 %. The gain is equal to what part of the cost? What was the gain? The selling price?

8. Cloth which cost 42 ¢ a yd. was sold at a loss of $16\frac{2}{3}$ %. The loss was what fraction of the cost? What was the loss on each yard? The selling price?

9. Silk which cost \$3.60 a yd. was sold at an advance of $33\frac{1}{3}\%$. Find the gain and the selling price per yd.

10. A farmer who had 360 sheep sold $22\frac{2}{3}\%$ of them. How many did he sell? How many did he keep?

11. The following articles were advertised in the papers subject to the discounts given. Find the actual selling price:

	MARKED PRICE	DISCOUNT
1. Tan shoes	\$ 6.00	25 %
2. Lace curtains	\$ 2.00	$37\frac{1}{2}\%$
3. Capes	\$ 7.50	$33\frac{1}{3}\%$
4. Shirts	\$ 1.25	60 %
5. Towels	\$ 0.50	30 %
6. Towelling	\$ 0.12 $\frac{1}{2}$	40 %
7. Parlor suits	\$42.50	50 %
8. Linen skirts	\$ 4.00	$62\frac{1}{2}\%$

12. Find the selling price of the following articles subject to the discounts given:

	MARKED PRICE	DISCOUNT
1. Silks	\$ 1.75	$14\frac{2}{7}\%$
2. Tables	\$ 4.50	$16\frac{2}{3}\%$
3. Chairs	\$ 0.75	20 %
4. Couches	\$12.00	$12\frac{1}{2}\%$
5. Umbrellas	\$ 1.98	$11\frac{1}{9}\%$
6. Suits	\$15.00	10 %

13. A farmer sold his crop of wheat for 1896 for \$180. The next year his wheat crop was $\frac{1}{2}$ greater, and the price of wheat $33\frac{1}{3}\%$ more than in 1896. Find what he got for the crop of 1897.

14. What is the selling price of an article costing \$16 and sold at a loss of $12\frac{1}{2}\%$? At a gain of $12\frac{1}{2}\%$?

15. What part of 1% is $\frac{1}{2}\%$? $\frac{1}{4}\%$? $\frac{1}{8}\%$? $\frac{2}{5}\%$? $\frac{5}{8}\%$? $\frac{3}{10}\%$?

16. What is 1% of \$1800? $\frac{1}{2}\%$? $\frac{1}{4}\%$? $\frac{2}{3}\%$? $\frac{3}{5}\%$? $\frac{2}{9}\%$?

17. If $\frac{1}{4}\%$ is charged for sending money from New York to Boston, what is charged for sending \$800? \$600? \$300? \$500?

18. If $\frac{1}{8}\%$ commission is charged for selling stock, what commission is charged for selling \$1600 stock? \$2400? \$848? \$3264?

19. What is the cost of insuring 600 bbl. of flour worth \$5 per bbl., the cost of insurance being $\frac{1}{2}\%$ of the value of the flour?

20. A merchant paid 60¢ a yd. for cloth and sold it at an advance of $33\frac{1}{3}\%$. After selling all but 2 yd., he put the remainder on the remnant counter and marked it to sell at 50% below the first selling price. Find what it was marked at.

21. A grocer bought potatoes at 45¢ a bushel and sold them at a gain of $33\frac{1}{3}\%$. If he received \$48 for the potatoes, how many bushels did he sell?

22. A fruit dealer paid \$10 for peaches at 25¢ a basket, part of which being spoiled he sold the remainder at an advance of 60%, receiving \$12. How many baskets were damaged?

23. A lawyer collected \$320 and charged 5% for his services. How much did he retain and how much did he pay over to his employer? What per cent is the amount paid over of sum collected?

24. A bookseller paid 80¢ each for some books. The expense of selling them was 5% of the cost, and the gain $16\frac{2}{3}\%$ of the whole outlay. Find their selling price.

25. A grocer mixes two kinds of tea, which cost him 44¢ and 66¢ respectively, in equal quantities. What must be the selling price of the mixture to gain 20%?

Lesson 39

1. A house worth \$2500 rents for \$300. What is the ratio of the rent to the value of the house? For what per cent of its value does it rent?

2. A town of 2400 population increases to 2700 in one year. What is the ratio of the increase to the original population? Find the rate per cent of increase.

3. A drover bought sheep at \$5 each; their food cost \$1.25 apiece. He then sold them at \$7.50 each. Find his gain per cent.

4. A man invested \$600 in real estate and sold out at a gain of $33\frac{1}{3}\%$. He re-invested the entire amount and again sold out at an advance of 25% . Find the last selling price and the total gain.

5. A trader sold a horse at an advance of $22\frac{2}{9}\%$, gaining \$16. This $22\frac{2}{9}\%$ is $22\frac{2}{9}\%$ of what? What fraction of the cost? What was the cost of the horse?

6. A grocer made \$12 by selling flour at a gain of $16\frac{2}{3}\%$. What did it cost him?

7. A merchant lost \$18 by selling cloth at a loss of $37\frac{1}{2}\%$. Find what he paid for it.

8. I was offered \$800 for a lot, but sold it for \$824, gaining 4% more than if I had accepted the first offer. Find what the lot cost me.

9. A merchant sold tea at 64¢ a lb., gaining $33\frac{1}{3}\%$. The gain is what fraction of the cost? The selling price is what fraction of the cost? How much a pound did the tea cost the merchant?

10. A man sold a cow for \$36, gaining $33\frac{1}{3}\%$. Find the cost.

11. What would have been the cost price of the cow given in example 10 if there had been a gain of 20% ? Of 50% ? $12\frac{1}{2}\%$? 80% ? $9\frac{1}{11}\%$? $11\frac{1}{9}\%$?

12. A grocer sold coffee at 28¢ a lb., thereby losing $12\frac{1}{2}\%$. The loss is what fraction of the cost? The selling price is what fraction of the cost? What was the cost?

13. A merchant sold cloth at $48¢$ a yard, thereby losing $33\frac{1}{3}\%$. What did it cost him?

14. What would have been the cost price of the cloth in example 13 if there had been a loss of 25% ? Of 20% ? $14\frac{2}{7}\%$? $11\frac{1}{9}\%$? $33\frac{1}{3}\%$? $7\frac{9}{13}\%$? 40% ? 60% ?

15. Eggs sold at $12¢$ a doz. net a profit of 20% ; find the cost price per doz.

16. By selling clothes at $\$12$ a suit a merchant gains 20% . What would have been the actual gain, and what the gain per cent, if they had been sold for $\$12.50$ a suit?

17. A merchant sells overcoats at $\$21$, thereby losing $12\frac{1}{2}\%$. What was the cost, and what per cent would he gain by selling them at $\$28$ apiece?

18. A wholesale merchant sold goods to a customer at a profit of 25% , but the buyer becomes bankrupt and pays only $60¢$ on the dollar. What per cent does the wholesale merchant lose on the sale?

19. A merchant bought goods for $\$900$. He sold $\frac{2}{3}$ of them at a gain of 15% and the remainder at a loss of 24% . Find his gain or loss on the whole transaction.

20. A grocer sold a chest of tea at $69¢$ a lb., thereby gaining 15% . If his entire gain was $\$6.75$, how many pounds of tea did the chest hold?

21. I sold a span of horses at \$105 each, gaining $16\frac{2}{3}\%$ on one and losing $16\frac{2}{3}\%$ on the other. Find the cost price of each horse and the gain or loss on both transactions.

22. A speculator sold two lots at \$720 each, losing on one 20% and gaining 20% on the other. Find the gain or loss on the whole transaction.

23. How many yards of cloth at \$3 a yd. must a merchant buy, so that by selling it at $12\frac{1}{2}\%$ profit he gains \$24?

24. Give answers to the following :

(a) $18\frac{3}{4}\%$ of 48 = ?

(b) \$480 is $18\frac{3}{4}\%$ of what number?

(c) .8% of 20 = ?

(d) 20 is .8 of what number?

(e) $\frac{1}{3}$ is what per cent of $\frac{5}{9}$?

25. A grocer buys flour at the rate of \$5.40 a bbl. At what price per 49-lb. sack must he sell it so as to gain $11\frac{1}{3}\%$?

Lesson 40

1. A wholesale merchant sold a bill of goods, list price \$240, discounts $16\frac{2}{3}\%$ and 10%. Find the net amount of the bill.

2. What is the net amount of a bill of goods, the list price of which is \$300, trade discounts 20% and $12\frac{1}{2}\%$? What would have been the net amount with trade discounts $12\frac{1}{2}\%$ and 20%?

3. What single discount would give the same net amount for a bill of \$300 as discounts of 20% and $12\frac{1}{2}\%$?

4. Find the net cash amount of a bill for \$400, subject to discounts of 25%, $16\frac{2}{3}\%$, and 4% off for cash.

5. What is the difference between the net amount of a bill of goods for \$800, trade discounts 25% and 15%, or a single discount of 40%?

6. A merchant buys at 40% below the list price, and sells at 20% below the list price. Find his gain per cent.

7. An auctioneer sold goods on a commission of 2%. What did he receive on a sale of \$1400? What per cent of the sales does his employer receive?

8. A commission merchant received $2\frac{1}{2}\%$ for selling goods. If his commission amounted to \$75, what was the selling price?

9. A broker sold \$6000 stock on a commission of $\frac{1}{8}\%$. Find his commission.

10. A commission merchant sold 600 bbl. of flour at \$4.50 on a commission of 3%. Find the commission and the amount remitted to his employer.

11. My agent received \$12 for selling apples at \$2.50 a barrel on a commission of 4%. How many barrels did he sell?

12. I paid my insurance premium of \$50 with $\frac{1}{3}$ of my commission at 6% for selling land. For how much did the land sell?

13. A young man was paid 6% commission by a merchant for collecting overdue accounts. If he earned \$31.80, how much did he collect?

14. A man insured his house for \$1875 at 2% premium. How much did he pay?

15. I insured my furniture for three years for \$600 at $1\frac{1}{5}$ % premium. What was the amount of the premium?

16. A mill owner insured his lumber for \$800, paying \$25 premium. What rate of insurance did he pay?

17. An insurance company received \$22.50 for insuring a house for 75% of its value at $\frac{5}{8}$ % premium. Find its value.

18. A farmer paid \$6.25 for insuring his barn and contents at $\frac{1}{2}$ %. For what amount did he insure?

19. A merchant insured his stock for \$400 for one year at $\frac{7}{8}$ %. Six months after the policy was cancelled at the request of the insured. Find the amount of premium returned, the short rate for six months being $\frac{5}{8}$ %.

20. I paid \$27 for insuring my house at $\frac{3}{4}$ of its value at $1\frac{1}{5}$ %. What is the value of the house?

21. My furniture was insured in one company for \$600 and in another for \$400. It was damaged to the extent of \$30. For what amount was each company liable?

22. My property is assessed for \$7200. What tax must I pay, the rate of taxation being $1\frac{1}{4}\%$?

23. What amount must a town be taxed to raise \$11,400, the collector's commission being 5% ?

24. The rate of taxation being reduced from 19 mills to 17 mills on the dollar, my taxes are lowered \$8. For how much am I assessed?

Lesson 41

Find the interest of:

1. \$600 for 1 yr. at 5% ; 4% ; 6% ; 8% .
2. \$400 for 1 yr. at 7% ; 3% ; 9% ; 10% .
3. \$800 for 1 yr. at 4% ; $4\frac{1}{2}\%$; $6\frac{1}{2}\%$; $3\frac{1}{2}\%$.
4. \$450 for 1 yr. at 4% ; 5% ; 8% ; 9% .
5. \$250 for 1 yr. at 3% ; $3\frac{1}{2}\%$; $5\frac{1}{2}\%$; $7\frac{1}{2}\%$.
6. \$375 for 1 yr. at 4% ; 3% ; 5% ; 8% .
7. 6% per annum is what per cent for 6 mo.?
4 mo.? 8 mo.? 3 mo.? 9 mo.? 10 mo.?
8. 8% per annum is what per cent for 3 mo.?
6 mo.? 4 mo.? $4\frac{1}{2}$ mo.? 9 mo.?

Find the interest of:

9. \$500 for 6 mo. at 8% ; 3 mo.; 9 mo.; 4 mo.
10. \$700 for 6 mo. at 6% ; 10 mo.; 4 mo.; 9 mo.

11. \$350 for 6 mo. at 4 % ; 9 mo. ; 3 mo. ; 4 mo.
12. What part of a year is 2 mo. 12 da.? 1 mo. 15 da.? 9 mo. 18 da.? 6 mo. 12 da.?

Find the interest of :

13. \$640 for 2 mo. 12 da. at 5 % ; 7 mo. 6 da.
14. \$325 for 6 mo. 12 da. at $7\frac{1}{2}$ % ; 9 mo. 18 da.
15. \$400 for 3 mo. 15 da. at 6 % ; 10 mo. 15 da.
16. In each of the above questions in which you find the interest, how would you find the amount? Find the amount for the first part of each of these questions.

17. A merchant whose capital was \$15,000 was making a profit of $12\frac{1}{2}$ % per annum on his capital, but on account of ill health he quit the business, and loaned his money at 6 %. How much is his yearly income diminished?

18. A man leaves unpaid a sum of money on which he pays 8 % interest until the interest equals $\frac{3}{50}$ of the principal. Find the time.

19. A person borrows a sum of money for 9 mo. at 6 %, and at the end of the time repays, as principal and interest, \$418. How much did he borrow?

20. Feb. 15, 1898, a young man deposited in the savings bank \$450. July 15, 1898, he withdrew the principal and interest at 4 % per annum. What amount did he withdraw?

21. I drew a note for \$550, due in 6 mo., and presented it at a bank for discount at 8%. What was the discount? What were the proceeds of the note?

22. What is the bank discount on a note for \$800 due in $7\frac{1}{2}$ mo. at 6%? How much cash would the owner of this note receive for it? Does the bank make 6%, or more or less than 6%, on this note?

23. A note due in 3 mo. was presented at a bank, and when discounted at 8% yielded \$490. Required the face of the note.

24. A wholesale merchant took a note due in 4 mo. in payment of certain goods. He had it discounted immediately at 9%, and received \$582. For what sum were the goods sold?

25. A merchant sold goods for \$540, subject to trade discounts of $33\frac{1}{3}$ % and $16\frac{2}{3}$ %, and took in payment a note due in 4 mo., which he had immediately discounted at 8%. Find the cash value of the sale.

Lesson 42

1. If I buy rugs at \$4.90 and sell them for \$5.60 each, what is my gain per cent?

2. A retail merchant bought carpet at \$1.55 list price, trade discount 20%, and sold it at an advance of 25% on cost. Find the selling price.

3. If $33\frac{1}{3}$ % is gained by selling cloth at \$1.00 a yd., find the gain or loss per cent if sold at 80¢ per yd.

4. A tradesman's prices are 40% above cost. If he allows a customer 10% on his bill, what profit does he make?

5. A person at the age of 25 insured his life in each of two companies for \$4000, the premiums being at the rate of $2\frac{1}{4}\%$ and $2\frac{1}{8}\%$ respectively. Find his annual payment.

6. A trader insured 300 bbl. of flour for $\frac{5}{6}$ of its value at 2%, paying \$25 premium. What did the flour cost him a barrel?

7. A man whose property is assessed for \$12,000 is taxed 15 mills on the dollar. Find his tax.

8. A town levied a tax to build a town hall at a cost of \$4900. If the collector's fee is 2%, find the tax.

9. I bought goods for \$400, list price. Is it to my advantage to accept trade discounts of 25 and 5 or of 20 and 10?

10. Goods are sold at a loss of 20%. By what percentage of itself must the selling price be advanced to yield a profit of 20%?

11. A man began business with a certain capital; he gained 20% the first year, which he added to his capital, and $37\frac{1}{2}\%$ the second year, which he also added to his capital. If his capital at close of the second year was \$6600, what was his original capital?

12. A man began business with a certain capital; he gained 10% the first year, which he added to his capital, and 20% the second year, which he also added to his capital; the third year he lost $9\frac{1}{11}$ %. He then had \$1000 more invested in the business than at first. Find the capital with which he commenced business.

13. A grocer bought 60 lb. of tea and 90 lb. of coffee, the cost of the latter per lb. being $33\frac{1}{3}$ % that of the former. He sold the tea at a profit of 25%, and the coffee at a profit of $16\frac{2}{3}$ %, gaining on the whole \$14.40. Find the buying and selling prices of each.

14. A carpet dealer sold carpet at 98¢ a yd., gaining $16\frac{2}{3}$ %. Afterward he sold some of the same carpet to the amount of \$28.80 and gained $14\frac{2}{7}$ %. What was the last selling price and how many yards did he sell at that price?

15. A merchant sold 40 yd. of silk at a gain of $37\frac{1}{2}$ %, and 45 yd., which cost him the same per yard, at a gain of $6\frac{2}{3}$ %. If his entire gain was \$36, find the cost price per yard.

16. A merchant bought goods for a certain sum, and marked $\frac{2}{5}$ of them at a profit of 25%, and the remainder at a profit of 15%. If his entire gain is \$76.38, find what he paid for the goods.

17. A stationer buys a gross of lead pencils for \$2.50. He sells 44 at the rate of 2 for 5¢ and the remainder at 3¢ each. Find his gain per cent.

18. A grocer purchases syrup in 50 gal. barrels at \$12.50 a bbl. At what price per gallon must he sell it to make 16 %?

19. I bought a house for \$3000 and spent $33\frac{1}{3}$ % of the cost in repairs. What must I rent it for a month to make a clear income of 6 % of the total cost, taxes and repairs amounting to \$60 a year?

20. A man having lost $6\frac{1}{4}$ % of his capital is worth twice as much as another who has just gained 50 % on his capital. What was the first man's capital?

21. If a furniture dealer buys chairs at a discount of 30 % from list price, and sells them at 9 % below list price, find his gain per cent.

22. A certain sum of money amounts to \$1236 in 6 mo., and to \$1254 in 9 mo. What is the rate per cent?

23. Bought 2000 bu. of wheat at 82¢ a bu., payable in 4 mo.; I sold it immediately for 80¢ a bu. cash, and put the money at interest at 6 %. At the end of 4 mo. I paid for the wheat. Did I gain or lose by the transaction, and how much?

24. A wholesale merchant bought 400 yd. of silk at \$2.50 a yd., and sold it at once, receiving in payment a note for \$1100 due in 60 da., which he at once discounted at a bank at 6 %. Find his gain.

MISCELLANEOUS EXAMPLES

Lesson 43

1. How many strips of paper 2 ft. wide are needed to cover the walls of a room whose length is 18 ft. and whose breadth is $\frac{2}{3}$ its length?

2. A gardener sold 7 bu. of potatoes at 35¢ a bushel, and with the proceeds he bought 3 yd. of ribbon at 15¢ a yard and sugar at 5¢ a lb. How many pounds of sugar did he buy?

3. A township is cut into farms of 80 A. Find the number of farms.

4. Two men separate, one driving north at the rate of 7 mi. an hr. and then returning at the same rate. The second walks south at the rate of 3 mi. an hr. How far apart will they be in 3 hr.?

5. The distance of a suburb of Chicago from the city is indicated in any one of the following ways: 11 mi., or 24 min., or \$5 for a monthly ticket. Which unit gives the most practical measurement of the distance of the suburb from the city?

6. Harriet puts 68¢ into the Penny Savings at one time, and has stamps of the largest denomination possible placed on her card as a receipt. If 1¢, 5¢, 10¢, and 25¢ stamps are used for the purpose, how many of each kind are used?

7. Dorothy, who has 7 10¢ stamps, 3 5¢ stamps, and 9 1¢ stamps on her penny savings card, has it cashed. How much does she realize?

8. The annual membership fee for adults in the Riverside Art League is 50 ¢, and for children 10 ¢. What will a family of two adults and three children pay in dues in 3 yr. if all are members?

9. What is the total cost of a revolver weighing $1\frac{1}{2}$ lb., for which \$9.50 was paid, if sent through the mail in a registered parcel, the buyer paying postage and the cost of registration?

10. I bought two crates of currants at different times and made 28 glasses of jelly out of each. The jelly from the first crate, for which I paid 90 ¢, cost a cent a glass more than that made from the second crate. Find what the second crate cost me.

11. La Grange is 13 mi. west of Chicago, and Niles 60 mi. east. How far apart are two places, one of which is 7 mi. east of La Grange, and the other 8 mi. west of Niles?

12. The sum of the ages of three brothers is 57 yr. The youngest is 15 yr. old and the next 2 yr. older. Find the difference between the ages of the oldest and the youngest.

13. A lady goes to the city by train at the cost of \$3.10 for a 25-ride ticket and a 5 ¢ street-car fare each way, using 4 25-ride tickets in one year. If she had gone by electric car it would have cost her 10 ¢ each way. How much would she have saved in one year if she had gone by the electric car?

14. If in the previous question it takes 36 min. to go by train and street car and 1 hr. by electric car, how many hours are saved in one year by going by train?

15. The sides of three boxes, each 4 ft. long, 3 ft. wide, and 1 ft. 6 in. high, are covered with wall paper cut from the same double roll. How much is left over if there is no waste?

16. Alice has 8 oranges, Caryl 6, and Marguerite 1. The oranges are divided equally amongst them, and Marguerite pays Alice and Caryl 16¢. How much should each receive?

17. When is a number divisible by 2? By 4? 8? 5? 10?

18. A lady buys stockings at the rate of 3 pairs for \$1 instead of 35¢ a pair. How many pairs of stockings will she buy before she saves the price of a single pair?

19. The average age of 10 boys is 8 yr. Five boys join the group whose average age is 3 yr. below the average of the others. What is the average of the entire group?

20. A barn is 32 ft. wide and its two gables are 12 ft. above the eaves. How long are the rafters if they project 1 ft. 6 in. over the sides?

21. Two men start from the same point and walk, one south at the rate of 3 mi. an hr., and the other west at the rate of 4 mi. an hr. How far will they be apart in 3 hr.?

22. What is the volume of a cube whose surface contains 96 sq. in.? What is the surface of a cube 8 times as large?

23. A man walks across the diagonal of a lot 8 rd. long and 6 rd. wide 4 times a day, instead of walking around the corner on the sidewalk. How much time does he save in a year of 300 da., if he walks at the rate of 3 mi. an hour?

24. A man spent $\frac{5}{8}$ of his money and then earned a sum equal to $\frac{1}{3}$ of what he had left. He then had \$60 less than he had at first. How much did he spend?

25. A lady spent $\frac{3}{5}$ of her money for a pound of tea, and with the remainder she bought a dozen lemons at 3¢ each. What did the tea cost per lb.?

26. A train ran 2 mi. 80 rd. at the rate of 36 mi. an hour. How far would it have gone in $1\frac{1}{2}$ times as long at the rate of 48 mi. an hour?

27. Sugar worth \$1.55 is weighed in a false balance which gives only $15\frac{1}{2}$ oz. to the pound. What is the selling price of the sugar?

28. A man agreed to dig a cellar for \$12, but after doing $\frac{2}{3}$ of the work he found that, owing to the nature of the soil, he could only work on the remainder $\frac{2}{3}$ as fast as he expected. What should he have charged for the entire work?

29. Divide \$30 between two men, giving the first \$6 more than $\frac{3}{5}$ of what the second gets.

30. What is the weight of 1 cu. ft. of water? What is meant by saying that the specific gravity of mica is 3? What is the weight of 1 cu. ft. of mica in air? In water?

31. The specific gravity of lead ore is 7.4. How many pounds will 1 cu. ft. of lead ore weigh in water?

32. Magnetite and hematite are two iron ores of specific gravity 6.5 and 5.3 respectively. How much more would 1 cu. ft. of magnetite weigh than 1 cu. ft. of hematite? How much more would it weigh in water?

33. A gallon of water weighs about $8\frac{1}{3}$ lb. Into a pail full of water a piece of mica, specific gravity 3, is carefully put and 1 gal. of water overflows. Find the weight of the piece of mica.

34. At the rate of how many feet per second must air be forced into a schoolroom containing 40 persons, through an opening whose area is 2 sq. ft., in order that each one may have 30 cu. ft. of fresh air per minute?

35. A vessel can sail up stream at the rate of 8 mi. and down stream at the rate of 12 mi. an hour. How far can it go down stream and up in 5 hr.?

36. The parallel sides of a field in the form of a trapezoid are respectively 60 rd. and 100 rd., and its depth 20 rd. What is the field worth at \$48.50 an acre?

37. A rectangular block of land containing 24 A. is 80 rd. on one side. How long will it take a boy to ride around the block on his bicycle at the rate of 1 mi. in 5 min.?

38. What is the weight of the wall paper required for the walls of a square room 15 ft. long and 9 ft. high, allowing 12 sq. yd. for doors and windows? (A double roll of wall paper is 16 yd. long, 18 in. wide, and weighs $1\frac{3}{4}$ lb.)

39. A box contains 150 lights of glass, each 6 in. by 8 in. How many lights of glass, each 12 in. by 30 in., are there in a second box that contains the same quantity as the first?

40. Lubricating oil for bicycles is sold in 8-oz. cans at \$1.54 a dozen and in 4-oz. cans at \$1.10 a dozen. By what per cent is it cheaper to buy a dozen 8-oz. cans of oil than to buy the same quantity in 4-oz. cans?

41. The cost of a box of glass 6 in. by 8 in., containing 150 lights, is \$2.50, and the cost of a box 12 in. by 24 in., containing 25 lights, is \$3.25. By what per cent is the price of the same quantity of glass increased in ordering the larger instead of the smaller panes?

42. A man loans $\frac{2}{3}$ of his money at 6% and the remainder at $4\frac{1}{2}$ %. If his income from the former is \$250 more than from the latter, what is his capital?

43. Which is cheaper, goods bought for \$200 subject to discounts of 25% and 20% or to discounts of 20% and 25%?

44. I bought a bill of goods for \$240, discounts 20% and $16\frac{2}{3}\%$. Find my gain per cent on selling them for \$235, if I lose \$15 in bad debts.

45. A grocer sold $\frac{5}{8}$ of his potatoes for 10% less than all cost him and the remainder at 28% below cost. Find his gain per cent on the entire lot.

46. I sold a lot of land, receiving for it \$800 cash and a note for \$640 due in 6 mo., which was immediately discounted at a bank at 6%. Find the cash value of the selling price.

MULTIPLICATION TABLE

Twice	Three times	Four times	Five times	Six times	Seven times
1 is 2	1 is 3	1 is 4	1 is 5	1 is 6	1 is 7
2 " 4	2 " 6	2 " 8	2 " 10	2 " 12	2 " 14
3 " 6	3 " 9	3 " 12	3 " 15	3 " 18	3 " 21
4 " 8	4 " 12	4 " 16	4 " 20	4 " 24	4 " 28
5 " 10	5 " 15	5 " 20	5 " 25	5 " 30	5 " 35
6 " 12	6 " 18	6 " 24	6 " 30	6 " 36	6 " 42
7 " 14	7 " 21	7 " 28	7 " 35	7 " 42	7 " 49
8 " 16	8 " 24	8 " 32	8 " 40	8 " 48	8 " 56
9 " 18	9 " 27	9 " 36	9 " 45	9 " 54	9 " 63
10 " 20	10 " 30	10 " 40	10 " 50	10 " 60	10 " 70
11 " 22	11 " 33	11 " 44	11 " 55	11 " 66	11 " 77
12 " 24	12 " 36	12 " 48	12 " 60	12 " 72	12 " 84

Eight times	Nine times	Ten times	Eleven times	Twelve times
1 is 8	1 is 9	1 is 10	1 is 11	1 is 12
2 " 16	2 " 18	2 " 20	2 " 22	2 " 24
3 " 24	3 " 27	3 " 30	3 " 33	3 " 36
4 " 32	4 " 36	4 " 40	4 " 44	4 " 48
5 " 40	5 " 45	5 " 50	5 " 55	5 " 60
6 " 48	6 " 54	6 " 60	6 " 66	6 " 72
7 " 56	7 " 63	7 " 70	7 " 77	7 " 84
8 " 64	8 " 72	8 " 80	8 " 88	8 " 96
9 " 72	9 " 81	9 " 90	9 " 99	9 " 108
10 " 80	10 " 90	10 " 100	10 " 110	10 " 120
11 " 88	11 " 99	11 " 110	11 " 121	11 " 132
12 " 96	12 " 108	12 " 120	12 " 132	12 " 144

UNITS OF VALUE

UNITED STATES MONEY

10 mills (m.)	= 1 cent (ct. or ¢)
10 cents	= 1 dime (d.)
10 dimes	= 1 dollar (\$)
10 dollars	= 1 eagle (E.)

BRITISH OR STERLING MONEY

4 farthings (far.)	= 1 penny (d.)
12 pence	= 1 shilling (s.)
20 shillings	= 1 pound (£)
5 shillings	= 1 crown
21 shillings	= 1 guinea

UNITS OF WEIGHT

A VOIRDUPOIS WEIGHT

16 ounces (oz.)	= 1 pound (lb.)
100 pounds	= 1 hundredweight (cwt.)
20 hundredweight	= 1 ton (T.)
1 pound Avoirdupois	= 7000 grains
1 ounce Avoirdupois	= 437½ grains

TROY WEIGHT

24 grains (gr.)	= 1 pennyweight (pwt.)
20 pennyweights	= 1 ounce (oz.)
12 ounces	= 1 pound (lb.)
1 pound Troy	= 5760 grains
1 ounce Troy	= 480 grains

APOTHECARIES' WEIGHT

20 grains (gr.) = 1 scruple (\mathfrak{D})3 scruples = 1 dram (\mathfrak{Z})8 drams = 1 ounce ($\mathfrak{℥}$)

12 ounces = 1 pound (lb.)

1 pound Apothecaries' weight = 5760 grains

1 ounce Apothecaries' weight = 480 grains

UNITS OF LENGTH

LONG MEASURE

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 = 1 mile (mi.)

1 mi. = 320 rd. = 1760 yd. = 5280 ft.

SURVEYORS' LINEAR MEASURE

100 links (l.) = 1 chain (ch.)

80 chains = 1 mile (mi.)

1 ch. = 4 rd. = 22 yd. = 66 ft. = 792 in.

UNITS OF SURFACE OR SQUARE MEASURE

SURFACE OR SQUARE MEASURE

144 square inches (sq. in.) = 1 square foot (sq. ft.)

9 square feet = 1 square yard (sq. yd.)

 $30\frac{1}{4}$ square yards = 1 square rod (sq. rd.)

160 square rods = 1 acre (A.)

640 acres = 1 square mile (sq. mi.)

10 square chains = 1 acre; 1 acre = 4840 square yards

A township is 6 mi. square, and contains 36 sq. mi. It is divided into 36 sections, each 1 mi. square.

UNITS OF VOLUME

CUBIC OR VOLUME MEASURE

1728 cubic inches (cu. in.) = 1 cubic foot (cu. ft.)

27 cubic feet (cu. ft.) = 1 cubic yard (cu. yd.)

A cord is a pile 8 ft. long, 4 ft. wide, and 4 ft. high. It contains 128 cu. ft. A cubic yard of earth is called a *load*.

UNITS OF CAPACITY

LIQUID MEASURE

4 gills (gi.) = 1 pint (pt.)

2 pints = 1 quart (qt.)

4 quarts = 1 gallon (gal.)

1 gallon contains 231 cu. in.

DRY MEASURE

2 pints (pt.) = 1 quart (qt.)

8 quarts = 1 peck (pk.)

4 pecks = 1 bushel (bu.)

1 bushel contains 2150.42 cubic inches

APOTHECARIES' FLUID MEASURE

60 minims (℥) = 1 fluid dram (f ʒ)

8 fluid drams = 1 fluid ounce (f ʒ)

16 fluid ounces = 1 pint (O)

8 pints = 1 gallon (cong.)

1 minim is about equal to 1 drop

UNITS OF TIME

MEASURE OF TIME

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

February has 28 or 29 days; April, June, September, and November, 30 days each; the other months, 31 days each.

ANGULAR MEASURE

60 seconds (")	= 1 minute (')
60 minutes	= 1 degree (°)
360 degrees	= 1 circumference (c.)

MISCELLANEOUS UNITS

NUMBERS	PAPER
12 units = 1 dozen (doz.)	24 sheets = 1 quire
12 dozen = 1 gross	20 quires = 1 ream
12 gross = 1 great gross	2 reams = 1 bundle
20 units = 1 score	5 bundles = 1 bale

Wheat, beans, clover seed, and potatoes each weigh 60 lb. to the bushel; corn, rye, and coarse salt, 56 lb.; barley, 48 lb.; and oats, 32 lb.

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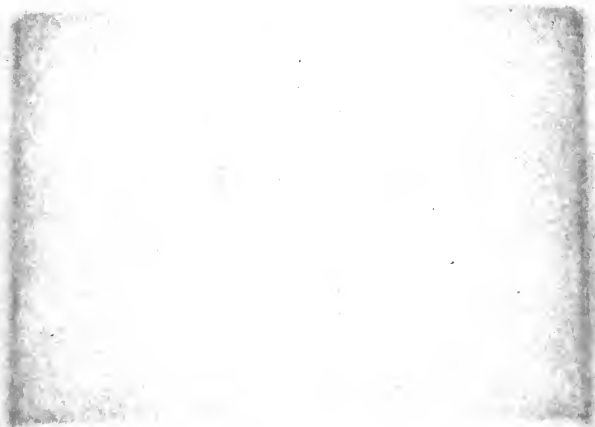
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