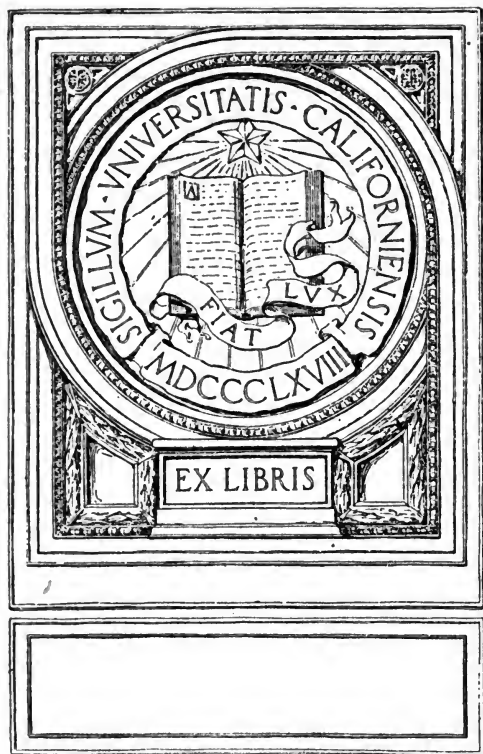


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PREFACE

While the annual volume of examination questions published by the College Entrance Examination Board has met the needs of many candidates for examination and their teachers, the Board is constantly in receipt of communications asking for the questions set in certain subjects in successive years. In order to meet this demand the Board has prepared pamphlets containing the questions in certain subjects from 1911 to 1915 inclusive. These pamphlets are as follows :

1. Examination questions in Latin and Greek, 1911-1915.
2. Examination questions in English and other modern languages, 1911-1915.
3. Examination questions in mathematics, 1911-1915.
4. Examination questions in history, 1911-1915.
5. Examination questions in the natural sciences and in drawing, 1911-1915.

Besides meeting the needs of candidates for examination and their teachers, these publications ought to have more widely a beneficial influence upon teaching for the reason that they illustrate in concrete form principles agreed upon by many leading teachers of the subjects represented.

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BIOLOGY

BIOLOGY

Monday

2-4 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

I. (*Answer both questions.*)

1. (a) Name and define three functions common to plants and animals.
(b) Make a drawing of some cell you have studied and label the various parts.
2. Name five animals or plants which are economically important and state in what way each is beneficial or injurious.

II. (*Answer any three questions.*)

3. (a) Compare the bean seed and corn kernel as to (1) number of seed leaves (cotyledons); (2) kinds of stored food; (3) position of stored food in each.
(b) Which one of these foods must be changed before being used by the young plant? (c) Why must this change occur? (d) How is this change accomplished?
4. Discuss photosynthesis, telling:
 - (a) the conditions necessary for carrying on the process;
 - (b) the kinds of material used in the process;
 - (c) the sources of the materials used.
5. (a) State briefly the common agencies of seed dispersal. (b) Describe three ways in which seeds and fruits are structurally adapted to use these agencies.
6. (a) Name three substances used by man which are found in seeds. (b) How would you detect the presence of any two of these substances? (c) What part of a plant furnishes: flour, manila-hemp, linen, castor oil?

III. (*Answer any three questions.*)

7. Name and describe briefly a representative of each of four different animal groups found in a fresh water pond.
8. Describe three examples of the adaptation of animals to their surroundings.
9. Name two important functions performed by any vertebrate and show how the animal selected is enabled by its structure to perform these functions.
10. Describe the life history of any insect whose development proceeds through a series of stages (metamorphosis).

BIOLOGY

Tuesday

4.15-6.15 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

GROUP A. GENERAL BIOLOGY. (*Answer two questions.*)

1. Explain the principle of the balanced aquarium.
2. Show how insects and flowers are structurally adapted to aid each other.
3. Explain fully why animals have to travel about for their food while green plants do not.

GROUP B. PLANTS. (*Answer four questions.*)

4. Name and briefly characterize one plant belonging to each of the groups or phyla of the plant kingdom.
5. Outline the life-history of a fern.
6. (a) Describe a simple flower and give the function of each part. (b) Discuss the development of a fruit, emphasizing the changes in the parts of the flower represented in it.
7. (a) Discuss the advantages which are derived by plants through the cultivation of the soil. (b) In what special way is a clover crop of value to the soil?

GROUP C. ANIMALS. (*Answer four questions.*)

8. Name some animal that is concerned with human disease and explain the case clearly, together with means for controlling the disease.
9. Describe the following structures and indicate the use of each to some particular animal:
 1. Gill-raker.
 2. Spiracle.
 3. Proboscis.
 4. Cilium.
 5. Tentacle.
10. Describe three types of animal reproduction, giving an example of each method.
11. Name at least five different types of structures used for locomotion in the animal kingdom from ameba to man.
12. Outline the life-history of a frog or of a butterfly.

BOTANY

BOTANY

Monday

3·45-5·45 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer any ten questions. No extra credit will be given for more than ten questions.

1. Discuss protoplasm as the basis of plant activity. Make a labeled diagram of an active cell.
2. Name the groups of plants associated on the basis of their environment, and discuss the characteristics of a representative plant of each group.
3. How do the nutritive processes of plants with chlorophyll differ from those without chlorophyll?
4. Show by sketches the important stages in the life cycle of (1) an alga, (2) a fungus, (3) a moss, or liverwort. Name the parts in each sketch.
5. Give the main characteristics of (1) a gymnosperm, (2) a monocotyledon, (3) a dicotyledon, in such form as to compare the three.
6. Give a brief account of the life of a plant from seed to seed. Use diagrams freely to illustrate the account.
7. Describe three experiments in plant physiology. Sketch and label the apparatus used in two of them.
8. Give the characteristics of flowers pollinated by insects, and compare with them the characteristics of flowers pollinated by wind. Illustrate.
9. Name the fundamental plant parts represented by the edible portion of a cabbage, a radish, a sweet potato, a common potato, and a strawberry. Of what use to the plant are these parts?
10. Enumerate ten plants from which manufactured products are derived. In each case indicate the part used.
11. Give the chief divisions of the vegetable kingdom in a classification showing natural relationship. Give examples of each division.
12. Discuss briefly the important relations between plants and animals. Illustrate by examples.

BOTANY

Monday

3.45-5.45 p.m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer any ten questions. No extra credit will be given for more than ten questions.

A. Select some green flowering plant familiar to you as a basis for answering questions 1-6:

1. Describe by use of words and by fully labelled sketches the parts of a seed of this plant.
2. Describe the important steps in the germination of this seed. Illustrate by means of sketches.
3. Make a diagram of a cross section of the stem of the plant growing from this seed. Label all parts.
4. What in general is the method of venation in the leaves of this plant?
5. Describe very carefully an experiment proving that your plant is able to produce starch.
6. Discuss any provisions found in this plant for (a) cross-pollination and (b) seed dissemination.

B. A study of plant groups.

7. Name in order of complexity, the great groups or phyla into which the plant kingdom is divided.
8. Describe characters of a representative plant for each of the groups given in 7.
9. Indicate those characters, in the plants just described that are important from the standpoint of advance from lower to higher plant forms.
10. Outline the life history of a fern plant. Illustrate by means of labelled sketches.
11. Enumerate those qualifications in the sporophyte of Angiosperms by which it is able to meet successfully modern conditions.
12. Give *fifteen* minutes to the discussion of any botanical topic, not included in the above questions, which has been of special interest to you.

BOTANY

Monday

2-4 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer any ten questions. No extra credit will be given for more than ten questions.

1. Characterize briefly the great plant group to which each of the following belongs: an alga, a pine tree, a moss, a lily; and arrange these groups in natural sequence.
2. Name the principal organs of a flowering plant and describe the characteristics which fit each organ for its especial use to the plant.
3. Compare by means of labeled diagrams in monocotyledonous and in dicotyledonous plants:
 - (a) the arrangement of fibrovascular bundles and
 - (b) the parts of the flowers.
4. (a) Describe an experiment to show the use of fibrovascular tissue in higher plants. (b) In what groups of plants is fibrovascular tissue present?
5. Name five plants belonging to different orders of seed-plants. Assign these to their respective families and state by what characters they are so assigned.
6. (a) Explain the importance of plant devices for scattering seeds. (b) Show the working of two such devices by drawing and description.
7. (a) Explain the method of reproduction of bacteria. (b) Mention two ways in which bacteria affect man's welfare?
8. Show by means of labeled diagrams and descriptions the sporophytic phase in the life-history of algae, mosses, and ferns.
9. Discuss the influence of light on plants. Describe an experiment showing the function of chlorophyll.
10. Describe an experiment showing how land plants take water, and two ways in which they use it.
11. Give a brief account of nutrition in plants. Describe experiments showing three sources of plant food.
12. Tell some important facts about the lives of two eminent botanists and particularly what they contributed to botanical science.

BOTANY

Monday

2-4 p. m.

A teacher's certificate covering the entire laboratory instruction must be presented as a part of the examination.

Answer ten questions. At least two questions must be selected from Group E and one from each of the other groups. The remaining four questions may be selected as desired by the student. No extra credit will be given for more than ten questions.

- A. The Plant Cell. (*Answer one question from this group.*)
1. Describe and illustrate by labeled drawings a typical cell.
 2. Why is the cell called the "unit of plant structure"?
- B. The Plant in Germination. (*Answer one question from this group.*)
3. Compare the process of germination in a seed with endosperm and in a seed without endosperm.
 4. By carefully labeled drawings, illustrate three stages in the germination of a monocotyledonous and of a dicotyledonous plant.
 5. Explain why a test for the presence of sugar in a wheat seedling shows a marked reaction, while the test for the same substance in a wheat kernel shows no reaction.
- C. Life Processes of the Mature Plant. (*Answer three questions from this group.*)
6. Name two important functions of roots and give the characteristics of the root which adapt it to perform these functions.
 7. Describe an experiment to prove that one of these functions is performed by the root.
 8. Describe an experiment to show that oxidation is carried on in green plants.
 9. How would you prove that the result of this process is the same as that produced by burning a match or by the respiration of an animal?
 10. Discuss photosynthesis, outlining in detail (1) the conditions necessary for carrying on the process together with (2) the nature and (3) the sources of the materials used.
- D. The Plant in Relation to Its Environment. (*Answer two questions from this group.*)
11. In what ways is the quantity of water in the environment of a plant of importance to its growth?
 12. Describe some modifications adapting the plant to a limited water supply.
 13. What in general are the characteristics of wind-pollinated flowers?
 14. State briefly the common agencies of seed dispersal, and describe the general structural modifications by which the plant makes use of these agencies.
- E. Plant Groups. (*Answer three questions from this group.*)
15. Discuss reproduction in the algae as illustrated by a type plant studied in class.
 16. Name a fungus and describe its life history.
 17. Give the principal similarities and differences in the life history of the fern and of the moss.
 18. Name and give the chief characteristics of five families of Angiosperms.
 19. What part of a plant furnishes: flour, manila-hemp, linen, cotton, castor oil?

BOTANY

Tuesday

4.15-6.15 p. m.

A teacher's certificate covering the entire laboratory instruction must be presented as a part of the examination.

GROUP A. (*Answer three questions.*)

1. (a) Name and briefly characterize the great groups or phyla of plants.
(b) Name and briefly characterize one plant belonging to each of the groups given above.
2. (a) To what group do the algae belong? (b) Name three algae that have been studied. (c) Outline the life-history of an alga with differentiated sex organs. Illustrate by sketches.
3. (a) How would you distinguish a fungus from an alga? (b) Name and give the life-history of a one-celled fungus. Illustrate by sketches.
4. (a) What diseases of plants have you studied? (b) Give a full discussion of one of them.
5. Outline the life-history of a fern.

GROUP B. (*Answer three questions.*)

6. (a) Sketch a longitudinal section through a young root. (b) Name and give function or functions of all the parts shown.
7. Give examples of five unusual or modified leaves and state in what way each is of use to the plant.
8. Discuss the progressive development of sex, as shown in *Pleurococcus*, *Ulothrix*, *Spirogyra*, and *Vaucheria* or other related algae studied.
9. Describe a simple flower and give the function of each part.
10. (a) Give two functions of the fruit in angiosperms. (b) Name five fruits.
(c) State what floral parts are represented in any three of the fruits named.

GROUP C. (*Answer two questions.*)

11. (a) What is respiration? (b) In what parts of the plant does it take place?
(c) What is its value to the plant?
12. Describe and illustrate by labeled diagrams the regions of growth in length and thickness in dicotyledonous stems and roots.
13. Discuss the life of the deciduous trees in relation to the seasons.

GROUP D. (*Answer two questions.*)

14. (a) Discuss the advantages which are derived by plants through the cultivation of the soil. (b) In what special way is a clover crop of value?
15. Explain the way in which fruit trees of known varieties are propagated.
16. Name five commercial products derived from the forests, and explain how each of these is obtained.

CHEMISTRY

CHEMISTRY

Friday

3.45-5.45 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer seven questions as indicated below. No extra credit will be given for more than seven questions.

GROUP A

Answer two questions from this group

1. (a) Describe briefly practical processes for bringing about any two of the following transformations:
 - (1) potassium nitrate to potassium sulphate
 - (2) calcium carbonate to calcium hydroxide
 - (3) sulphur to hydrogen sulphide
 - (4) lead nitrate to lead sulphate.
- (b) Explain in detail how you should prepare any three of the following in the laboratory: lime water, sulphur dioxide, ammonium nitrate, nitric oxide, concentrated hydrochloric acid, charcoal.
2. (a) Describe a method, involving chemical change, for distinguishing between:
 - (1) zinc and zinc oxide
 - (2) hydrogen and ammonia
 - (3) sodium carbonate and sodium sulphate.
- (b) Describe briefly two distinct experimental methods for showing the elements of which water is composed.
3. (a) What is a saturated solution of a salt?
- (b) In general, will a given amount of water dissolve more of a salt at a lower or at a higher temperature?
- (c) Describe two ways in which a solution of sodium chloride in water, saturated at room temperature, may be prepared.
- (d) How may a soluble salt be freed from soluble impurities?

GROUP B

Answer both questions in this group

4. (a) Complete the following equations, using formulae throughout:
 - (1) Silver nitrate (solution) + zinc =
 - (2) Sulphur dioxide + oxygen =
 - (3) Sodium sulphate + barium chloride =
 - (4) Sodium hydroxide + carbon dioxide =
 - (5) Manganese dioxide + hydrochloric acid =
 - (b) Illustrate by equations three general methods for making the chlorides of metallic elements.
 5. (a) How much sodium chloride would be necessary to produce 10 grams of dry sodium sulphate?
 - (b) What volume of oxygen under standard conditions could be obtained from 10 grams of potassium chlorate?
- O = 16, Na = 23, S = 32, Cl = 35.5, K = 39.
 One liter of oxygen at 0° and 760 mm. weighs 1.43 grams.

GROUP C

Answer one question from this group

6. (a) A gaseous compound contains 85.71 per cent carbon, and 14.29 per cent hydrogen, and has a specific gravity (specific gravity of oxygen = 16) of 35; what is its formula? $H=1, C=12$.
- (b) State and explain on the basis of the hypothesis of electrolytic dissociation, what happens when a current of electricity is passed through an aqueous solution of sodium chloride.
7. Answer (a), and either (b) or (c), but not both.
- (a) Hydrogen sulphide combines with an excess of oxygen to form sulphur dioxide and water vapor. What are the relations by volume between the hydrogen sulphide, the oxygen, the sulphur dioxide, and the water vapor? State the hypothesis upon which your conclusion is based.
- (b) Describe an experimental mode of demonstrating that aluminium is trivalent, the atomic weight of the element being assumed to be known.
- (c) Describe experiments which you could make to demonstrate the law of definite proportions. State the law.

GROUP D

Answer two questions from this group

8. (a) Give the symbols and names of 16 common elements, writing them in groups according to the periodic classification.
- (b) (1) Describe briefly the mode of extracting the metal from one of the important ores of aluminium or of zinc.
- (2) Name two practical uses to which this metal is put, and state what property renders it particularly suited to each purpose named.
9. (a) Give the chemical name, formula, color, and one important use of any five of the following substances: corrosive sublimate, galena, limestone, blue vitriol, iron pyrites, magnetite, saltpeter, hypo, marsh gas.
- (b) Name three of the rare and inert gases and state where they are found.
- (c) What peculiar chemical property is shown conspicuously by radium?
10. (a) Name the raw materials from which two of the following substances are made, and explain one commercial method of manufacturing each of the three: bleaching powder, soda, sulphuric acid, alcohol, kerosene.
- (b) Answer any one of the following:
- (1) Mention the three essential elements which plants obtain from the mineral constituents of the soil and give examples of fertilizers which furnish them.
- (2) Describe an experiment to show that electricity can be generated as a result of chemical action.
- (3) In a photographic dry plate, what is the substance sensitive to light, what function does the developer perform, and what is meant by "fixing"?

CHEMISTRY

Friday

3.45-5.45 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer eight questions as indicated below. No extra credit will be given for more than eight questions.

GROUP A. (*Omit one question.*)

1. Describe a laboratory method, involving chemical change, by which you could distinguish between: (a) a chloride and a carbonate, (b) nitrogen and carbon dioxide, (c) a nitrate and a sulphate.
2. What changes would take place if the following substances were left in an open vessel: (a) sodium, (b) anhydrous calcium chloride, (c) lime-water, (d) washing soda, (e) silver chloride, (f) concentrated sulphuric acid?
3. (a) What inferences of a chemical nature may be drawn in each case when a solid is heated in a narrow test-tube and behaves in one of the following ways: (1) chars, (2) gives off water vapor, without charring, (3) gives off carbon dioxide?
(b) How could you obtain: (1) ammonia from ammonium sulphate, (2) chlorine from zinc chloride, (3) sulphur dioxide from sulphuric acid?
4. (a) How should you show the presence of (1) carbon in impure manganese dioxide, (2) sand in impure sugar?
(b) How could you tell whether: (1) a solution is saturated, (2) water contains dissolved air, (3) a salt is deliquescent, (4) a colorless sample of water contains a dissolved solid?

GROUP B. (*Omit either 6 or 7.*)

5. (a) Complete and balance the following equations using formulae throughout:
 - (1) Barium chloride + sodium sulphate =
 - (2) Sodium hydroxide + cupric nitrate =
 - (3) Ferric chloride + sulphuric acid =
 - (4) Sulphur dioxide + water + sodium hydroxide =
 - (5) Sodium carbonate + hydrochloric acid =
 (b) Balance the following equations:
 - (1) $\text{HNO}_3 \rightarrow \text{H}_2\text{O} + \text{NO} + \text{O}$
 - (2) $\text{FeCl}_2 + \text{HCl} + \text{O} \rightarrow \text{FeCl}_3 + \text{H}_2\text{O}$
6. (a) What relation exists between the molecular weights and the specific gravities of gases?
(b) Arrange the following in the order of increasing specific gravity: CH_4 , CO , CO_2 , NH_3 , NO , N_2O (atomic weights: C = 12, H = 1, O = 16, N = 14).
(c) Calculate the weight of one liter of any one of the gases mentioned in 6 (b). (One liter of hydrogen weighs 0.09 g.)
7. (a) $3\text{Fe} + 4\text{H}_2\text{O} \rightleftharpoons \text{Fe}_3\text{O}_4 + 4\text{H}_2$.
Explain why this is called a reversible reaction. Under what circumstances is all the iron converted into oxide of iron? Under what circumstances is all the oxide reduced to iron?
(b) Give three examples of chemical changes, each producing a different form of energy.

GROUP C. (*Omit one question.*)

(*Put all your work upon the paper.*)

8. (a) Calculate the percentage of chlorine in hydrated barium chloride ($\text{BaCl}_2, 2 \text{H}_2\text{O}$). ($\text{Ba}=137, \text{Cl}=35.5, \text{H}=1, \text{O}=16$.)
- (b) How many grams of sulphuric acid (H_2SO_4) reacting with an excess of sodium carbonate (Na_2CO_3) are required to produce 200 g. of carbon dioxide (CO_2)? ($\text{H}=1, \text{S}=32, \text{O}=16, \text{Na}=23, \text{C}=12$.)
- (c) How many volumes of oxygen are required to burn one volume of methane to carbon dioxide and water?
9. (a) What weight of carbon dioxide is required to precipitate completely the calcium in 1 g. calcium hydroxide? ($\text{C}=12, \text{Ca}=40, \text{O}=16, \text{H}=1$.)
- (b) What volume will this weight of carbon dioxide occupy at room temperature and 760 mm.? (One liter of CO_2 , at room temperature and 760 mm. weighs 1.9 g.)
- (c) Assuming that each bubble of carbon dioxide contains 0.3 c.c., how many bubbles will be required; and assuming that they pass at the rate of 5 per second, how long will the operation take?
- (d) Two grams of a substance lose water upon heating, and the residue weighs 1.72 g.: what per cent of water was lost?

GROUP D. (*Omit one question.*)

10. (a) Give the reasons for any three of the following facts:
- (1) A solution of chlorine water bleaches writing ink but does not bleach printer's ink;
 - (2) iron rusts very rapidly at the sea-shore;
 - (3) sodium carbonate is used in washing-powders;
 - (4) lemon juice is used to remove iron rust from cloth;
 - (5) graphite is used in stove polishes;
 - (6) calcium carbonate is used in tooth powders.
- (b) Answer three of the following: Describe the structure and operation of the (1) blast lamp, (2) calcium light, (3) Welsbach light. Give the composition of (4) galvanized iron, (5) baking powder. Describe the process of (6) copper-plating.
11. (a) Give the formula, chemical name, color, and one use of any four of the following: coke, Epsom salt, calomel, alum, laughing gas, phosphoric anhydride, corundum, silica.
- (b) (1) What is the natural source of sodium compounds?
- (2) How is metallic sodium prepared?
- (3) How can the presence of sodium in a compound be shown?
- (4) Give the formulae and uses of three compounds of sodium.
12. (a) Describe briefly one typical method used in obtaining metals from their ores.
- (b) Name two physical properties of metals which serve to distinguish them from substances which are not metals.
- (c) Write an equation to illustrate one characteristic property of the hydroxides of the metals.
- (d) Name two metals which displace free hydrogen from dilute acids, and two which do not.

CHEMISTRY

Saturday

9-11 a. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer ten questions as indicated below. No extra credit will be given for more than ten questions.

Attach to the answer, in each case, the number and letter used in the printed paper.

GROUP A. (*Answer all questions in this group.*)

1. Give two tests, at least one of which involves chemical change, sufficient to identify each of the following substances: (a) concentrated nitric acid, (b) concentrated sulphuric acid, (c) concentrated ammonium hydroxide, (d) solution of sodium hydroxide.
2. (a) How should you free moist carbon dioxide gas from water vapor?
 (b) How should you obtain sulphur from a solution of the element in carbon disulphide?
 (c) How should you liberate copper from a solution of cupric sulphate?
 (d) How should you obtain a specimen of pure nitrogen from a mixture of nitrogen and oxygen?
 (e) How should you obtain pure specimens of manganese dioxide and potassium chloride from a mixture of the two?
3. Describe briefly, with or without the help of drawings, the apparatus, materials, operations, and precautions, necessary for the preparation of the following substances in the laboratory: (a) hydrogen, (b) carbon dioxide.

GROUP B. (*Omit 5 or 6.*)

4. Write equations for five of the following reactions, using formulae throughout. (The equation must be absolutely correct to receive credit.)
 (a) Slaked lime + any acid =
 (b) Cupric oxide + hydrogen =
 (c) Ammonium nitrate (heated) =
 (d) Zinc + sulphuric acid (dilute) =
 (e) Ferric sulphate + barium chloride =
 (f) Ammonia (gas) + hydrogen chloride =
5. (a) Derive the formula of a compound made up of sulphur 47.4 per cent, and chlorine 52.6 per cent, which has a vapor density of 67.5 (density of oxygen 16). (Atomic weights Cl, 35.5; S, 32.)
 (b) The specific heat of an element is 0.17. What is its approximate atomic weight? State the law involved.

6. Answer (a) and either (b) or (c).

- (a) The valence of cerium (Ce) being four and of indium (In) three, write the formulae of the chlorides, and of the sulphates of each of these elements, and that of the oxide of the latter.
- (b) Why is an aqueous solution of cupric sulphate acid in reaction?
- (c) Why is silver nitrate in aqueous solution decomposed by the electric current while sugar in solution is not?

GROUP C. (*Answer all questions in this group.*)

7. (a) How many grams of magnesium would displace all of the hydrogen in 10 grams of sulphuric acid? (Atomic weights: Mg, 24; H, 1; S, 32; O, 16.)
- (b) What is the percentage composition of mercuric oxide? (Hg, 200.)
8. (a) What volume of oxygen would be necessary completely to burn, to carbon dioxide and water, ten liters of a gas whose formula is C_2H_6 ?
- (b) What volume of carbon dioxide, at normal temperature and pressure, could be formed by the action of an excess of hydrochloric acid upon 100 grams of calcium carbonate? (Atomic weights, Ca, 40; C, 12; O, 16; 1 liter of carbon dioxide at 0° and 760 m/m. weighs 1.96 g.)

GROUP D. (*Omit one question in this group.*)

9. State the chemical reactions taking place in four of the following processes:
- (a) Action of baking powder; (b) Silver plating; (c) Passing steam over white hot coke; (d) Hardening of plaster of Paris; (e) Manufacture of soap; (f) Manufacture of iron from ferric oxide.
10. (a) Give the chemical name and formula of one of the most abundant natural compounds of each of five of the following elements: (1) sodium, (2) potassium, (3) mercury, (4) silicon, (5) phosphorus, (6) sulphur, (7) fluorine.
- (b) Mention one common use of each of five of the following substances, and in each case define the use specifically: (1) silver nitrate, (2) lime, (3) mercuric chloride, (4) alum, (5) carbon dioxide, (6) sulphur, (7) calcium phosphate.
11. (a) Describe briefly the manufacture of any two of the following substances, giving all the important chemical changes: (1) sulphuric acid, (2) sodium carbonate, (3) nitric acid, (4) sodium hydroxide.
- (b) Define and illustrate any two of the following: (1) saturated solution, (2) super-saturated solution, (3) allotropy, (4) catalysis.
12. (a) Draw a diagram of the Bunsen burner, and state the use of each part.
- (b) Explain spontaneous combustion and illustrate by an example.
- (c) What is acetylene; how is it made; what precautions must be taken in handling it?
- (d) Write an equation illustrating reduction, and explain how it also illustrates oxidation.

CHEMISTRY

Saturday

9-11 a. m.

A teacher's certificate covering the laboratory instruction must be presented as a part of the examination.

Answer nine questions as indicated below. No extra credit will be given for more than nine questions.

Attach to the answer, in each case, the number and letter used in the printed paper.

GROUP A

(Answer all questions in this group. Each question counts 12.)

1. Write equations for six of the following reactions, using formulae throughout. Equations must be absolutely correct to receive credit:
 - (a) Zinc + hydrochloric acid =
 - (b) Calcium hydroxide + carbon dioxide =
 - (c) Manganese dioxide + hydrochloric acid (conc.) =
 - (d) Quicklime + water =
 - (e) Calcium chloride + silver nitrate =
 - (f) Copper + nitric acid (dil.) =
 - (g) Ferrous sulphide + hydrochloric acid =
2. (a) Calculate the percentage of oxygen in the substance whose formula is $\text{Ca}(\text{NO}_3)_2$. Find the result to three significant figures. (Atomic weights: Ca 40, N 14, O 16.)
 - (b) How many liters of oxygen would be necessary to burn twelve grams of carbon to carbon dioxide? The volume of oxygen is to be estimated at standard conditions. (One liter of oxygen weighs 1.429 grams. Atomic weight: C 12.)
 - (c) What weight of silver chloride may be precipitated by silver nitrate from one kilogram of sea-water containing 2.5 per cent of sodium chloride? (Atomic weights: Ag 108, Cl 35.5, Na 23.)
3. Describe the method used by you in the laboratory in the preparation of two of the following substances; write the equation for the reaction, and tell how each compound may be identified: (a) ammonia; (b) hydrogen sulphide; (c) sulphur dioxide.
4. (a) Give specific examples of chemical changes each of which results in the production of one of the following forms of energy: (1) heat; (2) light; (3) electricity; (4) mechanical energy.
 - (b) What is meant by the statement, "the atomic weight of sodium is 23"?
 - (c) Why does an iron wire burn rapidly in pure oxygen but not in the air? State the principle involved.
 - (d) Define catalysis and give an example of catalytic action.

5. (a) Name four important constituents of the atmosphere, and state the relative amount of each. How does the air exhaled from the human body differ in composition from the normal atmosphere?
(b) How may sea-water be made suitable for drinking purposes? how may well-water which has been contaminated by sewage? Explain the principle in each case.

GROUP B

(Omit two of the following questions. Each question counts 10.)

6. (a) Give three different general methods for preparing salts. Write one equation illustrating each.
(b) How are two of the following compounds prepared: (1) bleaching powder; (2) sulphuric acid; (3) nitrous oxide?
7. Describe experiments involving chemical change sufficient to distinguish between the following: (a) chlorine and hydrogen chloride; (b) moist air and dry air; (c) pure water and water containing a soluble chloride; (d) calcium carbonate and calcium phosphate; (e) freshly prepared mortar and mortar from an old building.
8. (a) How many liters of hydrogen and how many of nitrogen are necessary to form ten liters of ammonia gas? State the law illustrated.
(b) What are the valences of the metallic elements in OsO_4 , $\text{Al}_2(\text{SO}_4)_3$, N_2Mg_3 ?
9. (a) What change takes place in the molecular condition of copper sulphate when it is dissolved in water?
(b) Describe the chemical changes which occur when the electric current is passed through such a solution.
(c) Why does an aqueous solution of sodium carbonate give an alkaline reaction?
10. (a) What is the objection to putting fresh coal on a hot fire and closing the damper in the flue, especially if the lid of the stove is left off?
(b) Why is calcium chloride sometimes used to keep road surfaces dustless?
(c) State the chemical reactions taking place in three of the following processes: (1) boiling water containing temporary hardness; (2) adding soap to hard water; (3) bessemerizing cast iron; (4) striking a match.
11. (a) Mention one common use of each of six of the following substances and in each case define the use specifically: (1) carbon monoxide; (2) sodium nitrate; (3) sodium carbonate; (4) silver chloride; (5) zinc; (6) lead; (7) sulphuric acid.
(b) In connection with two of the following substances describe two instances in which each has been used in your laboratory work, and explain its specific action in each case: (1) chlorine; (2) carbon dioxide; (3) sulphuric acid.

CHEMISTRY

Saturday

9-11 a. m.

A teacher's certificate covering the laboratory instruction must be presented as a part of the examination.

Answer nine questions as indicated below. No extra credit will be given for more than nine questions.

Attach to the answer, in each case, the number and letter used in the printed paper.

PART I

(Answer all questions in this group. Each question counts 12.)

1. Write equations for the following reactions, using formulae throughout. To receive credit, the equations must be absolutely correct.
 - (a) Iron+hydrochloric acid=
 - (b) Sodium chloride+sulphuric acid (cold)=
 - (c) Nitric oxide+oxygen=
 - (d) Slaked lime+sulphur dioxide+water=
 - (e) Sodium bicarbonate (heated)=
 - (f) Barium chloride+ferric sulphate=
2. (a) If the valence of A is two, derive the valences of B, C, and D from the following formulae: AB , A_3C_2 , CD_3 , BD_2 .
 - (b) Name the substances represented by the formulae $FeBr_2$, $FeBr_3$, H_2SO_3 , Na_2SO_3 , Na_2SO_4 , $Al_2S_3O_{12}$.
3. (a) Put into words all the information which is conveyed by the expression

$$2H_2+O_2=2H_2O.$$
 What factor of the change is not represented in this expression?
 - (b) In what way does the atomic theory explain the law of definite proportions?
4. (a) Give the sources and modes of preparation or purification of two of the following: (1) starch, (2) sugar, (3) carbon dioxide.
 - (b) Describe tests involving chemical change sufficient for the identification of two of the following soluble salts: (1) a sulphate, (2) a sulphide, (3) an ammonium salt.
 - (c) Describe the method used for the preparation and isolation of two of the following substances. Write the equation for each reaction. (1) potassium nitrate, (2) chlorine, (3) ethyl alcohol.
5. (a) Calculate the weight of sulphur in 50 g. of $Cr_2(SO_4)_3$. Find the result to three significant figures. (Atomic weights Cr 52, S 32, O 16.)
 - (b) How many liters of free oxygen measured under standard conditions may be obtained by heating 10 g. of potassium nitrate to give potassium nitrite (KNO_2)? (Weight of a liter of oxygen 1.43 g. Atomic weights K 39, N 14.)
 - (c) If 10 liters of air are passed into a closed space containing 100 liters of air at 760 mm. pressure, what change of pressure will be produced? Assume the temperature to remain constant.

PART II

(Omit one group. Each question counts 10.)

GROUP A

6. Starting with generally available raw materials, how should you prepare four of the following: (1) dry calcium chloride, (2) crystals of ferrous sulphate, (3) bromine, (4) dry nitrous oxide, (5) crystals of silver nitrate?
7. (a) How should you determine quantitatively the percentage of oxygen in the air?
(b) Describe experiments involving chemical change sufficient to distinguish between three of the four following pairs: (1) lead acetate and lead carbonate, (2) calcium chloride and zinc chloride, (3) concentrated and dilute sulphuric acid, (4) hydrogen peroxide and water.

GROUP B

8. (a) A compound of the elements A and B contains 45 parts of A and 28 parts of B by weight. If another compound of the same elements exists, what quantities of B should you expect to find combined with 45 parts by weight of A? State the law upon which your conclusion is based.
(b) According to the theory of electrolytic dissociation, what takes place when dilute solutions of an acid and a base are mixed?
9. (a) What are the reasons for believing that the hydrogen molecule contains two atoms?
(b) What is a reversible reaction? Give an illustrative equation. Under what circumstances do such reactions go to completion?

GROUP C

10. Mention one useful property of each of ten of the following substances, and give in each case one useful application based upon that property: hydrogen, chlorine, alum, zinc chloride, ferric oxide, Pb_3O_4 , copper sulphate, $HgCl$, $HgCl_2$, silver nitrate, sulphur dioxide, potassium nitrate.
11. (a) Name three general classes of foods and show in which class or classes each of the following should be placed: butter, lean meat, milk, wheat bread, corn starch, egg.
(b) (1) Why is a superphosphate used in preference to normal phosphate as a fertilizer? (2) Why is iron made in a blast furnace while zinc is made in a retort? (3) Why is sulphuric acid used in preference to hydrochloric in making nitric acid? (4) Why should sea-water not be used in a steam boiler? (5) What are the chief products of the distillation of soft coal?

DRAWING

DRAWING

Saturday

9-11 a. m.

Candidates must do exercise 1 and either 2 or 3.

Thirty minutes and no more should be devoted to the first exercise. If this drawing is not completed by 9.45 a. m., it should be left unfinished and work should be begun on the second exercise.

If the second exercise should be finished before 11 a. m., the candidate is at liberty to devote the remaining time to the completion of the first exercise.

An incomplete drawing, correctly laid out and executed by correct method, is better evidence of proficiency than a completed drawing, incorrect in construction and slovenly in execution.

Use a soft pencil, with a light touch.

All work must be strictly free-hand work without assistance from measuring slips, instruments, or artificial aids of any kind.

Accuracy of form is of more account than finished execution.

Students are advised not to erase completely the construction lines.

EXERCISE 1

Enlarge the portion of Fig. 1 lying between the lines EF and JK , making the distance between these lines $5''$. Draw the hexagon ABC as it would appear if resting against the cylinder, with the edge AB placed approximately at $A'B'$, and edge CD at $C'D'$; making the apparent width equal to the distance between the lines EF and GH . Vanishing lines and other construction lines should be drawn lightly, and should not be erased. Line in the visible edges of all three solids.

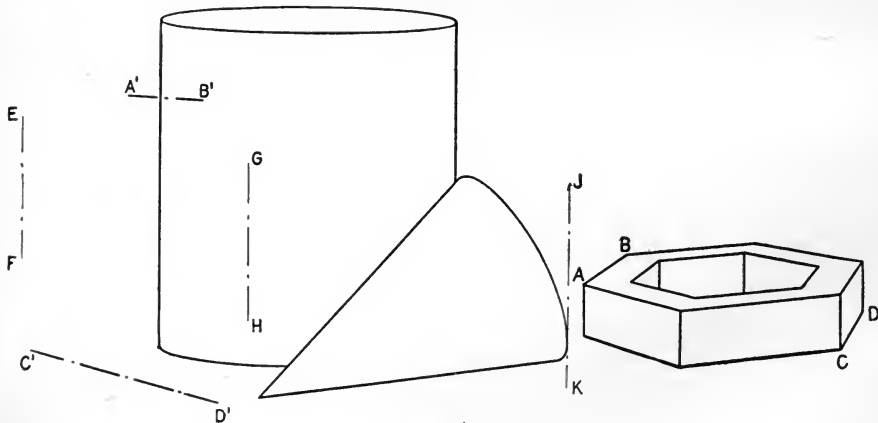


FIG. 1

EXERCISE 2

Enlarge the portion *A* of Fig. 2. Make the height of the drawing $2\frac{1}{2}$ inches. Enlarge Fig. 3 to 3 inches in height. Indicate the form of the object by shading.

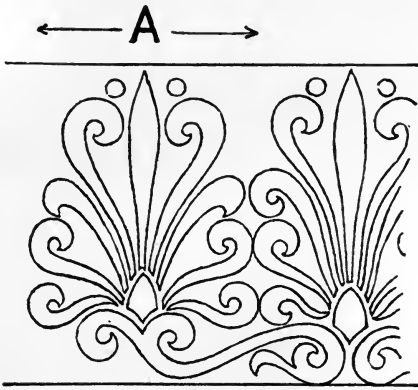


FIG. 2



FIG. 3

EXERCISE 3

Enlarge Fig. 4. Make the height of the drawing 4 inches. Make a shaded drawing, 3 inches in height, of Fig. 5.

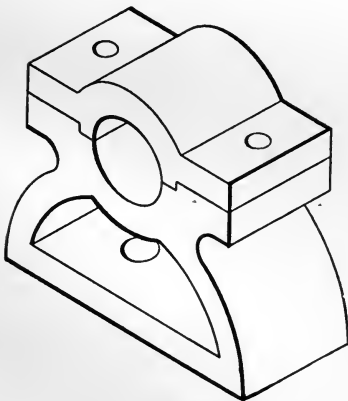


FIG. 4

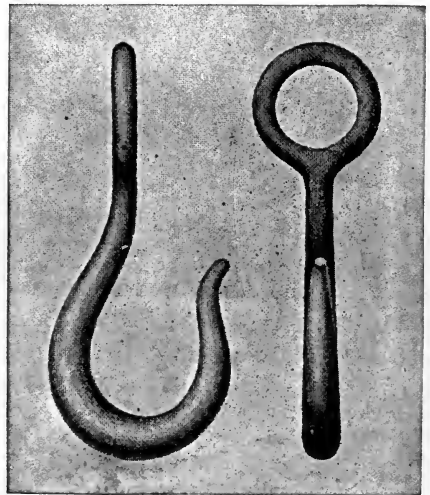


FIG. 5

DRAWING

Saturday

9-11 a. m.

Candidates must do exercise 1 and either 2 or 3.

Thirty minutes and no more should be devoted to the first exercise. If this drawing is not completed by 9.45 a.m., it should be left unfinished and work should be begun on the second exercise.

If the second exercise should be finished before 11 a.m., the candidate is at liberty to devote the remaining time to the completion of the first exercise.

An incomplete drawing, correctly laid out and executed by correct method, is better evidence of proficiency than a completed drawing, incorrect in construction and slovenly in execution.

Use a soft pencil, with a light touch.

All work must be strictly free-hand work without assistance from measuring slips, instruments, or artificial aids of any kind.

Accuracy of form is of more account than finished execution.

Students are advised not to erase completely the construction lines.

EXERCISE 1

Make a line drawing in perspective of the house shown in Fig. 1 as though seen on level ground somewhat below the eye, with one corner toward the spectator, the sides and ends being about equally inclined to the plane of the picture.

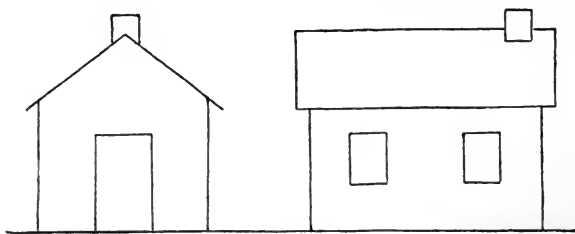


FIG. 1

Surround the drawing by an oblong to make a satisfactory enclosing frame. Indicate the position of the horizon line. The largest dimension of the house should be not less than 4 inches.

EXERCISE 2

Make a drawing in light and shade of A or B, Fig. 2. Make the longest dimension about 5 inches.



FIG. 2 A



FIG. 2 B

EXERCISE 3

Make a line drawing of A or B, Fig. 3. The longest dimension of the object should be about 5 inches.

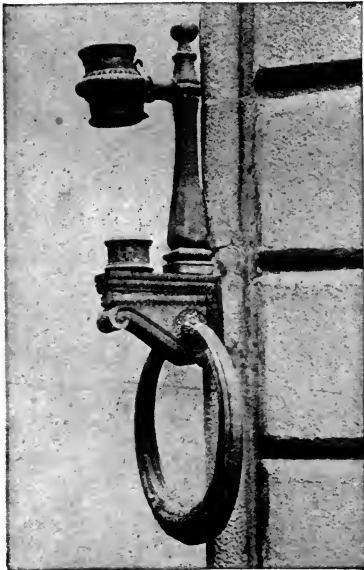


FIG. 3 A

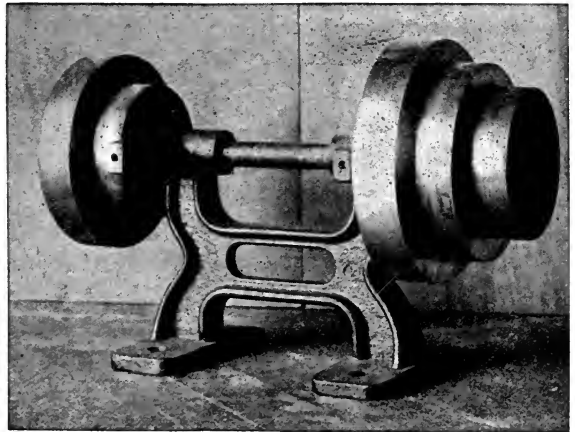


FIG. 3 B

DRAWING

Friday

4.15-6 p. m.

Candidates must do exercises 1 and 2, and either 3 or 4.

Thirty minutes and no more should be devoted to the first exercise. If this drawing is not completed by 4:45 p.m., it should be left unfinished and work should be begun on the second exercise.

If the third exercise should be finished before 6 p.m., the candidate is at liberty to devote the remaining time to the completion of the first exercise.

An incomplete drawing, correctly laid out and executed by correct method, is better evidence of proficiency than a completed drawing, incorrect in construction and slovenly in execution.

Use a soft pencil, with a light touch.

All work must be strictly free-hand work without assistance from measuring slips, instruments, or artificial aids of any kind.

Accuracy of form is of more account than finished execution.

Students are advised not to erase completely the construction lines.

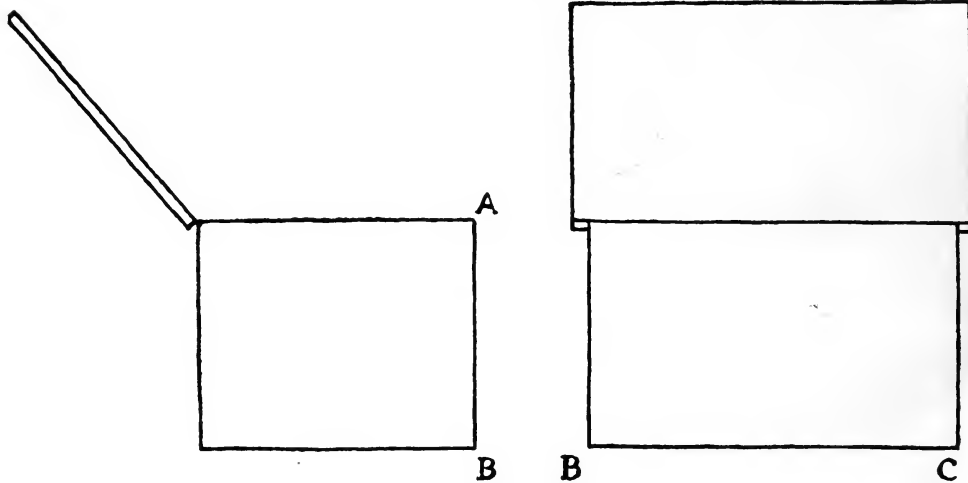
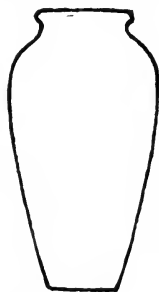


FIG. 1

1. Draw in oblique perspective the chest with raised lid shown in the two elevations, Fig. 1. Line AB should be at the front, the base line, BC, being drawn toward the right at an angle of about 30° with the horizontal. The entire object is supposed to rest on a horizontal surface and is below the eye level. Extend lines sufficiently to show clearly in the finished drawing their intended directions. The greatest dimension of the drawing should be about five inches.



2. Imagine the two pottery forms, Fig. 2, arranged in a group with one diagonally in front of the other to the left so that a small part of the rear form is hidden from view. Draw this group in perspective as seen below the eye level, showing light and shade with cast shadows. Imagine the light to come from the upper left-hand side. Make the greatest dimension of the drawing about five inches.

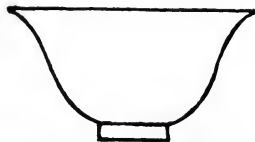


FIG. 2

3. Draw from memory, in line, any one of the following objects as viewed diagonally from above:

- A carpenter's hammer.
- The handle of a carpenter's saw.
- A pair of ice-tongs.
- A tea-cup and saucer.

Make the greatest dimension about five inches.



FIG. 3 A



FIG. 3 B

4. Make a drawing in light and shade of A or B, Fig. 3. Make the drawing the same size as the figure.

DRAWING

Friday

4.15-6 p. m.

Candidates must do either exercise 1 or 2 and exercise 3.

No more than forty-five minutes should be devoted to the first drawing. If this drawing is not completed by 5 p.m., it should be left unfinished and work should be begun on the second drawing. If this should be finished before 6 p.m., the candidate is at liberty to devote the remaining time to the completion of the first exercise.

An incomplete drawing, correctly laid out and executed by correct method, is better evidence of proficiency than a completed drawing incorrect in construction and slovenly in execution.

Use a soft pencil, with a light touch.

All work must be strictly free-hand work without assistance from measuring slips, instruments, or artificial aids of any kind.

Accuracy of form is of more account than finished execution.

Students are advised not to erase completely the construction lines.

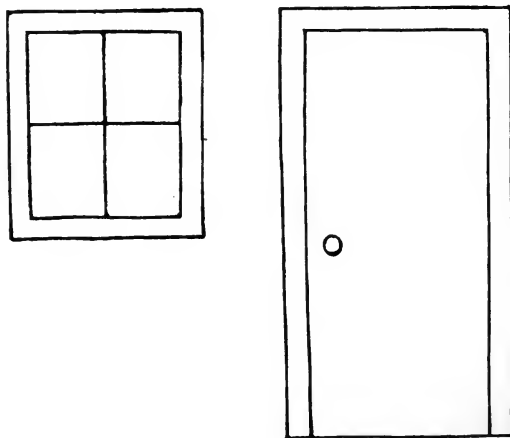


FIG. 1

1. Make a line drawing in perspective of the corner of a square room as seen from the center of the room. In the wall to the right is a partly open door, and in the other wall a window. The door and the window are to be drawn as indicated in the accompanying cut (Fig. 1). Wall and door are to be conceived as without thickness.

Make the line of intersection of the two walls about 3 inches long. Leave in all construction lines which indicate the position of vanishing points.

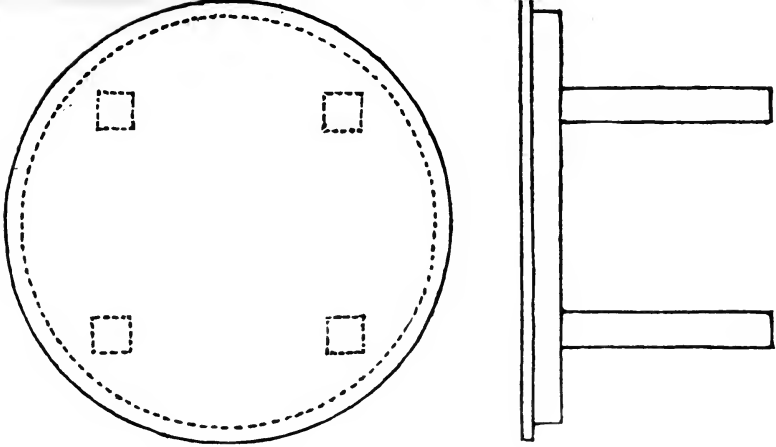


FIG. 2

2. Draw in oblique perspective the table shown in plan and elevation (Fig. 2), as seen some distance below the eye, but with parts of all the legs visible.

Make the total width of the drawing about 5 inches. Leave in all construction lines, lightly drawn.



FIG. 3 A



FIG. 3 B

3. Make a drawing in light and shade, without regard to color value, of Fig. 3A or Fig. 3B. Make the drawing the same size as the figure.

In 3B draw only the foreground plane without regard to the buildings seen in the distance.

DRAWING

Friday

4.15-6.15 p. m.

Candidates must do both exercises 1 and 2.

No more than forty-five minutes should be devoted to the first exercise. If this is not completed by 5 p. m., it should be left unfinished and work should be begun on the second exercise. If this should be finished before 6.15 p. m., the candidate is at liberty to devote the remaining time to the completion of the first exercise.

An incomplete drawing, correctly laid out and executed by correct method, is better evidence of proficiency than a completed drawing incorrect in construction and slovenly in execution.

Use a soft pencil, with a light touch.

All work must be strictly free-hand work without assistance from measuring slips, instruments, or artificial aids of any kind.

Accuracy of form is of more account than finished execution.

Students should leave in all construction lines.

1. Make a drawing of a rectangular shelf placed on a wall near the corner of a room at an angle above the observer, with a cylindrical hat-box standing upon it and projecting slightly over one corner. Draw the supports of the shelf. Indicate, by a few lines, both walls of the room.

Make the greatest dimension of the shelf no less than three inches. All construction lines must be left in.

2. Make a drawing in light and shade, without regard to color value, of Fig. 1 or Fig. 2. Make the drawing the same size as the figure.

In Fig. 2 omit the background.

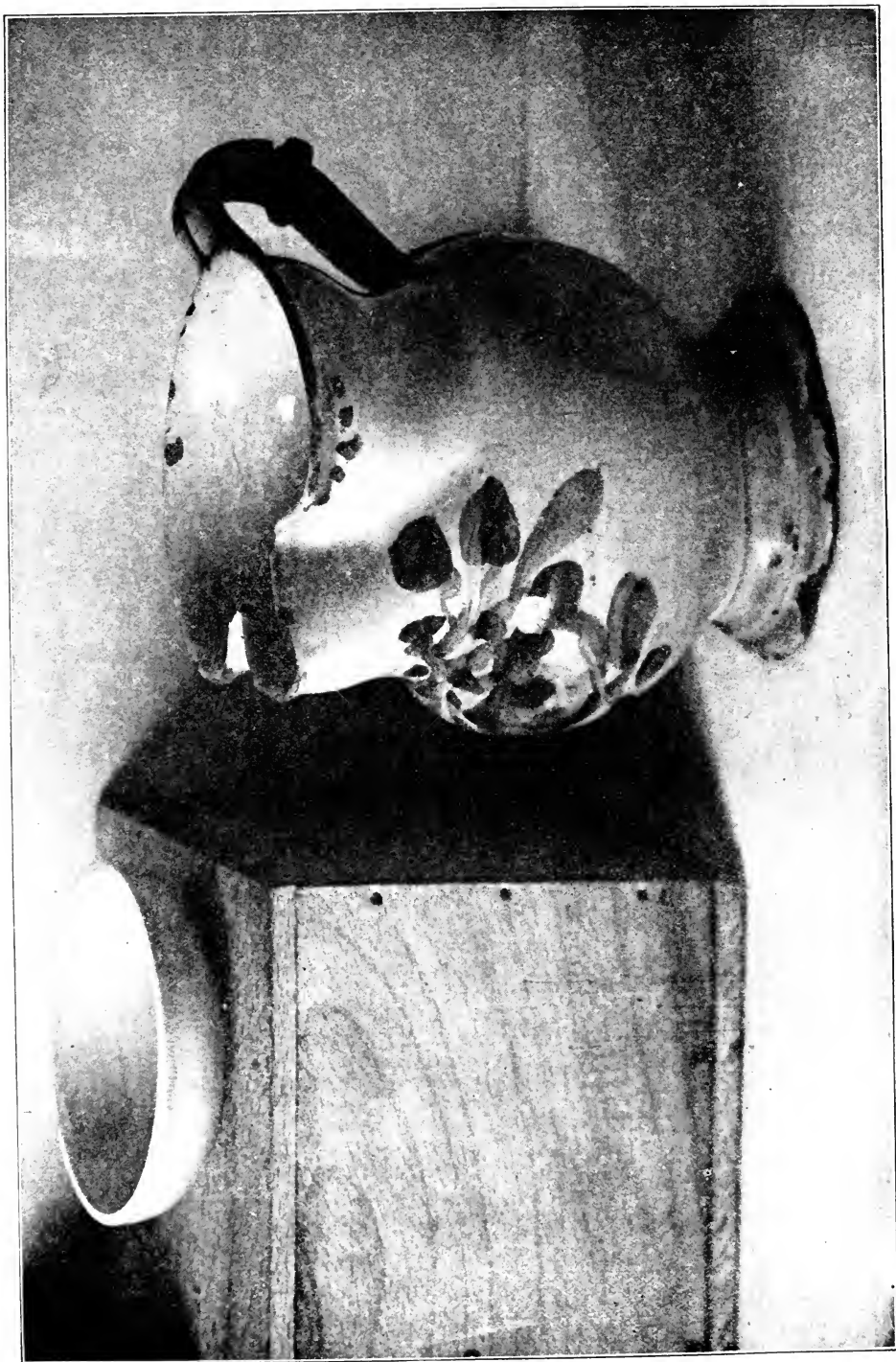


FIG. 1.

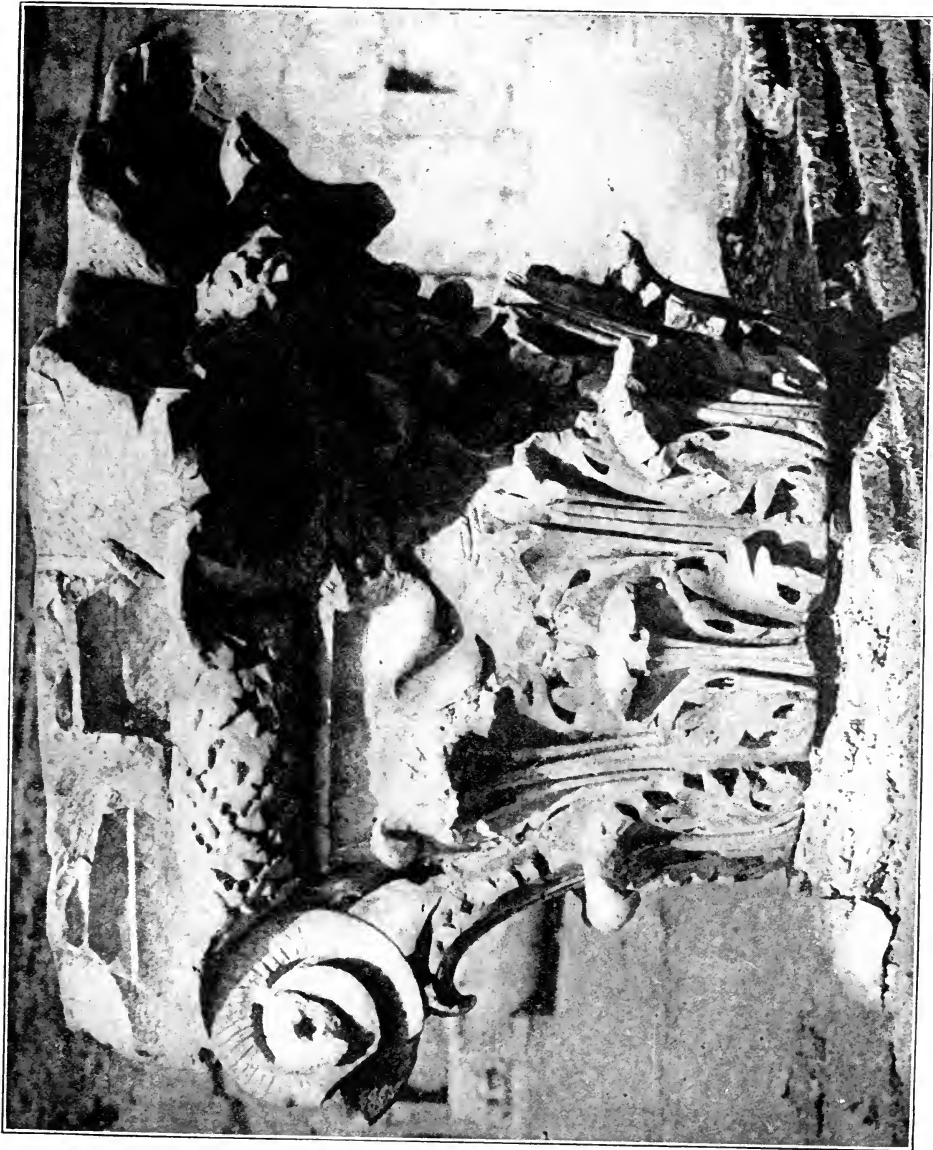
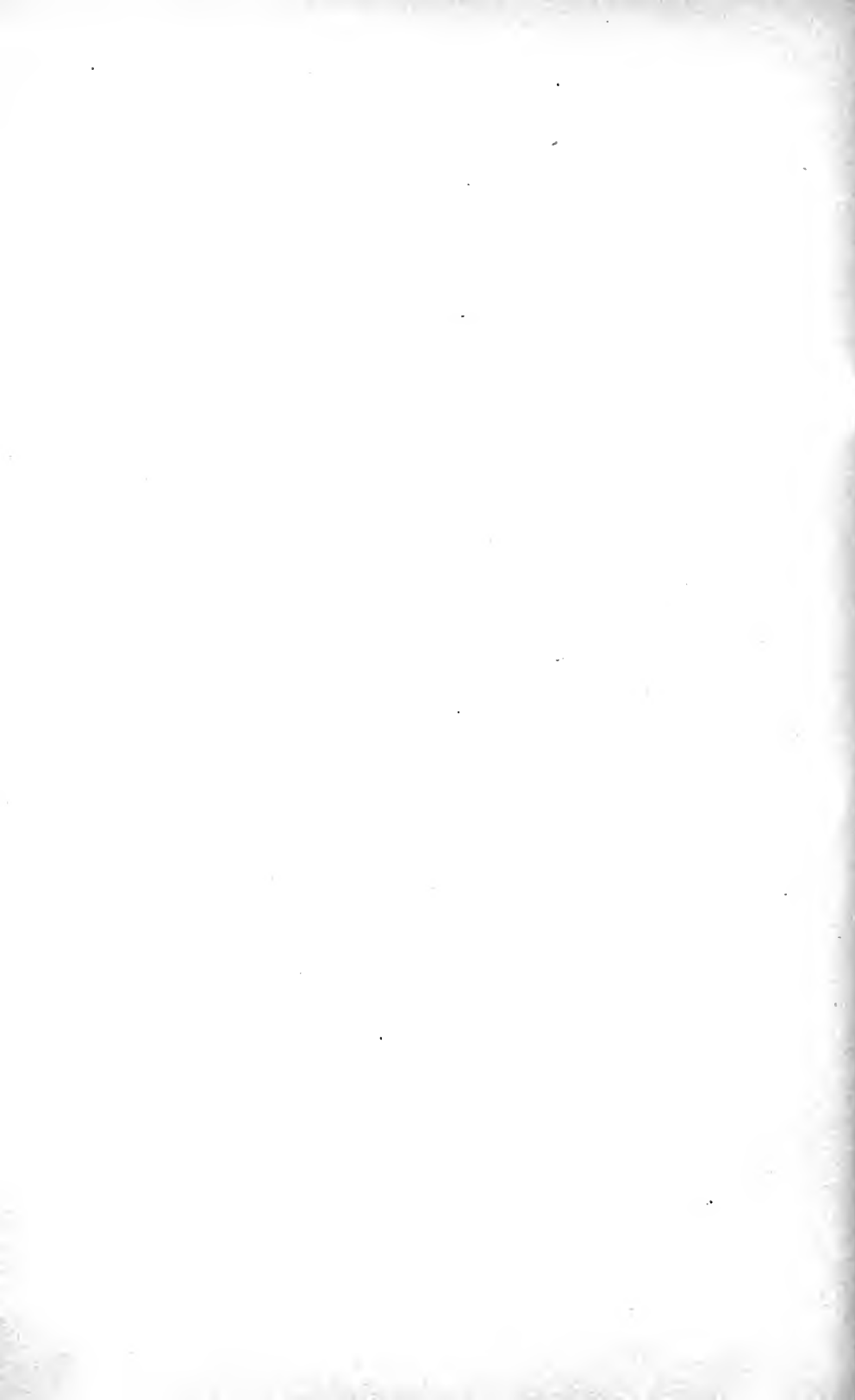


FIG. 2



GEOGRAPHY

GEOGRAPHY

Friday

3.45-5.45 p. m.

A teacher's certificate covering the laboratory instruction must be presented at the time of the examination.

No extra credit will be given for more than the required number of questions.

GROUP A. THE EARTH AS A GLOBE

Answer one question from this group

1. In his final dash for the Pole over the Arctic ice, Commander Peary found his compass of no value in determining directions; why was this so? How could he know when he had arrived at the North Pole?
2. The earth is an oblate spheroid; to what is its shape due? What is the approximate amount of flattening at the Poles? What facts show that the earth is approximately a sphere?

GROUP B. THE OCEAN

Answer one question from this group

3. Under what conditions do coral reefs develop in the ocean? What is an atoll? a barrier reef? Corals are found in the region of the Bermuda Islands, latitude 32 degrees 20 minutes North. They do not occur about the Galapagos Islands under the Equator westward from South America. Account for this.
4. Account for the clockwise circulation of the water about the North Atlantic; the counter-clockwise circulation about the South Pacific; the seasonal alternation in direction of circulation about the North Indian Ocean.

GROUP C. THE ATMOSPHERE

Answer two questions from this group

5. How do observations of meteors give us knowledge of the depth of the atmosphere? Based on such observations, how deep is it? Why are dust and water vapor confined to the lower air?
6. Why may we find lower temperatures, in general, either by traveling poleward or by ascending a mountain? Why has Lisbon, Portugal, a more equable climate than New York? and why are the climates of both more equable than that of St. Louis, Missouri?
7. The mountainous islands of the West Indian and Hawaiian groups have a wet and dry coast; locate and explain. Why has the City of Mexico a wet summer, and the city of San Francisco a wet winter?

GROUP D. THE LANDS

Answer three questions from this group

8. Explain fully the development of meanders and the production of cut-offs in an old river. Why are the ends of the ox-bow lake so quickly filled? Make a transverse profile of an ideal floodplain. Why are many floodplains of the world great agricultural regions?
9. What is the relative age of the Appalachians, the Rocky Mountains, and the Coast Range? On what evidence do you base your answer? Show how the Appalachians affected the progress of settlement.
10. Along the Connecticut River in Vermont several distinct terraces above the present floodplain may be seen; explain the origin of these terraces. Along the river at several places falls occur, and at these falls great paper mills have been built. Explain the location of this industry at these particular places.
11. Define ten of the following: residual soil, avalanche, pothole, base level, sand dune, cordillera, water gap, peneplain, caldera, till, drumlin, sedimentary rock, water table, fault, anticline.
12. Draw a contour map with:
 - a) An irregular coast line.
 - b) back of this a plain rising to an elevation of forty feet and about one mile wide.
 - c) back of the plain a mountain with a conical peak four hundred feet high and a ridge about three miles long and approximately three hundred feet high, cut by a stream in a gorge.Contour interval, twenty feet. Scale about one inch to the mile.

GEOGRAPHY

Friday

3·45-5·45 p. m.

A teacher's certificate covering the laboratory instruction must be presented at the time of the examination.

No extra credit will be given for more than the required number of questions.

GROUP A. THE EARTH AS A GLOBE

Answer one question from this group

1. Why does the Mercator map not have a scale of miles? A United States topographic map includes the same number of minutes of latitude and of longitude. Why is it neither square nor rectangular?
2. Explain two ways in which true north may be determined. How, in the absence of a time piece, may local time be determined?

GROUP B. THE OCEAN

Answer one question from this group

3. Why is the tidal range large in the Bay of Fundy, and small in the Mediterranean Sea? Apply this explanation in accounting for the difference of tidal range at the two ends of the Panama Canal.
4. If a part of a continental shelf were raised above sea level, what would be the form of the resulting shoreline? What would be its form if the coastal lands were partly submerged? Show the economic importance of such changes by illustrations from the coast lines of the United States.

GROUP C. THE ATMOSPHERE

Answer two questions from this group

5. Some portions of the trade wind belt are rainy, others desert. Give instances of each and account for the difference.
6. Make a sketch map of a low-pressure area, drawing lines of equal pressure and equal temperature, showing rainfall conditions, and, by means of arrows, the wind directions. How does the weather of the eastern and central United States change as cyclonic and anti-cyclonic conditions pass over it?
7. How and why does the variation in temperature of the land differ from that of the water? Give specific instances of the climatic influence of this difference.

GROUP D. THE LAND

Answer three questions from this group

8. Describe briefly the agencies in operation in the formation of (a) residual soils, (b) transported soils.
9. Locate two extensive ice-sheets of the present day and two of former times. State some of the effects of these vanished ice-sheets that have an important influence on human settlement or industry.
10. Describe the St. Lawrence system. In what stage of development is it? State clearly three ways in which this drainage system has been of decided geographic influence.
11. Where are active volcanoes found in North America? In Europe? What results of volcanic activity are found:
 - (a) In the region of the Columbia River Plateau?
 - (b) In the Yellowstone National Park?
 - (c) In the Cascade Range?
12. Define ten of the following: tornado, convection, insolation, relative humidity, moraine, meander, natural levee, bore, stalactite, artesian well, lava, fiord.

GEOGRAPHY

Saturday

9-11 a. m.

A teacher's certificate covering the laboratory instruction must be presented at the time of the examination.

No extra credit will be given for more than the required number of questions.

GROUP A. THE EARTH AS A GLOBE

Answer one question from this group

1. Illustrating by diagrams, compare a spherical and a flat earth as regards the measurement of time and the distribution of temperature; also show what effect the inclination of the earth's axis has upon the length of the day and the change of seasons.
2. Locate on the earth a person whose observations of the sun at noon on December 21st showed an altitude of 25 degrees, and whose watch, carrying Denver time, showed 10 o'clock A.M.

GROUP B. THE OCEAN

Answer one question from this group

3. Explain what icebergs are; account for their frequent presence in the neighborhood of Newfoundland and for the fact that icebergs once observed there, may subsequently be found northeast of the point where they were first seen.
4. Name five economic products derived from the sea; explain the methods by which they are derived; and give the regions from which they are obtained.

GROUP C. THE ATMOSPHERE

Answer two questions from this group

5. Compare the general weather characteristics of "temperate" and of "torrid" zones; also describe and explain the general course of an isotherm in the middle latitudes of the northern hemisphere in January.
6. Why does the temperature ordinarily fall, why do the winds weaken, and the skies clear upon the approach of a *high*; whereas the opposite of these changes accompanies the approach of a *low*?
7. Why does the Panama region have a rainy and a dry season? When should each occur? Explain the rainy and the dry seasons in California.

GROUP D. THE LANDS

Answer three questions from this group

8. Some regions, now land, have been sea-bottom, and other regions now sea-bottom, have been land; give an example of each sort of region, and state the evidences that the change has occurred.
9. Distinguish between *mantle-rock* and *bed-rock*; name three economic products derived from each, giving one important locality from which each product is obtained.
10. Describe five particulars in which northern United States differs from southern United States as a result of the ice-sheet of the *Glacial Period*. Locate the boundary between the glaciated and un-glaciated regions, and explain how it is recognized.
11. Give an account of some geographic excursion which you have made, stating its purpose and describing what you saw; *or* describe some laboratory exercise performed, stating the purpose, method, and results of the work.
12. Define ten of the following terms: weathering, meander, snow-line, canyon, tornado, barometric gradient, cold wave, sand dune, thermometer, spring tide, water table, continental shelf, artesian well, volcano.

GEOGRAPHY

Saturday

9-11 a. m.

A teacher's certificate covering the laboratory instruction must be presented at the time of the examination.

No extra credit will be given for more than the required number of questions.

GROUP A. THE EARTH AS A GLOBE

(Answer one question from this group.)

1. When it is 12 o'clock, noon, October 8, at San Francisco, having the time of 120° west longitude, what is the day and hour at Manila, having the time of 120° east longitude?
2. The sun is farthest from the earth in July; how then can July be a summer month? Explain the causes of seasons. Use diagrams.

GROUP B. THE OCEAN

(Answer one question from this group.)

3. Explain changes of temperature with increasing depth in (a) the Mediterranean Sea, (b) the Atlantic Ocean. Use diagram.
4. Draw two sketch maps of the northern Indian Ocean, showing the position of the equator. On one map indicate the winds and ocean currents for January; on the other the winds and ocean currents for July.

GROUP C. THE ATMOSPHERE

(Answer two questions from this group.)

5. Describe the distribution of forested areas and deserts which would prevail along the Pacific Coast of North and South America, if the direction of the earth's rotation were reversed. Illustrate by sketch map.
6. Compare the weather elements of temperature and precipitation of: Seattle, St. Paul, and Boston, (a) in summer; (b) in winter.
7. Describe the usual path of a cyclonic storm in the United States, stating and explaining the attendant conditions of temperature, wind, and precipitation.

GROUP D. THE LANDS

(Answer three questions from this group.)

8. Contrast the characteristics of young and mature streams, and show how these contrasted features affect transportation, manufacturing, and agriculture.
9. Describe a belted coastal plain and explain in detail its physiographic development. Use diagram.
10. Indicate on a sketch map of the United States the extent of the continental glacier. Name three ways in which glaciers aid in forming lakes.
11. Define ten of the following terms: block mountain, fault, moraine, water table, fiord, relative humidity, weathering, atoll, base level, equinox, pot hole, playa.
12. Make a contour map and longitudinal profile of a hill 480 feet high, six miles long and two miles wide, cliffed at one end by ocean waves; contour interval 50 feet. Give horizontal and vertical scales used.

GEOGRAPHY

Saturday

9-11 a. m.

A teacher's certificate covering the laboratory instruction must be presented at the time of the examination.

No extra credit will be given for more than the required number of questions.

GROUP A. THE EARTH AS A GLOBE

(Answer one question from this group.)

1. Why does the moon show phases?
Where is the full moon seen at midnight?
At what phase of the moon and under what conditions is there a total eclipse of the sun?
2. A mariner finds his local time 45 minutes slower than Greenwich time as indicated by his chronometer. At the same moment he finds the noon altitude of the sun to be 41° . The date is March 21. What is his latitude and longitude and what is the nearest land?

GROUP B. THE OCEAN

(Answer one question from this group.)

3. State several facts which indicate that winds cause ocean currents.
4. (a) Explain why tides at the head of the Bay of Fundy rise higher than at Naples, Italy.
(b) Why are successive high tides usually of unequal height?

GROUP C. THE ATMOSPHERE

(Answer two questions from this group.)

5. Discuss the composition of the atmosphere, including a statement of the approximate percentage and the uses of each component. Which components vary little in their percentage and which are the most variable?
6. Explain the direction of the southeast trade winds; also explain why, when they cross the equator, these winds become southwest winds. Why should trade winds ever cross the equator?
7. At a certain town the wind has shifted from southeast to south, with rising temperature and rain. Tomorrow will be clear and much colder, with strong northwest winds. Draw a weather map showing the cyclone and anticyclone responsible for these changes. Indicate position of town by letter *T*.

GROUP D. THE LANDS

(Answer three questions from this group.)

8. Draw a contour map of a hill, with steep eastern and gentle western slopes, with a river flowing west. Construct a north-south profile through the crest of the hill. Give horizontal and vertical scales used.
9. Describe some ocean harbor, including its method of origin and its commercial advantages.
10. Explain the formation of flood-plains and describe their peculiarities of slope and drainage. Give several reasons why flood-plains are productive.
11. Why are some lakes salt whereas others are fresh? Give an example of each kind. Why do salt lakes show a greater fluctuation in level than fresh lakes? Why do streams flowing from lakes show less variation in volume than do those entering lakes?
12. Define ten of the following terms: monsoon, spit, peneplain, mature valley, fault cliff, esker, till, fall line, mesa, geyser, dike, doldrums, standard time, base-level, spring tide.

PHYSICS

PHYSICS

Monday

3·45-5·45 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer ten questions as indicated below. No extra credit will be given for more than ten questions.

GROUP A

Omit one question from this group

1. Explain the meaning of the terms mass, density and weight. For what two reasons would the apparent weight of a body change if it were taken from the earth's pole to the equator?
2. Resolve a force of 100 lbs. into two components, acting at right angles to each other, one of the components to be three times as large as the other.
3. A straight uniform bar, 102 centimeters long and weighing 150 grams, is supported at its ends and a kilogram weight is suspended from the bar 22 centimeters from the left-hand end. Calculate the total pressure on the right-hand support.
4. When the barometer stands at a height of 75 centimeters what is the total atmospheric pressure upon a man's body, the area of surface being taken as 1.2 square meters? (The density of mercury is 13.6.)

GROUP B

Omit one question from this group

5. (a) How does a "noise" differ from a musical sound?
(b) Explain the formation of beats as they are sometimes observed when two tuning forks are sounded simultaneously. What determines the number of beats per second?
6. On a day when the temperature was 20° C. a gun was fired and, after 4 seconds, the echo from a distant hill was heard. How far away was the hill?

GROUP C

Omit one question from this group

7. (a) Explain the three methods of transferring heat known as conduction, convection, and radiation.
(b) Describe some experiment which shows that water has low conductivity for heat.

8. The Niagara Falls are 50 meters high. If no heat is lost by evaporation how much is the temperature of the water raised by the fall? (Assume the mechanical equivalent of heat to be 427 gram-meters per calorie.)
9. How many calories of heat are required to change 5 kilograms of ice at 0°C . into steam at 100°C .?

GROUP D

Omit one question from this group

10. (a) Distinguish between the shadow of an object and its image.
(b) Describe the pin-hole camera.
(c) A camera which employs a lens is generally made adjustable in length. Is there the same need of adjustment in length in the pin-hole camera? Give reasons for your answer.
11. Explain the meaning of the term index of refraction. The index of refraction for light passing from air to water being assumed to be 1.3, determine the speed of light in water. (The speed of light in air is 186,000 miles per second.)
12. The two sides of a paper screen are illuminated equally by a 4 candle-power electric light 40 centimeters distant on one side and a gas flame 140 centimeters distant on the other side. What is the candle-power of the gas flame?

GROUP E

Omit one question from this group

13. (a) What are the essential parts of the storage cell?
(b) What are the chief merits of this cell which are not possessed by the ordinary cell?
(c) What are the chief practical uses of this cell?
14. Determine the maximum current that may be obtained in an external circuit of 4 ohms resistance by employing three cells, each having an electromotive force of 1 volt and an internal resistance of 2 ohms.
15. A current of 10 amperes flowing through a coil of 20 ohms resistance generates 1,920 calories of heat in 4 seconds. How much heat would be generated by a current of 5 amperes flowing for the same length of time through a coil of 40 ohms resistance?

PHYSICS

Monday

3.45-5.45 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer ten questions as indicated below. No extra credit will be given for more than ten questions.

GROUP A

Omit one question from this group

1. (a) Explain the meaning of the terms *momentum* and *moment of force*.
 (b) Describe an experiment, preferably one which you have personally performed, by which the coefficient of sliding friction between two surfaces may be found and indicate the manner in which the numerical value of the coefficient may be computed from the data obtained.
2. A diving bell, or a caisson, is lowered into a lake until the surface of the water within it is 690 centimeters below the surface of the lake. What does one cubic centimeter of air within the bell weigh if, at the surface of the lake, where the barometric reading is 76 centimeters, one cubic centimeter of air weighs 0.0012 g.? (The density of mercury is 13.6).
3. A bucket of water weighing 30 pounds is to be raised from a well 20 feet deep by means of a windlass having an efficiency of 80 per cent. If the crank arm is 15 inches long and the drum on which the rope is wound is 6 inches in diameter how great an effort must be applied at the crank and through what distance must it act?
4. A power boat is equipped with a motor which develops 10 horse-power when propelling the boat at the rate of 15 miles per hour (22 feet per second). Calculate the resistance which the boat encounters when propelled at this speed, assuming that all of the work done by the motor is that required to overcome the resistance of the water.

GROUP B

Omit one question from this group

5. Describe some common form of resonator and explain resonance as illustrated by its action.
6. A train running 60 miles per hour (88 feet per second), strikes two torpedoes placed on the track 352 feet apart. What time interval occurs between the reports as heard at a station which the train is approaching, the temperature of the air being 20° C.?

GROUP C

Omit one question from this group

7. What is "the dew point" and how may it be determined experimentally? What is the meaning of the term "relative humidity"?
8. A copper tea-kettle weighing 850 grams contains 2,000 grams of water at temperature 20° C. If, of the heat supplied by a gas flame, 16,000 calories per minute are utilized in heating the kettle and water, how long a time would be required to raise the temperature of the water to 100° C.? (The specific heat of copper is 0.094.)
9. A liter of air at 0° C. and 76 centimeters pressure weighs 1.293 grams. What is the weight of a liter of air at 20° C., the pressure remaining unchanged?

GROUP D

Omit one question from this group

10. Describe a method of producing the spectrum of a luminous body and illustrate the method by a diagram.
What sort of a source of light will produce
 - (a) a continuous spectrum?
 - (b) a bright line spectrum?Explain the manner in which Fraunhofer's lines are produced.
11. An object 20 centimeters high is placed 15 centimeters in front of a concave mirror, the focal length of which is 30 centimeters.
 - (a) At what distance from the mirror is the image formed?
 - (b) How long is the image?
 - (c) Is the image real, or virtual?
12. What are conjugate foci?
A distinct image of an object placed 12 inches from a convex lens is projected on a screen 4 inches from the lens. At what distance from the lens would the image be formed if the object were placed 6 inches farther away from the lens?

GROUP E

Omit one question from this group

13. Describe some form of electric telephone transmitter and some form of electric telephone receiver and explain the action of each.
14. An electric flat-iron of 27.5 ohms resistance is connected to a 110 volt circuit.
 - (a) What current in amperes flows through the flat-iron?
 - (b) At 10 cents per kilowatt hour how much would it cost per hour to heat the flat-iron?
15. Two incandescent lamps connected in parallel take a current of one ampere. Their resistances are 180 ohms and 300 ohms respectively.
 - (a) What is the joint resistances of the two lamps in parallel?
 - (b) What current in amperes flows through each lamp?

PHYSICS

Monday

2-4 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer ten questions as indicated below. No extra credit will be given for more than ten questions.

GROUP A

Omit one question from this group

1. Describe the hydrometer as used in determining the specific gravity of a liquid. If the scale on the hydrometer is such that the specific gravity may be read directly from it, will the smaller numbers appear at the top of the scale, or will they be found at the bottom? Give the reasoning involved in your answer.
2. A boy drags a sled by exerting a force of 6 pounds on a rope reaching from his arm to the sled, a distance of 5 feet, his arm being 3 feet higher than the sled. What part of the force that he is exerting is effective in dragging the sled forward?
3. A pail 20 centimeters in diameter at the bottom, 30 centimeters in diameter at the top, 22 centimeters high, inside measurements, and weighing 1.5 kilograms stands, full of water, upon a table. The capacity of the pail is 10.943 liters. Calculate (a) The total pressure, due to the water, on the bottom of the pail. (b) The total pressure of the pail and contents against the table.
4. A straight, uniform stick of timber 10 feet long, weighing 6 pounds per foot of length, lies on level ground. Applying his hands to one end of the stick a man lifts this end 4 feet above the ground, vertical measure. How much work does the man perform against gravity?

GROUP B

Omit one question from this group

5. In what three respects, exclusive of duration, may musical tones differ from each other? Explain the causes of these differences.
6. When the velocity of sound, in air, is 1120 feet per second how many vibrations per second are necessary for the formation of sound waves 4 feet long? Determine the temperature of the air at the time of the experiment.

GROUP C

Omit one question from this group

7. Explain the meaning of the term Mechanical Equivalent of Heat. Describe an experimental method by which its numerical value has been determined.

8. A wheel is 3 meters in circumference. An iron tire measures 2.993 meters around its inner face. How much must the temperature of the tire be raised in order that it may just slip on the wheel? (The coefficient of linear expansion of iron is 0.000012.)

A kilogram of copper, at temperature 90°C ., is placed in a cavity in a block of ice whose temperature is 0°C ., and is left there until the temperature of the copper has fallen to that of the ice. It is then found that 107 grams of ice have been melted by the heat given out by the cooling of the copper. Calculate the value of the heat of fusion of ice, assuming that the specific heat of copper is 0.095.

GROUP D

Omit one question from this group

10. What is the cause of the apparent color of opaque objects? Of transparent objects? Explain why a mixture of yellow and blue pigments appears green.
11. The radius of curvature of a spherical concave mirror is 18 inches. At what distance in front of the mirror should an electric arc be placed in order that the reflected rays may be parallel, or nearly so?
12. When a screen was placed 3 meters from an object and a lens interposed, an image five times as long as the object was projected upon the screen.
- (a) What kind of a lens was used?
- (b) Where was the lens placed?
- (c) What was the focal length of the lens?

GROUP E

Omit one question from this group

13. Describe the construction of a commercial transformer as used on electric lighting circuits and explain its operation. What must be known in order to determine the electromotive force delivered by a transformer when the electromotive force supplied to it is known?
14. Describe, in general terms, the apparatus required for electroplating, stating particularly the direction in which the current must flow. What strength of current is necessary to deposit 9 grams of silver on a certain object in 30 minutes? (The electrochemical equivalent of silver is 0.001118.)
15. An electric bell having a resistance of 4 ohms is connected, by wires having a resistance of 5 ohms, with two cells connected in series, each cell having an electromotive force of 1.5 volts. The current in the circuit is found to be 0.3 amperes. What is the resistance of each cell?

PHYSICS

Monday

2-4 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer ten questions as indicated below. No extra credit will be given for more than ten questions.

GROUP A. (*Omit one question from this group.*)

1. Why is it easier to roll a barrel up a long board into a wagon than to lift it vertically?
How does the work done against gravity when the barrel is rolled up the board compare in amount with the work required to lift it vertically?
2. At what depth in a lake will a bubble of air have one-half the volume that it has on reaching the surface when the barometric height at the surface is 73 centimeters? (The density of mercury is 13.6.)
3. A 5-lb. weight is hung from one end of a uniform bar of wood 4 ft. long and weighing 6 lbs. At what point must the bar be supported to balance in a horizontal position?
4. A ball is thrown up and 5 seconds later is caught.
 - a) How high did it rise?
 - b) With what velocity did it return to the hand?

GROUP B. (*Omit one question from this group.*)

5. Describe an experiment, preferably one which you have personally performed, by which the pitch of a musical tone may be determined.
6. An observer sets his watch by the report of a signal gun one mile away. Find, to one-tenth of a second, the allowance that he should make on account of the distance of the gun, the temperature of the air being 20°C .

GROUP C. (*Omit one question from this group.*)

7. Explain the construction and operation of some form of refrigerating apparatus as used for making artificial ice or for cooling rooms.
8. What is meant by the specific heat of a substance?
A piece of nickel weighing 200 grams at temperature 98°C . was dropped into 500 grams of water at temperature 18°C . The resulting temperature was 21.4°C . Find the specific heat of nickel.
9. The volume of a body of gas at 27°C . is 100 cubic centimeters. If the pressure on the gas is doubled to what temperature must it be heated in order to maintain the volume constant?

GROUP D. (*Omit one question from this group.*)

10. How is the bending of a ray of light passing from air into water explained by the wave theory of light? Illustrate by means of a diagram.
11. Describe a method by which the velocity of light has been determined. The distance from the earth to the sun is approximately 93,000,000 miles. How long a time is required for light to traverse this distance?
12. At what distance from a 40-candle-power mantle burner would a newspaper receive the same illumination as it would receive from an 8-candle-power incandescent lamp 2 feet distant from it?

GROUP E. (*Omit one question from this group.*)

13. How does a charge of electricity distribute itself on an insulated conducting body such as a metal pail or cup? How is the distribution tested experimentally?
14. An electric motor, found, by a brake test, to develop 2 horse-power, requires 8.25 amperes at an electromotive force of 220 volts. What is the efficiency of the motor, expressed in per cent?
15. A galvanometer has a resistance of 171 ohms. With what resistance should it be shunted in order that only one-tenth of the current in the main circuit may pass through it?

PHYSICS

Tuesday

4.15-6.15 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer ten questions as indicated below. No extra credit will be given for more than ten questions.

GROUP A. (*Omit one question from this group.*)

1. State the law of the conservation of energy.
Explain how change of energy of one sort into energy of another sort is illustrated when a ball is thrown vertically upward.
2. A lump of metal weighs 160 grams in air, 140 grams in water, and 146 grams in oil. Find the specific gravity of the metal and that of the oil and also the volume of the metal.
3. A body weighing 120 pounds rests on an inclined plane the length of which is 10 feet, the height 6 feet, and the base 8 feet.
Neglecting friction find:
 - a) The pressure which the body exerts perpendicular to the plane;
 - b) The force exerted parallel to the plane;
 - c) How much work must be done to move the body from the bottom to the top of the plane.
4. A windlass has a drum 6 inches in diameter and a crank arm 12 inches long.
Neglecting friction find:
 - a) What force applied to the crank arm is required to support a 100-pound weight;
 - b) What would be the efficiency of the windlass if a force of 30 pounds was found necessary to raise the weight.

GROUP B. (*Omit one question from this group.*)

5. How does sound differ from light in respect to
 - a) The nature of the medium required?
 - b) The character of the motion of the medium?
 - c) Velocity? (The approximate velocity of each should be given.)
6. A blow struck upon a steel cable was heard through the cable in 0.2 seconds and through the air in 3 seconds. The temperature was 0° C.
 - a) How far from the observer was the blow struck?
 - b) What was the speed of sound in the cable?

GROUP C. (*Omit one question from this group.*)

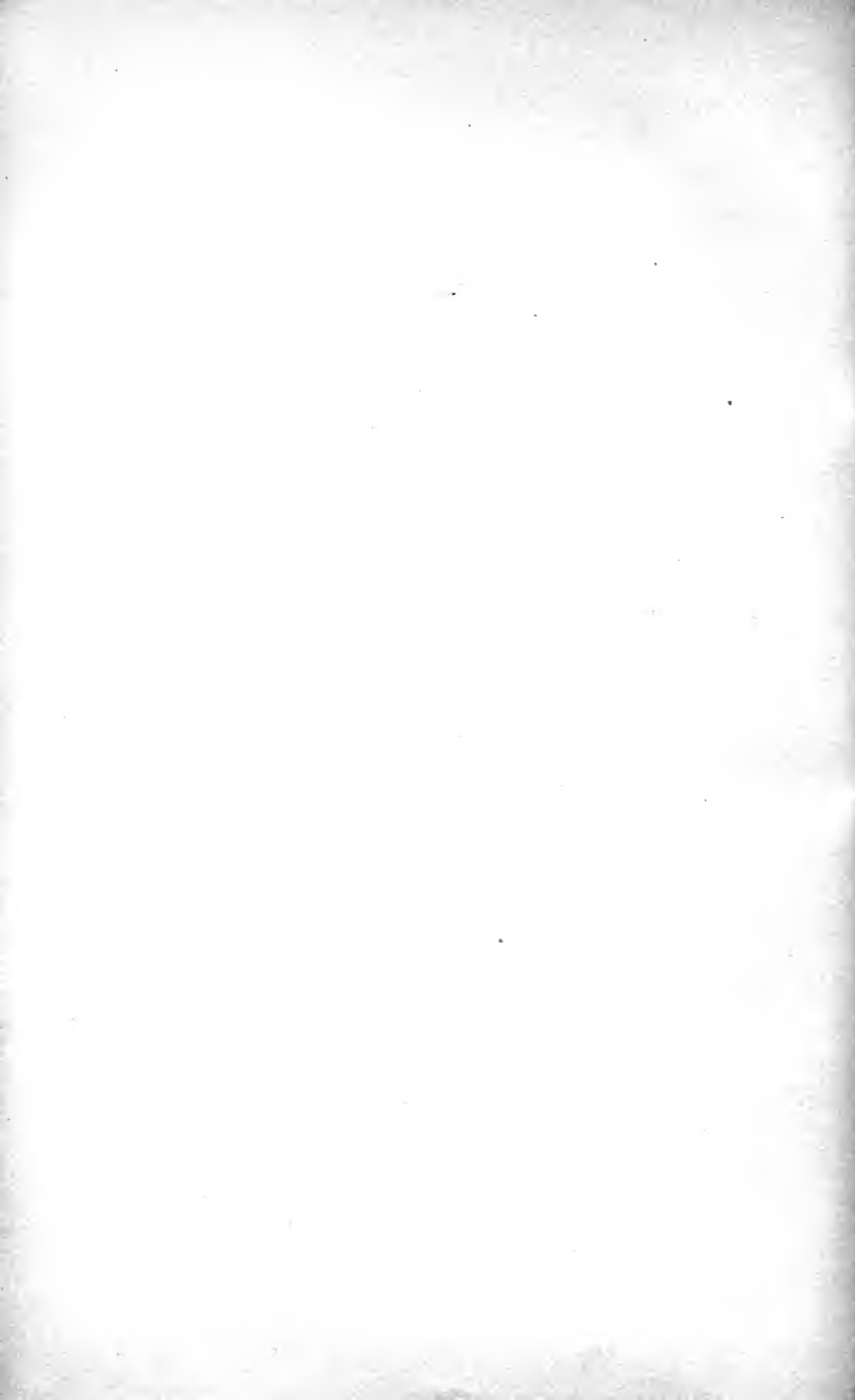
7. a) Why does sprinkling the floor with water cool the air?
b) Why is a clear night generally cooler than a cloudy one at the same season?
c) Why can you "see your breath" on a cold day?
8. When 1,000 grams of ice at 0°C . are put into 2,500 grams of water at 60°C . the temperature of the whole becomes 20°C . Find the heat of fusion of ice.
9. Neglecting loss of heat by radiation find how much steam at 100°C . is required to raise the temperature of an iron radiator weighing 60 kilograms from 10°C . to 100°C . (The specific heat of iron is 0.11.)

GROUP D. (*Omit one question from this group.*)

10. Explain by means of two diagrams, one showing the unaided eye and the other showing the eye assisted by a suitable lens, the effect produced by eye glasses which would enable a far-sighted person to see distinctly objects near at hand.
11. An object 1 foot high is placed 2 feet from a convex lens having a focal length of 18 inches.
a) Find the position and size of the resulting image.
b) Is the image real or virtual? Erect or inverted?
12. How may a distinct sun spectrum showing the Fraunhofer lines be obtained? How are the Fraunhofer lines explained?

GROUP E. (*Omit one question from this group.*)

13. Why do the leaves of a gold-leaf electroscope diverge when a positively charged body is brought near, although no charge passes from the charged body to the electroscope?
Indicate the distribution of the charge by means of a diagram.
14. Given a voltaic cell, a coil of wire, an ammeter, and a voltmeter, how may the resistance of the wire be determined?
Illustrate by means of a diagram the manner in which the apparatus is connected in the circuit employed.
15. Three voltaic cells, each having an electromotive force of 1.4 volts and a resistance of 0.1 ohm, are connected with a wire having a resistance of 3.9 ohms. Find the strength of the electric current
a) When the cells are connected in series;
b) When the cells are connected in parallel.



ZOÖLOGY

ZOOLOGY

Monday

3.45-5.45 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer any eight questions. No extra credit will be given for more than eight questions.

1. Describe, with sketches, the structure, method of feeding, locomotion, and reproduction of any protozoan. Outline the life-history of any protozoan that produces disease.
2. Name a song bird that needs protection and give detailed evidence of its usefulness to man.
3. By what features of structure can a housefly be distinguished from a honey-bee. Illustrate by drawings. State the economic importance of these insects.
4. Define the classes of vertebrates and name an example for each class.
5. Compare the skeleton of a fish, a frog, a snake, and a bird, and show how each is adapted to the life of the particular animal that possesses it.
6. Compare the circulatory system of a fish with that of a human being.
7. Compare respiration in an insect, a fish, and a mammal.
8. Give an account of the feeding habits of a freshwater mussel *or* a clam.
9. Give evidence to show that the higher vertebrates have evolved from fish-like ancestors.
10. Give an account of the methods of reproduction of hydra.

ZOOLOGY**Monday**

3.45-5.45 P. M.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer any eight questions. No extra credit will be given for more than eight questions.

1. Explain what is meant by alternation of generations and describe the life-history of some animal that exemplifies this process.
2. Name the classes of vertebrates and give three distinctive structural characteristics of each class.
3. Give an account of the malarial parasite stating the method by which it enters the human body and that of the intermediate host. How can malaria be controlled?
4. Describe the internal structure of a clam, illustrating your account with labeled diagrams, and explain the action of the parts labeled.
5. Compare the methods of breathing of an insect, a mollusk, a fish, and a bird, and describe the structures involved in each animal.
6. What changes occur in structure and function when a tadpole becomes a frog?
7. Discuss the life-history of two of the following animals: honey bee, mosquito, grasshopper, potato beetle.
8. What reasons can you give for the preservation of song birds, the extermination of house flies, and the support of fish hatcheries by the government?
9. Describe the general manner in which oxygen enters the body of a fish, circulates through it, and leaves it.
10. Explain the meaning of the terms: evolution, natural selection, variation, heredity, protective coloration, and illustrate each by an example from the animal kingdom.

Monday

2-4 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer any eight questions. No extra credit will be given for more than eight questions.

1. Name two insects that are beneficial to man and two that are harmful to him. Outline briefly the life-history of each of these insects.
2. Describe the changes that occur in the complete metamorphosis of any animal that you have studied.
3. Contrast, in parallel columns, the principal structural features that distinguish the different classes of vertebrates.
4. Compare the digestive systems of a hydra, a starfish, a fish, and a mammal. Illustrate by sketches.
5. Describe the mode of feeding of the clam or oyster and show how the animal may harbor germs of disease.
6. Name the class to which each of the following animals belongs and give the characteristics of each class: crab, coral, paramoecium, clam, mosquito.
7. Name three kinds of evidence for animal evolution, illustrating and explaining each.
8. Describe, with sketches, the structure of the earthworm, and show how the structure is correlated with the animal's mode of life.
9. Discuss briefly the important contributions made to science by any *three* of the following naturalists: Darwin, Cuvier, Huxley, Pasteur.
10. What reasons can you give for the presence in a bird of a large breastbone; of feathers? Explain the large size of the eggs of birds.

Monday

2-4 p. m.

A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer any eight questions. No extra credit will be given for more than eight questions.

1. Give an account of the life history of any reptile.
2. Name and describe briefly a representative of each of six different animal groups (phyla or classes) found in a fresh-water pond.
3. Contrast invertebrates with vertebrates. Name three phyla of invertebrates and give their distinguishing characteristics.
4. Describe the structure of any annelid that you have studied.
5. Name the classes of arthropods and describe fully the external structure of a representative of one of these classes.
6. Describe reflex action and give two examples.
7. Compare the process of breathing in a crayfish with that in an insect.
8. Describe the egg of a frog and give an account of the animal that hatches from it.
9. Describe three examples of the adaptation of animals to their surroundings.
10. Name three important discoveries in zoölogy, giving a brief account of the persons concerned in them.

ZOOLOGY

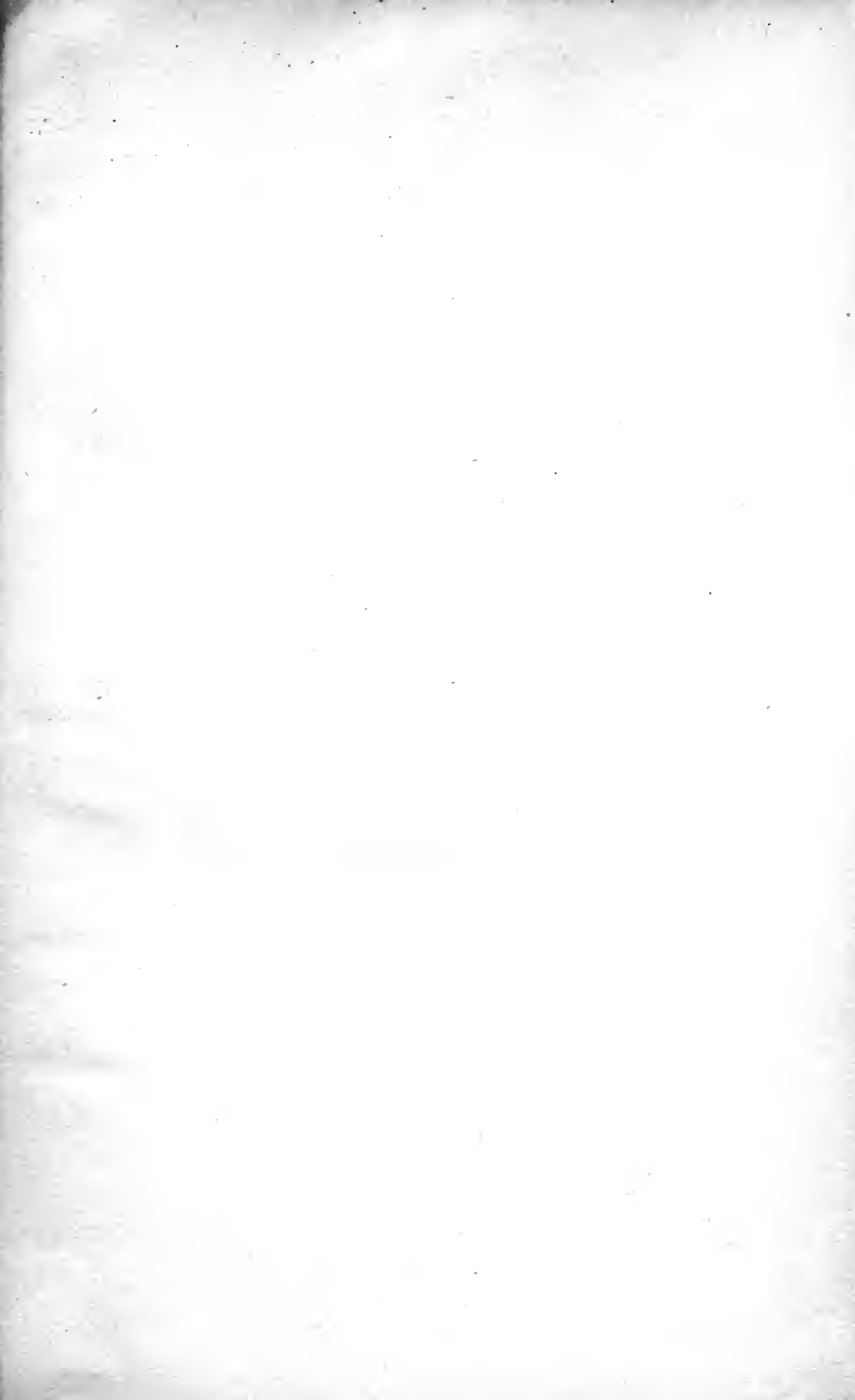
Tuesday

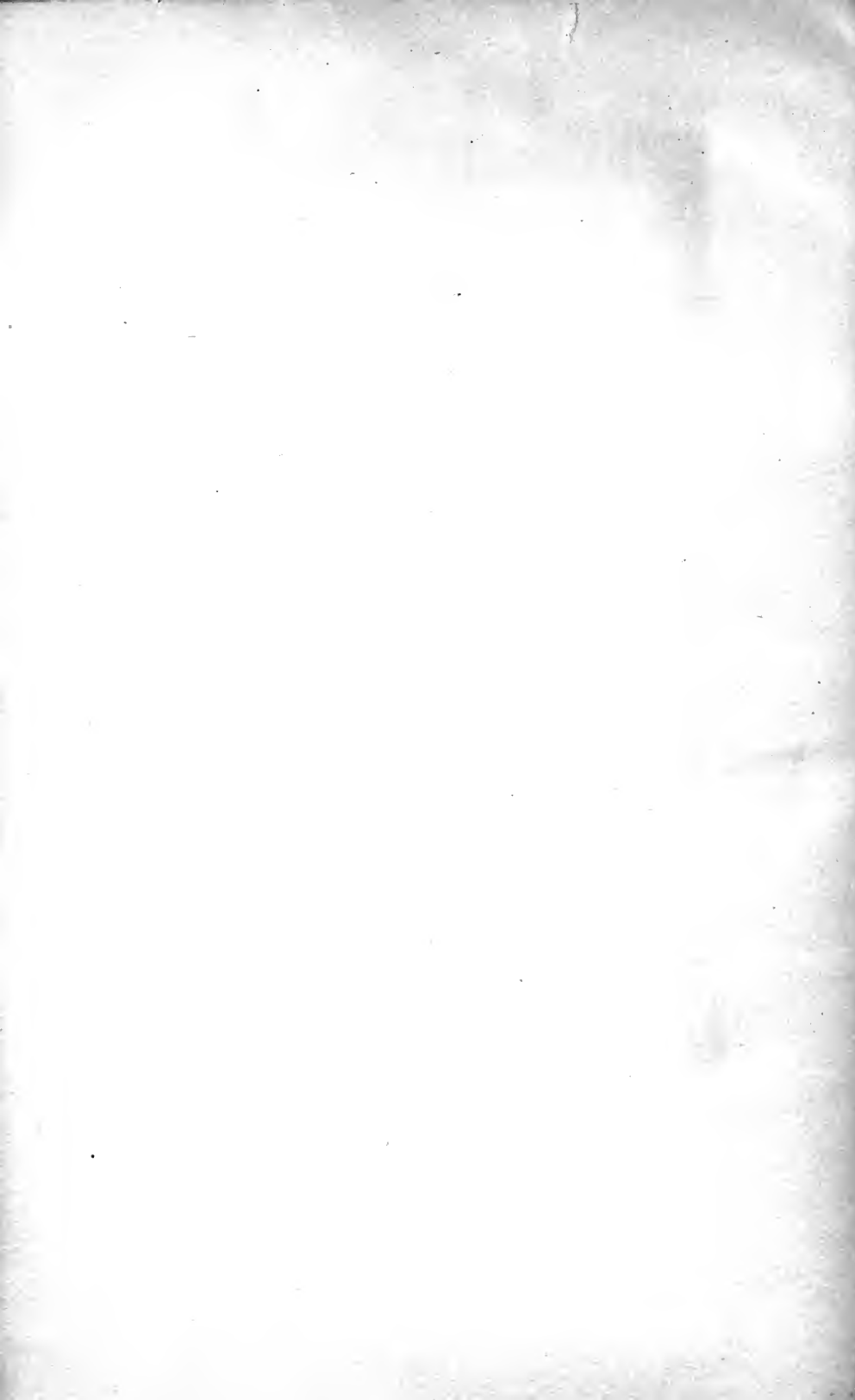
4.15-6.15 p. m.

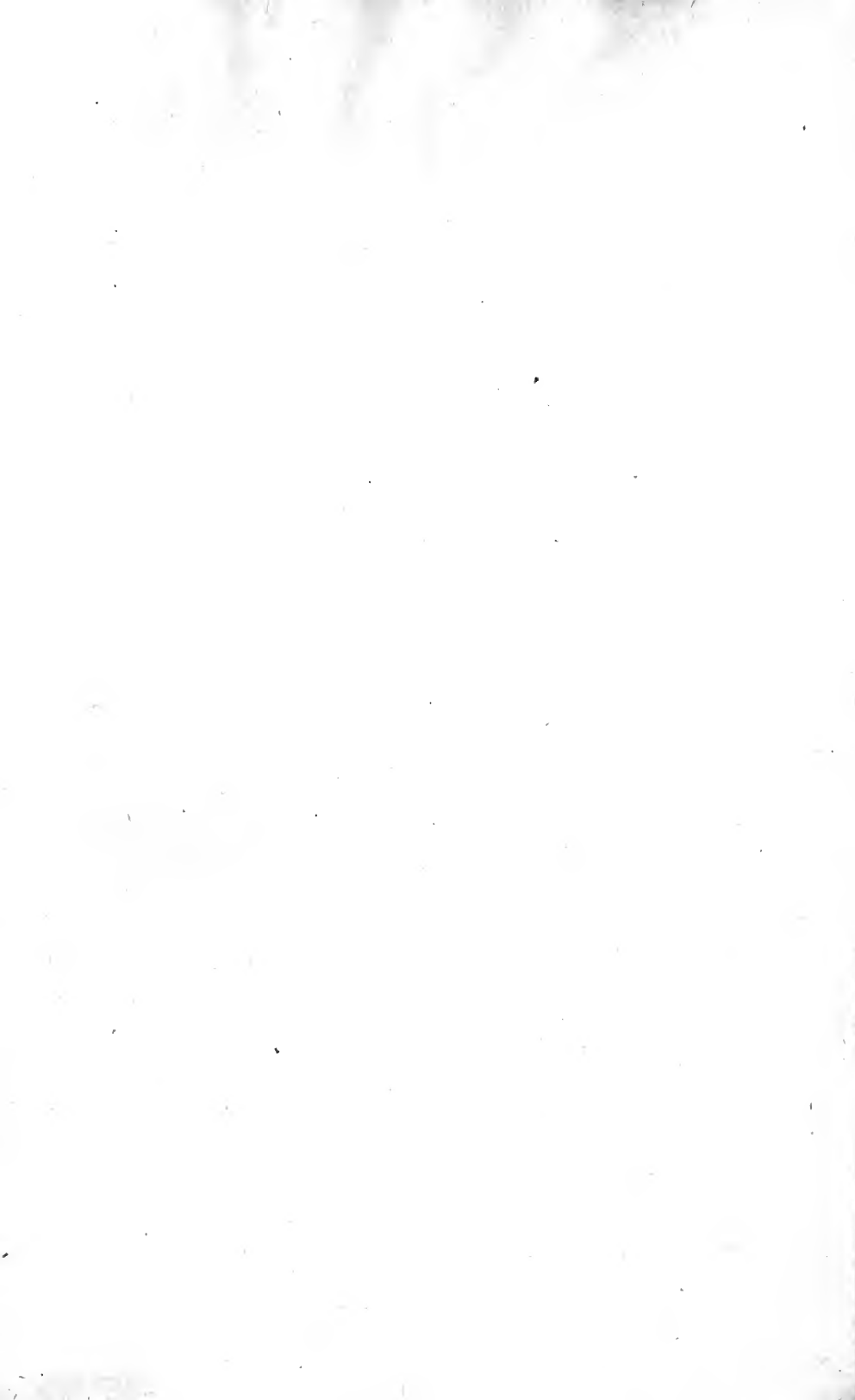
A teacher's certificate covering the laboratory instruction must be presented as part of the examination.

Answer any eight questions. No extra credit will be given for more than eight questions.

1. Give the probable cause of parasitism and illustrate by naming three animal parasites, each from a different branch (Phylum).
2. *a)* Explain in detail the life-history of the house-fly.
b) Exactly how is the house-fly a menace to the community?
c) How can the fly-menace be controlled?
3. In what important ways does an invertebrate such as a lobster differ from a vertebrate such as a fish?
4. Name the principal phyla, or large representative groups, of the animal kingdom with an example of each group.
5. Name three undomesticated animals common to your locality, each living in a different habitat. Describe the kind of place in which each may be found and show in detail how each is structurally adapted to live successfully in its surroundings.
6. Describe three types of animal reproduction, giving an example of each.
7. Discuss the activities of city, state, or national authorities for the protection of beneficial vertebrates or the restriction of invertebrate pests.
8. Name at least five different types of structures used for locomotion in the animal kingdom from ameba to man.
9. Explain the meaning of: (*a*) natural selection; (*b*) variation; (*c*) heredity.







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