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A Study Guide

IN GENERAL SCIENCE
AND BIOLOGY

FOR THE SMITHSONIAN
SCIENTIFIC SERIES

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FOREWORD

The Smithsonian Scientific Series

This series of twelve, beautifully printed and illustrated volumes is a unique and successful effort to bring to the layman the simple story of man's progress in the sciences. The story is told by specialists who can speak with authority. Their work is recognized by the whole world, as is also the institution by whom they are sponsored.

Because the audience to which the different authors have addressed themselves is meant to be the average intelligent citizen, the books are admirably suited for boys and girls in secondary schools. Teachers of science have long been searching for adequate supplementary reading for their pupils. There is a great need for material that is vivid enough to hold the attention of adolescents, scientifically accurate so as to command their respect, and sufficiently non-technical to be within their level of comprehension. All of this the Series achieves, in a framework which coincides with the modern courses of study in General Science and Biology.

In the words of Dr. Charles Greeley Abbot, world-renowned scientist and Editor of the Series, "These volumes do not represent an attempt to summarize all science, or even all branches of science on which the Smithsonian can speak with authority. They will, however, acquaint the reader with the organization, history, and activities of the scientific institution which has grown up with the nation and fostered the nation's scientific activities; they will introduce him to the workings and achievements of the scientific method over a large field, and open doors to some branches of science to which he will not find the key elsewhere." Thus, the Series is quite different from a textbook or an encyclopedia of information. Too often, in school work, we

are disappointed at pupil reactions to the text or to the reference volume. They will not read it; yet they devour the Sunday Science Supplement and the extravagantly written science magazines. In the Smithsonian Scientific Series, the teacher of science will find a center of pupil interest. The books will be read because they have human appeal. Since they do not attempt to cover all science topics with uniform completeness, they are better adapted to the needs of different science classes and different pupils.

Ideas Underlying the Study Outline

First, the material of the twelve volumes was carefully scrutinized for the contributions it may make to the science education of boys and girls in grades seven to ten, inclusive. For these age groups, the school curriculum includes a course in General Science, followed by another in General Biology. Courses of study in these subjects differ somewhat from each other in different localities; but the trend everywhere has been toward an integrated and articulated sequence of science studies through the grades. This sequence aims to develop an ever-growing understanding of the science environment in terms of the important generalizations or "big ideas" of science.

Secondly, a Study Outline was developed to include the important ideas and generalizations usually found in courses in General Science and Biology. For the sake of convenience in use by the teacher and pupil, the two courses have been treated as one. The Units of the Outline are progressively graded in the matter of difficulty and are presented in a teaching sequence which is well-adapted to a variety of conditions. The materials of the twelve volumes are organized around the Outline as a framework.

Thirdly, the Outline is replete with suggestions for teaching procedures based upon modern educational practice. It is assumed that the pupil learns most effectively when he is getting real experiences. Reading is an experience; so is an experiment, a construction project, a field trip, a museum visit, a class report, or a class discussion. All of these are indicated by the Outline.

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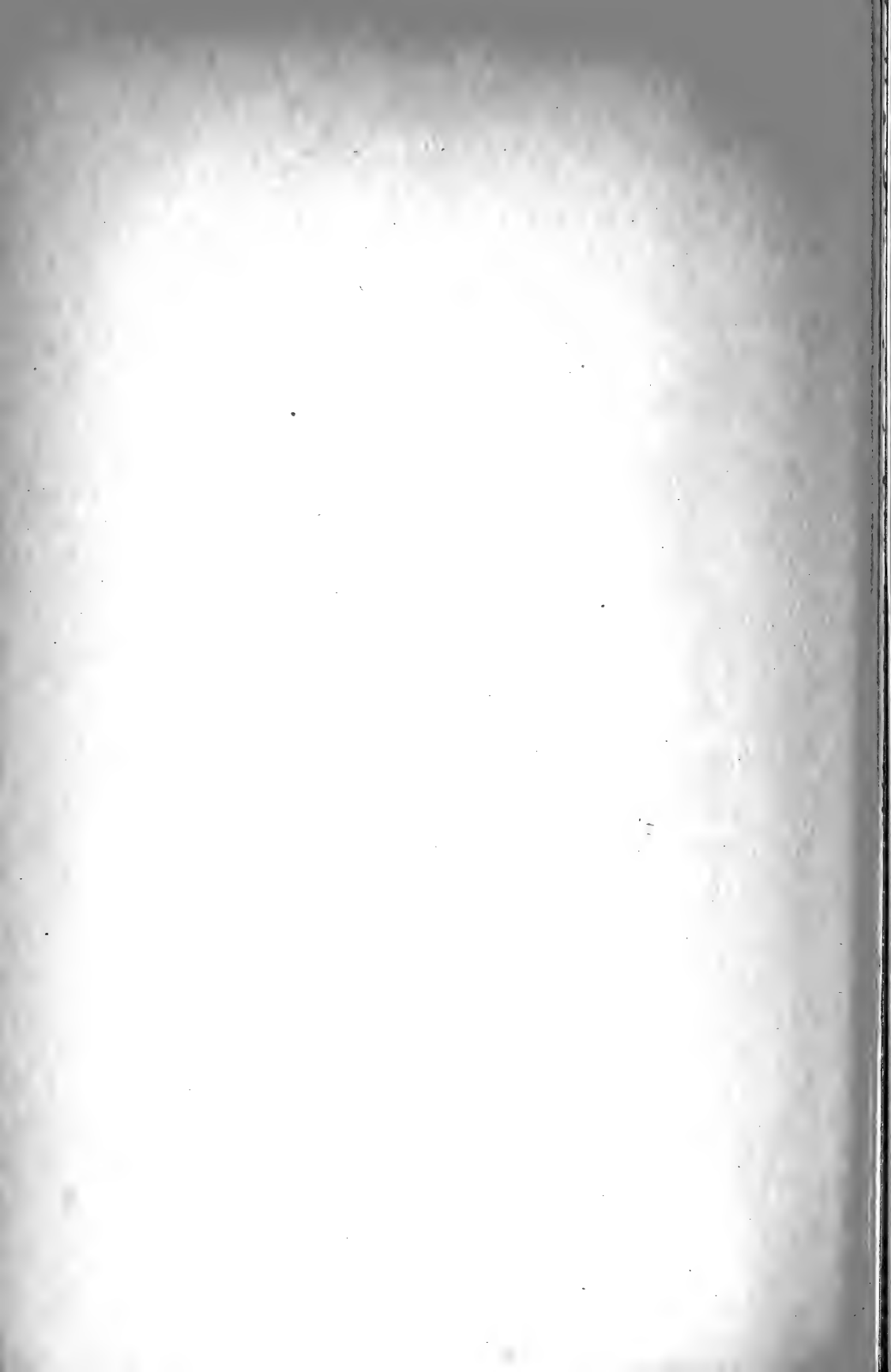
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10. What is the density of stars like Antares and Betelgeuse? II, 288-289
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21. What may make a new star contract? VII, 7
22. What are the colors of new and old stars? VII, 8
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2. What is the origin of the earth? VII, 8-9
3. What are the names of the planets? II, 242
4. What may be solar systems which are assuming form? VII, 6
5. How may a solar system form? VII, 8
6. What was the Yurok conception of the earth? IV, 198
7. How did the solar system originate? II, 299-300
8. What is the evidence that some meteors come

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9. What is the temperature range on the moon? II, 246
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6. How can a meteor's size be computed? III, 55
7. What were the early names for meteors? III, 79
8. What is the oldest meteorite? III, 7-8
9. How are meteors identified? III, 50
10. Why do meteorites disintegrate easily? III, 51
11. What happens to the meteor when it falls? III, 15
12. What is the tentative, accepted source of meteors? III, 98
13. Who proposed that meteors were shot at us by the moon? III, 84
14. What type of rock is entirely missing from meteors? III, 69
15. Where has cosmic dust been found? III, 62
16. What is the cause of the famous dark days in history? III, 63
17. Why do meteors lose their initial speed and fall at the speed of any falling body? III, 28
18. What is the speed of a meteor falling in the direction opposite to the earth's rotation? III, 27-28
19. What terrestrial stone approximates meteoric stone? III, 68-69
20. What causes sunglow? III, 83-87
21. How does a falling meteor appear? III, 4-6
22. If the earth had been built up by meteor showers, how long would it have taken to form? III, 4
23. How do we know that meteors strike the earth at rather slow speeds? III, 29-30
24. When do meteors become visible? III, 2

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25. Why are some meteors assumed to come from an oxygen-insufficient atmosphere? III, 65
26. What is the weight of each type of meteor? III, 67
27. What are the names of the three divisions of shooting stars? III, 79-81
28. What is the composition of 90% of meteoric stones? III, 75
29. What are the meteoric minerals? III, 66-67
30. How many meteors enter the earth's atmosphere? III, 3, 54
31. What is a meteorite? III, 4
32. What is a meteor? III, 1
33. What was the attitude of ancient peoples toward meteors? III, 37-38
34. What are some of the great areas where meteors have fallen? III, 42
35. Why is it difficult to locate the striking point of a meteor? III, 46-47
36. What did the Greeks report about meteors? III, 6
37. How far are meteoric disturbances heard or felt? III, 16-17
38. What is the first satisfactory account of a meteor fall in the United States? III, 13-15
39. What was the most remarkable meteor shower in the United States? III, 19
40. Why are the estimated twenty million meteors invisible? III, 4

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41. What kind of earth rock do stony meteorites resemble? III, 74
42. How are alloys interspersed in meteors? III, 70
43. What precious stone may be found in meteors? III, 69
44. How many meteors become shooting stars? III, 54
45. How many shooting stars reach the earth? III, 54
46. What alloys of nickel and iron are found in meteors? III, 70
47. What description of a meteor fall is found in the scriptures? III, 6
48. Are falling meteors dangerous to life on the earth? III, 36-37
49. What was the most remarkable meteor found? III, 22-24
50. What did early wise men say about meteors? III, 25

D. Movements of The Earth:

1. What is the place of the earth in the solar system? VII, 1
2. How does the sun rotate? II, 262
3. How does an eclipse form? II, 265-267
4. What holds the sun, earth, moon and other planets at their respective distances from each other? III, 3
5. What is the velocity of the earth in space? III, 3

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6. What possibility exists for the belief that the earth is a meteorite? III, 76-77
7. What is the speed of a meteor falling in the direction opposite to the earth's rotation? III, 27-28

E. Changing Seasons and Different Climates:

1. How may the variations of the sun's intensity cause climatic changes? II, 4-5
2. What is the effect of the variations of the solar radiation on the tropics? II, 157
3. In which latitudes do changes caused by solar radiation variations begin to take place? II, 157
4. What were the climatic conditions on the earth when dinosaurs were alive? VIII, 214
5. What is the temperature of the Arctic summer? IV, 67
6. What may have caused the concentration of civilization? VII, 189
7. When did present European climatic conditions begin? VII, 232
8. What was the climate of Europe in Solutrean times? VII, 207
9. What two cultures were in simultaneous existence in Europe at the beginning of the "Great Cold"? VII, 190
10. What happened to many animals of Europe when the climate changed? VII, 232
11. What was a big factor in population movement when the climate in Europe changed? VII, 232
12. What climatic conditions caused changes in the Acheulian Epoch? VII, 188

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13. What weather factor changes do the variations in sun cause? II, 4
14. How does the sun affect the seasons? II, 5

Pupil and Class Activities

A. Things To Do:

1. Make a chart of meteors which have fallen in or near your state. Use the lists given in III, 109-163
2. Make a list of things to watch for, should you see a meteor fall. III, 98-99
3. Make a meteoric map of the Arizona meteor crater. III, 23
4. Construct a model of an eclipse, as follows: Paint a black spot, the size of a quarter, on a square of clear glass. Cut a hole, slightly larger than the black spot, in a piece of cardboard. Place a light behind the glass and cardboard and move the black ball across the opening. The black spot representing the moon eclipses the circle of light, representing the sun.

B. Class Discussions:

Note: The statements listed below must not be considered as either true or false. The volume and page references will help the class to assemble the supporting evidence and furnish the basis for discussion. A similar plan is followed in every unit.

1. The earth is of meteoric origin. III, 1-5
2. The earth is a meteorite. III, 76-78
3. Meteors are cold when they land. III, 34-36

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4. Meteors hit the earth at terrific speeds. III, 27-34
5. Meteors fall in one piece. III, 42-53
6. Meteors come from other planets. III, 82-97
7. Meteoric iron has never been put to use. III, 100-106
8. The earth is the center of the solar system. VII, 1-2
9. The planets were formed by the collision of the sun with another star. VII, 7-11
10. Dark days are caused by eclipses of the sun by the moon. III, 62-63
11. There is life on the other planets. II, 242-251
12. The Arctic is warm in the summer. IV, 66-68

C. Pupil Reports:

1. The composition or contents of the Universe. VII, 5-8
2. Kinds of spiral nebulae. II, 296-300
3. World Origin—Learn and retell to your class or club the legend of the Cherokees, "How The World Was Made." IV, 218-220
4. How eclipses take place. II, 265-267
5. Early beliefs about meteors. III, 1-22
6. Historic names of meteors. III, 79-81
7. The composition of meteorites. III, 64-76
8. Historic meteor falls. III, 27-41
9. The work of Chladni proving that meteors are not magical objects. III, 25

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D. Self-Test Exercises:

TEST I

1. Give a four-letter word meaning "kind of heavenly body of which the sun is an example." II, 5
2. Give a four-letter word meaning "color of the hottest stars." II, 289
3. Give a three-letter word meaning "heavenly body from which our solar system came." VII, 8
4. Give a six-letter word meaning "shooting star." III, 3-4
5. Give a seven-letter word meaning "precious stones sometimes found in meteorites." III, 69
6. Give a six-letter word meaning "kind of heavenly body of which the earth is an example." VII, 1
7. Give a six-letter word meaning "rays observed streaming from the sun during a total eclipse." II, 265
8. Give a eleven-letter word meaning "force which holds the planets at their respective distances." III, 3
9. Give a six-letter word meaning "lens-shaped star cluster." VII, 2
10. Give a twelve-letter word meaning "an instrument which tells us what the sun is made of." II, 257

ANSWERS

- | | |
|------------|------------------|
| 1. star | 6. planet |
| 2. blue | 7. corona |
| 3. sun | 8. gravitation |
| 4. meteor | 9. galaxy |
| 5. diamond | 10. spectroscope |

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TEST II

Match each item in column A with the proper item in column B.

A	B
a. sun II, 287	1. one light year
b. hottest kind of stars II, 289	2. meteor
c. 6 trillion miles VII, 1	3. planets
d. billion stars VII, 2	4. 19.8 miles per second
e. formed from the sun VII, 8	5. moist, semi-tropical world climate
f. shooting star III, 3	6. epicycles
g. eclipse of the sun II, 265	7. star nearest to the earth
h. speed of the earth III, 3	8. cold, dry climate
i. Age of Dinosaurs VIII, 214	9. moon
j. Solutrean Epoch VII, 206, 207	10. blue stars
	11. galaxies

ANSWERS

a—7	f—2
b—10	g—9
c—1	h—4
d—11	i—5
e—3	j—8

UNIT II

THE EARTH'S ATMOSPHERE

A. An Invisible Ocean:

1. How did the atmosphere, troposphere, and stratosphere form? VII, 9
2. How high is the atmosphere? II, 45
3. What happens to the lighter gases in the atmosphere? II, 43-44
4. What is the temperature of air at different levels? II, 44
5. What is the composition of the atmosphere at sea level? II, 44
6. How many molecules does the atmosphere contain? II, 102-103
7. How do water molecules in high concentration act in the presence of dust? II, 103
8. How does air pressure change with altitude? II, 44

B. Air and Fire:

1. How did Eskimos kindle a fire? IV, 43
2. How did Eskimos cook in the igloo? IV, 43

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3. How did ancient people maintain constant fires? VII, 173
4. Did man first learn to kindle fires or to keep fires alive? VII, 172
5. When did man begin to use fire? VII, 172
6. Before which epoch had man learned to kindle a fire? VII, 192
7. How did the Pomas kindle a fire? IV, 185
8. What is the Eskimo lamp? IV, 43
9. Why do we assume that some meteors come from an atmosphere lacking in oxygen? III, 65
10. How does a meteor's trail of light form? III, 31-32
11. When do meteors become visible? III, 2
12. What effects of meteoric flights in air are found on a meteor's surface? III, 50

C. Air and Living Things:

1. Define respiration. V, 114
2. What gives a caterpillar energy to transform itself into an adult? V, 292
3. How does an insect get sufficient energy for flying? V, 116
4. Are insects able to keep their bodily heat? V, 116
5. What is the evidence that insects release heat energy? V, 116
6. What is the breathing rate of infants? VII, 35
7. What is the cause of the whale's "spout"? IX, 367

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8. To what circumstance may amphibians owe their origin? VIII, 173
9. Why is the bat a remarkable mammal? IX, 316
10. Why are bats able to fly? IX, 317
11. Where is there an exchange of gases in an insect's body? V, 115
12. What is the purpose of the "knees" of cypress trees? XI, 10
13. What is the purpose of stilt roots? XI, 10
14. Why do roots die when they receive no air? XI, 28
15. Can plants drown? What happened to the trees which were flooded in Panama? XI, 9
16. Why do large numbers of city trees often die? XI, 9

D. Why Our Air Supply Lasts:

1. Should plants be removed from a sick-room? XI, 28-29
2. What is the significance of bubbles coming off a water-plant in the sunshine? XI, 27
3. How do leaves breathe? XI, 24-25
4. How do plants supply us with oxygen? XI, 25-27
5. How is carbon dioxide removed from the air? XI, 299-300
6. What is the atmospheric make-up at sea level? II, 44

E. How Living Things Breathe:

1. How does a grasshopper breathe without a nose? V, 13, 114-116

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2. How do insects get their air if they have no lungs? V, 114
3. How does a mosquito larva breathe? V, 332-333
4. How do some fly larvae breathe? V, 326-327
5. How does an insect breathe? V, 115
6. What are spiracles? Where are they found? V, 114-115
7. Why can an insect's spiracles be compared with our nostrils? V, 114
8. Which salamanders have neither gills nor lungs? How can they breathe? What are their habits? VIII, 182-183
9. What special power does the skin of an amphibian possess? VIII, 175
10. How do tadpoles breathe? VIII, 197
11. How do fish breathe? IX, 368
12. Why are the gills of fish similar to lungs? VIII, 84
13. What different types of gills are found among fishes? VIII, 84-85
14. How are a fish's gills arranged? VIII, 65
15. Why do fish suffocate in warm water? VIII, 86
16. How does a mollusk get fresh water to its gills? X, 258
17. Discuss the breathing problems of land and water snails. X, 295-297
18. How does a mollusk breathe? X, 259

F. Hearing Through the Air:

1. What is the medium for transmitting sound? II, 305

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2. What is the velocity of sound? II, 305
3. How do crickets sing? V, 56-58
4. How do katydids produce their song? V, 33-37, 39, 41, 43-44, 47-49, 53
5. When are cicadas heard? V, 184
6. Can crustaceans make noises? What are some examples? X, 192-194
7. How does the pistol crab make its sharp reports? X, 192-194
8. Why do crabs make sounds? X, 197-199
9. Can a fish hear? VIII, 73-74
10. What is the purpose of a fish's ear? VIII, 73-74
11. Which cicada sex produces music? How is this done? V, 199, 207-212
12. How do birds inform other birds of danger, food, etc.? IX, 110-113
13. What birds are able to imitate other birds? IX, 107-109
14. How do birds differ in their ability to make sounds? IX, 103-105
15. What is the "syrinx" in birds? How is it used? IX, 103
16. When do birds sing best? IX, 109-110
17. How true is the belief that splitting a bird's tongue will improve its speech? IX, 108-109
18. What bird roars like a lion? IX, 105
19. What was the origin of the drum? VII, 258

Pupil and Class Activities

A. Things To Do:

1. Using a broomstick and scrap wood, construct a fire drill. In the out-of-doors, on a dry day, kindle a fire using your fire drill. VII, 238
2. Make a fire drill and start a fire. Use hard wood and dried cedar bark for tinder. VII, 172
3. With clay or plaster make an Eskimo oil lamp. IV, 44
4. Capture some katydids and put them into bottles. Listen to their music. Find out how katydids produce their music. Do the same with crickets.
5. Find out where and how water enters the leaves of celery. Place fresh-cut stalks in red or green ink for a few hours. XI, 22-24
6. Experiments: To find out the effect of lack of air on roots, place a potted geranium plant into a tank of water. Keep another potted geranium on the table, watering the earth as usual. Note the changes that take place. XI, 9-11
7. Excursion: Visit and study the school's ventilating system.

B. Pupil Reports:

1. The atmosphere at different altitudes. II, 43-45
2. How meteors get their light. III, 30-32, 50, 65

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3. Primitive methods of starting fires. VII, 172-173
4. How Eskimos get light and heat for their igloos. IV, 43
5. Learn and tell your classmates and fellow club members the legend as to the origin of fire. IV, 220-222
6. How do lungless animals breathe? V, 113-114, 116, X, 258, 295-297
7. The different means that insects employ for getting and using air for energy production. V, 114-116

C. Self-Test Exercises:

TEST I

Match each item in column A with the proper item in column B

A	B
a. respiration	1. salamander VIII, 182-183
b. bat	2. gills VIII, 86, 87
c. insect	3. warm water VIII, 86
d. stomata	4. breathing aperture V, 332-333
e. cypress trees	5. absorb oxygen XI, 28
f. roots	6. flying mammal IX, 316
g. animals without gills or lungs	7. exchange of gases V, 114
h. fish	8. spiracles V, 114-115
i. reduced air supply	9. knees XI, 10
j. mosquito larvae	10. leaves XI, 24-25

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ANSWERS

a—7	f—5
b—6	g—1
c—8	h—2
d—10	i—3
e—9	j—4

TEST II

ODIUSTVXZ. Change the letters in this code word as follows:

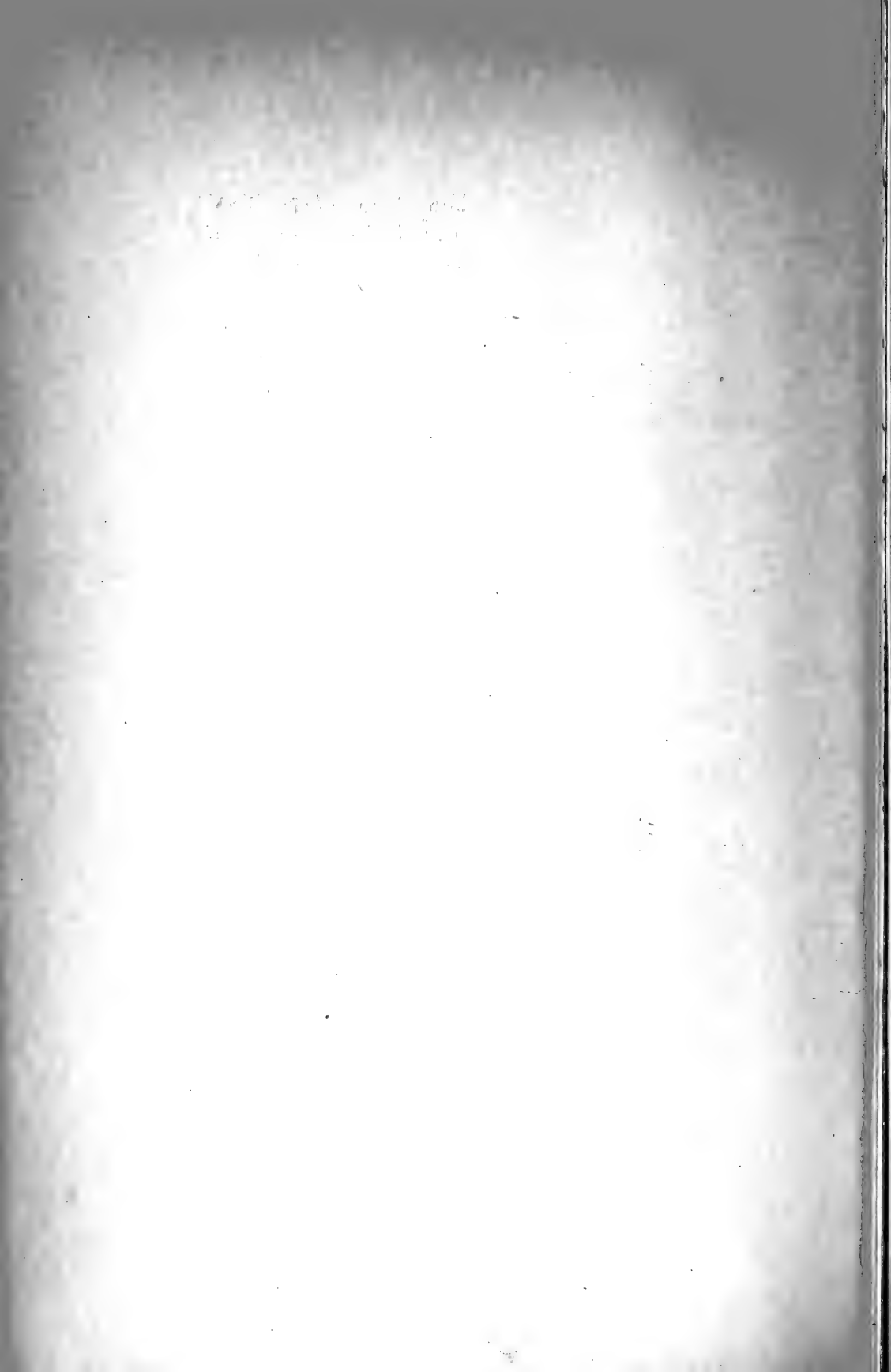
1. Change O to C if plants should be kept in sick rooms. If not, change to B. XI, 28-29
2. Change D to R if water plants give off oxygen. If not, change to A. XI, 27
3. Change I to R if the atmosphere is about 1,000 miles high. If the atmosphere is 150 miles high, change to E. II, 45
4. Change U to A if hydrogen can be found somewhere in the air. If not, change to P. II, 43-44
5. Change S to E if the temperature of the air is the same at all levels above the earth. If not, change to T. II, 44
6. Change T to H if sea mollusks supply fresh sea water to their gills. If not, change to N. X, 258
7. Change V to T if a grasshopper has a nose. If not, change to I. V, 113, 114-116
8. Change X to E if insects use little oxygen when flying. If insects use a great deal of oxygen when flying, change to N. V, 116
9. Change Z to R if the breathing rate of young infants

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is slower than that of adults. If infant breathing rate is the same as that of adults, do not change. If the breathing rate of young infants is much faster than that of adults, change to G. VII, 35

Note: When you have made all of the above changes correctly, you will have a word which represents one of the most important functions of life. What is the word?

ANSWER: BREATHING



UNIT III
WATER ON THE EARTH

A. Water and Living Things:

1. How much water does a square mile of hardwood forest consume in a season? II, 224
2. How does root pressure help a plant to obtain water? XI, 5
3. How does water flow through a plant? II, 226-227
4. What is meant by the transpiration current? XI, 23
5. What controls the amount of water a tree receives? XI, 22-23
6. What causes wilting? XI, 25-26
7. Why do trees shed their leaves in a dry season? XI, 21
8. How can a leaf get carbon dioxide without losing too much water by evaporation? XI, 299-300
9. How was it found that light can affect the amount of substance taken in by a plant? XI, 299
10. How do plants give off water? II, 224
11. How is evaporation from a leaf controlled? XI, 25

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12. How do plants control the amount of water vapor given off? II, 226
13. What are stomata? XI, 300
14. What controls the opening and closing of stomata? XI, 300
15. What happens to stomata at night? XI, 300
16. What is the condition of substances taken in by plant cells? XI, 297
17. What are the conditions necessary for substances to enter a cell? XI, 29
18. Why do molecules diffuse or spread through a liquid? XI, 297
19. Through what must molecules pass in order to enter a plant? XI, 297
20. What controls the entrance of molecules of salts into a plant? XI, 297-298
21. What causes the concentration of some molecules to be higher in a plant cell than in the surrounding soil water? XI, 298
22. How did irrigation cause the death of crops? XI, 11
23. What had to be done to make alkali soil capable of growing crops? XI, 11
24. How is the water supply related to plant movements? XI, 312-313
25. Why is life on land more strenuous than in the sea? X, 74
26. Why does a shallow sea like the Chesapeake Bay have such an abundance of life? X, 34

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27. What effect did the retreat of the seas have on trilobites and sea scorpions? X, 74
28. What happens to *Daphnia* when they reach the surface film of water? X, 121
29. Which crustaceans have eggs which can withstand a thorough drying? X, 114-115
30. How long can the winter eggs of some crustaceans resist drying? X, 120
31. Where are a lobster's gills? X, 107
32. In what kinds of surroundings do fishes live? VIII, 2
33. Where is one body of water that has no fish? VIII, 2
34. Why have not the fishes varied as much as the land animals? VIII, 3-4
35. What is the reason for the wide distribution of fishes? VIII, 2
36. What effect have floods upon fishes? VIII, 131-132
37. What theories try to account for the widespread distribution of some fishes? VIII, 150-151
38. What is meant by "vertical distribution" of fishes? VIII, 153
39. What is meant by "pelagic" fishes? VIII, 153-154
40. What are littoral fishes? VIII, 154
41. How are deep-sea fishes different from other fishes? VIII, 154
42. What fish hibernates in a mud cocoon? VIII, 4-5, 19-40

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43. What does the word "amphibians" mean? VIII, 161
44. Why do salamanders always avoid sunny places? VIII, 180
45. In development, tadpoles "race against death". What is the meaning of this statement? VIII, 197
46. Has it ever "rained frogs"? Can you explain this? VIII, 195
47. Can amphibians live in salt water? VIII, 173
48. Where may we find salamanders? VIII, 179-180
49. How do frogs react to salt water? VIII, 195
50. How do baby grebes which are hatched in a nest over water take care of themselves after birth? IX, 93-94
51. Why can kangaroo rats live without water? IX, 334
52. What caused the tremendous fossil deposits in a Colorado lake? X, 80
53. How did desert Indians get water in the desert? XI, 280

B. The Changing Forms of Water:

1. What forms of matter exist? XII, 49
2. Does water-vapor travel? II, 106
3. Where do fogs form? II, 105
4. What are the different kinds of clouds? II, 104-105
5. How do rain particles form? II, 103
6. What changes of water take place? XII, 49

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7. What is the importance of water in crystal formation? III, 174-175
8. What does nature need to form crystals? III, 174
9. What is formed by meteoric water? III, 174-175

C. *Water—The Great Dissolver:*

1. How does ammonia dissolve in water? XII, 240
2. What is the solubility of garnets? III, 245
3. What crystal does earth water produce? III, 175
4. What bird loses its bright colors when wet? VI, 251
5. What is soil water? XI, 5-6
6. What minerals must be dissolved in the soil for plant use? XI, 8
7. How is water used in gem mining? III, 194, 205-206

D. *Water Power:*

1. What is a Pelton wheel? XII, 150-151
2. When are Pelton wheels used? XII, 151
3. Why are water wheel buckets curved? XII, 151
4. How is water pressure converted into mechanical energy? XII, 151
5. How is the speed of a Pelton wheel controlled? XII, 152
6. How is large quantity low pressure water power harnessed? XII, 151-152
7. What is a Pelton wheel's efficiency? XII, 151-152

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8. What is a reaction turbine? XII, 152
9. What type of water turbine is popular in the United States? XII, 153
10. Why are inward flow turbines preferred? XII, 153
11. What is the advantage and disadvantage of the vertical reaction turbine? XII, 153

Pupil and Class Activities

A. Things To Do:

1. Make a simple Pelton water wheel using curved pieces of tin fastened to a wooden disk. Aim a stream of water from a rubber tube at the blades. XII, 150
2. Build a water turbine wheel from wood as shown in plate 47. XII, 152
3. Make a manometer to measure root pressure. XI, 6
4. Perform the experiment showing the effect of evaporation from leaves. XI, 23
5. Grow Mimosa from seeds obtained from a nursery. Tap its leaves and observe its movements as described in XI, 72-74
6. Examine the surfaces of different kinds of leaves for stomata. XI, 300
7. Find a small sapling. Cut sections of the stem at intervals of an inch. Count the annual rings in each section and tell how old each is. Can you tell the kind of seasons, dry or wet, in which the plant did its growing? Check your results with the Weather Bureau. XI, 15-16
8. Plant two evening primrose plants and expose one to sun for only 10 hours per day. Expose the

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other for the full length of a day as described in II, 232.

9. **Experiment:** To determine the effect of stomata on a leaf, cover the upper side of a rubber-plant leaf with vaseline and the underside of another rubber-plant leaf with vaseline. Pin them up on the bulletin board in your classroom for a few weeks. Note which leaf shrivels up first. Why did it do so? Use a microscope to verify your theory. XI, 24-25
10. **Excursions:**
 - a. Examine the school's sewage disposal system.
 - b. Examine the school's water supply system.
 - c. Visit a local water-works. Inspect the water purification plant.

B. Pupil Reports:

1. The movement of water in narrow channels. II, 227
2. The falling of leaves from tropical trees as compared with trees of the temperate zones. XI, 21
3. The Indian canteen for water. IV, 134

C. Self-Test Exercises:

TEST I

1. Give a nine-letter word for "animals which can live on land and water." VIII, 161
2. Give an eight-letter word for "a rat which can live a long time without water." IX, 334
3. Give two five-letter words for "the composition of a cloud." II, 106

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4. Give a four-letter word for "the material around which drops of rain form." II, 103
5. Give a nine-letter word for "a bird that loses its color when wet." VI, 251
6. Give a number for "the amount of ammonia which can dissolve in 100 lbs. of water at 77°F." XII, 240
7. Give a six-letter word for "the water wheel used for water falling great distances." XII, 150-151
8. Give a ten-letter word for "the most popular water turbine in the United States." XII, 153
9. Give two five-letter words which describe the means of converting water pressure into usable mechanical energy. XII, 151
10. Give one five-letter word, one six-letter word and one three-letter word which represent the forms of matter. XII, 49

ANSWERS

- | | |
|----------------|------------------------|
| 1. amphibian | 6. seventy-one lbs. |
| 2. kangaroo | 7. Pelton |
| 3. water-vapor | 8. inward flow |
| 4. dust | 9. water wheel |
| 5. touracous | 10. solid, liquid, gas |

TEST II

Rewrite the sentences which are not true so that a correct sentence results.

1. In one season a hardwood forest consumes 10,000 gallons of water. II, 224
2. Water flows through plants by capillary action. II, 226-227

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3. The giving off of water to the air by plants is called osmosis. XI, 23
4. Trees shed their leaves in a dry season to prevent further loss of water. XI, 21
5. Tiny ventilators in leaves are of one constant size and do not permit the control of the intake of carbon dioxide and the release of water and oxygen. XI, 299-300
6. Plants take in carbon dioxide from the air through small openings called stomata. XI, 300
7. Substances cannot be taken in by plant cells unless they are in a solution. XI, 297
8. Salt concentrations are always the same in plant cells as in the surrounding soil. XI, 298
9. There are no fish in the Great Salt Lake. VIII, 2
10. Fish are alike at all depths. VIII, 153

ANSWERS

1. In one season a hardwood forest consumes over a million tons of water.
2. True
3. Transpiration
4. True
5. Stoma openings vary in size in accordance with light and humidity.
6. True
7. True
8. Salt concentrations are frequently greater in plant cells than in the surrounding soil.
9. True
10. Fish of different types are found at different depths.

UNIT IV

THE SURFACE OF THE EARTH

A. Examining The Surface of The Earth:

1. How does a geologist measure time? IX, 255-259
2. How does a paleontologist decide a region's ancient history? X, 17
3. What are igneous rocks? How did they form? X, 9
4. What happens to the mud that reaches the ocean beds? X, 34
5. How many miles of sedimentary rock has been formed in the past? X, 8-9
6. How many feet of sedimentary rock have been formed since the beginning of the earth? X, 2
7. How are layers of rock made? X, 1-2
8. What is meant by sedimentary rocks? X, 1-2
9. What suggestion did Charles Darwin make in order to help decide how old the earth is? X, 1-2
10. What rock-forming process is going on today? X, 1-2
11. How long does it take to form an inch layer of mud? X, 2

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12. How are fossils exposed on a piece of rock? X, 61
13. What name has been given to the first sedimentary rocks? X, 41
14. What changes took place during the Proterozoic Era? X, 44-49
15. What happened during the Cambrian Period? X, 35-38
16. What is meant by Pliocene and Pleistocene? X, 81
17. When did the Alps and Himalaya Mountains form? X, 79
18. When were the Andes and the Rocky Mountains born? X, 78
19. When did the Sierra Nevada Mountains form? X, 76-77
20. How did the Appalachian Mountains form? X, 72
21. When do mountains reach "old age?" X, 3
22. What process wears down many feet of sedimentary rock? X, 3
23. When did an ice sheet cover Europe and North America? X, 81-82
24. What happened when the ice of the Ice Age melted? VII, 65
25. What four glacial stages are found recorded in the Alps? VII, 65-66
26. How were river terraces formed? VII, 65
27. What present-day continents had land bridges? VII, 63-64

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28. What proofs have we that Gibraltar and Africa were joined? VII, 65
29. Where did the ocean's salts come from? X, 4
30. What is loess? X, 11
31. What conditions exist in a desert? XI, 253-263
32. When did vast deposits of diatoms form? X, 80
33. Why are there so many marsupials in Australia? IX, 283
34. Which continent first emerged from the sea? X, 7
35. What has shown us that the level of the ground continually changes? X, 30-31
36. What has happened to the earth's surface in the past? X, 8
37. What is the ancient history of the Badlands of South Dakota? Why are they important to scientists? IX, 177-181, 188-191, 201, 204-206
38. How do fossils indicate old land and water areas? X, 18
39. Why is Europe best for the study of more recent life? X, 8
40. Why is North America best for the study of extremely ancient life? VI, 7-8
41. Which states were once covered by very large oceans? X, 37-38
42. How did the seas form? VII, 65
43. In what kind of world did the first amphibians live? VIII, 163

B. Change in The Surface of The Earth:

1. Why does the earth's crust move? VII, 9-10

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2. How thick is the earth's crust? VII, 9-10
3. What happened to the earth's crust when it formed? VII, 9-10
4. What is the basis for believing the earth is at least 12 million years old? X, 2
5. How did the earth's surface form? VII, 9
6. When do mountains reach "old age?" X, 3
7. How long does it take to form an inch layer of mud? X, 2
8. What process wears down many feet of sedimentary rock? X, 3
9. How do oceans, lakes and seas form? VII, 9
10. What were the surface conditions of Europe during the Magdalenian Epoch? VII, 214-215
11. What changes took place during the Proterozoic Era? X, 44-49
12. What happened during the Cambrian Period? X, 35-38
13. What species were alive during the Permian Period? VII, 16
14. What happens to the mud that reaches the ocean bed? X, 34
15. What are strata? VII, 8-10
16. When was the central part of North America covered by a sea from Alaska to the Gulf of Mexico? X, 77
17. What states were once covered by very large oceans? X, 37-38
18. What evidence is there of sea level changes? VII, 62

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19. What has shown us continuous changes of the level of the land? X, 30-31
20. Why are some animal fossils common to the British Isles and Scandinavia also found in the Appalachian Mountains? X, 37
21. What caused the Sahara to become a desert? VII, 294
22. Why does Southwestern Asia retain so many primitive traits? VII, 301
23. What proofs are there for a New World connection to Asia? VII, 326
24. Which country served as a highway between Africa and Europe? VII, 227
25. How did Cro-Magnon Man reach Europe? VII, 198
26. What happened to land surface elevation during the Glacial Period? VII, 61-62
27. What was the effect of the glacier on surface vegetation? VII, 60
28. What was the effect of the Glacial Period on sea water? VII, 62
29. How do glaciers form? VII, 57
30. When did an ice sheet cover Europe and North America? X, 81-82
31. What was the Ice Age like? X, 81-82
32. Where are there remains of the glacier today? VII, 57
33. How much ice is calculated to have formed during the Ice Age? VII, 62
34. What is loess? VII, 61

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35. What was the effect of the Ice Age on wind and soil? VII, 61
36. What does loess tell us about the past? VII, 61-62
37. What kind of land does loess come from? VII, 61-62
38. What caused the Colorado River to shift its course? XII, 209
39. How does grass keep land from blowing away? XI, 226-227

Pupil and Class Activities

A. Things To Do:

1. Make a large chart showing the major divisions of geological time as given in X, 15-16
2. Copy the geological time clock of the earth on a large chart for your classroom. X, 6
3. Make clay models of animals alive during the time of Krapina Man. VII, 105
4. Try to get some of the "core" materials brought up by an oil drill. Examine it for microscopic fossils. Preserve your slides for exhibition. X, 19-25

B. Class Discussions:

1. Discuss the conditions of rainfall, heat, and kind of soil one may expect to find in a desert. XI, 253-263
2. Another Ice Age is possible. VII, 56-59
3. Report: The Formation of Loess. VII, 60-61
4. How the continents were once connected. VII, 63
5. Evidences of the land bridge between Asia and North America. VII, 326-328

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C. *Self-Test Exercises:*

TEST I

Below are 10 statements. Some are true; some are false. On a sheet of paper rewrite each false statement in such a way that it becomes true. In doing this you may change or leave out any of the italicized words but you may not change or leave out any others.

1. Mud that reaches the ocean beds finally becomes *igneous rock*. X, 8
2. Since the beginning of the earth *one thousand* feet of sedimentary rock have been formed. X, 2
3. Many feet of sedimentary rock have been worn away by *earthworms*. X, 3
4. Salts found in the ocean have come from the *rocks*. X, 4
5. The earth's crust is *one mile* thick. VII, 9-10
6. The earth's crust bends, due to the weight of the *air*. VII, 9-10
7. The Sahara Desert was *never fertile* and able to support life. VII, 302
8. That North America once was joined to Asia is shown by the presence in both continents of *men with copper colored skin*. VII, 326
9. The glaciers that covered large parts of North America and Europe changed forests *into swamps*. VII, 60
10. An ice sheet 4,000 feet thick covered North America during the *Paleozoic Era*. X, 81

ANSWERS

- | | |
|---------------------|------------|
| 1. sedimentary rock | 3. erosion |
| 2. 350,000 | 4. rocks |

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- | | |
|------------------------------------|---------------------------------|
| 5. 60 miles | 8. men with copper colored skin |
| 6. detritus brought down by rivers | 9. into tundras |
| 7. once fertile | 10. Pleistocene |

TEST II

Fill in the missing word so that a true statement results.

1. A paleontologist decides the ancient history of a region by _____. X, 17
2. Rocks formed by heat action are called _____. X, 9
3. Mud that reaches the ocean beds becomes _____. X, 34
4. Rocks formed by the accumulation of layers of debris are called _____. X, 8-9
5. The oldest rocks are _____. X, 9
6. In the Alps Mountains we find _____ stages of glaciers recorded. VII, 65-66
7. The present day continents which had land bridges are _____. VII, 63-64
8. An extremely fine soil formed by glacial action is called _____. VII, 61
9. The continent which first emerged from the sea is _____. X, 7
10. Soil is prevented from blowing away by _____. XI, 226-227

ANSWERS

1. studying the kind of rocks in which remains are found
2. igneous

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3. rocks
4. sedimentary rocks
5. igneous
6. four
7. Asia, North America, Africa, Europe
8. loess
9. North America
10. grass

UNIT V

LIVING THINGS ON THE EARTH

A. Kinds of Living Things:

I. PLANTS:

1. Why are plants classified? XI, 148
2. What was Linnaeus' contribution to science? XI, 142-144
3. What is the practical importance of classifying plants? XI, 157-160
4. How do students of plant classification do their work? XI, 157-160
5. What is an herbarium? XI, 149-152
6. How are plants dried and pressed? XI, 365-366
7. How do students use an herbarium? XI, 153-155
8. How is a specimen labelled on an herbarium sheet? XI, 153
9. What do large plant collections teach us? XI, 154-156
10. What makes us realize the natural groupings of plants? XI, 86
11. Into what four great groups are plants put? XI, 86

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12. What are diatoms? X, 80-81
13. How many kinds of algae are there? XI, 175
14. What are "calcareous" algae? X, 46-47
15. What kinds of plants live in the sea? XI, 167
16. What is meant by the "Sargasso Sea"? XI, 88-89
17. How long do some seaweeds grow? XI, 88
18. What are lichens? How do they live? XI, 92-93
19. How are ferns different from mosses, algae, and fungi? XI, 93
20. What are some relatives of the ferns? XI, 94
21. What are gymnosperms? Give examples. XI, 94-95
22. What is the meaning of "angiosperm"? XI, 95
23. How are gymnosperms different from angiosperms? XI, 95
24. How many families of flowering plants are there? XI, 96
25. How are monocotyledons different from dicotyledons? XI, 95-96
26. What kind of plant is corn? XI, 213-214
27. When did maize reach the old world? XI, 323
28. Name some relatives of corn? XI, 331
29. Why do forest floors remain bare? XI, 32
30. Name some carnivorous plants? XI, 75
31. Give some examples of hydrophytes, xerophytes, halophytes, and mesophytes. Why are these plants so classified? XI, 78-80
32. How are mushrooms grown? XI, 92

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33. Discuss some interesting facts about algae. XI, 175-183
34. What are parasites and saprophytes? XI, 89

2. MOLLUSKS:

1. How many vertebrate and invertebrate species are known to exist? VII, 20
2. What is a mollusk? X, 252-263
3. How do shells of mollusks help us in classifying them? X, 254
4. Name the four classes of mollusks. Give an example of each. X, 255
5. What did the Indians use to make wampum? X, 275-276
6. What mollusks were used as a basis for trade among North American Indians? X, 283
7. To what animal group do shipworms belong? X, 269-270
8. To what length may a shipworm grow? X, 270
9. What is a gastropod? X, 284-287
10. What interests us in gastropods? X, 287
11. What gastropod spins threads like a spider? X, 261-262
12. Which gastropods have no shell? X, 291
13. What does "cephalopod" mean? X, 327
14. Give some examples of cephalopods. X, 321
15. In what group are the squid and octopus? X, 251-252
16. We sometimes read or hear reports of "sea serpents" seen at sea.
What animals may these have been? X, 348-349

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17. What is the only cephalopod with a shell? X, 325
 18. What connects the mollusks with the lower vertebrates? X, 252
 19. In what respects are mollusks considered the highest invertebrates? X, 251
 20. How do mollusks differ from arthropods? X, 252
3. CRUSTACEANS:
1. Why is an animal's structure rather than its way of living used in classification? V, 26
 2. What does "arthropod" mean? Give some common examples? V, 26
 3. What are crustaceans? X, 90-91
 4. How many species of crustaceans are there? X, 91
 5. How are crustaceans classified? X, 113-114
 6. What are some common examples of crustaceans? X, 90-91
 7. Name the largest and smallest crustaceans? X, 96
 8. How are crustaceans segmented? X, 98-99
 9. How do Crustacea larvae help us in identifying the adults? X, 128-129
 10. Who first began a scientific study of Crustacea? X, 94-95
 11. Why was cyclops given its name? X, 127
 12. What are fish lice? X, 129-130
 13. What are "water fleas?" X, 118

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14. Of what importance are water fleas in ponds and lakes? X, 118
15. What makes the copepod the most beautiful thing in nature? X, 126
16. Why are parasitic copepods so interesting? X, 128-129
17. What are some relatives of the Crustacea? X, 91
18. Has a crab a tail? Explain. X, 102
19. What interesting habits has the robber crab? X, 174-176
20. Of what substance are the shells of crabs and lobsters made? X, 97-98
21. Name some crabs that hold "conversations." X, 192-199
22. Where in the United States can we find a fresh-water shrimp weighing 3 lbs.? X, 173
23. What are "fairy shrimp?" X, 115-116
24. How many body regions has a shrimp? X, 100
25. How did the "glass" shrimp get its name? X, 168
26. What shrimp does "needlework" in building its house? X, 219-220
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43. How long ago and by what people were falcons trained for hunting? IX, 5
44. What birds build nests relished by the Chinese for a soup? IX, 77
45. What birds have been domesticated for many centuries? IX, 2-3
46. Who domesticated the turkey? VII, 339
47. In what manner did man learn how to domesticate birds? IX, 4-5
48. What led to our having parrots and canaries for pets? IX, 4-5
49. Where was the last passenger pigeon in the world kept before it died? How long did it live in captivity? VI, 250
50. What parrot attacks and kills living sheep? IX, 160
51. Why are the mountain parrots or keas being exterminated? VI, 252
52. How should we deal with birds which catch and eat fish? IX, 138-139
53. What do hawks and owls eat? IX, 140-141
54. What complaints have been made against the bobolinks and red-winged blackbirds? IX, 129-130

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55. What birds of prey should be kept in check? IX, 141
56. How are corn kernels treated to prevent crows from eating them? IX, 131
57. How did the National Zoological Park come into being? VI, 3-5
58. How does the National Museum get some of its bird specimens? IX, 8
59. What kind of work is done by "economic ornithologists?" IX, 124-125
60. Cite some examples which show how bird bandings give us information of a bird's travels. IX, 65-67
61. Why are birds' stomachs so carefully studied? IX, 125
62. Why is the mongoose not allowed to be imported into the United States? VI, 222
63. Which monkey is trained to climb coconut trees and throw down coconuts? VI, 49
64. What were the female llamas used for? VI, 156
65. How do people use reindeer? VI, 185
66. What evidence is there of the cleverness of the wolverine? Why is it becoming scarce? VI, 226-227
67. Why is the African cheetah in such demand in India? VI, 90-91
68. Why are leopards more dangerous than other "cats?" VI, 87
69. Why are leopards killed and trapped so frequently? VI, 85

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2. OUR HEALTH AND LIVING THINGS:

1. How do certain seaweeds aid the science of bacteriology? XI, 89
2. Should plants be removed from a sick room? Explain. XI, 28-29
3. Describe the damage done by some of the trypanosomes. V, 349
4. In what way are gastropods sometimes dangerous to man? X, 316
5. What mollusk can kill a man? X, 293
6. Why do the natives of New Guinea dread the bite of *Conus*, a snail? X, 301-302
7. Do octopuses and squids really attack man? X, 346-347
8. Does the house-fly ever bite people? V, 347-348
9. Why can a fly's bite cause a serious infection? V, 323
10. What is the most effective method of fly control we have? V, 343
11. Why are mosquito bites painful? V, 338
12. What is the only known carrier of the yellow-fever virus? V, 338-339
13. Why has yellow fever occasionally broken out in northern cities? V, 340
14. What damage may the "screw worm" cause to animals and man? V, 352
15. What is the carrier of the germs of African sleeping sickness and nagana? V, 348-349
16. What is the worst biting fly? V, 348

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17. How are crabs an aid to sanitation in the tropics? X, 245
18. How do sand-fleas help mankind? X, 158
19. What crab in Jamaica is used to "treat" deafness? X, 239
20. What two species are the only poisonous lizards now known? VI, 262-263
21. What lizard in the United States is as deadly as a rattlesnake? How does it inject its poison? VIII, 336
22. Why are geckos unwelcome visitors in warm countries? What interesting features do geckos have? VIII, 325-326
23. How dangerous is the cobra? How many people in India die each year from cobra bites? Why is not the cobra wiped out in India? VIII, 351-352
24. Is it true that a spitting cobra can shoot its poison at one's eye? VI, 269
25. Why is the mamba so feared? VIII, 354
26. How old must a baby of a poisonous snake be before it can inflict harm upon us? VIII, 343
27. How poisonous are copperheads? VIII, 348
28. What rattlesnake is considered the most dangerous in North America? What gives it its reputation? VIII, 349
29. How is antivenin used and prepared? VIII, 351
30. What monkey was used to teach ancient doctors anatomy? VI, 48
31. What do the Chinese use a rhinoceros' "horn" for? VI, 207
32. What is the rhinoceros' "horn" made of? VI, 208

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3. CONTROLLING OUR ENEMIES:

1. What is a "hopperdozer?" How is it used? V, 19
2. Describe an effective poison for grasshoppers. V, 19
3. What methods do we use to kill biting insects? V, 154
4. What methods do we use to kill sucking insects? V, 154
5. What is the most effective method of fly control? V, 343
6. How can we use insects to fight other insects? V, 19-21

4. ASCENDANCY OF MAN OVER OTHER LIVING THINGS:

1. What physical land conditions brought about the domestication of animals? VII, 250-251
2. What one defect has the Eskimo dog? IV, 4
3. What valuable sense do Eskimo dogs possess? IV, 50
4. How are Eskimo dogs handled? IV, 47
5. In what way were dogs useful to Mesolithic man? VII, 239
6. How did dogs become domesticated animals? VII, 239
7. What are the first evidences of domestic dogs? VII, 230-238
8. What early evidence have we of the use of mounted horses? VII, 323

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9. When were the horse and donkey introduced into Babylonia? VII, 305-306
10. What effect did the horse have upon civilization? VII, 306
11. How did the Egyptians come to use the camel? VII, 300
12. What animal changed the course of history? VII, 286-287
13. Why is the yak a useful animal in Central Asia? VI, 174
14. What was the ancient Peruvian beast of burden? VI, 156
15. Is a camel as patient as it is said to be? VI, 154
16. When did the United States attempt to domesticate camels? VI, 154
17. In what country were camels successfully domesticated? VI, 154-155
18. How long has the camel been in use? VII, 275
19. How did plow-oxen come into use? VII, 261
20. What led people to set aside some animals as sacred? VII, 251
21. How did man come to use animals as beasts of burden? VII, 255-256
22. What is believed to be the reason for animal drawings on walls of caves and weapons of ancient man? VII, 52, 202-203
23. Why was man able to overcome creatures stronger than himself? VII, 170
24. Why are forest people in Africa, New Guinea, and the Philippines so backward? XI, 204

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25. How did Neanderthal Man overcome mammoths and other powerful animals? VII, 195
 26. How was man able to rise above the level of the animal? VII, 171
 27. Why are the true or mountain zebras not extinct yet? VI, 213
 28. What animal has become one of the chief forces of destruction of plant and animal life? X, 82
5. GENERAL RELATIONSHIPS:
1. What probably caused the formation of our large oil deposits? X, 81
 2. What living things form iron ore today? XI, 47-48
 3. How do roots damage pavements? XI, 6
 4. Name some important uses to which we put the shells of mollusks. X, 253
 5. What mollusks were used as a basis for trade among North American Indians? X, 283
 6. What artist's pigment is obtained from squids? X, 76,335
 7. How is Tyrian purple obtained? X, 314-315
 8. What snails are used for dyes and ink? X, 314
 9. What is a pearl? III, 217-218
 10. How do pearls form in a mollusk? III, 218; X, 276-277
 11. What mollusks produce valuable pearls? III, 218
 12. Where are cultured pearls produced? III, 219
 13. How is a pearl removed from the mollusk? III, 220

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14. What gives luster to pearl and mother-of-pearl? III, 218
15. What different colors may pearls have? III, 219
16. How may mollusks be forced to make pearls? III, 223-224
17. How are pearl beds conserved? III, 219-220
18. Where are pearls found in North and South America? III, 221
19. Why are termites of economic importance to us? V, 129
20. When do we first discover the damage done by termites? V, 129
21. Describe some of the damage done by termites. V, 129
22. What crustacean has injured submarine cables by its boring? X, 219
23. How do barnacles injure shipping? X, 142-143
24. How much damage did the shipworm do in San Francisco Bay in 1919-1920? X, 271
25. What ancient people prized cicadas for their song? V, 183
26. How can you feed red salamanders in captivity? VIII, 184
27. How can you successfully keep spotted or marbled salamanders in captivity? What can you feed them? VIII, 186
28. What myths are centered around the turtle and the origin of the earth? VIII, 319
29. Where do we get our tortoise shells? VIII, 312
30. What economic value have lizards? VIII, 338

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31. How are pythons fed in a zoo? VI, 266
32. Does man hunt animals only for food? Explain. VI, 1-10
33. How did bull fights originate? VII, 252
34. What monkey makes the best pet? VI, 54-55
35. What is the commonest monkey pet in this country? VI, 45-46
36. What kind of a pet does a pig make? VI, 162
37. What is meant by "bear-baiting?" VI, 96-97
38. Are bears safe pets? VI, 98
39. How are lions trained for the circus? VI, 76-77
40. What is "takia?" How is it used? VI, 157
41. What camel relative is raised for its wool? VI, 157
42. Why is a dead llama in Peru and Bolivia worth as much as a live one? VI, 157

Pupil and Class Activities

A. Things To Do:

1. Make a clay model of a dinosaur. VII, 14
2. Make collections of mud from different types of streams, rivers, ponds, lakes, bays, or oceans. Examine them for diatoms. Preserve the diatoms as microscope exhibits. XI, 180-183
3. Make a collection of seaweeds from the ocean. Dry the plants, label them, and hang them up in a corner of your room at school. XI, 167-180, 184-190
4. Make a collection of lichens for your own museum. XI, 92-93
5. Collect as many species of lichens as you can from your locality. Study them with a lens or a microscope. Learn to identify them. II, 92-93
6. Make a collection of diatoms. Study them under a microscope. Learn to photograph them with your camera and microscope. X, 80-81
7. Learn to recognize some common algae found on tree trunks, flower pots, ponds, streams, seashores, etc. Try to cultivate some in your school. II, 175
8. By keeping such foods as bread, oranges, lemons, etc., in a dark place in covered bottles, grow various molds. Examine the filaments and spores under a microscope. XI, 39-40

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9. Make soap models of some common mushrooms found in your locality. II, 93
10. Make a collection of common mosses. Dry them and mount them in an herbarium. XI, 149-150, 153-155
11. Collect the common ferns in your locality and learn to recognize them. II, 93-94
12. Learn to identify twenty gymnosperms growing wild or cultivated in your community. XI, 94-95
13. Collect such carnivorous plants as sundew, pitcher plant and Venus' fly-trap. Grow them in a terrarium. XI, 74-76
14. Construct terraria showing examples of hydrophytes, xerophytes, halophytes and mesophytes. Take careful notes of the conditions they require for healthy living. XI, 78-80
15. Organize a wild flower club in your school. Beginning early in March, collect one plant in flower of each species; dry them, mount on an herbarium sheet, and label accurately. XI, 96, 149-153, 365-366
16. Mount your pressed plants as shown in the picture opposite page 153, XI
17. Make a collection of fifty common grasses in your vicinity. Identify them and place them in your herbarium. XI, 238-249
18. Copy on a large chart the diagram of an ordinary seed plant shown in XI, 2
19. Make a collection of winter twigs and buds. Identify each twig for your museum. XI, 19

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20. Open fresh or salt-water mussels and examine the inside of the shells for pearls. X, 276-278
21. Search the driftwood along the bay or ocean-front for wood riddled by shipworms. Include these specimens in your museum exhibits. X, 271-273
22. Make a collection of land snails in your locality. Exhibit and label these for your own museum. X, 284-286
23. Make a mollusk section for your club, home or school museum. Classify your specimens scientifically. On your labels state an interesting fact about each specimen. X, 251-356
24. Get a half shell of the chambered nautilus from some supply house. By using diluted nitric acid dissolve the white and brown covering on the shell, until a pearly sheen is obtained. X, 328
25. Ask some people who eat snails, for a recipe in preparing and cooking them. Buy some snails and cook them for yourself and friends. X, 284, 312-313
26. Buy or catch a blue crab. Using the diagram shown in X, 101 identify the different parts.
27. Follow directions given in X, 88 and study the luminescence of certain crustaceans.
28. Hunt for fish-lice in an aquarium. Detach one from a fish and make a drawing of it. Try to photograph it through a low-powered microscope. X, 129-137
29. Buy some shrimp. Prepare and cook some for your friends. X, 232-233

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30. Make an aquarium for water insects collected in a nearby pond.
31. Make a collection of different kinds of grasshoppers in your locality. If possible, get in touch with people in other parts of the United States and exchange specimens in order to increase your collection. V, 28-29
32. Make a collection of as many kinds of grasshoppers as you can, in all stages of development. To kill them painlessly, use a wide-mouthed jar in which is a wad of absorbent cotton sprinkled with a few drops of carbon tetrachloride. Mount the identified insects on pins in cigar-boxes lined with sheet cork or soft corrugated paper. V, 1-25
33. Make a collection of grasshopper relatives for your museum. Include the roaches. V, 28-84
34. Try to find (in April) certain holes in the ground from which cicada nymphs emerge. Pour liquid plaster-of-Paris into some of the holes. Dig out the hardened casts of the underground chambers and exhibit them. V, 187-190
35. Get a number of fish gills and hunt among the gills for parasitic copepods. Draw some of them. Preserve the rest as microscopic mounts. X, 128-137
36. Make a community tank of tropical fish. VIII, 101
37. Paint pictures of luminous fish on a dark background. For light organs use luminous paint. Exhibit in a darkened room. VIII, 80-81
38. Build a terrarium of marsh or swamp plants. Place in it some of the smaller frogs. Feed them with small, live insects. VIII, 205-206

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39. Learn to recognize the poisonous and non-poisonous snakes in your community. VIII, 339-355
40. Collect and exhibit some skins shed by snakes. VIII, 343
41. In your own museum at school, home or camp, build a "Live Snake Section." Have each cage properly labelled with an interesting fact or two about each kind of snake you exhibit. VI, 266-271
42. Organize a bird club. Observe birds as often as possible and make a bird census of your locality. IX, 143
43. By listening to, and observing the song birds, learn to recognize bird songs and calls even when you can not see the bird. IX, 103-113

B. Class Discussions:

1. The factors which today cause the geographical distribution of plants. XI, 80-85
2. The history of our knowledge of plant life. XI, 133-147
3. The part played by Linnaeus in advancing the cause of science. XI, 142-144
4. The kind of activities engaged in by men who study plants. XI, 148-163
5. Plants do not need oxygen in order to live and grow. II, 224-226
6. Some interesting things about the group of plants known as algae. XI, 87-89
7. The uses of algae by man. XI, 184-196
8. Discuss the products man obtains from grasses. XI, 216-218

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9. The effect of grasses on civilization. XI, 201-215
10. The value of grasses as land builders. XI, 226-229
11. The uses of cacti to man. XI, 125-126
12. A desert is bare of plant and animal life. XI, 264-281
13. What behavior of the termites entitles them to be called social insects. V, 125-151
14. Some strange tales about octopuses and squids. X, 345-352
15. The damage done by barnacles to the shipping industry. X, 142-143
16. The fight of farmers against crustaceans. X, 241-247
17. The variety of homes built or occupied by crustaceans. X, 210-228
18. Luminescence among the crustaceans. X, 200-205
19. Protective coloration among the crustaceans. X, 205-207
20. Toads, if handled, will give you warts. VIII, 201
21. Keeping animals healthy in a zoo is one of the most difficult jobs in the world. VI, 277-283
22. Man has been the greatest enemy of the bison. VI, 166-168
23. Monkeys make excellent pets for the children. VI, 40-41
24. The chimpanzee is the most intelligent ape. VI, 29-32
25. Gorillas are very human. VI, 21-29

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26. "Man is the most destructive animal the world has even known."
27. Dinosaurs were superior to mammals. VII, 16-17

C. Pupil Reports:

1. How the National Zoological Park came into being. VI, 2-7
2. The early forms of life on the earth. VII, 13-14
3. The work of botanists on a collecting trip. XI, 364-369
4. Write a report on the Sargasso Sea. Include in it the "Adventures of a Baby Eel in The Sargasso Sea." XI, 88-89
5. Report on the extent of the damage done by plagues of grasshoppers. V, 17-19
6. Report on various methods used in destroying termites. V, 128-130
7. How scientists study bird life in the field and in the laboratory. IX, 114-125
8. How birds are classified. IX, 143-166
9. How the scientific study of mammals began and grew. IX, 228-241
10. How mammals are collected by scientists for study. IX, 207-217
11. How mammals are prepared for museum exhibition. IX, 218-227
12. Characteristics of mammals as a group. IX, 242-243
13. The different kinds of mammals. IX, 243-255

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14. Some mammals and what makes them interesting. IX, 311-375
15. Some interesting facts about the marsupials. IX, 280-310
16. The case against the mongoose. VI, 222-224
17. How we know that the whale is not a fish. IX, 366-375
18. The most famous elephant in captivity. VI, 130-133

D. Experiments:

1. Place germinated mustard seeds on cotton gauze over a jar filled with water. Let the roots grow into the water. Cover the jar with a box, except for an opening in the box which lets in a beam of sunlight. Observe the way the seedling grows. XI, 308
2. Capture some fireflies at night and make records of the frequency of light flashes. II, 269-270
3. To find out if toads will give you warts, let ten students handle a toad. Compare the results with ten students who do not handle it. VIII, 201

E. Excursions:

1. Make trips to the seashore and collect seaweeds of all kinds. Dry them in the sun and hang them up attractively in your schoolroom. XI, 88
2. Make an excursion to the ocean waterfront or to salt-water rivers and inspect the sides of boats, the piles, and rocks. Take home a collection of barnacles from these sources. Take some photographs of these crustaceans. X, 142-143

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3. Make an excursion to the ocean-front or bay at low tides. Observe some fiddler crabs and their habits. Put one into the water and see how it behaves. X, 168-172
4. Go on a crab-hunting expedition in a boat among the piles of an ocean waterfront. Learn to cook the crabs. X, 101
5. Visit a fish market regularly. Identify and record the various species of sea life that come to your city.
6. Visit the reptile house at the zoo. VI, 261-276
7. Visit the bird house in the local zoological park. What orders of birds are represented there? IX, 143-166; VI, 232-260
8. Speak to the keeper of the bird house in the local zoological park. Ask him about the habits and behavior of unusual birds, such as the ostrich and the rhea. Report to your club or class. IX, 144-145
9. Visit the lion house at the zoo. VI, 68-93
10. Visit the small mammal house at the zoo. VI, 221-231
11. Visit the elephants at the zoo or circus. VI, 126-145
12. Visit the bear dens at the zoo. VI, 94-106

F. Self-Test Exercises:

TEST I

The letters of one word in each of the sentences below are jumbled. If you arrange these letters properly you will find that they spell a word which makes the sentence true.

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1. LEANCRABS are crustaceans and not mollusca. X, 138
2. The only arthropods with six legs are called NESTICS. V, 28
3. It is not true that STODA give you warts. VIII, 201
4. Among the longest snakes are the SHOTPNY. VIII, 352
5. One characteristic common to all birds is their possession of RATSEEFH. IX, 1
6. A mammal which lays eggs like a bird is the DINEACH. IX, 269
7. One mammal which carries its babies in a pouch, is the AKROOGNA. IX, 281-282
8. An insect which spends the early period of its life in water, is the QUOTOSIM. V, 331
9. The pigment sepia, used by artists, is obtained from the SIDUSQ. X, 76, 335
10. Scientists believe that most of our petroleum was made by microscopic plants called SMADOTI. X, 81

ANSWERS

- | | |
|--------------|-------------|
| 1. barnacles | 6. echidna |
| 2. insects | 7. kangaroo |
| 3. toads | 8. mosquito |
| 4. pythons | 9. squids |
| 5. feathers | 10. diatoms |

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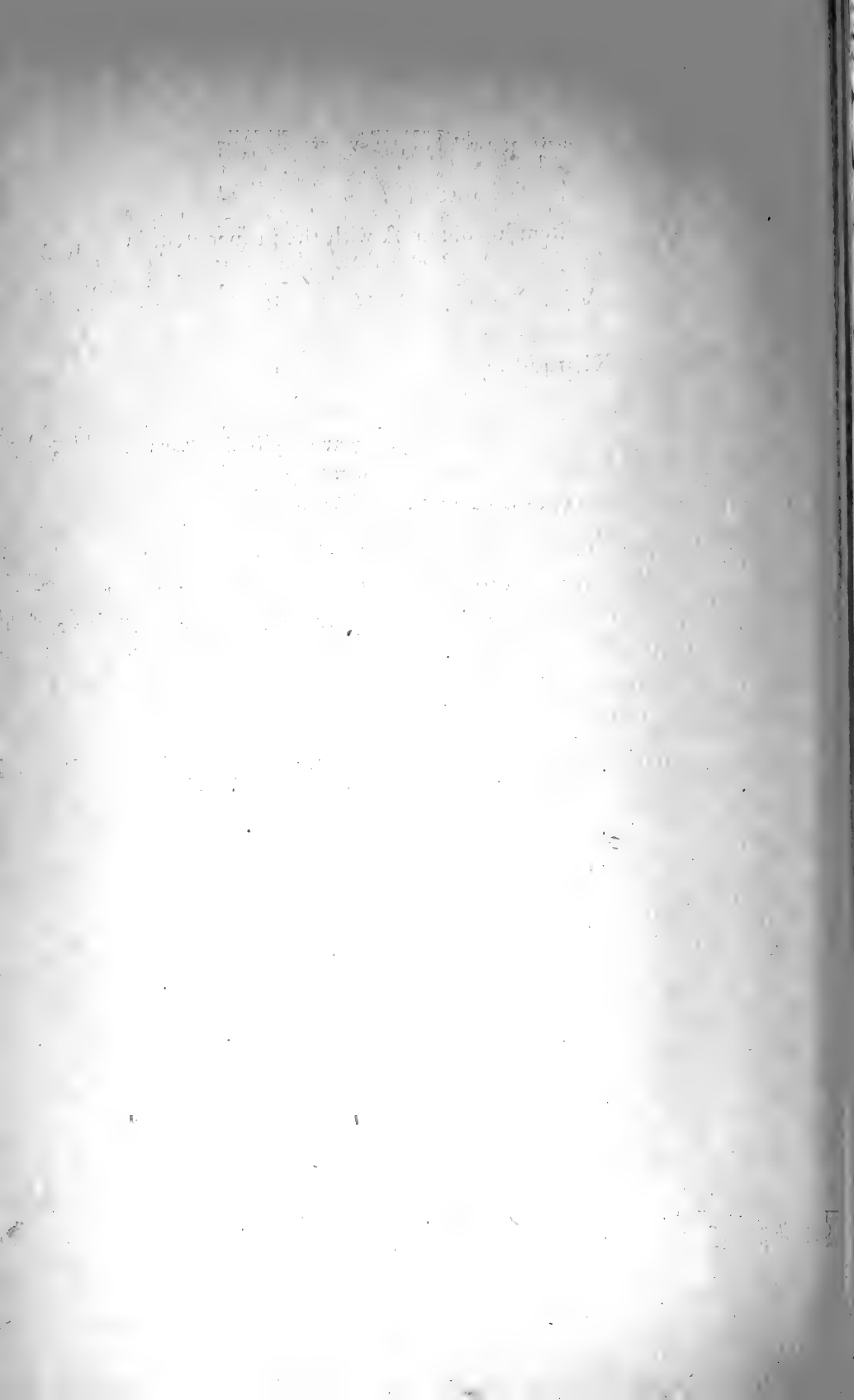
TEST II

Match each item in column A with the proper item in column B.

A	B
a. Plant and animal classification XI, 142	1. first backboned animal
b. algae X, 80	2. two wings
c. grass XI, 213	3. warm - blooded vertebrate
d. mushroom XI, 92	4. coelenterate
e. octopus X, 321	5. crustaceans
f. barnacles X, 138-140	6. social insects
g. flies and mosquitoes V, 315	7. a plant which grows in the dark
h. termites V, 128	8. Linnaeus
i. fish VIII, 1	9. corn
j. mammal IX, 242	10. diatoms
	11. cephalopods

ANSWERS

a—8	f—5
b—10	g—2
c—9	h—6
d—7	i—1
e—11	j—3



UNIT VI

THE COMPOSITION OF LIVING THINGS

A. The Chemical Substances in Living Things:

1. How are living things different from lifeless things? V, 99
2. What are living things made of? VII, 25
3. How much of the body is water? II, 244
4. What does a bird's egg consist of? IX, 79
5. Why do crabs often eat their discarded shell? X, 106
6. What causes the hardening of a crab's shell? X, 105-106
7. Of what materials are the skeletons of the different fishes made? VIII, 61

B. Protoplasm:

1. What is meant by "being alive"? V, 101
2. What substance is possessed by all living things? V, 100-101
3. What is protoplasm? V, 100
4. What is the living substance of a plant cell? XI, 11
5. What is the appearance of protoplasm? XI, 12

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C. Cells:

1. What does a cell contain? VII, 26
2. What are the functions of a cell? VII, 25-26
3. Where in the plant or animal is energy released? V, 100-101
4. Through what must molecules pass in order to enter a plant? XI, 297
5. What two kinds of chromosomes are found in all cells except sperm and ovum cells? VII, 28
6. Although daughter cells are always similar through generations, what may happen to certain cells when colonizing takes place? VII, 28
7. What experiments have been conducted to influence basic cell changes? VII, 33
8. What is the relationship between the quantity of yolk in eggs incubated inside and outside of an animal's body? VII, 30
9. Describe a typical plant cell. XI, 11-12
10. In what way are tall trees and small herbs alike? XI, 11
11. What is a phagocyte? Of what use are phagocytes to a developing insect? V, 301
12. How is waste matter removed from an insect's cells and blood? V, 116

D. Tissues and Organs:

1. What produces wood in a plant? XI, 13-14
2. How much of a tree trunk is alive? XI, 14
3. What structures have plants for transporting water from the roots? XI, 227-228

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4. How can one tell the age of a tree? XI, 15
5. Why does bark become furrowed? XI, 14
6. What produces bark in a plant? XI, 13-14
7. Why does "girdling" a tree kill it? XI, 14-15
8. How do cells reproduce? VII, 27
9. Why is cleavage necessary in all cells? VII, 26
10. What does the endoderm develop into? VII, 30
11. What does the mesoderm develop into? VII, 30
12. What does the ectoderm of the embryo become? VII, 29-30
13. Into what categories do the cells of an embryo divide themselves? VII, 29
14. How are embryos nourished? VII, 30
15. Is it true that an insect's insides are a soft pulpy mass? Explain. V, 116-117
16. What is the creamy pulp inside a pupa? V, 303-304
17. How does a pupa differ from a larva? V, 250
18. What is histolysis? Where and why does it occur? V, 259-260
19. How do fish scales grow? VIII, 34-35
20. How do feathers grow? IX, 20
21. Do feathers on a bird grow haphazardly or in definite patterns? IX, 20
22. On what part of a bird do we find "contour feathers?" IX, 17
23. What are "powder downs" and how are they used? IX, 18-19

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24. How is a fish's spine constructed? VIII, 62
25. Have fishes any ribs? What are they used for? VIII, 61-62
26. Has an insect any blood? What is it like? V, 112-113
27. What is a "ganglion?" V, 118
28. Where is an insect's nerve cord? Is there any brain? Describe it. V, 117-119
29. Can an octopus grow a new arm? Explain. X, 330
30. Do cast-off limbs on lobsters grow back? Give examples. X, 103
31. Can a fish that has lost a fin replace it? Explain. VIII, 50
32. How is an insect able to send its food all over its body? V, 111
33. Where is an insect's heart? Describe it and its position in the body. V, 112
34. How does blood circulate in an insect? V, 112
35. What kind of blood circulation is found in fishes? VIII, 97-98
36. How is a vertebrate's food sent to the cells? Compare this with an insect's method. V, 111
37. Describe the alimentary canal in fishes. VIII, 95-97
38. What kind of eye has a lobster? X, 110

E. How Living Things Grow:

1. How are the rings in a tree trunk made? XI, 15
2. How does a twig grow in thickness. XI, 13-14

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3. How can trees tell us when ancient civilizations flourished? XI, 16
4. How can one tell when seasons were rainy or dry by examining a cross-section of a tree trunk? XI, 15-16
5. When does a twig grow most? XI, 14
6. How long do roots grow? XI, 6
7. How do fence wires become embedded in a tree trunk after a time? XI, 17
8. During what part of the day do stems grow more rapidly? XI, 305
9. Which part of a plant grows least in darkness? XI, 301
10. Which part of a plant grows longest in darkness? XI, 301
11. How long may a squid grow? X, 349
12. How long can shipworms grow? X, 270
13. What is molting? How is it done? X, 103-105
14. Why do crustaceans molt? X, 103-104
15. What is meant by a "soft-shell" crab? X, 105
16. How often do crabs molt? X, 172
17. Do amphibians molt? VIII, 175
18. What is the rate of growth among reptiles? VIII, 230-231
19. How do snakes shed their skins? VIII, 343
20. How are rattles formed on a rattlesnake? Is it true that the age of a rattlesnake can be told from the number of rattles? VIII, 350-351

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21. How long may box turtles take until they reach maturity? How long can they live? VIII, 318
22. How does the interior of a bird's egg get fresh air? IX, 80
23. Why do newly-hatched birds weigh much less than the freshly laid egg? IX, 92

F. How Living Things Respond:

1. What stimulates nerve cells to function? V, 119
2. Are we saying something scientific when we use the word "instinct?" Explain, V, 120
3. What is a "tropism?" How are tropisms related to instincts? V, 121
4. What evidence is there that gastropods have a keen sense of smell? X, 308-309
5. How well can snails see? X, 309-310
6. How are snails able to respond to sound? X, 311-312
7. Have oysters any brain? Explain. X, 263
8. What substance causes the octopus to cease clinging to a rock when it is hunted by man? X, 352-353
9. What kind of a nervous system has a lobster? X, 107
10. Which senses in a lobster are very keen? X, 110
11. What gives the lobster a keen sense of touch and smell? X, 111
12. How does a lobster do his "seeing" in the dark? X, 110

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13. What helps a lobster swim right side up? X, 111-112
14. What is a "hormone?" Have insects any? What activities of an insect might be caused by hormones? V, 119
15. Are insects conscious of what they do? Explain. V, 121
16. Why can an insect with its head cut off still live for a while? V, 118-119
17. How does an insect control each segment? V, 118
18. Where and how large is the brain of the caterpillar? V, 285
19. How does the glass snake escape its enemies? Why may a glass snake sometimes be found with three tail tips? VIII, 335-336
20. How does the puff adder behave when captured? VIII, 346
21. Why do geckos drop their tails? Is the tail lost forever? Explain. VIII, 326
22. What is meant by "positively" or "negatively" phototropic? XI, 307-308
23. What causes a plant to respond to light? XI, 308-309
24. In plant experiments what is used to lengthen the duration of light? XI, 303
25. What other factor besides light intensity affects plant growth? XI, 302-303
26. What does weak light do to a plant? XI, 302
27. During what part of the growing season is good light most necessary to a plant? XI, 302

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28. What are some of the factors which change the amount of light a plant gets? XI, 301
29. How does light affect the shape of leaves in the bluebell plant? XI, 301-302
30. Why do leaves turn to the light? XI, 307
31. Why do house plants have leaves facing the same way? XI, 307
32. What is the response to light called? XI, 307
33. What is the effect of high temperatures, as in deserts, upon living cells? XI, 259-262
34. Why do roots grow downward? XI, 63
35. What is meant by geotropism? XI, 63
36. What evidence is there to show that the tips of plants send stimuli down to the base? XI, 310

Pupil and Class Activities

A. Things To Do:

1. Examine microscopic slides of woody stems and draw what you see. Locate the structures shown in XI, 13
2. Mark a young leaf with small squares drawn in India ink. After each week observe and measure the rate of growth of the leaf. Report your findings to your club. XI, 4
3. Using India ink, mark a seedling's root with horizontal lines. Place the seed on cotton gauze over a bottle of water containing earth, making sure the root is in the water. Observe the rate of growth every day. Report to your club. XI, 4
4. Make a diagram of an insect's circulatory system. V, 112
5. Examine a leaf of *Elodea* under the microscope. Note the movements of the chloroplasts, indicating the streaming of protoplasm. XI, 12
6. Make a model of a plant cell out of suitable materials. XI, 11-12
7. With a sharp razor, make thin slices of various plant materials and examine them under the microscope for cell structure. XI, 11-13

B. Class Discussions:

1. Protoplasm is the physical basis of life. V, 11-12

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2. Stripping bark from a tree does not harm the tree. V, 14-15
3. Changes in living things are dependent upon environment. VII, 20-22
4. A human being's development is unique. VII, 23-36

C. Pupil Reports:

1. Mitosis—the division of cells. VII, 26-28
2. Describe an experiment to discover the effect of red and of blue light on a plant. XI, 313-314
3. Describe an experiment to show the effect of duration of light on a plant. XI, 303-304
4. Describe an experiment to show how a root moves away from light. XI, 308
5. Describe an experiment to discover how plants are able to turn toward the light. XI, 308-310

D. Self-Test Exercises:

TEST I

Complete the following sentences with a word or words that make the sentence correct.

1. The human body is made up of countless _____. VII, 25
2. The human body is _____% water. II, 244
3. The living substance found in all cells is _____. XI, 11
4. In order to enter a plant, molecules must pass through _____. XI, 297
5. A plant tissue which produces wood is the _____. XI, 13, 14

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6. The part of a cell which is chiefly engaged in reproduction is the _____. VII, 26, 27

7. Small nerve masses are known as _____. V, 118

8. That part of a plant which grows longest in the dark is the _____. XI, 301

9. A substance which, thrown off by cells in one organ controls the action of another organ, is called a _____. V, 119

10. A plant's response to light is known as _____. XI, 307

ANSWERS

- | | |
|-------------------|------------------|
| 1. cells | 6. nucleus |
| 2. 70 | 7. ganglia |
| 3. protoplasm | 8. stem |
| 4. cell membranes | 9. hormone |
| 5. cambium | 10. phototropism |

TEST II

Match each item in column A with the proper item in column B.

- | A | B |
|------------------------------|------------------------------|
| a. 70% of human body II, 244 | 1. a small nerve mass |
| b. protoplasm V, 100 | 2. able to regenerate an arm |
| c. annual rings XI, 15 | 3. roots grow downward |
| d. cell division VII, 27 | 4. water |
| e. ganglion V, 118 | 5. age of a tree |

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- | | |
|-------------------------|------------------------------|
| f. cephalopod X, 330 | 6. soft-shell crab |
| g. molt X, 105 | 7. chromosomes |
| h. phototropism XI, 307 | 8. living matter |
| i. geotropism XI, 63 | 9. makes wood |
| j. cambium XI, 13, 14 | 10. bones |
| | 11. leaves turn to the light |

ANSWERS

- | | |
|-----|------|
| a—4 | f—2 |
| b—8 | g—6 |
| c—5 | h—11 |
| d—7 | i—3 |
| e—1 | j—9 |

UNIT VII

LIGHT AND HEAT FROM THE SUN

A. The Sun's Heat:

1. What is the sun's temperature? II, 256
2. What do we know about the effect of different rays of the sun? II, 317
3. How are the qualities of the rays of the sun studied? II, 316
4. What kind of bodies radiate heat most efficiently? II, 311-312
5. How much energy does the sun radiate per square yard on the earth? VII, 3
6. What is the source of the sun's energy? VII, 4
7. How do scientists believe solar energy is formed? II, 290
8. How does the sun compare with the other stars? VII, 1
9. How long will the sun's energy last? VII, 4
10. What effect would a 10% change in the sun's temperature have on the earth? VII, 5
11. What possibility exists for the sun causing another Ice Age? VII, 56-57

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12. How much of the sun's energy does man receive? VII, 4
13. How much heat is radiated from the sun? II, 8
14. What instruments are necessary to measure the sun's radiations? II, 12-15
15. What is a coelostat? II, 1-84
16. How do solar radiation constants taken in different parts of the world compare? II, 34
17. What are sun-spots? II, 5
18. What variations in solar heat take place? II, 17-65
19. What is the solar constant of radiation? II, 51
20. How is solar heat increased? II, 65
21. What is a bolometer? II, 122
22. How cold must a body be before it stops radiating? II, 91
23. What happens to the wave-length of rays of heated bodies as their temperature rises? II, 91
24. How much of the solar heat received by the earth is re-radiated into space? II, 109
25. How is the sun's heat measured? II, 121-125
26. How does the sun affect the earth's surface? II, 138
27. What happens to the solar constant of radiation as sun-spots pass the center of the sun while it rotates? II, 149
28. How is the temperature of the earth affected by heat changes in the sun? II, 153
29. What is the average value of the sun's intensity? II, 160

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30. How can gases be used to absorb sun energy in order to drive engines? II, 207-208
31. How is the earth maintained at a fairly constant temperature? II, 246-248
32. With which sun factors are the northern lights associated? II, 259
33. What may be the cause of sun-spots? II, 264
34. What electrical phenomena are demonstrated in the rotation of sun-spots? II, 263
35. What sun-spot variations take place? II, 259-260
36. How may the sun's heat preserve our food some time in the future? XII, 239
37. What is a calorie? XI, 294
38. Why does coal give us heat? XI, 294
39. What is the relationship of coal to Devonian plants? VII, 15
40. Where do hydrocarbons, gasoline, etc., originate? VII, 5
41. How is natural gas obtained? XII, 34
42. How does temperature affect most fishes? VII, 152-153
43. How was the first sun engine built? II, 214-215
44. What is the efficiency of a sun engine? II, 212-213

B. The Sun's Light:

1. What is light energy? XI, 287-288
2. What is a light year? VII, 1

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3. What would happen to life on the earth if ozone disappeared from the atmosphere? VII, 5
4. What happens to the solar constant of radiation as sun-spots pass the center of the sun as it rotates? II, 149
5. What are the relative quantities of the different colors in the sun? II, 51
6. What basis is there for the theory explaining the blue sky? II, 102
7. What is the relation between transparency of atmosphere and transmission of light of different wavelengths? II, 112
8. Which colors are lost as they are transmitted through the atmosphere? II, 113-114
9. What does the atmosphere do to light? II, 116-117
10. What causes absorption lines in the sun's spectrum? II, 129
11. How do solar radiation variations affect the color of the sun's rays? II, 145
12. How can solar heat be used for cooking? II, 195-196, 216-217
13. What are some types of sun reflectors? II, 197, 204-205
14. What supplies the energy for turning liquid water of plants into water-vapor? II, 230
15. What is the importance of ozone in the atmosphere to life on the earth? II, 238
16. What are the effects of ultra-violet rays on poultry? II, 236-237

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17. What colors are found in the sun? II, 255
18. What is the sun's corona? II, 265-269
19. When is the sun's corona visible? II, 285
20. How do glass and atmospheric water transmit sun rays? II, 311-314
21. How are the qualities of sun rays studied? II, 316

C. Where Food Comes From:

1. What is indispensable to life processes? VII, 4-5
2. Is sunshine necessary for living things? Explain. V, 104
3. What kind of energy do plants need? XI, 288
4. Which living things manufacture their own food? What is the name of this process? XI, 289
5. How was it found that light affects the amounts of substances taken in by a plant? XI, 299
6. Where is light energy stored by plants? XI, 294
7. Describe the work of leaves. XI, 3
8. How much light is required by plants for photosynthesis? XI, 292
9. What percent of the light energy is used by plants? XI, 294
10. How much light is wasted by a plant? XI, 293-294
11. What may be said about the efficiency of green plants in photosynthesis? XI, 295
12. Which rays are most effective in photosynthesis? XI, 293

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13. What are the chemical formulae for chlorophyll *a* and *b*? XI, 290
14. Which light rays does chlorophyll absorb? XI, 292
15. What part does chlorophyll play in photosynthesis? XI, 289-290
16. What color light is most important to plant growth? II, 234
17. Where does the sun do its work in plants? II, 230
18. Which rays of the sun promote the most active plant growth? II, 234
19. What are the raw materials used by plants in food making? XI, 289
20. How do plants take in carbon dioxide? II, 224-225
21. Why do plant leaves have many small openings instead of one large opening to the air? II, 225
22. What are stomata? XI, 300
23. What controls the opening and closing of stomata? XI, 300
24. What happens to stomata at night? XI, 300
25. How can a leaf get carbon dioxide without evaporating too much water? XI, 299-300
26. How does water rise in plants from the roots? II, 227
27. What is the most important chemical reaction in the world? XI, 26
28. Write the chemical formula for photosynthesis. XI, 289

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29. What method was used to discover the source of a plant's food? XI, 296
30. When did actual experiments on food making in plants originate? XI, 296
31. During which part of the day does a plant make food? XI, 300
32. What ancient ideas explained food making in plants? XI, 295-296
33. What are carbohydrates? XI, 27
34. How is sugar made? XI, 26
35. How much sugar is produced per day by an acre of corn? XI, 295
36. What is the origin of starch, wood, proteins, and fats found in plants? XI, 295-296
37. Where do plants store their sugar and starch? XI, 29
38. What kind of plant stores food best? II, 233
39. How do plants adapt themselves to different light conditions? XI, 290-291
40. How can pale plants be made greener? XI, 290
41. Which plants do not need light energy? XI, 288-289
42. What causes the appearance of a green scum on the surface of a pond? XI, 88

D. How Man Helps The Plant:

1. What is the debt mankind owes to plants? XI, 97
2. How many important food plants have been added to civilization since prehistoric times? XI, 321

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3. When did the modern plant arise? VII, 17
4. What was the only kind of farming of Mesolithic Man? VII, 242
5. Why was the tending of the crops given over to women? VII, 243
6. How was soil fertilized in ancient times? VII, 246
7. How long have the agricultural improvements of the Indus Valley people survived? VII, 314
8. How was the ground cultivated by Neolithic Man? VII, 258
9. How did the Iroquois cultivate crops? IV, 80-81
10. How did the Indians cultivate the soil? IV, 22
11. How did Indians clear land? IV, 22
12. What food plants were in use by Indians before the arrival of white men? IV, 71
13. What especially prevented the growth of a large Indian population? IV, 24
14. What is the Eskimo's main food supply? IV, 44
15. What change in food gathering took place at the end of the Magdalenian Epoch? VII, 226
16. Where did the sweet potato come from? VII, 328
17. What important parts of Indian culture were borrowed by the white man? IV, 8
18. What did Indians cultivate? IV, 24
19. How was maize cultivation spread? VII, 324
20. Where did the Irish potato come from? VII, 328

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21. What was the main supply of the Indian's food? IV, 21
22. What was the Inca's food? VII, 341
23. What was the food of the Hupa Indians? IV, 202
24. What kind of food was necessary before a civilization could arise? VII, 243
25. What were the crops of early Egypt? VII, 297
26. What plants grow in the Arctic summer? IV, 68
27. What is a reaper? XII, 303-304
28. How does a reaper do its work? XII, 304-305
29. What improvements were added to the reaper? XII, 307
30. Which two men perfected reapers? XII, 305
31. What types of power machine are helping agriculture? XII, 308
32. What was the effect of the reaper on population? XII, 308

E. Interdependence of Living Things:

1. How are minerals returned to the soil? XI, 8
2. What caused the change of primitive giant insects to those we now know? X, 71
3. Why does the yucca moth pollinate yucca flowers? XI, 50-51
4. Why will not yucca seed develop from plants which are not visited by a yucca moth? XI, 50
5. What proportion of the seeds of the yucca are eaten by the larvae of the moth? XI, 51
6. Why are ants absolutely necessary to the life of the corn aphids? V, 172-173

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7. What animals came in with grasses? X, 79
8. How is the life of the sardine dependent on algae? XI, 191
9. How did the Proterozoic plants affect the development of animal life? X, 49
10. What is symbiosis? XI, 92

F. Plant Products:

1. What are the materials in a broom? XI, 229-230
2. Name some uses of bamboo? XI, 229
3. What is a sod house? XI, 230
4. How was sod used by pioneers? XI, 230
5. What products do we obtain from maize or corn? XI, 217-218
6. How are diatom skeletons used today? X, 81
7. What is the origin of peat? XI, 93
8. How was coal formed? X, 68
9. What compressed the decayed plants into coal? X, 71
10. What may have been the source of the world's supply of petroleum? XI, 195
11. Where is rubber obtained? XII, 315
12. How is latex tapped? XII, 316
13. How is rubber extracted from latex? XII, 316-317
14. What were the important uses of rubber seventy years ago? XII, 310
15. Who perfected the vulcanization of rubber? XII, 317

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16. What interesting substances do plants provide? XI, 104
17. What plants furnish us with tanning material, rubber, chicle, tobacco, olive oil, and other oils? XI, 103-104
18. How does man use algae? XI, 184-196
19. What kind of algae help make dynamite? XI, 87-88
20. Why is dynamite so easily handled? XI, 194
21. What algae are used in silver polish? XI, 194
22. What plants does man use for drugs? XI, 100-101
23. What plants furnish us with dyes? XI, 103
24. Name some plants which provide us with lumber? XI, 102-103
25. What plants furnish fibres for clothes, paper, rayon, etc.? XI, 101-102
26. What plants are a source of beverages? XI, 101

Pupil and Class Activities

A. Things To Do:

1. Make a black-bulb thermometer by applying lampblack to the bulb of an ordinary thermometer. II, 245
2. Construct a hot-box, using a wooden box lined with wool or hair. Place a thermometer inside, and cover the box with glass. Observe the temperature in the box after a half hour. II, 110-111
3. Construct a water-flow pyrheliometer, using glass tubing. Follow the diagram and explanation given in II, 88-89
4. Make a model of a pyrheliometer following the instructions and descriptions given in II, 44-47
5. Construct a simple bolometer for measuring solar radiation by using nichrome wire and a galvanometer or coil of wire around a compass. Follow the circuit diagram and description as given in II, 76-77
6. Turn up some slabs of rocks out-of-doors. Note the color of the plants under the rocks as compared with plants exposed to the light. Can you explain this? XI, 290
7. Cover a green plant with a black screen for a few weeks until it is very pale. Expose it to sunlight and note how soon the plant turns green. XI, 290

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8. Place a house-plant near a window. Note the movements the leaves make in order to face the source of light. How long does this take? XI, 307
9. Make a cotton gin following the diagram in XII, 303. Gin some cotton from a cotton boll, or mix ordinary seeds into cotton and then gin to remove the seeds.
10. Grow plants in boxes, the walls of which are colored cellophane. Use a different color for each box. Keep a record of the growth which took place under each color.

B. Class Discussions:

1. The sun's energy can be directly harnessed to give man power. II, 196-222
2. Cool bodies can emit radiations. II, 306-308
3. The universe is running down. II, 301
4. The sun is a variable star. II, 287-290
5. The sun's heat which evaporates water from plants, will cause plants to die. II, 230-231
6. How plants store light energy. XI, 287-295
7. The connection between light, and normal plant growth. XI, 301-306
8. Natural rubber is best. XII, 315-322

C. Pupil Reports:

1. Why men study the sun. II, 1-9
2. How hot is the sun? II, 254-258
3. A storm in the sun. II, 260-261, 263

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4. The early measurement of the sun's radiation constant. II, 12-29
5. The instruments used to measure solar radiation. II, 75-97
6. The effect of the atmosphere on solar radiation. II, 109-113
7. A scientist's day when measuring solar radiation. II, 121-133
8. Effect of sun-spots on solar radiation. II, 139-148
9. The power value of the sun. II, 194-196
10. Principles of solar heat engines. II, 19, 222
11. The transmission of ultra-violet light by different materials. II, 237
12. The cheapest form of light. II, 209-270
13. Some experiments made to find out what makes plants respond to light as they do. XI, 308-314
14. The relationship of ozone in the atmosphere to the maintenance of life. II, 314
15. The fruit crops of the Indians. IV, 77

D. Self-Test Exercises:

TEST I

1. Give a four-letter word meaning "that part of a tree which manufactures food." XI, 22
2. Give a five-letter word meaning "energy needed in food-making." XI, 26
3. Give a fourteen-letter word meaning "to produce carbohydrates in sunlight." XI, 26

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4. Give a six-letter word meaning "a gas released by plants in sunlight." XI, 27
5. Give a thirteen-letter word meaning "sugars and starches." XI, 27

ANSWERS

1. leaf
2. light
3. photosynthesis
4. oxygen
5. carbohydrates

TEST II

Complete the following sentences with a word or words that make the sentence correct.

1. The sun's energy may last another _____ years.
VII, 4
2. A slight decrease in the sun's radiation may cause another _____. VII, 57
3. The sun's temperature is _____ centigrade.
II, 256
4. Red, blue and violet light are valuable to the plant in the process of _____. XI, 293
5. The Irish potato originally came from _____.
VII, 328
6. Plants which can grow without light are the _____
_____. XI, 288-289
7. With the aid of light, green plants produce sugar from _____ and _____. XI, 26
8. The number of important food plants added to civilization since prehistoric times is _____. XI, 321
9. A machine used to cut grain is the _____.
XII, 304

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10. An important source of alcohol is _____
XI, 218

ANSWERS

- | | |
|-------------------|-----------------------------|
| 1. 15 trillion | 6. saprophytes |
| 2. Ice Age | 7. carbon dioxide and water |
| 3. 6000 degrees | 8. none |
| 4. photosynthesis | 9. reaper |
| 5. Peru | 10. corn |

TEST III

The letters of one word in each of the sentences below are jumbled. If you rearrange these letters properly, you will find that they spell a word which makes the sentence true.

1. A valuable substance for polishing silverware is TIMADOS. X, 81

2. Sphagnum moss furnishes people with TAPE. XI, 93

3. Tiny openings in leaves through which gasses pass are called AATTOMS. XI, 300

4. Plants which do not need light energy are PASH-SPOTRYE. XI, 288

5. A waste product of photosynthesis is EGONYX. XI, 26-27

ANSWERS

- | | |
|------------|----------------|
| 1. diatoms | 4. saprophytes |
| 2. peat | 5. oxygen |
| 3. stomata | |

UNIT VIII

FOOD FOR LIVING THINGS

A. What is Food for Plants and Animals:

1. Where do plants get some of their food? V, 106
2. Through what must molecules pass in order to enter a plant? XI, 297
3. In what condition must substances be in order to enter a cell? XI, 29
4. Why do molecules diffuse or spread through a liquid? XI, 297
5. What controls the entrance of molecules of salts into a plant? XI, 297-298
6. What causes the concentration of some molecules to be higher in a plant cell than in the surrounding soil? XI, 298
7. What kind of cells in young bark carry food? XI, 12-13
8. Why does "girdling" a tree result in its death? XI, 14-15
9. Why do some roots take in more of one mineral than do other roots? XI, 6-7
10. How does the seed embryo get its nourishment? XI, 59

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11. What kinds of food are stored in seeds? XI, 42-43
12. How do carnivorous plants trap their food? XI, 75-76
13. How does the Venus's fly-trap get its animal food? XI, 74
14. Name some carnivorous plants. XI, 75
15. How do plant parasites get their food? XI, 30-31
16. How many important food plants have been added to civilization since prehistoric times? XI, 321
17. What is said to be the most ancient cultivated plant? XI, 324
18. Why is corn an ideal food plant? XI, 325-326
19. What is an enzyme? XI, 29; V, 111
20. How do enzymes work? XI, 29
21. Which algae serve as food for sea animals? XI, 190-191
22. How do algae save the lives of millions of sea animals? XI, 188-189
23. In what way are diatoms the chief support of all the animal life of the sea? XI, 87
24. Why does an abundance of grass mean plenty of meat? XI, 201
25. Why are grasses the best plants for grazing animals? XI, 201-203

B. Enemies of Animal Food Supply:

1. Describe the damage done by some of the trypanosomes. V, 349

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2. Where in a whale may we find copepod parasites? X, 132
3. On what portion of a fish's body may we find copepod parasites? X, 129-131
4. Have copepod parasites any parasites of their own? X, 134-136
5. What mollusks have copepod parasites? X, 133-134
6. What kind of damage is done by pill-bugs? X, 245
7. Describe the damage crustaceans do to oysters? X, 245-247
8. What is meant by a "parasite?" Describe how one works. V, 12-25
9. What is a hyperparasite? V, 181
10. What is an insect parasite? V, 179
11. Do parasites completely exterminate the insect tribe they feed on? Explain. V, 179-180
12. Do insect parasites attack only harmful insects? V, 180
13. What means of defense have aphids against their many parasites? V, 173-174
14. Explain the presence of a door cut into the body of an aphid. V, 178
15. Name some enemies of the aphids. V, 173-181
16. What does the Hessian fly larva injure? V, 352
17. Why are horn flies a menace to cattle? V, 348
18. How does the tsetse fly feed on blood? V, 350
19. Do mosquitoes eat only the blood of man? Explain. V, 338

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20. Does the female mosquito eat blood only? V, 337-338
21. How are horses and cattle affected by the larvae of the botfly and the ox warble-fly? V, 352
22. What damage may the "screw worm" cause to animals and man? V, 352
23. How do tent caterpillars eat? What damage do they cause? V, 277
24. How do tent caterpillars behave when their tree no longer has any leaves? V, 278-279

C. *Eating Habits of Animals:*

I. CRUSTACEANS AND MOLLUSKS:

1. What can slugs eat? X, 303-304
2. How does the oyster eat? X, 260-261
3. How do the mollusk's gills aid in getting food? X, 259
4. How do oysters digest their food? X, 262-263
5. Describe the oyster's blood and its circulation. X, 263
6. What kind of jaws has a cephalopod? X, 334
7. What do cephalopods eat? X, 333
8. What evidence of intelligence is shown by an octopus in capturing its food? X, 333
9. How do copepods make plant food available to all sea life? X, 125
10. Why can life in the sea not exist without crustaceans? X, 89-90
11. What do ostracods eat? X, 123-124

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12. What do fiddler crabs eat? X, 171
13. Describe the stomach of a crab. X, 106-107
14. Why do crabs often eat their discarded shell? X, 106
15. How does the robber crab remove a coconut from its husk? X, 177-178
16. Where is the heart of a crab? X, 107
17. What kind of circulation has a crab? X, 107
18. What are the feeding habits of the mantis shrimp? X, 180-183

2. INSECTS:

1. How are insects adapted to getting their food? V, 107
2. What is the chief function of all insect mouth parts? V, 109
3. How are the mouth parts of insects related to their feeding habits? V, 107-109
4. What chief types of mouth parts do insects have? V, 108-109
5. Name some insects with sucking, or piercing and sucking mouth parts. V, 108-109
6. What kind of mouth parts do crickets, beetles, grasshoppers and caterpillars have? V, 108
7. Why do caterpillars eat so much? V, 291
8. When and why does a caterpillar's stomach serve as food to its owner? V, 293
9. How do caterpillars digest their food? V, 290
10. How can you tell when a caterpillar is hungry? V, 290

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11. Describe the caterpillar's alimentary canal? V, 289-290
12. Compare the alimentary canal of an insect with your own. V, 109-110
13. Describe the alimentary canal of an insect. V, 109-110
14. How is an insect able to send its food all over its body? V, 111
15. Describe the proboscis with which moths and butterflies get their food? V, 307-308
16. In what way do the caterpillar and its moth differ in feeding methods? V, 237
17. Are insects to blame for the damage they cause us? How is that explained? V, 152
18. Why do insects visit flowers? XI, 51
19. Why are ants absolutely necessary to the life of the corn aphids? V, 172-173
20. Describe the type of food eaten by aphids in general. V, 172
21. Why is the aphid so useful to us? V, 174-176
22. What do adult cicadas eat? How do they eat? V, 200-204
23. What do the cicada nymphs eat? V, 187
24. Where is a cicada's stomach? V, 205-206
25. What type of mouth parts has a cicada? V, 186
26. What happens to trees inhabited by adult cicadas? V, 185
27. "People who are not fond of roaches should protect centipedes." Explain. V, 82-83

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28. How do moths and butterflies generally get their food? V, 307
 29. What can a house-fly eat? V, 346-347
 30. Why can the horse-fly "bite?" V, 322-323
 31. How does the robber fly kill and eat its prey? V, 324
 32. Are animals the only living things affected by fly larvae? Explain. V, 352
 33. Name an unusual liquid eaten by some flies. V, 320
 34. What does the male mosquito eat? V, 337-338
 35. What termites raise their own food? V, 148
 36. Why are termites able to eat wood? V, 137
 37. How is the mantis able to obtain its food? V, 73-75
 38. Why should a ladybird beetle be protected? V, 173-175
 39. Name some insect enemies of the grasshopper. V, 19-25
 40. Describe a typical day of a tent caterpillar. V, 271-274
 41. What do tent caterpillars eat? V, 263
 42. What happens to the food carried along by the blood in an insect? V, 112-113
 43. How does the pupa manage to feed itself and form new tissues? V, 260
3. FISH:
1. What do fishes eat? VIII, 138-142

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2. What truth is there in stories that fishes eat their own young? VIII, 114-115
3. How does a fish's mouth affect its eating habits? VIII, 53-57
4. Why does a fish swallow its food whole? Has a fish a sense of taste? VIII, 75
5. What fishes migrate in pursuit of smaller migrating fish? VIII, 129
6. How is the life of the sardine dependent on algae? XI, 191
7. What enables microscopic copepods to form the food supply of so many fish? X, 125-126
8. What constitutes from 63 to 97 percent of the food of whitefish and lake herring? X, 125
9. What is meant by "no copepods, no herring?" X, 125
10. What crustaceans feed more fish and other water forms than any other kind of animals? X, 125-126
11. How does the lamprey get its food? VIII, 5-6
12. What important fish is caught with squid bait? X, 355
13. Which crustaceans affect the size of the tuna fish catch? X, 163
14. What do sharks eat? VIII, 140-141
15. How well can a shark bite? VIII, 59-60
16. How is the shark sucker adapted to attach itself to sharks? Why does it steal rides? VIII, 46-47
17. What crustacean forms most of the food of the chub? X, 151-152

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18. How do some fish poison other animals? VIII, 50-52
19. What fish uses its dorsal fin as bait for small fish? VIII, 47

4. REPTILES AND AMPHIBIANS:

1. What kind of food do salamanders eat in nature? VIII, 181
2. What sort of reputation has the hellbender? VIII, 181-182
3. How do amphibians eat? VIII, 175-176
4. How can you successfully keep spotted or marbled salamanders in captivity? What can you feed them? VIII, 186
5. How can you feed red salamanders in captivity? VIII, 184
6. How do toads eat? VIII, 201
7. Which is the most common North American snake? What does it eat? VIII, 346
8. What do some people believe about milk snakes? Why are the milk snakes found near barns? VIII, 344
9. What is the real basis for the belief that snakes can charm their prey? VIII, 343-344
10. What gave the king-snake its name? How does it get its food? VIII, 344
11. What do blacksnakes eat? VIII, 344-345
12. What lizards catch and eat chicks? VI, 264
13. What food habits of crocodiles and alligators led man to reduce their number? VIII, 305

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14. Which common lizard is able to change its color?
What does it eat? VI, 264-265

5. BIRDS:

1. Why are birds' stomachs so carefully studied?
IX, 125
2. How is a bird's beak adapted for the kind of food
it eats? IX, 126-127
3. Of what use are long legs and long necks to a
heron or flamingo? IX, 127
4. What kind of food is eaten by the different kinds
of birds? IX, 126
5. How are hard seeds handled by birds? IX, 127-
128
6. How well do birds get rid of weed seeds for us?
IX, 129
7. Why do birds eat tiny pieces of sand and gravel?
IX, 128
8. What kind of wild fruits do birds eat? IX, 130-
131
9. Name some insect-eating birds? IX, 134-137
10. What do "night-flying" birds eat? IX, 134
11. How do birds react when one kind of insect be-
comes unusually numerous? IX, 136-137
12. What bird is able to eat clams and oysters, shell
and all? IX, 137
13. What birds fly aloft with clams in their bills and
then drop them on rocks below? IX, 137
14. How do some birds get the fish they eat? IX,
137-138
15. What birds are fond of snakes? IX, 140

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16. What bird drops turtles on a stone in order to kill them? IX, 140
17. What bird stuffs its stomach with its own feathers during a meal? IX, 150
18. What birds (not owls or hawks) will swallow half-grown kittens, muskrats, and gophers? IX, 152
19. What causes cannibalism among the young pelicans? IX, 99
20. Why is one bird called the "grasshopper" sparrow? IX, 107
21. What do vultures eat? IX, 142
22. What kind of birds are not affected by ptomaines? IX, 142
23. What is the diet of a barn-owl each year? IX, 141-142
24. How are owl pellets made? IX, 141
25. What do hawks and owls eat? IX, 140-141
26. Why have hawks and owls sharply-hooked beaks? IX, 127
27. Is the pouch of the pelican used to carry fish? Explain. IX, 99
28. How are baby pelicans fed? IX, 99-100
29. How does the black-headed gull get its crustacean food? X, 164-165
30. How do neglected albatross babies manage to keep themselves alive? IX, 98-99
31. How does a mother albatross feed its baby? IX, 98

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32. What bird has a strainer in its beak? How does it work? IX, 126
33. What kind of food enables a bird to stay in cold climates instead of migrating? IX, 128
34. What birds are very fond of acorns? How are they cracked open? IX, 131-132
35. What bird stores acorns in holes it drills in trees? IX, 132
36. What bird drills holes in apple trees and drinks the sap which oozes out? IX, 133
37. What is "pigeon's milk?" IX, 134
38. Why do woodpeckers drill holes in trees? IX, 136
39. Why are cowbirds so named? IX, 135
40. How are different colors in bird feathers produced? IX, 25-34
41. What complaints have been made against the bobolinks and red-winged blackbirds? IX, 129-130
42. Why do humming birds visit flowers? Why are their beaks so thin and long? IX, 133
43. How should we regard birds which catch and eat fish? IX, 138-139
44. What do flickers eat? How are they adapted for getting their food? IX, 136
45. How are corn kernels treated to prevent crows from eating them? IX, 131
46. What parrot attacks and kills living sheep? IX, 160
47. Why are the corners of a baby-bird's mouth soft and light colored? IX, 101-102

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6. MAMMALS:

1. How many seeds of the water primrose did one duck have in its stomach? IX, 129
2. How many tons of weed seeds are eaten by tree sparrows in Iowa in a single winter? IX, 129
3. How are some nut-bearing trees planted? XI, 58
4. What is the food of all mammal babies just after birth? IX, 242
5. What group of mammals, aside from man, has learned to store up food for later use? IX, 333
6. What is the food of carnivores? IX, 248
7. What are insectivores? IX, 247-248
8. What marsupials are flesh eaters? IX, 298-303
9. Can a whale swallow a man? Explain your answer. IX, 368-370
10. How did the killer whale get its name? What are some of its activities? IX, 372
11. What do newborn whale babies eat? IX, 242
12. What mammal, aside from man, attacks the squid? X, 356
13. What forms most of the food of Antarctic whales, penguins, seals, and petrels? X, 165-166
14. Why are "vampire" bats so named? How do they eat? IX, 318
15. What do ungulates eat? IX, 340-341

D. Food for Human Beings:

1. Why are plant collecting trips useful to mankind? XI, 376

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2. Why did people hunt for plants in Mexico and South America? XI, 353-354
3. Where did the American Indian get his plants? VII, 327-328
4. What did the Sioux Indian eat? IV, 152
5. What food plants are used by man? XI, 98-100
6. How are grasses related to our dairy products, beef, wool, leather, horse power, hogs, and poultry? XI, 218
7. What is the estimated value of our annual grass crops such as corn, barley, wheat, oats, and rye? XI, 216-217
8. How did the Pilgrims escape starvation during their first winter in America? XI, 213
9. What was the effect of corn on the American Indians, the Incas, Mayas, and Aztecs? XI, 213
10. Why were the American Indians interested in a corn crop? XI, 323-324
11. What products do we get from maize or corn? XI, 217-218
12. Why were the people of the Old World interested in a wheat crop? XI, 323-324
13. When and where were rice, barley, oats and rye first cultivated? XI, 209-210
14. What grass furnishes us with sugar? XI, 212
15. When and where was sugar cane first cultivated? XI, 212
16. What place has the oyster in economics? X, 275
17. How extensively are snails used for food? X, 312-313

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18. What portion of the mollusk do we eat when we have scallops? X, 257
19. Where are octapuses considered a delicacy? X, 352
20. What people eat barnacles? X, 237
21. In what country are barnacles eaten by man? X, 143
22. Are crayfish ever eaten? X, 234
23. How extensive is shrimp-fishing in the United States? X, 233
24. What is the annual catch of crabs in Chesapeake Bay? X, 229
25. What use have the natives for robber crabs? X, 178
26. What is the source of caviar? VIII, 23
27. Which salamander is eaten extensively by man? VIII, 186
28. Which lizard is a favorite food in tropical America? VI, 265
29. Why are green turtles in the market turned on their backs? VIII, 312
30. Which turtles are used for food? How large do they become? Why are the green turtles becoming more scarce? VIII, 311-312
31. What poisonous snake is used for food? VIII, 354-355
32. What disease was prevalent among sailors due to lack of proper food, which could not be carried because of absence of refrigeration? XII, 239
33. How may the value of the ultra-violet rays be transmitted by foods and medicines? II, 238-239

Pupil and Class Activities

A. Things To Do:

1. Make a list of important food plants and the parts used by man. XI, 104-110
2. Watch a praying mantis eat a grasshopper. Write a report on how this was done. How is the mantis built to catch its food? XI, 73-76, 107
3. Using methods described in a book on microscopic technique, make slides of the eyes and mouth parts of flies and mosquitoes. V, 322, 330, 334, 346-347
4. Using Benedict's or Fehling's solution, test a large variety of plants eaten by man for simple sugar. Do likewise with garden plants. XI, 26-29
5. Make a collection of various plant parasites and saprophytes that grow in the fields and woods.
6. Visit a local cold storage warehouse.
7. Visit a local milk pasteurizing and bottling plant.
8. Visit a local ice refrigeration plant.
9. Visit a local creamery.

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B. Class Discussions:

1. The connection between grasses and dairy products, meat, wool, leather and horse power. XI, 218-226
2. The effect of various elements or lack of them upon plant growth. XI, 296-299
3. Crustaceans used as food and medicine for man. X, 229-240
4. Primitive man had no ability to improve the plants which he needed for living. XI, 321
5. Man's mechanical skill is the best measure of human progress. XI, 319-328
6. Some theories to account for the present development of maize. XI, 329-348

C. Pupil Reports:

1. Methods used to discover where a plant obtained its food. XI, 296
2. The extent of the damage done by plagues of grasshoppers. V, 17-19
3. How insects prepare the food they eat for distribution to their cells. V, 109-113
4. How birds get their food. IX, 126-142
5. Kinds of food eaten by birds. IX, 126-142
6. The food of early man. VII, 18, 226, 253
7. The proper preservation of food. XII, 239-247

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D. Self-Test Exercises:

TEST I

Match each item in column A with the proper item in column B.

A	B
a. grasshopper parasite V, 19	1. vultures
b. enzyme XI, 29	2. drills holes in apple trees
c. piercing mouth parts V, 108, 109	3. to determine food habits of birds
d. sucking mouth parts V, 108, 109	4. converts solids into liquids
e. roaches V, 82	5. bison
f. eats wood V, 137	6. sarcophaga
g. copepods X, 125	7. butterflies
h. stomach contents studied IX, 125	8. mosquito
i. carrion eaters IX, 142	9. food for centipedes
j. sapsucker IX, 133	10. termites
	11. food for herring

ANSWERS

a—6	f—10
b—4	g—11
c—8	h—3
d—7	i—1
e—9	j—2

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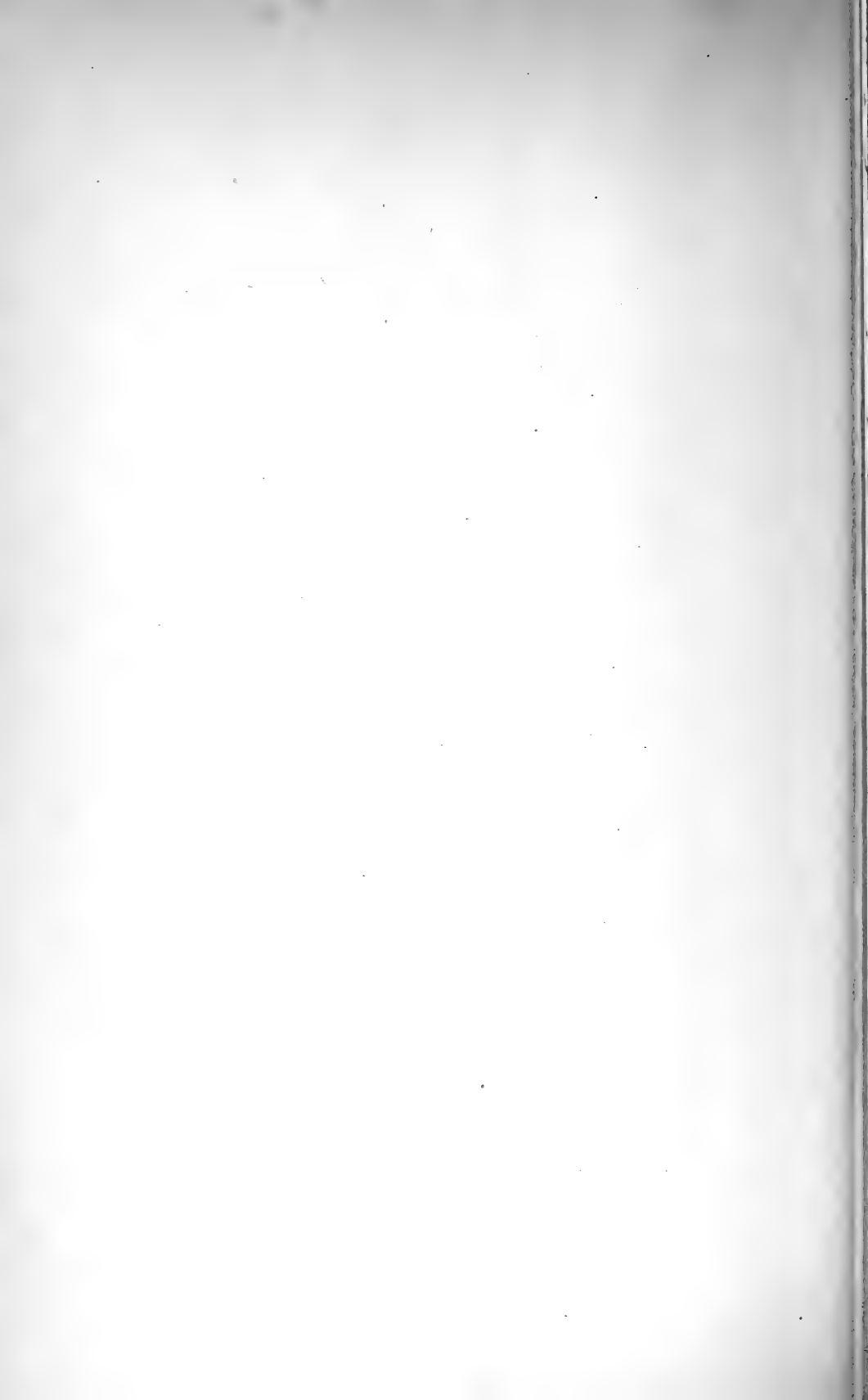
TEST II

Below are ten statements. Some are true and some are false. On your paper re-write each false statement in such a way that it becomes true. In doing this you may change or leave out any of the italicized words but you may not change or leave out any others.

1. An insect whose larvae eat another insect is known as a *parasite*. V, 179
2. African sleeping sickness is caused by *bacteria*. V, 349
3. Insects visit flowers in order to *pollinate them*. XI, 51
4. An unusual liquid eaten by mosquitoes is *beer*. V, 320
5. An insect which should be protected by us is the *drone fly*. V, 73-75
6. Most of the food of whitefish and lake herring consists of *other fish*. X, 125
7. The food of milk snakes consists of *cow's milk*. VIII, 344
8. Birds not affected by ptomaines in putrid meat are *vultures*. IX, 142
9. Newborn whale babies eat *fish*. IX, 242
10. The chief support of all animal life in the sea are *young fish*. XI, 87

ANSWERS

- | | |
|-------------------|------------------|
| 1. parasite | 6. copepods |
| 2. trypanosomes | 7. rats and mice |
| 3. get nectar | 8. vultures |
| 4. human blood | 9. milk |
| 5. praying mantis | 10. diatoms |



UNIT IX

ADAPTATIONS BY LIVING THINGS

A. To Air:

1. What purpose do the "knees" of cypress trees serve? XI, 10
2. What are stilt roots for? XI, 10
3. Why is it that flies have only one pair of wings? What advantage is it? V, 315
4. Why are the wings of a honeybee hooked together? V, 318
5. Of what use to the beetle are its hard upper wings? V, 318
6. Why are the butterfly's wings different in size? V, 318
7. Why is the abdomen of a cicada filled with air? V, 206-207
8. Why does a mosquito pupa stay near the surface of the water? V, 334
9. Why do crabs make sounds? X, 197-199
10. How does the pistol crab make its sharp reports? X, 192-194
11. Can crustaceans make noises? Give examples. X, 192-194

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12. How do gastropods close their shell? X, 288
13. How do gastropods without an operculum keep from drying out? X, 289-290
14. How are snails able to respond to sound? X, 311-312
15. Discuss the breathing problems of land and water snails. X, 295-297
16. Why can some fish stay out of water for a time? VIII, 88-89
17. In what way are the gills of fishes similar to lungs? VIII, 84
18. What types of gills are found among fishes? VIII, 84-85
19. What special seeing abilities have the "four-eyed" fishes? VIII, 70-71
20. How are frogs adapted for jumping? VIII, 193-194
21. What frogs can "fly?" VIII, 208
22. How are tree frogs fitted for tree life? Describe their habits. VIII, 205-208
23. What type of skin have amphibians? Explain its advantages. VIII, 175
24. How are a chameleon's feet fitted for its way of living? VIII, 324
25. What remarkable adaptation has the dragon lizard for flight? VIII, 327
26. In what ways are birds adapted for flying? IX, 13-15
27. Just how are the wings of a bird suited for flying? IX, 13-14

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28. What is the driving force which enables a bird to fly? IX, 14
29. In what general way are bird's feathers wonderful adaptations for flight? IX, 15
30. What strange forms may some feathers take? IX, 24
31. Describe the construction of a bird's feather? IX, 15-17
32. Why are the bones in a bird's wing so stiff? IX, 14
33. What two adaptations of the skeleton help a bird to fly? IX, 14-15
34. What birds have horny tubes growing out of their nostrils? Why? IX, 150-151
35. How do birds inform other birds of danger, food, etc.? IX, 110-113
36. How true is it that splitting a bird's tongue will make it speak better? IX, 108-109
37. What birds are able to imitate others? IX, 107-109
38. How do birds differ in their ability to make sounds? IX, 103-105
39. What bird roars like a lion? IX, 105
40. What is the "syrinx" in birds? How is it used? IX, 103
41. How high can kangaroos jump? IX, 285
42. How are kangaroos adapted to their surroundings? IX, 284-285
43. What are the habits of the kangaroo? IX, 285-287

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44. What features enable a "flying" squirrel to get about? IX, 334
45. Why is the bat a remarkable mammal? IX, 316
46. Why are bats able to fly? IX, 317

B. To Water:

1. Why are seaweeds so soft and delicate? XI, 168-172
2. How does root pressure help a plant get water? XI, 5
3. What are root-hairs? How do they work? XI, 5
4. In which direction do roots grow? What advantage is it to the plant? XI, 32
5. What kinds of cells do we find in a cross-section of a twig? XI, 12-13
6. What are thorns and prickles? XI, 18-19
7. Why do trees shed their leaves in a dry season? XI, 21
8. Do trees hibernate? Explain. XI, 21
9. How is evaporation from a leaf controlled? XI, 25
10. Why is adaptation to desert life extremely difficult for a plant? XI, 280-281
11. Why are desert plants so spiny? XI, 272-273
12. Why are desert plants so juicy? XI, 273-279
13. How does a bivalve maintain its balance? X, 264
14. How does a mollusk get fresh water to its gills? X, 258
15. In which gastropods is the foot used as a swimming organ? X, 293-294

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16. How can snails move about? X, 292
17. To what use do bivalves put their feet? X, 261
18. Where are a mollusk's eyes? X, 257-258
19. How do octopuses creep about? X, 328-329
20. Why can lobsters move only forward or backward? X, 98
21. What helps a lobster swim right-side up? X, 111-112
22. What are some of the most interesting adaptations among fishes? VIII, 143-148
23. How is a fish's shape adapted for speed? How fast can a mackerel or shark swim? VIII, 30
24. Do all fishes have scales? Explain. VIII, 34
25. What is the purpose of fish scales? VIII, 34
26. Why does the air bladder mystify fish students? VIII, 89-90
27. What purpose does the air bladder in a fish serve? VIII, 91-92
28. How does the air bladder work? VIII, 92-93
29. What is meant by the "lateral line" of a fish? How does it help a fish? VIII, 77-79
30. What purpose does the fish's "ear" serve? VIII, 73-74
31. What in a fish corresponds to the four legs of a higher vertebrate? VIII, 63-64
32. How do the fins form in fishes? VIII, 38-39
33. What types of fins are there? VIII, 39-41
34. What is the chief purpose of the caudal or tail fin? VIII, 47-48

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35. How do fins serve the fishes? VIII, 38
36. How are the paired fins of fishes attached to their skeletons? VIII, 63-64
37. What keeps a fish from rolling over in the water? VIII, 45-46
38. What is the purpose of the ventral fins? VIII, 43-45
39. How are the paired pectoral fins used by rays, flying fishes, mudskippers, and sea robins? VIII, 42-43
40. What makes fins flexible? VIII, 39-41
41. What fish hibernates in a mud cocoon? VIII, 4-5, 19-20
42. How do salamanders spend their time when a dry season comes to their locality? VIII, 180
43. How do penguins swim? IX, 148
44. What families of tropical birds have webbed feet? IX, 151-152
45. How did the seal become capable of moving in water? VI, 123
46. Are men and horses adapted to desert life? XI, 280
47. What makes the Bactrian camel able to live where it does? VI, 155
48. How long can a camel go without water? VI, 153
49. Why is a camel called the "ship of the desert?" VI, 153
50. Why can kangaroo rats live without water? IX, 334
51. How might the whale have become fitted for ocean life? IX, 253-254

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C. To The Need for Food:

1. Why have animals developed the power of movement? V, 107
2. How does the backbone serve the vertebrate animals? VIII, 1
3. How do the mollusk's gills aid in getting food? X, 259
4. How do oysters digest their food? X, 262-263
5. How powerful are the suckers of an octopus? X, 330
6. What kind of jaws has a cephalopod? X, 334
7. What type of eyes have the cephalopods? X, 336
8. How does the radula aid a snail in eating? X, 297-299
9. Are slugs able to bite the hand? X, 304
10. How are insects adapted to getting their food? V, 107
11. How are the mouth parts of insects related to their feeding habits? V, 107-109
12. What is the chief function of all insects' mouth parts? V, 109
13. Name some insects with sucking, or piercing and sucking mouth parts. V, 108-109
14. What chief types of mouth parts do insects have? V, 109
15. What kind of mouth parts do crickets, beetles, grasshoppers, and caterpillars have? V, 108
16. Why have roaches existed for so many millions of years? V, 98

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17. What is histolysis? Where and why does it occur? V, 259-260
18. When and why does a caterpillar's stomach serve as food for its owner? V, 293
19. How are a caterpillar's legs adapted for sticking to flat surfaces? V, 286
20. Have moths and butterflies any mandibles (jaws)? V, 255
21. Describe the proboscis with which moths and butterflies get their food. V, 307-308
22. What stage of an insect's development is adapted chiefly for eating? V, 236
23. What kind of mouth parts has a house-fly? V, 345-346
24. What animal uses intestinal parasites to digest wood? V, 137
25. What type of mouth parts has a cicada? V, 186
26. How are fish-lice adapted to clinging to a moving fish? X, 137
27. Describe a crustacean appendage? X, 102-104
28. What important uses have the ten pairs of appendages in crustaceans? X, 102
29. Are teeth in fishes found only in the mouth? Give examples. VIII, 57
30. What fish grows teeth all over its body? How are these teeth formed? VIII, 37
31. What fishes have no teeth? VIII, 59
32. How do the gills of a fish strain small bits of food from the water taken in? VIII, 65-66
33. What are "gill rakers?" VIII, 87-88

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34. What fish uses its dorsal fin as bait for small fish? VIII, 47
35. How well can a shark bite? VIII, 59-60
36. How does a fish's mouth affect its eating habits? VIII, 53-57
37. How do some fishes poison other animals? VIII, 50-52
38. How is the shark sucker adapted to attach itself to sharks? Why does it steal rides? VIII, 46-47
39. In what unusual part of the mouth are the teeth of salamanders? VIII, 181
40. What peculiar features does a chameleon have? How does it use its tongue? VIII, 324
41. Why do humming birds visit flowers? Why are their beaks so thin and long? IX, 133
42. How is a bird's beak adapted to the kind of food it eats? IX, 126-127
43. How is a snake's mouth adapted to the task of swallowing food wider than itself? VIII, 340
44. Of what use are long legs and long necks to a heron or flamingo? IX, 127
45. What do flickers eat? How are they adapted for getting their food? IX, 136
46. Why have hawks and owls such sharply-hooked beaks? IX, 127
47. What bird has a strainer in its beak? How does it work? IX, 126
48. How are owls adapted for night life? IX, 160
49. How are the teeth of carnivores adapted to their food habits? IX, 248

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50. What carnivorous animal has the most powerful teeth or jaws? VI, 113
51. What kind of teeth have rodents? IX, 331
52. How are the hippo's tusks used? VI, 150
53. Why do hippos in captivity have trouble with their teeth? VI, 149-152
54. Describe the head of the sperm whale. Describe its teeth. IX, 371-372

D. To Light:

1. Why are mountain-top plants more brilliantly colored than lowland plants? XI, 305-306
2. In what four ways do plants climb? XI, 34-37
3. How are leaves arranged in trees? XI, 17-18
4. What work do leaves do? XI, 22
5. How are leaves adapted to their work? XI, 23-25
6. In which direction do leaves and stems grow? XI, 32
7. What is heliotropism? XI, 32
8. How can leaves turn to the light? XI, 32
9. What is a leaf rosette? XI, 32
10. Why are leaves in rosettes arranged as they are? XI, 32-33
11. How are plants able to move? Give examples. XI, 72-76
12. How do vines manage to reach the light? XI, 33-34
13. In what ways do plants adapt themselves to different light conditions? XI, 290-291

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14. What causes plants to move or go to sleep? XI, 72
15. How can a caterpillar see? How many eyes has it? V, 285
16. What deep-sea cephalopods give off light? X, 343-345
17. How do crustaceans produce light? X, 201-202
18. Which crustaceans give off flashes of light? X, 165
19. Why do crustaceans give out light? X, 200-203
20. What kind of organs in fishes produce electricity? VIII, 82-84
21. How do certain fishes produce luminous light? VIII, 79-81
22. What theories have been proposed to explain the usefulness of light organs in fishes? VIII, 81
23. What fish can shut its eyes? VIII, 66
24. What has happened to the eyes of certain deep-sea fishes which live in total darkness? VIII, 71

E. To Heat:

1. How is the barnacle adapted to travelling in warm and cold waters with whales? X, 141-142
2. What crustacean lives in hot springs at a temperature of 112° F.? X, 153-154
3. How is it possible for frogs and toads to withstand extremely cold weather? VIII, 195
4. How do box turtles spend the winter? VIII, 318
5. Where are the down feathers? What is their function? IX, 17-18

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6. When do bison look shaggy and naked? VI, 168
7. How do warm-blooded animals keep the heat in their bodies? VIII, 38

F. To The Need for Protection:

1. How does the mimosa or sensitive plant behave? What causes this behavior? XI, 72-74
2. How well-developed is the brain of a fish? VIII, 99
3. Why does the hermit crab look for abandoned shells? X, 221-222
4. What protection against enemies or weather have fly pupae? V, 252
5. Discuss the variety of homes inhabited by crustaceans. X, 210-228
6. How does the spider crab camouflage itself? X, 226
7. What crustacean resembles the praying mantis insect? X, 179
8. What crustacean's tail resembles a sea-urchin? How is it protective? X, 180
9. How do the skeleton shrimp fit in with their surroundings? X, 62-63
10. Why does a crustacean cast off a limb? X, 103
11. How does a lobster pinch off an appendage? X, 103
12. Which senses in a lobster are very keen? X, 110
13. How does a lobster do his "seeing" in the dark? X, 110
14. Why do crustaceans change colors? X, 205-207

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15. Name some crustaceans that can change color at will. X, 205-207
16. Why are parasitic copepod. so interesting? X, 128-129
17. What is the "byssus?" X, 261-262
18. How do mussels attach themselves to objects? X, 261
19. Discuss the smoke screens made by gastropods. X, 315-316
20. What is the only cephalopod with a shell? X, 325
21. Why does an octopus use its ink sac? X, 335
22. Where is the "shell" of a squid or octopus? X, 325
23. What is the work of chromatophores in the octopus? X, 342-343
24. Why is the swimming mechanism of an octopus like that of a rocket ship? X, 330
25. What evidence is there that gastropods have a keen sense of smell? X, 308-309
26. How well can snails "see?" X, 309-310
27. What are adductor muscles? How are they used? X, 256-257
28. How are pearls formed? X, 276-277
29. What fish has a sense of direction? How is this shown? VIII, 132
30. Of what use are the nostrils to a fish? VIII, 73
31. What adaptations give a fish its sense of touch? VIII, 76-77
32. Can a fish hear? Explain. VIII, 73-74

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33. How does the sawfish protect itself? VIII, 55
34. What makes ganoid fishes so hard externally? VIII, 36
35. How did the flatfishes get both their eyes on top of their head? VIII, 68-69
36. How well can fish with fully developed eyes see? VIII, 72
37. How is a fish's spine constructed? VIII, 62
38. What gives the porcupine fish its name? VIII, 36
39. Why are male birds so brilliantly colored? IX, 36
40. What lizard will "turn green with fright?" VIII, 324-325
41. Which lizard commonly seen is able to change its colors? What does it eat? VI, 264-265
42. Why do geckos drop their tails? Is the tail lost forever? Explain. VIII, 326
43. Why are horned toads invisible a few feet away from us? VIII, 331
44. What two species are the only poisonous lizards now known? VI, 262-263
45. Which harmless snake can scare people with a vicious display of anger? How did this snake get its name? VIII, 345-346
46. How efficient are the senses of smell, touch, taste, hearing, and seeing in snakes? VIII, 342
47. Can snakes actually spit their venom? Explain your answer. VIII, 354
48. How is a turtle's shell constructed? VIII, 308-309

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49. Describe the fangs of a rattlesnake and how they are adapted to injecting poison. VIII, 341
50. What gave the box turtle its name? Does this habit serve any special function? Explain. VIII, 315
51. Why does the "painted" terrapin have such a name? Why does it always have such a smooth shell? VIII, 314-315
52. Name the pigments commonly found in feathers? IX, 25-34
53. What gives a bird its color? IX, 25
54. When is protective coloration of special benefit to birds? IX, 37-38
55. Why do bird colors harmonize with their surroundings? IX, 37
56. What is given as the reason for the barred (dark and light) coloring in a bird? IX, 34-35
57. How are color patterns arranged in birds? IX, 32-33
58. Would the lion or the tiger win in a fight between them? Explain why. VI, 82
59. What interesting feature has the armadillo? IX, 363

G. *To The Need for Reproduction:*

1. How is the flower adapted for reproduction? XI, 41
2. Can you explain why your trousers or stockings are covered with seeds after a walk through a field? XI, 57-58

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3. How are fleshy and juicy fruits able to scatter their seeds? XI, 58
4. What tree endangers a passerby when it scatters its seeds? XI, 56
5. Name some plants that use the wind to scatter their seeds? XI, 56
6. What enables some seeds to steal a ride on animals? XI, 57-58
7. How do the touch-me-not, the violet, witch-hazel, and bean plants scatter their seeds? XI, 55-56
8. How do the elms, maples, willows, poplars, and dandelions scatter their seeds? XI, 56-57
9. How is the mollusk's shell made? X, 253-254
10. Name some insects whose larvae spin cocoons? V, 251-252
11. How is a cocoon made? V, 251-252
12. How can a caterpillar spin a cocoon? V, 286
13. Where does a caterpillar get its silk? V, 287-289
14. Why do insects molt? How is this done? V, 14-17
15. What is the origin of the hard, shiny coat of a pupa? V, 251
16. How are pupae adapted to live in cold weather? V, 251
17. How does the adult moth get out of the pupa case and the cocoon? V, 305-306
18. Why are the exits of cocoons always brown in color? V, 306
19. Why are the tent moth eggs protected? V, 311-312

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20. Why do grasshopper eggs hatch when they do? V, 7-8
21. Where are grasshopper's ears? V, 29-31
22. How do crickets sing? V, 56-58
23. How do katydids produce their song? V, 33-37, 39, 41, 43-44, 47-49, 53
24. When do you hear cicadas most? V, 184
25. Why are fiddler crab eggs hatched at dusk? X, 168
26. What is molting? How is it done? X, 103-105
27. What is meant by a "soft-shell" crab? X, 105
28. What causes the hardening of a crab shell? X, 105-106
29. How have copepods adjusted their breeding habits to the life of the West Indian crabs? X, 133
30. How is the winter egg of *Daphnia* protected against winter conditions? X, 120
31. What fish uses sea-shells in which to deposit its eggs? VIII, 112
32. How are male salmon recognized at the spawning season? VIII, 102
33. How are the pointed eggs of murrens able to stay on a rocky ledge? X, 79
34. What color are eggs which are placed in holes or under cover? Why? IX, 81-82
35. What is meant by "incubation patches?" How are they used? IX, 88
36. How does a baby bird crack its shell? IX, 91

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37. How do neglected albatross babies manage to keep themselves alive? IX, 98-99
38. What birds fly as soon as they are hatched? IX, 92-93
39. What birds have heel pads for support when they are too young to stand up? IX, 100

H. To The Earth:

1. What work does a tree trunk do? XI, 3
2. What kind of cells support a woody stem? XI, 12
3. How is a tender young root protected as it pushes its way through the hard soil? XI, 4-5
4. How do clams bury themselves in sand? X, 273-275
5. Describe the instincts shown by the newborn cicada nymph from egg-hatching until it enters the ground. V, 224-225
6. How are the legs of a cicada nymph adapted for digging? V, 190
7. How do shipworms bore into wood? X, 270
8. Name a bivalve which burrows into hard rocks. X, 269

I. Migration:

1. Which ancient animals migrated extensively? VII, 18-19
2. Describe a locust migration. V, 18
3. What is a sea-horse? How is it adapted for traveling? VIII, 31

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4. What fishes migrate in pursuit of smaller migrating fish? VIII, 129
5. What one American fish leaves fresh water to spawn in salt water? VIII, 119
6. Where do the young American and European eels go to live after hatching? VIII, 119-120
7. Why do salmon and eel migrate? VIII, 118-123
8. How does the salmon know where he was born? VIII, 121
9. How do salmon get to fresh water? How long does this take? VIII, 122-123
10. What price does the salmon pay for its migration to fresh water? VIII, 123
11. When do salmon babies return to salt water? VIII, 124
12. What fishes besides the salmon and eel make long voyages to fresh water to cast their spawn? VIII, 119-124
13. Name some superstitious ideas connected with bird migration? IX, 6-9
14. What mistaken notions were held by people regarding bird migration? IX, 51-53
15. What explanations have been given to account for bird migration? IX, 50-55
16. What may have caused birds to migrate in prehistoric times? IX, 53-54
17. What role have bird hormones played in stimulating migration? IX, 54-55
18. During what time of day do most birds travel while migrating? IX, 55

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19. Why is it best for migrating birds to travel at night? IX, 56
20. When do migrating birds eat during their travels? IX, 56
21. How high up in the air do migrating birds travel? IX, 56
22. How fast do birds fly? IX, 57-58
23. Do all migrating birds travel long distances? Explain. IX, 58-59
24. Where do migrating birds go? IX, 58-60
25. How far do plover fly in migration? IX, 59-60
26. What bird is famous for its long distance flights? IX, 60
27. What birds that breed in the Southern Hemisphere regularly fly north? IX, 61-62
28. How are migratory birds directed to their destination? IX, 62-63
29. What evidence have we which tells us a good deal about bird migration? IX, 63-64
30. What is bird banding? What does it teach us about birds? IX, 63-64
31. When were birds first marked in order to learn more about their movements? IX, 64
32. How does the Biological Survey cooperate with banding societies? IX, 64-65
33. How many returns were made on banded birds? IX, 65
34. What causes the usually rare snowy owl to be seen here recently? VI, 257

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35. How do lemmings migrate? What causes this migration? IX, 335-336
36. Where is the origin of the Indian? IV, 1-2
37. Why is it believed that the Indians migrated from Asia in waves? IV, 3
38. Were there mass migrations in primitive times? Explain. VII, 198
39. How long did the Cro-Magnon migrations take? VII, 198
40. How did the Solutreans come into Europe? VII, 210

Pupil and Class Activities

A. Things To Do:

1. Boil green leaves of different plants in alcohol. (Caution: Keep open flame away from top of dish.) Extract the chlorophyll and exhibit it to the class. XI, 290
2. Place some timothy grass seeds on moist blotting paper and keep them dark between two saucers for a few days. Notice the root hairs that have grown out of the roots. Make careful drawings of what you see. XI, 5
3. Find some pitcher plants in a bog. Cut one down to the base and examine what you find inside the pitcher. What does this show about pitcher plants? XI, 76
4. Find some sundews in a bog near your home. Take some home in the original mass of humus and mosses. Grow them. Observe how tiny insects get caught and are digested by the plant. XI, 75-76
5. Hunt for dodder plants on other plants growing wild. Note the way dodder attaches itself to the host plant, and the damage done by the dodder parasite. XI, 31-32
6. On a clear spring night turn your binoculars or your telescope toward the moon. Can you see

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- birds traveling across the face of the moon?
How high up do these birds fly? IX, 55-57
7. Construct terraria showing examples of hydrophytes, xerophytes, halophytes, and mesophytes. Take careful notes of the conditions they require for healthy living and how they are adapted to their surroundings. XI, 78-80
 8. Capture a praying mantis. Observe it catch and eat a grasshopper or roach. Note how well-adapted the mantis is for this work. V, 73-76
 9. Find a Venus's fly-trap in a bog. Place a pointed object against the "hairs" on the opened trap. Observe what happens. Try this several times. How long does the trap remain closed? XI, 74
 10. Exhibit a collection of feathers arranged as in the colors of the spectrum. IX, 25-38
 11. Secure variously colored feathers. Try to extract the colors by means of alcohol, ether, or chloroform. Cork the bottles with the pigments for display with the feathers from which you obtained them. IX, 26
 12. Exhibit a collection of various kinds of bird feathers. IX, 15-20
 13. In order to show your class how to recognize the rattling of a rattlesnake, obtain the real rattles from some supply source, and fasten them to the hammer of a gong or bell. Press the switch button each time you want to hear the rattling. Arrange this exhibit in your school museum.

B. Class Discussions:

1. Birds can fly with a speed of 200 miles an hour. IX, 57-58

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2. Some modern theories which try to explain the causes of bird migration. IX, 53-55
3. Some superstitions believed in by people with regard to bird migration. IX, 50-53
4. Distances covered by birds in migration. IX, 58-62
5. How scientists find out where birds go when they migrate. IX, 63-67
6. The ways in which plants adapt themselves to desert life. XI, 264-281
7. The value of different color patterns to birds. IX, 36-38
8. How the nervous system of insects helps them to respond to their environment. V, 117-121

C. Self-Test Exercises:

TEST I

Match each item in column A with the proper item in column B.

A	B
a. pelvic and pectoral fins VIII, 63-64	1. called "the ship of the desert"
b. the lungfish VIII, 4	2. stiff and fused hand bones
c. the legs of a seal VI, 123	3. the bat
d. the camel VI, 153	4. attaches itself to objects by means of a byssus
e. an important adaptation of birds IX, 14	5. correspond to the legs of a higher vertebrate

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- | | |
|---------------------------------|---|
| f. a flying mammal IX,
316 | 6. hypodermic teeth |
| g. the mussel X, 261 | 7. a mammal covered
with bony plates |
| h. the rattlesnake VIII,
341 | 8. live in abandoned sea-
shells |
| i. hermit crabs X, 221 | 9. has six legs |
| j. the armadillo IX, 363 | 10. modified into flippers |
| | 11. hibernates in a mud co-
coon |

ANSWERS

- | | |
|------|-----|
| a—5 | f—3 |
| b—11 | g—4 |
| c—10 | h—6 |
| d—1 | i—8 |
| e—2 | j—7 |

TEST II

Underline the phrase in each sentence which makes the sentence true.

1. Animals have developed the power of movement in order to:
(a) migrate (b) escape floods (c) get food.
V, 106, 107
2. The radula of a snail is used to:
(a) grind food (b) move along smooth rocks
(c) dig into sand. X, 297
3. An insect with sucking mouth parts is the:
(a) grasshopper (b) Japanese beetle
(c) butterfly. V, 108-109

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4. The stage in a butterfly's life which is adapted chiefly for feeding is the:
(a) caterpillar (b) pupa (c) adult. V, 236
5. An insect which uses intestinal parasites to digest the wood it eats is the:
(a) dragon-fly (b) potato beetle (c) termite.
V, 137
6. A fish which grows teeth all over its body surface is the:
(a) mackerel (b) shark (c) stickleback.
VIII, 37
7. A plant's response to light is called:
(a) geotropism (b) heliotropism
(c) thigmotropism. XI, 32
8. A tree which scatters its seeds with the aid of the wind is the:
(a) witch-hazel (b) cherry tree (c) maple tree.
XI, 57
9. An American fish which leaves fresh water to spawn in salt water is the:
(a) shark (b) salmon (c) eel. VIII, 119
10. A warm-blooded vertebrate which migrates the greatest distance is the:
(a) bat (b) eel (c) Arctic tern. IX, 60

ANSWERS

1—c	6—b
2—a	7—b
3—c	8—c
4—a	9—c
5—c	10—c

UNIT X

REPRODUCTION IN LIVING THINGS

A. The Life Cycle:

1. Describe the life history of the malaria parasite. V, 342
2. What is the life history of the liver fluke? X, 316-318
3. How many eggs may an oyster have? X, 264-265
4. What prevents the excessive reproduction of oysters? X, 265-266
5. What is the life history of the common *Daphnia* or water flea? X, 118-120
6. Describe the steps in the life history of the fiddler crabs. X, 168-171
7. What is meant by "metamorphosis?" Give some examples. V, 226-231
8. What two kinds of metamorphoses may insects have? V, 245
9. Name some insects that have no metamorphosis at all. V, 247-248
10. What is the difference between a larva and a nymph? V, 245-246

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11. How does a pupa differ from a larva? V, 250
12. What is a chrysalis? V, 251
13. How is a cocoon made? V, 251-252
14. Where do insect larvae that live in the water turn into pupae? V, 328
15. Describe the life history of the common Culex mosquito. V, 331-335
16. What is the reason for the name "wigglers" given to mosquito larvae? V, 333
17. Why do fly puparia have a circular hole when found empty? V, 345
18. Describe the life history of the house fly. V, 343-345
19. What is a puparium? V, 344
20. How long do most insects require to reach maturity? V, 184
21. For how long a time do cicadas enjoy fresh air? V, 185
22. Make a report on the life history of the cicada. V, 186-199
23. How often does a cicada molt? V, 186-187
24. What is the story behind the hollow, shiny shells you have found stuck to the bark on a tree? V, 184
25. What is a nymph? V, 185
26. What is the goal of each cicada nymph? V, 194-195
27. Describe the cicada nymph's behavior before molting. V, 195
28. Describe the act of molting. V, 195-198

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29. When do the wings of a new cicada stretch? V, 197
30. What causes the wholesale death of cicadas? V, 214
31. How do the young nymphs of cicadas reach the ground? V, 223-224
32. Describe the progressive changes of a tent caterpillar into an adult. V, 293-305
33. Why do they say that roaches are "born alive?" Is this really true? Explain. V, 80-82
34. How many generations are necessary before the offspring resemble both parents in the case of aphids? V, 155-156
35. How many parents do summer aphids have? V, 162
36. What is meant by parthenogenesis? V, 162
37. How many kinds of offspring do female aphids have in summer? V, 163
38. How does a tropical climate affect the production of sexual generations of aphids? V, 167-168
39. Write a report on the life history of the termite. V, 136-139
40. Describe the life history of a frog. VIII, 196-197
41. Describe the life history of the spotted salamander. VIII, 185-186
42. Describe the life history of *Pseudotriton*, the red salamander of the east. VIII, 183-185
43. What example of metamorphosis can be found in human beings? V, 305

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B. Parents And Offspring:

1. Why do offspring resemble their parents? V, 103
2. Why is it not correct to say that offspring are "chips off the parental block?" V, 103
3. Give a definition of reproduction. V, 102
4. What does "spontaneous generation" mean? XI, 90
5. How is a species continued? XI, 38
6. What do the parents do for the germ cells? V, 103
7. What is the origin of the "somatic" or body cells? V, 104
8. What are the "servants" of the germ cells? V, 104
9. When are germ cells set aside in an individual? V, 104
10. Do termites produce young exactly like the parents? V, 137
11. How do roaches reproduce their kind? V, 80-82
12. What decides whether an insect will be male or female? V, 123
13. What stage of an insect's development is adapted chiefly for reproduction? V, 235-236
14. How does the sunfish protect its eggs? VIII, 108
15. What fish incubates its very large eggs in its mouth? How does the fish eat? VIII, 113
16. What birds have forgotten how to build nests or take care of their young? How do their young ones get along? IX, 159

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17. How do chromosomes determine the sex of birds? VII, 28
18. What steps do chromosomes go through in reproduction? VII, 26
19. Do parent birds mate for life? IX, 72
20. What birds have the smallest eggs? IX, 85
21. Why do birds of temperate zones produce more eggs than their tropical relatives? IX, 86
22. How many broods may the song sparrow raise in one season? IX, 86
23. What does the bird do after she lays the eggs? IX, 87
24. Why does a bird sit on the eggs? IX, 88
25. At what temperature are eggs incubated in the nest? IX, 88
26. How do mother birds protect the eggs from the heat of the sun? IX, 88
27. In what species of birds do males help in incubating the eggs? IX, 89
28. What is meant by "incubation patches?" How are they used? IX, 88
29. Why are the corners of the baby-birds' mouths soft and light colored? IX, 101-102
30. What is meant by "altricial young?" Give examples. IX, 92
31. What is meant by "precocial young?" Give examples. IX, 91-92
32. How do ducks take care of their newly born young? IX, 94-97

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33. How far do mother pelicans often fly in order to get food for their babies? IX, 99-100
34. How does a mother albatross feed her baby? IX, 98
35. How do newborn marsupials reach their mother's pouch? IX, 280-282
36. Why are kangaroo babies so helpless? IX, 280-281
37. Why was infanticide necessary in primitive times? VII, 179
38. What is the contribution of the father and mother to the human embryo? VII, 23
39. What is the function of the mother? VII, 23
40. What is one of the most important of all life functions? VII, 35

C. The Continuity of Life:

I. IN PLANTS:

1. How do bacteria reproduce? XI, 38
2. What is a spore? XI, 39
3. How do spores carry on the life of a plant? XI, 39
4. Are all spores produced sexually? Explain. XI, 39
5. How do yeasts reproduce? XI, 38, 90
6. What is the dust in ripe puffballs? XI, 40
7. What is the black powder of corn smut? XI, 40
8. How does bread mold produce spores? XI, 39-40
9. Is sex found only in animals? Explain. XI, 38-39

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10. Compare fertilization in plants with that in animals. XI, 39
11. How do sex cells in a lower plant behave? XI, 39
12. How do filamentous algae reproduce? XI, 39
13. How do some algae reproduce? XI, 38
14. Do ferns have seeds? Explain. XI, 94
15. Where are the spores of mosses and ferns found? XI, 40
16. How is the process of fertilization in flowers carried on? XI, 41
17. Where is the egg of a plant found? XI, 41-42
18. What happens to an egg cell after it has been fertilized? XI, 42
19. What is the yellow powder that comes off some flowers? XI, 41
20. Why is the stigma sticky? XI, 41
21. What is pollination? XI, 43
22. How do plants avoid self-pollination? XI, 43-44
23. What effect on the next generation has cross-pollination? XI, 44
24. What are some of the ways in which pollen is transported? XI, 44
25. Why are so many pollen grains produced? XI, 44
26. Why are wind-pollinated flowers often produced before the leaves? XI, 44
27. Why are some plants either male or female but not both? XI, 45-46

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28. What advantage to a flower are its bright colors? XI, 46-47
29. Why do insect-pollinated flowers have so very little pollen? XI, 46
30. What kind of flowers have very showy petals? XI, 46
31. Why do flowers have odors? XI, 47
32. How does a bumblebee pollinate a lady-slipper or mocassin flower? XI, 47-49
33. How is the yucca flower pollinated? XI, 50-51
34. Why are colonies of honey-bees raised near orchards? XI, 52
35. Why do growers plant two varieties of strawberries together in the same field? XI, 52
36. Why must several varieties of Bartlett pears be planted in the same orchard? XI, 52-53
37. What is a seed? XI, 40-41, 54
38. What kinds of food are stored in seeds? XI, 42-43
39. How long can seeds live? XI, 54-55
40. In what chief ways are seeds scattered? XI, 55
41. How are fleshy and spicy fruits able to scatter their seeds? XI, 58
42. How do the touch-me-not, the violet, witch-hazel, and bean plants scatter their seeds? XI, 55-56
43. What tree endangers a passerby when it scatters its seeds? XI, 56
44. Name some plants that use the wind to scatter their seeds. XI, 56

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45. How do the elms, maples, willows, poplars and dandelions scatter their seeds? XI, 56-57
46. Can you explain why your trousers or stockings are covered with seeds after a walk through a field? XI, 57-58
47. What enables some seeds to steal a ride on animals? XI, 57-58
48. How are some nut-bearing trees planted? XI, 58
49. Why are brambles and cedars often close to fences? XI, 58
50. How has man spread weeds in all parts of the world? XI, 58
51. In what plant do seeds need no rest period? XI, 54
52. What is meant by germination? XI, 59
53. What is the first stage in germination? XI, 59
54. What is the first thing to come out of a seed? XI, 59
55. How do beans germinate? XI, 60-61
56. How does corn germinate? XI, 60
57. How does the garden pea germinate? XI, 60
58. How do maple seeds germinate? XI, 61-62
59. How do some plants propagate themselves without seeds? XI, 63
60. What is meant by vegetative propagation? XI, 63
61. How do plants propagate vegetatively? XI, 64
62. Why are potato seeds never planted? XI, 67
63. What is a bulb? XI, 68

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64. What methods has man invented to propagate some plants? XI, 68
 65. Discuss some ways in which plants propagate themselves. XI, 66-67
 66. Discuss the methods of plant propagation by cuttings, budding and grafting. XI, 68-71
 67. Why is it so difficult to get rid of dandelions on a lawn? XI, 65-66
 68. What becomes the fruit in a flower? XI, 42
 69. What becomes the seed in a flower? XI, 42
 70. What causes many plants to produce flowers and fruits only at certain seasons of the year? XI, 303
2. IN MOLLUSKS:
1. How long do mollusks live? X, 255
 2. Where do mollusks store their fertilized eggs? X, 260
 3. How do bivalves reproduce? X, 264
 4. How can we distinguish the sexes in octopuses? X, 337-339
 5. What kind of care is given by octopuses to their eggs? X, 341-342
 6. Where does a squid deposit its eggs? X, 340
 7. How are the eggs of land mollusks fertilized? X, 305
 8. How are gastropod eggs deposited? X, 306-307
3. IN CRUSTACEANS:
1. What animal today has an embryo stage very much like a trilobite's? What does this indicate? X, 56

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2. How do crustaceans reproduce? X, 107-108
 3. How many eggs may a lobster have? X, 108
 4. How long can lobsters live? X, 172-173
 5. How are the eggs of a lobster protected? X, 108
 6. Do baby crustaceans resemble their parents? Give examples. X, 108-109
 7. How are winter-resisting eggs of *Daphnia* produced? X, 119-120
 8. How do ostracods reproduce? X, 124
 9. How have copepods adjusted their breeding habits to the life of the West Indian crabs? X, 133
 10. During what stage in a barnacle's life can it swim freely? X, 140-141
 11. How are young fiddler crabs born? X, 168
 12. Why are fiddler crab eggs hatched only at dusk? X, 168
 13. Why do fiddler crabs rarely go into the water? X, 171-172
 14. How long can a crab live? X, 172
 15. Why does the robber crab, which lives on land, return once a year to the ocean? X, 178
 16. How does the mantis shrimp take care of its eggs? X, 183-184
 17. For what diseases were crayfish "eyes" prescribed some centuries ago in Western Europe? X, 239
4. IN INSECTS:
1. Is it possible for some eggs to develop without fertilization? V, 104

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2. What decides whether an insect will be male or female? V, 123
3. Why are the exits of cocoons always brown in color? V, 306
4. How does the adult moth get out of the pupa case and the cocoon? V, 305-306
5. What stage of an insect's development is adapted chiefly for reproduction? V, 235-236
6. What kind of an adult insect results from a starved larva? V, 292-293
7. Where does the female moth store sperm cells received from the male? V, 311
8. What is stored in the ovary of a moth? V, 311
9. Where are eggs and sperms formed in insects? V, 122-123
10. Where did grasshoppers come from, according to ancient people? V, 1
11. How can we distinguish the male from the female grasshopper? V, 3
12. Describe the way in which female grasshoppers lay eggs. V, 4-5
13. Describe the egg of a grasshopper and its contents. V, 6
14. Describe what takes place when a grasshopper egg hatches. V, 8-9
15. Why do insects sing? V, 49
16. How does a male cricket attract its mate? V, 49
17. How do roaches reproduce their kind? V, 80-82
18. Describe the work of the worker termites. V, 131

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19. Describe the work of the "soldier" termites. V, 131-132
20. Name three kinds of termites in a nest. V, 131-135
21. What kind of termites can reproduce? V, 132-135
22. How may one tell the female termite from the other termites? V, 133
23. What is meant by "caste" among insects? V, 134
24. Which termites are winged? V, 132-133
25. Which termite produces all the eggs of the colony? V, 133
26. With what other insect is the queen termite comparable? V, 133-134
27. When and why do termites "swarm?" V, 134-135
28. What happens to most of the termite swarm? V, 134-135
29. How does a female termite start a colony? V, 135-136
30. What does the first brood of the termites become? V, 137
31. Do termites produce young exactly like the parents? Give examples. V, 137
32. Who relieves the termite parents of the duties of caring for the increasing colony? V, 138
33. When are new king and queen termites produced in a colony? V, 139
34. Are winged termites the only ones which start colonies? How is this possible? V, 140

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35. How is the continued life of the colony insured even when the king and queen termites die? V, 140-141
36. Discuss some termite theories which try to explain why there are different castes produced from the same parents. V, 142-143
37. Describe the various mound nests built by termites. V, 148
38. How often does the fertile termite queen lay eggs? V, 149
39. Where are the eggs of termites taken by the workers? Why? V, 151
40. How large is the fertile queen termite? Can you explain why this is so? V, 149
41. How many generations roll by before the offspring resemble both parents in the case of aphids? V, 155-156
42. How many parents do summer aphids have? V, 162
43. What is meant by parthenogenesis? V, 162
44. How many kinds of offspring do female aphids have in summer? V, 163
45. Where are aphid eggs laid? V, 167
46. How does a tropical climate affect the production of the sexual generation in aphids? V, 167-168
47. Why are male and female aphids necessary in October? V, 166-168
48. What means of defense have aphids against their many parasites? V, 173-174
49. Which sex produces music in cicadas? How is this done? V, 199, 207-212

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50. What is the chief difference between the male and female cicadas? V, 199
 51. How many eggs does a female cicada deposit? V, 214
 52. What is an ovipositor? How does it work? V, 199-200, 212-214
 53. Where are the eggs of an apple tree tent moth found? V, 262-263
 54. When do tent moth eggs hatch? V, 262
 55. How does the tent moth larva get out of its egg? V, 264
 56. How is the tent made by the tent moth larvae? V, 269-270
 57. How do the caterpillars of tent moths molt? V, 274
 58. What happens to deserted insect tents? V, 279-280
 59. Where can we find cocoons of the tent caterpillar? V, 282
 60. How are tent moth cocoons made? V, 282-283
 61. How does a caterpillar get its silk? V, 287-289
 62. How are the tent moth eggs protected? V, 311-312
 63. What condition is necessary to complete the development of the tent moth eggs? V, 312-313
 64. What is a "wiggler?" How do they get into rain barrels? V, 329-331
5. IN FISH:
1. What do baby fish look like? VIII, 134-136

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2. How do the sex glands in fishes behave? VIII, 102
3. Discuss the number of eggs certain fishes produce. VIII, 103
4. What is meant by "viviparous" fishes? VIII, 103-104
5. In what ways do oviparous fishes differ from viviparous fishes? VIII, 104
6. How long does it take to hatch fish eggs? VIII, 105
7. What advantages have baby fishes, born alive, over baby fishes which come from eggs dropped in water? VIII, 107
8. How are male salmon recognized at the spawning season? VIII, 102
9. How does the sunfish protect its eggs? VIII, 108
10. What fish deposits its eggs in seashells? VIII, 112
11. What male fish incubates eggs in a pouch on his body? VIII, 111-112
12. What fish incubates its very large eggs in its mouth? How does the fish eat? VIII, 113
13. How does the bowfin build its nest? VIII, 109-110
14. What fish builds the largest nest? VIII, 110
15. Name the only vertebrate that can spin threads from body secretions? VIII, 110
16. Why is it said that the sticklebacks have carried nest building to its highest development among fishes? VIII, 110-111

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17. What fishes breed all year round? VIII, 116
 18. What truth is there in stories that fishes eat their own young? Give examples. VIII, 114-115
 19. What one American fish leaves fresh water to spawn in salt water? VIII, 119
 20. Who first found out where the eel spawns? VIII, 119
 21. Where do American eels spawn? Where do European eels spawn? VIII, 119
 22. How often does an eel spawn in its life time? VIII, 120
 23. What happens to eels kept in aquaria? VIII, 121
 24. What are the spawning habits of the salmon? VIII, 123
 25. What deep-sea fishes go inshore to spawn? Why? VIII, 125
6. IN AMPHIBIANS:
1. Why must amphibians lay their eggs in water? VIII, 174
 2. How did the midwife toad get its name? What part does the male take in hatching the eggs? VIII, 202
 3. What salamander species is remarkable because its larvae can reproduce? VIII, 187
 4. What frogs incubate their eggs in pockets on their backs? How are the young developed? VIII, 198-199
 5. Since a toad may lay as many as 12,000 eggs, what tends to keep its numbers down? VIII, 197-198

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6. How old are toads before they return to the water to breed? VIII, 198

7. IN REPTILES:
 1. Describe the eggs of reptiles. VIII, 294
 2. Describe the eggs of dinosaurs. VIII, 218-219
 3. How do crocodiles find each other in the water during mating season? VIII, 300-301
 4. How do crocodiles reproduce? VIII, 302
 5. How do alligators reproduce? VIII, 303
 6. Why do leatherback turtles return to land? VIII, 310-311
 7. How do leatherback turtles reproduce? VIII, 310-311
 8. How do box turtles reproduce? VIII, 316-317
 9. During what stage of a box turtle's life is it in danger of its life? VIII, 318

8. IN BIRDS:
 1. Describe the famous eggs of *Aepyornis* of Madagascar. IX, 85
 2. How do male birds act during the mating season? IX, 71-72
 3. What birds are polygamous? IX, 73
 4. What is the purpose of the excess food in the hen's egg? VII, 23
 5. What is the length of a chick's period of gestation? VII, 23-24
 6. What is the comparative size of the nuclei of the chick and human embryo? VII, 23

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7. What kind of hens lay blue eggs? IX, 82
8. What evidence is there that internal secretions (endocrines) influence color and pattern in birds? IX, 35
9. What is meant by the "breeding territory" of a bird? Why is it defended against invaders? IX, 68-70
10. How does the male ruffed grouse produce its drumming sounds? IX, 112-113
11. When do birds sing best? IX, 109-110
12. Do parent birds mate for life? Give examples. IX, 72
13. Why are male birds so brilliantly colored? IX, 36
14. What shapes may birds' eggs have? IX, 79
15. Name some pigments which give color to the eggs of birds. IX, 84
16. What color are birds' eggs which are placed in holes or under cover? IX, 81-82
17. How long do birds' eggs require for incubation? IX, 90
18. What birds carry on no incubation? How, then, is it possible to hatch the eggs? IX, 89-90
19. How is the sex of birds determined by the chromosomes? VII, 28
20. What kinds of birds excavate holes in trees for their nests? IX, 77
21. How do baby grebes which are hatched on a nest over water take care of themselves after birth? IX, 93-94

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22. What birds have forgotten how to build nests or take care of their young? How do their young ones get along? IX, 159
 23. What common bird builds no nest of its own, nor takes care of its eggs? IX, 90
 24. What bird seals its mate in the cavity of a tree with mud? VI, 256
 25. Describe some different types of nests. IX, 73-78
 26. What birds have the simplest kinds of nests? IX, 73
 27. What bird builds up its nest when the water level threatens to flood it? IX, 74
 28. Of what material are humming bird's nests made? IX, 74-75
 29. What bird builds a nest that often breaks the tree? Why does this happen? IX, 75
 30. What is the story behind a weaver bird's nest? IX, 78
9. IN MAMMALS:
1. What are the breeding habits of the duckbill? IX, 279
 2. What striking facts are known about the rate at which mice reproduce? IX, 336-338
 3. How much does a baby hippo weigh at birth? VI, 147
 4. Can you explain the presence of great calluses on the knees of a wart-hog embryo? VI, 158
 5. Why are kangaroo babies so helpless? IX, 280-281

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6. Why are kangaroo babies often found in the pouch of their mother? VI, 219
7. How do newborn marsupials reach the mother's pouch? IX, 280-282
8. Why is it often necessary to remove the horns of a male deer? VI, 183-185
9. What is the size of the human egg? VII, 23
10. Why is it necessary for the hen's egg to be one million times larger than man's? VII, 23
11. How large is the human embryo? VII, 23
12. How did Cro-Magnon man try to increase the animal population? VII, 203
13. Are egg and sperm cells alike? Explain. VII, 24
14. What is the "seat of inheritance?" VII, 26
15. What does the microscope reveal about chromosomes? VII, 27
16. How do the chromosomes divide in the formation of sperm and egg cells? VII, 27
17. What steps do chromosomes go through in reproduction? VII, 26
18. What happens to the chromosomes as the cell divides? VII, 26-27

Pupil and Class Activities

A. Things To Do:

1. Make spore-prints of common gilled mushrooms. XI, 92
2. In the spring, observe the flowers of mountain laurel. Touch the stamens lightly and observe their reaction. XI, 127
3. Make collection of fruits and seeds spread by animals, wind, water and by mechanical devices of the fruit itself. Exhibit them, labelled conspicuously in your classroom. XI, 55-59
4. Germinate various kinds of seeds. Observe the way the seed opens and how the young leaves seek the light. Inspect the cotyledons. XI, 59-62
5. Cut a potato so that each section has some buds or "eyes" on it. Plant them two inches deep in earth and keep them well watered. How is it possible for these portions to grow new potato plants? XI, 66-67
6. Obtain some onions, tulips, narcissus, lilies, crocuses and gladioluses. Cut them from top to bottom and observe the arrangement of food-bearing leaves around a protected stem. XI, 68
7. Propagate a pussy-willow branch in water, then in soil. Let it grow up in your back yard and you will have pussy-willow branches for home decoration each spring. XI, 68-69

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8. Practice propagating plants by budding. Use a peach bud. Try to implant peach buds on other trees, such as the sweet cherry tree, or plum tree. XI, 69-70
9. Practice propagating fruit plants by grafting. Use one plant on which to graft several varieties of twigs from fruit trees. XI, 69-71
10. Make a pure culture of daphnia, and study their life history. X, 118-120
11. Isolate cyclops from some pond water and work out its life history yourself. X, 127-128
12. Make a collection of differently-sized crab molts from the seashore, or from a crab kept in a salt-water aquarium. X, 105-106
13. Catch some grasshoppers among some weeds. Include some young ones. Feed them grasses and weeds thrown into their cage. Note how often they molt. Watch the female digging into the earth at the bottom of the cage. Why does she do this? V, 1-25
14. Exhibit a series of grasshopper nymphs from early stages to adult forms. V, 13
15. In the late summer look for katydid eggs on twigs of various shrubs and trees. Exhibit them in your classroom or museum. V, 10-11
16. Find a few egg cases of the praying mantis. Keep them through the winter in a cool place. When they hatch in the jar, feed them tiny fruit-flies raised for that purpose. How long can you succeed in raising the mantes? V, 75-76
17. Imprison some houseflies in a screened tank containing some manure. Take notes on your ob-

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- servations of the life history of houseflies. V, 324-325
18. Collect larvae of mosquitoes from some stagnant water. Cover the tank with gauze and observe the steps in the life history of mosquitoes. V, 335-336, 340-341
 19. Catch some honeybees in a net. Kill them in fumes of carbon tetrachloride in a bottle. Brush the pollen stuck to the bee into a drop of water on a slide and examine under a microscope. Draw the variety of pollens you see. What does this teach you? XI, 47.
 20. Dig into rotted wood in the woods near your home. See if you can find the larvae of termites as well as the pupae and adults. The queen termite, if found, will give you some interesting observations. V, 128
 21. Study the activities and kinds of individuals in an ant nest in your vicinity. Try to make an artificial ant nest, making sure you get a queen ant. V, 128
 22. Make an observation beehive for your school. The local dealer can supply you with a queen bee, drones and workers. V, 128
 23. Construct aquaria for fresh water or pond fishes. Observe their mating behavior and how they care for their young. VIII, 108-112, 115
 24. In early May look in shallow ponds for nests of sunfishes being guarded by the parent fish. Observe their mating behavior. The nests are merely a gravel bed swept clean by the fish. How does the male act towards an intruder? VIII, 108-109

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25. Using your camera, photograph a nest with eggs or young birds in it. IX, 68-102
26. Try getting rid of dandelions or other weeds from your lawn. Consult bulletins from the United States Department of Agriculture. XI, 65-66
27. To find out whether spontaneous generation of bacteria is possible, repeat Pasteur's experiment. Put some food in test tubes. Boil them an hour or two. Place sterile cotton plugs in some tubes, leaving the others exposed. In which tubes do the foods spoil after a few days? Why? XI, 90

B. *Class Discussions:*

1. The fertility of mollusks, such as the oyster. Of what value is this to the oyster species? X, 264-266
2. The relationship between insects and plants as illustrated by the yucca. XI, 50-51
3. The development of the embryo shows man's relationship to other animals. VII, 23-36

C. *Pupil Reports:*

1. Report on the first month of the tent caterpillar's life. You can secure some egg masses from fruit trees. Keep them in a screened cage. Feed them with wild black cherry leaves until the caterpillars spin cocoons. Write up your daily notes in the club magazine. V, 262-313
2. The life history of a housefly. V, 342-345
3. The travels of a Pacific Coast salmon. VIII, 121-124

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4. The Odyssey of the Eel. VIII, 118-121
5. The home life of young birds. IX, 91-102
6. The kinds of homes made by birds and where they are built. IX, 68-78
7. How birds take care of their eggs. IX, 79-90
8. How egg-laying mammals feed their young. IX, 269
9. Some interesting things about egg-laying mammals. IX, 269-279
10. How beavers make their home. VI, 118-121
11. Learn and tell your club and classmates the Seneca Myth of Creation. IV, 222-225
12. The bearers of heredity. VII, 26-28

D. Excursions:

1. Make a trip to some fruit farm and investigate the methods employed to insure pollination. XI, 52-53
2. Look for frogs' eggs in swamps and marshes from the middle to the end of March. Bring them home to your tank. Observe their development into tadpoles. VIII, 195-198
3. Around the middle of March visit a marsh or swamp to hear the symphony of the frogs and toads. What is the meaning of all that music? VIII, 193-198

E. Self-Test Exercises:

TEST I

Complete the following sentences with a word or phrase so that the sentence is true.

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1. A method of reproducing plants without seeds is called _____. XI, 63
2. That part of a flower which becomes the fruit is _____ . XI, 42
3. The stage in an insect's life during which it is able to reproduce is called the _____. V, 235
4. Unfertilized eggs may develop to the adult stage by the process of _____. V, 162
5. An American fish which leaves fresh water to spawn in salt water is the _____. VIII, 119
6. Bacteria reproduce by _____. XI, 38
7. The dust which comes out of ripe puffballs consists of _____. XI, 40
8. It is believed that flowers have odors to _____ . XI, 47
9. In nature, seeds are scattered by _____ . XI, 55
10. A bird which never builds a nest nor takes care of its young is the _____. IX, 159

ANSWERS

- | | |
|--------------------------------|--|
| 1. vegetative propaga-
tion | 6. cell division |
| 2. the pistil | 7. spores |
| 3. adult | 8. attract insects |
| 4. parthenogenesis | 9. wind, by water, by ani-
mals and by mechani-
cal contrivances |
| 5. eel | 10. cuckoo |

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TEST II

The letters of one word in each of the sentences below are jumbled. If you arrange these letters properly you will find that they spell a word which makes the sentence true.

1. A bird which seals its mate in the cavity of a tree with mud is the ROBINLHL. VI, 256
2. A bird whose nest often breaks a tree with its weight is the YESROP. IX, 75
3. Bacteria reproduce their own kind by the process of NOISIVILLCED. XI, 38
4. Honey-bees are raised near orchards in order to bring about PONIONTAILL. XI, 52
5. A tree which endangers a passerby when it scatters its seeds is the NOXDABS. XI, 56
6. An insect species which has three types of individuals in one nest is the TEETRIM. V, 131
7. An instrument for egg laying possessed by some insects is the SPROOTOIVI. V, 199
8. An extinct bird which laid eggs holding over two gallons of fluid was the RAINSPEYO. IX, 85
9. The NICEPAL has young which are born naked. IX, 20
10. A fish which may produce more than 3,500,000 eggs in one season is the BUTHAIL. VIII, 103

ANSWERS

- | | |
|------------------|---------------|
| 1. hornbill | 6. termite |
| 2. osprey | 7. ovipositor |
| 3. cell division | 8. Aepyornis |
| 4. pollination | 9. pelican |
| 5. sandbox | 10. halibut |

UNIT XI

GOOD HEALTH FOR LIVING THINGS

1. Who was Louis Pasteur? Why did he become famous? XI, 90
2. Are all bacteria harmful? Explain. XI, 28
3. What kind of fungi may cause diseases in man, animals and plants? XI, 89-90
4. How can a fly's bite cause a serious infection? V, 323
5. Why is the housefly so dangerous? V, 347
6. What three types of disease germs may be carried by the housefly? V, 347
7. Why is yellow fever a tropical disease? V, 340
8. Why has yellow fever occasionally broken out in northern cities? V, 340
9. What have we learned about the diseases of prehistoric man? What kind of evidence teaches us about their diseases? VII, 196
10. How did primitive people treat diseased men and women? VII, 178
11. How did early man explain diseases, accidents and poor hunting? VII, 177-178

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12. What part did alcohol play in curing sickness among primitive people? VII, 178-179
13. When did liquor first become a serious problem? Whom did it affect most? VII, 179
14. Did early man enjoy perfect health? How do you know? VII, 176
15. What state of health did the Indians enjoy? IV, 27
16. What caused the change in the Indian population? IV, 6
17. What is our most effective method of fly control? V, 343
18. What type of tuberculosis is treated by sun therapy? II, 235
19. What conclusions have been reached concerning the treatment of rickets? II, 239-240
20. What diseases are treated with sunlight? II, 235
21. Why did the American Indian use a sweat bath? IV, 26-27

Pupil and Class Activities

A. Things To Do:

1. To find out how flies spread bacteria which may be harmful, capture a housefly and let it walk across sterile nutrient agar in a petri-dish. Incubate the bacteria for 24 hours and report the results to your class. Use a control dish. V, 347
2. To find out where bacteria may be found, expose sterile petri-dishes containing nutrient agar to air, soap, a hair, a powder puff, a coin, a finger tip, dust, handkerchief, some water, milk, earth, etc. Close the dishes and incubate them. After a few days what has happened? XI, 89

B. Class Discussions:

1. The relation between fungi and diseases of man, animals and plants. XI, 89-91
2. Indians were exceptionally healthy. IV, 27-28
3. The part snails play in spreading the flukes which cause disease in man. X, 316-320
4. The relationship of ultra-violet light to disease. II, 233-241

C. Self-Test Exercises:

TEST I

Underline the word or phrase that makes each of the following sentences true statements.

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1. All bacteria are (a) harmful (b) harmless (c) not harmful. XI, 27, 28
2. Yellow fever is a tropical disease because (a) it is spread by tropical insects (b) it is due to the heat of the tropics (c) it is caused by breathing the hot, heavy air of the tropical swamps. V, 339-340
3. House-flies can carry (a) typhoid fever (b) typhoid bacteria (c) malaria parasites. V, 347
4. Louis Pasteur became famous because he (a) discovered rabies (b) invented pasteurized milk (c) showed that bacteria cause disease. XI, 90
5. The best method of controlling house-flies is to (a) swat every fly (b) keep food covered (c) destroy their breeding places. V, 343
6. A disease which is cured by sunlight is (a) scurvy (b) xerophthalmia (c) rickets. II, 235
7. American Indians treated diseases by (a) injections (b) sweat baths (c) dieting. IV, 27
8. Prehistoric man suffered from such diseases as (a) obesity (b) pyorrhea (c) melancholia. VII, 196
9. Primitive people treat diseases by (a) scientific methods (b) beating drums (c) prescribing drugs. VII, 178
10. Hard liquor was invented by (a) prehistoric men (b) American Indians (c) Arabs. VII, 179

ANSWERS

- | | |
|-----|------|
| 1—c | 6—c |
| 2—a | 7—b |
| 3—b | 8—b |
| 4—c | 9—b |
| 5—c | 10—c |

UNIT XII

CHANGING WEATHER

A. How The Weather Changes:

1. What is the temperature of air at different levels?
II, 44
2. When did our present day climate originate?
VII, 68; X, 81
3. What was the original climate at the poles? VII,
68
4. What was the weather during the Ice Age? VII,
59-61
5. What evidence is there that the Proterozoic era
was cool? X, 45-46
6. What is the relationship of dust to rain? II, 103
7. What are the effects of sun variations on weather
factors? II, 156
8. How do sun-spots affect the sun's radiant energy?
II, 139-141
9. How do sun-spots affect atmospheric tempera-
ture? II, 144-145
10. How does the sun affect atmospheric pressure?
II, 138

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11. What is the relationship of solar radiation to atmospheric pressure? II, 152
12. How is upper atmospheric pressure measured? II, 43-45
13. What conclusions concerning weather factors are reached from studies of the relation of solar variations and weather? II, 157-158
14. Trace the path of a West Indies hurricane. II, 106
15. Describe the appearance of a tornado. II, 113
16. What prevents the escape of the earth's radiant heat? II, 110-111
17. What kinds of clouds are there? II, 104-105

B. Predicting The Weather:

1. What basis is there for believing that the sun is the answer to meteorological problems? II, 10
2. What would be the effect of removing ozone from the upper atmosphere? II, 314
3. What effect has the sun's variations on barometric readings? II, 161
4. When was the effect of solar radiation on temperature first discovered? II, 16-17
5. How is weather forecasted by the use of solar radiation variations? II, 67-68
6. How closely do predictions of weather based on sun activity follow the actual weather? II, 155
7. How did long range weather forecasts for New York compare with the actual weather? II, 159

Pupil and Class Activities

A. Things To Do:

1. Visit your local weather bureau.
2. For a period of several months plot the daily temperature. Write to Washington to obtain the solar variations for that period and compare with your record of temperature changes. II, 60-61
3. Watch newspaper articles for descriptions of tornadoes in the United States. Paste these articles into your scrap book. II, 113

B. Class Discussions:

1. Europe has always had a temperate climate. VII, 65-70
2. Weather can be forecasted on the basis of solar variability. II, 151-160

C. Pupil Reports:

1. The relation of sun-spot activity to weather changes. II, 60-61
2. The accuracy of weather predictions based on solar radiation variations. II, 67-71
3. Forecasting weather on the basis of solar variability. II, 151-160

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D. *Self-Test Exercises:*

TEST I

Below are 10 statements. Some are true; some are false. On your paper re-write each false statement in such a way that it becomes true. In doing this, you may change or leave out any of the italicized words but you may not change or leave out any others.

1. The original climate of the North Pole was *ALWAYS COLD*. VII, 68

2. The climate we enjoy today began on this earth during the *NEW STONE AGE*. VII, 68

3. Another glacial period is *NO LONGER POSSIBLE*. VII, 57

4. Moisture in the air condenses around *ELECTRICAL PARTICLES*. II, 103

5. The amount of radiation from the sun is *CONSTANT*. II, 138

6. The earth retains its heat due to *GRAVITY*. II, 110.

7. Extreme ultra-violet rays from the sun would burn our eyes and skin, were it not for the presence of *NITROGEN* in the atmosphere. II, 314

8. Some plants *CAN GROW* in a temperature below 32° F. II, 230

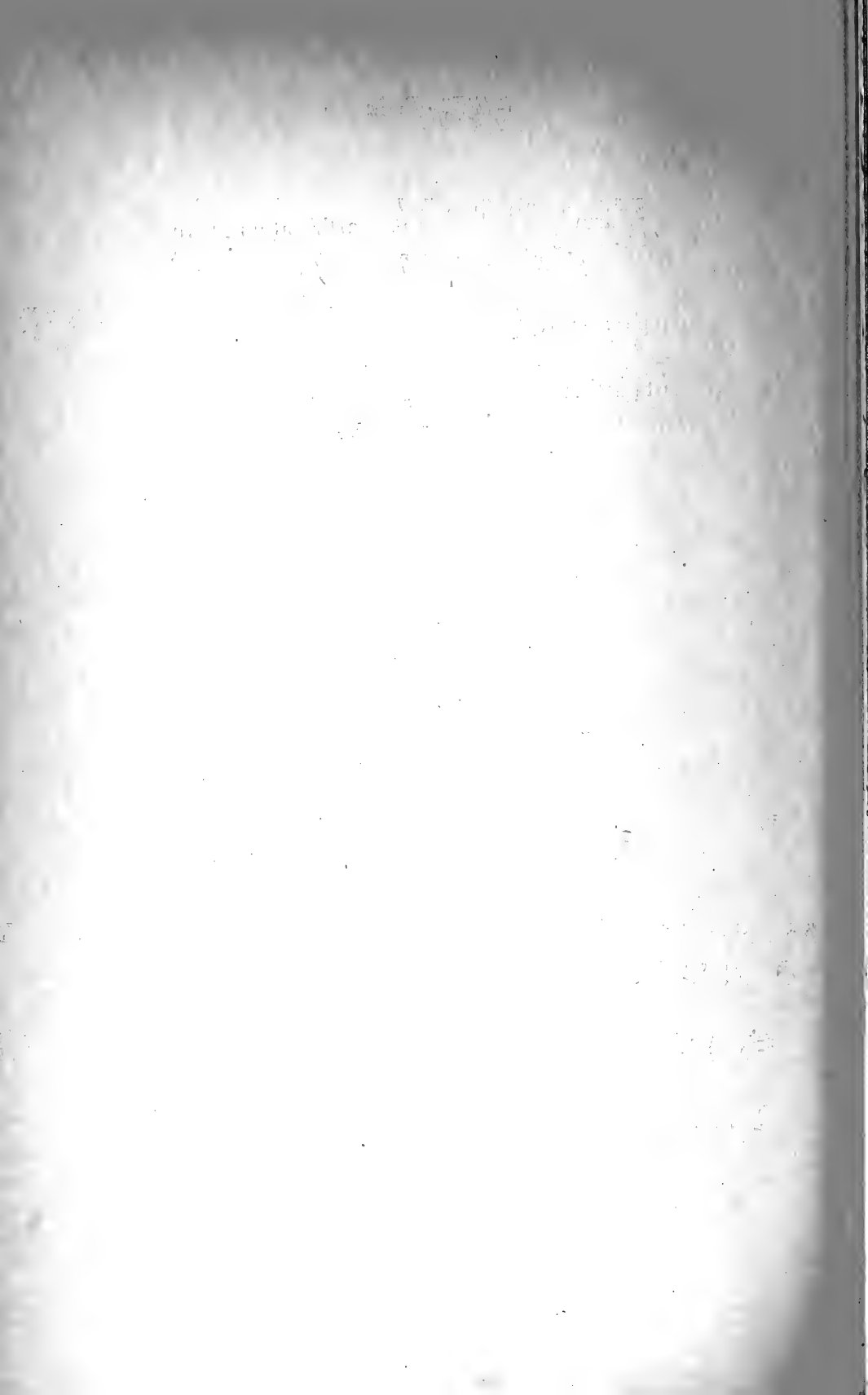
9. Of fifty-one long range weather forecasts, *ONLY TWO* were correct. II, 159

10. The weather during the Ice Age was characterized by *MILD TEMPERATURES*. VII, 60

SCIENCE AND BIOLOGY

ANSWERS

1. once warm
2. New Stone Age
3. possible if the mean temperature drops 9° F.
4. dust particles
5. variable
6. earth's atmosphere
7. ozone
8. can not
9. thirty-one
10. severe storms



UNIT XIII
SEEKING SHELTER

1. Why did Eskimos remain in the North? IV, 3
2. Why were Indians constantly migrating? IV, 5
3. What did Indians make from stone? IV, 20
4. What was the importance of bark to the Indian? IV, 22-23
5. How does the Eskimo live in winter and in summer? IV, 40
6. What was the Iroquois dwelling? IV, 73
7. Why did the Cliff-dwellers build in cliffs? IV, 110
8. What is the estufa? IV, 111-112
9. What is the only pre-white man pueblo still in use? IV, 113
10. How did the Pueblos build houses? IV, 113
11. How did the Yuma build his lodge? IV, 175
12. How is the Yurak house built? IV, 191-192
13. How far back has man worn skins or clothing? VII, 173
14. What kind of shelter did Chellean man invent? VII, 185
15. When did man first use shelter? VII, 192

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16. Who were the first regular cave dwellers? VII, 192
17. What part of the cave was occupied by a cave-dweller? VII, 192
18. Who were the first to wear some kind of covering? VII, 192
19. What caused Neanderthal man to wear skins and furs? VII, 192
20. How was Neanderthal man able to withstand the severe winters in cold caves? VII, 195
21. Who were probably the first people to use shelters in warm weather? VII, 195
22. What caused man to seek shelter in the mouths of caves? VII, 214
23. What proofs are there of well-made shelters in the Aurignacian epoch? VII, 217-218
24. What was the shelter of Neolithic man? VII, 236
25. What kind of shelters did Neanderthal man build? VII, 264-265
26. When did architecture begin? VII, 264
27. What is the probable development of the brick throughout the ages? VII, 282-283
28. How were walls decorated in the Bronze Age? VII, 284-285
29. What was the Sumerian house? VII, 103
30. What improvement in brick had the Aryans learned? VII, 308
31. Why was Cretan architecture of a wilder range than other civilizations? VII, 310

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32. What kind of architecture developed in Crete? VII, 310
33. What preceded Mayan stone architecture? VII, 330
34. What was the purpose of Mayan architecture? VII, 331
35. What kind of stone was easily worked by the Mayans? VII, 331
36. Why were Mayan rooms small? VII, 331-332
37. How did the Toltecs build houses? VII, 337
38. What was the quality of Inca architecture? VII, 343-344
39. What remarkable construction was accomplished by the Incas? VII, 344
40. How was sod used by pioneers? XI, 230
41. What is a sod house? XI, 230

Pupil and Class Activities

A. Things To Do:

1. From some twigs and grass construct a Paiute lodge. IV, 173, Plate 59
2. In winter (wearing proper clothing) build an igloo or snow house. II, 40-42
3. Build models of Chippewa houses from mats and bark. IV, 72
4. Build a model Passamaquoddy birch bark house using straight twigs for the frame and bark for the covering. IV, 73
5. Build a model of an Iroquois long-house. IV, 88
6. Using an egg or an orange crate box, build a Karok plank house. IV, 188
7. Make a model of an Indian tipi. IV, 158
8. Using an old skin or a cloth and beads, make a duplicate of Chief Powhatan's mantle. IV, 252

B. Self-Test Exercises:

TEST I

Choose the correct answer.

1. Neanderthal Man was able to withstand severe winters because: (a) he wore warm clothing (b) caves were warm (c) only those who could withstand severe winters remained alive. VII, 196

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2. Eskimos remained in the North because (a) food was plentiful (b) they were kept from going South by other tribes (c) they found it healthy. IV, 3

3. Pioneers built sod houses because (a) the material was ready at hand (b) it was an excellent weather protection (c) no trees were available. XI, 230

4. Cave-dwellers occupied (a) the rear of a cave (b) the edge (c) the middle. VII, 192

5. Man sought shelter in caves to protect himself against (a) cold (b) animals (c) rain. VII, 214

6. The first people to use shelters in warm weather were the (a) Piltdown (b) Chellean (c) Cro-Magnon. VII, 217

7. Early houses were heated by (a) fireplaces (b) steam from hollow logs heated by hot stoves (c) fires. VII, 173

8. Mayan rooms were small (a) in order to keep out spirits (b) to keep out the tropical heat (c) because walls were extremely thick. VII, 331-332

9. Mayans first built their buildings of (a) stone (b) wood. (c) thatch. VII, 330

10. Pueblos built their cliffs for (a) the view (b) it was easier to build (c) protection against enemies. IV, 110.

ANSWERS

1—c

6—c

2—b

7—c

3—a

8—c

4—b

9—b

5—a

10—c

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TEST II

1. Write a six-letter word which names the Indians who lived in cliffs. IV, 112
2. Give a seven-letter word which describes what Indians frequently had to do in order to have food. IV, 5
3. Give a six-letter word which describes the house where Southwestern Indian men met. IV, 111-112
4. Give a four-letter and a five-letter word which describe an Eskimo's winter house. IV, 40
5. Give a four-letter word for a material from which Indians made clothing and houses. IV, 22-23
6. Give a seven-letter word which names a people who produced fine architecture before all others. VII, 310
7. Give a seven-letter word which describes the materials with which Aryans improved bricks. VII, 308
8. Give a four-letter word which describes the clothing of early man. VII, 192
9. Give a five-letter word which describes the method of heating the Indians' bathing house. IV, 26
10. Give a four-letter word which describes what Eskimos used for cooking, heating and lighting their homes. IV, 43-44

ANSWERS

- | | |
|---------------|-----------------|
| 1. pueblo | 6. cretans |
| 2. migrate | 7. glazing |
| 3. estufa | 8. furs or skin |
| 4. snow house | 9. steam |
| 5. bark | 10. lamp |

UNIT XIV

ENERGY

1. What is the effect of an increased number of sun-spots on solar radiation? II, 140
2. What is the comparison of ultra-violet radiation to solar radiations when sun-spots increase? II, 146
3. How does gravity make meteors fall to the earth? III, 2
4. When do meteors become visible? III, 2
5. What was the calculated speed of some meteors? III, 27
6. What causes variations in the speed of a meteor? III, 27
7. How great is the speed of a meteor falling in the opposite direction to the earth's rotation? III, 27-28
8. Why do meteors lose their initial speed and fall in the atmosphere at the speed of any falling body? III, 28
9. How do we know that meteors strike the earth at rather slow speeds? III, 29-30
10. What effects of meteoric flight in air are found on a meteor's surfaces? III, 50

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11. How does friction cause depressions on a meteorite's surface? III, 57
12. What improvements in tools took place in the Chellean Age? VII, 186
13. What is a fist axe? VII, 186-187
14. What advantage did flint chips have over pebble flints? VII, 193
15. What were the uses of the stone tools of Neanderthal man? VII, 193
16. How did man first use clubs? VII, 194
17. Why are we led to believe that ancient man used handles for his tools? VII, 194
18. How did Cro-Magnon man use the burin or engraving tool? VII, 202
19. When did the engraving tool first come into use? VII, 202
20. What improvement in stone tool-making took place in the Solutrean epoch? VII, 206-207
21. What types of instruments were used in Solutrean times? VII, 207
22. What type of instrument is found only in Solutrean times? VII, 207
23. What importance may the sharp ripple flaked instruments have had in spreading Solutrean culture through Europe? VII, 208
24. What kind of tool material is not Solutrean? VII, 208
25. What is the ripple flaking of stone tools? VII, 208
26. What replaced ripple flaking of stone? VII, 216

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27. What is the first evidence of the use of the bow and arrow? VII, 229
28. How were tools mounted in Mesolithic times? VII, 235
29. Why is it incorrect to say that the plow was an evolution of the hoe? VII, 259
30. How were bronze tools hafted? VII, 270
31. How was the composite bow made? VII, 323
32. What was the composite bow? VII, 323
33. What was the great aid to safety of railroad brakes? XII, 33
34. What are the advantages and disadvantages of machines? XII, 149-150
35. What kinds of mechanical energy do machines use? XII, 150-151
36. How much mechanical energy is produced annually in the United States? XII, 150
37. What are the energy sources of the annual mechanical energy output? XII, 150
38. How are wheels of engines prevented from skidding around sharp curves? XII, 194
39. How was loss of power in locomotives due to lack of friction eliminated? XII, 194-195
40. How do large engines follow the curvature of the track? XII, 195
41. How were early trains stopped? XII, 195
42. How did inertia prevent the early popularity of air brakes? XII, 196
43. How is air pressure used to apply brakes? XII, 196

Pupil and Class Activities

A. Things To Do:

1. Take a large coffee can with a cover. Punch a hole in the cover. Mount a pinwheel above the hole. Put some water into the can and heat over a Bunsen burner or electric stove. When steam is formed the pinwheel will spin. Discuss the transformations of energy which took place.
2. Lift weights of different sizes from the floor to a table. Calculate the amount of work done in each case.
3. Estimate the amount of work you do when you walk up stairs and on an equivalent distance along level ground. Which forces do you work against?
4. Using cord and thread spools, make a block and tackle with various rope numbers. Lift a small weight and calculate the mechanical advantage.
5. Using a spring balance, draw one-half pound weights over a smooth surface (glass), sandpaper and plain wood. Compare the amount of force required to pull the weight over each kind of surface. What do you conclude?

B. Class Discussions:

1. The force of gravity can be reduced.
2. Energy can be destroyed.
3. The world would be better without friction.

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C. Pupil Reports:

1. How gravity helps man.
2. The places where friction occurs in an automobile.
3. How friction is reduced in machines.
4. Sources of heat energy.
5. Energy transformations in a steam locomotive.
6. Energy transformations in the automobile.

D. Self-Test Exercises:

TEST I

E G H U B C Z D F J K

Change the letters in this code word, as follows:

1. Change E to G if meteors may move much faster than the speed of a falling body. If not, change to F. III, 27
2. Change G to L if gravity has no effect on meteors. If it has, change to R. III, 28
3. Change H to A if the friction of the air reduces meteoric speed. If not, change to O. III, 28
4. Change U to W if locomotives do not skid on turns. If locomotive wheels do skid, change to V. XII, 195
5. Change B to I if inertia prevented the immediate use of air brakes. If not, do not change. XII, 196
6. Change C to E if early trains were stopped without brake friction. If not, change to T. XII, 195
7. Change Z to A if the annual mechanical horsepower output in the United States is 92 million horsepower. If not, change to T. XII, 150
8. Change D to E if two-thirds of the mechanical energy

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in the United States comes from water power. If not, change to T. XII, 150

9. Change F to I if friction causes meteors to become visible. If not, do not change. III, 2.

10. If machines have no disadvantages to man, change J to L. If machines do have disadvantages, change to O. XII, 149-150

11. If all meteors fall at the same speed, do not change. If they do not, change K to N. III, 27-28

NOTE: If all the changes listed above are properly made, a word will be formed, which represents the theory by which the sun holds planets in their places.

ANSWER

Gravitation

TEST II

Rewrite correctly any of the following statements which are false.

1. Meteors fall and hit the earth at a speed equal to gravity plus the initial speed. III, 28

2. Friction causes depressions in meteorite surfaces. III, 57

3. Water pressure is a great aid to railroad brakes. XII, 33

4. Machines use mainly the mechanical energy of rotating wheels. XII, 150-151

5. Early pebble-chipped stones were superior to flint chips. VII, 193

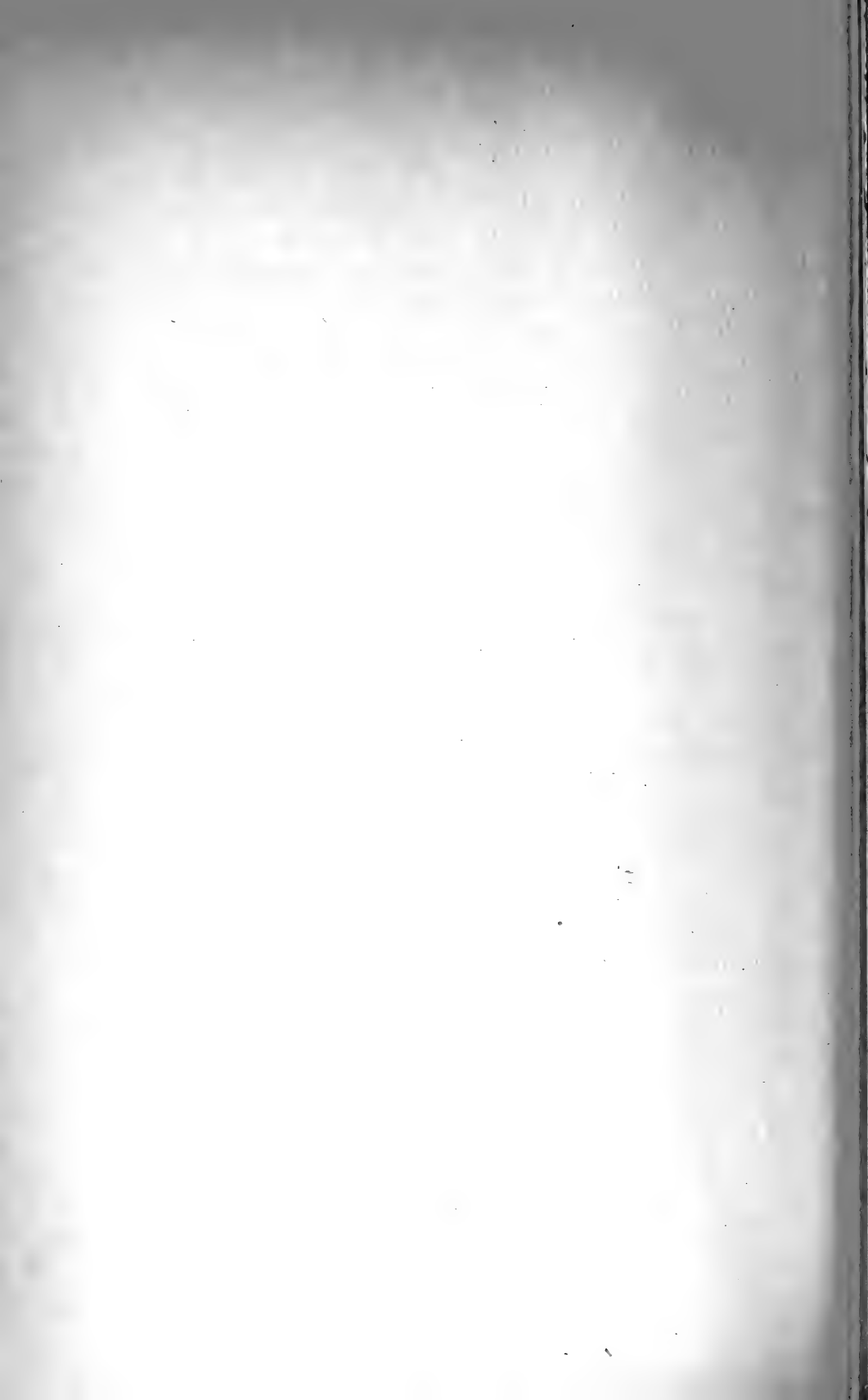
6. Cro-Magnon Man used the burin engraving tool for practical purposes. VII, 202

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7. Neanderthal Man used tools against friction and gravity to cut, scrape and chop. VII, 193
8. Solutrean advanced culture spread through Europe because friction did not affect their tools. VII, 208
9. Ancient man used handles on tools to increase their ability to overcome friction and gravity. VII, 194
10. In a bow, friction and gravity play no part. VII, 229, 323

ANSWERS

1. False—Meteors are slowed down by friction until their speed is that produced by gravity.
2. True
3. False—Air pressure is used to apply railroad brakes.
4. True
5. False—Flints were sharper than pebble chips.
6. False—Cro-Magnon Man engraved for decorative purposes.
7. True
8. False—Solutrean culture spread, due to sharper tools.
9. True
10. False—Friction at the bow and in the air retard the flight of an arrow.



UNIT XV

MAN'S USE AND CONTROL OF HEAT ENERGY

A. Heat Energy from Fuels:

1. Where is light energy stored by plants? XI, 294
2. What is takia? How is it used? VI, 157
3. What is the relative heat efficiency of coal and oil? XII, 159
4. How does coal give us heat? XI, 294
5. How much fuel is consumed in the United States? II, 194
6. What are the by-products of coke? XII, 338
7. What is a British thermal unit? XII, 159
8. What is a calorie? XI, 294
9. What is a fire tube boiler? XII, 157
10. What is a water tube boiler? XII, 157
11. What is dry steam? XII, 155-157
12. How may heat energy be converted to mechanical energy? XII, 155
13. What was the purpose of Watt's condenser? XII, 160

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14. What happens to steam at 700° F.? XII, 158
15. How does steam pressure increase with temperature? XII, 155
16. What fuels are used by internal combustion engines? XII, 171
17. What is the meaning of the flash point of oil? XII, 175
18. How is fuel ignited in a Diesel engine? XII, 175

B. Heat Operated Engines:

1. What was the Newcomen steam engine? XII, 159
2. What was the defect of the Newcomen engine? XII, 159
3. Who made steam engines before James Watt? XII, 159
4. What is the difference between the Watt and Newcomen engines? XII, 160
5. How did Watt's engine work? XII, 160
6. What is a horsepower? XII, 159
7. Why are single cylinder engines the least efficient? XII, 166
8. What was the first steam power installation in New York City? XII, 183
9. Who built the first rotary steam engine? XII, 182
10. Why is it important to maintain a high cylinder temperature? XII, 166
11. What is a reciprocating steam engine? XII, 161-162

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12. What is the defect of the simple reciprocating engine? XII, 162
13. How can the greatest amount of energy be obtained from steam? XII, 166
14. How is steam made to give us most of its mechanical energy? XII, 168
15. Who invented the steam turbine? XII, 167-168
16. Why does a turbine increase the efficiency of a steam engine? XII, 171
17. How is pressure equalized in a Parson's turbine? XII, 170
18. What is the reaction turbine? XII, 169
19. What is the defect of the impulse turbine? XII, 168
20. What substance is taking the place of steam in high power steam installations? XII, 47-48
21. How is mercury used in steam engines? XII, 158-159
22. How much electricity is manufactured by steam power? XII, 47
23. What is the maximum efficiency of a steam engine? XII, 158
24. What conditions determine steam engine efficiency? XII, 158
25. Who calculated the maximum efficiency of a steam engine? XII, 157-158
26. What is an internal combustion engine? XII, 171
27. What type of engine was the Brayton? XII, 216
28. What was the pioneer gas engine? XII, 171

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29. What is a carburetor? XII, 174, 178
30. How is fuel admitted to the cylinder of a gas engine? XII, 171, 174
31. How is pressure produced in a cylinder? XII, 172
32. When was compression discovered? XII, 172
33. How is the fuel in a gas engine ignited? XII, 174-177
34. How do exhaust gases leave a gas engine? XII, 172, 174
35. What is the greatest complication of internal combustion engines? XII, 176
36. Why must engines be cooled? XII, 176
37. How are internal combustion engines cooled? XII, 176
38. What limits the efficiency of gas engines? XII, 179-180
39. What type of action is generally found in a gas engine? XII, 172
40. What were the earliest commercial gas engines? XII, 171
41. Who invented the four-cycle gas engine? XII, 215
42. What is the order of events in a four-cycle gas engine? XII, 172
43. Why are internal combustion engines more efficient than steam engines? XII, 158
44. What are the advantages and disadvantages of the steam and gas engines? XII, 180
45. What is a Diesel engine? XII, 175

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46. What is the cycle of operation of a two-cycle Diesel? XII, 176
47. What is the cycle of operation of a four-cycle Diesel? XII, 175
48. How was the first sun engine built? II, 214-215
49. What is the efficiency of a sun engine? II, 212-213
50. How can gases be used to absorb sun energy in order to drive engines? II, 207-208

C. Refrigeration:

1. What is latent heat? XII, 240
2. What factors of gases are concerned in refrigerators? XII, 239-240
3. How does ammonia dissolve in water? XII, 240
4. How can expanding ammonia absorb heat from its surroundings? XII, 241
5. How is CO₂ used for refrigeration? XII, 243-244
6. What types of refrigeration are adapted to home use? XII, 244
7. How is cold produced by heat? XII, 239
8. What are the parts of absorption refrigerators? XII, 221
9. How does the home absorption refrigerator (Electrolux) work? XII, 244-248
10. How may the sun's heat preserve our food some time in the future? XII, 239
11. How does the home compression refrigerator work? XII, 245-249

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12. What are the best refrigerator temperatures for some common foods? XII, 242-243
13. What common method other than heat is used for refrigeration? XII, 241-242

Pupil and Class Activities

A. Things To Do:

1. Make a cross-section model of the early type of gas engine. Use scraps of tin and wood found in the scrap heap. XII, 172
2. Construct a solar boiler from a test tube in the center of a tin funnel. Blacken test tube with candle soot. Fill test tube with water. Use positions shown on pages 195-198. II
3. Make a simplified model of the steam boiler on page 156. XII
4. Make a diagram of the cross-section of a one cylinder gas engine. Color the different parts. XII, 173-175
5. Types and operation of steam engines. XII, 159
6. A history of solar engines and solar heat devices. II, 19-22
7. Examine the school's thermostat system.
8. Visit a local gas-producing plant.
9. Make a colored chart of an electric refrigerator. Label the important parts. XII, 249
10. Make a colored chart of the operation of a gas refrigerator. XII, 248
11. Construct a solar cooker from glass tubing and sheet tin following the photograph and instructions on pages 216-222. II

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B. *Class Discussions:*

1. The gasoline engine is superior to the Diesel engine. XII, 171-180
2. Watt did not invent the steam engine. XII, 159-162
3. Parsons invented the steam turbine. XII, 166-171
4. The relative advantages of Diesel and gasoline engines. XII, 171-180
5. Solar engines and cookers are new developments. XII, 194-222

C. *Self-Test Exercises:*

TEST I

Match each item in Column A with the proper item in Column B.

A	B
a. sun energy	1. Oil XII, 159
b. United States coal consumption	2. unit of heat XII, 159
c. unit of heat	3. United States oil consumption II, 194
d. internal combustion engine	4. high power engine XII, 155-157
e. boiler	5. calorie XI, 294
f. British thermal unit	6. compression ignition XII, 175
g. desert fuel	7. oil fuels XII, 171
h. Diesel	8. stored in plants XI, 294
i. half billion barrels	9. steam engine XII, 157
j. most efficient fuel	10. half billion tons II, 194
	11. takia VI, 157

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ANSWERS

a—8	f—2
b—10	g—11
c—5	h—6
d—7	i—3
e—9	j—1

TEST II

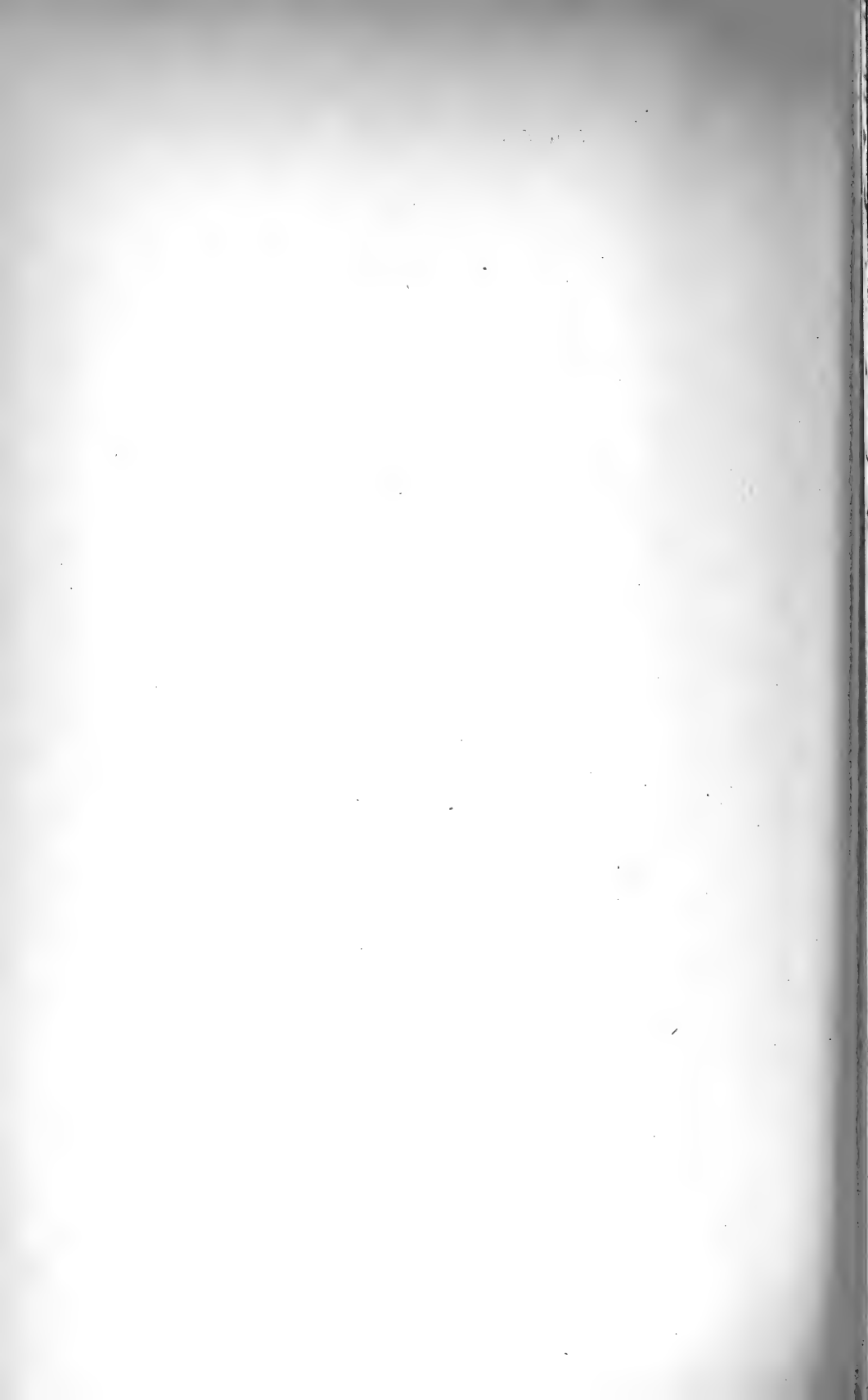
By using all of the letters below you can form the names of five men who helped develop the steam engine.

E A N
V O N O M
S C A V E
E T E L W
A R T A E
S S N T L
P N D W S

References—XII, 159, 167-168, 170, 175-176, 181-184, 215-216.

ANSWERS

Newcomen
deLaval
Stevens
Parsons
Watt



UNIT XVI

MAN'S USE AND CONTROL OF LIGHT ENERGY

A. The Structure And Function of The Eye:

1. How can a caterpillar see? How many eyes has it? V, 285
2. What type of eyes has the cephalopods? X, 336
3. Where are a scallop's eyes? X, 257-258
4. How well can snails see? X, 309-310
5. What kind of eye has a lobster? X, 110
6. What fish has the simplest kind of eye? What theory has been advanced to account for further eye development? VIII, 71-72
7. How is the fish's eye constructed? VIII, 66-73
8. How well can fish with fully developed eyes see? VIII, 72

B. How Pictures Are Made:

1. When was the effect of light on silver known? XII, 356
2. Who proved that light tarnishes silver? XII, 357

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3. Who invented the first practical method of photography? XII, 357
4. What is a Daguerreotype? XII, 358
5. How were Daguerreotypes exposed and developed? XII, 358-359
6. Who perfected sensitized paper photography? XII, 358-359
7. Who invented the glass photographic plate? XII, 360
8. Who was the first inventor of the dry photographic plate? XII, 136
9. Who introduced dry plates? XII, 360
10. What was the first popular amateur camera? XII, 364
11. When was the roll film invented? XII, 363-364
12. Why is it difficult to photograph shooting stars? III, 6
13. How were pictures printed before photography? XII, 353-356
14. What materials have been used for engraving? XII, 353-356
15. What is photoengraving? XII, 366-367
16. What is a Ben Day screen? XII, 374
17. What is rotogravure? XII, 370-371
18. How is electricity used in printing pictures? XII, 367

C. Helping The Eye to See:

1. How is the speed of light measured? II, 303-305

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2. What is the speed and wave length of light? II, 303
3. What is interference? II, 310
4. What is the reflection of light? II, 308
5. How are objects seen in mirrors? II, 308
6. What do scientists believe about light? II, 306-307
7. How old is glass? XII, 322
8. What is glass? XII, 323
9. What are some important uses of glass? XII, 311
10. What is optical glass? XII, 324
11. How do glass and atmospheric water transmit sun rays? II, 314
12. What was the Eskimo window? IV, 42
13. How are astronomical mirrors silvered and cleaned? II, 95
14. What is used to replace glass for astronomical mirrors? II, 96
15. What are the disadvantages and advantages of stellite and glass for mirrors? II, 97
16. When were lenses discovered? XII, 311
17. How old is the eyeglass? XII, 311
18. How can the sun and stars be seen when they are below the horizon? II, 116
19. What makes oars appear to bend in water? II, 115
20. What is refraction? II, 308-309

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21. How was the part of Einstein's theory concerning the bending of light shown to be possible? II, 285
22. What is chromatic aberration? II, 310
23. What is a diffraction grating? II, 310-311
24. How does refraction affect gems? III, 181
25. What two factors of light are studied in cutting a stone? III, 306-307
26. What spoils crystal transparency? III, 176
27. What types of telescopes are in use? II, 310
28. What metal before stellite was used as a reflector in telescopes? XII, 169

D. What Is Color?

1. Why is the sky blue? II, 98
2. What is the efficiency of the eye for different colors? II, 101
3. What colors are found in the sun? II, 74
4. Why can white light be broken into colors? II, 309
5. Who first discovered the sun's spectrum? II, 74
6. What colors are found in the sun? II, 255
7. What causes the colors of the sunset? II, 115-116
8. What causes the quantity of spectrum rays to increase? II, 313
9. Which colors are transmitted most efficiently by the atmosphere? II, 113-114
10. What proof exists for the theory explaining the blue sky? II, 102

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11. What happens to a star's spectrum as it cools? VII, 7
12. What color changes do new stars pass through? VII, 7-8
13. What is believed to be the cause of spectral shift? II, 293
14. What is found in the spectra of colored stars? II, 285
15. How are the different colors of "Neon" lights produced? XII, 50-51, 71
16. What is the range of rays beyond X-rays? II, 11
17. What is the chemistry of color production in animals? X, 207-209
18. Name some crustaceans which can change color at will. X, 205-207
19. Why do crustaceans change colors? X, 205-207
20. What gives fish their remarkable colors? VIII, 34
21. How may male fish differ in color from females? VIII, 101
22. What is the origin of sepia used by artists? X, 335
23. How do plants react to different wave lengths of light? XI, 304-306
24. What are collotype pictures? XII, 373
25. How are colored pictures made? XII, 369
26. What is dispersion in gems? III, 181
27. What produces the color of amethyst? III, 226
28. What is the color of benitoite? III, 252-253

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29. What is the color of spodumene? III, 250
30. What are the colors of diamonds? III, 191
31. What is the color of jade? III, 254
32. What is the color of variscite? III, 259
33. What is the color of chrysoberyl? III, 247
34. What are the colors of pearls? III, 219
35. What are the colors of feldspars? III, 262-264
36. What is the color of zircon? III, 253
37. What are the colors of coral? III, 270-271
38. What kind of diamond produces the best colors?
III, 191
39. What forms the luster of pearl and mother-of-
pearl? III, 218
40. What is the color of sodalite? III, 262

Pupil and Class Activities

A. Things To Do:

1. Construct a spectroscope using ordinary pipe, a convex lens and a glass prism. Follow the diagrams and explanations. II, 311
2. Use printing-out paper instead of films in a plate camera. Wash the paper after developing and then fix in hypo. You will then have a Talbot paper picture.
3. Take a picture of the class. Develop in a red cellophane-walled box so that your class can see the steps of developing and fixing.
4. Make a Daguerreotype by electroplating a copper sheet with silver. Polish the silver and expose to iodine fumes. When a rich yellow brown is obtained, expose for thirty minutes in a camera. XII, 357-358

B. Class Discussions:

1. Glass is perfectly transparent. II, 108-109
2. George Eastman made modern photography possible. XII, 361-366
3. Daguerre invented the first camera. XII, 356-361

C. Pupil Reports:

1. How light travels. II, 302-304

STUDY GUIDE IN GENERAL

2. The measurement of the speed of light. II, 303-305
3. How we see colored objects. II, 99-100
4. The colors of the sun. II, 74, 115-116, 255
5. Why the sky is blue. II, 98-99, 102
6. The colors in the sun. II, 51-53
7. Tourmaline, a stone of many colors. III, 238-243
8. How colorless crystals show colors. III, 180-181
9. How photographs are printed for publications. XII, 370-375
10. The chemistry of photography. XII, 356-361
11. The history of photography. XII, 353-375

D. Experiments:

1. Using a glass prism break up a beam of sunlight into its component colors as Newton did. II, 99
2. Place a stick in a glass of water. Observe the appearance of the stick. Draw what you see and explain the observation. II, 115

E. Self-Test Exercises:

TEST I

By rearranging the spelling of the scrambled words, the sentences will make true statements.

1. Over one hundred years ago it was known that light turned VERLIS black. XII, 356
2. The first practical method of photography was perfected by RUGAEDRE. XII, 357-358
3. Sensitized paper photography was invented by BLATTO. XII, 358-359

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4. Before photography, pictures were printed by RAG-INGVEN. XII, 353-356
5. Today, photographs may be printed by a NAYBED screen. XII, 374
6. The colors of the sun are called the sun's STRUM-PEC. II, 74-75
7. The sun spectrum was found by TENNOW. II, 74
8. Plant growth changes with changes in light LAW-NEVGHET. XI, 304-306
9. The colors of the sunset are caused by the FER-RACTION. II, 115-116
10. The quantity of the rays in the sun spectrum changes when the SNOSTUPS change. II, 140

ANSWERS

- | | |
|--------------|---------------|
| 1. silver | 6. spectrum |
| 2. Daguerre | 7. Newton |
| 3. Talbot | 8. wavelength |
| 4. engraving | 9. refraction |
| 5. Ben Day | 10. sun-spots |

TEST II

In order to make the following sentences complete, fill in the missing words.

1. As a star cools, its _____ changes. VII, 7-8
2. The different colors of Neon signs are obtained by using different _____. XII, 50-51
3. The Eskimo used _____ ice for a window. IV, 42

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4. The sepia used by artists comes from a _____.
X, 335
5. Colored photographs are made by using separate negatives for each _____. XII, 369-373
6. The color of transparent gems is heightened by _____. III, 181
7. Diamonds may be found in black, blue, clear and _____ colors. III, 191
8. The different colors of gems are formed by different _____. III, 179
9. The speed of light is _____. II, 303
10. Images seen in mirrors seem to be _____ the distance from a person. II, 308

ANSWERS

1. color
2. gases
3. fresh water
4. squid
5. primary color
6. dispersion
7. yellow
8. chemicals
9. approximately 186,000 miles per second
10. twice

UNIT XVII

MAN'S USE AND CONTROL OF
ELECTRICAL ENERGY

A. How Magnets Push And Pull:

1. What is the shape of the magnetic field about the poles of a horseshoe magnet? XII, 20-21
2. What does a piece of iron between the poles of a horseshoe magnet do to its magnetic field? XII, 20-21
3. Who discovered that a wire with current passing through it behaved like a magnet? XII, 1-2
4. Which two men invented the electromagnet? XII, 3-4
5. Which metals are attracted by magnets? XII, 9
6. Who first used the idea of "lines of force" in connection with electromagnets? XII, 20
7. How was Faraday's galvanometer constructed? XII, 9
8. What is the relation of electricity to the poles of a magnet? XII, 15
9. How is an ultra-sensitive galvanometer assembled? II, 80

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10. Why are opposing sets of magnets used in the bolometer galvanometer? II, 80
11. What happens to compasses during outbursts on the sun's surface? II, 260-261
12. What is a gyro-compass? XII, 190
13. How does a gyro-compass maintain true north? XII, 190
14. How does a gyro-compass control the steering of a ship? XII, 190-191
15. How is the steel of a ship prevented from affecting the compass? XII, 190

B. Electricity from Chemical Action:

1. What are electrons and protons? VII, 5
2. Who was one of the first men to use electric current for chemical decomposition? XII, 4
3. How is the production and quality of electroplated copper increased? XII, 136
4. How is electric current used in photoengraving? XII, 367
5. What was the name of Volta's first battery? XII, 2
6. What application of the chemical action of electric current was made in early electrical signaling? XII, 79

C. Electricity from Moving Magnets:

1. Who was Michael Faraday? XII, 4-5
2. What observation of Arago led Faraday to his famous experiment? XII, 13

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3. What relationship of magnetism to electricity was discovered by Henry and Faraday? XII, 10
4. What is a galvanometer? XII, 7-9
5. How is electric current obtained from magnets? XII, 21
6. What was Faraday's first dynamo? XII, 14
7. When was the electromagnetic field first used for dynamos? XII, 19
8. What was the earliest type of practical armature winding? XII, 20
9. Who invented the commutator? XII, 18
10. Why are electromagnet cores laminated? XII, 19
11. How did Edison change the dynamo? XII, 143
12. What determines the number of field poles of an alternator? XII, 40
13. How are the field magnets of an alternator excited? XII, 30
14. Who was the first man to see that brushes and a commutator were unnecessary to procure electric current? XII, 31
15. What are the advantages of the AC dynamo? VII, 37
16. How is current produced in an alternator? XII, 39-40
17. What was the first large AC installation? XII, 36
18. When was the three-phase dynamo invented? XII, 29

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19. How are modern high power dynamos wound? XII, 26
20. What is the difference between the AC and DC dynamo? XII, 22
21. What is the difference between radio and electric alternators? XII, 41, 47
22. Why is the alternator simpler than the DC dynamo? XII, 40
23. What is the importance of the steam turbine to the electrical industry? XII, 169-170
24. Why is the alternator especially suited to the turbine? XII, 29
25. How much of Niagara Falls water is used to generate electric current? XII, 153
26. How is continuous electric service from Niagara Falls insured? XII, 154
27. How much electricity is made by steam power? XII, 47

D. The Flow of Electricity:

1. Who was Michael Faraday? XII, 4-5
2. What did Faraday prove? XII, 11-16
3. Who was Joseph Henry? XII, 5-7
4. What did Henry prove? XII, 11-16
5. What is a galvanometer? XII, 7-9
6. What relationship of magnetism to electricity was discovered by Henry and Faraday? XII, 10
7. Who gave mathematical definition to electromagnetic phenomena? XII, 20

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8. What is believed to be the condition inside a copper wire? XII, 56, 58
9. How does electric current travel through a wire? XII, 56-57
10. What is the speed of electrical changes? XII, 57
11. What were the objections to alternating current in the eighties? XII, 35
12. What is meant by single-phase, two-phase and three-phase current? XII, 41
13. What retarded the use of AC? XII, 32, 35
14. What AC frequencies are popular in the United States? XII, 40
15. When was the first commercial electric distributing plant constructed? XII, 144
16. How did Edison distribute his current? XII, 144
17. What efficient means of transmission did Edison devise? XII, 143
18. What is the reason for a three-wire system? XII, 143-144
19. Who standardized the 110-volt circuit? XII, 143
20. What is the most efficient method of changing AC to DC? XII, 68-70
21. What is a transformer? XII, 37-38
22. What principles of transformers were discovered by Joseph Henry? XII, 75-77
23. How does a transformer work? XII, 38
24. How can electricity be transferred from one circuit to another without any wire connections? XII, 12

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25. What was the earliest example of a transformer? XII, 12
26. How is voltage controlled by a transformer? XII, 39
27. Why is it more efficient to transmit high voltage low current electricity instead of low voltage high current electricity? XII, 37
28. What is the importance of the transformer in the extensive and inexpensive use of electric current? XII, 35
29. When was the transformer first used to step down AC to the usable level? XII, 27
30. When was the transformer first used for commercial current distribution? XII, 27
31. What was the first great installation of transformer-distributed power? XII, 36

E. Electricity for Light And Heat:

1. What kind of electric light was in use before Edison's incandescent lamp? XII, 28
2. What kinds of lamps were used before electric lights? XII, 135
3. What was the earliest practical use of the arc light? XII, 135
4. What kind of electric lighting was popular for street lights for many years? XII, 145, 147-148
5. What is a flaming arc? XII, 148
6. Why did Edison believe that the arc light was not practical for home use? XII, 138
7. On whose experiments was Edison's lamp based? XII, 35

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8. What was Swan's process for making carbon lamp filaments? XII, 136
9. What was the defect of early incandescent lamps? XII, 135-136
10. What materials did Edison try for a filament? XII, 138-141
11. What were the advantages of Edison's lamp? XII, 140
12. What was the life of an early Edison lamp? XII, 142
13. What replaced Edison's carbonized filaments? XII, 143
14. What was the first practical metal filament? XII, 143
15. What metal is now used as a filament for electric light lamps? XII, 143
16. What are the properties of tungsten? XII, 145
17. Who made tungsten lamps possible? XII, 145-146
18. What are the difficulties of working tungsten? XII, 146-147
19. Who invented the screw base socket? XII, 142
20. Why do modern electric bulbs contain inert gas instead of a vacuum? XII, 147
21. Compare the efficiency of Edison's first lamp with the modern lamp? XII, 142
22. How many incandescent electric lights are in use in the United States? XII, 145
23. How do gases behave in a vacuum? XII, 49
24. When will gases conduct electricity? XII, 49

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25. What use is made of the effect of high voltage on gases? XII, 50
26. What is electric welding? XII, 27
27. Who discovered electric welding? XII, 25
28. Who improved the transformer for lighting and power? XII, 35

F. Doing The Work of The World with Electricity:

1. What kind of electric motor did Henry build? XII, 72-73
2. What is the purpose of supplementary pole pieces on electric motors? XII, 24
3. What makes a direct current motor work? XII, 43
4. How is a DC motor wound? XII, 43-44
5. Who invented the repulsion motor? XII, 29
6. What is the principal of the repulsion motor? XII, 29-30
7. What is a synchronous motor? XII, 46
8. What is a constant speed motor? XII, 45
9. What is a squirrel cage in an electric motor? XII, 45
10. What is the difference between an AC and DC motor? XII, 44-45

Pupil and Class Activities

A. Things To Do:

1. Make a working model of Joseph Henry's first electric motor using copper wire, an iron bar, mercury and two wet cells. See photographs. XII, 72-75
2. Using a horseshoe magnet covered with insulated copper wire, pivot a bar magnet and a bell from an old alarm clock in the manner shown in the diagram. Connect ends of wire to a battery and turn current on and off. XII, 73
3. Using carbons from discarded flashlight cells build simple arc lamps. Connect lamps in series with an electric heater to obtain necessary current. XII, 145
4. Using a Florence flask and a small electric bulb and a wooden base, reconstruct a model of Edison's first lamps. XII, 141
5. Connect a coil which is wound around a compass to various weak sources of electricity. Note the movement of the needle in each case. XII, 9
6. Construct a sensitive galvanometer from copper wire and twelve sewing needles following the diagram and instructions. VII, 80-82
7. Using an iron ring and copper wire make a transformer according to Michael Faraday's instructions. XII, 12

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8. Take a dead dry cell apart. Heat the carbon rod until all wax is burned off. Clean and scrape a piece of zinc cut from the cup. Place both in a strong solution of salammoniac. Connect to a bell or small electric flashlight bulb. Discuss the energy changes.
9. Wind two layers of cotton-covered copper wire around a nail. Connect to a dry cell. Place near some small pieces of steel or iron.
10. Wind a coil of wire around a thin cardboard tube. Place a large nail in the tube. Connect the ends of the coil to a battery and switch. Cause the nail to jump up and down by turning the current on and off.
11. Make a model of a simple polyphase dynamo using the photograph shown. XII, 29
12. Make a large model of a dynamo using two large bar magnets, a thick wire, two metal strips and two metal rings. Follow diagram. XII, 22
13. Using an old toy electric motor reconstruct it into a Jumbo Edison dynamo using long iron electromagnets. Follow the photographs. XII, 144

B. Class Discussions:

1. Faraday was the first to discover magnetic induction. XII, 5-16, 72-78
2. The American telegraph is inferior to the European telegraph. XII, 78-89
3. Morse invented the electric telegraph. XII, 80-99
4. The DC motor is superior to the AC motor. XII, 42-46

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5. AC is better than DC for magnets. XII, 37-40
6. Arago discovered the electromagnet. XII, 9-10
7. The sun affects the earth's magnetism. II, 259-261
8. Inventions are the work of one man. Consult XII
9. Edison invented the first electric light. XII, 135-146
10. Arc lights are the best form of illumination. XII, 133-148
11. What are the merits of AC and DC? XII, 35-36
12. Electric wires carry electric current the way a water pipe carries water. XII, 56-58
13. Elihu Thomson's main contribution is the construction of machines. XII, 25-34

C. Pupil Reports:

1. The major discoveries of Michael Faraday. XII, 4-16
2. Early types of telegraph systems. XII, 84-89
3. The major discoveries of Joseph Henry. XII, 72-78
4. The work of Hans Christian Oersted. XII, 1-2
5. The obstacles which were overcome in setting up the Atlantic cable. XII, 87-98
6. Visit a neon sign factory.
7. How the different colors of neon signs are made. III, 50-51, 70
8. The operation of transformers. XII, 38-39
9. A comparison in the construction of AC and DC dynamos. XII, 40-50

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D. Experiments:

1. Suspend a bar magnet. Hold another bar magnet near the first. As the magnet spins keep changing the poles of the magnet in your hand.
2. Pass the poles of a magnet through a sheet of paper and sprinkle iron filings out and around the poles. Tap the paper. Study the outline of the iron filings. XII, 20
3. Connect a battery, sending key, condenser and galvanometer in the circuit shown on page 98, volume XII. Observe the effect on the galvanometer as you operate the sending key. XII, 98
4. Place a compass needle under a thick wire through which a strong DC current is passing. Observe the action of the needle. Vary the strength of the current. Note the effect on the movement of the needle. XII, 7-8
5. Place a coil in which current is flowing near the pole of an active electromagnet. Observe what the coil does. Place the other side of the coil near the magnet. This movement is the action of a repulsion motor. A diagram will be found on page 29, XII.
6. Build a horseshoe electromagnet similar to Joseph Henry's. See how many pounds your magnet can pick up. XII, 72
7. Connect a coil of wire to a battery. Note the amount of iron filings which will be attracted. Place an iron core inside the coil and measure the effect again. XII, 10
8. Using some square iron bars wind two coils of different sizes on the iron core. Apply low volt-

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age AC to the small coil. Measure the effect on the above coil. Apply low voltage AC to the large coil. Note the effect on current obtained from the small coil. Consult diagram. XII, 38

9. Connect a coil of wire to a flashlight bulb and place in a jar of water. Bring the pole of a powerful electromagnet, which is energized by AC, near the coil. You will see the effect of a transformer and of a repulsion motor. XII, 30
10. Make a galvanometer following Michael Faraday's directions. XII, 9
11. Produce induced current by connecting a coil to 200 turns of fine wire around a compass. Move a magnet near the coil.

E. Excursions:

1. Visit a storage battery repair shop.
2. Visit an electric bulb factory.
3. Examine your school's electric wiring system.
4. Visit your local electric power house to see the dynamos.

F. Self-Test Exercises:

TEST I

Fill in the missing words to make a true statement.

1. When current flows through a wire, the wire behaves like a _____. XII, 2
2. Induction in long wires was discovered by _____
_____. XII, 74-76
3. When a magnet moves near a coil of wire, electric current is _____. XII, 12-15

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4. AC voltage can be stepped up or down by using _____ . XII, 37-38
5. Most dynamos are driven by the energy obtained from _____ . XII, 150-151
6. The inventor of electric arc welding was _____ . XII, 27-28
7. The electric light bulb does not contain _____ . XII, 140
8. The principal parts of an electric motor are the commutator and brushes, the field magnet and _____ . XII, 43
9. The earliest means of measuring the flow of electric current was _____ . XII, 9
10. High power alternators have magnetic fields which _____ . XII, 41, Plate 14

ANSWERS

- | | |
|-----------------|---------------------|
| 1. magnet | 6. Thomson |
| 2. Henry | 7. air |
| 3. induced | 8. armature |
| 4. transformers | 9. the galvanometer |
| 5. combustion | 10. rotate |

TEST II

The letters in one or two words of each of the following sentences are jumbled. If you re-arrange the letters, you will find that it spells a word which makes the sentence true.

1. The electromagnet was discovered by Davy and ROAGO. XII, 1
2. Magnets attract metals made of LETES AND NIOR. XII, 9

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3. Opposing sets of magnets are used in very sensitive galvanometers to offset the earth's ASTIGMENM. II, 80
4. The quality of electroplated copper is improved by using TAGLEINE. XII, 136
5. Electricity was first obtained from magnets by DAFRAYA. XII, 4-11
6. Edison dynamos were called BOJUMS. XII, 144, Plate 42
7. The number of field poles of a dynamo is determined by the DEPES. XII, 40
8. The man who did away with brushes and commutators on dynamos was LESAT. XII, 31
9. Modern electric power transmission is made possible by the use of TORNFARMERSS. XII, 38
10. Electric lights in use before Edison were electric SRAC. XII, 28

ANSWERS

- | | |
|-------------------|-----------------|
| 1. Arago | 6. jumbos |
| 2. steel and iron | 7. speed |
| 3. magnetism | 8. Tesla |
| 4. gelatine | 9. transformers |
| 5. Faraday | 10. arcs |



UNIT XVIII

ENERGY FOR COMMUNICATION

A. The Telegraph:

1. What means of electrical signalling existed before the telegraph? XII, 79
2. How did Henry make a telegraph in 1831? XII, 73
3. Upon whose work is the English telegraph system based? XII, 79-80
4. What was the first commercial telegraph? XII, 78-79
5. What type of system was Morse's telegraph? XII, 80
6. What is the difference between Morse's telegraph and the popular sounder and key? XII, 81, 85
7. How did Morse's telegraph record messages? XII, 81, 84-85
8. What was the first long distance telegraph message in the United States? XII, 81
9. Between which cities was the first telegraph line operated in the United States? XII, 81

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10. What was the principle of Morse's telegraph? XII, 81
11. Who invented the relay? XII, 81-82
12. What is the Wheatstone bridge method of telegraphy? XII, 82
13. What were Edison's contributions to telegraphy? XII, 137-138
14. How does the modern printing telegraph operate? XII, 89
15. When did the telegraph sounder supersede Morse's recording telegraph? XII, 86
16. How is the cost of wire reduced in telegraphy? XII, 86
17. How does duplex telegraphy operate? XII, 87
18. How is multiplex telegraphy maintained? XII, 88
19. What was the effect of the great length of the Atlantic cable? XII, 90
20. How does electrostatic capacity accumulate in a cable? XII, 91
21. How are earth currents induced in a cable? XII, 91
22. When was the first Atlantic cable laid? XII, 93
23. What caused the first cable to break down? XII, 96
24. How was electrostatic discharge overcome? XII, 97
25. What instrument replaced the sounder in cable operations? XII, 98

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26. How are earth-induced currents prevented in the cable? XII, 98
27. Why was the first Atlantic cable slow? XII, 98
28. How did Edison get his start in the field of electricity? XII, 137
29. What was Edison's first practical invention? XII, 137-138

B. The Telephone:

1. Who invented the telephone? XII, 99
2. What was Bell working on when he discovered the telephone? XII, 101
3. What was Bell's first telephone? XII, 102
4. How did Bell's telephone operate? XII, 104-105
5. When did Bell's telephone attract attention? XII, 108
6. What was the difference between Gray's and Bell's telephones? XII, 106-107
7. What makes modern long distance telephony possible? XII, 112
8. Which two men invented the microphone? XII, 109
9. What is the purpose of the loading coil in the telephone? XII, 111-112
10. How does the modern telephone operate? XII, 110-111
11. How are we able to telephone to Europe? XII, 113-114

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12. How many wires are enclosed in a telephone cable? XII, 111
13. How much telephone wire is in use in the United States? XII, 111
14. What is permalloy? XII, 111-112

C. *Radio:*

1. Who foreshadowed wireless and radio? XII, 78
2. When was radio prophesied? XII, 78
3. Why is induction not suitable for long distance communication? XII, 116
4. Why is it impossible to use telephone instruments directly on a radio wave? XII, 114-115
5. What makes radio possible? XII, 121-122
6. Where can magnetic waves travel? XII, 117
7. Who were the men whose inventions made modern radio possible? XII, 135
8. What was the work of Hertz? XII, 128-129
9. What did Branly and Lodge do for early radio? XII, 129
10. What was Marconi's wireless? XII, 129-133
11. What is the relation of radio to light waves? XII, 113-114
12. How is frequency determined? XII, 119-120
13. How is a radio wave started? XII, 116-117
14. How do radio waves travel around the earth? XII, 117
15. What is the Heavyside Layer? XII, 117
16. What is a discontinuous radio wave? XII 117-118

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17. Who perfected the modulation of radio waves with speech? XII, 133
18. What modern transmitter did Marconi perfect? XII, 134
19. Who made the crystal oscillator possible? XII, 133
20. How is the constant frequency of a broadcast station maintained? XII, 127
21. How is a radio wave transmitted? XII, 118, 121
22. How is speech combined with a radio wave? XII, 126
23. What is resonance? XII, 119
24. What is regeneration? XII, 123-124
25. How is regeneration accomplished? XII, 124-127
26. Who invented the radio tube? XII, 60-61
27. What is emitted by heated bodies? XII, 57
28. Why does a hot filament emit electrons? XII, 59
29. Who discovered the principle of the vacuum tube? XII, 58-59
30. What is radiated from the hot cathode of a vacuum tube? XII, 51-52
31. Why is a good vacuum necessary in a radio tube? XII, 61-62
32. What happens in the space of a radio tube? XII, 59
33. What laws do vacuum tubes follow? XII, 63
34. What are the parts of a radio tube? XII, 60
35. Who studied the laws of vacuum tubes? XII, 59

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36. What limits the number of electrons thrown off by the filament of a radio tube? XII, 63
37. What causes some radio tubes to glow? XII, 60
38. What is the purpose of the grid in a radio tube? XII, 60
39. What is the purpose of the plate of a radio tube? XII, 61
40. What was the first practical use of the electron? XII, 54
41. Who perfected the modern radio tube? XII, 133
42. Who perfected the AC radio? XII, 133
43. How are very minute currents measured? XII, 123
44. What is a dielectric? XII, 118
45. What is a condenser? XII, 118
46. Why do the earth and clouds act as a condenser? XII, 118
47. Who invented the radio frequency amplifier? XII, 133
48. Who invented the neutrodyne receiver? XII, 133
49. What is an underground aerial? XII, 133
50. Who developed radio control? XII, 133
51. Who invented the radio direction finder? XII, 133
52. How does a ship determine its position by a radio beam? XII, 191-192
53. How does the quality of radio music compare with the original? XII, 128

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D. X-Rays:

1. What things emit invisible rays? II, 302
2. What is the speed and the wavelength of X-rays? II, 303
3. Why are X-rays called "X?" XII, 65
4. What are X-rays related to? XII, 65
5. How are X-rays produced? XII, 66
6. Which metals are opaque and which are transparent to X-rays? XII, 66
7. How are X-ray effects made visible? XII, 66
8. How do X-rays behave in a magnetic field? XII, 67
9. How do cathode rays differ from X-rays? XII, 67
10. What is the structure of an X-ray tube? XII, 64, 67
11. What is the operating voltage of modern X-ray tubes? XII, 68
12. What is the range of rays beyond X-rays? II, 11

Pupil and Class Activities

A. Things To Do:

1. Make a model of Bell's first telephone. Use two electromagnets and two strips of spring steel. See diagram XII, 102
2. Make a model of Bell's improved working telephone using megaphone, electromagnets and a battery. See pages 103-104. XII
3. Visit an X-ray laboratory.
4. Visit a radio tube factory.
5. Visit your local telephone exchange.

B. Class Discussions:

1. Dr. Lee DeForest invented the radio tube. XII, 58-65
2. Marconi invented all of his apparatus. XII, 128
3. Faraday discovered magnetic induction. XII, 5-13, 74-78
4. The Atlantic cable is simply a telegraph wire under the ocean. XII, 89-99
5. Morse invented the electric telegraph. XII, 72-89
6. The Bell telephone was the only electric telephone. XII, 99-109

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C. *Pupil Reports:*

1. The discovery and application of X-rays. XII, 65-68
2. The rays which exist beyond X-rays. II, 11
3. The operation of vacuum tubes. XII, 59-61
4. The discovery of the radio tube. XII, 58-64
5. The story of Marconi's wireless telegraph. XII, 129-133
6. Men who contributed to Marconi's invention. XII, 128-129
7. Scientists who made modern radio possible. XII, 133-134

D. *Experiments:*

1. Connect the filament of a radio amplifier tube to several dry cells. Connect the plate to the high potential side of an induction coil. Connect the other side of the secondary of the coil to the filament after the filament is hot. Turn on the induction coil. X-rays will be produced in the radio tube. Expose pieces of printing paper or films, covered in lightproof envelopes under the top of the bulb. Develop and fix as in ordinary photography.
2. Connect a telephone transmitter to batteries and an induction coil. Connect the other side of the coil to a receiver. You may run the telephone receiver as far as your wires will let you. XII, 110

E. *Self-Test Exercises:*

TEST I

1. Give a four-letter word for the inventor of the telephone. XII, 99

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2. Give two six-letter words for the inventors of the microphone. XII, 109
3. Give a seven-letter word which describes the coil used for long distance telephone. XII, 111-112
4. Give a five-letter word which describes the method of transmitting trans-oceanic telephone messages. XII, 113-114
5. Give a nine-letter word which describes the metal used in telephone induction and loading coils. XII, 111-112
6. Give a five-letter word for the inventor of the first practical demonstration of energy transmission across space. XII, 128-129
7. Give a seven-letter word which describes the first practical wireless detector. XII, 129
8. Give a four-letter word which shows the relation of light to radio. XII, 113-114
9. Give a ten-letter word which describes the method of impressing speech upon a radio wave. XII, 133
10. Give a seven-letter word and a ten-letter word which describe the method of controlling the frequency of radio broadcast stations. XII, 133

ANSWERS

- | | |
|-------------------|------------------------|
| 1. Bell | 6. Hertz |
| 2. Berlin, Edison | 7. coherer |
| 3. loading | 8. wave |
| 4. radio | 9. modulation |
| 5. permalloy | 10. crystal oscillator |

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TEST II

From the words below, form the names of six men who helped develop the telegraph.

LEEKEH

VINSON

DRIESN

STONY FIELD

MORE WHEAT

References: XII, 73, 79-80, 82, 92, 98, plate 29, 137,
138

ANSWERS

Morse, Henry, Kelvin, Field, Edison, Wheatstone

1871

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UNIT XIX

ENERGY FOR TRANSPORTATION

A. Early Means of Transportation:

1. How did man learn to travel over water? VII, 239-240
2. What was the crudest means of water transportation? VII, 241
3. What were the early water-crafts of man? VII, 276
4. What means of boat propulsion were developed? VII, 277
5. Why are the Egyptians believed to be the inventors of the sail? VII, 298
6. What type of sea craft finally permitted unlimited sea travel? VII, 277-278
7. What means of water travel was used by the Sumatrans? VII, 304
8. How was the Iroquois canoe made? IV, 77-78
9. Which tribes built the biggest canoes? IV, 210
10. What types of boats were used by the Incas? VII, 344
11. Why are boats still given individual names? VII, 241

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12. How did man come to use animals as beasts of burden? VII, 255-256
13. How did the Incas transport objects? VII, 344
14. How old is the wheel? VII, 256
15. What was the religious implication of the wheel? VII, 257
16. What were the earliest uses of the wheeled cart? VII, 257
17. How old is the horse chariot? VII, 288
18. Did the use of the horse precede the use of the horse and wagon? VII, 286
19. What type of carriage was first used? VII, 256
20. When and how was the horse and chariot introduced into Egypt? VII, 300
21. What kind of transportation did the Indus valley people have? VII, 314
22. What means of transportation did the Aryans use? VII, 315
23. How is an Eskimo sled constructed? IV, 45

B. On Land; Railroads and Automobiles:

1. How old are railways? XII, 192
2. What was the first motive power for railways? XII, 192
3. What was the first practical railroad locomotive built in the United States? XII, 192
4. What was the first modern locomotive? XII, 193
5. What is the difference between English "T" rails and United States rails? XII, 193

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6. How is safety promoted in coupling cars? XII, 199-200
7. What was the great aid to the safety of railroad brakes? XII, 33
8. How was electricity used to control air brakes? XII, 196-197
9. How do trains take curves at high speed? XII, 193
10. What was the first gasoline automobile in the United States? XII, 216
11. What type of action is generally found in a gas engine? XII, 172
12. What is the order of events in a four-cycle gas engine? XII, 172
13. What were the earliest commercial gas engines? XII, 171
14. What is a carburetor? XII, 174, 178
15. What is the difference between an automobile engine and a gas engine? XII, 174-175
16. How does gas enter the cylinder of a gas engine? XII, 172
17. What was the Brayton engine? XII, 216
18. What were the defects of using a horse carriage for the automobile? XII, 220
19. Who first applied the gas engine to a vehicle? XII, 215
20. What was the Haynes machine? XII, 220-221
21. Why is more than one cylinder necessary for an automobile? XII, 176

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22. What did Daimler do to the speed and weight of the four-cycle engine? XII, 215
23. What was the first car with equipment arranged in the present way? XII, 215
24. How was power transmitted to the rear wheels in early automobiles? XII, 216
25. How are the rear wheels of a car able to make turns at different speeds? XII, 216
26. What modern devices did the Duryea automobile possess? XII, 219
27. What is a "V" type engine? XII, 176-178
28. Why are "V" type engines used? XII, 179
29. How many cars were produced in the United States in 1930? XII, 224
30. What was the secret of Henry Ford's success? XII, 224

C. On Water; Steamships:

1. When did commercial steamboats begin operation in England? XII, 187
2. Who was the first man to build steamboats in the United States? XII, 181
3. How did Fitch's engine move his steamboat? XII, 181-182, 184
4. Who built the first rotary steam engine? XII, 182
5. What kind of engine did Fitch use? XII, 182
6. What was the mechanical beast? XII, 181
7. What was Fulton's particular skill with the steamboat? XII, 187

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8. Why was Fulton's steamboat a success? XII, 187
9. What was Robert Fulton's profession? XII, 186
10. What was the first large steamboat built for commerce in the United States? XII, 184-185
11. What was the first transatlantic steamer? XII, 188
12. Who first used the screw propeller? XII, 183
13. How was the screw propeller proved more efficient than the paddle wheel? XII, 189
14. What engine in 1870 revolutionized shipping? XII, 189
15. Why was steam able to displace sail? XII, 188
16. Why is Parson's steam turbine best adapted to steamships? XII, 171
17. What are the speed possibilities of a Parson's turbine? XII, 170
18. What is the efficiency of a Parson's turbine? XII, 170
19. What did some people prophesy for iron ships? XII, 189
20. Why does a steel ship float? XII, 190
21. Why was the oared ship a handicap to commerce? VII, 277
22. How long did clipper ships take to travel from England to China? XII, 188
23. What was the disadvantage of clipper ships? XII, 188
24. What was the largest sailing vessel? XII, 189

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25. When were sailing vessels in their prime? XII, 188
26. What modern safety devices are used by steamships? XII, 191-192
27. How does a gyro-compass control the steering of a ship? XII, 190-191
28. What is a gyro-compass? XII, 190
29. How does a gyro-compass maintain a ship's direction? XII, 190
30. How does a ship determine its position in mid-ocean? XII, 191-192

D. In the Air; Airplanes:

1. What is a glider? XII, 225
2. Who were the early American glider flyers? XII, 225
3. Who was the first to fly successfully a heavier-than-air ship? XII, 225
4. How did Langley devise his plane? XII, 225
5. Did Langley's plane ever fly? XII, 227
6. Why did Langley's full size plane fail to fly? XII, 227
7. What was the first successful mechanically driven, heavier-than-air ship? XII, 225-226
8. What improvement to flying did the Wrights contribute? XII, 232
9. What was the power of the first plane of the Wright brothers? XII, 230
10. What was the first gasoline aeroplane engine? XII, 226

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11. What was the first successful flight of a heavier-than-air motor driven passenger plane? XII, 228
12. How is wind resistance reduced? XII, 235-236
13. How are the characteristics of airships and planes tested? XII, 232-233 Plates 81-85
14. How are seaplane pontoons tested? XII, 233, 236
15. How are small models of planes tested to determine the qualities of the full size plane? XII, 232, 236
16. What is a radial engine? XII, 179
17. Which was the first radically different aviation motor? XII, 226-227
18. What is an autogiro? XII, 238

Pupil and Class Activities

A. Things To Do:

1. Build a model of the Wright brothers' plane. XII, 228-229
2. Build rubberband-powered flying models of Langley's plane. XII, 226
3. Make a model of a primitive cart using the round wood bottoms of a bushel basket for wheels. VII, 256-257
4. Construct a model of a Chinese dragon boat from scrap wood. VII, 241
5. Following the model on page 276 build a Caroline Islands outrigger sailing canoe. VII, 276
6. From twigs and skins build a model Indian bull-boat. VII, 276
7. Make a native Brazilian balsa boat from reeds and grasses found in the fields. XII, 185
8. Build a model of a Yurok boat. IV, 188
9. Using the illustration on page 64 make a model of an Eskimo sled. IV
10. Make models of Eskimo kayaks. Use balsa model airplane wood for framework and cover with Japanese tissue. IV, 56
11. Make a model of an Eskimo umiak (sailboat), from wood and cloth. IV, 57

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12. Make a model of Fulton's "Clermont." XII, 184
13. Make a model of Fitch's oar-driven steamboat. XII, 184
14. Make a model of a clipper ship using the photograph on page 188 as a guide. XII
15. Build a wood model of the first steam locomotive train made in the United States. XII, 192
16. Make a wind tunnel from a large can with both ends open. Place an electric fan at one end, suspend suitably sized model planes facing the fan. Make the planes fly by operating the fan. XII, 232

B. Class Discussions:

1. The Wright brothers did not invent the aeroplane. XII, 225-238
2. Selden invented the automobile. XII, 214-225

C. Pupil Reports:

1. The effect of streamlining on speed. XII, 235
2. Methods used to determine the airworthiness of airships and aeroplanes. XII, 232-238
3. The operation of radio beacons for guiding ships at sea. XII, 190-192
4. Early automobiles. XII, 214-225

D. Excursions:

1. Visit a local electric railroad or railway shop or roundhouse.
2. Visit a local auto assembly plant.
3. Visit a local steam locomotive roundhouse.

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E. Self-Test Exercises:

TEST I

Match each item in Column A with the proper item in Column B.

A	B
a. first locomotive in the United States	1. automobile engine XII, 172
b. early internal combustion engine	2. English XII, 193
c. modern steamships	3. gasoline XII, 174, 178
d. "T" rails	4. steamboat XII, 181
e. first modern type automobile	5. Tom Thumb XII, 192, Plate 63
f. four-cycle	6. early automobile XII, 176
g. high speed light-weight automobile engine	7. Brayton XII, 216
h. mechanical beast	8. Parson's turbine XII, 170, 171
i. carburetor	9. Duryea XII, 219
j. one-cylinder	10. Daimler XII, 215

ANSWERS

a—5	f—1
b—7	g—10
c—8	h—4
d—2	i—3
e—9	j—6

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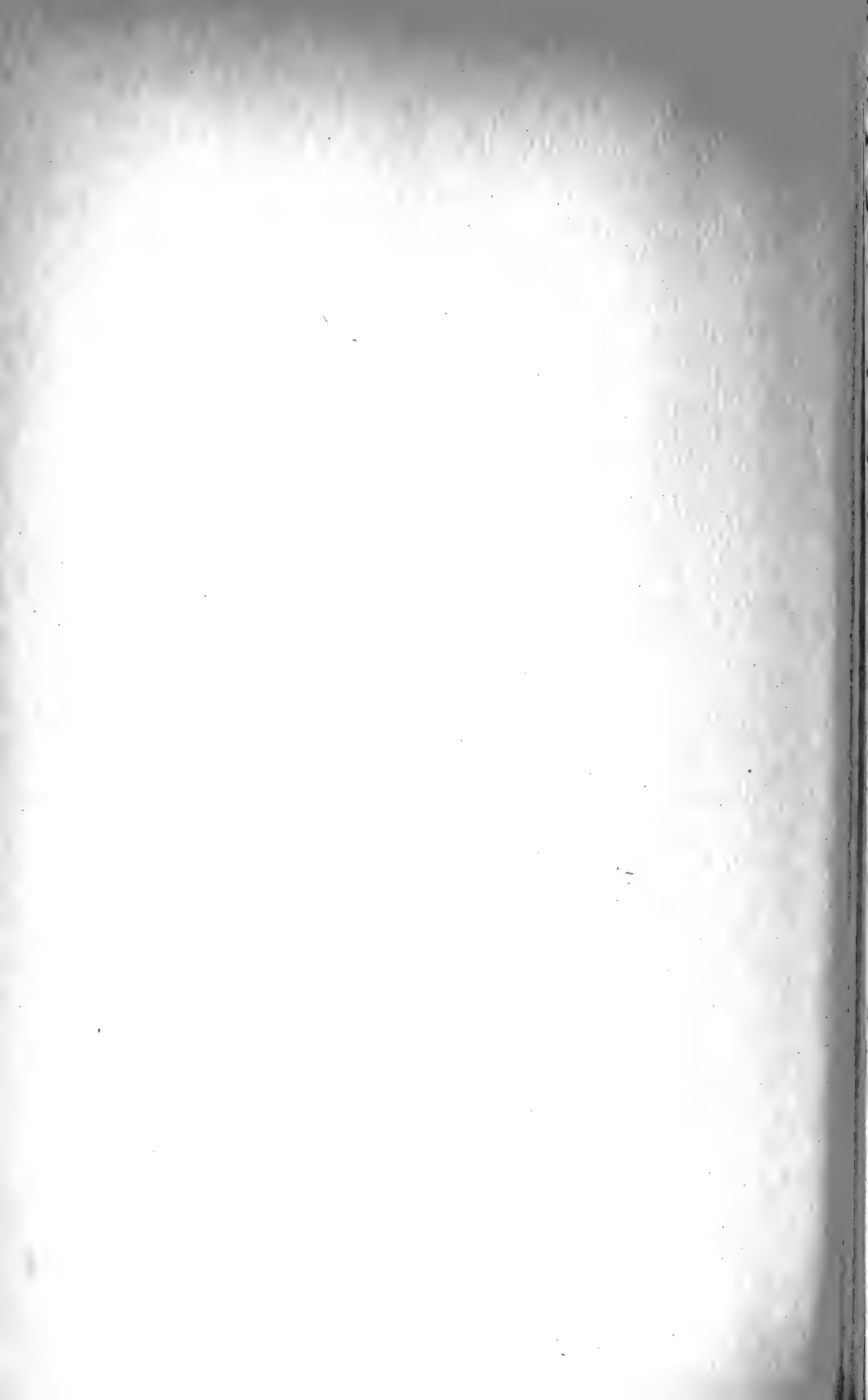
TEST II

If you correctly re-arrange the letters of the jumbled word, the sentence will be true.

1. The first heavier-than-air machines were DRIEGLS. XII, 225
2. First to fly non-passenger, heavier-than-air, motor driven plane was LEYLANG. XII, 225-226
3. The modern plane was first successfully developed by the GRIWTHS. XII, 230
4. The first gasoline airplane engine was the DRIALA type. XII, 226
5. Wind resistance on an airplane is reduced by LOWC-ING. XII, 235-236
6. The characteristics of airships and airplanes are tested in DIWN LUNTENS. XII, 232, plate 81
7. A plane which can rise almost perpendicular to the ground is an GOITRAOU. XII, 238
8. Egyptians are believed to have invented the ALSI. VII, 298
9. The use of the COITHAR preceded the use of saddled horses. VII, 286
10. Before the Middle Stone Age, SHORES were used as food and not for transportation. VII, 255-256

ANSWERS

- | | |
|------------|-----------------|
| 1. gliders | 6. wind tunnels |
| 2. Langley | 7. autogiro |
| 3. Wrights | 8. sail |
| 4. radial | 9. chariot |
| 5. cowling | 10. horses |



UNIT XX

IMPROVED WAYS OF USING MATERIALS

A. Clothing Materials:

1. How are skins softened for use as clothing? IV, 55
2. How do Eskimos make clothes? IV, 50-53
3. What did Indians weave into cloth? IV, 23
4. What was the dress of the upper Caspian period? VII, 229
5. How was clothing sewn in Solutrean times? VII, 209
6. When did needles come into use? VII, 202
7. Who invented the first sewing machine in the United States? XII, 248-249
8. What objection was there to Howe's machine? XII, 252
9. Who made the first sewing machine? XII, 247
10. What were the defects of early sewing machines? XII, 248-249
11. What was the first commercially used sewing machine? XII, 248
12. What is the rotary hook? XII, 259

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13. What improvement was made on the bobbin? XII, 259
14. Who perfected the four-motion feed for cloth? XII, 259
15. How did Singer improve the sewing machine? XII, 256
16. What effect did Eli Whitney's cotton-gin have on the South? XII, 301
17. How does the cotton-gin work? XII, 302-303
18. Who foreshadowed the spinning wheel? XII, 273
19. How is thread made? XII, 267-268
20. What is spinning? XII, 265
21. What was the old way of spinning? XII, 268
22. How does a modern spinner operate? XII, 274
23. What were the weaving fibres in different parts of the world? VII, 262
24. What is the difference between silk and other thread? XII, 267
25. When did the weaving of cloth begin? VII, 261
26. What is weaving? XII, 265
27. How old is the art of weaving? XII, 265-266
28. How do we know the type of loom used in olden times? XII, 269
29. Describe the simplest loom? XII, 266
30. How is weaving performed? XII, 271
31. What are the essentials of a loom? XII, 277-278
32. Describe the African loom? XII, 276

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33. What happened to the earliest attempt at mechanical weaving? XII, 299
34. Who invented the fly shuttle? XII, 299
35. Who established the first power weaving mill? XII, 300
36. How are patterns woven? XII, 281-286
37. What is a heddle? XII, 272, 279-280
38. Why did a drawboy fork become necessary? XII, 287-289
39. What is Jacquard weaving? XII, 290-298

B. Building Materials:

1. How is an igloo built? IV, 40
2. How is the Kwakiutl house built? IV, 209
3. Name some uses of bamboo? XI, 229
4. How are brooms made? XI, 229-230
5. How did the Chippewas use matting in building? IV, 72
6. What was a common Indian building material? IV, 73
7. Which people built extensively with stone? VII, 297
8. Which mineral stones are used as building materials? III, 280-282

C. Metals:

1. When did man know nothing of metals? VII, 42
2. How did prehistoric man in Ohio use meteoric iron? III, 104-105
3. How were metal nuggets first used? VII, 24

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4. What kind of metal work was done by Neolithic man? VII, 265
5. What use was made of meteoric iron in Mexico? III, 100-101
6. How was meteoric iron used in the United States? III, 100-101
7. What uses have been made of meteoric iron? III, 100-101
8. What use was made of meteoric iron in Greenland? III, 100-101
9. When did the use of metals begin? VII, 167
10. How did the Mayans use gold and copper? VII, 334
11. When did the Hopis become silversmiths? IV, 138
12. What metals did Indians work before the coming of white man? IV, 21-22
13. Why was copper the first metal used by man? VII, 266
14. How did the Bronze Age replace the New Stone Age? VII, 267
15. Why was not gold a practical metal in the Bronze Age? VII, 266
16. What was the true basis of the Bronze Age? VII, 268
17. How did bronze-making occur? VII, 268
18. Where was early metallurgy practiced? VII, 266
19. What was the form of the earliest bronze instruments? VII, 269

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20. Why was bronze better than iron for battle axes? VII, 306
21. What is the lost wax process of casting? VII, 269-270
22. Why is not all meteor iron usable? III, 104-105
23. How was iron made in ancient times? XII, 338
24. When did iron come into use in different parts of the world? VII, 41
25. How long has iron been in use? VII, 41
26. Where does most of the iron ore come from? XII, 337
27. What is the effect of the presence of carbon or sulphur in iron? XII, 342
28. How is iron made today? XII, 338
29. How does a blast furnace operate? XII, 340-341
30. When did the steel age begin? VII, 41
31. What is the difference between steel and iron? XII, 336-337
32. Who invented the Bessemer process? XII, 342
33. When is the Bessemer process impractical? XII, 345
34. How does an iron converter operate? XII, 342-344
35. What are the raw materials and products of the blast furnace? XII, 338-339
36. What is a reverberatory furnace? XII, 346
37. What is the open hearth process? XII, 346-347
38. How is high-grade steel made? XII, 346, 348

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39. How is steel shaped? XII, 348
40. What are the by-products of coke? XII, 338

D. Writing Materials:

1. When was paper discovered? XII, 312
2. How was paper made by hand? XII, 313-314
3. How much paper is consumed in one year in the United States? XII, 309
4. What materials are used in paper-making? XII, 313
5. How is paper made by machine? XII, 314
6. What was the Mayan writing material? VII, 332, 334
7. What determines the deterioration of paper? XII, 315
8. What material did western Indians use to carry the written story of their exploits? IV, 167

E. Gems And Precious Stones:

I. NATURE OF CRYSTALS:

1. What is the difference between minerals and rocks? III, 279-280
2. What gives a mineral a gem value? III, 170
3. How many minerals are used as gems? XII, 171
4. What determines a gem's beauty? III, 178
5. How many mineral species are there? III, 170-171
6. How are natural stones distinguished from synthetic stones? III, 177

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7. How did minerals get their names? III, 188-189
8. What is the significance of the "ite" ending in a mineral name? III, 188
9. What are some shapes and kinds of crystals? III, 172
10. What determines the shape of a crystal? III, 173
11. What will happen to almost all minerals if allowed to grow without interference? III, 172
12. What size can crystals become? III, 172-173
13. What is the largest crystal? III, 173
14. What is the smallest number of faces a crystal may have? III, 173
15. According to which factors do most crystals arrange their faces? III, 174
16. Which minerals have more than one crystalline shape? III, 174
17. What is constant in any crystal? III, 172
18. What spoils crystal transparency? III, 176
19. What is dispersion in gems? III, 181
20. How does refraction affect gems? III, 181
21. What causes variations in shade of color in a crystal? III, 179-180
22. In which gems is the cause of color still doubtful? III, 179
23. What important property of a gem is measured scientifically? VII, 183
24. What crystal does earth water produce? III, 175
25. Which minerals form without water? III, 175

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26. How do crystals form naturally? III, 174
 27. How do the different colors of gems form? III, 178-179
 28. What colors are imparted to gems by different elements? III, 179
 29. What common metals are the basis for different garnets? III, 244
 30. What is the importance of hardness in gem value? III, 182
 31. What are volcanic pipes? III, 196
 32. What forms in volcanic pipes? III, 196
 33. What are the physical properties of a diamond? III, 190
 34. What is a synthetic gem? III, 289
 35. Which gems are made commercially? III, 289
 36. What is mineral hardness? III, 182
 37. How hard must minerals be to resist wear? III, 182-183
2. PRECIOUS STONES:
1. What is the name of the gems of the beryl group? III, 210
 2. What is the color of beryl? III, 210-211
 3. Where are diamonds found in the United States? III, 199-200
 4. How long has the diamond been known? III, 190
 5. To which minerals is diamond related? III, 191
 6. What is the original matrix of diamonds? III, 193-194

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7. Where are diamonds found? III, 191-195
8. What is the geology of the area where diamonds are found in the United States? III, 207
9. How are diamonds mined? III, 193
10. How is the value of a diamond estimated? III, 191
11. What are the colors of diamonds? III, 191
12. What kind of diamond emits the best colors? III, 191
13. What is a black diamond? III, 191
14. Who made the first synthetic diamonds? III, 289
15. How big are artificial diamonds? III, 289
16. Who considered diamonds as poisonous as arsenic? III, 203
17. What is the crystalline shape of emeralds and beryls? III, 211
18. Where are emeralds found? III, 211
19. What is the composition of emeralds and beryls? III, 210
20. What makes emeralds and beryls valuable? III, 210
21. What kind of emerald is the rarest gem? III, 212
22. What is mistaken for emeralds? III, 213-214
23. In what kind of stone are rubies found? III, 204-205
24. What is the relation of spinel to ruby? III, 204

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25. What minerals are both ruby and sapphire? III, 203
 26. Where are rubies found? III, 204-205
 27. What may cause the color difference between ruby and sapphire? III, 203
 28. Where are sapphires found in the United States? III, 207
 29. How does the sapphire mineral occur? III, 208
 30. What is a star or cat's eye sapphire? III, 203
 31. How hard is a sapphire? III, 203
 32. What is the primitive method of mining rubies and sapphires? III, 206
 33. Where are sapphires found? III, 205-206
3. WELL-KNOWN SEMI-PRECIOUS STONES:
1. What is amber? III, 267
 2. What is the appearance of amber? III, 268
 3. What was the Greek name for amber? III, 267
 4. How long has amber been known? III, 257
 5. When did amber form? III, 268
 6. What fossils are found in amber? III, 268
 7. Where is amber found? III, 268-269
 8. How is amber mined? III, 268-269
 9. How can true amber be detected? III, 267
 10. How is amethyst formed? III, 227
 11. Where is amethyst found? III, 227
 12. What causes the color of amethyst? III, 226
 13. How is amethyst mined? III, 227

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14. How are garnets formed? III, 244-245
15. Where are garnets found? III, 245-246
16. Where are garnets found in the United States?
III, 245-246
17. What are the colors of garnets? III, 244
18. How hard is garnet? III, 244
19. What is the solubility of garnets? III, 245
20. In what rock is jade found? III, 255
21. Where is jade obtained? III, 255-256
22. What is the difference between Chinese and
Mexican jade? III, 255
23. What is lapis lazuli? III, 260
24. Where is lapis lazuli found? III, 261
25. How is lapis lazuli formed III, 260
26. What is the color of lapis? III, 260
27. How is opal formed? III, 232
28. Where are gem opals obtained? III, 232-234
29. What is the composition of opal? III, 231-232
30. What kind of opal is a gem mineral? III, 232
31. How is opal formed? III, 232, 234
32. What is the color of opal? III, 233
33. How hard is opal? III, 232
34. How valuable is opal? III, 232
35. Where are pearls found in North and South
America? III, 221
36. Where are pearls found in the United States?
III, 221
37. What is an abalone pearl? III, 222

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38. How is topaz formed? III, 236
 39. Where is topaz found? III, 236-237
 40. Where is topaz found in the United States? III, 237
 41. Where did topaz get its name? III, 235
 42. What are the colors of topaz? III, 236
 43. How is pink topaz obtained? III, 237
 44. How hard is topaz? III, 235
 45. Where is tourmaline found? III, 239-240
 46. How long has tourmaline been known? III, 239
 47. In which colors do tourmalines form? III, 239
 48. For which gem is tourmaline sometimes mistaken? III, 240
 49. How is turquoise formed? III, 257
 50. Where is turquoise found? III, 257
 51. How long has turquoise been used? III, 258
 52. What is the color of turquoise? III, 257-259
 53. Where is zircon found? III, 253-254
 54. What is the crystal shape of zircon? III, 253
 55. What is the color of zircon? III, 253
4. UNCOMMON SEMI-PRECIOUS STONES:
1. What is the color of malachite and azurite? III, 276
 2. In what kind of rock is benitoite found? III, 252-253
 3. Where is benitoite found? III, 252-253
 4. What is the color of benitoite? III, 252-253

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5. Where is chrysoberyl found? III, 247-248
6. What is chrysoberyl made of? III, 247
7. What is the color of chrysoberyl? III, 247
8. Where is chrysolite found? III, 249-250
9. Where is chrysolite found in the United States? III, 250
10. What is the composition of chrysolite? III, 249
11. Why is cyanite not used for gems? III, 275
12. Where is euclase found? III, 273
13. What is a cultured pearl? III, 224
14. What is phenocite? III, 274
15. What is rhodonite? III, 274
16. Where is rhodonite found? III, 274
17. What are the uses of rhodonite? III, 274
18. Where is sodalite found? III, 262
19. In what kind of rock is spodumene found? III, 251
20. Where is spodumene found? III, 250-252
21. What is spodumene made of? III, 250
22. What is the color of spodumene? III, 250
23. What is staurolite? III, 278
24. How and where is staurolite found? III, 278
25. Where is titanite found? III, 273
26. Why is titanite not used in place of diamonds although it is the more brilliant? III, 273
27. What is the difference between turquoise and variscite? III, 260
28. Where is variscite found? III, 259

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29. What is the color of variscite? III, 259
 30. What is vesuvianite? III, 274
 31. For which gem is vesuvianite sometimes substituted? III, 274
5. ORNAMENTAL STONES:
1. Where does most agate come from? III, 229
 2. What common semi-precious stones belong to the class of agates? III, 230
 3. How did the stripes of agate form? III, 228
 4. What is moss or landscape agate? III, 229
 5. What is basalt? III, 287-288
 6. What is calcite? III, 276
 7. What crystal forms does calcite take? III, 276
 8. What is chalcedony? III, 228
 9. What are the colors of coral? III, 270-271
 10. What is the use of non-gem corundum? III, 204
 11. Is all corundum usable for gems? III, 204
 12. Where is feldspar found? III, 263
 13. Where is feldspar found in the United States? III, 263-264
 14. What are the different kinds of feldspars? III, 262
 15. What is the composition of feldspars? III, 262
 16. What are the colors of feldspars? III, 262, 264
 17. What is granite? III, 287
 18. Where is granite found? III, 286-287
 19. Where is hematite found? III, 279

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20. What is a Herkimer diamond? III, 225
21. What is jet? III, 270
22. Where is marble found? III, 281
23. What is the difference between foreign and American marble? III, 282-283
24. What is the difference between limestone and marble? III, 280
25. What is obsidian? III, 287
26. How was obsidian used? III, 287
27. What is onyx? III, 228
28. What is Mexican onyx? III, 282
29. What is porphyry? Where is it found? III, 287
30. What are pyrites? III, 278
31. What is "fool's gold?" III, 278
32. How prevalent is quartz? III, 224
33. How does quartz occur? III, 224-225
34. With which metallic ore is quartz associated? III, 225-226
35. What is the crystalline structure of quartz? III, 224-225
36. What is the composition of quartz? III, 224
37. What are the names of quartz gems? III, 225
38. What gems are made from quartz? III, 227
39. Where is clear quartz found? III, 225-226
40. What is the importance of clear quartz? III, 226-227
41. What kind of rock contains gem quartz? III, 225

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42. What is serpentine? III, 284
 43. Where is serpentine found? III, 284
 44. When is serpentine used as a substitute for jade?
III, 285
 45. What is sodalite? III, 262
6. HOW GEMS ARE CUT:
1. What determines the line of cleavage in minerals? III, 181
 2. What kind of gem carving is the most artistic?
III, 314
 3. Which crystals cleave into smooth even sections?
III, 181
 4. What natural property of crystals is taken into
consideration in cutting? III, 180
 5. Which two factors of light are studied in cutting
a stone? III, 306-307
 6. Which crystals do not cleave smoothly? III, 181
 7. How is a diamond cut? III, 182
 8. What determines how a stone will be cut? III,
306
 9. Why are most stones cut differently? III, 306
 10. What is the brilliant cut? III, 308-309
 11. What are the names of the parts of the brilliant
cut? III, 308
 12. What are the perfect proportions of a brilliant
cut diamond? III, 309
 13. When is the half brilliant cut used? III, 310
 14. What is the double brilliant cut? III, 310

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15. What is the trap brilliant cut? III, 311
 16. Which stones are brilliant cut? III, 309
 17. What are the cameo and intaglio cut? III, 314
 18. What is the cabochon cut? III, 314
 19. What is the rose cut? III, 312
 20. What is the star cut? III, 311-312
 21. What is the step brilliant or mixed cut? III, 313
 22. What is the table cut? III, 314
 23. What is the trap or step cut? III, 313
 24. Why are cut stones so much smaller than the original? III, 307
 25. What is facetting? III, 306
 26. Which cuts are bounded by plane surfaces? III, 308
 27. What are the styles of cutting stones? III, 308
 28. Which cuts are bounded by curved surfaces? III, 308
 29. Which cut is bounded by curved and plane surfaces? III, 308
7. GEMS IN HISTORY:
1. What gems are mentioned in the Bible? III, 316, 319
 2. What stones stood for each tribe of Israel in the Bible? III, 316-317
 3. What are the so-called magical properties of gems? III, 183-185
 4. Who were the early mineralogists? III, 295-296
 5. Which people perfected the working of jade? III, 254-255

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6. What is a gem collector? III, 291
7. What must a true collector know? III, 292
8. What is the importance of a mineral collection? III, 292
9. What was the first public mineral collection in the United States? III, 290, 295
10. Where are the great gem collections housed? III, 294
11. What gem minerals have become commercially and scientifically important? III, 293-294
12. What is the Canfield collection? III, 300
13. Who was Doctor King? III, 304
14. What is the Lea collection? III, 297
15. What is the Roebling collection? III, 297
16. Who was Professor Shepard? III, 301
17. What has become of most of the great mineral collections? III, 296
18. How did Congress enable the National Museum to build up its collections of minerals? III, 295

Pupil and Class Activities

A. Things To Do:

1. Make models in soap of the important types of gem cuts. III, 302-314
2. Polish bright colored stones found in river beds.
3. Make a collection of the rocks and minerals native to your locality.
4. Make a collection of colored glass chips which approximate the colored gem photos shown in III, 210, 224, 232, 238, 242, 246, 250, 264, 272, 274, 276, 286.
5. Make a Peruvian knot-writing record from some old rope. VII, 345
6. Make a cross-section model of a Bessemer converter by consulting the diagram. XII, 343
7. Make some glass by melting a small quantity of pulverized limestone and sand in the flame of a blowtorch or blowpipe. XII, 323
8. Build a Creek log-house from straight twigs. IV, 288
9. Build models of Swiss lake dwellings using twigs. VII, 264
10. Make a miniature spinning wheel and use it to spin some thread from cotton. XII, 273
11. Make an Indian loom from sticks and cord. Weave a piece of cloth. VII, 264; XII, 276

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12. Build a model of the earliest known loom from sticks and cord. Weave a small piece of cloth. XII, 266

B. Class Discussions:

1. All jade is genuine. III, 254-256
2. Opals are unlucky stones. III, 231-235
3. Quartz has no value other than its use as a building stone. III, 224-230
4. Culture pearls are as good as natural pearls. III, 217-224
5. Emeralds are the most beautiful of the large gems? III, 210-217
6. Since diamonds are pure carbon, they are not worth the values assigned to them. III, 190-203
7. Gems possess magical properties. III, 183-189
8. We could easily do without paper. XII, 312-315
9. The weaving of cloth is a modern art. XII, 265-300
10. Singer invented the sewing machine. XII, 247-264
11. Weaving is a modern process. VII, 261-264

C. Pupil Reports:

1. The cutting of gems. III, 306-315
2. Little known gems. III, 247-254, 272-278
3. Minerals used for decoration. III, 280-288
4. Sources of diamonds. III, 191-202
5. History of rubies. III, 203-210
6. The hardness of gems. III, 182

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7. The process of making paper. XII, 312-314
8. The development of writing. VII, 288-293
9. The weaving of intricate patterns. XII, 278-300
10. Inventors and improvers of the sewing machine. XII, 247-264

D. Excursions:

1. Visit your natural history museum to inspect gems and rocks.
2. Visit such local mines as coal, iron, copper and report to your class.
3. Visit a local iron works.
4. Visit a rubber factory.
5. Visit a sewing machine factory or store. Observe the operation of the parts.
6. Visit a local textile weaving mill.
7. Visit a local dyeing and dry cleaning plant.

E. Self-Test Exercises:

TEST I

Choose the answer which properly completes the sentence in each question.

1. Eskimos softened skins by (a) rubbing (b) chewing (c) pounding. IV, 55
2. Needles came into use during the (a) Bronze Age (b) Iron Age (c) Old Stone Age. VII, 202
3. The first sewing machine in the United States was invented by (a) Hunt (b) Howe (c) Singer. XII, 248-249
4. The main defect of early sewing machines was (a) too expensive (b) difficult to operate (c) continuous work was not possible. XII, 248-249

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5. Thread is made by (a) spinning (b) weaving (c) the cotton-gin. XII, 267-268

6. Men began to weave cloth in the (a) Old Stone Age (b) New Stone Age (c) Middle Stone Age. VII, 261

7. Paper has been known since (a) 5000 B.C. (b) 1432 A.D. (c) 200 B.C. XII, 312

8. Iron came into use (a) in Europe (b) and immediately replaced bronze (c) gradually in different parts of the Old World. VII, 41

9. Most iron ore in the United States comes from (a) Pennsylvania (b) Alabama (c) Mesabi range. XII, 337

10. The use of steel in place of iron was first brought about by the (a) open hearth furnace (b) Bessemer converter (c) crucible process. XII, 342-345

ANSWERS

1—b	6—b
2—c	7—c
3—a	8—c
4—c	9—c
5—a	10—b

TEST II

Match each item in Column A with the proper item in Column B.

A	B
a. hydrocarbon	1. gypsum
b. silicates	2. diamond, gold
c. sulphates	3. quartz
d. phosphates	4. calcite

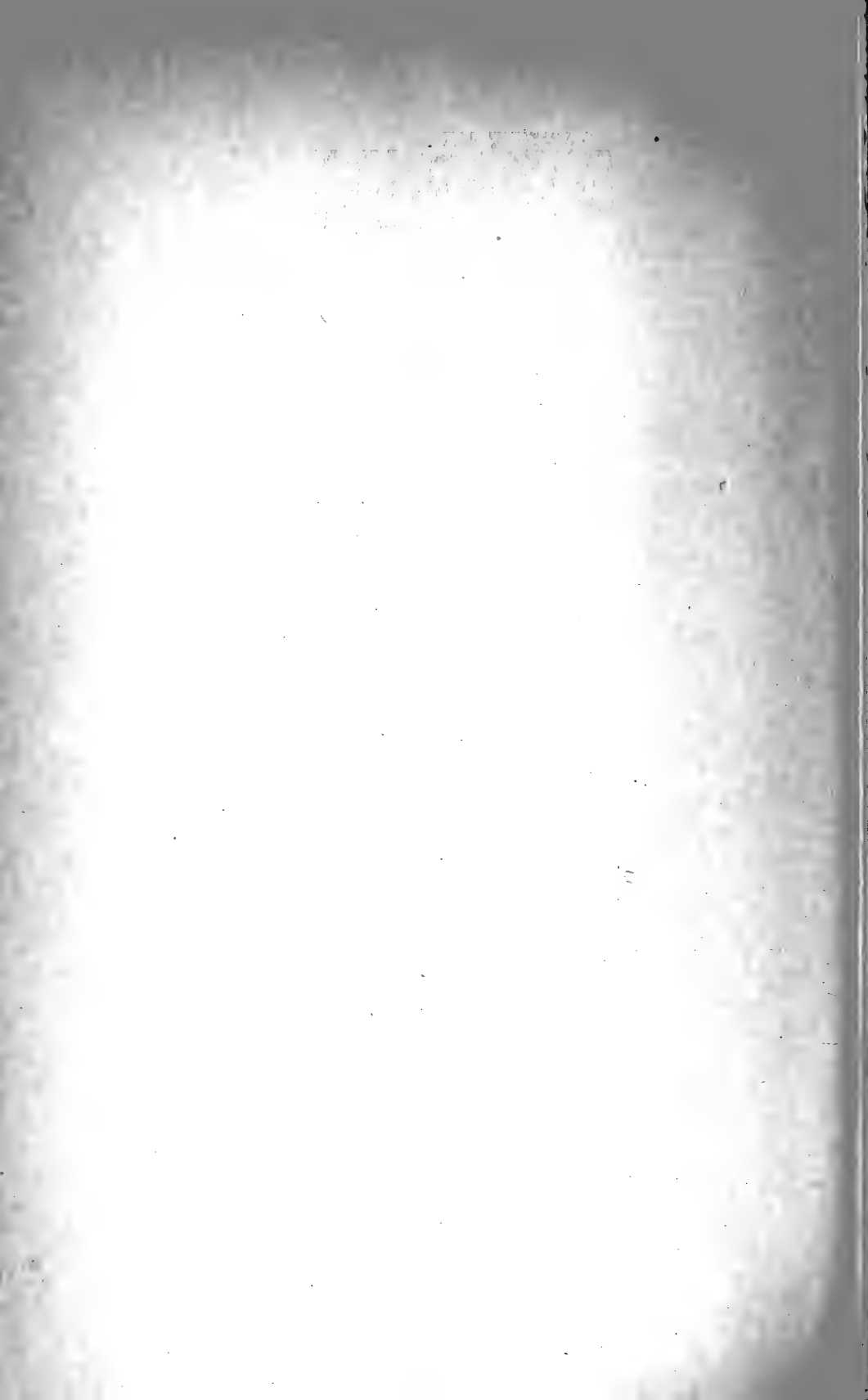
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- | | |
|---------------|------------------------|
| e. oxides | 5. pyrites |
| f. elements | 6. turquoise |
| g. carbonates | 7. emeralds and beryls |
| h. sulphides | 8. amber and jet |

Reference: III, 170-171

ANSWERS

- | | |
|-----|-----|
| a—8 | e—3 |
| b—7 | f—2 |
| c—1 | g—4 |
| d—6 | h—5 |



UNIT XXI
CONSERVING LIFE

A. Animals That Are Becoming And Have Become Extinct:

I. SEA ANIMALS:

1. Why are so many species wiped out? V, 124
2. Why are crabs so expensive? X, 230
3. What methods of crabbing in Chesapeake Bay are rapidly wiping out crabs? X, 230
4. Why is the robber crab disappearing from many of its former haunts? X, 178
5. Why have lobsters become a luxury? X, 229
6. What is happening to the salmon fisheries? VIII, 126
7. Why are the green turtles becoming scarce? VIII, 311-312
8. Why have the Galapagos turtles almost been wiped out in recent years? VIII, 313

2. BIRDS:

1. What has happened to our bird population in the past 400 years? IX, 40

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2. What bird species have already been exterminated by man? IX, 11
3. What led to the extinction of the great auk and the passenger pigeon? IX, 87
4. What is the estimated annual slaughter of wild ducks in the United States? IX, 39-40
5. How many wild ducks were sold in 1910 in San Francisco markets? IX, 39
6. How many wild ducks were sold in New Orleans in 1913 as food? What does this show? IX, 39
7. What hawks and owls should be protected? IX, 141
8. What happens when we kill off hawks and owls? What conclusions can you reach? IX, 140-142
9. What species of parrot was once native to the United States? VI, 254
10. What led to the extermination of the Carolina parakeet? VI, 254

3. MAMMALS:

1. Why are marsupials dying out today? IX, 282-283
2. Why was it once difficult for the National Zoological Park to get a beaver? VI, 117
3. How is the whale hunted? What does this indicate to you? IV, 64
4. Why are otters so rare today? VI, 116
5. How are seals hunted? What chances have they for survival? IV, 49-50, 64
6. How does the Eskimo hunt seals? IV, 47-48

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7. Why do we rarely, if ever, see a West Indian seal? VI, 125
8. What has happened to the lion population in Africa? VI, 70
9. How are tigers captured? How does this affect the tiger population? VI, 81-82
10. How are the wart hogs captured? VI, 158-159
11. Why is the zebra-like quagga now extinct? VI, 212-213
12. What made the American bison fear man? VI, 163
13. Why were bison shot? How do you feel about the reasons given? VI, 167
14. Where was the center of the bison population at one time? VI, 166
15. About how many bison were there on the Great Plains in 1870? VI, 166
16. What was the bison population in 1907? VI, 167
17. What practically wiped out the European bison population by 1925? VI, 173
18. How and why are elephants captured in India? VI, 137-139

B. Improving Plant Life:

1. What evidence is there of ancient man's ability as a plant breeder? XI, 321
2. What is meant by "selection" in plant breeding? XI, 54
3. What mental qualities do plant and animal breeders need? XI, 320-321

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4. Why is progress in plant and animal breeding so slow? XI, 320-321
5. Why did people cultivate grasses in prehistoric times? XI, 203-205
6. For how long a time has man cultivated grasses? XI, 204-205
7. What is said to be the most ancient cultivated plant? XI, 324
8. What crops did the Incas originate? XI, 329-330
9. What country is said to have first domesticated corn? XI, 329-330
10. What special type of agriculture developed around Mexico City? VII, 338
11. What is said to be the crowning achievement of the American Indian? XI, 346
12. Why did Indians have colored corn? XI, 328
13. How did the Indian carry on agriculture in a dry region? VII, 328
14. What were the probable ancestors of corn? XI, 214
15. What evidence is there of corn's ancient development? XI, 327-328
16. Why is the origin of corn still a mystery? XI, 336-337
17. Why are scientists unable to determine the ancestors of corn? XI, 324
18. What practices caused the corn plants to become so highly specialized and developed? XI, 324

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19. Why does corn never grow without man's aid? XI, 326
20. How might mutations have produced modern corn? XI, 343
21. Name some recent mutations which have occurred in corn? XI, 344
22. What chief objections have we to the idea of mutations in the production of corn? XI, 345-346
23. Discuss some theories to explain the origin of the ear in corn. XI, 339-340
24. What part did selection play in producing modern corn? XI, 342-343
25. What evidence have we of the hybrid nature of corn? XI, 345
26. What corn relative hybridizes with corn? XI, 335
27. How does corn today compare with that grown by ancient Indians? XI, 327
28. Why is corn considered an ideal food plant? XI, 325-326
29. Why were the cereal plants so hard to domesticate? XI, 325
30. When and where were rice, barley, oats and rye first cultivated? XI, 209-210
31. How are new plants propagated or kept alive? XI, 53-54
32. How have new varieties of orchids, irises, roses, etc., been originated? XI, 53

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C. Improving Domestic Animals:

1. Why are present-day species successfully carrying on? V, 125
2. What is the probable ancestor of our poultry? VI, 247
3. What is the origin of the domestic fowl? IX, 3
4. What results when bison are mated to domestic cattle? VI, 168
5. Why were scientists interested in zebra-ass hybrids? VI, 213
6. What hybridization experiments have been made with zebras, horses and asses? VI, 213

D. Conserving Wild Animal Life:

1. How did people come to realize that wild animals in this country were being wiped out? VI, 2
2. How was interest in wild life preservation aroused? VI, 3
3. What practice almost wiped out the California shrimp? X, 230
4. What remedied the shrimp situation in California? X, 230
5. What practice among Andalusian fishermen has maintained the crab population? X, 230-231
6. Why do Florida fishermen break off the large claws of crabs and then throw the crabs back? X, 230
7. What crab is protected in Florida? X, 230
8. Name some parks which raise bison? VI, 162

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9. When were steps taken to prevent the slaughter of bison? VI, 167
10. What steps have been taken to protect wild gorillas? VI, 28

E. Conserving The Health of Human Beings:

1. How do certain seaweeds aid the science of bacteriology? XI, 89
2. Should plants be removed from a sick room? Explain. XI, 28-29
3. Describe the damage done by some of the trypanosomes. V, 349
4. In what way are gastropods sometimes dangerous to man? X, 316
5. What mollusk can kill a man? X, 293
6. Why do natives of New Guinea dread the bite of *Conus*, a snail? X, 301-302
7. Do octopuses and squid attack man? X, 346-347
8. Does the housefly ever bite people? Explain. V, 347-348
9. Why can a fly's bite cause a serious infection? V, 323
10. What is the most effective method of fly control we have? V, 343
11. Why are mosquito bites painful? V, 338
12. What is the only known carrier of the yellow fever virus? V, 338-339
13. Why has yellow fever occasionally broken out in northern cities? V, 340

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14. What damage may the "screw worm" cause to animals and man? V, 352
15. What is the carrier of the germs of African sleeping sickness and nagana? V, 348-349
16. What is the worst biting fly? V, 348
17. What crab in Jamaica is used to "treat" deafness? X, 239
18. How are crabs an aid to sanitation in the tropics? X, 245
19. How do sand fleas help mankind? X, 158
20. What two species are the only poisonous lizards now known? VI, 262-263
21. What lizard in the United States is as deadly as a rattlesnake? How does it inject its poison? VIII, 336
22. How dangerous is the cobra? How many people in India die each year from cobra bites? Why is not the cobra wiped out in India? VIII, 351-352
23. Is it true that a spitting cobra can shoot its poison at one's eye? Explain. VI, 269
24. Why is the mamba so feared? VIII, 354
25. How old must a baby of a poisonous snake be before it can inflict harm upon one? VIII, 343
26. How poisonous are copperheads? VIII, 348
27. What rattlesnake is considered the most dangerous in North America? What gives it its reputation? VIII, 349
28. How is antivenin used and prepared? VIII, 351

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29. What monkey was used to teach ancient doctors anatomy? VI, 48
30. What is the rhinoceros' "horn" made of? VI, 208
31. To what use were rhinoceros' horns put at one time? VI, 207
32. What do the Chinese use a rhinoceros' horn for? VI, 207

Pupil and Class Activities

A. Things To Do:

1. Make a representative collection of harmful and beneficial insects in your locality. Consult all of Volume V.
2. Make a collection of plants suffering from fungus diseases. Preserve the plants in alcohol for your museum. XI, 91
3. To find out whether or not the praying mantis is a useful insect, place some live mantes together with twenty grasshoppers in a screened cage. By daily observations note how soon the grasshoppers decrease in number. V, 73-76
4. Write to an agricultural experimental station in your state and ask for pamphlets on corn genetics. Examine these with your biology teacher. XI, 348

B. Class Discussions:

1. The gorillas will soon be wiped out. VI, 28
2. White man owes the American Indian nothing. XI, 346
3. Hawks and owls are the worst pests with which a farmer has to deal. IX, 141
4. Horses and cows developed before the grasses appeared on earth. XI, 203

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C. Self-Test Exercises:

TEST I

Underline the word or phrase which makes the sentence a true statement.

1. The lion population in Africa is (a) increasing (b) decreasing (c) remaining stationary. VI, 70

2. Bison were shot (a) for their tongues (b) for their tails (c) for being nuisances. VI, 167

3. The Carolina paroquet was exterminated because (a) it was too noisy (b) it has bright feathers (c) it killed chickens. VI, 254

4. When we kill off hawks and owls (a) chickens increase (b) rats and mice increase (c) rats and mice decrease. IX, 140-142

5. The passenger pigeon was wiped out by (a) hawks (b) diseases (c) man. IX, 87

6. The most ancient cultivated plant is (a) the tomato (b) the potato (c) corn. XI, 324

7. The American Indian's chief contribution to civilization was (a) tobacco (b) corn (c) the art of weaving. XI, 346

8. Florida fishermen break off the large claws of crabs and then throw the crabs back in order to (a) make the crabs suffer (b) let the crabs grow new, large claws (c) feed the fishes to be caught later. X, 230

9. The best way to control house-flies is to (a) swat every fly we see (b) fumigate the house (c) cover manure. V, 343

10. The yellow fever virus is carried by (a) a fly (b) a trypanosome (c) a mosquito. V, 339

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ANSWERS

1—b	6—c
2—a	7—b
3—b	8—b
4—b	9—c
5—c	10—c

TEST II

Below are ten statements. Some are true and some are false. On your paper re-write each false statement in such a way that it becomes true. In doing this, you may change or leave out any of the italicized words but you may not change or leave out any others.

1. The passenger pigeon *IS BEING WIPED OUT* by man. IX, 87

2. Some hawks and owls *SHOULD BE PROTECTED*. IX, 141

3. Whales *ARE INCREASING IN NUMBER*. IV, 64, 65

4. Otters are rare today because *THEY CAN NOT GET ENOUGH FOOD*. VI, 116

5. The American bison as a species *BECAME EXTINCT*. VI, 166, 167

6. Steps have been taken *TO EXTERMINATE* the gorillas. VI, 28

7. The crowning achievement of the American Indian was his development of *THE CANOE*. XI, 346

8. *CORN* was the most ancient of cultivated plants. XI, 324

9. Plant breeders select for propagation only those plants *THAT NEED LITTLE ATTENTION*. XI, 54

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10. Grazing animals, like horses and cattle, owe their development *TO THE USE OF BARNS*. XI, 203

ANSWERS

1. has been wiped out
2. should not be protected
3. are being hunted to death
4. their skins are in great demand by the fur industry
5. was almost wiped out
6. protect
7. corn
8. corn
9. that show the desired characteristics
10. to grasses



UNIT XXII

THE NATURE OF MATTER

A. Atoms And Molecules:

1. Why do we assume the earth formed before the decomposition of radio active material? VII, 3
2. Who laid the groundwork for atomic investigation? VII, 5
3. What is the structure of an atom? XII, 54-55
4. What is the composition of atoms? II, 290
5. What is the composition of all elements? VII, 5
6. What happens to some atoms as stars cool? VII, 7
7. What happens to atoms in the sun? II, 5-6
8. What is the structure of simple elements according to Moseley? VII, 5
9. What atomic and molecular conditions exist in the sun? II, 5-6

B. Elements And Compounds:

1. What is the composition of the sun? II, 256-258
2. What are the elements in the sun? VII, 5
3. Why are compounds not possible in the sun? II, 7

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4. How can it be proved that iron is in the sun?
II, 256
5. What happens to common compounds in the sun?
II, 289
6. What is the composition of the products of the sun's work in plants? II, 232
7. What types of compounds are found in minerals?
III, 170-171
8. What elements are valuable gems? III, 170
9. Which compounds contribute to the largest number of gems? III, 171
10. What is the chemical relationship of synthetic to natural gems? III, 290
11. How are artificial diamonds made? III, 289
12. How many elements occur in meteorites? III, 65
13. How is meteoric composition determined? III, 64
14. What is the comparative composition of stony and iron meteorites? III, 73
15. What is the average chemical composition of iron meteors? III, 67
16. What is the average composition of stony iron meteors? III, 67
17. What is the average composition of stony meteors? III, 67
18. What is the composition of 90% of meteoric stone? III, 75
19. What colors do the elements produce in gems?
III, 179
20. What is the composition of alabaster? III, 283

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21. What is the composition of amethyst? III, 226
22. What is the composition of malachite and azurite? III, 275
23. How do malachites and azurites form? III, 275
24. What is the composition of chrysoberyl? III, 247
25. What is the composition of chrysolite? III, 249
26. What is the composition of coral? III, 271
27. What is the composition of cyanite? III, 275
28. What is the composition of euclase? III, 273
29. What is the composition of emeralds and beryls? III, 210
30. What is the composition of feldspars? III, 262
31. What is the composition of garnet? III, 243
32. What common metals are the bases of different garnets? III, 244
33. How is glass made? XII, 325
34. What is the composition of gypsum? III, 284
35. What is the composition of hematite? III, 279
36. What is the composition of lazuli? III, 260-261
37. What is the composition of marble? III, 280-281
38. What alloys of nickel and iron are found in meteors? III, 70
39. What makes opal unstable? III, 232
40. What is the composition of opal? III, 231-232
41. What is the composition of Mexican onyx? III, 282
42. What is the composition of pyrites? III, 278
43. What is the composition of pearl? III, 223

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44. How are artificial rubies and sapphires made? III, 290
45. What is the composition of sodalite? III, 262
46. What is the composition of spodumene? III, 250
47. What is the composition of topaz? III, 235
48. What is the composition of Thomsonite? III, 275
49. What is the composition of titronite? III, 273
50. What is the composition of tourmaline? III, 239
51. What is the composition of turquoise and variscite? III, 256-257

C. Electrons And Protons:

1. What are electrons and protons? VII, 5
2. Who first demonstrated the existence of particles smaller than atoms? XII, 51
3. How is the existence of electrons demonstrated? XII, 51-52
4. Where are free electrons found? XII, 53-54
5. What is the weight of an electron? XII, 51, 54
6. What prevents the proton and electrons in an atom from smashing into each other? XII, 55
7. What is Moseley's law? VII, 5
8. How do distances of electrons from the nuclei in atoms compare with the distance of the sun from the planets? XII, 55
9. What atomic differences determine the spectra of the elements? VII, 6

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D. Matter And Energy:

1. What are the forms of matter? XII, 49
2. What form of matter is the sun? II, 7
3. Why is the enormous output of star and sun radiation possible? VII, 7
4. What laws do spiral nebulae follow? VII, 6
5. How does the sun get its energy? VII, 4
6. How does a star form? VII, 7
7. What is a possible origin of the matter of the stars? II, 297-298
8. How do electrons affect the activity of matter? XII, 56

Pupil and Class Activities

A. Class Discussions:

1. Electrons are real things. XII, 49-56
2. Edison discovered a phenomenon which helped provide a basis for electron study. XII, 58-59
3. Electrons are everywhere. XII, 54-55

B. Pupil Reports:

1. How gems get their colors. III, 178-179, 191, 218-219, 239, 247, 252-254, 259, 262, 270-271, 306-307
2. The chemical elements found in a leaf. II, 232-233
3. How crystals grow. III, 172-177
4. The chemistry of gems. III, 170-171
5. Elements and the colors they impart to gems. III, 179
6. The chemistry of garnets. III, 243-247
7. The chemistry of turquoise. III, 256-260
8. Practical applications of atomic structure. XII, 68-71
9. The building blocks of the sun. II, 290
10. Professor J. J. Thomson proved the existence of the electron. XII, 51-54

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C. Self-Test Exercises:

TEST I

B J K 8 I F N E 2 P Y L

Change this code word as follows:

1. If atomic investigation is based on the work of Moseley, change B to M. If not, change to W. VII, 5
2. Change J to E if nothing smaller than atoms exist. If something smaller than atoms does exist, change to O. XII, 54-55
3. Change K to L if atoms in the sun have the same structure as on the earth. If not, change to S. II, 5-6
4. If all elements have the same basic materials for their structure change 8 to E. If not, change to C. VII, 5
5. Change I to O if molecules exist in their ordinary state in the sun. If not, change to L. II, 5-6
6. Change F to M if radioactive materials were the first on the earth. If not, change to E. VII, 3
7. Change N to E if the sun is composed of compounds. If compounds do not exist on the sun, change to Y. II, 7, 289
8. If most of the elements of the earth are found in the sun, change E to S. If not, do not change. VII, 5
9. If iron cannot be proved to be present in the sun, change 2 to X. If iron can be shown to be present in the sun, leave blank. II, 256, Plate 63
10. Change P to L if correct chemical duplicates of gems can be made. If not, change to A. III, 290
11. Change Y to C if many elements occur in meteorites. If only a few occur change to A. III, 65

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12. Change L to W, if an electron has weight. If not, change to T. XII, 51, 54

Note: If all of the above changes were correctly made, you will find the name of a rule upon which atomic research is based.

ANSWER

Moseley's Law

TEST II

Match each item in Column A with the proper item in Column B

A	B
a. matter	1. arrangement of electrons VII, 6
b. gaseous	2. valuable metals III, 170
c. nickel and iron	3. electrons exist XII, 51
d. difference in elements	4. cathode ray tube XII, 51-52
e. elements	5. elements in sun II, 256, Plate 63
f. star formation	6. sun energy VII, 4
g. tracing path of electrons	7. electrons and protons VII, 5
h. spectrum analysis	8. form of matter in the sun II, 7
i. atomic disintegration	9. meteors III, 70
j. Thomson	10. spiral nebulae VII, 6-7

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ANSWERS

a—7	f—10
b—8	g—4
c—9	h—5
d—1	i—6
e—2	j—3



UNIT XXIII

ORIGIN AND EVOLUTION OF LIVING THINGS

A. The Record in The Rocks:

I. AGE OF THE EARTH:

1. How old is the earth? VII, 3
2. How is the earth's age measured? VII, 3
3. How can we know the approximate age of the earth's crust? VII, 10-11
4. What is the yardstick of nature's time clock? VII, 3
5. Where did the ocean's salts come from? X, 4
6. What does the percentage of salts in the ocean tell us about the age of the earth? X, 3-4
7. What criticisms have been suggested to show that the consideration of ocean salts is unreliable in estimating the earth's age? X, 4
8. What is the most scientific way of estimating the earth's age? X, 5
9. How slowly does uranium disintegrate? X, 5
10. How old is the earth according to studies made of uranium products in the earth? X, 5

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11. Has the question of the earth's age been finally settled? Why? X, 5
 12. How does a geologist measure time? IX, 255-259
 13. How long were the various geological eras? X, 73
 14. Name the various grand divisions of geologic time. X, 7
2. FOSSILS:
1. Name the eras of life on the earth. VII, 12
 2. What effect did Darwin's work have on our ideas of life on the earth? IX, 237
 3. What do we mean by "fossils?" X, 10
 4. What is the oldest record of a fossil collected by civilized man? IX, 228
 5. Where was the first discovery of an American fossil made? IX, 232
 6. What conditions must be present for a fossil to be formed? VIII, 282-283
 7. How were ancient plants and animals preserved in the rocks? X, 6-7
 8. What does the presence of carbon in rocks mean? X, 43
 9. Just how is a plant fossil made? X, 12
 10. Are fossils being formed exactly as in the past? Give an example. X, 11
 11. How does an animal become petrified? VIII, 279-280

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12. How do animal remains become embedded in rock? VIII, 281
 13. How were prehistoric footprints made into fossil tracks? VIII, 271
 14. How are fossil molds or imprints formed? X, 11-12
 15. How perfect can fossil impressions be? Give examples. X, 12
 16. Why are fossil so few in number? VIII, 283-284
 17. Why are the fossil records so incomplete? X, 26-29
 18. Why are so few seaweed fossils found? X, 12
 19. Why are fossils not found in igneous rocks? X, 10
 20. Why are sea plants and animals more often found as fossils than those of the land? X, 11
3. THE IMPORTANCE OF FOSSIL STUDY:
1. What did people once upon a time think fossils were? IX, 228
 2. How did the ancient Greeks and Romans explain the fossils they found? X, 13
 3. How did some people since the Middle Ages look upon fossils? X, 13-14
 4. How did people in the sixteenth century explain fossils? VIII, 281-282
 5. When did people first begin to understand what fossils really were? IX, 230
 6. Read the interesting story of a professor who thought fossils were not animal remains. VIII, 282

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7. What is the science of paleontology? X, 14-16
8. What is the work of a paleontologist? X, 16
9. Who was the father of modern paleontology? IX, 232
10. Who were some pioneer students in the science of fossils? What did they find out? IX, 230-232
11. What president of the United States was a great scientist? IX, 233-234
12. Where do collectors go for fossils? Once found, how are fossils extracted from rocks? VIII, 284-285
13. Where in the United States is there a deposit of fossils in almost perfect condition? How was this made possible? IX, 46-47
14. What caused the tremendous fossil deposits in a Colorado lake? X, 80
15. When was it first found out that Northwestern United States had many fossils? What hindered exploration there? IX, 235-236
16. What do museum workers do with specimens received from collectors? IX, 220-221
17. What kind of work is done on fossils collected in the field? VIII, 286-290
18. Explain why there are so few fossils exhibited in the museums? VIII, 286
19. How are fossils "restored?" VIII, 288-289
20. How can the age of different remains be determined? VII, 39
21. How does a paleontologist determine the ancient history of a region? X, 17

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22. How do paleontologists know when mammals arose and when dinosaurs first appeared? X, 15
 23. Were all present day animals in existence in the distant past? How do we know? X, 15-16
 24. How do fossils indicate old land and water areas? X, 18
 25. What has shown us that the level of the land continually changes? X, 30-31
 26. What happens to the mud that now reaches the ocean beds? X, 34
 27. What happened during the Cambrian period? X, 35-38
 28. Why are some fossils of western North America the same as those found in China? X, 36
 29. Why are some animal fossils found in the British Isles and Scandinavia also found in the Appalachian Mountains? X, 37
 30. What states were once covered by very large oceans? X, 37-38
 31. Why are radically different animal fossils found in Alabama? X, 37
 32. Why is North America best for the study of extremely ancient life? X, 7-8
 33. Why is Europe best for the study of more recent life? X, 8
4. LIFE ON THE EARTH DURING DIFFERENT PERIODS OF ITS HISTORY:
1. What successive forms of life occurred on the earth in the periods and eras of the earth's history? VII, 19-20

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2. What took place during the first era on the earth? VII, 12-13
3. How long was the first period? VII, 12
4. What took place during the second period? VII, 13
5. What evidences of life during the second period have we found? VII, 13
6. When were the first fossils formed? VII, 13
7. What forms of life existed during the Cambrian era? VII, 13
8. What animals lived during the Ordovician era? VII, 13
9. In which era did invertebrates arise? VII, 14
10. How many known species existed during the Devonian period? VII, 15-16
11. What were animals like during the Eocene period? VII, 18
12. What happened to life during the Permian period? VII, 15
13. How many species were alive during the Permian period? VII, 16
14. What animals were confined to America in the Miocene period? VII, 18
15. Has life since it began on the earth ever been completely wiped from the face of the earth? Explain. VII, 37
16. When was life on the earth at its lowest ebb? VII, 37
17. What estimates have been made of time since the beginning of the Ice Age? VII, 68

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18. When did the Glacial period take place? VII, 19
19. What was the weather like during the Ice Age? VII, 58
20. When did the Ice Age end? VII, 68-69
21. How much time has elapsed since the last Ice Age? VII, 69-70
22. How much ice is calculated to have formed during the Ice Age? VII, 62
23. What evidence do we have today of the effect of glaciers? VII, 60
24. What animals survived the Ice Age in Europe? VII, 68
25. In what kind of rocks are the majority of fossils found? X, 11
26. What is meant by strata? VII, 8-10
27. How many feet of sedimentary rock have been formed since the beginning of the earth? X, 2
28. Where do scientists usually look for the earliest forms of life? X, 40-41
29. What name has been given to the first sedimentary rocks? X, 41
30. Where are Archeozoic formations found? X, 41-42
31. Why are Archeozoic rocks practically without any kind of fossils? X, 42
32. What kind of plant was found in the Archeozoic rocks? X, 43
33. What name was given to the oldest known form of life? X, 43

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34. What changes took place during the Proterozoic era? X, 44-49
35. What evidence is there that the Proterozoic era was cool? X, 45-46
36. What kind of fossils are found in the Proterozoic rocks? X, 46-49
37. What evidences of plant life are found in the Proterozoic rocks? X, 47-48
38. How did the Proterozoic plants affect the development of animal life? X, 49
39. What does "Paleozoic" mean? X, 50
40. Why do we find more fossils in rocks formed during the Paleozoic era than in earlier eras? X, 50
41. What kind of animals lived in the Paleozoic era? X, 55
42. What Paleozoic animal became for a time the world's dominant animal type? X, 55
43. Were any vertebrates found in Paleozoic rocks? Explain. X, 55
44. What locality is famous for having fossils whose soft internal structure has been preserved? X, 57-58
45. What did we learn from the fossils collected by Dr. Walcott of the Smithsonian? X, 58-59
46. What kind of sedimentary rock is used today for lithographing? X, 59-60
47. How do we explain the presence of perfect fossils in Burgess shale? X, 60

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48. What animals were abundant in the Silurian Period? X, 63-64
49. What plants and animals died out during the Permian Period? X, 72
50. What do Mesozoic and Cenozoic mean? X, 73
51. What effect did the birth of the Appalachian Mountains have on the surrounding land? X, 73
52. When did the Triassic Period occur? X, 74
53. What kind of animals roamed the land during the Jurassic Period? X, 75
54. What invertebrate animals were dominant in the Age of Reptiles? X, 75
55. What happened to the ancient Ammonites? X, 75-76
56. What animals ruled the land during the lower Cretaceous period? X, 77
57. What caused the formation of large chalk beds? X, 78
58. What is meant by the Cenozoic era? X, 78-79
59. What great changes took place at the beginning of the Cenozoic era? X, 78
60. What is meant by Oligocene? X, 79
61. What does amber look like? III, 268
62. How did amber originate? X, 80
63. When did amber form? III, 268
64. What has amber preserved for us? X, 80
65. What fossils are found in amber? III, 268
66. In what kinds of rock are emeralds found? III, 211-213

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67. What is the difference between minerals and rocks? III, 279-280
68. What is basalt? III, 287-288
5. THE RECORD OF INVERTEBRATES IN THE ROCKS:
 1. What kind of climate occurred in the Eocene Period? X, 79
 2. What killed many animals in the Miocene Period? X, 79
 3. Have jellyfish ever been perfectly preserved in rocks? Explain. X, 59
 4. How ancient are the oyster and clam? VII, 13
 5. What peculiar type of shell life existed during the Silurian Period? VII, 14
 6. What were the ancestors of our present day squid or cuttlefish? X, 76
 7. How ancient is the octopus? VII, 13
 8. How far back has the ancestry of cephalopods been traced? X, 322-325
 9. In what way does the cartilaginous skeleton take the place of the cephalopod shell? X, 326-327
 10. What caused the greater development of the nervous system of the octopus? X, 321-322
 11. How large were the ancestors of our present day chambered nautilus? X, 62-63
 12. What did the ancestor of crustaceans look like? X, 97
 13. Why do the Chinese treasure fossil crabs? X, 238
 14. Why were insects able to live and reproduce freely in the Carboniferous period? V, 89

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15. Why did insects before the Carboniferous period leave no fossils? V, 93
16. How many pairs of wings did the first insects have? V, 91-93
17. What two kinds of insects gave rise to all our present day types of insects? X, 71
18. How did ancient roaches compare with present day roaches? V, 89
19. How ancient is the roach family said to be? V, 82
20. How large were roaches in the Coal Measures? X, 70-71
21. What were some of the plant and animal neighbors of the roaches many millions of years ago? V, 85-89
22. How large were the Coal Measures dragon flies? X, 70
23. What modern insects had giant ancestors with a wing-spread of two feet? V, 93-96
24. What does the fly group teach us about evolution? V, 353
25. What is the meaning of the "halters" or balancers behind each wing of a fly or mosquito? V, 319
26. What caused the change from primitive giant insects to those we now know? X, 71
27. What did the ancestors of our present day scorpions look like? When did they live? X, 64
28. When did great scorpion-like creatures live on the earth? VII, 14

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29. What animal today has an embryo stage which looks very much like a trilobite? What does this indicate? X, 56
 30. What were trilobites once thought to be? X, 56
 31. Who first showed us the trilobites' relationship to the shrimps and crabs of today? X, 56
 32. Why is a trilobite not considered a primitive creature? VII, 13
 33. What effect did the retreat of the seas have on trilobites and sea scorpions? X, 74
 34. When did trilobites decline? VII, 14
 35. What happened to the trilobites? X, 55-56
6. THE RECORD OF EARLY VERTEBRATES AND FISHES :
1. What is the connecting link between crustaceans and vertebrates? VII, 14
 2. What were the oldest known vertebrates? X, 64-65
 3. What were the ancient ostracoderms like? What happened to them? VIII, 10-12
 4. How long have fishes been on this globe? VIII, 10
 5. What fish stands between the lancelet and the shark in development? VIII, 9-10
 6. What does the lancelet teach us about the first fishes? VIII, 8-9
 7. Why is the shark considered to be the forerunner of our modern fishes? VIII, 12-13
 8. What is the evidence that fishes changed little since prehistoric times? VIII, 4

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9. When did fishes first appear on the earth? VII, 14
 10. From what group of fishes did our common bony fishes come? VIII, 25
 11. How large must the ancient sharks have been? VIII, 3
 12. Name some Devonian fishes. X, 65
 13. What ancient fish was larger than a whale? VIII, 14
 14. When did true fishes flourish? VII, 4
 15. What is the origin of the lower jaw in fishes? VIII, 65
 16. How does a fish's skull compare with that of a higher vertebrate? VIII, 64
 17. What part of a fish's body tells more about its relations than does any other part? VIII, 60
 18. What fishes have lost some fins? VIII, 42
 19. How did the flat fishes get both their eyes on top of their heads? VIII, 68-69
 20. Why is a fish so insensible to pain? VIII, 99
7. THE RECORD OF AMPHIBIANS:
1. When did animals first acquire lungs? X, 69-70
 2. When did air-breathing land vertebrates first appear? X, 22
 3. From what type of animals did amphibia develop? VIII, 161-162
 4. What were the ancestors of amphibians? VIII, 2
 5. What conditions may have led to the development of amphibians from fishes? VIII, 20-21

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6. What did the extinct amphibians look like?
VIII, 164
 7. Describe the most perfect amphibian fossil yet found. VIII, 164-165
 8. Why are complete fossils of amphibian dinosaurs rarely found? VIII, 231
 9. Where was the greatest number of amphibian fossils found? VIII, 165-166
 10. What particular structures are looked for in fossil amphibians? VIII, 167-168
 11. What was the size of Devonian amphibians?
VII, 15
 12. How large were fossil amphibia during the Great Coal period? X, 70
 13. How big was the largest amphibian fossil ever found? VIII, 163
 14. Describe the best known North American amphibian now extinct. VIII, 168-169
 15. What did fossil frogs look like? How large were they? VIII, 169
 16. What in the life history of frogs and toads shows us their relationship to salamanders? VIII, 195-196
 17. In what ways have cave salamanders been changed? VIII, 189-190
 18. What happens to the eyes of salamanders that live in caves? Describe the eye changes that occur during their lifetime. VIII, 183
8. THE RECORD OF DINOSAURS AND OTHER REPTILES:
1. How are the amphibians linked with the reptiles?
VIII, 2

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2. What does the word "dinosaurs" bring to your mind? VIII, 213-214
3. What was the size and shape of various dinosaurs? VII, 17
4. Describe some flesh-eating dinosaurs. VIII, 219-226
5. What was the most ferocious flesh-eating animal the world has ever known? Describe it and its habits. VIII, 224
6. When did the dinosaur become supreme? VII, 17
7. When did the Age of Reptiles begin? X, 74
8. What group of animals ruled the earth during the Jurassic Period? VII, 17
9. When did reptiles begin to flourish? VII, 17
10. What forms of life arose during the Triassic, Jurassic and Cretaceous Periods? VII, 16-17
11. How far back in history do reptiles go? VIII, 212
12. Why were the ancient reptiles wiped out? X, 77
13. What features of the giant dinosaur skeletons enabled the animal to stand and move about? VIII, 229-230
14. What can you say about the brain capacity of a dinosaur? VIII, 235-236, 243
15. How large were the brains of ancient reptiles? X, 77
16. What dinosaur had two "brains?" Explain this condition. VIII, 243-244

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17. Describe the skin of dinosaurs. How can we determine what sort of skin they had? VIII, 217
18. What was the outstanding discovery in paleontology in recent times? VIII, 217-218
19. Have you ever heard rumors that dinosaurs may still be found living in some parts of the world? What truth is there in the stories? VIII, 213
20. What kinds of dinosaur fossils are found in our "Dinosaur National Monument?" Why is this place so rich in fossils? VIII, 215-216
21. What are the South Dakota Badlands famous for? X, 78
22. What states in our country have rich fossil deposits of dinosaurs? VIII, 216
23. What caused all the dinosaurs to perish? VIII, 249-250
24. How heavy was the Brontosaurus? VIII, 230
25. What is meant by "ichthyosaurs?" VIII, 251
26. How did the ichthyosaurs become fitted to sea life? VIII, 251-254
27. What was the size and shape of ichthyosaurs and plesiosaurs? VII, 16
28. Describe the paddle of the ichthyosaurs. VIII, 254
29. How did Ichthyosaurus reproduce its kind? State the evidence for your statement. VIII, 252-253
30. What were the "mosasaurs?" What interesting story is connected with the finding of the first mosasaur? VIII, 256-257

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31. What state is famous for its aquatic dinosaur fossils? VIII, 256
32. How do we know what mosasaurs ate? VIII, 258-259
33. What were the plesiosaurs? How were they fitted to sea life? VIII, 260-261
34. What ancient turtle weighed three tons? VIII, 262
35. What were the pterodactyls? When did they live? VIII, 263
36. What was the first vertebrate to fly? VII, 17
37. What was the largest flying reptile? VII, 17
38. Describe the pterodactyls and their habits. VIII, 264-268
39. How were pterodactyls identified as having been flying reptiles? VIII, 264
40. What was the ancestry of our present-day alligators and crocodiles? VIII, 299-300
41. Describe some "beaked" dinosaurs and their habits. VIII, 232-250
42. What dinosaurs had more than 2,000 teeth in their mouths? VIII, 238
43. How is a dinosaur "mummy" formed by nature? VIII, 239-240
44. Describe some of the tracks and trails left by dinosaurs. VIII, 269-277
45. Where and how were the first fossil tracks found in North America? VIII, 269-271
46. Why are many people misled into thinking certain rocks are fossils? VIII, 280

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47. Why did the glass snake lizard lose its legs? VIII, 334
48. What has happened to the class of reptiles since prehistoric times? VIII, 211-212

9. THE RECORD OF BIRDS:

1. What evidence have we that birds came from reptiles? IX, 48-49
2. Describe the main features of Archaeopteryx, Ichthyornis and Hesperornis. IX, 41-45
3. What fossil birds had teeth? IX, 43-44
4. When did toothless birds first appear? IX, 45
5. What did fossil birds look like? IX, 42-44
6. Where were the oldest fossils of birds found? What were they like? IX, 41-42
7. How many fossil bird species have been found? IX, 39
8. Why are there so few fossils of birds in spite of their past abundance? IX, 40-41
9. When did the true birds first appear? X, 79
10. When did sea birds arise? VII, 17
11. What catastrophe overtook birds in the Northern Hemisphere during the Pleistocene? IX, 40
12. Why was the prehistoric bird, Diatryma, famous? IX, 45
13. What recent bird stood over ten feet high? IX, 47-48
14. What bird had an egg with a capacity of two gallons? IX, 47

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15. What bird gave us the idea of the roc of Sinbad's adventures? IX, 47
16. What kind of birds were known to prehistoric men? How do we know this? IX, 3-4
17. Give some evidence to show that the ostrich came from a flying ancestor. IX, 13

10. THE RECORD OF MAMMALS:

1. How did the phrase "Age of Mammals" get its name? IX, 267
2. Where are the ancestors of modern animals found? VII, 18
3. When were modern sea mammals formed? VII, 18
4. Describe the titanotheres and their habits. IX, 181, 191-192
5. How was a great titanotheres skeleton found and dug up from the Badlands? IX, 181-187
6. How were the titanotheres wiped out? IX, 194-195
7. Where did mastodons live? VII, 18
8. Describe three rhinoceroses found in the Dakota Badlands. IX, 199
9. What animals developed at the same time as did the grasses? X, 79
10. What has been the history of mammoths and elephants in North and Central America? IX, 349-358
11. When did the ox appear? VII, 18
12. When did deer first appear? VII, 18

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13. How did the modern horse develop? IX, 353-361
14. What were the ancestors of our present day horses like? IX, 193
15. When did horses first appear? VII, 18
16. When did camels first appear? VII, 18
17. Where did the possible ancestors of camels first appear? IX, 199
18. What was the largest animal that ever lived on land or sea? IX, 368
19. Where were saber-tooth tigers plentiful in the United States? IX, 200
20. What happened to the saber-tooth tiger? VII, 18
21. What is the probable ancestor of our domestic cat? VI, 92
22. What do we know about the ancestors of the cat? IX, 322
23. What do we know about the ancestors of the dog? IX, 321-322
24. When did dogs arise? VII, 18
25. When did rodents arise? VII, 18

11. THE RECORD OF PLANTS IN THE ROCKS:

1. How old are the animal and vegetable kingdoms? VII, 3
2. How long have modern species existed? VII, 20
3. When did plants begin to flourish? VII, 14
4. When did the modern plant arise? VII, 17

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5. When did the earliest flowering plants appear?
X, 77
6. When did flowering plants assume supremacy?
X, 79
7. Name some trees which lived in the Cenozoic Era. X, 79
8. How did the trees in Arizona become petrified?
X, 74-75
9. What evidence have we that the Rocky Mountain climate was once milder and damper than today? X, 80
10. What effect did the Ice Age have on plants and animals? X, 82
11. What kind of climate existed the world over in the Coal Age? X, 69
12. What kind of animals lived when "Coal Measures" plants flourished? X, 69-70
13. When did giant ferns flourish? X, 67-68
14. How do we know that ferns once were the dominant group of plants? XI, 94
15. How tall were the ancestors of our horsetail plants of today? X, 67
16. Why was the Carboniferous Period so named? X, 65
17. What kind of plants became prominent during the Carboniferous Period? VII, 14
18. How was coal formed? X, 68
19. What type of root system did tall plants have in the "Great Coal" Period? X, 66

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20. What have fossils of bark in the "Coal Measures" been mistaken for? X, 67
21. Name some present-day plants, the ancestors of which formed our great coal deposits. V, 87-88
22. What kind of plants replaced the plants of the Carboniferous Period during the Permian Period? VII, 17
23. What is the effect of a dry environment upon leaves? XI, 271-272
24. What were some of the factors that led to the development of desert plants? XI, 264-270

B. The Record of Man in The Rocks:

I. EARLY MAN'S HISTORY:

1. How are the prehistoric records of man read? VII, 51-52
2. How do records of man come to light? VII, 53-54
3. What kinds of scientists have helped decipher man's past? VII, 37
4. When does early man seem to fade from the picture of the earth? VII, 2
5. What period saw the dawn of human life? VII, 18
6. During which period did true man arise? VII, 19
7. How far back does man's history go? VII, 32
8. Why is it impossible to answer the question of man's original beginning? VII, 32
9. What are some theories regarding man's origin? IX, 330
10. When may man have first appeared? X, 82

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11. Why is it so difficult to trace man's origin from primates? IX, 329-330
12. What evidences are found of man before the Stone Age? VII, 43
13. Where were the remains of earliest known man found? VII, 134
14. How can animals and plants give us information about man's history? VII, 38
15. Why have the bones of man and animals remained as records? VII, 44
16. What animals were alive during the age of the "dawn man?" VII, 134
17. What happened to many types of animals which were alive during early man's days on the earth? VII, 44
18. What part of the body of man and animals is best preserved? VII, 45
19. What is known about the "dawn man?" VII, 72
20. What is another name for the "dawn man?" VII, 134
21. What evidences have we of man and animals of the Pleistocene Period? VII, 19
22. Why is the Piltdown Man called Eoanthropus? VII, 140
23. What deductions may be made from the Piltdown skull? VII, 141
24. Who was Pithecanthropus erectus? VII, 146-148
25. What does the skull of Pithecanthropus resemble? VII, 149-150

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26. Why is it impossible to place the age of the Rhodesian skull? VII, 162
 27. Where may the Rhodesian skull be placed in history? VII, 161
 28. When did *Pithecanthropus erectus* live? VII, 149
 29. To which age does the *Pithecanthropus* belong? VII, 149
 30. Where was the Rhodesian Man found? VII, 154-158
 31. Why is it difficult to put the Rhodesian skull in its proper historical place? VII, 160
 32. Why would it be possible to judge a gorilla's posture from its skull without our ever having seen one? VII, 47
 33. What is the difference in brain case between man, gorilla, chimpanzee and orang outang? VII, 45
 34. How can skulls give us information regarding intelligence? VII, 46
 35. What is the relation of chin development to intelligence and historical age? VII, 47
 36. What was the shape of Brunn Man's skull? VII, 76
 37. What is the general appearance of the Rhodesian skull? VII, 160
2. OLD STONE AGE:
1. When did the Stone Age begin? VII, 42
 2. When did the Mousterian epoch begin in Europe? VII, 191

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3. What important skull differences are found in the La Quina man? VII, 124
4. What is the difference in skull vault between Krapina man and modern man? VII, 108
5. What are the comparative sizes of the brain from chimpanzee to man? VII, 163
6. How does a skull reveal the posture of the original man or animal? VII, 46-47
7. What is the importance of the folds of the brain? VII, 46
8. What do teeth tell us about the age, culture and intelligence of prehistoric man? VII, 48
9. What conclusions are drawn from the Heidelberg skull? VII, 144-145
10. What do we know of man before Neanderthal man? VII, 133
11. When did the Mousterian culture of the Neanderthal man possibly begin? VII, 166
12. What animals are found with Neanderthal remains? VII, 95
13. What animals were alive during the Mousterian period? VII, 124
14. What animals were found to have lived during the life of the man of La Chappelle-aux-Saints? VII, 116
15. To which fossil groups does the fossil man of La Chappelle-aux-Saints belong? VII, 118
16. What type of culture did the Neanderthal man have? VII, 67-68

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17. Where in the Neanderthal group do the Galilee skulls belong? VII, 128
18. How do the bones of the Krapina man compare with those of the white man today? VII, 106-107
19. What animals were common during the life of Krapina man? VII, 104
20. To what age did the fossil man of La Chappelle-aux-Saints belong? VII, 113-116
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22. What proof have we that Neanderthal man was not confined to Europe? VII, 126-128
23. What proof of Mousterian culture was found in Germany? VII, 110-113
24. How do the teeth of Krapina man compare with those of modern man? VII, 108
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28. Approximately when did the Stone Age begin? VII, 166
29. How much culture was in existence at the beginning of the Stone Age? VII, 166
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31. What are the characteristics of the Heidelberg jawbone? VII, 143
32. How ancient is the fossil jawbone of Heidelberg Man? VII, 142
33. How were the stone tools of Neanderthal man used? VII, 193
34. What were some of the tools made from bone? VII, 194
35. Why are many of ancient man's materials not found today? VII, 187
36. When did man first appear on the American continent? VII, 327
37. Why is it wrong to say that mankind disappeared from Europe at the end of the Old Stone Age? VII, 234
38. What is the difference in stone implements between those of the Mousterian culture and those of the Acheulian culture? VII, 193
39. When were bone instruments first found to have been in use? VII, 194
40. What race superseded the Neanderthal? VII, 198
41. Before which epoch had man learned to kindle a fire? VII, 192
42. Why are we led to believe that ancient man used handles for his tools? VII, 194
43. What kind of implements were used by Pre-Chellean man? VII, 184
44. How did Pre-Chellean man appear in Europe? VII, 182

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45. What differences and similarities are there between the Chellean and Pre-Chellean Age? VII, 185
46. When did the Mousterian culture end? VII, 191
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48. Why are there no wood remains of ancient tools? VII, 194
49. How did man first use clubs? VII, 194
50. What kind of life did the Pre-Chellean man lead? VII, 184
51. What is meant by the Acheulian epoch? VII, 187
52. What kind of climate occurred in Europe during the Chellean days? VII, 184
53. How long did Solutrean culture exist in Europe? VII, 211
54. What distinguishes the human life of the Solutrean epoch? VII, 74-75
55. What part of Europe did Solutrean culture affect? VII, 207
56. When did Solutrean culture disappear? VII, 211
57. What followed the disappearance of the Solutrean epoch? VII, 212
58. What developments took place during the Acheulian epoch? VII, 189
59. Did the earlier and later type of cave dweller live at the same time? Explain. VII, 199
60. What two cultures were in simultaneous existence in Europe at the beginning of the Great Cold? VII, 190

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61. How long ago did Cro-Magnon man appear in Europe? VII, 166
62. When did Cro-Magnon man exist? VII, 73
63. When did Cro-Magnon appear in Europe? VII, 76
64. Where did the Cro-Magnon race live? VII, 77
65. What was the appearance of Cro-Magnon man? VII, 75
66. How much of man's culture was in existence when Cro-Magnon man appeared? VII, 167
67. When did the Magdalenian epoch begin? VII, 214
68. What evidence of Cro-Magnon man is found in Africa? VII, 79
69. What evidence is there that Grimaldi man had his origin in Africa? VII, 79-80
70. What simple modern tool was used extensively by the Magdalenian man? VII, 217
71. What caused the great artistic era of Magdalenian man? VII, 218-219
72. Which animals were represented on the walls of caves? VII, 203
73. What was the purpose of Cro-Magnon drawings? VII, 220
74. What evidence is in existence that Cro-Magnon man employed medicine men? VII, 222-223
75. What is the only source of clay sculpture left by Magdalenian man? VII, 221
76. What changes took place regarding food-getting by Cro-Magnon man at the end of the Magdalenian epoch? VII, 226

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77. Where were Cro-Magnon people buried? VII, 78
 78. Why is it that Cro-Magnon people often had a larger brain than that of modern man? VII, 73-74
 79. What tools did Cro-Magnon man use? VII, 201
 80. What caused the decline of the Magdalenian man? VII, 225
 81. What group displaced Cro-Magnon? VII, 228-229
 82. What definite evidence have we of man during the Glacial period? VII, 19
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 2. What are some old theories regarding the cause of the Ice Age? VII, 56-57
 3. How much would the temperature of Europe have to drop in order to bring on another Ice Age? VII, 56-57
 4. How long ago did the Ice Age occur? VII, 57
 5. Has there been more than one Ice Age? Explain. VII, 56
 6. Explain how the sun might have been the cause of the Ice Age. VII, 56-57
 7. What must have happened to winters during the Ice Age? VII, 60
 8. What kind of animals lived during the Ice Age? VII, 60-61
 9. What kind of men lived during the Ice Age? VII, 67

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10. What kind of life did man lead in the last Glacial period? VII, 68
 11. What kind of man inhabited Europe at the close of the Glacial period? VII, 71
 12. What race other than Cro-Magnon occupied Europe at the close of the Ice Age? VII, 74-76
 13. What type of life persisted in the Spanish Peninsula while the Glacier was over the rest of Europe? VII, 227
 14. Why is it believed that the Pre-Chellean age falls in the third or second Interglacial period? VII, 182
 15. What leads us to believe that population was sparse in Pre-Chellean times? VII, 182
 16. What climatic changes took place during the Old Stone Age and the Middle Stone Age? VII, 43
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1. What types of man existed after Cro-Magnon man? VII, 74
 2. Where is the Stone Age in existence today? VII, 41
 3. What is the Middle Stone Age? VII, 43
 4. What is the difference between the Old Stone Age and the Middle Stone Age? VII, 244-245
 5. How did the Middle Stone Age man live? VII, 234
5. NEW STONE AND BRONZE AGES :
1. What animals were known to early Indus River people? VII, 313

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2. Why have we practically no traces of Neolithic artistry? VII, 263
 3. What people living in the New Stone Age were found by explorers? VII, 263
 4. What kinds of ancient remains have lasted until today? VII, 264
 5. What proof do we have that Solutrean man ate horses for food? VII, 253
 6. What are the demarcations of the ages of man? VII, 266
 7. How can Bronze Age remains be easily identified? VII, 273
 8. How far are we now from the Bronze Age? VII, 275
 9. How long and over which area did the Bronze Age hold sway? VII, 293
6. DEVELOPMENT OF MAN:
1. What are the periods and eras in the history of man? VII, 19-20
 2. How does a skull reveal the posture of the original man or animal? VII, 46-47
 3. How can a skull give information regarding intelligence? VII, 46
 4. Why should it be possible to judge a gorilla's posture from its skull without our ever having seen a gorilla? VII, 47
 5. What part of Piltdown Man establishes him as a primitive type? VII, 138-139

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6. What is the difference in tongue muscle projection in the skull in modern man, ape and prehistoric man? VII, 47-48
7. How do the bones of Krapina man compare with the white man of today? VII, 106-107
8. What are the comparative sizes of the brain from chimpanzee to man? VII, 163
9. What are the similarities and differences of the Krapina skulls and modern skulls? VII, 104
10. What is the importance of the folds of the brain? VII, 46
11. What kind of cell changes are the only ones which will change future generations? VII, 32
12. How thick was the skull of "dawn man?" VII, 136
13. What kind of brain did Pithecanthropus erectus have? VII, 148
14. What do we know about the posture of Pithecanthropus? VII, 151-152
15. What is the brain capacity of the ape and Pithecanthropus? VII, 150
16. Was Pithecanthropus a tree climber or ground walker? Explain. VII, 152
17. Why is Pithecanthropus considered a transitional form? VII, 153-154
18. What is the difference in skull vault between the Krapina, Neanderthal and modern man? VII, 108
19. What information do lower jawbones give to the anthropologist? VII, 47

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20. How is the weight of the organs, chest and head carried in man? VII, 49
21. How is the weight of the upper body carried in animals? VII, 49
22. How was the erect body balanced? VII, 48
23. What were the anatomical peculiarities of Neanderthal man? VII, 131
24. How do the jawbones of the Neanderthal man, a European man and a young chimpanzee compare? (See illustration.) VII, 95
25. Why is it correct to accept reconstruction of skulls made from a few fragments? VII, 49-50
26. What changes in his anatomy took place as man developed? VII, 48
27. How does the shape of the knee affect upright carriage? VII, 49-50
28. What is the relationship of thighbone size to height? VII, 49-50
29. What evidence is there that environment caused organic evolution in all forms of living things? VII, 21
30. What is the origin of species? VII, 20-21
31. Why is man not believed to have descended from a monkey? VII, 21-22
32. What profound changes in the human being have taken place? VII, 35
33. What is the relative weight and length of a newborn baby compared with that of an adult? VII, 34

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34. What appendages do humans have which are not now necessary? VII, 31
35. What is the size and weight of the human embryo during the period of gestation? VII, 33
36. How does an infant's heart beat? VII, 34
37. What are the rates of growth of a human being at different stages? VII, 34
38. What is the weight of the parts of the body in infants and adults? VII, 34
39. What change takes place in human beings at birth? VII, 33
40. What changes take place in the heart-beat as a child grows? VII, 34
41. Why are there no two human beings exactly alike? VII, 24
42. What caused the change in stature of Cro-Magnon man? VII, 212
43. What is the difference between the Cro-Magnon and Caspian man? VII, 228
44. Where are descendants of Cro-Magnon man found today? VII, 228
45. What caused a different culture to develop among the West Coast Indians than among the others? IV, 175
46. What is the belief of scientists concerning the development of man? VII, 31-32
47. How does the Spy skull compare to the skull of Neanderthal and of modern man? VII, 102
48. What was the external appearance of early man? VII, 168

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49. What was the structure of early man's nose, lips and eyebrows? VII, 169
50. Did erect posture and use of arms of body come before the development of the brain? VII, 169
51. What is the similarity of "dawn man's" skull to other human species? VII, 136
52. How do the jawbones of the chimpanzee, Pilt-down, Heidelberg and modern man compare? VII, 144
53. What do some believe to be the origin of the operculum? X, 288-289
54. What does the human embryo teach us about our ancestors? VIII, 1
55. What is the doctrine of recapitulation? VII, 31

Pupil and Class Activities

A. Things To Do:

1. Visit your local museum for an interview with the paleontologist. Ask him about his experiences while hunting fossils. Try to get him to address your school. X, 16-18
2. Inquire at your local museum as to where you could collect fossils for your home, club, or school museum. Make trips to those places with your friends. X, 16-18
3. Visit a bituminous coal mine or sandstone hill to look for fossils.
4. Visit a coal mining district and look in the dump pits for fossils in shale or coal. Try to get the assistance and guidance of an official. X, 66-69
5. Visit your local museum of natural history. Make pen, pencil, charcoal, or color portraits of dinosaur restorations. Exhibit these in your classroom. VIII, 219-226
6. Make a trip to the dinosaur section in your local museum.

B. Class Discussions:

1. Some methods used by scientists to measure the age of the earth. VII, 2, 3, 8; X, 1-9
2. The age of remains found in the ground can be estimated. VII, 38-40

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3. Life has been extinguished from the earth in the past. VII, 15-16
4. Discuss the way sedimentary rocks form in nature. X, 1-3
5. How nature preserves plants and animals. X, 11-13
6. The reasons for our having so few fossils of plants and animals that once lived. X, 26-29
7. The connection between diatoms and the world's supply of petroleum. XI, 195-196
8. The formation of coal. X, 66-68
9. Roaches had ancestors before the human race existed. V, 84-90, 97-98
10. Prehistoric birds looked very different from modern birds. IX, 41-49
11. Man is as old as the earth. VII, 2-4

C. Pupil Reports:

1. The earth before the age of living things. VII, 12-13
2. How geologists read the story locked up in the rocks. IX, 188-206
3. How geologists reckon prehistoric time. IX, 255-259
4. The formation of fossils in nature. VIII, 279-290
5. Early plants of the earth. VII, 14-15
6. The changes that have taken place in the wings of insects since they first appeared on earth. V, 91-96

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7. Report on the type of plant which existed when insects first appeared on earth. V, 86-89
8. The evolution of fishes. VIII, 8-29
9. The evolution of the amphibia. VIII, 173-176
10. What we know about land dinosaurs. VIII, 213-250
11. What we know about prehistoric fish lizards. VIII, 251-262
12. What we know about flying reptiles in prehistoric times. VIII, 263-268
13. How mammal fossils are located and removed from the rocks. IX, 171-187
14. The evolution of the horse. IX, 353-361

D. *Self-Test Exercises:*

TEST I

Match each item in column A with the proper item in column B.

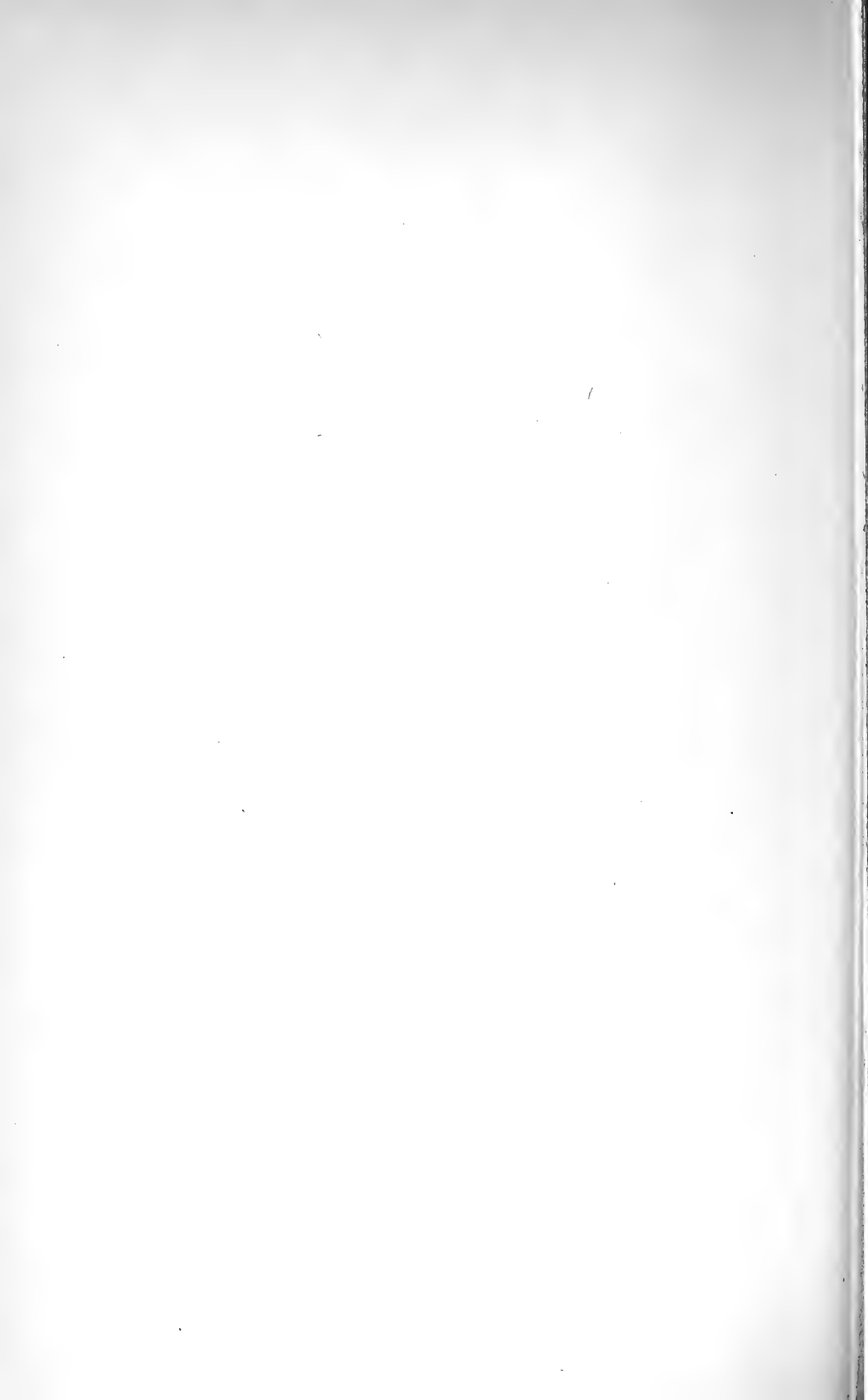
- | A | B |
|---|---|
| a. age of the earth X, 5 | 1. Carboniferous period |
| b. fossils X, 10 | 2. prehistoric birds |
| c. paleontology X, 14 | 3. formed our petroleum |
| d. pterodactyls VIII, 263 | 4. carbon in rocks |
| e. Paleozoic X, 50 | 5. two and a half billion years old |
| f. diatoms XI, 195 | 6. science dealing with fossils |
| g. evidence of prehistoric plant life X, 43 | 7. the preserved remains of prehistoric living things |

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7. _____ may have formed the world's supply of petroleum. XI, 195
8. Our present day types of insects arose from prehistoric _____ and _____. X, 71
9. The largest animal that ever lived on land or sea is the _____. IX, 368
10. An ancient dinosaur that weighed over twenty tons was _____. VIII, 230
11. Prehistoric flying reptiles are known as _____ VIII, 263
12. Scientists have evidence that birds arose from prehistoric _____. IX, 48
13. A prehistoric bird which laid eggs each with a capacity of more than two gallons was _____. IX, 47
14. The most ferocious flesh eating animal the world has ever known was the _____. VIII, 224
15. Some states in the United States which once were covered by large oceans, are _____. X, 37

ANSWERS

- | | |
|--------------------------------|------------------------|
| 1. Uranium | 9. blue whale |
| 2. fossils | 10. Brontosaurus |
| 3. sedimentary | 11. Pterodactyls |
| 4. Lower Cretaceous | 12. reptiles |
| 5. volcanoes | 13. Aepyornis |
| 6. bacteria and algae | 14. Tyrannosaurus |
| 7. diatoms | 15. Texas, Oklahoma, |
| 8. cockroaches and dragonflies | Missouri and Wisconsin |



UNIT XXIV

PROGRESS AND HISTORY OF MAN

A. Evidence on Which The History Is Based:

1. What records do we possess of man's early history? VII, 38
2. Who were the men who discovered man's great accumulations of the past? VII, 53-55
3. What evidences are found of the cultural practices of ancient people? VII, 49-51
4. What evidence is there of ancient man's ability as a plant breeder? XI, 321
5. How do we use the early discoveries of ancient man? XI, 321
6. Why are restorations of fleshy bone structures the only correct ones? VII, 198
7. What do teeth tell us about the age, culture and intelligence of man? VII, 48
8. How does intelligence develop with time in earth history? VII, 2
9. What is the difference in tongue-muscle projection in the skulls of modern man, ape and prehistoric man? VII, 47-48

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10. How long has man been master of the earth? VII, 20
11. What are the evidences of Neanderthal existence? VII, 84-85
12. What caused the extinction of some races? VII, 176

B. Probable Origin of Man:

1. Is man's history completely solved? VII, 34
2. When did the first semblance to man arise? VII, 18
3. When is human life believed to have begun? VII, 38
4. During which period did true man arise? VII, 19
5. What single factor makes Pithecanthropus different from the gibbon or ape? VII, 153
6. What is the difference in the brain case of man, gorilla, chimpanzee and orang-outang? VII, 45
7. What bone structure demonstrates that Pithecanthropus was a man and not an ape? VII, 151
8. What proportion of the human body is similar to other animals? VII, 31
9. What portion of the human body is not found in other animals? VII, 31
10. Why is it inaccurate to say that man is descended from apes? VII, 32
11. Why was early man like other living creatures in the woods? VII, 171
12. Why is Neanderthal man not classed as Homo sapiens? VII, 130

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13. What is the relationship of the size of the brain case to the intelligence of man and other animals? VII, 45
14. Which activities are carried on only by man? VII, 20

C. Cave Dwellers:

1. What is the earliest known bone instrument? VII, 135
2. How did early man fasten things? VII, 174-175
3. When did man begin to use sticks and stones? VII, 166
4. When did man become a user of tools? VII, 172
5. How long has man been master of the world? VII, 20
6. How did ancient man solve his food problem? XI, 320
7. How many species of man existed in very early times? VII, 167

D. Old Stone Age:

1. What was the highest type of cave dwellers? VII, 199
2. What were the three basic tools with which man rose over animals? VII, 173
3. Why did the cave man use beads and paint? VII, 197
4. What was the purpose other than protection for clothes worn by early man? VII, 175
5. Who were the first to wear some kind of covering? VII, 192

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6. How did man become a tool user? VII, 172
7. When was the barb used on spear and hunting weapon heads? VII, 209
8. Why are human representations without all the fingers found? VII, 204
9. What may be the significance of the female statuettes? VII, 205
10. To what extent did magic dominate early man? VII, 177
11. Is there sufficient evidence of cannibalism among the men of the Stone Age? VII, 197
12. How did the Aurignacians earn their livelihood? VII, 201
13. What common purpose has the art of the Caspian, Magdalenian and Aurignacian culture? VII, 230-231
14. Who were the Caspians? VII, 228
15. How did Pre-Chellean man appear in Europe? VII, 182
16. What kind of implements were used by Pre-Chellean man? VII, 184
17. What was the clothing of Chellean man? VII, 185
18. When did Mousterian culture appear in Europe? VII, 82
19. What is the range of Mousterian culture? VII, 130
20. Which skulls are possible links between modern man and Neanderthal man? VII, 96-102

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21. What is the comparative size of modern and Neanderthal skulls? VII, 88
22. What is the capacity of the Neanderthal skull? VII, 88
23. What is the shape of the Neanderthal skull? VII, 91-92
24. Why were Neanderthal men buried doubled up and supplied with food and equipment? VII, 197, 224-225
25. How did Neanderthal man distinguish between the natural and the supernatural? VII, 196
26. What race superseded the Neanderthal race? VII, 198
27. To which fossil group does the fossil man of La Chappelle-aux-Saints belong? VII, 118
28. What are the characteristics of Cro-Magnon man? VII, 74, 77
29. Has the Cro-Magnon race completely vanished today? VII, 226
30. Why did the Cro-Magnon man paint himself and the dead with red? VII, 206
31. What were the burial customs of Cro-Magnon man? VII, 206
32. What evidence is found in Africa of Cro-Magnon man? VII, 79
33. What culture replaced Magdalenian culture? VII, 226
34. Why were Magdalenian tools carved? VII, 216
35. With which group is Magdalenian culture most closely associated? VII, 212

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36. What race other than Cro-Magnon occupied Europe at the close of the Ice Age? VII, 74-76
37. What negroid type race existed in early Europe at the same time as Neanderthal and Cro-Magnon? VII, 79
38. What type of artistry developed in Solutrean times? VII, 209
39. What parallels exist between the Solutrean and Aurignacian groups and the Iroquois and Algonquin tribes? VII, 210
40. What distinguishes the human life of the Solutrean Epoch? VII, 74-75
41. What was the Solutrean attitude toward the dead? VII, 211
42. How do higher cultures affect lower cultures? VII, 200
43. What do higher cultures obtain from lower cultures? VII, 200
44. What were the bad habits of ancient man in the light of modern thought? VII, 178
45. Which cultural traces are found in present day Spain? VII, 227-228
46. What do many anthropologists believe to be the origin of religion? VII, 225
47. When did burial of the dead begin to take place? VII, 189
48. Why is it difficult to distinguish the exact dividing line between cultures? VII, 187-188
49. How much of ancient man's culture do we have? VII, 187

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50. What people were still living in the Old Stone Age, 300 years ago? VII, 184
51. How was the quality of ancient races maintained? VII, 196
52. Where does the Australian Bushman belong in the order of present day races? VII, 132
53. Why is not the Australian Bushman of Neanderthal origin? VII, 132

E. Middle Stone Age:

1. How did the people of Crete dress? VII, 310-311
2. When did pottery and basket weaving begin? VII, 238
3. What was the effect of the bow and arrow on man? VII, 237
4. What was the attitude of Mesolithic man toward his stone axe? VII, 235
5. How far into the present time has reverence for the axe been transmitted? VII, 236
6. What was the purpose of cannibalism? VII, 255
7. What is the history of the ancient Cretes? VII, 309
8. When did European civilization begin? VII, 309
9. What were the new inventions of Mesolithic man? VII, 234
10. What kind of harpoon heads were developed? VII, 235
11. How did the Middle Stone Age man live? VII, 234

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F. New Stone Age:

I. NEW STONE AGE MAN:

1. When did agriculture begin? XI, 322
2. Where was agriculture first practised? XI, 322
3. How was flint mined in Neolithic times? VII, 248
4. Why are forest people in Africa, New Guinea and the Philippines backward? XI, 204
5. How do we explain the failure of primitive people of today? XI, 319
6. What vestiges have we of the early "medicine man's bag?" VII, 262
7. What are the homes of the Hottentots? II, 189
8. What brought about the abandonment of human sacrifices? VII, 248
9. What brought the civilization of ancient Crete to a close? VII, 312
10. How were the rulers of Crete chosen? VII, 310-311
11. What was the religion of the Cretes? VII, 310
12. What was Sumerian culture? VII, 303-304
13. What race followed the Sumerians? VII, 304
14. Why can we not say that all people passed through the same stages of civilization? VII, 249
15. How did slavery develop? VII, 254
16. Why were probably the first rulers of men? VII, 177

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17. What kind of government developed in ancient China? VII, 320
18. What civilization developed in the environs of the Indus River? VII, 313
19. What were the industries of the Indus people? VII, 313
20. What was the writing of the Indus valley people? VII, 314
21. What change in construction did the Persians bring to India? VII, 316
22. What was the effect of war upon ancient life? VII, 180

2. EGYPTIAN AND RELATED CULTURAL HISTORY:

1. Who were the painted pottery people of Babylonia? VII, 302
2. What was the merit of Babylonian art? VII, 307
3. What was the Babylonian attitude toward conquered people? VII, 307
4. Why is it wrong to say that Egypt was the cradle of civilization? VII, 295
5. Which is the only other region which can compete with Egypt as to age of civilization? VII, 301
6. What was the purpose of Egyptian sculpture? VII, 299
7. Why was mummification practised? VII, 300
8. Why were the pyramids erected? VII, 299
9. Why was stone used extensively in Egypt? VII, 297

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10. What was the purpose of the common worship of one ruler? VII, 305
 11. What were the so-called empires of the Semitic period? VII, 305
 12. What does civilization owe to Persia? VII, 308
 13. How do present-day Egyptians compare with ancient Egyptians? VII, 296
3. SOUTH AND CENTRAL AMERICAN INDIANS:
1. What was the origin of the Aztecs? VII, 337
 2. What kind of culture was developed by the Aztecs? VII, 339
 3. How did Aztecs record history? VII, 340
 4. What was the Aztecs' religious attitude to sacrifice? VII, 339
 5. What is the origin of Mexico City? VII, 338
 6. What was the origin of the Incas? VII, 341
 7. How old was the Inca empire? VII, 341
 8. Why was the Inca culture lower than other South American cultures? VII, 345
 9. What was the religion of the Incas? VII, 346
 10. How was Inca literature possible without writing? VII, 346
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 26. Why did Mayan culture disappear easily? VII, 335
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 2. How many distinct cultures were found among the Indians north of Mexico? IV, 34-35

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4. What great Indian family lived in North America when white man came? IV, 4
5. How many Indian families live in North America? IV, 3
6. Into what general types are Indians classed? IV, 3
7. How was it possible for a million people speaking 200 different languages to communicate with each other? IV, 10
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15. What parts of Indian culture do we still retain? VII, 351
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17. What was the prevalence and significance of smoking tobacco? IV, 26-27
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 30. What historical record did the Indians keep before the coming of white man? IV, 250
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2. What practises lifted ancient man to a civilized state? XI, 97
3. What is the relation between grasses and the civilization of man? XI, 203-204
4. Why is the world indebted to the American Indian? XI, 346
5. In what modern science is corn a valuable tool? XI, 348
6. What amazing kind of work was carried on in the Bronze Age? VII, 283-284
7. What artistic work developed in the Bronze Age? VII, 280-281
8. How were the Bronze Age people dressed? VII, 272-273
9. How were early measurements made? VII, 280
10. When did the potter's wheel appear? VII, 273
11. When did true porcelain originate? VII, 274
12. When did jewelry develop? VII, 281
13. How did money originate? VII, 278-279

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14. What were early kinds of money? VII, 279-280
15. What did some primitive people do to their stone battle-axes when they first saw bronze ones? VII, 271-272
16. What protection against bronze arms was developed? VII, 272
17. How did picture writing begin? VII, 290
18. How were sounds first written? VII, 290
19. Why is writing a fundamental achievement? VII, 289
20. When did the knowledge of writing begin? VII, 167
21. What part of man's history is recorded in writing? VII, 167
22. What enabled the people of Crete to rapidly develop a Bronze Age civilization? VII, 309
23. Why is the alphabet the best system of writing? VII, 291
24. What race inhabited China before the Chinese? VII, 318
25. What culture did the conquerors of early China possess? VII, 318
26. When was the Chinese Empire established? VII, 325
27. What changes caused the overthrow of Chinese Feudalism? VII, 324
28. When did the great thinkers and philosophers of China begin their work? VII, 324
29. Where did Chinese obtain their Bronze culture? VII, 320

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30. When does the historical period of China begin? VII, 321
31. What happened to many small Chinese cities? VII, 321
32. What mystical properties were attributed by the ancients to ruby and sapphire? III, 209-210
33. What changes in warfare did the Bronze Age bring about? VII, 285
34. How were the Indo-Europeans able to conquer? VII, 288
35. How is food supply related to the development of art and science? XI, 319
36. Where did the Bronze Age last the longest? VII, 284-285
37. When did the Aryan invasion of India take place? VII, 314-315

H. Age of Iron:

1. What is the real measure of man's progress in civilization? XI, 319
2. When was iron adopted in Egypt? VII, 300
3. What town developments took place in the Middle Ages? VII, 282
4. Which activities are only carried on by man? VII, 20
5. Why is man master of the Earth? VII, 20
6. Why is this called the Steel Age and another the Copper Age? VII, 39-41
7. What is the effect of war on present civilization? VII, 181

Pupil and Class Activities

A. Things To Do:

1. Carve wooden models of early bronze axes. Paint with bronze gilt. VII, 270-271
2. Sew from rough cloth the garments of a man and woman of the late Bronze Age. VII, 274-275
3. Make clay copies of Pueblo water jars. Ornament them with black ink. IV, 12
4. Make a chart of the Cherokee alphabet. IV, 16
5. Using ordinary beads, make some of the Eskimo ornaments shown on page 49. IV
6. Using odd pieces of fur make an Eskimo doll. IV, 51
7. Using two pieces of wood, and following the drawing on page 52, carve a model of an Eskimo woodpecker toy. IV, 52
8. Construct a Wichita grass lodge from hay, straw or grass. IV, 161
9. Using white pine or balsa carve a totem pole. IV, 213
10. Paint Indian designs on shallow bowls. IV, 232
11. Weave an Indian sitting cradle from raffia. IV, 184
12. Make an Indian dog travois for carrying your equipment on a hike. VII, 255

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13. Make wooden models of earlier digging implements. VII, 258-260
14. Construct a Tasmian canoe model from bark lashed together in the manner shown in the diagram. VII, 240
15. Make a stone hatchet from a stone and wood. VII, 235
16. Make an early stone oil lamp from clay. Fill with animal fat and light a wick which stands in the fat. VII, 220
17. Carve a set of bone implements using triangular files. VII, 215
18. Make a set of Aurignacian implements. VII, 200
19. Make a set of Acheulian fist axes. VII, 189
20. Make a set of Chellean tools. VII, 186
21. Make pointed stone eoliths like those of 1,000,000 years ago. VII, 183
22. Chip a stone into an eolith. VII, 171
23. Make wood copies of the oldest tools known. VII, 135
24. Make a set of Mousterian stone tools. VII, 191
25. Make plaster casts of modern and Neanderthal man's skull to the same scale in order to compare the structure. VII, 118
26. Make large drawings of the skeletons of Neanderthal and modern Australian man to the same scale. VII, 115
27. Make plaster or clay models of prehistoric skulls. VII, 42-55

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28. Draw large outline diagrams which show the size of the brain from chimpanzee to modern man. VII, 163
29. Make models of the development of the jawbone in man. VII, 144
30. Visit a local museum of Natural History or an Indian Museum.

B. Class Discussions:

1. The plow is in universal use today. VII, 258-261
2. The little Island of Crete affected the civilization of large areas for many years. VII, 308-312
3. Egypt was the seat of civilization. VII, 294-308
4. Writing is the most important aspect of a civilization. VII, 288-293
5. Until the coming of the Bronze Age, man made little progress. VII, 40-44
6. The Chinese civilization was developed completely independent of all other cultures. VII, 317-325
7. Machines are causing civilization to go backward. XII, 309-352
8. Farm machines have lessened the importance of the farmer. XII, 303-308
9. Aztecs possessed a civilization. VII, 337-340
10. The Mayans had a great civilization. VII, 329-336
11. Civilization originated in the Indus valley. VII, 313-317
12. Man used horses for drawing carts before he rode horseback. VII, 285-289

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13. White man has had a constructive influence upon the Indians. IV, 5-8
14. Gems were known only in modern times. III, 316-319
15. Indians possessed traces of European culture before the coming of white men. XII, 349-351
16. White man had nothing to learn from the Indians about good diet and cooking. IV, 25-26
17. Indians were poor organizers. IV, 71-103
18. The Plains Indians lived solely a nomadic life. IV, 152-154
19. The wheel was invented in many places on the earth. VII, 256-257
20. The Middle Stone Age shows little advance over the Old Stone Age. VII, 234-245
21. Solutrean tools were superior to other contemporary tools. VII, 207-209.
22. It was man's physical superiority which enabled him to conquer the beasts of the jungle. VII, 168-172
23. Little change in the skull of man has taken place in the development of man. VII, 130-131
24. Negroid and white races were limited to Africa and Europe respectively. VII, 79-82
25. Cro-Magnon man physically, was the most superior man ever to inhabit the earth. VII, 77-79
26. Cro-Magnon men made drawings on their caves to fulfill a creative urge. VII, 201-206
27. Cro-Magnon man was more intelligent than modern man. VII, 73-78

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28. Rhodesian Man is related to Neanderthal man. VII, 160-164
29. All races of man developed from the same stock and became different because of local variations. IV, 1-2
30. Piltdown Man was really an ape. VII, 135-141
31. Pithecanthropus erectus was not a man. VII, 145-154
32. It is impossible to learn anything from the fragmentary remains of man. VII, 49-50

C. *Pupil Reports:*

1. Man's three greatest achievements. VII, 173
2. The hold of "magic" upon ancient man. VII, 177-181
3. The importance of the harvester and reaper to American development. XII, 303-308
4. How Indians name things. IV, 14-16
5. The Cherokee alphabet. IV, 16
6. The religion of the native Indian. IV, 28-34
7. The sign language of the Indians. IV, 11-12
8. A day in an Eskimo's life. IV, 45-49
9. A Pueblo village. IV, 131
10. How Cushing studied the customs of the Zuni Indians. IV, 118-128
11. The appearance of a cliff dwelling. IV, 102-110
12. What caused the differences between the culture of Indians on the west and inland. IV, 175-178
13. Tribes of the west coast. IV, 175-213

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14. Krapina man — an almost modern man. VII, 104-109
15. The cultures of the Old Stone Age. VII, 53-55
16. The relationship between the balancing of the head on the spine and man's development. VII, 46-49
17. The eras of life on the earth. VII, 13-22
18. The evolution of the jawbone. VII, 46

D. Self-Test Exercises:

TEST I

Change the letters in this code word as follows:

B J E S X W N O R I V

1. If no evidence concerning the existence of man 7000 years ago has been found, change B to V. If evidences of man more than 100,000 years ago has been found, change to P. VII, 2.
2. If man descended from primates, change J to O. If man descended from previous living things, change to A. VII, 22.
3. If the Pueblo Indians were the Cave Dwellers, change E to S. If the men of La Chappelle-aux-Saints were Cave Dwellers, change to L. IV, 110, VII, 114-118.
4. If Neanderthal man lived in the Old Stone Age, change S to E. If Java man belongs in the Old Stone Age, change to M. VII, 182-192
5. If Middle Stone Age man improved his weapons, change X to O. If Middle Stone Age man did not improve his weapons, do not change. VII, 235.

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6. If woven clothing was worn in the New Stone Age, change W to L. If only skins were worn, change to A. VII, 261-262.

7. If there are no people at the present time in the Stone Age stage of development, change N to L. If people have recently been found living in the Old Stone Age, change to I. VII, 184.

8. If iron quickly replaced the use of bronze, change O to B. If bronze was superior to early iron, change to T. VII, 306.

9. If the brain case of earliest known man and apes are the same, change R to C. If not, change to H. VII, 151.

10. If brain cases showed the development of intelligence, do not change. If brain cases are not valid evidence, change to O. VII, 131.

11. If the difference between a civilization and a lower type of civilization is the quality and quantity of goods produced, change V to A. If writing is an essential difference, change to C. VII, 345.

Note: If the above is correctly done, it will spell the name of an early era in the development of the earth.

ANSWER

Paleolithic

TEST II

Match each item in column A with the proper item in column B.

- | A | B |
|-----------------|----------------------------|
| a. man on earth | 1. tools invented. VII, 20 |
| b. grasses | 2. Piltdown. VII, 135 |

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- | | |
|-----------------------------|--|
| c. early writing | 3. Java. VII, 18 |
| d. growth of intelligence | 4. stone axe. VII, 235 |
| e. reverence | 5. civilization. XI, 203-204 |
| f. man, master of earth | 6. Cro-Magnon. VII, 198, 199 |
| g. highest type cave man | 7. Indus valley people. VII, 314, 315 |
| h. earliest bone instrument | 8. Less than one million years ago. VII, 2 |
| i. end of Neanderthal | 9. Mousterian. VII, 82 |
| j. earliest known man | 10. Pleistocene. VII, 19 |

ANSWERS

- | | |
|------|-----|
| a—10 | f—1 |
| b—5 | g—6 |
| c—7 | h—2 |
| d—8 | i—9 |
| e—4 | j—3 |

TEST III

In the first group you will find incomplete sentences. The second consists of completion of the first group. Re-write the sentences by matching proper second halves of sentences to make a true statement.

- | | |
|--|---|
| a. The record of man in the rocks VII, 52-53 | 1. during the Ice Age small populations of Chellean men were alive. |
| b. Men who study the record of man in the rocks VII, 135 | 2. during the Pleistocene period. |

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- | | |
|---|--|
| <p>c. Early man fades from the earth. VII, 2, 18-19</p> <p>d. "Dawn man" VII, 135</p> <p>e. Piltdown man VII, 140</p> <p>f. Java man VII, 146, 148</p> <p>g. The skull's stage of brain development VII, 46</p> <p>h. Neanderthal man was VII, 198</p> <p>i. Man did not disappear from Europe but VII, 234</p> <p>j. Cro-Magnon, a possibly physically superior man and possessing a larger brain than modern man VII, 73-76</p> | <p>3. used tools.</p> <p>4. is called Eoanthropus.</p> <p>5. is read by the markings of the folds of the brain.</p> <p>6. is called Pithecanthropus.</p> <p>7. superseded by Cro-Magnon man.</p> <p>8. is read in the strata and accumulations found in strata.</p> <p>9. are called anthropologists.</p> <p>10. is not considered to be more intelligent than modern man.</p> |
|---|--|

ANSWERS

- | | |
|-----|------|
| a—8 | f—6 |
| b—9 | g—5 |
| c—2 | h—7 |
| d—3 | i—1 |
| e—4 | j—10 |

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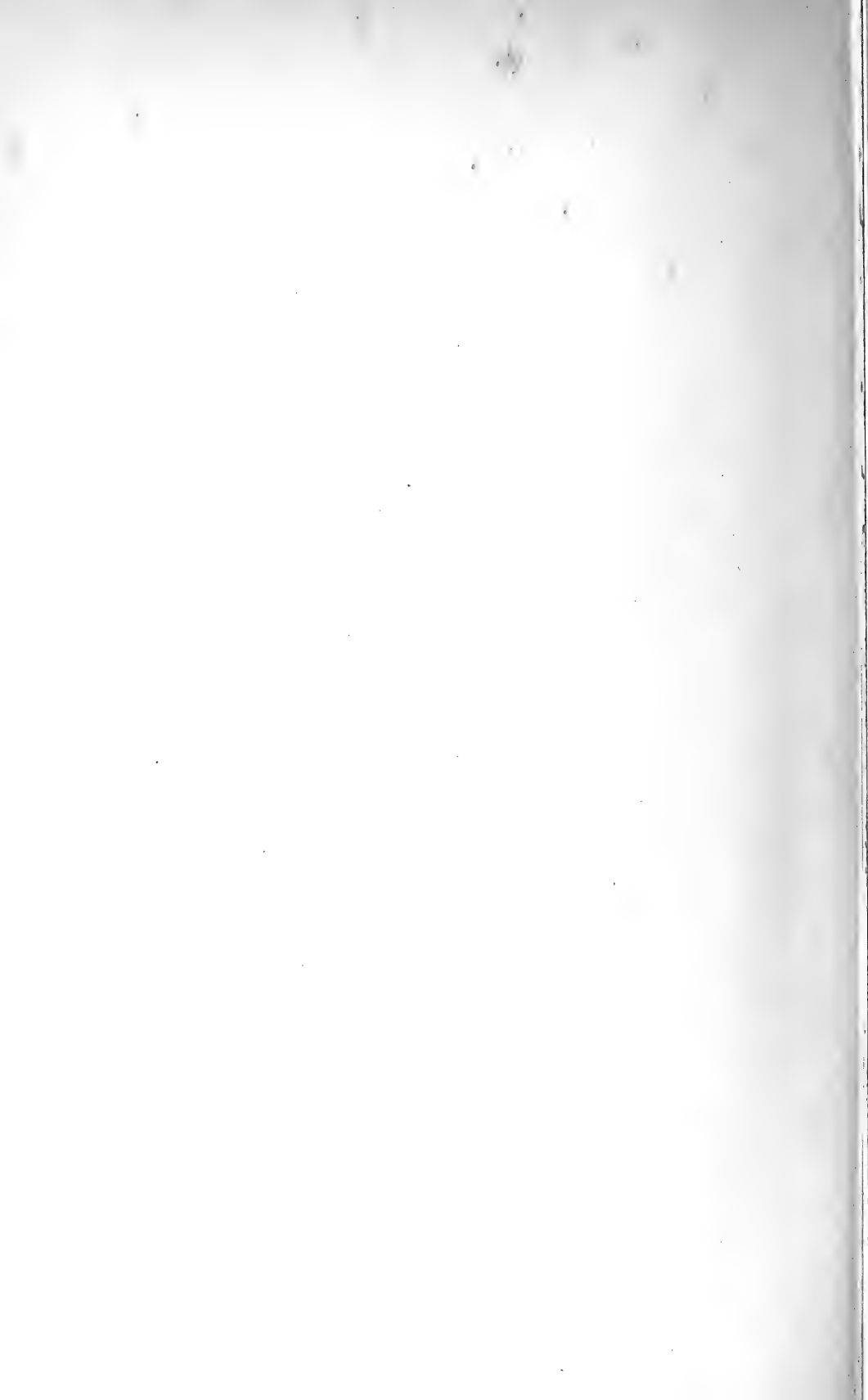
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December

Dr. Charles Greeley Abbot Former Smithsonian Secretary

By Jody Beck

Special to the Star-News

Dr. Charles Greeley Abbot, 101, a pioneering astrophysicist and former secretary of the Smithsonian Institution, died yesterday at Leland Memorial Hospital. He lived on Beechwood Road in Hyattsville.

Dr. Abbot spent much of his life investigating how man could use the sun for energy. Thirty years ago he said that when supplies of coal and oil were depleted, solar energy would become a primary source of power.

He continued his research into the problem long after he retired as secretary in 1944, taking out more patents when he was in his late 90s. Just before his 100th birthday last year, he received a patent on a device that converts solar energy to electricity—making him the oldest inventor ever to receive a patent, according to the Patent Office.

S. DILLON RIPLEY, secretary of the Smithsonian Institution

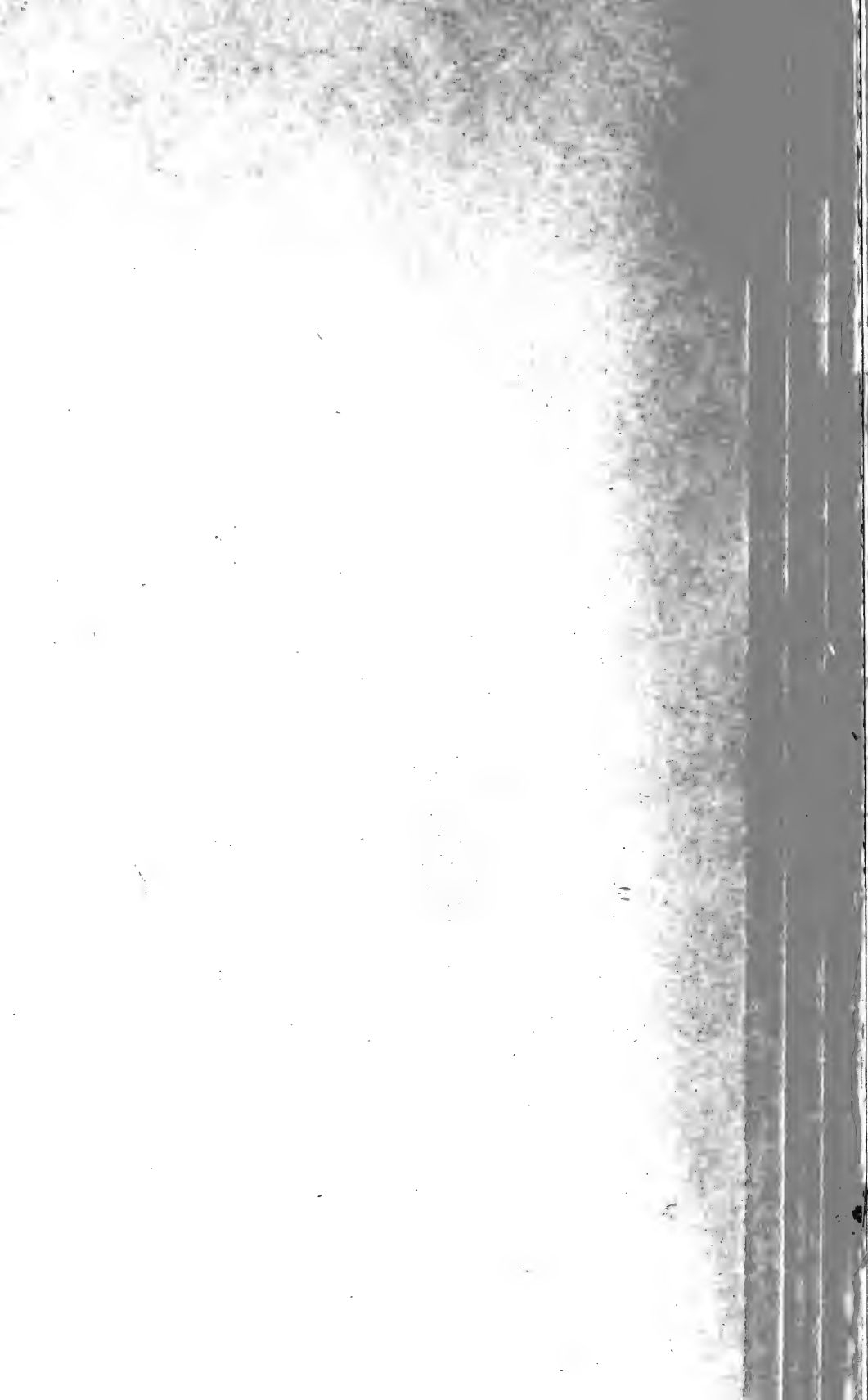


DR. CHARLES G. ABBOT

1928. One of his first acts as secretary was to set up his office in the tallest tower of the "castle" building.

"EVEN THOUGH he was an outstanding scientist, it is the person, one might even say the legend, that we will recall most vividly,"

Dr. Ripley's statement con-



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S. DILLON RIPLEY, secretary of the Smithsonian, said yesterday:

"It is truly amazing that a man who was ahead of his time 70 years ago could still be ahead of his time today, and yet that has been the case with Dr. Abbot. He began measuring solar radiation in 1902, built a solar-powered oven in 1922, and in 1972 received a patent on a solar battery. Today the energy crisis has us finally looking seriously at a subject Dr. Abbot has been pioneering throughout the entire 20th century."

JOINING the Smithsonian in 1895 after earning a masters degree in physics from the Massachusetts Institute of Technology, Dr. Abbot helped revolutionize the field of astrophysics. One of his early experiments established that the sun's radiation fluctuates in recurring cycles. That led to another theory—still scoffed at by weathermen—that the earth's weather is tied to solar radiation and that knowledge of the cycles can be used to forecast weather as far as 60 years in advance.

During the nearly three decades of his retirement, Dr. Abbot and his assistants continued to study the relationship of solar radiation to the weather. As a part of his work, he regularly made four-monthly and yearly predictions for more than 50 places around the world.

Dr. Abbot became secretary, or chief executive officer, of the Smithsonian in



DR. CHARLES G. ABBOT

1928. One of his first acts as secretary was to set up his office in the tallest tower of the "castle" building.

"**EVERY** **THOUGH** he was an outstanding scientist, it is the person, one might even say the legend, that we will recall most vividly," Dr. Ripley's statement continues. "Dr. Abbot, Merlin-like in the tower of the Smithsonian castle, forecasting the weather years hence; Dr. Abbot taking time to tell brides if their wedding days would be sunny; Dr. Abbot singing sea chanteys at his 100th birthday party; Dr. Abbot standing on top of the tower to watch Samuel Langley's pre-Wright brothers attempt at flight and then being present when the Apollo 11 astronauts brought the first lunar sample to the Smithsonian."

When he retired at 72, Dr. Abbot kept his tower office, where he worked as a research associate. Several years ago, he moved to a lower floor in deference to his age. The office has since been closed.

BORN ON A FARM near Wilton, N.H., in 1872, Dr. Abbot dropped out of school at 13 to become a carpenter. He soon returned, completed high school and then attended Phillips Andover Academy for a year. At the urging of friends, he went to Boston and took the entrance exams for M.I.T. as a lark. He began at M.I.T. as a chemical engineering student, but later switched

to physics and graduated with high honors.

Throughout his career, Dr. Abbot invented technical aides to his research or improved other's inventions. In his first year at the Smithsonian he was an assistant to Prof. Samuel P. Langley, who was trying to plot the Fraunhofer lines in the invisible infra-red spectrum. Dr. Abbot altered the measuring device, the bolometer, and the experiment was completed successfully.

ALTHOUGH the practical application of solar energy for everyday use was his second area of interest—after the weather theory—he built a device he called a solar cooker in 1922, which heated an oven hot enough to bake a loaf of bread.

A solar engine he developed was exhibited at the Great Lakes Exposition in Cleveland in 1933. Another of his inventions generated power for a 1936 nationwide NBC radio broadcast from the old Smithsonian building.

One of the more important theories—now well accepted—first advanced by Dr. Abbot was that the photosphere of the sun is not a cloud of liquid particles, but is entirely gaseous.

Following the sun to observe eclipses and measure solar radiation took Dr. Abbot to every continent but Antarctica. There is even a crater named for him on the back side of the moon, an honor from Soviet cosmonauts.

"**EVERY DAY MYSTERIES**," a group of scientific stories for young people, and classic volumes on the sun are among the 12 books and more than 175 technical papers written by Dr. Abbot.

Dr. Abbot was a former president of the Cosmos Club of Washington and a

former vice president of the American Astronomical Society. He was elected to the National Academy of Sciences in 1915 and was its oldest member at his death. He belonged to numerous other scientific organizations.

He received honorary doctorate degrees from Case School in Cleveland, George Washington University and Toronto University. In 1932 he was elected to Sigma Xi.

Dr. Abbot leaves his wife, Virginia A. Johnston. His first wife, Lillian E. Moore, died in 1944.

Services will be held at 1 p.m. Thursday at Georgetown Presbyterian Church, 3115 P St. NW, with burial in Fort Lincoln Cemetery.



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