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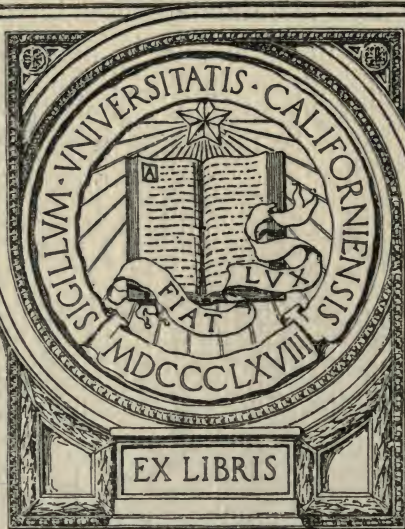
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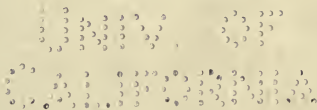
# OUTLINE OF SCIENCE

FOR THE

## FOUR UPPER GRADES

BY

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## PREFACE.

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The material which is given in these outlines is intended for children in the grades as numbered.

The selection of the subject matter is based upon the author's own experience with children from those grades and is not too difficult. It must be remembered that a title of a section in a science book does not indicate the method of presentation, thus the same title might be found in a book intended for the lower grades as in a book for college students, but the treatment of the subject matter would be entirely different. The best results are obtained by presenting a subject in a manner which brings it just within the capability of the pupils; working them up to their highest efficiency, but stopping short of their limitations.

The needs of the child are heat, air, water, food, and the conveniences and comforts of civilization. For that reason the subject matter has been divided into ten general sections, while the outline of the complete course has been divided into work suitable for the fifth, sixth, seventh and eighth grades. This outline is offered as an aid to those who wish to develop their own courses. Four books, one for each of the grades mentioned, and based upon these outlines, are in the process of preparation by the same author.

- The divisions of the subject matter are as follows:
- |  |    |     |      |       |
|--|----|-----|------|-------|
| 1. The Sun, Stars and Planets                            | V. | VI. | VII. | VIII. |
| 2. Light   | V. | VI. | VII. | VIII. |
| 3. Heat  | V. | VI. | VII. | VIII. |
| 4. Air   | V. | VI. | VII. | VIII. |
| 5. Water   | V. | VI. | VII. | VIII. |
| 6. Plants and Animals                                    | V. | VI. | VII. | VIII. |
| 7. Food  | V. | VI. | VII. | VIII. |
| 8. Mechanics   | V. | VI. | VII. | VIII. |
| 9. Magnetism and Electricity                             | V. | VI. | VII. | VIII. |
| 10. The Arts and Industries<br>(applications of science) | V. | VI. | VII. | VIII. |

There is not only a gradual transition from the work of one grade to the work of the next higher grade, aided by a brief summary of each topic, but there is also an easy development of each topic from the preceding one. For example: (1) The sun produces (2) Light, (3) Heat, affects the (4) Air, and the (5) Water, causing (6) Plants and Animals to live, produces (7) Food, has gravitation, which is considered under (8) Mechanics, has an effect upon (9) Magnetism, while aiding many of the (10) Industries. The material has been carefully selected, while the development proceeds from topic to topic and year to year.

PERCY ELLIOTT ROWELL.

Berkeley, California.

March, 1913

## INTRODUCTION.

The teaching of Science in the grades has been attempted many times and in various ways, with different degrees of success. Several of the difficulties have arisen from the fact that only a narrow field of science has been presented and that field has usually been too highly specialized. The temptation to elaborate a single course produces a result, which while complex with details, remains narrow in its field. The child requires the simpler parts of all the branches of science.

All children of the grades have many common experiences. The youngest child bathes, eats, turns on the electric lights, uses an electric car and experiences all of the changes in the weather alike with the eldest child. To confine the younger child to a study of any one thing or group of things, is to deprive him of natural opportunities of learning. The beginnings of all branches of science should be given in order that the child may, as soon as possible, obtain a bird's-eye view of the field of general knowledge. He then can see the interrelations of the different facts and begin really to think and to reason.

The science which is the most valuable to the child is that which explains the phenomena of the environment—the science of common things—the science of everyday life. Therefore science, even in the grades, should deal with its common and simpler applications. Science will lose none of its cultural value but will become a living thing.



# OUTLINE OF SCIENCE FOR THE FIFTH GRADE.

## THE SUN, STARS, AND PLANETS. V.

1. **Time of sunrise and sunset.**
  - a. How it varies
  - b. At the same hour twice a year.
2. **Experiments.**
  - a. The definition of experiments.
  - b. The value of experiments.
3. **Direction of the North.**
  - a. North star located by means of the Great Dipper.  
Experiment 1. To locate the north by means of the north star.  
Experiment 2. The movement of the Great Dipper. Chart.
  - b. North by means of a shadow at local noon.  
Experiment 3. To locate the north by means of a shadow.  
Experiment 4. To locate the south by means of a watch.
  - c. The north side of trees has the most moss.
4. **North, south, east, and west.**
5. **North-east, north-west; south-east, south-west.**
6. **The Direction of sunrise and sunset.**
  - a. What was it today?  
Experiment 5. The direction of sunrise and sunset by shadows.

- b. How does the direction of sunrise and sunset vary?

Experiment 6. The record of directions.

7. **Telling time by the sun.**

- a. The Sundial.

Experiment 7. Horizontal and vertical sundials.

8. **Other ways of telling time.**

Experiment 8. The sand glass and the sand wheel.

9. **The height of the sun at noon.**

- a. The height of the sun at noon today.

Experiment 9. The height of the sun by means of a shadow.

- b. The variation in the height of the sun at noon.

Experiment 10. A record of the height of the sun. The altitude measurer.

(These subjects, The Sun, Stars, and Planets, are continued in the work for the sixth grade.)

## LIGHT. V.

10. **The light we receive from the sun.**

- a. The variation in the amount of light.

Experiment 11. Look at the sun through smoked glass.

11. **The sunlight makes plants green.**

Experiment 12. Effect of sunlight on growing plants.

12. **The sunlight changes the color of many objects.**
- Tans the skin and causes freckles.
  - Fades and bleaches color from paper and clothes.

Experiment 13. The effect of sunlight on color.. Bleaching.

- The sunlight affects chemical or photographic paper.—(See Section 70.)

Experiment 14. Leaf and other blue prints.

13. **The sunlight good for the health.**

- Sunbaths.
- Dark corners gather dirt and disease.

14. **Light travels in straight lines.**

Experiment 15. To show how light travels.

Experiment 16. How to make and use a pin-hole camera.

15. **The reflection of light.**

- Regular reflection of light.

Experiment 17. Experiments with mirrors.

- Diffused reflection of light.

Experiment 18. How we see objects by diffused reflection of light.

16. **Light from sources other than the sun.**

- Light with heat.

Experiment 19. Ordinary sources of light.

- Light without heat.

Experiment 20. Cold light.

(This subject, Light, is continued in the work for the sixth grade.)

## HEAT. V.

### 17. The heat we receive from the sun.

- a. The heat varies with the time of day and with the seasons.

Experiment 21. The varying heat from the sun.

- b. The heat varies with the color of the object receiving it.—(See Section 71.)

Experiment 22. The effect of the sun's heat upon different colors.

- c. The heat received by a large surface may be brought to a small surface, making it very hot.

Experiment 23. "The burning glass."

### 18. Expansion due to heat.

- a. Examples of expansion.—(See Section 72.)

Experiment 24. Heat causes expansion.

- b. All materials do not expand the same amount.

Experiment 25. The results of unequal expansion.

### 19. The thermometer an application of expansion.

Experiment 26. How to read a thermometer.

### 20. Heat produces light.

- a. The temperature of red heat and of white heat.

Experiment 27. Red-hot and white-hot.

### 21. Heat from friction.

- a. The old way of making fire.

Experiment 28. Primitive fire-making.



- b. The flint and steel.  
Experiment 29. The flint and steel.
- c. The modern heat from friction—the match.  
The proper care of matches. Danger from mice.

22. **Heat from combustion.**

- a. Complete combustion — no smoke — economical.
- b. Incomplete combustion—smoky—wasteful.  
Experiment 30. Complete and incomplete combustion.

23. **Combustibles and fuels.** (See Section 73.)

- Experiment 31. The combustion of different materials.

24. **Flames.**

- Experiment 32. The cause of flame.

25. **First aid to the burned.**

- Experiment 33. Drill for extinguishing burning clothing.

26. **Conduction of heat.**

- a. Good and poor conductors.  
Experiment 34. Good and bad conductors of heat.
- b. Why some objects feel warm and others feel cold although both are at the same temperature.

(This subject, Heat, is continued in the work for the sixth grade.)

## AIR. V.

27. **Air is necessary for life of any kind.**  
Experiment 35. Deep breathing and holding the breath.  
Experiment 36. The effect of depriving a plant of air.
28. **There is air in the soil.**  
Experiment 37. To show the presence of air in the soil.
29. **The composition of the air.**  
Experiment 38. The amount of oxygen in the air.  
Experiment 39. The amount of carbon dioxide in the air.
30. **Oxygen.**  
Experiment 40. To prepare and use oxygen.
31. **Nitrogen.**  
a. Dilutes the oxygen.  
b. Is used by plants.
32. **Respiration.**  
a. The number of breaths per minute.  
b. The amount of air inhaled at each breath.  
Experiment 41. The capacity of the lungs.
33. **Carbon dioxide.**  
a. Used by plants.  
b. Exhaled by animals and given off by fires.  
Experiment 42. Carbon dioxide from the breath and from a candle.  
(This subject, Air, is continued in the work for the sixth grade.)

## WATER. V.

### 34. Water is a liquid.

- a. A liquid has no shape, but its surface is always flat.

Experiment 43. The level.

- b. Liquids flow and break into drops.

Experiment 44. "Water seeks its own level." Size of drops.

### 35. Water can pass into some things.

- a. Porous bodies and how they may be changed.

Experiment 45. Porous bodies absorb water.

Experiment 46. To make porous bodies waterproof.—(See Section 74.)

- b. Filters—nature's and man's.

Experiment 47. Filtration.

### 36. Solution.

- a. Water as a solvent.

Experiment 48. Solution and its oddities.

- b. Other solvents.—(See Sections 75 and 76.)

Experiment 49. The use of alcohol and gasolene as solvents.

### 37. Crystals.

- a. From solution.

Experiment 50. Crystallization.

- b. Some crystals as they occur in nature.

### 38. Water for drinking.

- a. Importance of pure water.

- b. The advantage of drinking considerable water.

- c. Harmful drinks—alcohol, coffee, and tea.

39. **Water for cleansing.**—(See Section 77.)
- a. Hard and soft water.  
Experiment 51. Hard and soft water.  
Soap.
  - b. The importance of bodily cleanliness.
40. **Plants need water.**  
Experiment 52. The effect of water upon seeds and plants.
41. **Capillarity.**
- a. In tubes and in porous bodies.  
Experiment 53. Examples of capillarity.
  - b. In the soil.  
Experiment 54. How water is held in the soil.
- (This subject, Water, is continued in the work for the sixth grade.)

## PLANTS AND ANIMALS. V.

42. **The testing of seeds.**  
Experiment 55. Germination tests.
43. **The beginning of plant life.**  
Experiment 56. How several of our common vegetables start from their seeds. "The pocket garden."
44. **The proper planting of seeds.**  
Experiment 57. To show proper and improper planting.
45. **Names and descriptions of the common birds.**  
Experiment 58. The food of the common birds.
46. **Names and descriptions of the domestic animals.**

47. **Names of the common garden and common wild flowers.**

Experiment 59. (A continuous experiment.) To make a collection of pressed flowers, mounted on cards.

48. **Names of the common trees.**

- a. Leaves.
- b. Fruits and seeds.
- c. Bark.

Experiment 60. (A continuous experiment.) To make a collection of leaves, seeds, or seed cases, and bark of the common trees.

Experiment 61. Plant seeds of the common trees.

49. **A queer plant—yeast.** (See Sections 78 and 80.)

- a. Used in bread making.
- b. Used in fermentation.

Experiment 62. Fermentation.

50. **Another queer kind of plant—the bacteria.**

- a. Useful.
- b. Harmful

51. **Souring and decay.**

- a. If the bacteria are killed there will be no souring or decay.

Experiment 63. Two ways of preserving milk.

- b. The harmfulness of decayed food.
- c. The care of the teeth.

52. **Disease and sanitation.**

(These subjects, Plants and Animals, are continued in the work for the sixth grade.)

## FOOD. V.

53. **The source of all food.**
  - a. Plant food.
  - b. Animal food.
54. **The farm a workshop.**
55. **Tilling the soil.**

(Garden work may begin here)
56. **Alcohol as a dangerous drug.**
57. **The harmfulness of chewing tobacco and of chewing gum.**

(This subject, Food, is continued in the work for the sixth grade.)

## MECHANICS. V.

58. **Simple measurement.**
  - a. Length.
  - b. Area.
  - c. Volume.

Experiment 64. The arithmetic of measurement.
  - d. Circular measurement.
59. **Everything has weight.—The balance.**

Experiment 65. Air has weight.
60. **Everything occupies space.**

Experiment 66. Displacement of water by solids and air.
61. **Density.**

Experiment 67. Different bodies of the same size have different weights.
62. **Drawings.**
  - a. Making straight lines and curves.
  - b. Drawings should be made of all experiments.

- c. Tracings of drawings may be duplicated by blue print paper.

Experiment 68. Blue printing from tracings.—(See Section 70.)

63. **The pendulum.**

- a. The weight of the bob makes no difference in the number of swings per minute.  
b. The effect of length.

Experiment 69. The simple pendulum.

64. **Forces.**

- a. Pushes and pulls. Elasticity.  
Experiment 70. Weight is a pull.  
b. Pressure is the push on a certain surface.

65. **The lever.** (See Section 79.)

Experiment 71. The use of a lever.

66. **The inclined plane.**

Experiment 72. The use of the inclined plane.

(These subjects, Mechanics, are continued in the work for the sixth grade.)

## MAGNETISM AND ELECTRICITY. V.

67. **The lode stone.**

68. **Steel magnets.**

- a. Attraction.

Experiment 73. Magnetic materials.

- b. The space around a magnet.

Experiment 74. To draw a magnetic field.

Experiment 75. Blue prints of magnetic fields. (See Section 70.)

c. Repulsion.

Experiment 76. The rule of attraction and repulsion.

(These subjects, Magnetism and Electricity, are continued in the work for the sixth grade.)

## THE ARTS AND INDUSTRIES. V.

69. Weather observation.

A simple record of the weather should be kept.

70. How to make blue print paper.—(See Sections 12, 62, and 68.)

71. Solar heaters.—(See Section 17.)

72. Hot air engines.—(See Section 18.)

Experiment 77. The way a hot air engine works.

73. Fireproofing.—(See Section 23.)

Experiment 78. Simple fireproofing.

74. Waterproofing.—(See Section 35.)

75. Flavoring extracts and perfumes.—(See Section 36.)

76. To remove grease and stains.—(See Section 36.)

77. How to make soap.—(See Section 39.)

Experiment 78. How to make scap.

78. Bread making.—(See Section 49.)

79. The pantagraph.—(See Section 65.)

Experiment 79. How to make and use a pantagraph.

80. Alcohol for industrial purposes—(See Section 49.)  
(More applications of science are given in the work for the sixth grade.)



# OUTLINE OF SCIENCE FOR THE SIXTH GRADE.

## THE SUN, STARS, AND PLANETS. VI.

1. A brief summary of the facts stated under the same topics in the work for the fifth grade.
2. The earth a large magnet.
  - Experiment 1. The magnetism of the earth.
3. The magnetic compass.
  - Experiment 2. Direction by a compass.
4. Latitude and longitude.
  - Experiment 3. The use of cross section paper.
5. Maps.
  - a. What maps show and how to use them.
  - b. Making maps.
    - Experiment 4. Making a map of the school grounds.
6. The moon.
  - Experiment 5. Why the moon changes its appearance.
  - Experiment 6. Observation of the moon.
7. The earth and the moon.
  - a. Shape and size.
  - b. Distance to the moon.
    - Experiment 7. Drawing to scale.
8. Motions of the earth.
  - a. Rotation on an axis.
    - Experiment 8. The gyroscope. The top.
  - b. Revolution around the sun.

9. **Time.**

a. Sun time or local time.

Experiment 9. The real noon.

b. Standard time.

10. **The seasons.**

Experiment 10. Area covered by unit area of sunshine.

Experiment 11. The cause of seasons.

11. **The changing length of day and night.**

Experiment 12. The cause of the changing length of day and night.

12. **The story of the calendar.**

(These subjects, The Sun, Stars, and Planets, are continued in the work for the seventh grade.)

**LIGHT. VI.**

13. **A brief summary of the facts stated under the same topic in the work for the fifth grade.**

14. **Light passes through some objects easily.**

Experiment 13. Transparent objects — the "burning glass."

15. **Light passes through some object with difficulty.**

Experiment 14. Translucent objects.

16. **Diffused light.—(See Section 90.)**

a. Best for the eyes.

b. Why the sun seems largest at sunrise and sunset.

17. **Reflection of light.**

a. Images in a mirror.

Experiment 15. The location of images in a mirror.

b. The direction of reflected light.

Experiment 16. The angle of reflection.

18. **Twilight and the afterglow.**  
19. **Light cannot pass through some objects. Opaque bodies.**

Experiment 17. The change from transparent to translucent and opaque.

20. **Shadows.**

- a. The cause of shadows.  
b. Variation in the shape and size of shadows.

Experiment 18. The shape and size of shadows. The shadow of the sphere.

- c. The magic of shadows.

Experiment 19. Shadow pictures.

- d. The height of buildings and trees found by their shadows.

Experiment 20. Height from shadows.

21. **The shadow of the earth upon the moon.**

Experiment 21. A report upon an eclipse of the moon.

22. **The effect of light upon bacteria. Hygienic living.**

(This subject, Light, is continued in the work for the seventh grade.)

## HEAT. VI.

23. **A brief summary of the facts stated under the same topic in the work for the fifth grade.**

24. **Convection.**—(See Section 92.)

- a. In water.

Experiment 22. The hot-water system of heating.

- b. In air.

Experiment 23. The hot-air system of heating.

25. **Solids, liquids and gases.**  
a. Characteristics.  
b. Heat the cause of the difference.  
Experiment 24. Melting and vaporizing.
26. **The way a thermometer is marked.**  
Experiment 25. The freezing point and the boiling point.
27. **All things do not have a melting temperature.**  
Experiment 26. The melting of waxes; glass bending.
28. **Evaporation.**  
a. Requires heat.  
Experiment 27. Freezing by the evaporation of ether.  
b. The value of perspiration.
29. **Other uses of evaporation.**  
a. Cooling of food.  
b. Distillation.  
Experiment 29. The distillation of water.  
c. Steam causes pressure.—(See Section 94.)
30. **Kindling temperature.**—(See Section 95.)  
Experiment 30. "Setting fire" without flame.
31. **Slow combustion.**  
a. Rusting, decay—damp leaves.  
b. Animal heat.  
Experiment 31. To find the temperature of the body.
32. **Spontaneous combustion.**  
a. The danger from oily rags.  
Experiment 32. Spontaneous combustion of oily rags.

- b. Other examples of spontaneous combustion.
- 33. **Clothing.**—(See Section 96.)
  - a. Kinds of clothing.
    - Experiment 33. The flame test for cotton and wool.
  - b. Uses of clothing. The dangers from too much clothing.
- 34. **Heat kills bacteria.**
  - a. Pasteurizing.
  - b. Purification by boiling. Its limitations. (This subject, Heat, is continued in the work for the seventh grade.)

## AIR. VI.

- 35. A brief summary of the facts stated under the same topic in the work for the fifth grade.
- 36. **Drafts in stoves.**
  - b. How to use them properly.
- 37. **Ventilation.**
  - a. Convective.
    - Experiment 34. Ventilation in a chalk box.
  - b. Forced.
- 38. **Dangers from impure air.**
  - a. Temporary results.
  - b. Permanent results.
- 39. **Tests for bad air.**—(See Section 98.)
  - a. By odor. The limitations of the sense of smell.
  - b. By chemicals.
    - Experiment 35. To test the air of a room.
- 40. **The warming of the atmosphere.**

- a. Direct heating.
  - b. Reflected heating.
  - c. Heating by convection.
41. **The cause of winds.**  
Experiment 36. The weather vane.  
(See Section 88.)
42. **The work of the winds.**
  - a. Effects on surface of the earth.
  - b. The wind wheel.  
Expèriment 37. How to make a wind wheel.  
Experiment 38. How to make a good kite.
  - c. The velocity of the winds—(See Section 88.)
43. **The weight of the atmosphere.**  
Experiment 40. To show that air has weight. (No air pump is needed.)
44. **The pressure of the atmosphere.**—(See Section 97.)
  - a. Equal in all directions. v  
Experiment 41. Pressure of the atmosphere equal in all directions.  
Experiment 42. An inverted glass of water.
  - b. The amount of the atmospheric pressure.
45. **The barometer.**—(See Section 88.)  
Experiment 43. How to make a barometer.
46. **The weather and climate.**
  - a. Fair, cloudy, or rainy.
  - b. The direction and strength of the wind.
  - c. The temperature; morning, noon, and evening.

- d. The pressure of the atmosphere.  
(This subject, Air, is continued in the work for the seventh grade.)

## WATER. VI.

47. **A brief summary of the facts stated under the same topic in the work for the fifth grade.**
48. **The capacity of different soils for water.**  
Experiment 44. The effect of texture upon the water capacity of soils.
49. **How to increase the moisture-holding capacity of soils.**  
Experiment 45. The effect of tilling.
50. **Moisture of the soil.**  
a. Its importance to the soil.  
b. The amount used by plants.  
c. The amount lost.
51. **Conservation of moisture of the soil.**  
a. Tilling.  
b. Mulching.  
Experiment 46. Conservation of moisture.
52. **The effect of water upon the surface of the earth.**  
a. Erosion.  
b. Effect of freezing.
53. **How seeds obtain water.**  
Experiment 47. Osmosis.
54. **Water can exert force.**  
Experiment 48. Water pressure.
55. **Buoyancy a force.**—(See Section 101.)  
a. Floating bodies.  
b. Bodies which sink.  
Experiment 49. Buoyancy.

56. Water has an elastic surface.  
Experiment 50. Surface tension.
57. Disease and bad odors may be prevented by solutions.  
a. Antiseptic washes. 2  
b. Disinfectants.  
c. Deodorants.  
(This subject, Water, is continued in the work for the seventh grade.)

## PLANTS AND ANIMALS. VI.

58. A brief summary of the facts stated under the same topic in the work for the fifth grade.
59. Names of the common vegetables.  
Experiment 51. Draw or model the vegetables.
60. Roots.  
a. Need air.  
Experiment 52. Roots need air.  
b. How roots obtain food from the soil.
61. Plant stems.  
a. Different kinds.  
b. Use and construction.  
Experiment 53. Structure and use of stems.
62. Linen.—(See Section 96.)
63. Leaves.  
a. Construction of leaves.  
Experiment 54. Skeleton leaves.  
b. The food the leaf makes.  
Experiment 55. Starch from leaves.  
c. Leaves give off water.  
Experiment 56. Transpiration.



64. **Buds and flowers.**

Experiment 57. The common flowers.  
Fruit flowers.

65. **Fruits and seeds.**

Experiment 58. The common fruits and seeds.

66. **Cotton.**—(See Section 96.)

67. **Weeds.**

Experiment 59. Collect the weeds of the neighborhood.

68. **Domestic animals.**

69. **Wool.**—(See Section 96.)

(These subject, Plants and Animals, are continued in the work for the seventh grade.)

## FOOD. VI.

70. **A brief summary of the facts stated under the same topic in the work for the fifth grade.**

71. **The resources of the soil.**

a. Plant-food ready for the plants.

Experiment 60. Nutrient solution.

b. Changes taking place in the soil.

72. **Enriching the soil.**

a. Barnyard manure.

b. Green manures.

c. Fertilizers.

73. **Humus.**

a. Its composition.

b. Its use.

74. **Irrigation.**

a. Surface.

b. Sub-irrigation.

Experiment 61. Sub-irrigation.

75. Preservation of food.

- a. Cleanliness.
- b. Coolness.
- c. By sealing.
- d. By heating.

Experiment 62. Preserving food by heating.

- e. By chemical means. Some of the dangers.
- Experiment 63. Preserving eggs.

76. The teeth.

- a. Care of the teeth.
- b. Cause of decay.

(This subject, Food, is continued in the work for the seventh grade.)

## MECHANICS. VI.

77. A brief summary of the facts stated under the same topic in the work for the fifth grade.

78. Altitude measurement.

Experiment 64. How to make and use altitude measurer.

79. The wheel and axle.

Experiment 65. The wheel and axle a lever.

80. The pulley.

- a. Fixed.
- b. Movable.

Experiment 66. The pulley a lever.

81. The screw.

Experiment 67. The screw a circular inclined plane.

82. Inertia.

Experiment 68. Tricks based upon inertia.

**83. Velocity.**

a. Speed indicators.—(See Section 88.)

Experiment 69. How to make a speed indicator for the wind.

b. Momentum.

Experiment 70. Examples of momentum (These subjects, Mechanics, are continued in the work for the seventh grade.)

**MAGNETISM AND ELECTRICITY. VI.**

**84. A brief summary of the facts stated under the same topic in the work for the fifth grade.**

**85. Magnetic effects of electricity.**

Experiment 71. How to make an electric magnet.

**86. Applications of magnetism due to electricity.**

a. The electric bell.

Experiment 72. How to make an electric bell.

b. The telegraph.

Experiment 73. How to make a telegraph instrument.

c. The electric motor.

Experiment 74. How to make an electric motor.

(These subjects, Magnetism and Electricity, are continued in the work for the seventh grade.)

**THE ARTS AND INDUSTRIES. VI.**

**87. Man's applications of nature's principles.**

**88. Weather instruments.—(See Sections 41, 42, 45, and 83.)**

Experiment 75. Home-made weather instruments.

89. **History of lighting.**
90. **Systems of illumination.**—(See Section 16.)
91. **History of heating.**
92. **Modern systems of heating.**—(See Section 24.)
  - a. The hot-air system.
  - b. The hot-water system.
93. **Temperature regulators.**
94. **The steam engine.**—(See Section 29.)
95. **Davy's safety lamp.**—(See Section 30.)

Experiment 76. Davy's safety lamp.
96. **Clothing.**—(See Sections 33, 62, 66 and 69.)

Experiment 77. The testing of cloth.
97. **The use of compressed air.**—(See Section 44.)
98. **The uses of carbon dioxide.**—(See Section 39.)
  - a. Baking soda.
  - b. The chemical engine.

Experiment 78. The chemical engine.
  - c. Mortar.
99. **Cement and plaster of paris.**

Experiment 79. Work with plaster of paris.
100. **First aid to the injured.**

Experiment 80. Exercises in "first aid."
101. **Applications of buoyancy.**—(See Section 55.)
  - a. Hydrometers and lactometers.

Experiment 81. A home-made hydrometer.
  - b. The diving bell.

Experiment 82. The diving bell.

(More applications of science are given in the work for the seventh grade.)

# OUTLINE OF SCIENCE FOR THE SEVENTH GRADE.

## THE SUN, STARS, AND PLANETS. VII.

1. A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.
2. Gravitation.
  - a. Causes weight.  
Experiment 1. Specific weight.
  - b. Center of gravity. The plumb bob.—(See Section 84.)  
Experiment 2. The balancing horse and tight-rope walker.
3. Tides. (See Section 85.)
  - a. Due to moon and sun.
  - b. Time of.  
Experiment 3. Plotting height and time of tides.
4. Planets.
  - a. The size of planets.
  - b. Their distance from the sun.  
Experiment 4. Drawing the planets to scale.
5. Changes in the surface of the earth.
  - a. Agents of weathering.
  - b. Agents of erosion.  
Experiment 5. Effects of running water  
The sand table.
6. Changes in the surface of the earth.
  - a. Due to plants and animals.
  - b. Due to bacteria.
7. Slowness of change in the surface of the earth.

**8. The heat of the earth's interior.**

a. Hot springs and geysers.

Experiment 6. A geyser.

b. Volcanoes.

(These subjects, The Sun, Stars, and Planets, are continued in the work for the eighth grade.)

**LIGHT. VII.**

**9. A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.**

**10. The bending of light.**

Experiment 7. The path of light through thick glass.

**11. The effect of a prism upon the direction of light.**

Experiment 8. The path of light through a prism.

**12. White light is composed of many colors.**

Experiment 9. Dispersion of light by a prism.

Experiment 10. The composition of white light.

**13. Color.**

a. Depends upon the light reflected.

Experiment 11. Colors as seen by the sodium flame.

b. Depends upon light transmitted.

Experiment 12. The transmission of color.

Experiment 13. Color from reflection and transmission.

**14. The rainbow.**

a. Single.

b. Double

Experiment 14. The rainbow.

15. The intensity of light in relation to distance.  
Experiment 15. The intensity of light determined by a shadow.
16. The measurement of light.  
a. The candle-power.  
b. Measurement by shadows.  
Experiment 16. The shadow photometer. How made and how used.  
c. Measurement by translucence.  
Experiment. 17. The paraffin block photometer. How made and how used.
17. Lenses.  
a. Convex.  
b. Concave.  
Experiment 18. Lenses are prisms. The reducing glass.
18. Images from a convex lens.  
a. Magnified and upright.  
Experiment 19. The magnifying glass.  
b. Real, both large and small; inverted.  
Experiment 20. Images on a screen.  
(This subject, Light, is confined in the work for the eighth grade.)

## HEAT. VII.

19. A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.
20. Heat causes boiling.  
a. Boiling temperature raised by dissolved substances.  
Experiment 21. Boiling temperature of solutions.  
b. Boiling temperature raised by increased pressure.

Experiment 22. Effect of increased pressure upon the temperature of boiling.

- c. Boiling temperature lowered by reduced pressure. ,

Experiment 23. Effect of decreased pressure upon the temperature of boiling.

21. **Sublimation— a change from solid to gas.**

Experiment 24. Two kinds of sublimation.

22. **Frost and snow.**

Experiment 25. Imitation frost.

23. **Special forms of combustion.**

- a. Deflagration.

Experiment 26. Examples of deflagration.

- b. Explosions. (See Sections 85 and 87.)

Experiment 27. Examples of explosions.

24. **Physical changes.**

- a. Due to heat.

Experiment 28. Effect of heat upon conditions of matter.

- b. Due to dampness.

Experiment 29. Sympathetic ink.

25. **Heat from compression.**

Experiment 30. Heat due to compression.

26. **Chemical changes.**

- a. In air and in solution.

Experiment 31. Examples of chemical changes.

- b. Due to heat.

Experiment 32. Heat aids chemical changes.



c. Heat from chemical changes.

Experiment 33. Heat due to chemical changes.

**27. Cooking.**

a. An example of one kind of chemical change.

b. Aids digestion and prevents disease.

**28. The difference between heat and temperature.**

Experiment 34. Heat and temperature distinguished.

**29. Destructive distillation.**

a. The making of charcoal.

b. The making of illuminating gas. (See Section 88.)

Experiment 35. Destructive distillation. (This subject, Heat, is continued in the work for the eighth grade.)

## AIR. VII.

**30. A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.**

**31. The buoyancy of the air.**

a. The hot-air and gas balloons.

Experiment 36. Blowing soap-bubbles with gas.

b. Bodies heavier than air.

Experiment 37. How to make a toy boomerang and a toy glider.

**32. "Suction"—vacuum. (See Section 89.)**

Experiment 38. To show what suction is. The "sucker."

**33. Pumps.**

a. The lift pump.

Experiment 39. How to make a suction pump.

- b. The force pump.
- c. The air compression pump.

Experiment 40. The simple air compression pump.

34. **The siphon.** (See Section 90.)

Experiment 41. Siphons.

35. **Humidity in the air.**

- a. Dew.
- b. Frost.
- c. Fog.
- d. Clouds.

Experiment 42. Forms of water in the air.

(This subject, Air, is continued in the work for the eighth grade.)

## WATER. VII.

36. **A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.**

37. **The warming of water.**

- a. Water requires more heat than other material to become warmed.

Experiment 43. The heat capacity of water.

- b. The effect upon nature.

38. **The ocean and other large bodies of water.**

- a. Source of food.
- b. Transportation.

39. **Waves.**

- a. In water. (See Section 91.)
- b. In air—sound.
- c. Other waves—light and electric.

Experiment 44. Waves in water and in air.

40. **Icebergs.**  
Experiment 45. Why ice floats.
41. **The composition of water.**  
a. Chemical  
Experiment 46. To prepare hydrogen.  
b. Physical.  
Experiment 47. A physical examination of water.
42. **Spring and streams.** (See Sections 92 and 93.)
43. **Geysers and hot springs.**  
Experiment 48. To illustrate a geyser.
44. **Artesian wells.** (See Section 94.)  
Experiment 49. To illustrate an artesian well.  
(This subject, Water, is continued in the work for the eighth grade.)

## PLANTS AND ANIMALS. VII.

45. A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.
46. **Forestry.**  
a. What is meant by forestry.  
b. Practical forestry. (See Section 96.)  
Experiment 50. The collection and planting of seeds of forest trees.
47. **Forest conservation.**  
a. Its advantages.  
Experiment 51. The effect of forests upon the run-off of water.  
b. How accomplished.  
c. The enemies of the forest.
48. **The propagation of plants.**  
a. Agency—roots, cuttings, leaves, buds, grafts, and seeds.

b. Advantages of each method.

Experiment 52. Slipping, budding, and grafting.

**49. Pruning.**

a. Method.

b. Advantages.

**50. Plants which live upon other plants or upon animals.**

a. The kinds—bacteria, yeasts, molds, blights, mildews, smuts, rusts, scale, toadstools, and mushrooms.

b. Their dangers and their prevention.

Experiment 53. The growth of bacteria.

**51. Bacteria—harmful and helpful.**

Experiment 54. Acid fermentation.

**52. Mushrooms and Toadstools.**

a. Mushrooms as food.

b. The dangers from toadstools.

**53. Insects.**

a. Useful and harmful.

Experiment 55. (A continuous experiment.) To make a collection of insects.

b. Pests and their control.

**54. The silk worm.**

a. The worm.

Experiment 56. How to raise silk worms.

b. The product.

**55. Flies.**

a. The dangers from flies.

b. Their prevention.

**56. Mosquitoes.**

a. The danger from their bites.

b. Their prevention.

Experiment 57. (A continuous experi-

ment.) The prevention of flies and mosquitoes.

57. **The stings of insects.**
  - a. Why they hurt.
  - b. The cure of stings.
58. **Poisonous plants.**
  - a. Their description.
  - b. The cure for their poison.
59. **Some wild animals.**
60. **Furs and skins.**

Experiment 58. How to cure a skin.  
(These subjects, Plants and Animals, are continued in the work for the eighth grade.)

## FOOD. VII.

61. **A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.**
62. **The geography of food.**

Experiment 59. Food geography maps.
63. **The renovation of worn-out soil.**
64. **Home-mixed fertilizers.**

Experiment 60. Making fertilizers for garden crops.
65. **Acid soil.**
  - a. The cause and effect.
  - b. The cure—liming.

Experiment 61. Testing acid soils and liming them.
66. **Food values.**

Experiment 62. The use of food charts.
67. **Starch.**
  - a. Sources.
  - b. Cooking.
  - c. Test.

Experiment 63. Cooking and testing starch.

68. Sugar.

- a. Sources.
- b. Test.

Experiment 64. Testing for sugar.

69. Proteids.

- a. Sources.
- b. Cooking.
- c. Test.

Experiment 65. Cooking and testing proteids.

70. Fats.

- a. Sources.
- b. Test.

Experiment 66. Testing for fats.

71. Digestion of food.

Experiment 67. The digestion of a proteid.

(This subject, Food, is continued in the work for the eighth grade.)

## MECHANICS. VII.

72. A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.

73. The pendulum.

- a. The compound pendulum used in clocks.  
(See Section 97.)

74. Vibrations.

- a. Forced.
- b. Sympathetic—dangerous for buildings.

Experiment 68. Forced and sympathetic vibrations.

75. Reaction.

Experiment 69. The reaction water wheel:

76. **Measurement of rotary motion.**

a. Revolutions per minute.

b. Velocity of point on circumference of wheel.

Experiment 70. Velocity and number of revolutions.

77. **Centrifugal force.** (See Section 98.)

Experiment 71. Centrifugal force.

(These subjects, Mechanics, are continued in the work for the eighth grade.)

## **MAGNETISM AND ELECTRICITY. VII.**

78. **A brief summary of the facts stated under the same topic in the work for the fifth and sixth grades.**

79. **Sources of electricity.**

a. Friction.

Experiment 72. Electricity from friction.

The Leyden jar.

b. Chemical.

Experiment 73. The simple cell.

80. **Heat and light from electricity.**

Experiment 74. Electricity produces heat and light.

81. **Chemical effects of electricity.**

Experiment 75. Electroplating.

(These subjects, Magnetism and Electricity, are continued in the work for the eighth grade.)

## **THE ARTS AND INDUSTRIES. VII.**

82. **Business and nature.**

83. **The chemical analysis of cloth.**

Experiment 76. Testing silk, linen, wool, and cotton.

84. **Surveying.** (See Section 2.)  
Experiment 77. Levelling with an "A".
85. **Tide motors.** (See Section 3.)
86. **Blasting.** (See Section 23.)
87. **Gas and gasoline engines.** (See Section 23.)  
Experiment. 78. The gas cannon.
88. **Manufactured gas.** (See Section 29.)  
a. Coal.  
b. Water.  
Experiment 79. To make water gas.
89. **Vacuum cleaners.** (See Section 32.)
90. **Traps in plumbing.** (See Section 34.)  
Experiment 80. Different forms of traps.
91. **Wave motors.** (See Section 39.)
92. **Water motors.** (See Section 42.)  
a. Water wheels.  
b. Pelton wheels.  
c. Turbines.
93. **Water supply of a city.** (See Sections 42 and 44.)
94. **Measurement of water.**  
a. Cubic feet and gallons.  
b. Miner's inch.
95. **How to read meters of all kinds.**
96. **Lumbering.** (See Section 46.)
97. **Clocks.** (See Section 73.)
98. **Applications of centrifugal force.** (See Section 77.)  
a. Laundry dryers.  
b. Babcock milk tester.  
c. Cream separators.  
(More applications of science are given in the work for the eighth grade.)



# OUTLINE OF SCIENCE FOR THE EIGHTH GRADE.

## THE SUN, STARS, AND PLANETS. VIII.

1. A brief summary of the facts stated under the same topic in the work for the fifth, sixth, and seventh grades.
2. Theories.
  - a. What a theory is.
  - b. The use of theories.
3. The solar system.

Experiment 1. Drawing the solar system to scale.
4. The stars.
  - a. What they are.
  - b. Their distance from the earth.
5. The earth.
  - a. The age of the earth, shown by formations.
  - b. The shape and size of the earth.

Experiment 2. The shape of the earth caused by rotation.
6. The crust of the earth.
  - a. Rocks and minerals. (See Section 81.)
  - b. Soil.
7. Kinds of rock.
  - a. Water formed.

Experiment 3. Sedimentary rock.
  - b. Fire formed.
  - c. Chemically formed.

Experiment 4. Stalactites and stalagmites.

8. **Rocks that once had life.**

Experiment 5. Organic rock.

9. **Coal.** (See Section 82.)

a. Soft.

b. Hard.

10. **Other forms of carbon.**

11. **The sun the source of all energy.**

12. **Natural gas.**

13. **Petroleum.**

Experiment 6. The distillation of petroleum.

14. **Mountains.**

a. How made.

Experiment 7. Folded and block mountains.

b. As barriers. (See Section 95.)

## LIGHT. VIII.

15. **A brief summary of the facts stated under the topic in the work for the fifth, sixth, and seventh grades.**

16. **The velocity of light.**

17. **Photography.** (See Section 83.)

a. The lens.

Experiment 8. The camera lens.

b. The sensitive plates and papers.

Experiment 9. Why we can make photographs.

18. **The eye a camera.** (See Section 84.)
  - a. The parts of the eye.
  - b. Proper care of the eyes.
19. **The telescope.**
  - Experiment 10. To make a simple telescope.
20. **Sound**
  - a. Caused by vibrations.
    - Experiment 11. Sources of sound.
  - b. Carried by matter.
    - Experiment 12. Sound not heard in a vacuum.
21. **Velocity of sound.**
  - Experiment 13. Distances determined by sound.
22. **The ear.**
  - a. The parts of the ear.
  - b. The care of the ear.
  - c. The Eustachian tube.
23. **Music and musical instruments.** (See Section 85.)
  - a. Vibrating strings.
    - Experiment 14. The variation of pitch.
  - b. Vibrating columns of air.
    - Experiment 15. The whistle. The organ pipe.
24. **The voice.**

## HEAT. VIII.

25. A brief summary of the facts stated under the same topic in the work for the fifth, sixth, and seventh grades.

26. **Carbon a part of all fuels.** (See Section 85.)  
Experiment 16. Carbon from fuels.  
Experiment 17. Perfect and imperfect combustion.
27. **Radiation of heat.** (See Section 87.)  
Experiment 18. Good and poor radiators.
28. **Absorption of heat.**  
Experiment 19. A good radiator is a good absorber of heat.
29. **Temperature curves.**  
Experiment 20. Making temperature curves.
30. **The measurement of heat.**  
Experiment 21. The difference between temperature and heat.  
Experiment 22. The unit of heat.
31. **Heat-holding power.**  
Experiment 23. Heat capacity.
32. **The heat required to melt ice.**  
Experiment 24. The heat of melting.  
Experiment 25. Freezing mixtures.
33. **The heat required to boil water.**  
a. The heat absorbed.  
Experiment 26. The heat of boiling.  
b. The heat given out. Heating by steam.  
Experiment 27. The heat of condensation.
34. **The history of heating.**

## AIR. VIII.

35. A brief summary of the facts stated under the same topic in the work for fifth, sixth, and seventh grades.
36. Humidity in the air.
- a. Absolute.
  - b. Relative.
    - Experiment 28. The dew-point.
    - Experiment 29. The wet-bulb thermometer.
37. Rain.
- a. Cause.
    - Experiment 30. Cooling by expansion.
  - b. Measurement, valuable.
    - Experiment 31. The rain-gauge.
38. Snow and hail.
- a. Cause.
  - b. The shape of ice crystals.
    - Experiment 32. Copying microphotographs of snow flakes.
39. Ice.
- a. Icebergs and glaciers.
  - b. Why ice floats.
    - Experiment 33. The space occupied by melting ice.
40. Painting.
- a. For adornment.
  - b. For preservation from the weather.
    - Experiment 34. Preservation of wood and metal.
41. Atmospheric electricity.
- a. Lightning.

b. Northern lights.

Experiment 35. Electric glow from sugar and from paper.

## WATER. VIII.

42. A brief summary of the facts stated under the same topic in the work for the fifth, sixth, and seventh grades.

43. Hard water.

a. Temporary hardness.

Experiment 36. The cause of temporary hardness.

Experiment 37. Stalactites and stalagmites.

b. Permanent hardness.

Experiment 38. To measure permanent hardness.

44. Precipitation. (See Section 88.)

Experiment 39. Precipitation.

45. Purification of water.

a. Removal of bacteria.

b. Removal of other plants.

46. Acids and bases. (See Sections 89, 90, and 91.)

a. Tests.

Experiment 40. Testing acids and bases.

b. Neutralization.

Experiment 41. Neutralization makes a salt.

47. Salts.

a. Efflorescent salts.

Experiment 42. Efflorescent salts.

- b. Hygroscopic salts.  
Experiment 43. Hygroscopic salts.

## PLANTS AND ANIMALS. VIII.

- 48. A brief summary of the facts stated under the same topics in the work for the fifth, sixth, and seventh grades.
- 49. Acid soils.
  - a. The cause.
  - b. The remedy—lime and rotation of crops.  
Experiment 44. Acid soils and liming.
- 50. Practical forestry. (See Section 92.)
- 51. The geography of animals.  
Experiment 45. Making animal charts.
- 52. Fishes.  
Experiment 46. The balanced aquarium.  
Experiment 47. Fishes need air.
- 53. Man's place in nature.
- 54. The mind.  
Experiment 48. The senses of taste, smell, and touch.
- 55. Sleep.
  - a. The need.
  - b. Dangers from using sleep producers.
- 56. The nose and throat.
  - a. Care.
  - b. Adenoids.
- 57. Yellow fever and malaria.
  - a. Cause.
  - b. Prevention.

## FOOD. VIII.

58. A brief summary of the facts stated under the same topic in the work for the fifth, sixth, and seventh grades.
59. Cost of production of food.
- Cost of land. (See Section 94.)
  - Labor.
  - Transportation. (See Section 95.)
  - Profit to all who handle it.
60. Vegetable food.
- Experiment 49. Composition of vegetable food.
61. Animal food.
- Experiment 50. Composition of animal food.
62. Analysis of food.
- Experiment 51. Tests for fats, proteids, and carbohydrates.
63. Adulteration of food. (See Section 96.)
- Experiment 52. Tests for adulterants and preservatives.
64. The value of food.
- Digestion.
  - Assimilation and nutrition.
65. The drug habit.—Its dangers. (See Section 97.)
- Tobacco.
  - Alcohol.
  - “Pain-killers.”



## MECHANICS. VIII.

66. A brief summary of the facts stated under the same topic in the work for the fifth, sixth, and seventh grades.
67. **Work.**
- a. Force acting through distance.
  - b. No gain in work by machines.  
Experiment 53. Work and machines.
69. **Power.**
- a. Work performed in a given time.
  - b. Horse-power.  
Experiment 54. The work and power in climbing stairs or a hill.  
Experiment 55. To find the power of a stream.
69. **Dams.**
- a. Construction.
  - b. Pressure against.  
Experiment 56. The shape of dams.
70. **The conservation of water-power.**
71. **The strength of wooden beams.**  
Experiment 57. The bending of beams.

## MAGNETISM AND ELECTRICITY. VIII.

72. A brief summary of the facts stated under the same topics in the work for the fifth, sixth, and seventh grades.
73. **The measurement of electricity.**  
Experiment 58. How to make and use a galvanometer.

74. **The courses of electricity.**
- a. Friction.  
Experiment 59. Frictional electricity.
  - b. Chemical.  
Experiment 60. Electric batteries.
  - c. Magnetic.  
Experiment 61. Electricity from magnetism.
75. **Chemical effects of electricity.**
- a. Electrolysis.  
Experiment 62. Electrolysis of water.
  - b. Electroplating and electrotyping.  
Experiment 63. How to electroplate and electrotype.
76. **The storage cell.**  
Experiment 64. How to make a storage cell.
77. **The induction coil.**  
Experiment 65. How to make an induction coil.  
Experiment 66. Experiments with an induction coil.
78. **Wireless telegraphy.**
- a. Theory.  
Experiment 67. Wireless telegraphy across a room.
  - b. Practice.
79. **Other applications of electricity.**  
Experiment 68. Practical work in electricity.

## THE ARTS AND INDUSTRIES. VIII.

80. **Man's applications of nature's principles.**
  - a. The arts.
  - b. The industries.
81. **Metals.** (See Section 6.)
  - a. The common metals.
  - b. The rare metals.
  - c. Obtaining metals from the ores.  
Experiment 69. The reduction of an ore.
82. **Illuminating gas.**
  - a. Coal gas. (See Section 9.)  
Experiment 70. How to make coal gas.
  - b. Water gas.  
Experiment 71. How to make water gas.
83. **How newspaper cuts are made.** (See Section 17.)
84. **Motion pictures.** (See Section 18.)  
Experiment 72. The theory of motion pictures.
85. **The phonograph.** (See Section 23.)
86. **Steel.**
  - a. Composition. (See Section 26.)
  - b. Tempering.  
Experiment 73. Tempering steel.
87. **Fireless cookers.** (See Section 27.)
88. **Dyeing.** (See Section 44.)
  - a. Silk and wool.
  - b. Cotton and linen.  
Experiment 74. Dyeing.
89. **Tanning of leather.** (See Section 46.)
90. **Bleaching.** (See Section 46.)
  - a. Natural.

b. Chemical.

Experiment 75. Bleaching.

91. **Mercerized cotton and artificial silk.** (See Section 46.)
92. **Paper manufacture.**  
a. From cloth.  
b. From wood. (See Section 50.)  
Experiment 76. Papier mach(e)
93. **Sanitary plumbing.**  
Experiment 77. Drawing plans of plumbing.
94. **Reclaiming land.** (See Section 59.)
95. **Transportation.** (See Sections 14 and 59.)
96. **The Pure Food and Drug Act of 1906.** (See Section 63.)
97. **Simple household remedies.** (See Section 65.)
98. **How to plan buildings.**  
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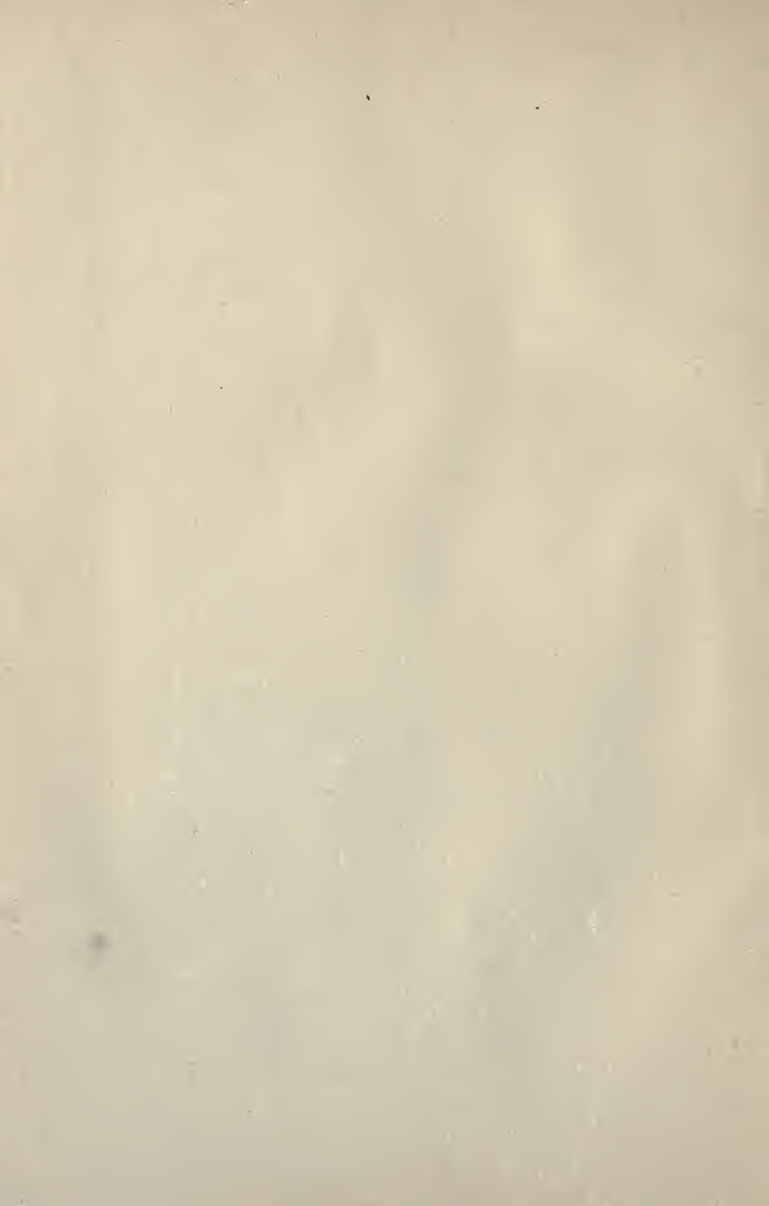
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