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ABSTRACT

In 1965 the International Association for the Evaluation of Educational Achievement (IEA) inaugurated a cross-national survey of achievement in six subjects: Science, Reading Comprehension, Literature, English as a Foreign Language, French as a Foreign Language, and Civic Education. The overall aim of the project was to use international tests in order to relate student achievement and attitudes to instructional, social, and economic factors, and from the results to establish generalizations of value to policy makers worldwide. Contained here are 22 Science tests measuring achievement in the following areas and for the following student populations: General Science (population I, II, IV); Advanced Science (population IV); Specialist Biology, Chemistry and Physics (population IVS); Practical Science (population II); Practical Science, Biology, Chemistry, and Physics (population IV); and Understanding the Nature of Science (populations II, IV). Population I consists of students aged 10 to 11 years; population II, 14 to 15 years; population IV, students enrolled in the final year of pre-university training; and population IVS, those students in population IV specializing in Science. Answer keys and statistical data can be found in ED 081 639. (RC)

IEA SIX-SUBJECT SURVEY INSTRUMENTS

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2 IEA/M1 Manual for National Centers
IEA/M2 Manual for School Coordinators
IEA/M3 Manual for Test Administrators

Stage 3 IEA/M1/Stage 3 Manual for National Centers
IEA/M2/Stage 3 Manual for School Coordinators
IEA/M3/Stage 3 Manual for Test Administrators

These manuals are available from ERIC Clearinghouse.

The following extracts from these manuals have been appended to this particular IEA instrument to provide researchers with the minimum necessary test instruction information (e.g., such things as the instructions on the practice items and the warnings concerning the amount of time left for the test have been omitted here). For full details, please consult the appropriate manuals.

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E = Examination (student)
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1 = I
2 = II
3 = III
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5 = I and II
6 = II and IV
7 = I, II and IV
8 = I and IV
S = IV Specialist
N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
F = French as a Foreign Language
C = Civic Education
2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Science Test - Section A

Data Bank Instrument Number 21SA

IEA/M3

Pop 1, p. 4-5

"Now look at the front cover of Booklet 1. Follow carefully while I read the directions to you."
Read the directions to the group, giving them time to mark the answers to the practice questions when these are reached.
Directions:-
"This test contains questions dealing with different branches of Science.

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.

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Now try these three questions for practice. Fill in the space of your chosen answer on the answer card in section L."
Then say:-
"Are there any questions? You will have 30 minutes for the test. Work as quickly as you can. Do not waste time if you cannot answer a question, but leave it and go on to the next. Open your test booklet and begin."

This test contains questions dealing with different branches of Science. Some you will know about from your school work, some from your general knowledge and others you will be able to answer by using commonsense. Others you may not be able to do. Do not waste time over questions you cannot do; leave them and go on to the next question. You can come back to questions you have missed later, if you have time. You may answer even if you are not quite sure, but do not guess blindly.

Each of the questions or unfinished statements in this test is followed by five suggested answers, lettered A,B,C,D, or E. You have to decide which <u>one</u> answer you think best and then on your answer card make a solid pencil mark in the oval containing the correct answer letter.

Here is an example of how to fill in the answer on your answer card. Remember that the examples given on this page are to be answered in the section marked L on your answer card.

1. How long does the earth take to travel once around the sun?

   A. A day.
   B. A week.
   C. A month.
   D. A year.
   E. None of the above.

Since the earth travels round the sun in a year, the answer space D should be marked. This has been done on the answer card for question 1 in the example section L.

Now try these three questions for practice. Fill in the space of your chosen answer on the answer card in section L.

2. Water would be turned into ice by

   A. heating it.
   B. stirring it quickly.
   C. putting salt in it.
   D. pouring it into a shallow dish.
   E. cooling it.

3. Which day of the year in the southern hemisphere has the longest period of daylight?

   A. 21st January.
   B. 21st March.
   C. 22nd December.
   D. 23rd September.
   E. 22nd June.

Sometimes you may be asked to pick out the <u>one</u> <u>wrong</u> answer or the one that does <u>not</u> fit in with the others.

4. Which of the following does <u>NOT</u> belong to the same group as the others?

   A. Eagle.
   B. Lion.
   C. Mouse.
   D. Elephant.
   E. Deer.

DO NOT TURN OVER UNTIL YOU ARE TOLD TO DO SO.

SECTION A

1. The sun is the only body in our solar system that gives off large amounts of light and heat. We see the moon because it is

   A. reflecting light from the sun.
   B. without an atmosphere.
   C. a star.
   D. the biggest object in the solar system.
   E. nearer the earth than the sun.

2. Imagine yourself leaving a rocket ship on the surface of the moon. You would

   A. be overcome with molten lava.
   B. weigh less.
   C. be poisoned by the atmosphere.
   D. shoot off into space.
   E. burn to death with the heat of the sun.

Questions 3 - 6 refer to the following chart which shows some readings made at different times on three days.

	6.0 a.m.	9.0 a.m.	12.0 Noon	3.0 p.m.	6.0 p.m.
Monday	15° C	17° C	20° C	21° C	19° C
Tuesday	15° C	15° C	15° C	10° C	9° C
Wednesday	8° C	10° C	14° C	14° C	13° C

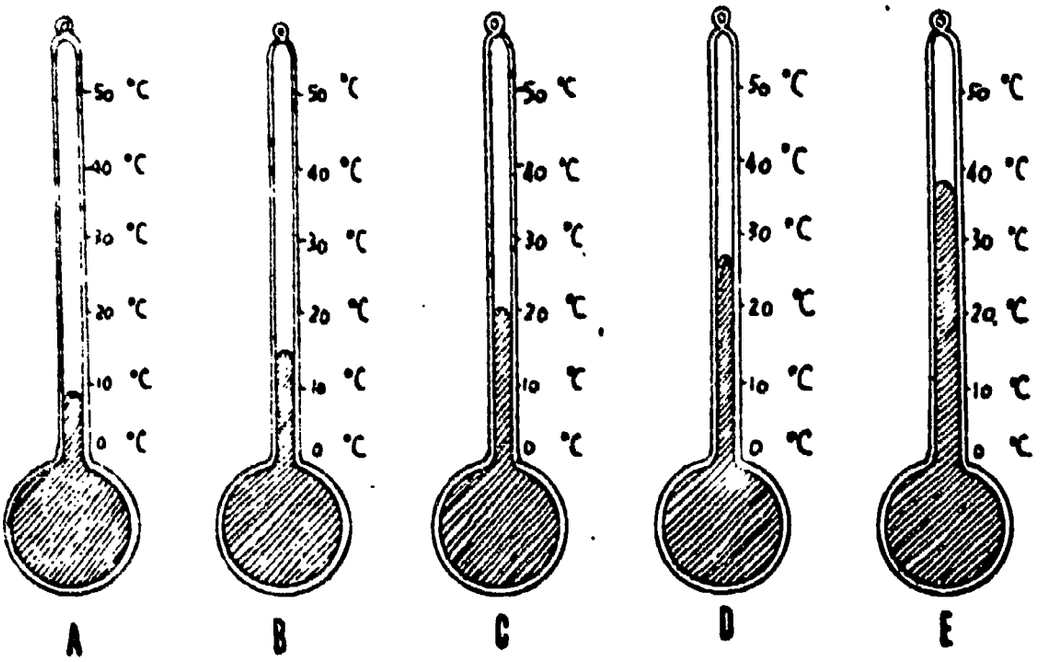
3. To obtain these readings it was necessary to have a

   A. ruler and a thermometer.
   B. barometer and a clock.
   C. ruler and a clock.
   D. thermometer and a barometer.
   E. thermometer and a clock.

4. When was the highest temperature recorded?

   A. Noon on Monday.
   B. 3.0 p.m. on Monday.
   C. Noon on Tuesday.
   D. Noon on Wednesday.
   E. 6.0 p.m. on Wednesday.

5. Which of the following instruments gives the temperature at 6.0 a.m. on Wednesday?



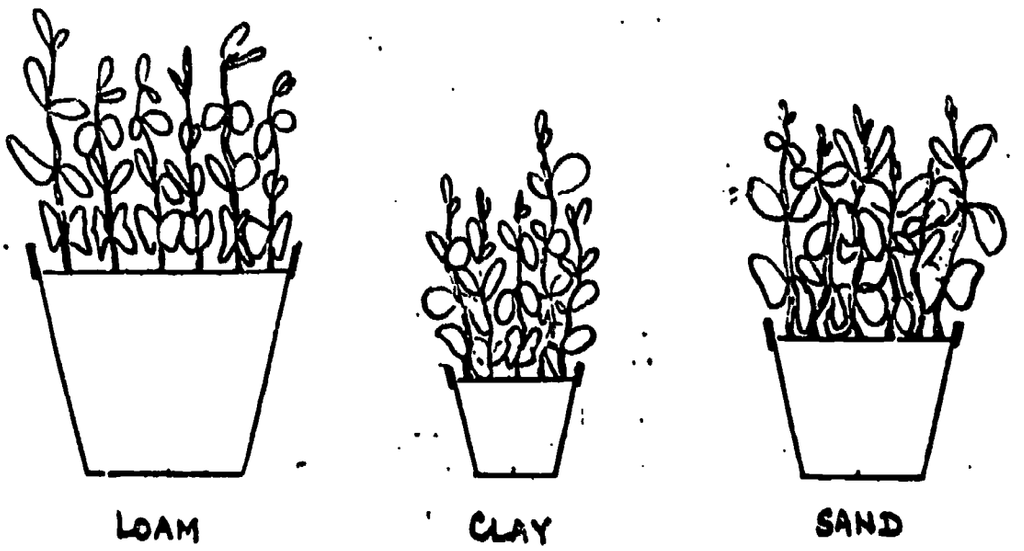
6. On one day a cool wind began to blow. When do you think this happened?

A. Monday morning.
B. Monday afternoon.
C. Tuesday morning.
D. Tuesday afternoon.
E. Wednesday afternoon.

7. Which of the following statements is true about seeds?

   A. All plants produce seeds.
   B. All fruits contain a large number of seeds.
   C. All seeds are good to eat.
   D. Every seed contains a young plant, stored food and a seed coat.
   E. The food stored in seeds is always in the cotyledon.

8. Tom wanted to learn which of three types of soil - clay, sand or loam - would be best for growing beans. He found three flowerpots, put a different type of soil in each pot, and planted the same number of beans in each, as shown in the drawing. He placed them side by side on the window sill and gave each pot the same amount of water.



Why was Tom's experiment NOT a good one for his purpose?

   A. The plants in one pot got more sunlight than the plants in the other pots.
   B. The amount of soil in each pot was not the same.
   C. One pot should have been placed in the dark.
   D. Tom should have used different amounts of water.
   E. It would get too hot on the window sill.

9. John put some seeds on moist cotton wool in a dish. Jane put some seeds of the same kind into a glass full of water by the side of his. After two days John's seeds sprouted but nothing seemed to happen to Jane's. Which of the following is the most probable explanation?

A. Jane's seeds had been kept dry for too long.
B. Jane did not allow her seeds enough air.
C. Jane did not put the glass in a warm enough place.
D. Jane should have used a different kind of seed.
E. Jane did not use any cotton wool.

10. John's pet rabbit was injured by a car and became lame. Some months after the accident she produced a litter. Which of the following describes what the babies would probably be like?

A. All of them would be lame because the mother was.
B. Most of them would be lame but not all of them because the father was not lame.
C. Most of them would not be lame because the father was not lame.
D. None of them would be lame because the mother's lameness was due to an accident.
E. Only one of them would be lame because the mother was lame.

11. A certain wild bird has webbed feet. In which of the following places would you be most likely to find it?

A. A forest.
B. A meadow.
C. A cornfield.
D. A desert.
E. A lake.

12. Paint applied to an iron surface prevents the iron from rusting by

A. preventing nitrogen from coming in contact with the iron.
B. reacting chemically with the iron.
C. preventing oxygen and moisture from coming in contact with the iron.
D. preventing carbon dioxide from coming in contact with the iron.
E. making the surface of the iron smoother.

13. Which one of the following is often used for making the metal containers in which food is preserved and sold?

A. Tin with a thin coating of steel.
B. Steel.
C. Nickel.
D. Copper.
E. Steel with a thin coating on it.

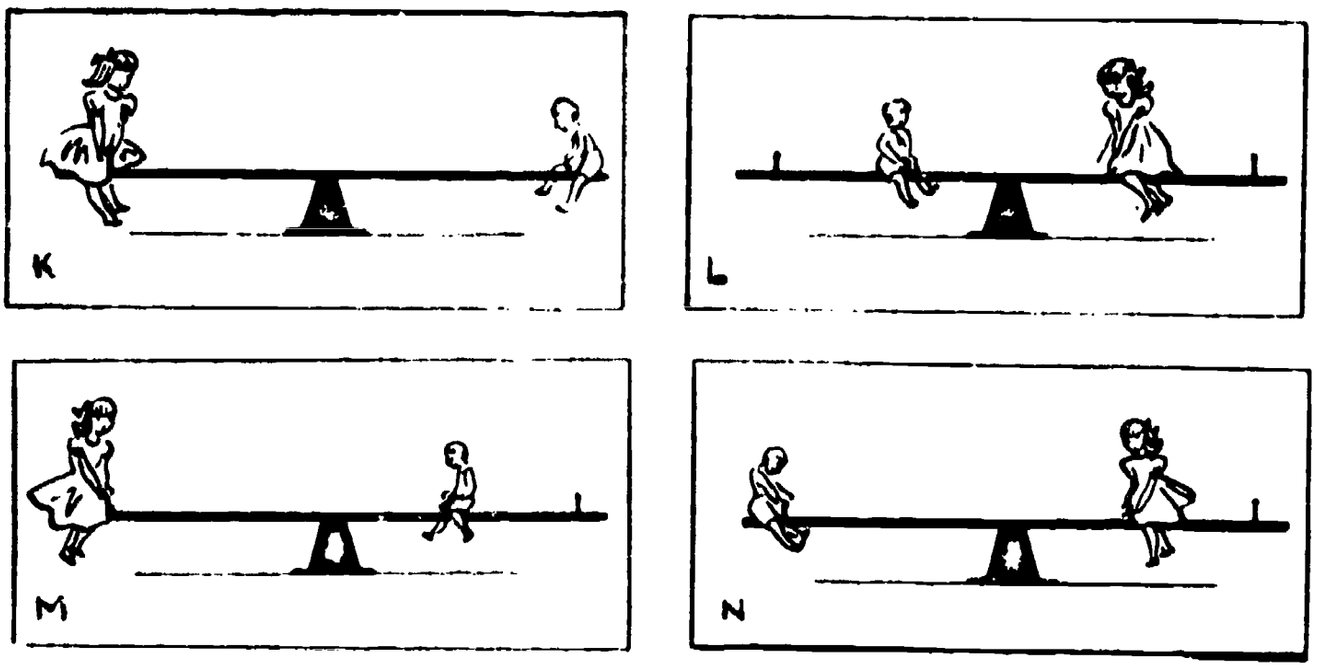
14. Mary and Jane each bought the same kind of rubber ball. Mary said, "My ball bounces better than yours." Jane replied, "I'd like to see you prove that." What should Mary do?

A. Drop both balls from the same height and notice which bounces higher.
B. Throw both balls against a wall and see how far each ball bounces off the wall.
C. Drop the two balls from different heights and notice which bounces higher.
D. Throw the balls down against the floor and see how high they bounce.
E. Feel the balls by hand to find which is the harder.

15. In order to open a can of tomato juice Betty punched <u>two</u> holes. Why do you think she did this? To

A. let the juice pour out of the can more slowly.
B. let the air go into one hole while the juice poured out of the other.
C. let the air get into the can before the juice was poured.
D. let the juice pour out of the can more quietly.
E. watch how the juice was pouring out.

16. Betty wanted to seesaw with her little brother, George. Which picture shows the best way for Betty, who weighed 100 pounds, to balance George, who weighed 50 pounds?



A. Picture K
B. Picture L
C. Picture M
D. Picture N
E. None of these

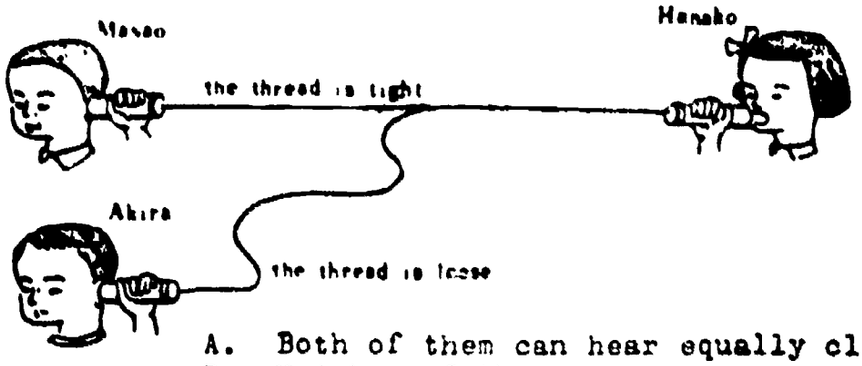
17. Tony was using his hand pump to put more air in the tyre. After a while he found that it became harder to use the pump. This was because the

A. air in the tyre pushed against the pump.
B. air started to leak out of the pump.
C. pump got too hot to hold.
D. pump got too sticky to push.
E. tyre is bigger than the pump.

18. When water is boiling it

A. changes colour.
B. becomes heavier.
C. changes to steam.
D. gets hotter.
E. stops bubbling.

19. The picture shows Masao and his friends playing with a thread-telephone. Hanako is speaking. Masao and Akira are trying to listen. Which of them can hear her speak?



A. Both of them can hear equally clearly.
B. Neither of them can hear.
C. Akira alone can hear clearly.
D. Masao alone can hear clearly.
E. Both of them hear equally faintly.

20. Harry wondered if sound is able to travel through water. To find out by an experiment which of the following should he do?

A. Hit two stones together in a jet of water.
B. Hit two stones together above the water of a lake or swimming pool and listen to the sound.
C. Put his ear next to the water of a lake or swimming pool and hit two stones together above the water.
D. Put his head under the water of a lake or swimming pool and hit two stones together in the water.
E. Drop a stone into the water and listen for the splash.

END OF SECTION A

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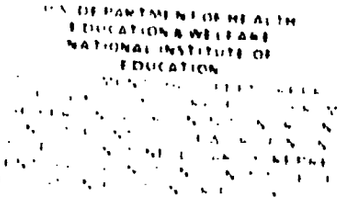

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Instrument Name Science Test Section B

Data Bank Instrument Number S1SB

See instrument number E1SA for instructions given at the beginning of the booklet in which instrument E1SB was contained.

[illegible]:
Pop 1, page 6

"You will have 30 minutes for this test. Remember, do not waste time if you cannot answer a question, but leave it out and go on to the next. Turn to the next page in your booklet and begin."

SECTION B

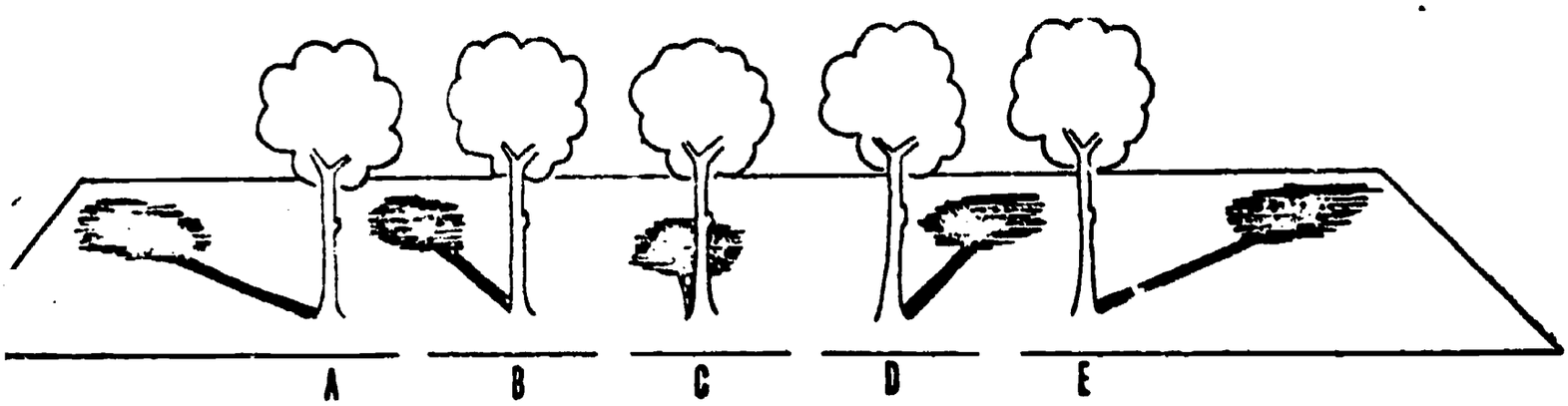
1. Let us imagine you are taking a trip to the moon in a rocket ship. As the rocket ship approaches close to the moon, you would be travelling through

   A. air.
   B. clouds.
   C. gas.
   D. space without air.
   E. time.

2. About how long would it take a rocket ship to reach the moon?

   A. Two hours.
   B. Several hours.
   C. A few days.
   D. A light-year.
   E. Several years.

3. At different times during a sunny day a tree was seen to have cast a shadow of different length as shown in the diagrams below. Which diagram shows the shadow at mid-day (12.00 hours)?



4. The reason that milk kept in a refrigerator does not go sour is that the cold

   A. changes the water of the milk into ice.
   B. separates the cream.
   C. slows down the action of bacteria.
   D. keeps flies away.
   E. causes a skin to form on the surface.

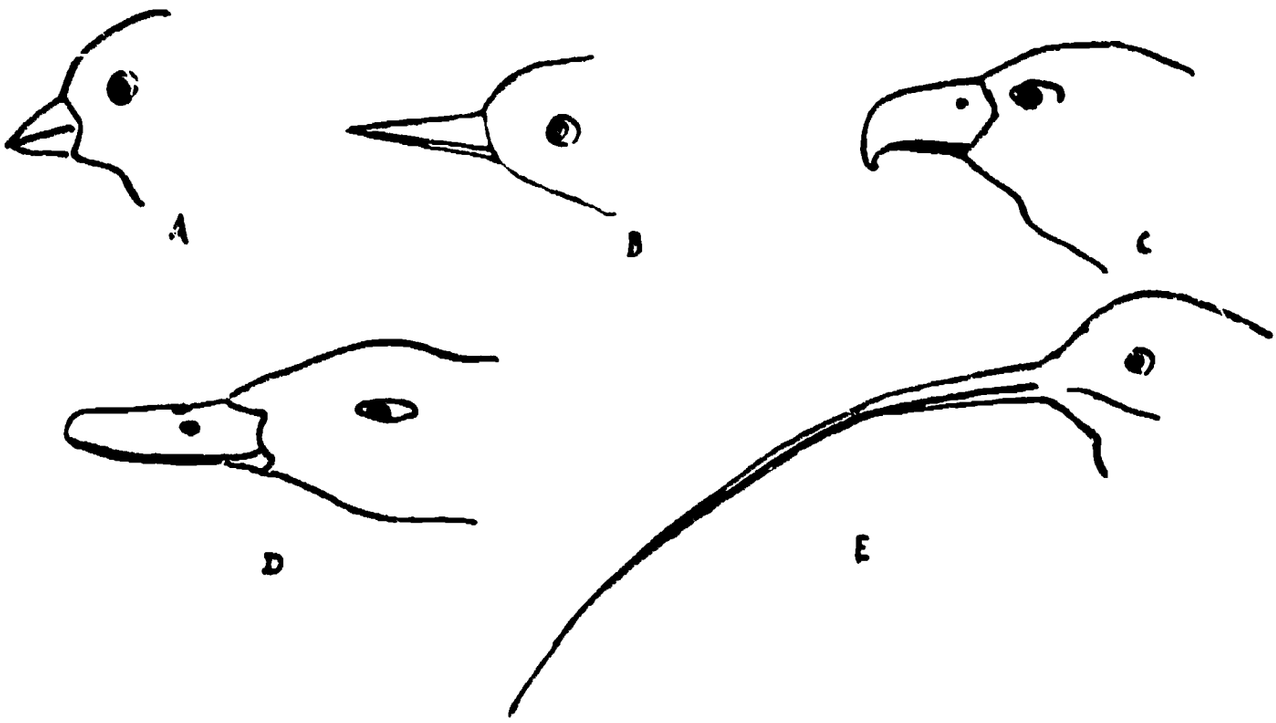
5. Which one of the following plants is <u>NOT</u> grown for food?

   A. Wheat.
   B. Rice.
   C. Potato.
   D. Sugar cane.
   E. Cotton.

6. John brought the skull of a dead animal to school. His teacher said she did not know what the animal was but she was sure that it was one that preyed on other animals for its food. Which clue, do you think, led her to this conclusion?

A. The eye sockets faced sideways.
B. The skull was much longer than it was wide.
C. There was a projecting ridge along the top of the skull.
D. Four of the teeth were long and pointed.
E. The jaws could work sideways as well as up and down.

7. While Joe was sitting under a tree, he watched a bird getting insects from between the cracks of the bark. Which drawing shows the kind of beak this bird had?



8. If, immediately before and after a 50 metre race, your pulse and breathing rates were taken, you would expect to find

A. no change in pulse but decrease in breathing rate.
B. an increase in pulse but no change in breathing rate.
C. an increase in pulse and breathing rate.
D. a decrease in pulse and breathing rate.
E. no change in either.

9. Flowers cannot usually produce seeds unless

A. they are visited by insects.
B. they appear in the summer.
C. they are on plants growing in good soil.
D. they produce nectar.
E. suitable pollen is placed on their stigmas.

10. Some seeds germinate best in the dark, others in the light, while others germinate equally well in the dark or the light. If you wanted to find out by means of an experiment to which group a certain kind of seed belonged, you would sow some of the seeds on damp blotting paper and

A. keep them in a warm place in the dark.
B. keep one batch in the light and another in the dark.
C. keep them in a warm place in the light.
D. sow some on dry blotting paper and keep them in the light.
E. sow some on dry blotting paper and keep them in the dark.

11. Which one of the following animals does <u>not</u> usually live in the kind of place shown?

A. Zebras on grassy plains.
B. Seals on rocky sea shores.
C. Beavers on river banks.
D. Monkeys in forests.
E. Moles in rocky places.

12. John gave some reasons why kettles and kitchen pans are often made of copper. Which of his reasons was wrong?

A. Copper is a bad conductor of heat.
B. Copper is a tough metal.
C. Copper can be polished to give a pleasing finish.
D. Copper is easy to shape.
E. Copper does not dissolve in hot water.

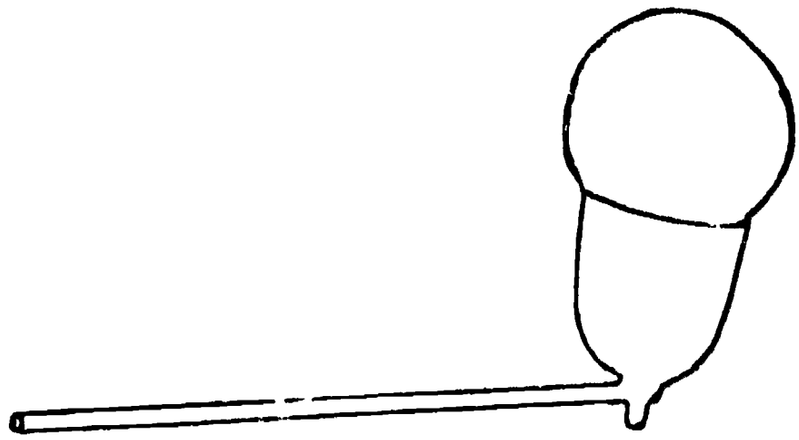
13. What gas in the air is essential for us to breathe in order to live?

A. Nitrogen
B. Oxygen.
C. Carbon dioxide.
D. Hydrogen.
E. Water vapour.

14. When Tom threw his rubber ball into the air, it came back to the ground because

A. the air pushed it back.
B. rubber always bounces back.
C. the earth pulled it back.
D. the air is very light.
E. the earth is a large magnet.

15. Ann was playing with a bubble pipe. When the bubble was the size of the one in the picture, she took the pipe out of her mouth. What do you think happened to the bubble <u>after</u> that?



A. It got larger for a time and then stayed at this size.
B. It got smaller for a time and then stayed at this size.
C. It got smaller and smaller and disappeared into the pipe.
D. It stayed on the pipe without getting larger or smaller.
E. It became larger and larger until it burst.

16. Some children had made a space-ship from wooden boxes. Today they are making plans for their first trip to the moon. Judy says, "Scientists tell us that the moon has no atmosphere." Jack asks, "How can we keep in touch with each other?" Which one of the children's ideas is best?

A. Judy says, "Let's take a garden hose to use as a speaking tube."
B. Phil says, "Let's find out from Mr. Jones where he got his hearing aid. We could take some of those."
C. Joe says, "Let's make sure we take enough walkie-talkies with plenty of fresh batteries."
D. Betty says, "Let's bring along some large megaphones like the cheerleaders use."
E. John says, "Our voices would carry better on the moon and there would be no problem."

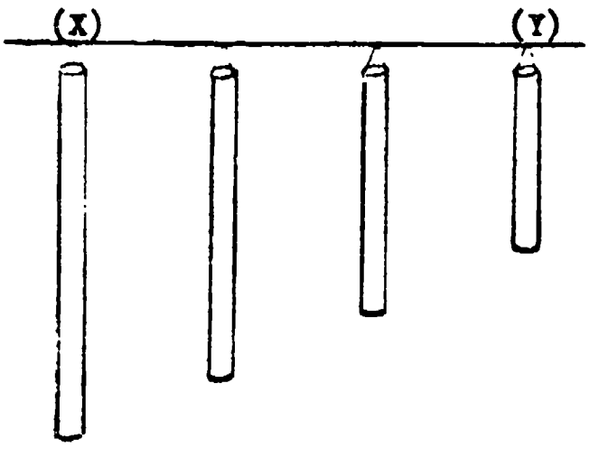
17. Betty was trying to take the metal screw-top off a jar of jam but it wouldn't turn. What should Betty do in order to open the jar with the least risk of breaking it?

A. Force the cap off with a screw driver.
B. Run hot water on the glass part of the jar.
C. Run cold water on the cap.
D. Hammer the cap off.
E. Run hot water on the cap.

18. As part of an investigation a cupful of water and a similar cupful of petrol were placed on a window sill on a hot sunny day. A few hours later it was observed that both the cups had less liquid in them and that there was less petrol left than water. The experiment showed that

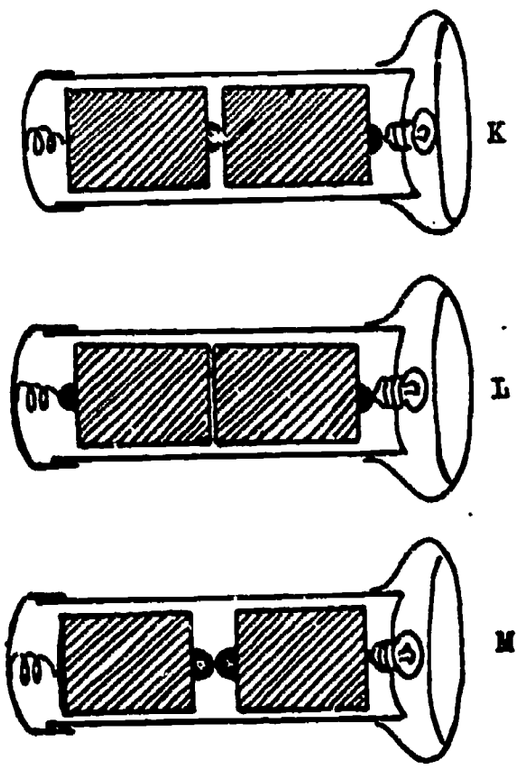
A. all liquids evaporate.
B. petrol gets hotter than water.
C. some liquids evaporate faster than others.
D. liquids will only evaporate in sunshine.
E. water gets hotter than petrol.

19. Some boys made a set of chimes by cutting four pieces of pipe of different lengths from a long metal pipe and hanging them as shown in the picture below. Which of the pipes gave the lowest note when they struck it with a hammer?



A. Pipe (X)
B. Pipe (Y)
C. All gave the same note.
D. You cannot tell without trying.
E. It depends on where you hit it.

20. A flashlight holds two cells. In order to make it work, in which of the following ways must we place the cells?



A. As in K
B. As in L
C. As in M
D. Either as in L or M
E. None of these would do.

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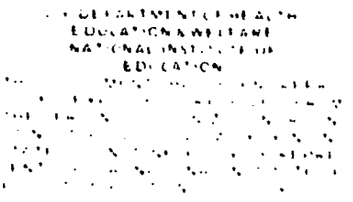

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C = Civic Education
2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Science Test Section A

Data Bank Instrument Number E2SA

IEA/M3
Pop II, p. 2-4

"Now look at the front cover of Booklet 4. Follow carefully while I read the directions to you."
Read the directions to the group, giving them time to mark the answers to the practice questions when these are reached.
Directions:-
"This test contains questions dealing with different branches of Science.

.

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Now try these three questions for practice. Fill in the space of your chosen answer on the answer card in Section L."
Then say:-
"You will have 60 minutes for this test. Work as quickly as you can. Do not waste time if you cannot answer a question, but leave it and go on to the next. Are there any questions?"

SCIENCE

This test contains questions dealing with different branches of Science. Some you will know about from your school work, some from your general knowledge and others you will be able to answer by using commonsense. Others you may not be able to do. Do not waste time over questions you cannot do; leave them and go on to the next question. You can come back to questions you have missed later, if you have time. You may answer even if you are not quite sure, but do not guess blindly.

Each of the questions or unfinished statements in this test is followed by five suggested answers, lettered A,B,C,D, and E. You have to decide which one answer you think best and then on your answer card make a solid pencil mark in the oval containing the correct answer letter.

Here is an example of how to fill in the answer on your answer card. Remember that the examples given on this page are to be answered in the section marked L on your answer card.

1. How long does the earth take to travel once around the sun?

   A. A day.
   B. A week.
   C. A month.
   D. A year.
   E. None of the above.

Since the earth travels round the sun in a year, the answer space D should be marked. This has been done on the answer card for the question 1 in the example section L.

Now try these three questions for practice. Fill in the space of your chosen answer on the answer card in section L.

2. Water would be turned into ice by

   A. heating it.
   B. stirring it quickly.
   C. putting salt in it.
   D. pouring it into a shallow dish.
   E. cooling it.

3. Which day of the year in the southern hemisphere has the longest period of daylight?

   A. 21st January.
   B. 21st March.
   C. 22nd December.
   D. 23rd September.
   E. 22nd June.

Sometimes you may be asked to pick out the one wrong answer or the one that does not fit in with the others.

4. Which of the following does NOT belong to the same group as the others?

   A. Eagle.
   B. Lion.
   C. Mouse.
   D. Elephant.
   E. Deer.

DO NOT TURN OVER UNTIL YOU ARE TOLD TO DO SO.

1. About how long would it take a rocket ship to reach the moon?

   A. Two hours.
   B. Several hours.
   C. A few days.
   D. A light-year.
   E. Several years.

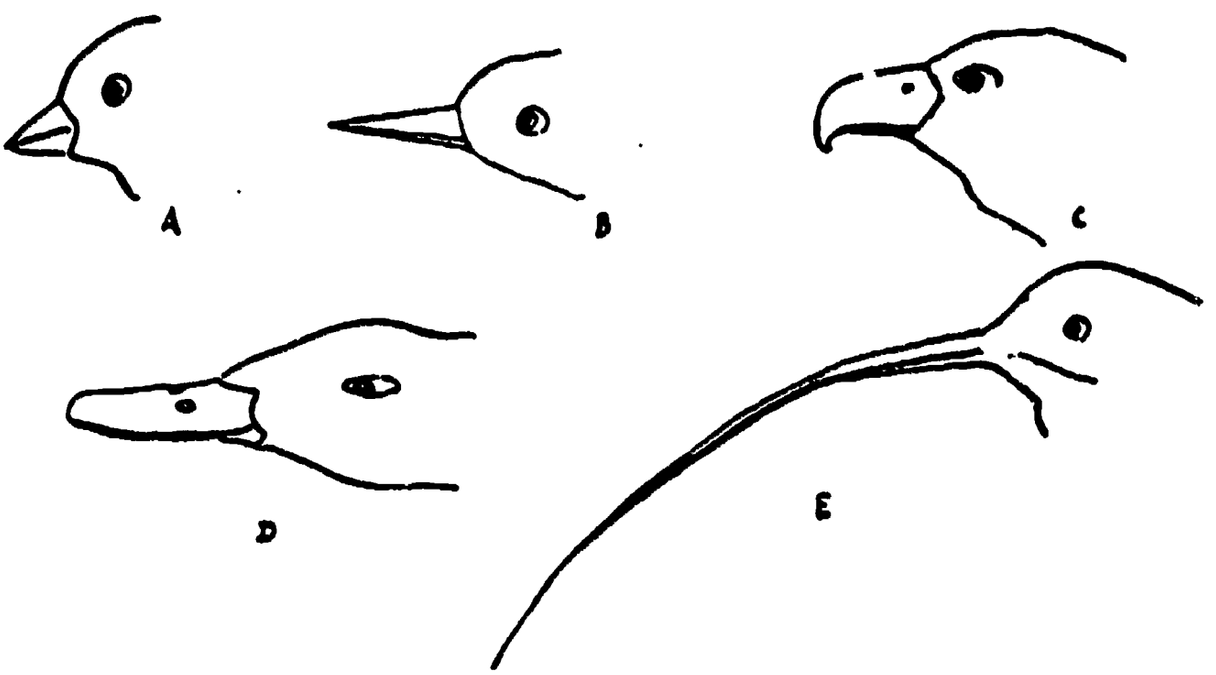
2. Which of the following statements is true about seeds?

   A. All plants produce seeds.
   B. All fruits contain a large number of seeds.
   C. All seeds are good to eat.
   D. Every seed contains a young plant, stored food and a seed coat.
   E. The food stored in seeds is always in the cotyledon.

3. Which of these substances is found in every living cell?

   A. Protein.
   B. Chlorophyll.
   C. Cellulose.
   D. Starch.
   E. Haemoglobin.

4. While Joe was sitting under a tree, he watched a bird getting insects from between the cracks of the bark. Which drawing shows the kind of beak this bird had?



5. One of the following lists of small invertebrate animals contains only insects. Which one is it?

   A. Houseflies, Spiders, Mosquitoes, Woodlice.
   B. Millipedes, Butterflies, Houseflies, Mosquitoes.
   C. Butterflies, Ants, Cockroaches, Houseflies.
   D. Cockroaches, Butterflies, Spiders, Mosquitoes.
   E. Ants, Moths, Beetles, Centipedes.

6. Which of the following organs is NOT situated in the abdomen?

   A. Liver.
   B. Kidney.
   C. Stomach.
   D. Bladder.
   E. Heart.

7. The serving of reheated meat in restaurants is often discouraged and sometimes prohibited by law. Which of the following is the main reason for this?

   A. Most people do not like it.
   B. Valuable mineral salts are lost on reheating.
   C. It is uneconomic to heat food twice.
   D. Bacteria will multiply quickly on the warmed up meat.
   E. Reheating causes a reduction in protein content.

8. Tissue from a cow is shown on analysis to contain protein, a small amount of fat, some iron, and large quantities of vitamins A and D. Which part of the body did it come from?

   A. Muscles.
   B. Kidney.
   C. Liver.
   D. Heart.
   E. Brain.

9. Which of the following experimental procedures would serve best to determine the effectiveness of inoculating children against measles?

   A. Take 50 children who have never had measles and expose them to the disease and then inoculate all of them.
   B. Inoculate 25 of 50 children who have never had measles and then expose all 50 of them to the disease.
   C. Inoculate 50 children who have not had measles and then expose all of them to the disease.
   D. Take a random sample of 50 children, inoculate 25 of them and then expose all 50 of them to the disease.
   E. Take a random sample of 50 children, inoculate all of them and ther expose 25 of them to the disease.

10. Why is it that your body temperature does not fall even though you lose heat continually?

A. The blood distributes heat round the body.
B. Respiration results in the liberation of heat.
C. Heat is constantly being absorbed from the sun.
D. Hot meals are eaten regularly.
E. Warm clothes are good insulators.

11. John put some seeds on moist cotton wool in a dish. Jane put some seeds of the same kind into a glass full of water by the side of his. After two days John's seeds sprouted but nothing seemed to happen to Jane's. Which of the following is the most probable explanation?

A. Jane's seeds had been kept dry for too long.
B. Jane did not allow her seeds enough air.
C. Jane did not put the glass in a warm enough place.
D. Jane should have used a different kind of seed.
E. Jane did not use any cotton wool.

12. When alcohol is burned in air, water is formed. Another product of the combustion is a gas which turns lime water cloudy. Consider the following three statements with regard to these two facts

Statements.
I. Carbon is a constituent element of alcohol.
II. Hydrogen is a constituent element of alcohol.
III. Oxygen is a constituent element of alcohol.

Which statement or combination of these statements can be deduced from the two facts given?

A. I and II.
B. I, II and III.
C. I and III.
D. II and III.
E. I only.

13. When 2 g of zinc and 1 g of sulphur are heated together, practically no zinc or sulphur remains after the compound zinc sulphide is formed What happens if 2 g zinc are heated with 2 g of sulphur?

A. Zinc sulphide containing approximately twice as much sulphur is formed.
B. Approximately 1 g of sulphur will be left over.
C. Approximately 1 g of zinc will be left over.
D. Approximately 1 g of each will be left over.
E. No reaction will occur.

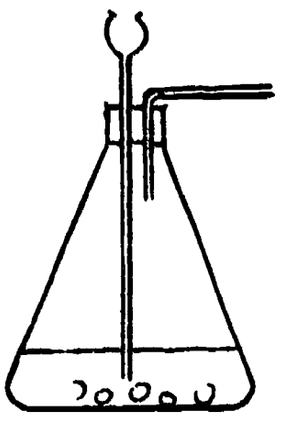
14. Heating a mixture of powdered iron and sulphur will result in the formation of

A. a single element.
B. two other elements.
C. a solution.
D. an alloy.
E. a compound.

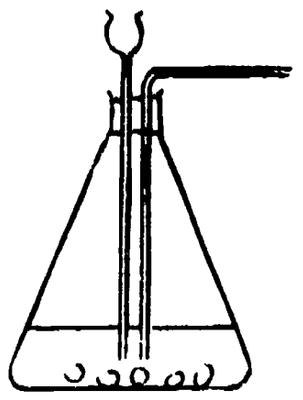
15. A clear solution of substance X is added to a clear solution of substance Y. No colour change is observed. Which of the following would provide evidence that in spite of no change in colour a chemical reaction had taken place?

A. Any product is soluble in water.
B. The solutions of X and Y can be mixed in all proportions and still give the same result.
C. There is a rise of temperature when the two solutions are mixed.
D. The final liquid is shown to be neutral by using an indicator.
E. The experiment gives the same result when different concentrations of the two solutions are used.

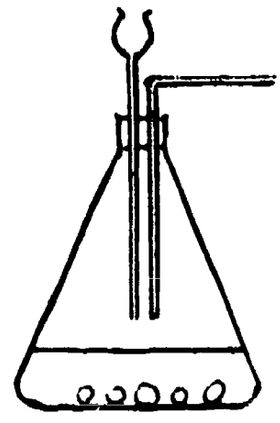
16. Which of the following is the correct arrangement of apparatus for preparing a gas produced by the action of a liquid on a solid?



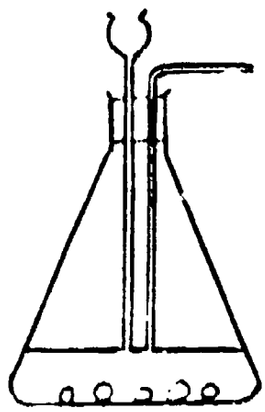
A



B



C



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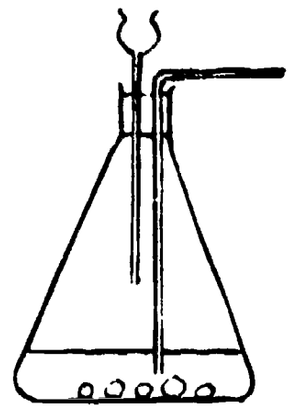


E

17. Which of the following methods would you employ in order to obtain copper from copper oxide? You may find that your knowledge of the activity series will help you.

A. Heat copper oxide with silver.
B. Pass hydrogen through copper oxide suspended in cold water.
C. Pass hydrogen over hot copper oxide.
D. Heat copper oxide with dilute hydrochloric acid.
E. Pass steam over hot copper oxide.

18. We can explain chemical changes in terms of the gain or loss or sharing of

A. electrons furthest from the nucleus of the atom.
B. electrons closest to the nucleus of the atom.
C. electrons from the nucleus of the atom.
D. protons from the nucleus of the atom.
E. neutrons from the nucleus of the atom.

Items 19 and 20 refer to the following table.

Substance	Electrical Conductivity	Melting Point	Boiling Point	Effect of Heating in Air
P	Good when solid or liquid	97°C	889°C	Burns to form a single oxide which forms an alkaline solution in water.
Q	Nonconductor	113°C	444°C	Burns to form a single oxide which forms an acidic solution in water.
R	Nonconductor	5°C	80°C	Burns to form carbon dioxide and water.
S	Nonconductor when solid, good conductor when molten	800°C	1413°C	Melts; no new substance formed.

19. Which substance could be a metallic element?

A. Substance P.
B. Substance Q.
C. Substance R.
D. Substance S.
E. None of these.

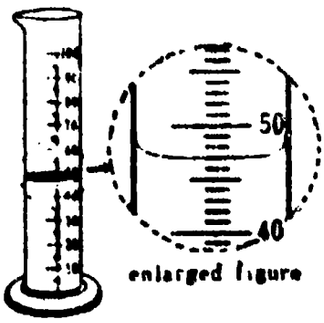
20. Which substance would not change in weight when heated in air?

A. Substance P.
B. Substance Q.
C. Substance R.
D. Substance S.
E. None of these.

21. Mary and Jane each bought the same kind of rubber ball. Mary said, "My ball bounces better than yours." Jane replied, "I'd like to see you prove that." What should Mary do?

A. Drop both balls from the same height and notice which bounces higher.
B. Throw both balls against a wall and see how far each ball bounces off the wall.
C. Drop the two balls from different heights and notice which bounces higher.
D. Throw the balls down against the floor and see how high they bounce.
E. Feel the balls by hand to find which is the harder.

22. The measuring cylinder contains a certain volume of water. The enlarged figure shows a view of the surface of the water as seen from the side. What is the volume of the water ?



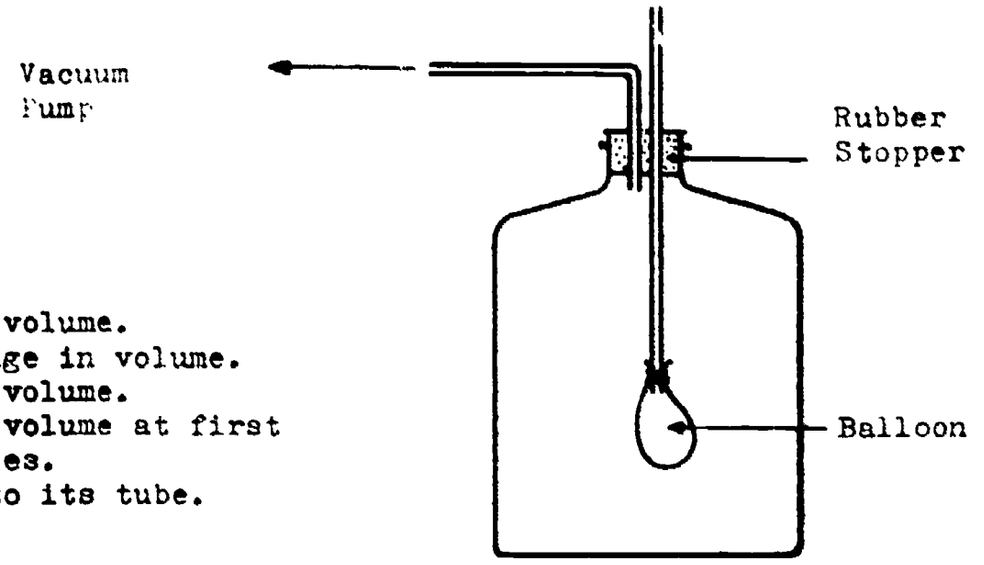
enlarged figure

A. 50 cm^3
B. 49 cm^3
C. 48 cm^3
D. 47 cm^3
E. 46 cm^3

23. It is said that, dressed in the same way, a man would be able to jump higher on the Moon than on the Earth. Which of the following is the best explanation of this?

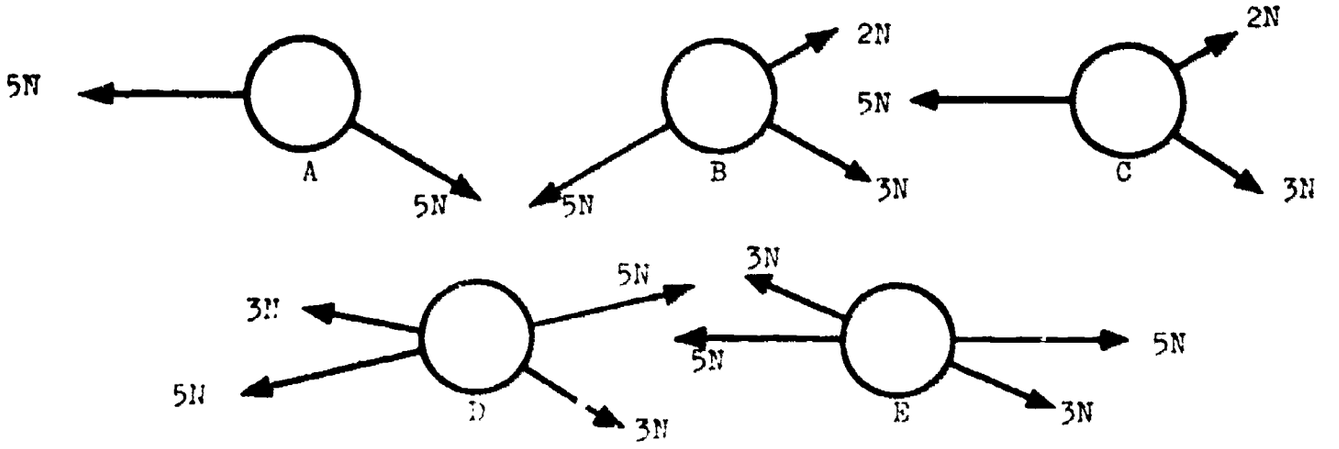
A. His mass is less when he is on the Moon.
B. The force of gravity is less on the Moon than on the Earth.
C. His distance from the Earth is greater when he is on the Moon.
D. There is no air on the Moon to offer resistance.
E. Newton's Laws of Motion do not apply on the Moon.

24. What happens to the balloon when the air in the bottle is extracted by a vacuum pump?

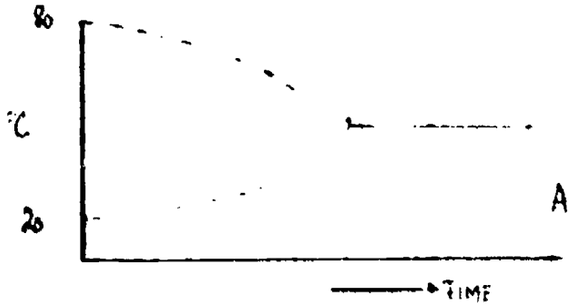


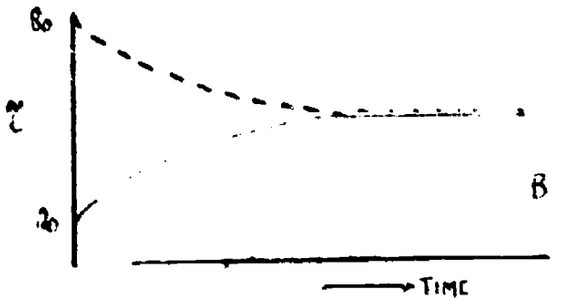
A. It increases in volume.
B. It does not change in volume.
C. It decreases in volume.
D. It decreases in volume at first but then increases.
E. It is sucked into its tube.

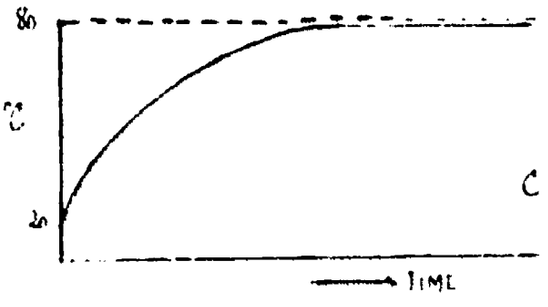
25. The diagrams show rings being pulled by different forces in the same plane. Which ring is in equilibrium under the action of the given forces?

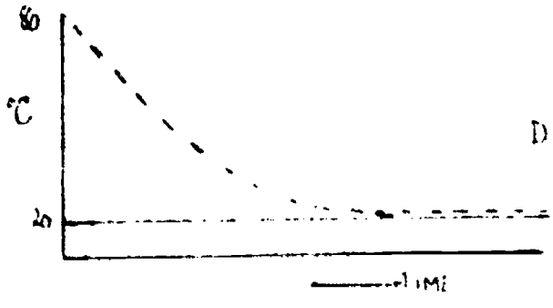


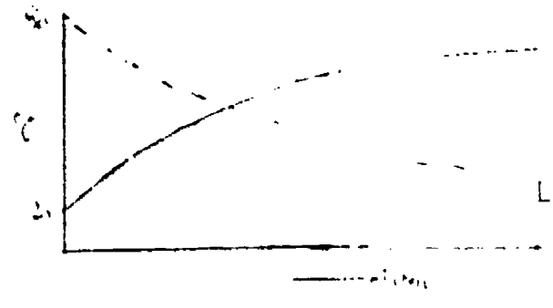
26. Using the apparatus shown in the figure below, 100g of water at 20° C was poured into the outer container P and its temperature read at intervals from theomometer 2. At the same time 100g of water at 80° C was poured into the inner container Q and its temperature read at intervals from thermometer 1. Which of the following graphs best represents the changes in the temperatures of the water in the two containers.

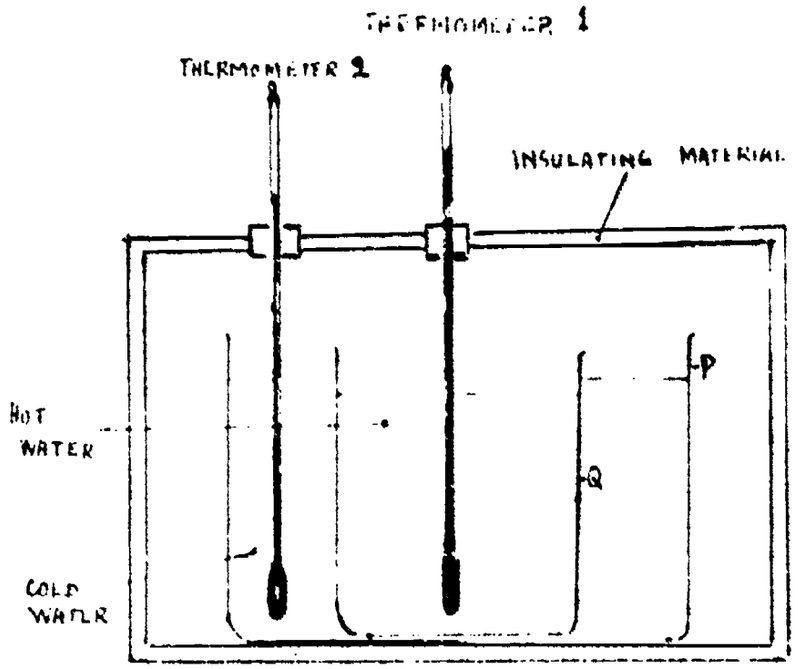












THERMOMETER 1

THERMOMETER 2

27. Under which of the following conditions does water evaporate fastest?

A. On a hot and dry day.
B. On a hot and moist day.
C. On a cold and dry day.
D. On a cold and moist day.
E. On a calm and moist day.

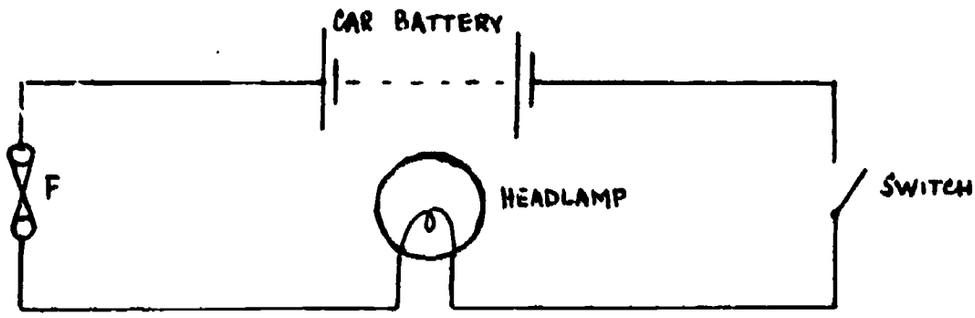
28. The crews of two ships at sea can communicate with each other by shouting through loudhailers. It is impossible for the crews of spaceships a similar distance apart in space to do this because

A. the temperature is too low.
B. the sound is reflected.
C. the pressure is too high inside the space ship.
D. the sound barrier has been broken.
E. there is no air.

29. Jane was trying to find out which things she could pick up with a magnet. With which one of the following would she **NOT** succeed?

A. A magnetic compass needle.
B. A steel screw.
C. An iron nail.
D. A sewing needle.
E. A brass paper fastener.

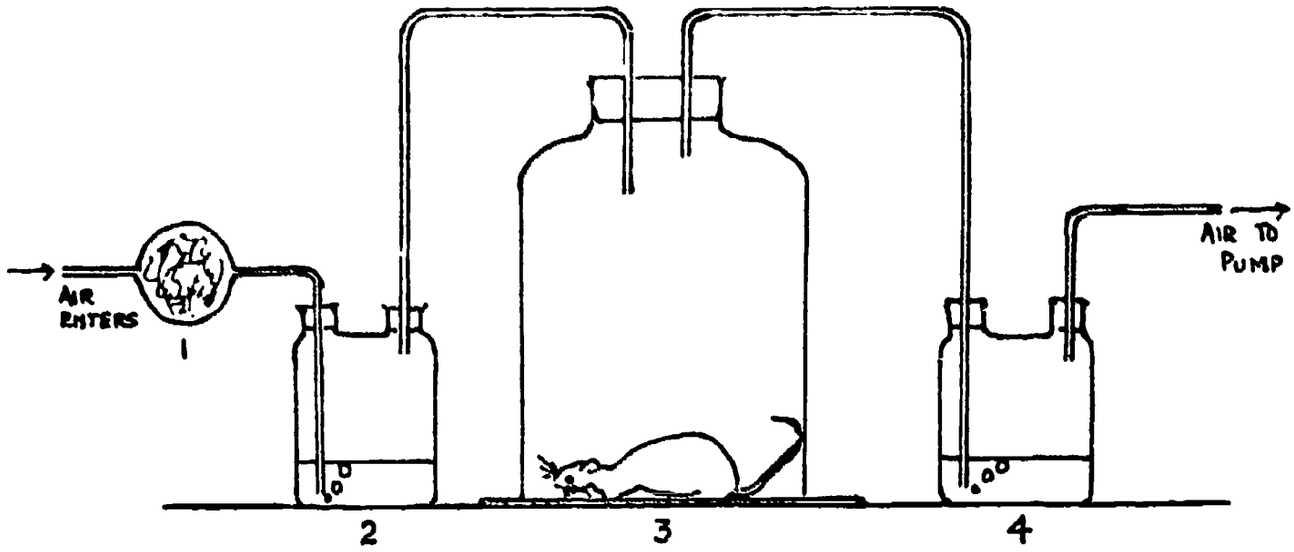
30. The following diagram shows a lighting circuit in a car.



Fuse F would most probably be made of

A. thin wire with low melting point.
B. thick wire with low melting point.
C. thick wire with high melting point.
D. thin wire with high melting point.
E. the same wire as the connecting leads.

Questions 31 and 32 refer to the following diagram which shows an arrangement of apparatus which can be used to show that an animal gives out carbon dioxide in respiration.



1 contains a substance which removes carbon dioxide from air, 2 and 4 both contain a liquid which changes in appearance when carbon dioxide passes through it.

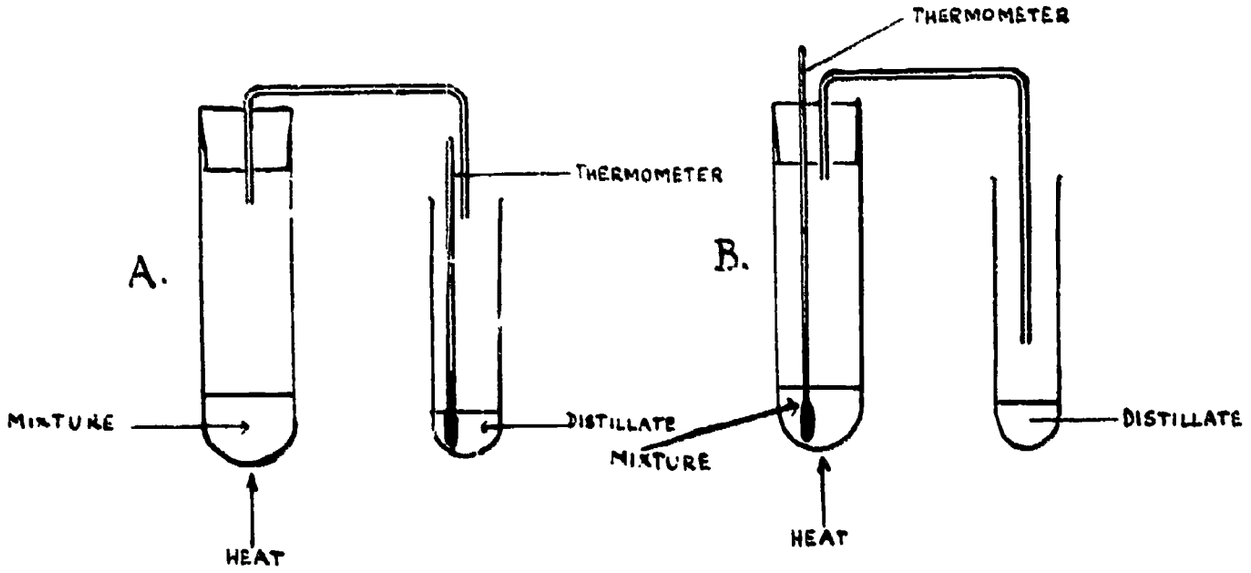
31. Of the following kinds of containers for the animal which one would give the quickest result?

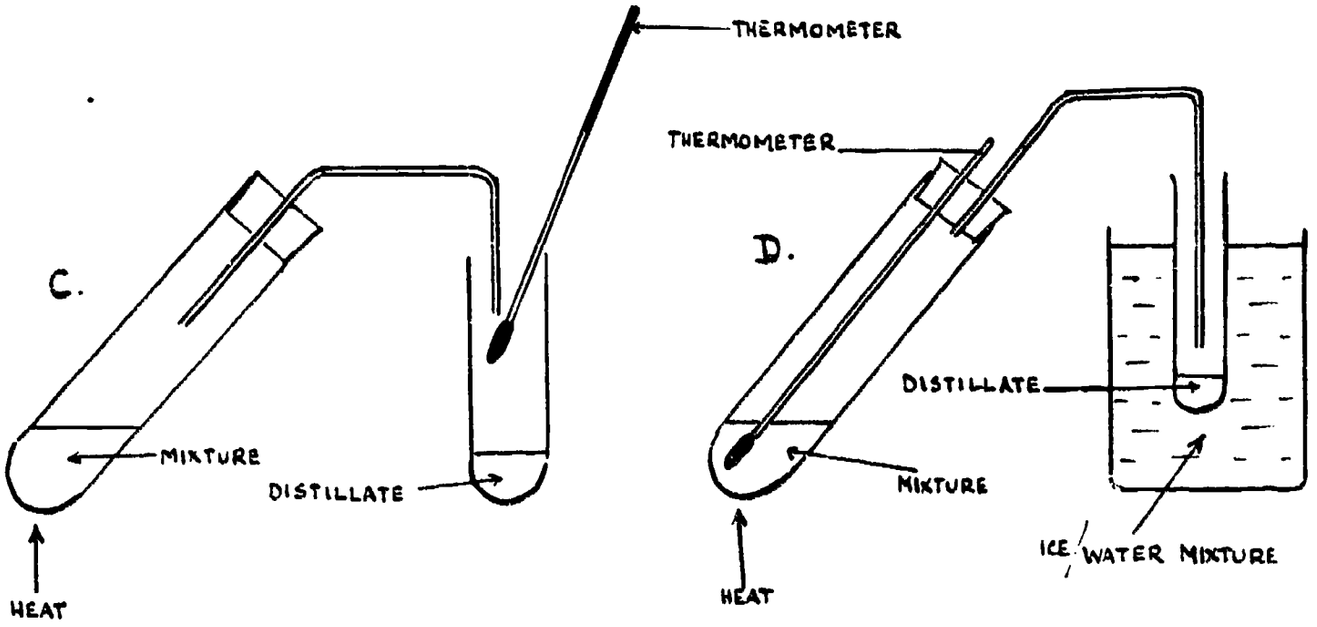
A. A small container.
B. A large container.
C. A container in bright light.
D. A container covered with a dark cloth.
E. A container in which the air is kept moist by means of wet cotton wool.

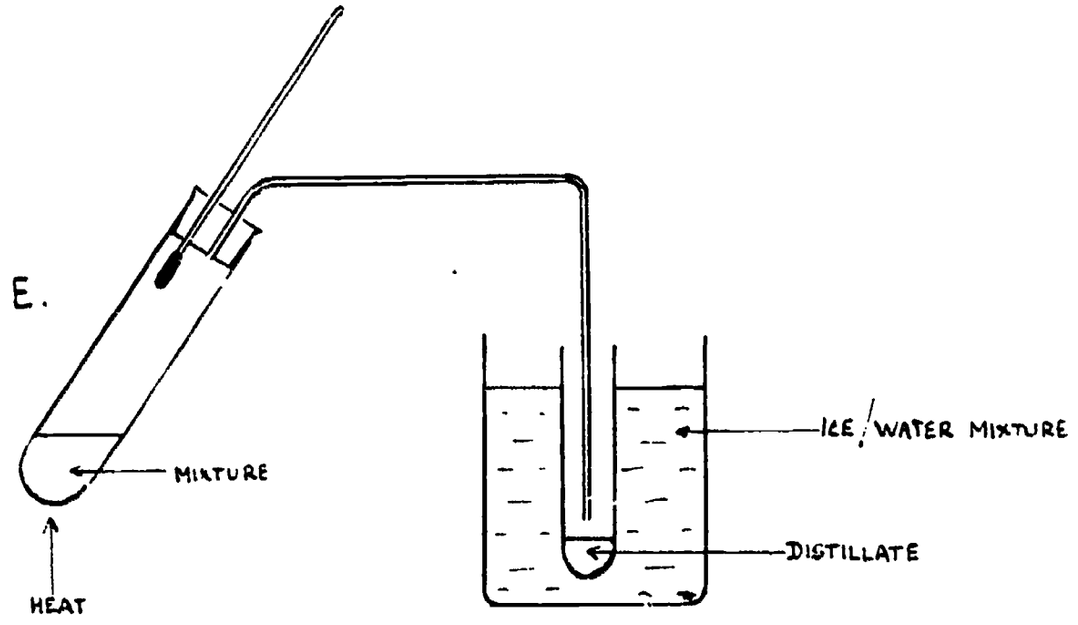
32. If air leaked into chamber 3, which one of the following effects would be seen?

A. The liquid in 4 would change more rapidly.
B. The rate of bubbling in 2 would slow down or stop.
C. The rate of bubbling in 4 would slow down or stop.
D. Liquid would pass from 4 into 3.
E. The liquid in 2 would change more rapidly.

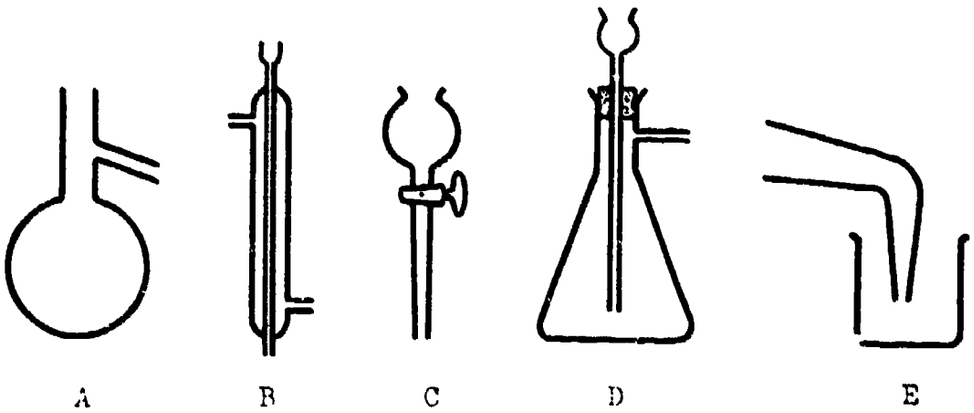
53. A small sample of a mixture of liquids with different boiling points is to be separated into its components by distillation. Which of the following sets of apparatus is most suitable for carrying this out and for determining the temperature at which each of the components of the mixture boiled?





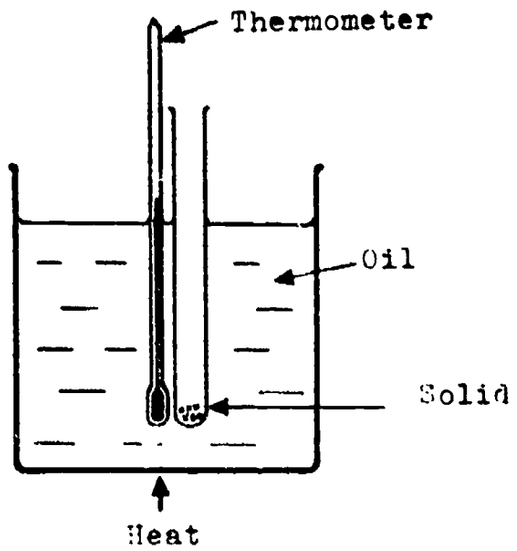


34. Which of the following pieces of glassware is mainly for condensing gases to liquids



A B C D E

35.



In order to decide whether a substance is pure the apparatus illustrated above is used to find its melting point. The melting point of the pure substance is known. Which one of the following is the most important in choosing the oil to use?

A. The oil should be colourless.
B. The oil should boil at the same temperature as the melting point of the pure solid.
C. The oil should boil at least ten degrees higher than the melting point of the solid.
D. The oil should boil at a temperature at least ten degrees lower than the melting point of the solid.
E. The oil should have a high density.

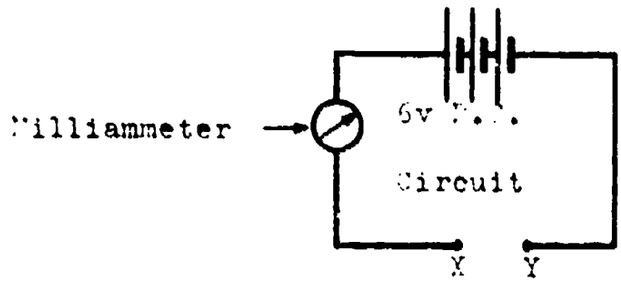
36. It is unwise to condense the vapour of a liquid with a boiling point of 240° C in a glass water-cooled condenser because

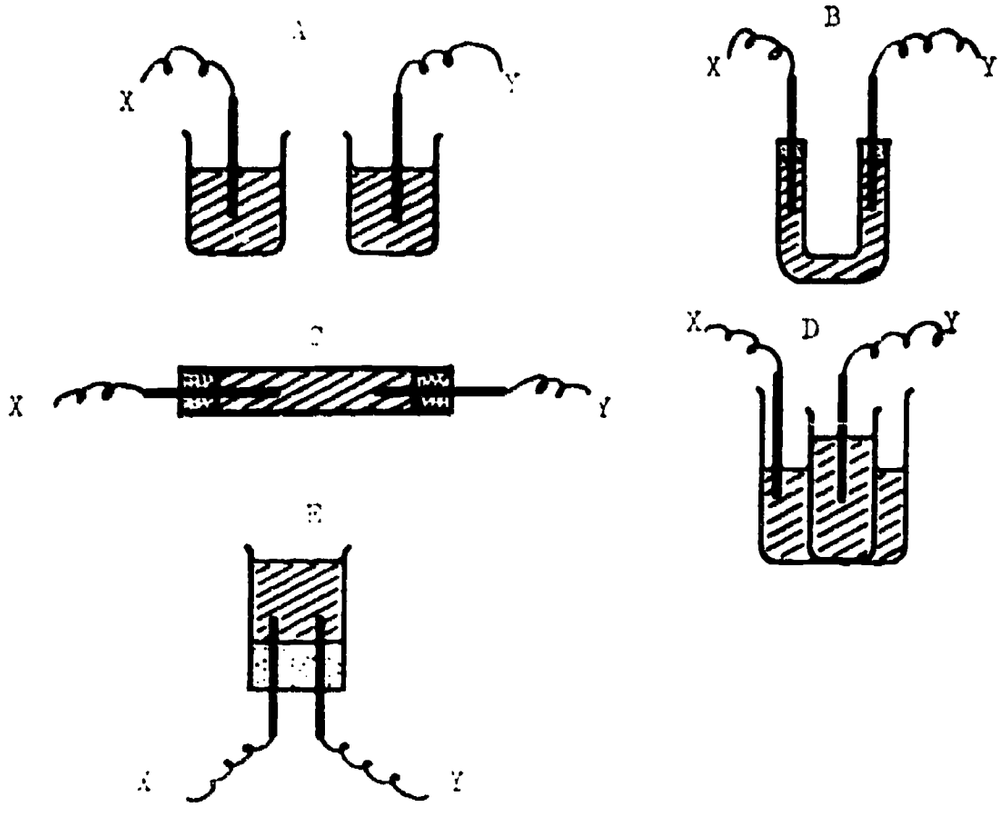
A. the vapour might react with the water,
B. the vapour will not be condensed,
C. the condenser will probably crack,
D. the water will boil,
E. solid will form and block the condenser.

37. A number of different solutions have to be tested to find out whether or not they will each conduct electricity and, if so, what products are liberated.

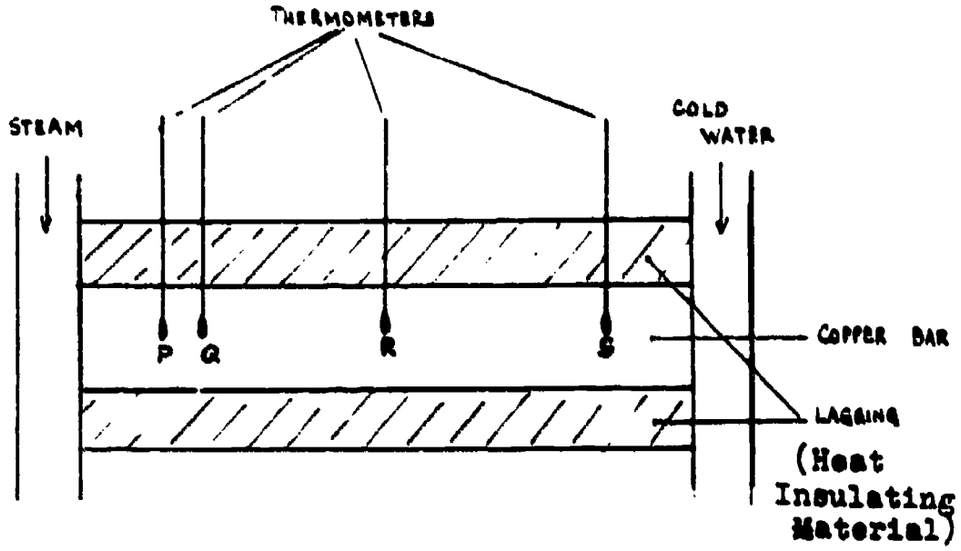
Using the circuit shown below, which of following pieces of apparatus would be most suitable when connected between points X and Y

(All the beakers and tubes are made of glass, the electrodes of carbon, and solutions are shown shaded.)





38. One end of a well-insulated copper bar is heated and the other kept cold, as shown in the figure. The temperature at different points on the bar can be read by thermometers dipping into small holes at P, Q, R and S. The distances between P and Q is 1.0 cm. and the drawing is to scale.



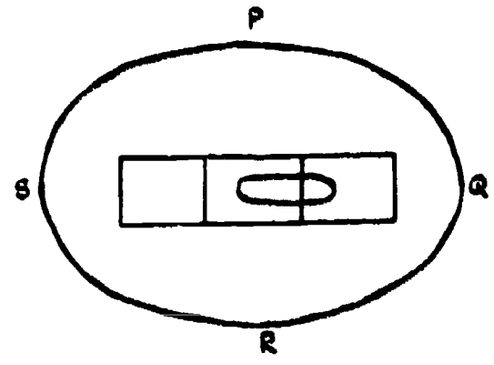
The temperature falls uniformly along the bar, and it is required to find the temperature gradient, or fall in temperature for unit length.

The two thermometers to be read for this purpose should be those placed at

A. P and Q
B. P and R
C. P and S
D. Q and S
E. R and S

39. A spirit level is placed on the top of a table and viewed from above when it appears as shown in the diagram. Which of the points P,Q,R and S should be raised as a first step towards making the table level?

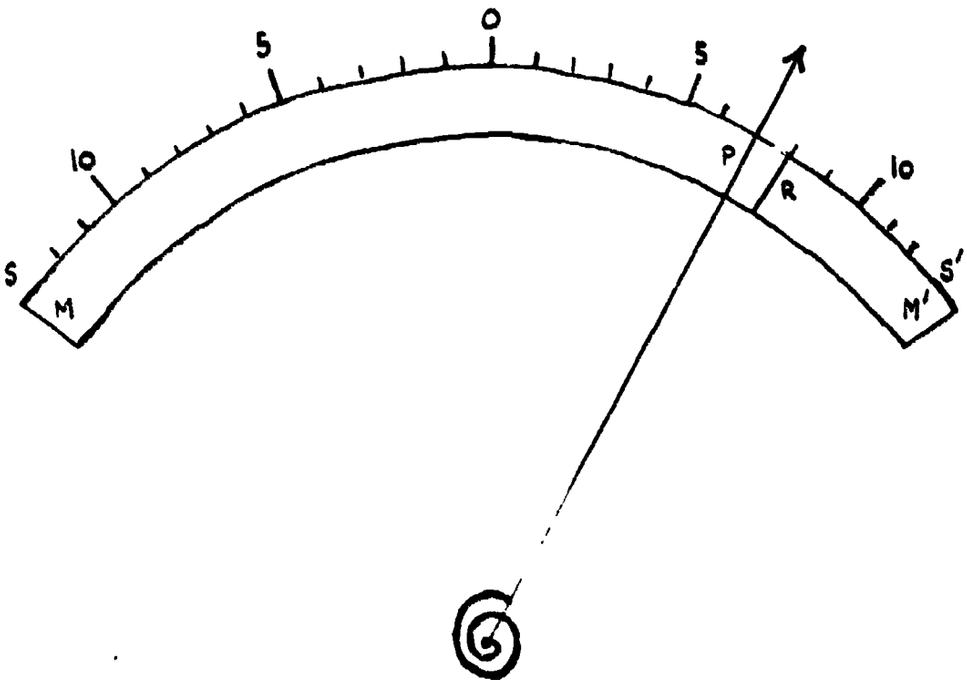
A. P
B. Q
C. R
D. S
E. Any one of the above



40. A meter has a pointer P which moves over a strip mirror MM' and a scale SS'. When photographed at an angle, the meter appears as shown, where R is the reflection of the pointer in the mirror.

What is the correct meter reading

A. Between 6 and 7 units.
B. 7 units.
C. Between 7 and 8 units.
D. 8 units.
E. Between 8 and 9 units.



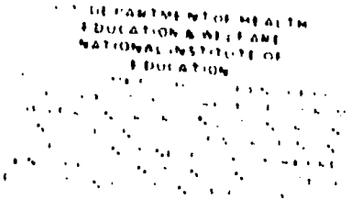
END OF SECTION A

DO NOT TURN OVER UNTIL YOU ARE TOLD TO DO SO

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2 IEA/M1 Manual for National Centers
IEA/M2 Manual for School Coordinators
IEA/M3 Manual for Test Administrators

Stage 3 IEA/M1/Stage 3 Manual for National Centers
IEA/M2/Stage 3 Manual for School Coordinators
IEA/M3/Stage 3 Manual for Test Administrators



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The Data Bank Instrument Number which appears below is a new number assigned since the instruments were administered for the purpose of easily linking items in the instruments with the resultant variables in the Data Bank holdings. Each such variable is named in the codebook using the new instrument number and (usually) the number of the item within the instrument from which the variable is derived. The key to the new instrument numbers is as follows:

1: Type of Instrument

E = Examination (student)
Q = Questionnaire (student)
T = Teacher questionnaire
S = School questionnaire

2: Student Population

1 = I
2 = II
3 = III
4 = IV
5 = I and II
6 = II and IV
7 = I, II and IV
8 = I and IV
S = IV Specialist
N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
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2 = All Stage 2 Subjects
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5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Science Test Section B

Data Bank Instrument Number E2SB

See instrument number E2SA for instructions given at the beginning of the booklet in which instrument E2SB was contained.

IEA/M3
Pop II, p. 5

"We are now ready to begin section B. The answers to questions in this section are to be marked in part B on the answer card. Find part B on your answer card."
Indicate Section B on the answer card. Then say:-
"You will have 60 minutes for Section B of the test. Remember, do not waste time if you cannot answer a question, but leave it and go on to the next. Are there any questions?"

SECTION B

1. The sun is the only body in our solar system that gives off large amounts of light and heat. We see the moon because it is

   A. reflecting light from the sun.
   B. without an atmosphere.
   C. a star.
   D. the biggest object in the solar system.
   E. nearer the earth than the sun.

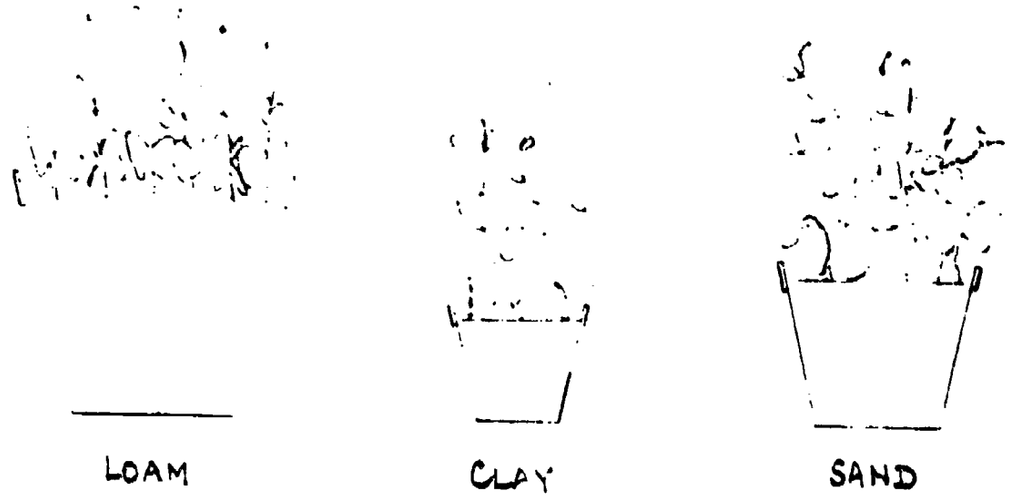
2. In an experiment green leaves were put in a jar and the apparatus was kept in the dark. Lime water was turned cloudy by the gas that formed in the jar. Which of the following gives the best explanation of this result?

   A. O_2 was produced by photosynthesis.
   B. O_2 was produced by respiration.
   C. CO_2 was produced by respiration.
   D. O_2 was used up in respiration.
   E. CO_2 was produced by photosynthesis.

3. John brought the skull of an animal to school. His teacher said she did not know what the animal was but she was sure that it was one that preyed on other animals for its food. Which clue, do you think, led her to this conclusion?

   A. The eye sockets faced sideways.
   B. The skull was much longer than it was wide.
   C. There was a projecting ridge along the top of the skull.
   D. Four of the teeth were long and pointed.
   E. The jaws could work sideways as well as up and down.

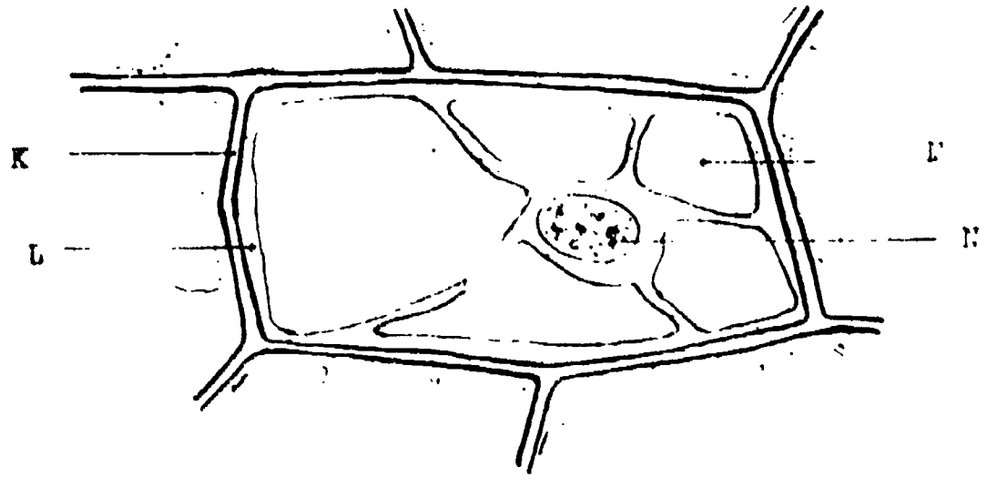
4. Tom wanted to learn which of three types of soil- clay, sand or loam- would be best for growing beans. He found three flowerpots, put a different type of soil in each pot, and planted the same number of beans in each, as shown in the drawing. He placed them side by side on the window sill and gave each pot the same amount of water.



Why was Tom's experiment NOT a good one for his purpose?

A. The plants in one pot got more sunlight than the plants in the other pots.
B. The amount of soil in each pot was not the same.
C. One pot should have been placed in the dark.
D. Tom should have used different amounts of water.
E. The plants would get too hot on the window sill.

5. The drawing represents a plant cell. In which of the four regions marked might chloroplasts be found?

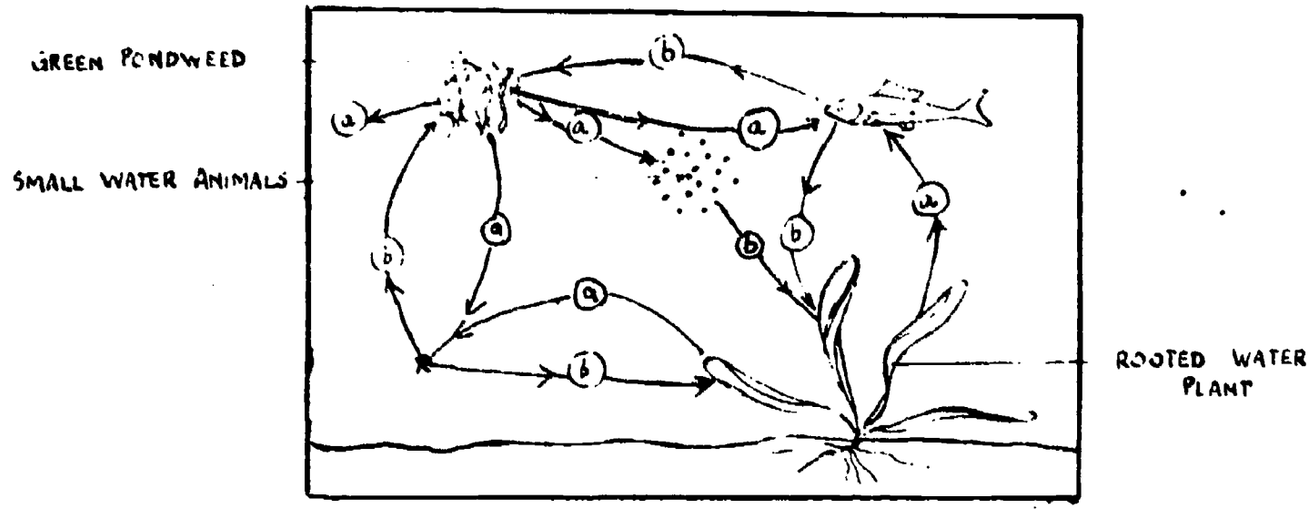


A. [illegible]
B. In K only
C. In M only
D. In N only
E. In both M and L

6. The energy for photosynthesis is generally obtained from

A. chlorophyll.
B. chloroplasts.
C. sunlight.
D. carbohydrates.
E. carbon dioxide.

7. The diagram below shows an example of interdependence among aquatic organisms. During the day the organisms either use up or give off (a) or (b) as shown by the arrows. Choose the right answer for (a) and (b) from the alternatives given.



A. a is oxygen and b is carbon dioxide.
B. a is oxygen and b is carbohydrate.
C. a is nitrogen and b is carbon dioxide.
D. a is carbon dioxide and b is oxygen.
E. a is carbon dioxide and b is carbohydrate.

8. What does an active muscle, that is, a muscle which is doing work, give up to the blood?

A. Carbon dioxide.
B. Oxygen.
C. Nitrogen.
D. Vitamin B.
E. Glucose.

9. The Andes are high mountains in South America and their inhabitants live and work at high altitudes. These people have almost twice as many red corpuscles in their blood as do the people living in the valleys. Which one of the following is the best explanation of this?

A. In the Andes there is less air pressure acting on the inhabitants' blood vessels and so new red corpuscles can be produced more quickly.
B. Because there is a smaller amount of oxygen in the air of the Andes the inhabitants breathe more deeply in order to increase the total amount of oxygen in their lungs.
C. In the Andes there is less oxygen entering the lungs of the inhabitants so that an increase in the number of red corpuscles enables a larger proportion of this oxygen to be absorbed.
D. Inhabitants of the Andes need more red corpuscles to transport oxygen through the blood vessels because there is less oxygen in the air they breathe.
E. The lower air pressure in the Andes causes blood to circulate more quickly through the blood vessels and so more red cor-

10. All of the following are aspects of the reproductive process. Which one of these must occur before we can be certain that fertilisation has taken place?

A. [illegible] must find a mate.
B. Reproductive organs must be produced.
C. The nucleus of a male gamete must fuse with that of a female gamete.
D. A spermatozoon must reach an egg cell.
E. A female gamete must provide a store of food for the embryo.

11. Paint applied to an iron surface prevents the iron from rusting by

A. preventing nitrogen from coming in contact with the iron.
B. reacting chemically with the iron.
C. preventing carbon dioxide from coming in contact with the iron.
D. making the surface of the iron smoother
E. preventing oxygen and moisture from coming in contact with the iron.

---

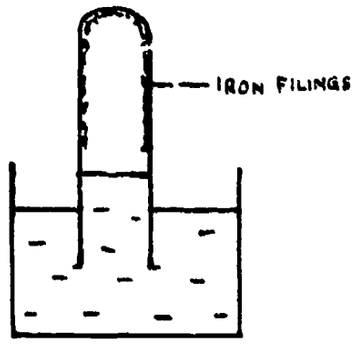
12. Flour is a fine powder obtained by grinding wheat or other cereal grains. A pile of grain burns only very slowly whereas flour dust suspended in air is explosive. Which of the following is the best explanation of this?

A. The heat produced when small particles burn is greater than the heat produced by the burning of large particles of the same substance.
B. Grinding the grain changes its chemical composition.
C. For the same quantity of the material, small particles have a greater surface area in contact with air than large particles.
D. Small particles possess more energy than large particles.
E. The flour burns completely whereas the pile of grain does not.

13. Two given elements combine to form a poisonous compound. Which of the following conclusions about the properties of these two elements can be drawn from this information?

A. Both elements are certainly poisonous.
B. At least one element is certainly poisonous.
C. One element is poisonous, the other is not.
D. Neither element is poisonous.
E. Neither element need be poisonous.

14. **A test tube coated with iron filings on the inside was clamped vertically in a beaker of water. Water gradually rose a short distance in the test tube as shown in the sketch.**



Of the following, the best explanation of this is that

A. water condenses inside the tube.
B. the iron gives off a gas which dissolves in the water.
C. the rust which replaces the iron takes up less space than the iron.
D. the iron reacts with oxygen from the air inside the tube.
E. oxygen from inside the tube dissolves in the water.

15. The presence of ions in a given water solution is most directly detected by

A. finding out if the solution conducts electricity.
B. measuring the density of the solution and comparing it with those of the pure solute and water.
C. finding out if the solution has an electric charge.
D. evaporating the solution and testing the residue for conductivity.
E. adding an ionic substance and seeing if there is a reaction.

16. Which one of the following elements forms an oxide which turns red litmus paper blue when added to water?

A. Phosphorus.
B. Carbon.
C. Iron
D. Sulphur.
E. Calcium.

17. In which of the following cases will heat be generated?

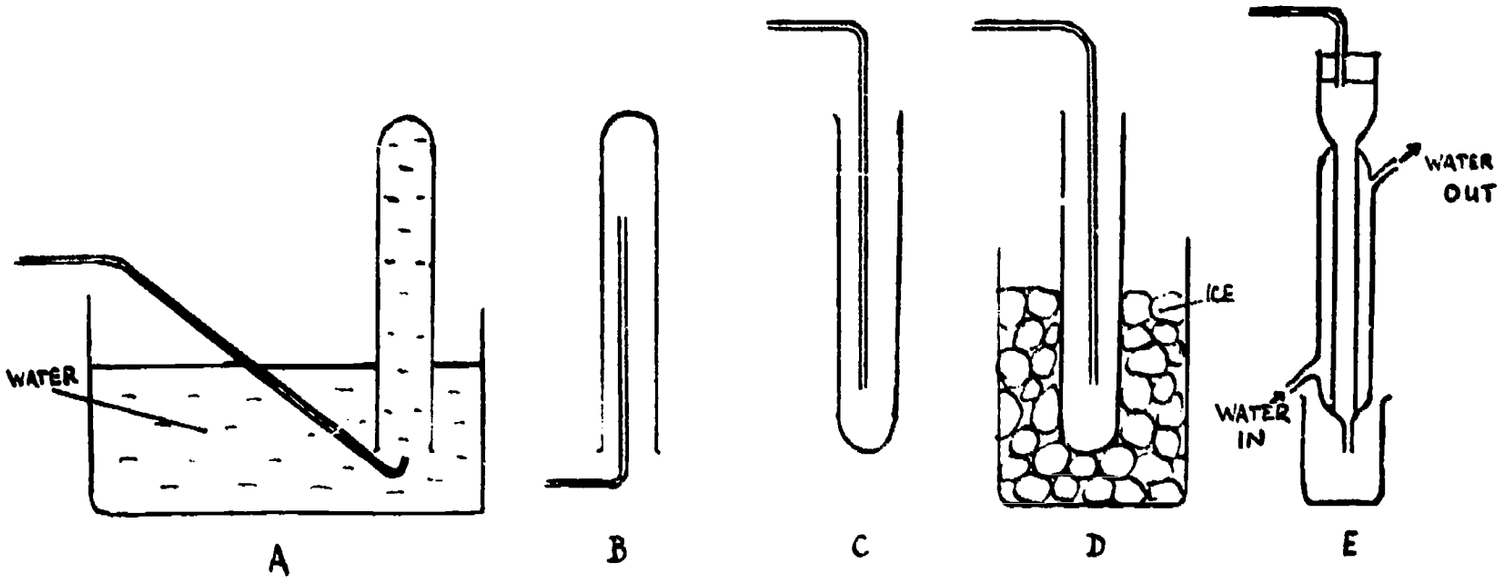
1. When sodium hydroxide dissolves in water.
2. When water is decomposed.
3. When ice thaws.
4. When water evaporates.
5. When concentrated sulphuric acid dissolves in water.

A. 1 and 2.
B. 1 and 5.
C. 3 and 4.
D. 3, 4 and 5.
E. 2, 3, 4 and 5.

18. You find what appear to be salt (sodium chloride) deposits. In order to learn what the deposits are, which of the following items of information would be most valuable?

A. Percentage of sodium chloride in the sample.
B. Percentage of magnesium chloride in the sample.
C. Specific gravity of the sample.
D. Chemical composition of the sample.
E. Solubility in water of the sample.

19. Which is the most suitable apparatus from those shown below for collecting pure oxygen gas by a student in a school laboratory?



20. Which one of the following substances does <u>not</u> consist mainly of carbon atoms?

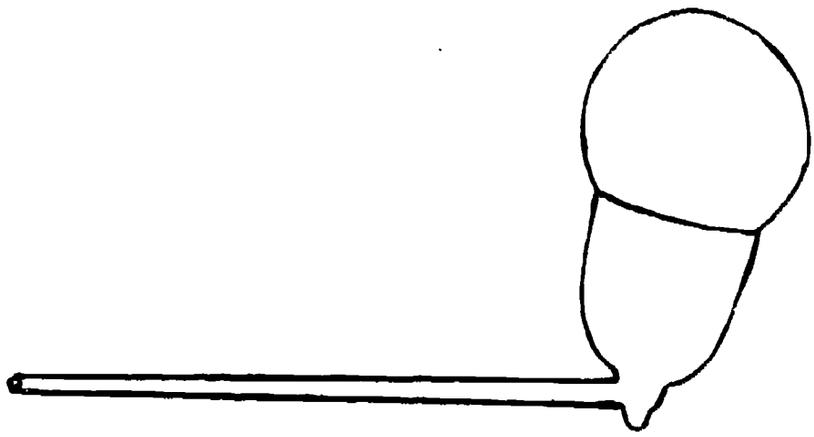
A. Diamond.
B. Graphite.
C. Soot.
D. Ruby.
E. Charcoal.

21. An iron container is evacuated and weighed. Then it is filled with hydrogen gas and weighed again.

The weight of the container full of hydrogen compared to the weight of the evacuated container is

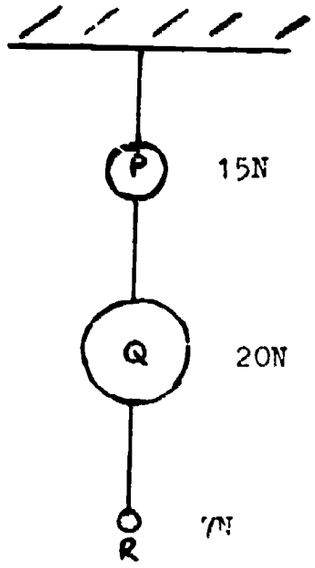
A. less.
B. greater.
C. the same.
D. greater or less depending on the volume of the gas in the container.
E. greater or less depending on the temperature of the gas in the container.

22. Ann was playing with a bubble pipe. When the bubble was the size of the one in the picture, she took the pipe out of her mouth. What do you think happened to the bubble <u>after</u> that?



A. It got larger for a time and then stayed at this size.
B. It got smaller for a time and then stayed at this size.
C. It got smaller and smaller and disappeared into the pipe.
D. It stayed on the pipe without getting larger or smaller.
E. It became larger and larger until it burst.

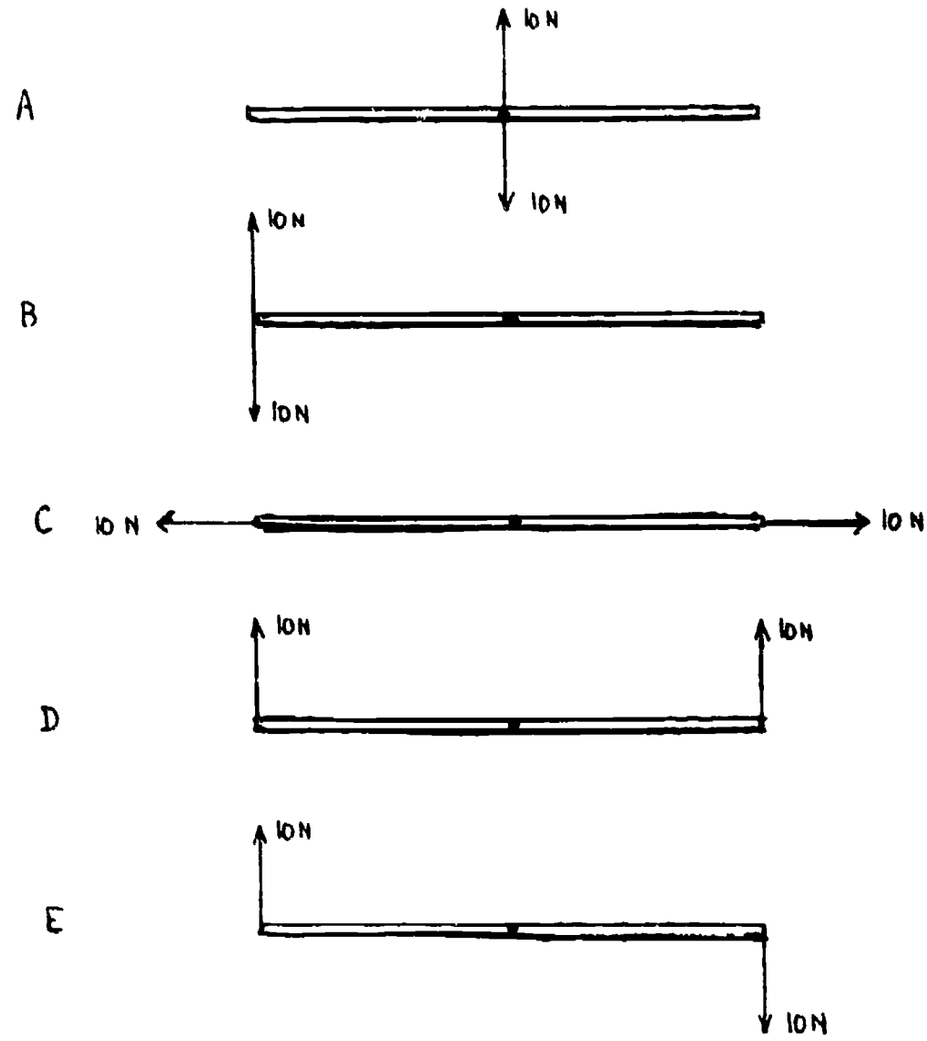
23. The objects P, Q and R of weight 15N, 20 N and 7 N, are hung with a light thread as shown in the figure.



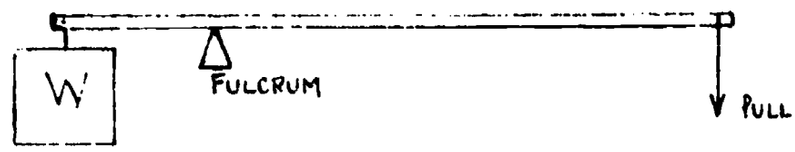
What is the tension between P and Q?

A. 42 N
B. 35 N
C. 27 N
D. 15 N
E. 7 N

24. A uniform rod, pivoted at its centre, is acted on by two forces in the same plane. In which case is there a turning effect?

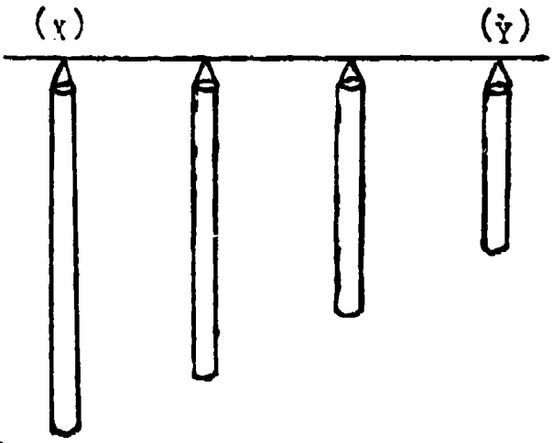


25. The advantage of using a lever such as that shown in the diagram to raise a weight W instead of lifting it directly is that



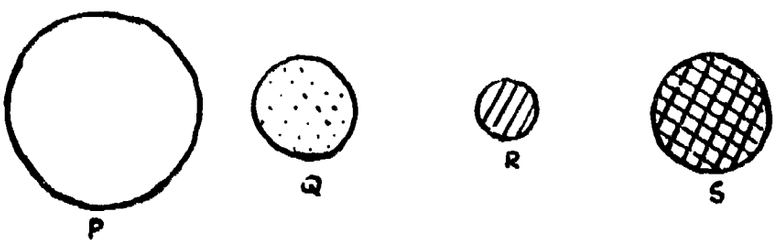
A. less energy is required.
B. it is quicker.
C. less force is needed.
D. less movement is required.
E. less work has to be done.

26. Some boys made a set of chimes by cutting four pieces of pipe of different lengths from a long metal pipe and hanging them as shown in the picture below. Which of the pipes gave the <u>lowest</u> note when they struck it with a hammer?



A. Pipe (X).
B. Pipe (Y).
C. All gave the same note.
D. You cannot tell without trying.
E. It depends on where you hit it.

27. Four balls, P, Q, R and S shown to scale in the figures, are made of different materials, but have the same weight.



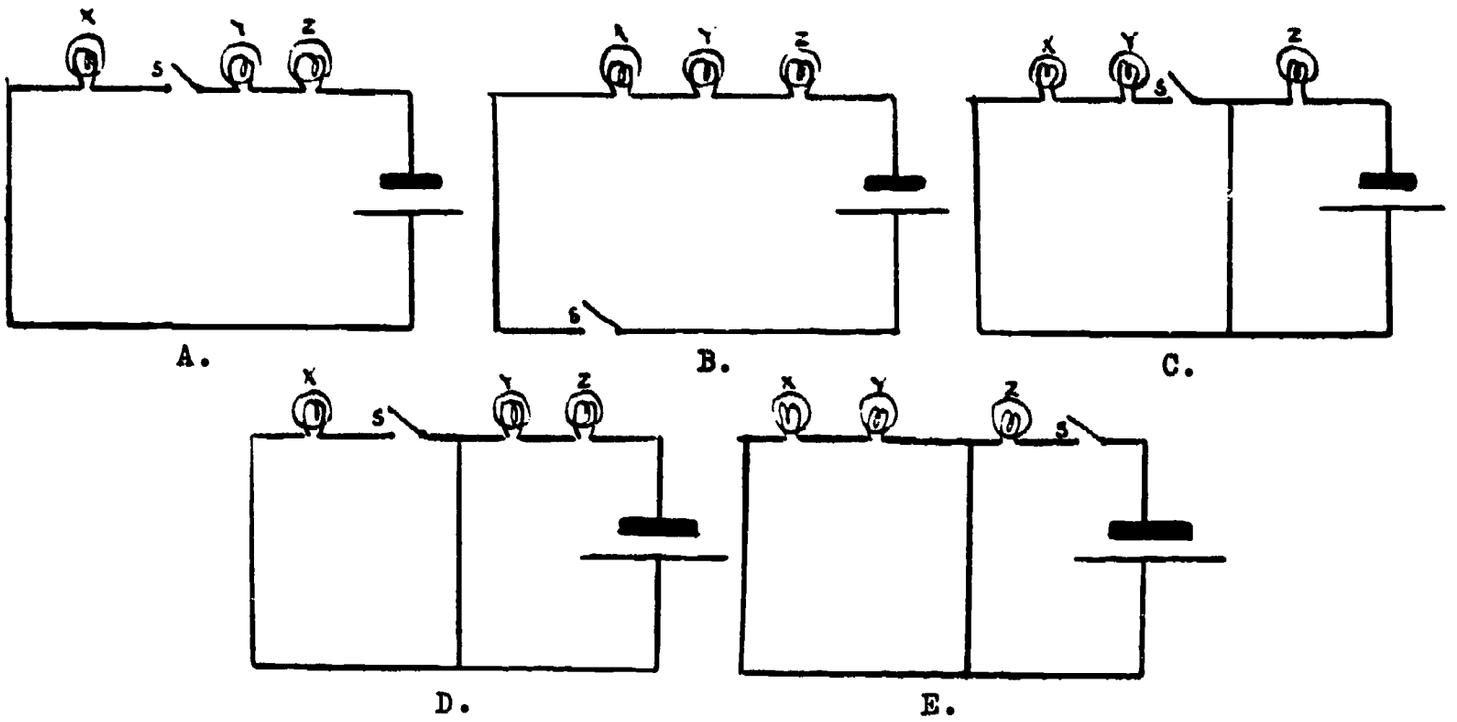
Which one of the following statements about their densities is true?

A. They all have the same density.
B. You cannot know anything about their densities.
C. Which one has the highest density depends on how the volumes are measured.
D. P has the highest density.
E. R has the highest density.

28. A metal tray feels colder to touch than its plastic handle. This is because

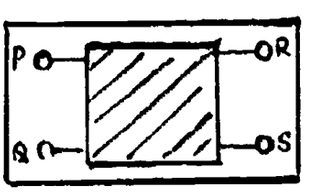
A. metal always has a lower temperature than plastic.
B. metal radiates much more heat than plastic and so cools more quickly.
C. metal conducts the heat away from your hand better than plastic.
D. plastic is a better heat conductor than metal.
E. a smooth surface allows a closer contact than a rough one.

29. X, Y and Z represent three lamps in a circuit, which also includes a battery and a switch S. When the switch is open X fails to light while Y and Z do. Which one of the following circuits is it?

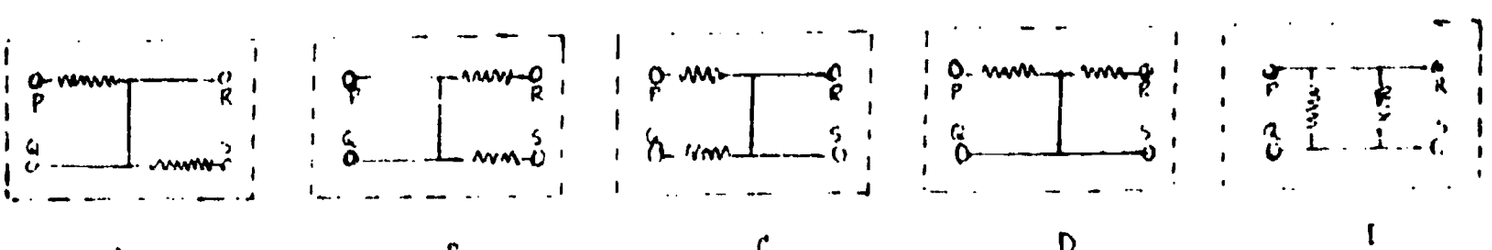


30. The figure shows a box with four terminals, P, Q, R and S. The following observations were made.

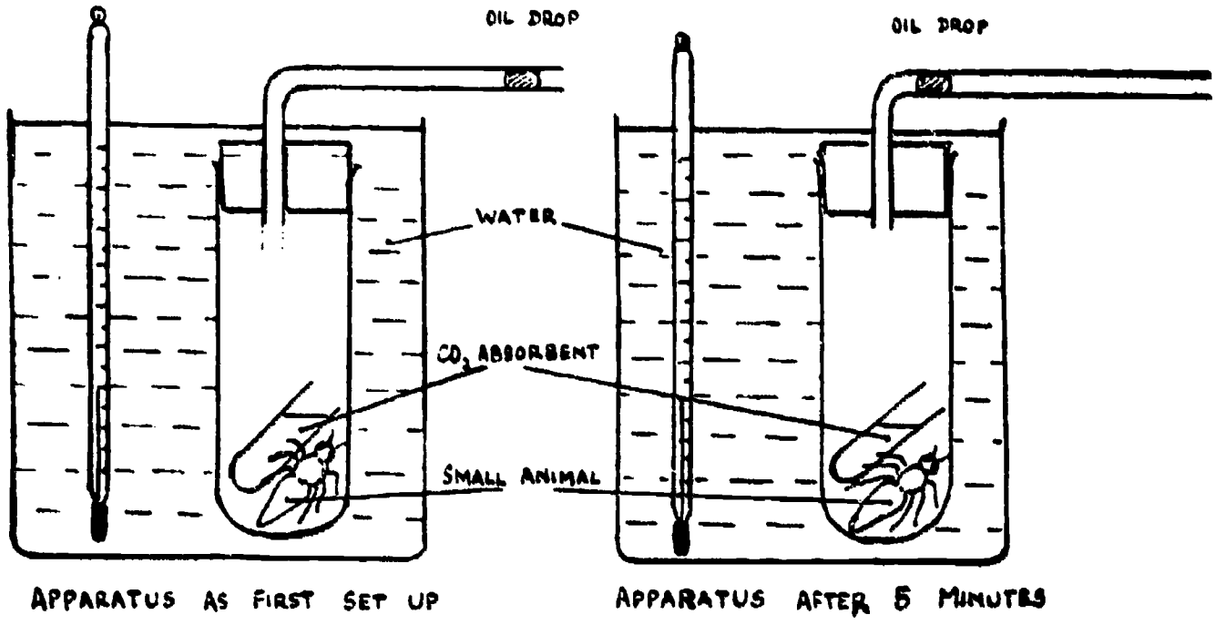
1. There is a certain amount of resistance between P and Q.
2. Resistance between P and R is twice that between P and Q.
3. There is not any appreciable resistance between Q and S.



Which of the following circuits is most likely to be within the box, assuming the resistances shown to be equal?



Questions 31, 32, 33 and 34 refer to the following diagram:



Animals take in oxygen and give out carbon-dioxide. Ordinary air contains very little carbon-dioxide.

31. Which of the following is measured with this apparatus?

A. The rate of movement of the animal.
B. The amount of heat produced by the animal.
C. The rate of respiration of the animal.
D. The effect of carbon dioxide on the animal.
E. The amount of carbon-dioxide absorbed by the animal.

32. Why are a water bath and thermometer used?

A. To keep the animal cool.
B. To keep the animal warm.
C. To keep the temperature from changing.
D. To prevent leakage of gases from the apparatus.
E. To keep the pressure constant around the animal.

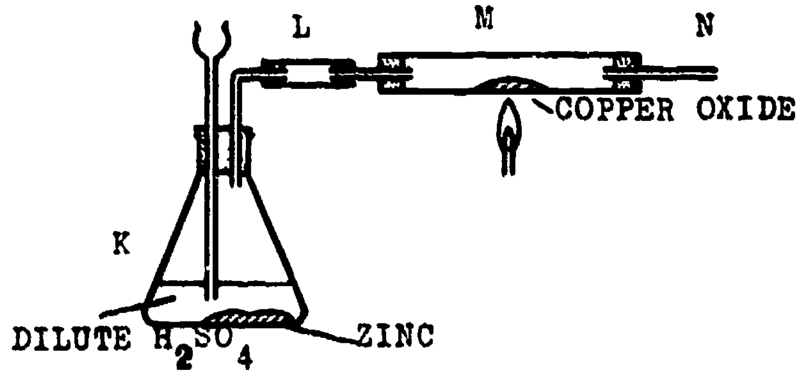
33. Which one of the following is true after 5 minutes?

A. The volume of air enclosed in the apparatus has increased.
B. The volume of air enclosed in the apparatus has decreased.
C. No change has taken place.
D. No further movement of the oil drop can be expected.
E. The oil drop will now begin to move in the other direction.

34. By which one of the following methods could the apparatus be made more sensitive to small changes of volume?

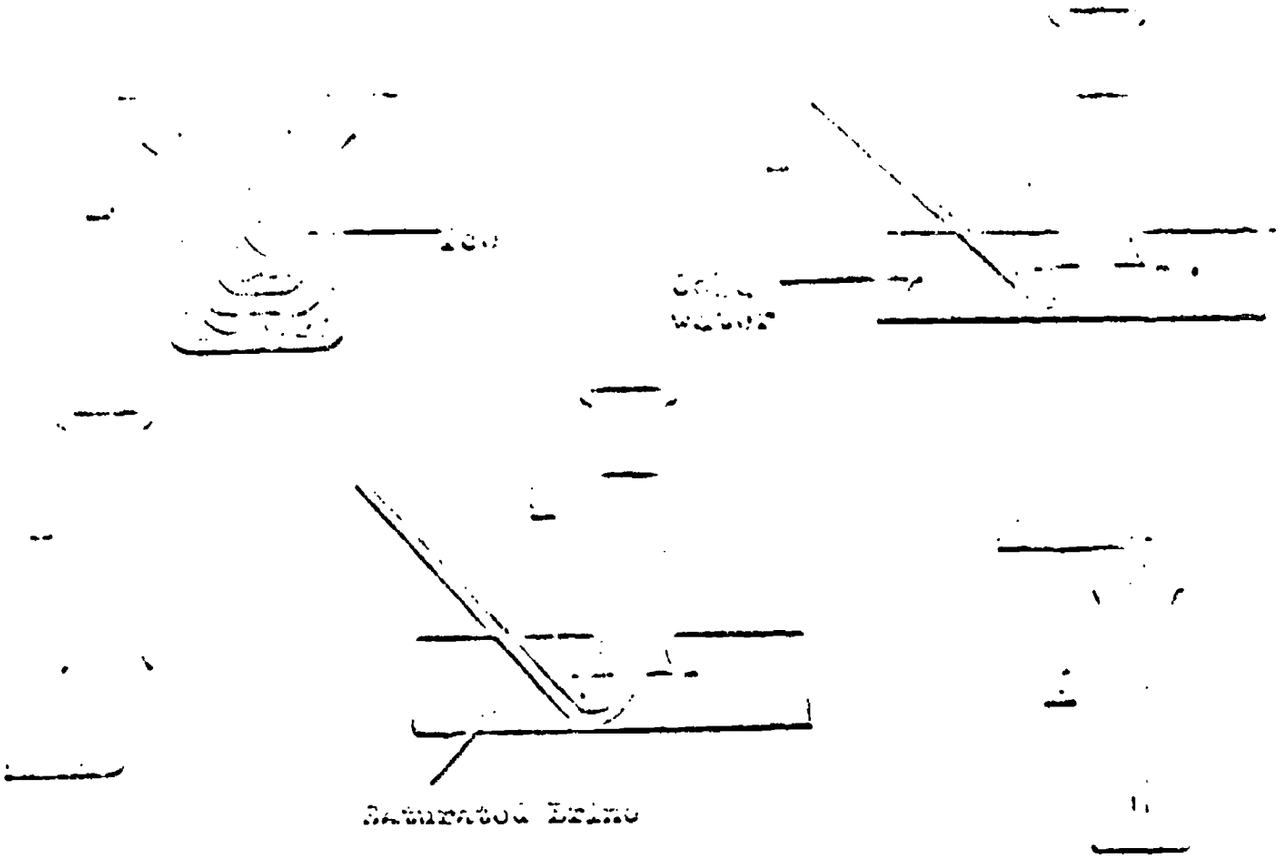
    A. By using a smaller test tube.
    B. By raising the temperature of the water.
    C. By using more of the carbon dioxide absorbent.
    D. By using a wider tube for the oil drop.
    E. By using a narrower tube for the oil drop.

35. The apparatus shown below is assembled to reduce copper (II) oxide with hydrogen gas.

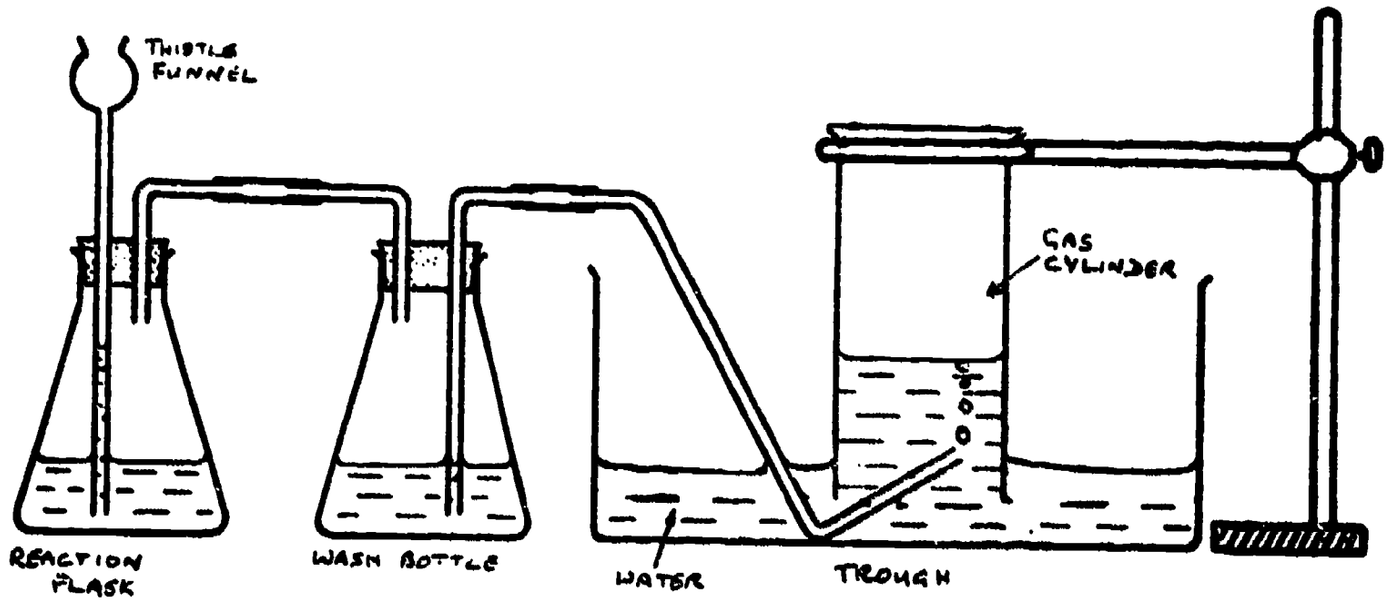


Hydrogen gas is produced in generator 'K' and is passed over hot copper (II) oxide in glass tube 'M'. Tiny droplets of water collect on the inside of tubes 'M' and 'N'. These droplets could possibly come from the generator 'K', being carried through into the rest of the apparatus by the stream of hydrogen. In order to test the truth of this explanation it would be best to

    A. heat tube 'M' further
    B. heat the generator 'K'
    C. add a calcium chloride drying tube at the right of tube 'M'
    D. add dry calcium chloride to tube 'L'
    E. try to produce hydrogen by the reaction of zinc with a different acid.



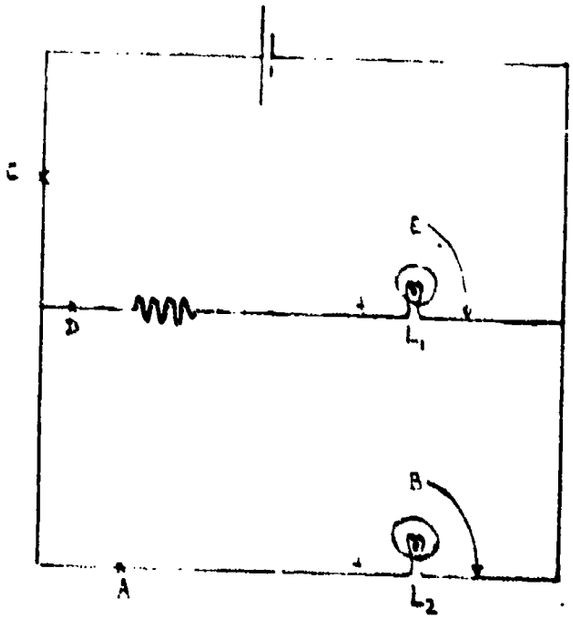
A substance has a boiling point of -100°C. In its gaseous state it is less dense than air and soluble in water. From the diagrams above select the one representing the most suitable apparatus by which to collect the gas.



Which one of the following correctly lists the errors in the apparatus diagram shown above for preparing a water-insoluble gas?

A. The thistle funnel tube goes below the level of the liquid in the reaction flask, and the wash bottle is connected the wrong way round.
B. The level of the water in the trough is too low, and the tube leading to the wash bottle does not come from below the level of the liquid in the reaction flask.
C. The wash bottle is connected the wrong way around, and no level of liquid is shown in the bowl of the thistle funnel.
D. The thistle funnel tube goes below the level of the liquid in the reaction flask, and the level of the water in the trough is too low.
E. The level of the water in the trough is too low, and the wash bottle is connected the wrong way around.

Questions 38, 39 and 40 refer to the following circuit diagram.



For the following questions, <u>indicate</u> the letter denoting the appropriate responses in the blank spaces on the answer card.

38. <u>Indicate</u> where you would place a switch to cut off lamp L_2 only.

39. <u>Indicate</u> where you would place a variable resistor to dim both lamps.

40. <u>Indicate</u> where you would place a variable resistor to dim lamp L_2 only.

END OF BOOKLET 4

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
Stage 3	IEA/M1/Stage 3	Manual for National Centers
	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators

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R = Reading Comprehension
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M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
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2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Science Test Section A

Data Bank Instrument Number E4SA

IEA/S5

Pop IV, p. 4-4

"Now look at the front cover of Booklet 10. Follow carefully while I read the directions to you."

Read the directions to the group, giving them time to mark the answers to the practice questions when these are reached.

Directions:-

"This test contains questions dealing with different branches of Science.

.
.
.

Now try the next three questions for practice. Fill in the space of your chosen answer on the answer card in Section L."

"We are now ready to begin Section A. The answers to the test are to be placed in the section marked A on your answer card."

Indicate the appropriate section of the answer card. Then say:-

"You will have 60 minutes for this test. Work as quickly as you can. Do not waste time if you cannot answer a question, but leave it and go on to the next. Are there any questions?"

This test contains questions dealing with different branches of science. Some you will know about from your school work, some from your general knowledge and others you will be able to answer by using commonsense. Others you may not be able to do. Do not waste time over questions you cannot do; leave them and go on to the next question. You can come back to questions you have missed later, if you have time. You may answer even if you are not quite sure, but do not guess blindly.

Each of the questions or unfinished statements in this test is followed by five suggested answers, lettered A,B,C,D, and E. You have to decide which one answer you think best and then on your answer card make a solid pencil mark in the oval containing the correct answer letter.

Here is an example of how to fill in the answer on your answer card. Remember that the examples given on this page are to be answered in the section marked L on your answer card.

1. How long does the earth take to travel once around the sun?

   A. A day.
   B. A week.
   C. A month.
   D. A year.
   E. None of the above.

Since the earth travels round the sun in a year, the answer space D should be marked. This has been done on the answer card for the question 1 in the example section L.

Now try these three questions for practice. Fill in the space of your chosen answer on the answer card in section L.

2. Water would be turned into ice by

   A. heating it.
   B. stirring it quickly.
   C. putting salt in it.
   D. pouring it into a shallow dish.
   E. cooling it.

3. Which day of the year in the southern hemisphere has the longest period of daylight?

   A. 21st January.
   B. 21st March.
   C. 22nd December.
   D. 23rd September.
   E. 22nd June.

Sometimes you may be asked to pick out the one wrong answer or the one that does not fit in with the others.

4. Which of the following does NOT belong to the same group as the others?

   A. Eagle.
   B. Lion.
   C. Mouse.
   D. Elephant.
   E. Deer.

DO NOT TURN OVER UNTIL YOU ARE TOLD TO DO SO.

1. A student wrote the following note on a laboratory project.

"Using a cork-borer I obtained several cylinders from a large potato. The cylinders were 7 cm long and 0.5 cm in diameter. I kept them on a dry plate and measured them again on the following day. I found that all of them had become shorter and thinner."

The student then put the cylinders into a beaker of tap water and wrote.
"If I measure them tomorrow I shall find that they have all returned to their original size."
In writing this second sentence the student was

A. making a statement of fact.
B. making an observation.
C. drawing a tentative conclusion.
D. describing an experimental procedure.
E. making a hypothesis.

2. Which of the following features present in an animal would make you certain it was a mammal?

A. A vertebral column.
B. Small tufts of "hair - like" bristles on its skin.
C. Two pairs of limbs.
D. Two pairs of milk glands.
E. Five digits on each fore-limb.

Questions 3 and 4 refer to the following data.

Several different parts of plants were placed in sealed containers of equal volume. The amounts of CO_2 (carbon dioxide) used by the plant parts under different conditions were measured and recorded.

Container	Plant	Plant Part	Vol. of Plant Part (cm^3)	Colour of Light	Temp. ($^\circ C$)	Time Elapsed (days)	CO_2 Used (cm^3)
1	Myrtle	Leaf	100	Red	15	2	150
2	Myrtle	Leaf	100	Red	27	2	200
3	Myrtle	Stem	100	Blue	21	2	50
4	Oak	Root	100	Blue	27	3	0
5	Oak	Leaf	100	Orange	27	2	100
6	Oak	Leaf	100	Orange	27	3	150

Assume that the experimental conditions not listed were identical in all six containers.

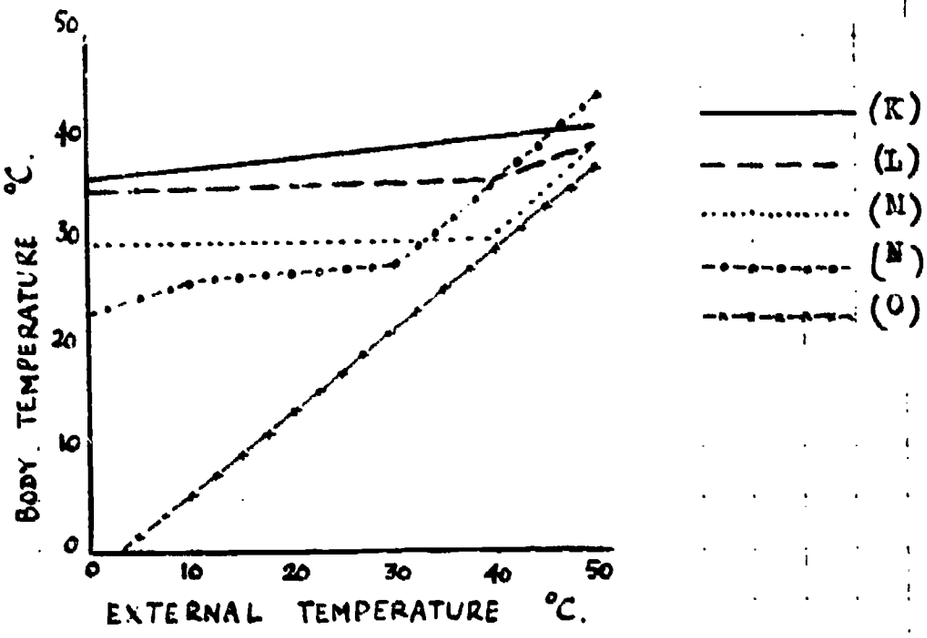
3. On the basis of the data in the table, one could properly compare the amount of CO_2 used in one day by

   A. myrtle leaves at $15^\circ C$ and at $27^\circ C$.
   B. myrtle stems and myrtle leaves.
   C. myrtle leaves in red light and in orange light.
   D. oak leaves in orange light and in blue light.
   E. oak leaves at $15^\circ C$ and at $27^\circ C$

4. Which one of the following statements about the use of CO_2 by oak leaves would be supported by the given data?

   A. They use more CO_2 in orange light than in blue light.
   B. They use more CO_2 at $27^\circ C$ than at $15^\circ C$.
   C. They use more CO_2 per day than did the myrtle leaves.
   D. They use an average of 50 cm^3 CO_2 each day.
   E. They use 50 cm^3 of CO_2 each day.

5. The graph shows the results obtained when the changes in body temperature resulting from changes in external air temperature for various animals were being investigated.



Which of these curves is most likely to represent the results obtained from a lizard?

A. K
B. L
C. M
D. N
E. O

6. A lizard in a laboratory at 20°C was placed close to three temperature controlled areas, one at a temperature of 50°C, one at a temperature of 37°C and one at a temperature of 15°C. It always moved to the 37°C area.

This behaviour is an example of

A. a response to a stimulus.
B. reasoning.
C. a reflex arc.
D. geotropism
E. thigmotaxis

7. All of the following are aspects of the reproductive process. Which one of them must occur before we can be certain that fertilisation has taken place?

   A. A male organism must find a mate.
   B. Reproductive organs must be produced
   C. The nucleus of a male gamete must fuse with that of a female gamete.
   D. A spermatozoon must reach an egg cell.
   E. A female gamete must provide a store of food for the embryo.

8. Which of the following is a correct statement about hibernating animals?

   A. There is no life in any part of the animal.
   B. The animal ceases to breathe.
   C. The animal is absorbing energy for use when it returns to active life.
   D. The animal's body temperature is higher than when it is active.
   E. The animal is using less energy than during the period of active life.

9. When 16 g of dilute sulphuric acid was poured onto 3 g of zinc in an open test tube, hydrogen gas was generated. What was the weight of the contents of the test tube after the reaction was completed?

   A. Slightly more than 19 g.
   B. Slightly less than 19 g.
   C. Equal to 19 g.
   D. Slightly less than 16 g.
   E. Equal to 16 g.

10. A sample of oxygen gas in a plastic bag weighed 0.32 g. A sample of another gas in an identical bag, under the same conditions of temperature and pressure, weighed 0.26 g.

    Atomic weight of oxygen = 16.

    What is the weight of 1 mole of the second gas?

    A. 13 g.
    B. 26 g.
    C. 48 g.
    D. 58 g.
    E. 64 g.

11. One kind of stainless steel contains approximately 13% chromium and 1% nickel by weight; the rest is iron. Which of the following gives the closest approximation to the ratio of the number of chromium atoms to iron atoms in this stainless steel?

Atomic weight of chromium = 52 Atomic weight of iron = 56

A. $\frac{13}{52} : \frac{1}{56}$.

B. $\frac{13}{52} : \frac{86}{56}$.

C. $\frac{13}{108} : \frac{86}{108}$.

D. $\frac{13}{(100-52)} : \frac{87}{(100-56)}$.

E. $\frac{13}{100} \times 52 : \frac{86}{100} \times 56$.

Questions 12-14 relate to the simplified periodic table with main group elements shown below:

Group

Period	IA	IIA	IIIA	IVA	VA	VIA	VIIA	O
1								
2	F			N	P	Q	T	
3	G	K	L			R		U
4	H		M			S		V
5	I							W
6	J			O				X

12. Which element in the table has the smallest nuclear charge?

A. F.
B. U.
C. J.
D. X.
E. T.

13. In the third period of the table, the most metallic element is

A. G.
B. K.
C. L.
D. M.
E. T.

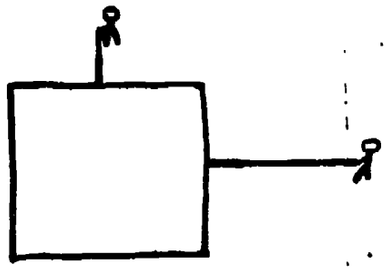
14. Which element in Group IA would most easily form an ion of +1 charge when in the gaseous state?

A. F.
B. G.
C. H.
D. I.
E. J.

15. Human respiration can best be described as

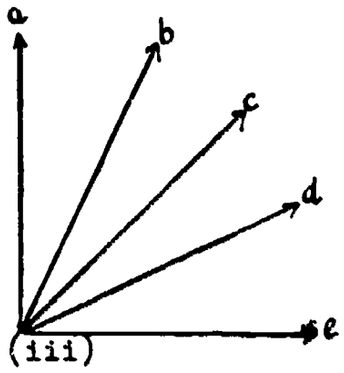
A. double decomposition.
B. a gas-phase reaction.
C. anaerobic respiration.
D. gaseous diffusion.
E. slow combustion.

16. Two men pull on a box by ropes as shown in the diagram. The lengths of the arrows on the force diagram are drawn proportional to the magnitude of the forces exerted by the men. In which of the directions shown in the third diagram will box move to tend to move?



(i)

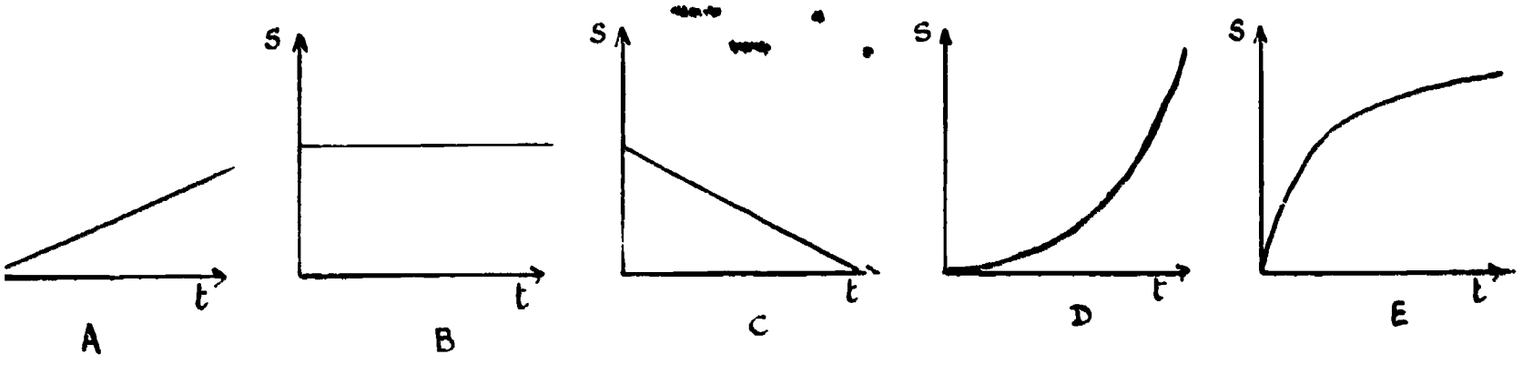
(ii) Force diagram



(iii)

A. a.
B. b.
C. c.
D. d.
E. e.

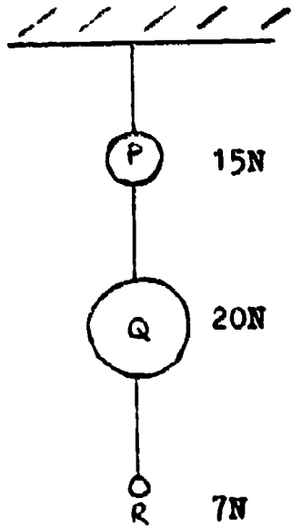
17. A steel ball rolls down an inclined plane. Which of the graphs below best represents the relationship between the distance travelled (s) and the time (t) (assume retarding forces are negligible).



18. The objects P, Q and R of **weight 15N, 20N and 7N** are hung with a **light thread as shown in the figure.**

What is the tension in the thread between P and Q?

A. 4 N
B. 35 N
C. 27 N
D. 15 N
E. 7 N



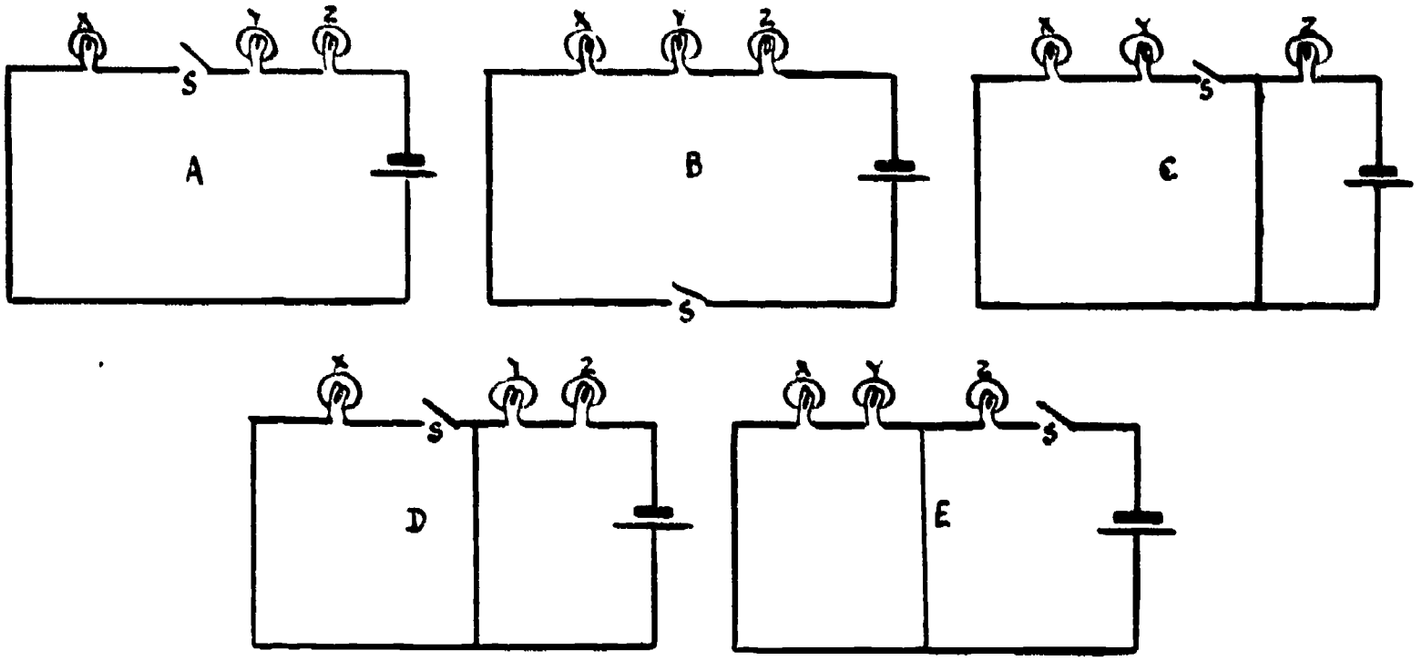
19. Which of the following would occur if a moving atom X were to collide with a stationary atom Y at room temperature?

A. Both atoms would lose kinetic energy.
B. Both atoms would gain kinetic energy.
C. Kinetic energy would be gained by atom X and lost by the atom Y.
D. The kinetic energy of each atom would remain the same.
E. Kinetic energy would be lost by atom X and gained by atom Y.

20. **A sensitive mercury-in-glass thermometer registering room temperature is immersed in boiling water. The mercury level first drops slightly and then rises. Why does the drop occur?**

A. **The specific heat of glass is greater than that of mercury.**
B. **The coefficient of expansion is greater for glass than for mercury.**
C. **The glass expands before the mercury does.**
D. **At room temperature, mercury has a negative coefficient of expansion like that of water from $0^{\circ}C$ to $4^{\circ}C$.**
E. **The surface tension of mercury increases with temperature.**

21. X, Y and Z represent three lamps in a circuit, which also includes a battery and a switch S. When the switch is open X fails to light while Y and Z do. Which one of the following circuits is it?



22. Which of the following devices in their common form would not function on a steady direct current?

A. Electromagnet.
B. Transformer.
C. Electric heating element.
D. Filament lamp bulb.
E. Electric bell.

23. The following are all examples of waves -- radiowaves, ultra-violet waves, infra-red waves, light waves, sound waves.

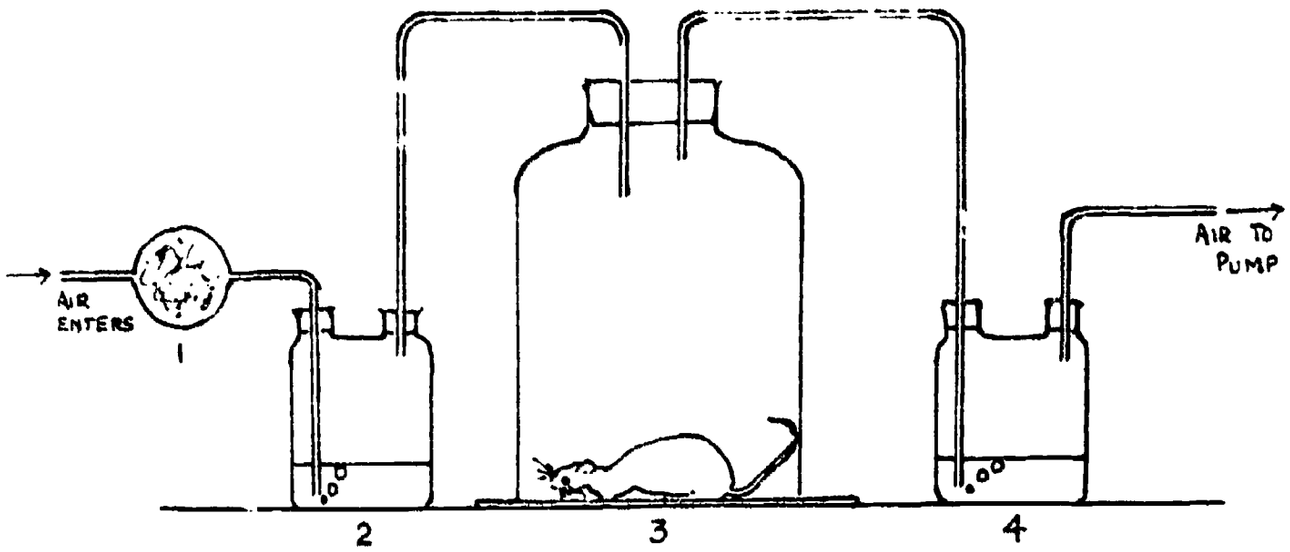
Each type of wave is different in some way from the other four. Which one of the following statements is correct?

A. Radiowaves are the only waves which carry energy.
B. Ultra-violet waves are the only waves you cannot see.
C. Infra-red waves are the only transverse waves.
D. Light waves are the only waves which travel very fast.
E. Sound waves are the only longitudinal waves.

24. A radioactive substance has a half life 6 days. What fraction of the original activity of a sample remains after 12 days?

A. None of it.
B. $\frac{1}{2}$.
C. $\frac{1}{1}$.
D. $\frac{1}{4}$.
E. $\frac{1}{}$.

Questions 25 and 26 refer to the following diagram which shows an arrangement of apparatus which can be used to show that an animal gives out carbon dioxide in respiration.



1 contains a substance which removes carbon dioxide from air, 2 and 4 both contain a liquid which changes in appearance when carbon dioxide passes through it.

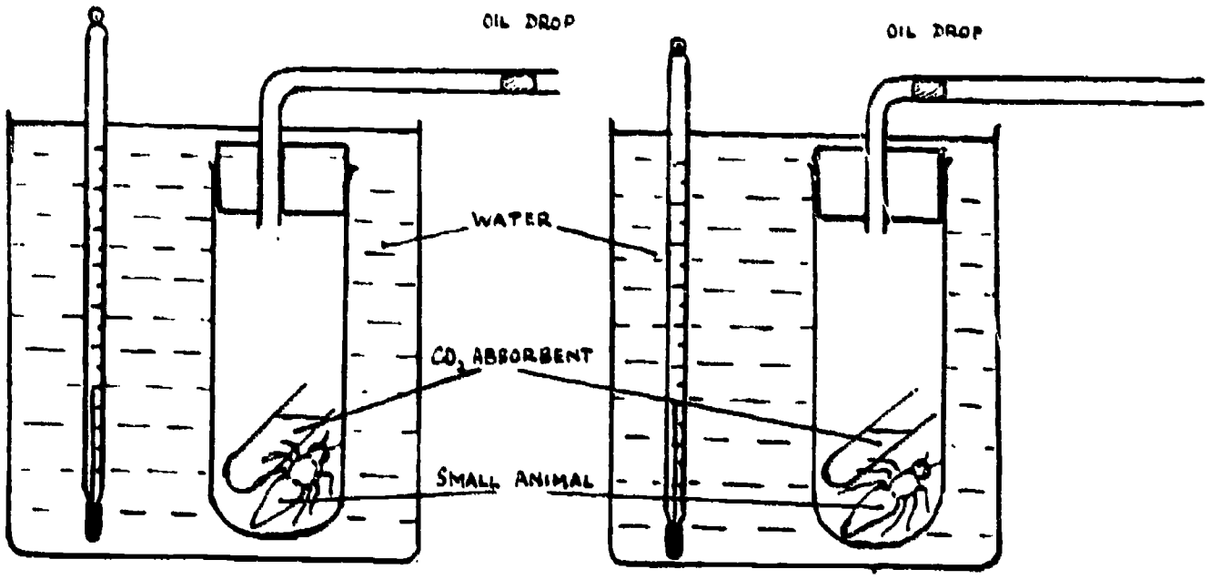
25. Of the following kinds of containers for the animal which one would give the quickest result?

A. A small container.
B. A large container.
C. A container in bright light.
D. A container covered with a dark cloth.
E. A container in which the air is kept moist by means of wet cotton wool.

26. If air leaked into chamber 3, which one of the following effects would be seen?

A. The liquid in 4 would change more rapidly.
B. The rate of bubbling in 2 would slow down or stop.
C. The rate of bubbling in 4 would slow down or stop.
D. Liquid would pass from 4 into 3.
E. The liquid in 2 would change more rapidly.

Questions 27 and 28 refer to the following diagram:



Animals take in oxygen and give out carbon-dioxide.
Ordinary air contains very little carbon-dioxide.

27. Which of the following is measured with this apparatus?

A. The rate of movement of the animal.
B. The amount of heat produced by the animal.
C. The rate of respiration of the animal.
D. The effect of carbon-dioxide on the animal.
E. The amount of carbon-dioxide absorbed by the animal.

28. Which one of the following is true after 5 minutes?

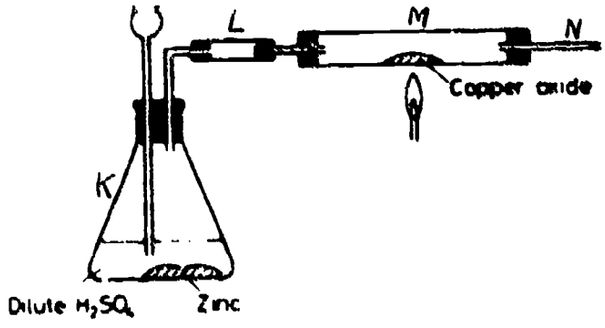
A. The volume of air enclosed in the apparatus has increased.
B. The volume of air enclosed in the apparatus has decreased.
C. No change has taken place.
D. No further movement of the oil drop can be expected.
E. The oil drop will now begin to move in the other direction.

29. A chemist working for a toothpaste firm wishes to prepare 250 cm^3 of a 0.010 molar aqueous solution of stannous fluoride, SnF_2. Fortunately for him, SnF_2 is soluble in water. One mole of SnF_2 weighs 156.7 g. Equipment available includes a 250 cm^3 volumetric flask, a 10 cm^3 pipette, a 0.01 g sensitivity balance, and a 400 cm^3 beaker.

Once the proper amount of SnF_2 has been weighed, which one of the following procedures would be best?

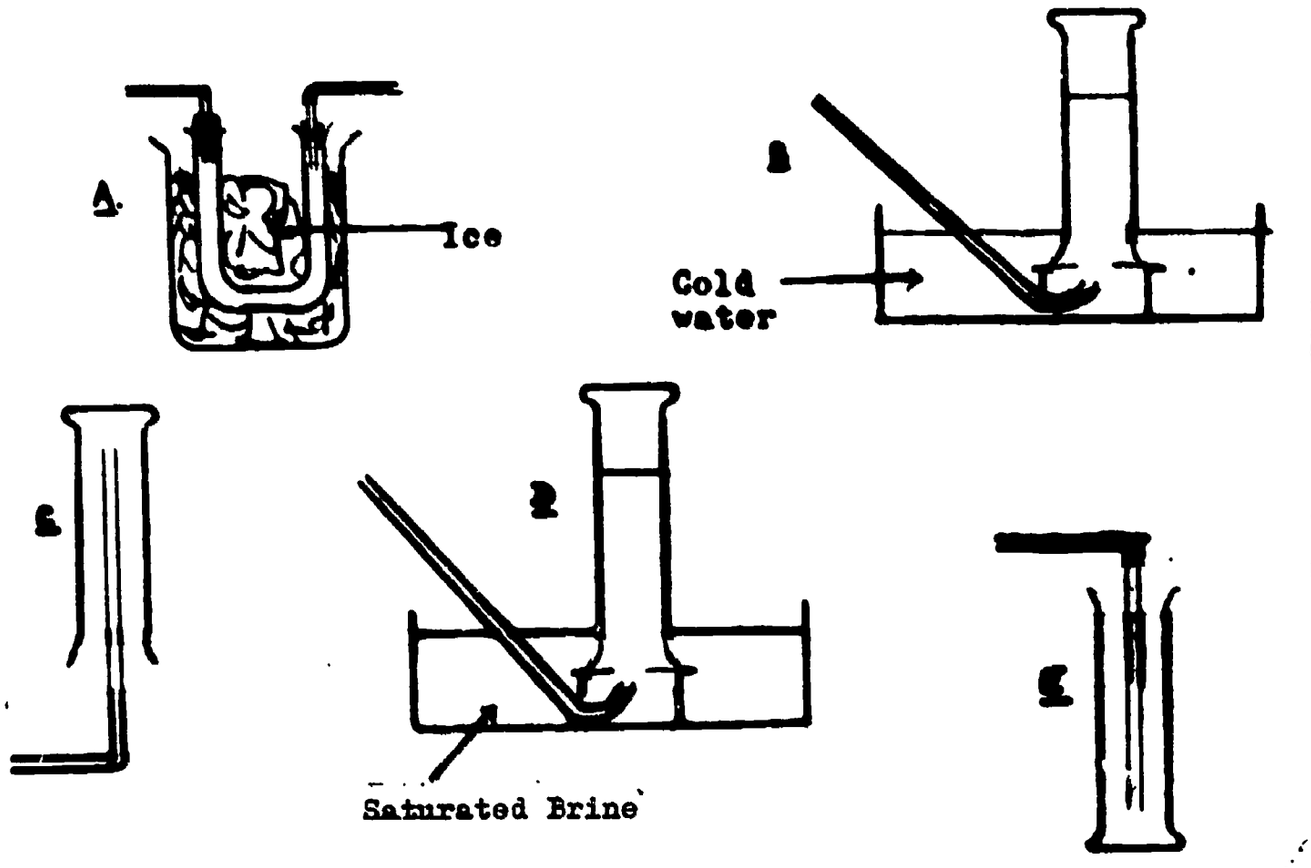
A. Place the SnF_2 in the beaker and add exactly 250 cm^3 of water from volumetric flask.
B. Place the SnF_2 in the beaker and add exactly 250 cm^3 of water from the pipette in 10 cm^3 portions.
C. Place the SnF_2 in the volumetric flask, dissolve it in less than 250 cm^3 of water, and then dilute to the 250 cm^3 mark.
D. Using the beaker and balance, weigh out exactly 250 g of water and add the SnF_2 to it.
E. Dissolve the SnF_2 in more than 250 cm^3 of water in the beaker mix thoroughly, and then fill the volumetric flask to the line with the solution.

30. The apparatus shown below is assembled to reduce copper (II) oxide with hydrogen gas.



Hydrogen gas is produced in generator 'K' and is passed over hot copper (II) oxide in glass tube 'M'. Tiny droplets of water collect on the inside of tubes 'M' and 'N'. These droplets could possibly come from the generator 'K', being carried through into the rest of the apparatus by the stream of hydrogen. In order to test the truth of this explanation, it would be best to

A. heat tube 'M' further
B. heat the generator 'K'
C. add a calcium chloride drying tube at the right of tube 'M'
D. add dry calcium chloride to tube 'L'
E. try to produce hydrogen by the reaction of zinc with a different acid.



A substance has a boiling point of 21°C. In its gaseous state it is denser than air and soluble in water. From the diagrams above select the one representing the most suitable apparatus by which to collect a sample of the substance.

32. The following apparatus is set out on the laboratory bench: two vacuum (thermos) flasks, two thermometers, two measuring cylinders, a beaker containing 1 M sodium hydroxide solution and a beaker containing 1 M hydrochloric acid.

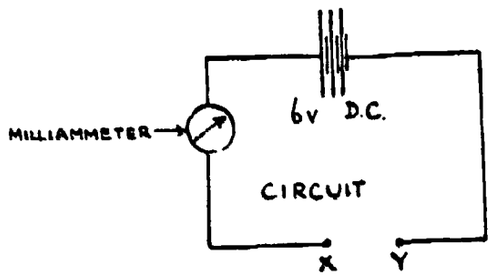
Which one of the following procedures would give most accurately a value for the molar heat evolved in the neutralization of sodium hydroxide and hydrochloric acid?

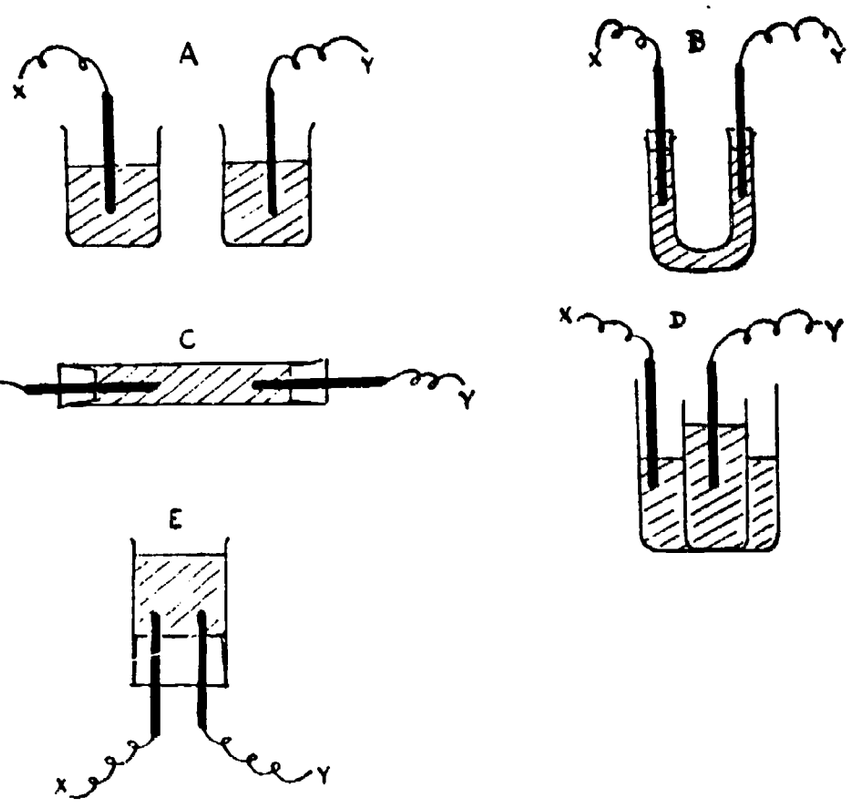
A. Take the temperatures of the acid and alkali in their respective beakers, mix them into a vacuum flask and record the rise in temperature produced.
B. Mix the acid and alkali in one vacuum flask, record the temperature, transfer the contents to the second flask and record any change in temperature.
C. Allow all the acid and half the volume of alkali to come to steady recorded temperatures in the respective vacuum flasks, mix them and record the temperature rise produced.
D. Allow equal volumes of acid and alkali to come to steady recorded temperatures in the respective vacuum flasks, mix them and record the temperature rise produced.
E. With a known volume of acid in the one vacuum flask, record the temperature at regular intervals of time as alkali is added from the other flask.

33. A number of different solutions have to be tested to find out whether or not they will each conduct electricity and, if so, what products are liberated.

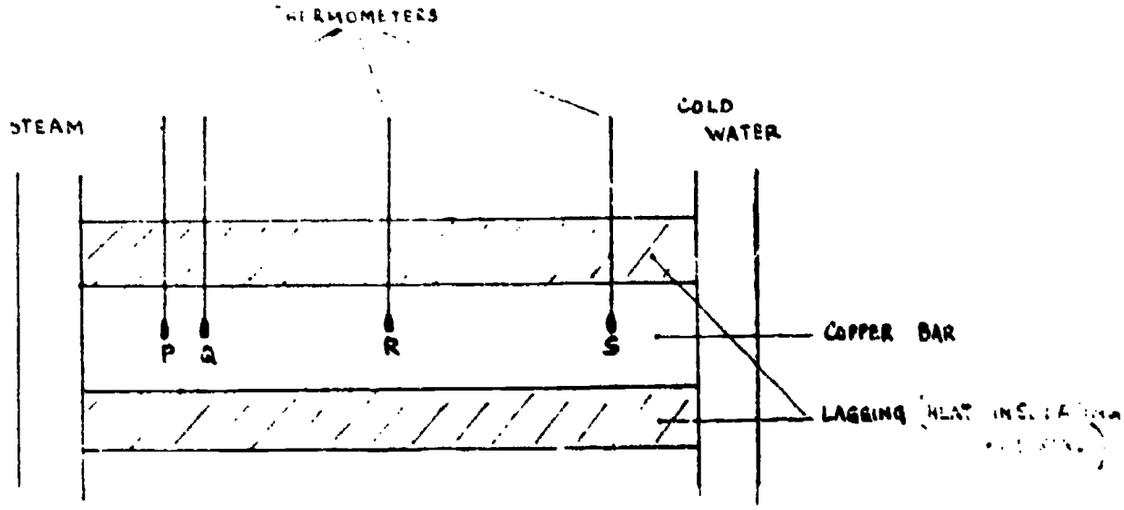
Using the circuit shown below, which of the following pieces of apparatus would be most suitable when connected between points X and Y?

(All the beakers and tubes are made of glass, the electrodes of carbon, and solutions are shown shaded.)





34. One end of a well-insulated copper bar is heated and the other kept cold as shown in the figure. The temperature at different points on the bar can be read by thermometers dipping into small holes at P, Q, R and S. The distance between P and Q is 1.0 cm and the drawing is to scale.



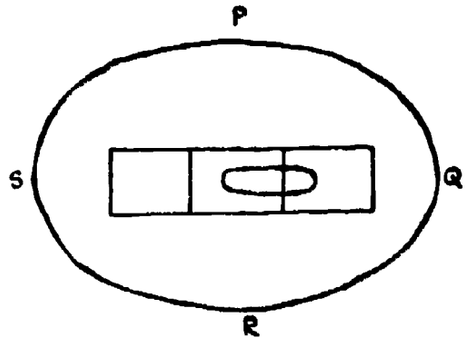
The temperature falls uniformly along the bar, and it is required to find the temperature gradient, or fall in temperature for unit length.

The two thermometers to be read for this purpose should be those placed at

A. P and Q
B. P and R
C. P and S
D. Q and R
E. R and S

35. A spirit level is placed on the top of a table and viewed from above when it appears as shown in the diagram. Which of the points P, Q, R and S should be raised as a first step towards making the table level?

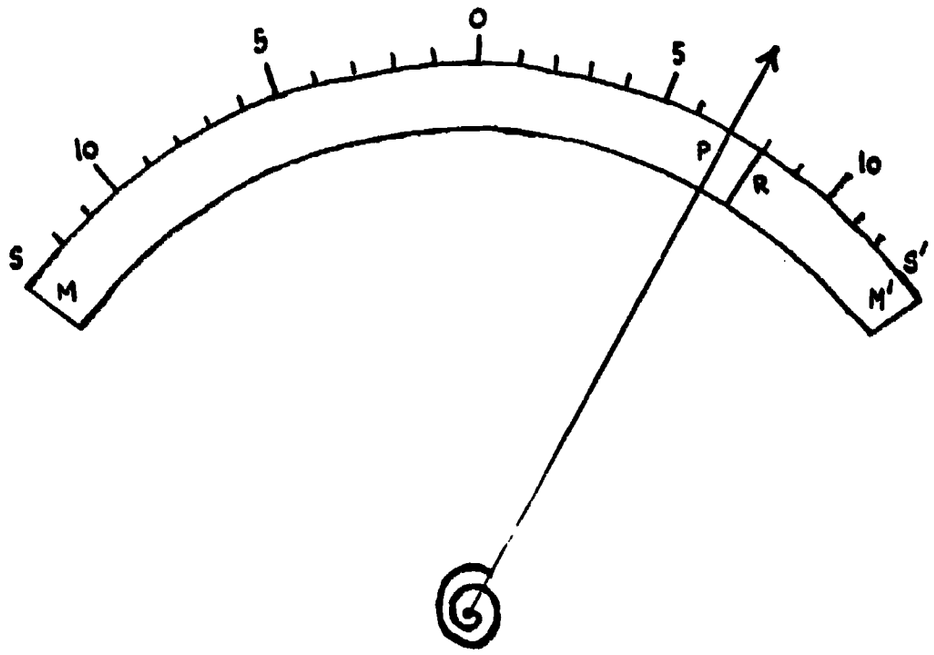
A. P
B. Q
C. R
D. S
E. any of the above



36. A meter has a pointer P which moves over a strip mirror MM' and a scale SS'. When photographed at an angle the meter appears as shown, where R is the reflection of the pointer in the mirror.

What is the correct meter reading?

A. Between 6 and 7 units
B. 7 units
C. Between 7 and 8 units
D. 8 units
E. Between 8 and 9 units



END OF BOOKLET 10

IEA SIX-SUBJECT SURVEY INSTRUMENTS

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
Stage 3	IEA/M1/Stage 3	Manual for National Centers
	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators

These manuals are available from ERIC Clearinghouse.

The following extracts from these manuals have been appended to this particular IEA instrument to provide researchers with the minimum necessary test instruction information (e.g., such things as the instructions on the practice items and the warnings concerning the amount of time left for the test have been omitted here). For full details, please consult the appropriate manuals.

The Data Bank Instrument Number which appears below is a new number, assigned since the instruments were administered for the purpose of easily linking items in the instruments with the resultant variables in the Data Bank holdings. Each such variable is named in the codebook using the new instrument number and (usually) the number of the item within the instrument from which the variable is derived. The key to the new instrument numbers is as follows:

1: Type of Instrument

E = Examination (student)
Q = Questionnaire (student)
T = Teacher questionnaire
S = School questionnaire

2: Student Population

1 = I	6 = II and IV
2 = II	7 = I, II and IV
3 = III	8 = I and IV
4 = IV	S = IV Specialist
5 = I and II	N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
F = French as a Foreign Language
C = Civic Education
2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

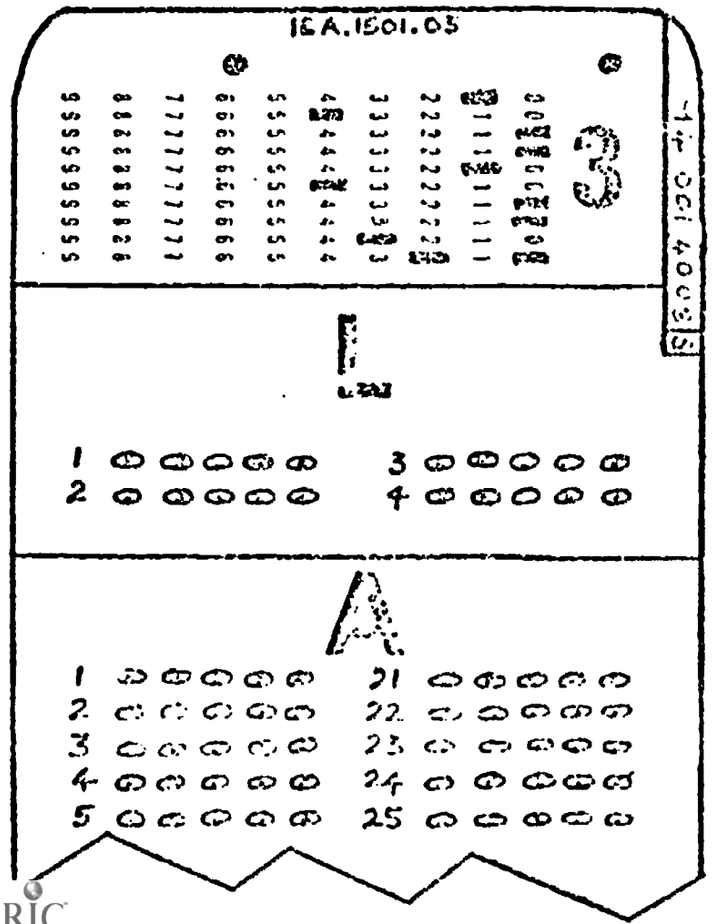
Instrument Name Science Test Section B, Nonrotating items

Data Bank Instrument Number E1SB

Note that six separate booklets were prepared. The first 24 items in each were those found in instrument E4SB, and items 25-30 were those found in instrument E4SP, E4SQ, E4SR, E4SS, E4ST, or E4SU, respectively.

IEA/M3
Pop IV, p. 5-6

"Take out Booklet 11 from your envelope. Also, take out the small envelope of answer cards and remove the yellow answer card No. 3. On the front of Booklet 11 is a letter. It will be either a "P", a "Q", an "R", an "S", a "T" or a "U". Also on your answer card there is a column of letters and numbers at the top right hand edge by the large number 3. The last of these will also be a "P", a "Q", an "R", an "S", a "T" or a "U". Make sure this letter is the same as the one on your test booklet."
(The test administrator should hold up a copy of Booklet 11 and answer card 3 and show where they should match.)



This is the letter that should match the letter on the front of the test booklet.

IEA/M3) continued
Pop IV, p. 5-6)

If any student finds that the answer card does not match the test, then the test administrator should correct the discrepancy by giving him a booklet which matches the letter on his answer card. The student should not be allowed to change answer cards.

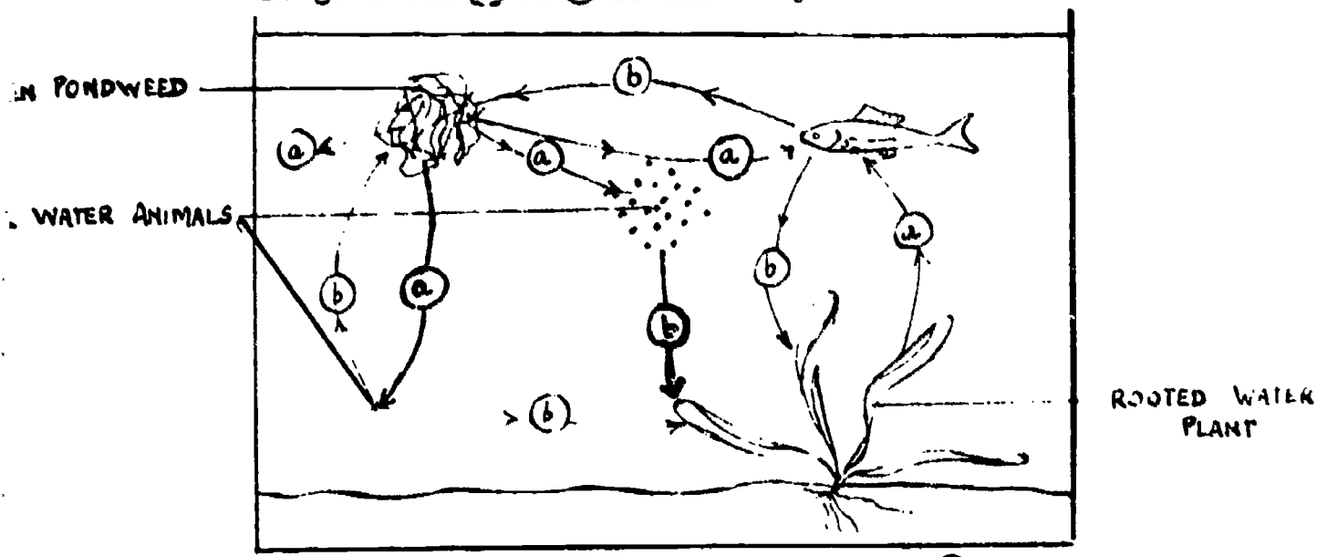
Then say:-
"We are now ready to begin Section B. The answers to questions in this section are to be marked in part B on the answer card. Find part B on your answer card."
Indicate Section B on the answer card. Then say:-
"You will have sixty minutes for Section B of the test. Remember do not waste time if you cannot answer a question, but leave it and go on to the next. Are there any questions?"

SECTION B

1. The energy for photosynthesis is generally obtained from

   A. chlorophyll.
   B. chloroplasts.
   C. sunlight.
   D. carbohydrates.
   E. carbon dioxide.

2. The diagram below shows an example of interdependence among aquatic organisms. During the day the organisms either use up or give off (a) or (b) as shown by the arrows.



Choose the right answer for (a) and (b) from the alternatives given

   A. a is oxygen and b is carbon dioxide.
   B. a is oxygen and b is carbohydrate.
   C. a is nitrogen and b is carbon dioxide.
   D. a is carbon dioxide and b is oxygen.
   E. a is carbon dioxide and b is carbohydrate.

3. Mushrooms can be grown in the dark because

   A. they are then in a constant temperature.
   B. they can then form more vitamins.
   C. they need not be pollinated by bees.
   D. they feed on decaying material.
   E. they do not produce seeds.

A person wanted to determine whether bile aided in the digestion of fats. He found that whenever he mixed pancreatic juice with fats a small amount of the fat was digested. But whenever he mixed pancreatic juice and bile with fat, he found that the fat was completely digested. When he mixed bile alone with fat, he found that there was no digestion.

He interpreted this as showing that bile aided in the digestion of fats.

Which of the following statements best describes this interpretation?

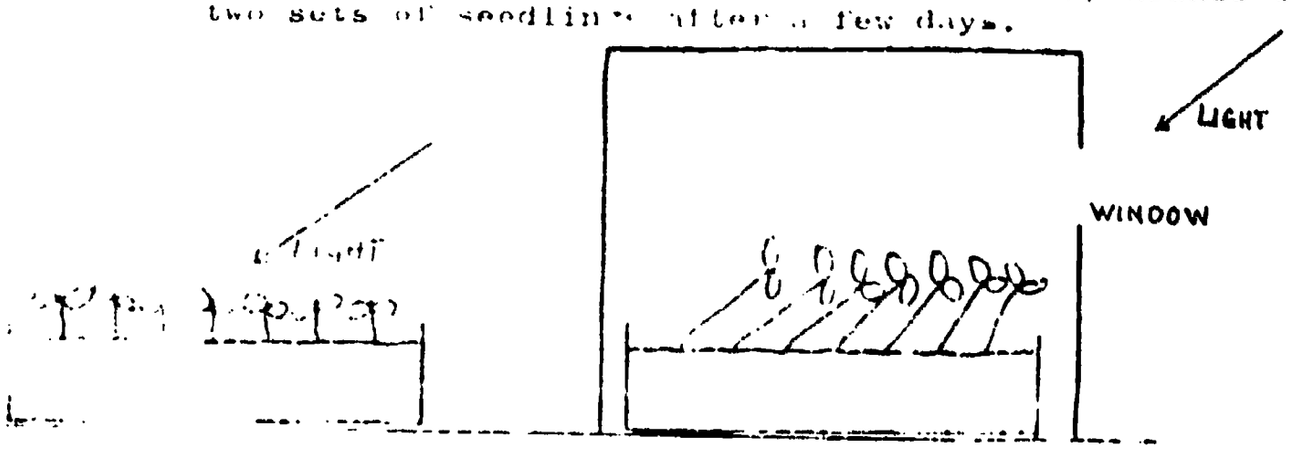
The interpretation is

A. justified.
B. unjustified because it does not answer the question.
C. unjustified because the experiment lacks a control.
D. unjustified because the data are inadequate.
E. unjustified because it is contradicted by the data.

. Why is it that your body temperature does not fall even though you lose heat continually?

A. The blood distributes heat round the body.
B. Respiration results in the liberation of heat.
C. Heat is constantly being absorbed from the sun.
D. Hot meals are eaten regularly.
E. Warm clothes are good insulators.

. Two similar boxes of soil were sown with the same kind of seeds and placed side by side in a greenhouse. One was covered with a light-tight box which had a small "window" cut in one side. The drawings show the appearance of the two sets of seedlings after a few days.



What is the best conclusion from this experiment?

A. The seedlings grow quicker if they are stimulated by light.
B. Seedlings grow towards the light.
C. Seedlings grow quicker in limited light and they bend towards the light.
D. Seedlings illuminated on one side bend towards that side.
E. Light slows down the rate of growth of that part of the stem on which it falls.

7. Fossils very similar in shape to marine shellfish which live in oceans today have been found in the rocks of high mountains. The most likely explanation of this is that

   A. the particular marine shellfish can live in the sea or on land.
   B. marine forms once had organs that enabled them to breathe atmospheric air.
   C. the rocks in which the fossils were found were formed under the sea.
   D. marine forms, in certain cases, migrate on to the land.
   E. marine forms have evolved from land forms.

8. You can be reasonable certain that organs in two different animals are homologous and not merely analogous if both organs

   A. fulfill similar functions but have different names.
   B. excrete metabolic waste.
   C. are used for locomotion.
   D. are called by the same name.
   E. originate from the same part of the embryo.

9. When alcohol is burned in air, water is formed. Another product of the the combustion is a gas which turns lime water cloudy. Consider the following three statements with regard to these two facts.

   Statements.
   I. Carbon is a constituent element of alcohol.
   II. Hydrogen is a constituent element of alcohol.
   III. Oxygen is a constituent element of alcohol.

   Which statement or combination of these statements can be deduced from the two facts given?

   A. I and II.
   B. I, II and III.
   C. I and III.
   D. II and III.
   E. I only.

10. Zinc strips are inserted into each of four beakers containing four different liquids. Each beaker is identified by a single roman numeral.

The following observations were made.

Beaker	Initial Observation	Conductivity before zinc is added
I	no visible reaction	very poor
II	bubbles of a colourless gas form on the zinc strip	good
III	a reddish-brown gas is evolved from the surface of the zinc strip	good
IV	no visible reaction	very poor

On the basis of the evidence given which one of the following is the most reasonable inference?

A. Beakers I and IV contain aqueous solutions of strong acids.
B. Beaker II could contain an aqueous acid.
C. Beaker III could not contain an aqueous acid.
D. Beaker III must contain sulphuric acid, H_2SO_4.
E. Beakers I and IV contain alkalies.

11. **Flour is a fine powder obtained by grinding wheat or other cereal grains. A pile of grain burns only very slowly whereas flour dust suspended in the air is explosive. Which of the following is the best explanation of this?**

A. **The heat produced when small particles burn is greater than the heat produced by the burning of large particles of the same substance.**

B. **Grinding the grain changes its chemical composition.**

C. **For the same quantity of the material small particles have a greater surface area in contact with the air than large particles.**

D. **Small particles possess more energy than large particles.**

E. **The flour burns completely whereas the grain does not.**

12. On a new temperature scale, graduated in degrees N, the reading 0°N corresponds to 0° K and the reading 100° N corresponds to 273° K (the freezing point of water).

If the temperature of a sample of 100 cm^3 of gas were changed from 50°N to 49°N, at constant pressure, its volume would

A. increase to 101 cm^3.
B. decrease to 99 cm^3.
C. increase to 102 cm^3.
D. decrease to 98 cm^3.
E. remain constant

13. A 15.0 millilitre sample of a 1.00 molar solution of HCl will exactly neutralize 7.5 millilitres of a 1.00 molar solution of

A. $NaHCO_3$

B. KOH

C. C_2H_5OH

D. $Ba(OH)_2$

E. $MgCl_2$

14. Chemical equilibrium occurs only when

A. all components stop reacting.
B. the substances initially present have now reacted completely.
C. the substances start reacting.
D. the components decompose at the same rate as they are formed.
E. the concentrations of all the components become equal.

15. Some nitrogen, hydrogen and ammonia reach equilibrium in a stainless steel container at 500°C.

The equilibrium is symbolised by the equation

$$N_2 + 3H_2 \rightleftharpoons 2\ NH_3 + \text{heat}$$

(i.e. reaction to the right is exothermic)

Which of the following is the best description of the effect of now increasing the concentration of hydrogen and allowing a new equilibrium to be reached?

A. There is a decrease in the yield of ammonia but no rise in temperature.
B. The equilibrium concentrations remain the same as in the initial system.
C. There is an increase in the yield of ammonia.
D. There is a rise in temperature.
E. Both C and D are correct.

16. Which one of the following substances does not consist mainly of carbon atoms?

A. Diamond.
B. Graphite.
C. Soot.
D. Ruby.
E. Charcoal.

17. A hydrocarbon is found to contain carbon and hydrogen atoms in the ratio 1 : 2 and to have a molecular weight about 28. Which of the following is the most likely molecular formula of the compound

A. CH_2.
B. CH_2N.
C. C_2H_4.
D. C_3H_6N.
E. C_4H_8.

Atomic weights: H = 1, C = 12, N = 14.

18. An iron container is evacuated and weighed. It is then filled with hydrogen gas and weighed again.

The weight of the container full of hydrogen compared to the weight of the evacuated container is

A. less.
B. greater.
C. the same.
D. greater or less depending on the volume of the gas in the container.
E. greater or less depending on the temperature of the gas in the container.

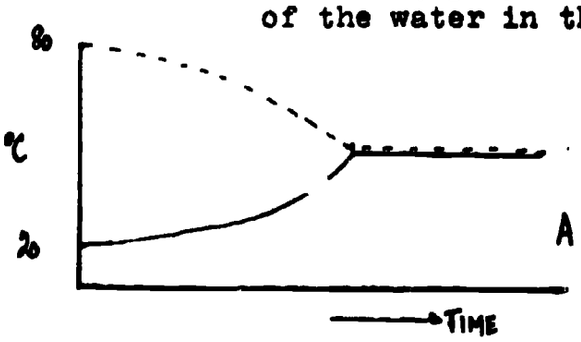
19. A certain force was needed to keep a trolley moving along a horizontal surface at a uniform velocity. This indicates that

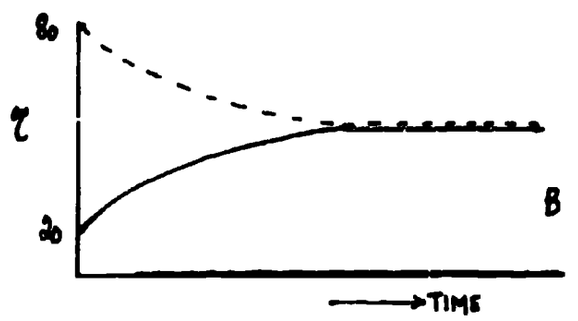
A. the trolley had inertia.
B. the trolley had weight.
C. the friction forces acting on the trolley were equal to the force applied.
D. the friction forces acting on the trolley were not less than the force applied.
E. the trolley had mass.

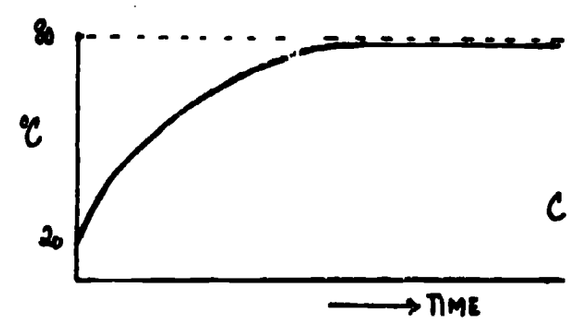
20. A stone is thrown upward at an angle of 45° . At the highest point reached by the stone its

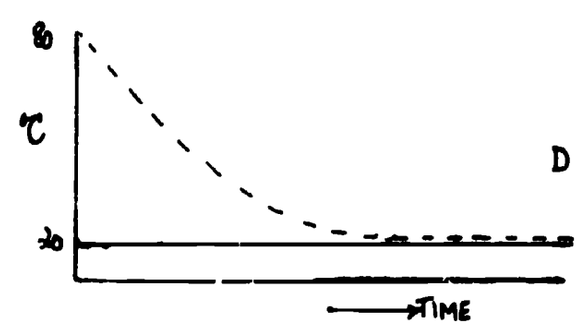
A. acceleration is zero.
B. acceleration is at a minimum, but not zero.
C. total energy is at a maximum.
D. potential energy is at a minimum.
E. kinetic energy is at a minimum.

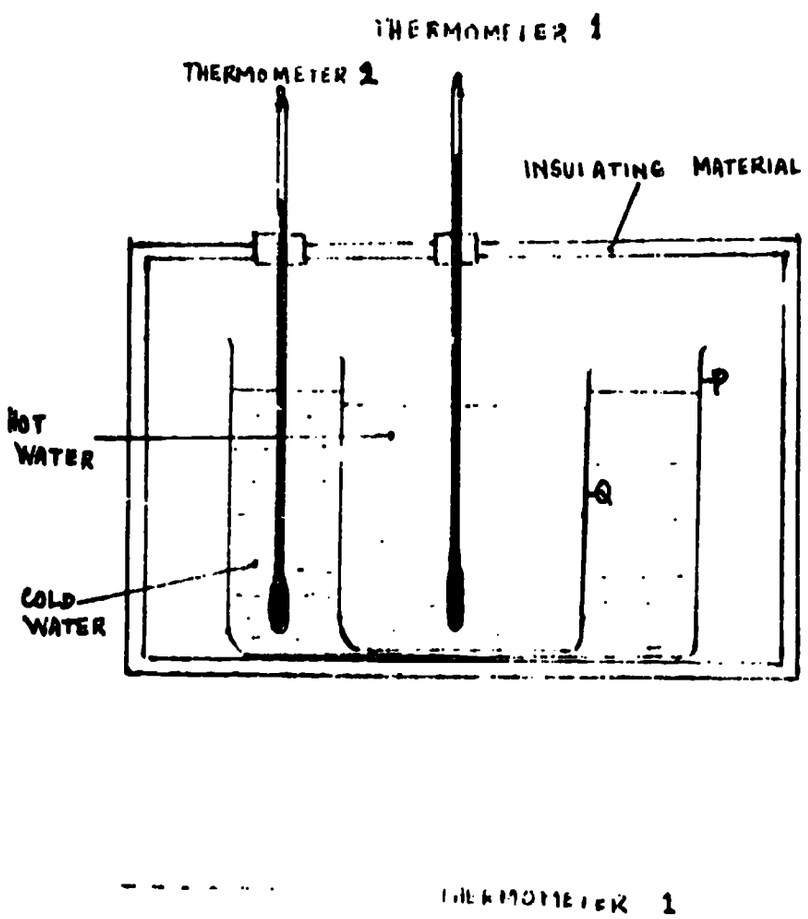
21. Using the apparatus shown in the figure below, 100g of water at 20° C was poured into the outer container 1 and its temperature read at intervals from thermometer 2. At the same time 100g of water at 80° C was poured into the inner container Q and its temperature read at intervals from thermometer 1. Which of the following graphs best represents the changes in the temperatures of the water in the two containers.











. . A one-ton truck coasts from rest down an incline of a vertical height of 50 metres and is braked to a stop at the bottom. Air friction is negligible. In order to estimate the quantity of heat produced by the brakes what additional information is required?

A. The length of the incline.
B. The length and slope (gradient) of the incline.
C. The rise in temperature of the brake surfaces.
D. The average speed of the truck.
E. None of the information in statements A to D is required.

33. A man standing outdoors in the cold sounds an instrument at pitch C. Another man, standing in a warm room, hears the sound. What will be the pitch of the note heard by the man in the room.

A. The note will seem higher in pitch than C.
B. The note will seem lower in pitch than C.
C. The note will sound in the pitch of C.
D. Any of the above, depending on the difference in temperature.
E. Any of the above, depending on the amplitude of the sound.

34. By which one of the following methods can geological time be measured most accurately?

A. Size of fossils.
B. Thicknesses of the layers of sedimentary rocks.
C. Proportion of uranium isotopes in certain rocks.
D. Rate of salt accumulation in the ocean.
E. Temperatures in the mantle of the earth.

National Centers : Set P or Q or R or S or T or U to be entered here.

IEA SIX-SUBJECT SURVEY INSTRUMENTS

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
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	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators

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4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

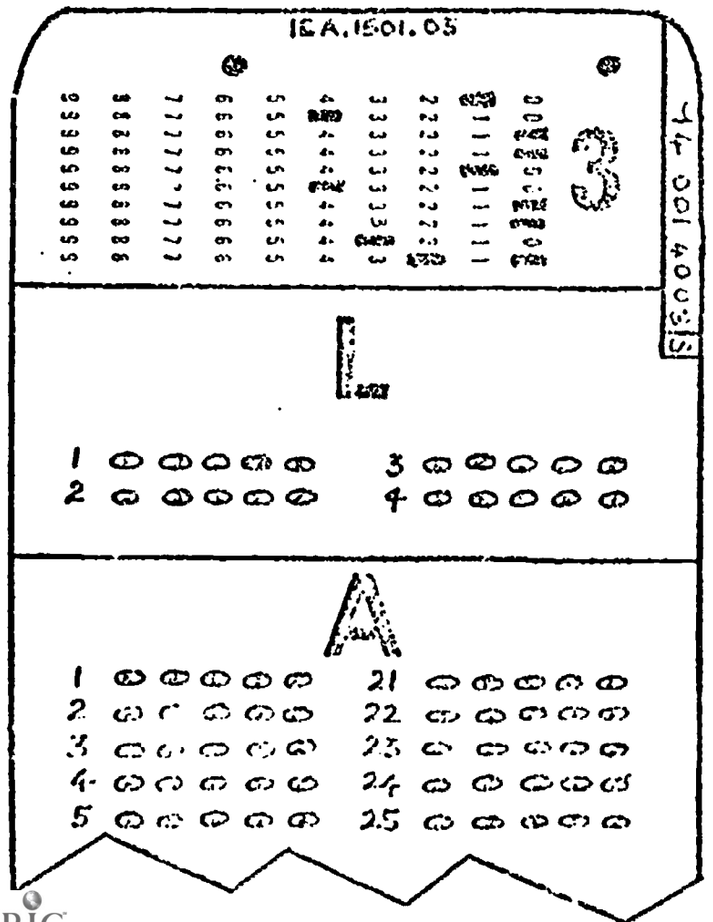
Instrument Name Advanced Science Rotating items, Set P

Data Bank Instrument Number E4SP

Note that six separate booklets were prepared. The first 24 items in each were those found in instrument E4SB, and items 25-30 were those found in instrument E4SP, E4SQ, E4SR, E4SS, E4ST, or E4SU, respectively.

IEA/M3
Pop IV, p. 5-6

"Take out Booklet 11 from your envelope. Also, take out the small envelope of answer cards and remove the yellow answer card No. 3. On the front of Booklet 11 is a letter. It will be either a "P", a "Q", an "R", an "S", a "T" or a "U". Also on your answer card there is a column of letters and numbers at the top right hand edge by the large number 3. The last of these will also be a "P", a "Q", an "R", an "S", a "T" or a "U". Make sure this letter is the same as the one on your test booklet."
(The test administrator should hold up a copy of Booklet 11 and answer card 3 and show where they should match.)



This is the letter that should match the letter on the front of the test booklet.

IEA/M3) continued
Pop IV, p. 5-6)

If any student finds that the answer card does not match the test, then the test administrator should correct the discrepancy by giving him a booklet which matches the letter on his answer card. The student should not be allowed to change answer cards.

Then say:-
"We are now ready to begin Section B. The answers to questions in this section are to be marked in part B on the answer card. Find part B on your answer card."
Indicate Section B on the answer card. Then say:-
"You will have sixty minutes for Section B of the test. Remember do not waste time if you cannot answer a question, but leave it and go on to the next. Are there any questions?"

SCIENCE - TEST 11B Set P

25. What fills the space between the cell wall and the protoplast when a plant cell is plasmolyzed with a salt solution?

A. Water.
B. Air.
C. Salt solution.
D. Ectoplasm.
E. Cell sap.

26. In order to obtain two crops in one growing season a farmer planted some seeds which he had harvested the previous week, but the seeds failed to germinate. What can be concluded from this observation?

A. The farmer did not provide the right conditions for germination.
B. The seeds needed a longer period of maturation.
C. The farmer had not removed inhibiting substances.
D. The seeds required a period of low temperature.
E. The data are inadequate for a conclusion to be reached.

27. What is the change in oxidation number (oxidation state : valency) of manganese in the reaction represented by the equation

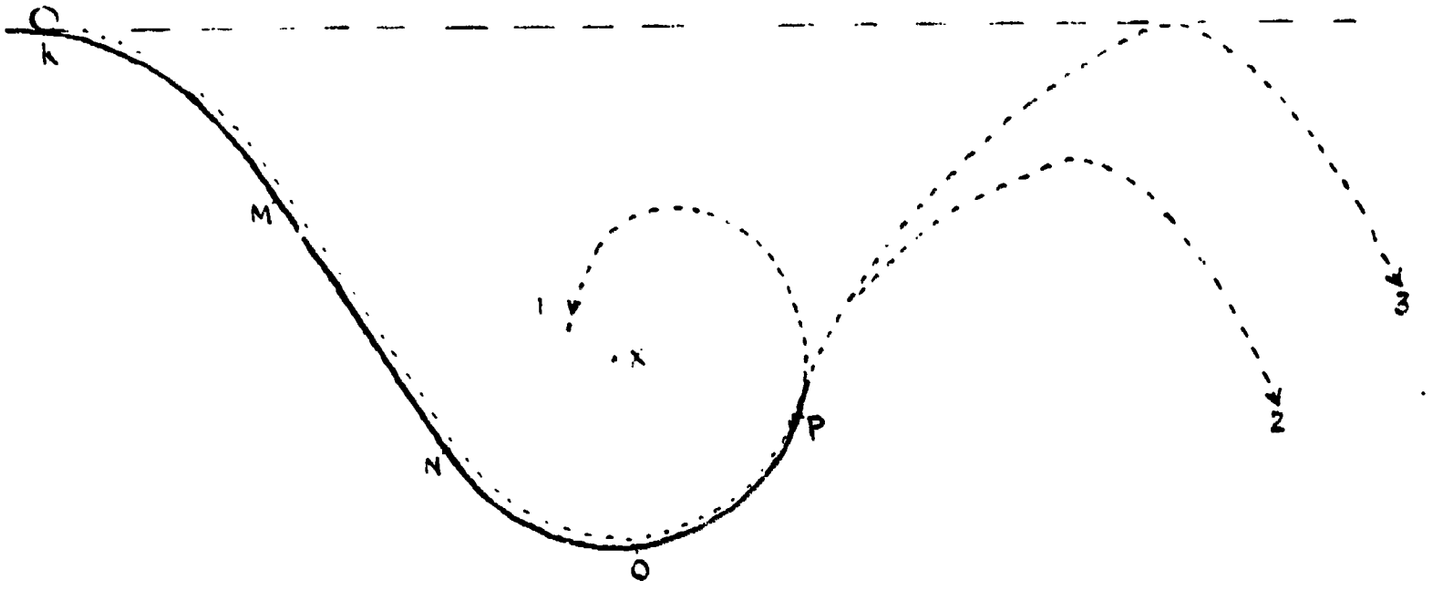
$$MnO_2 + 4\ HCl \longrightarrow MnCl_2 + Cl_2 + 2\ H_2O$$

A. 2.
B. 3.
C. 4.
D. 5.
E. 6.

28. Selenium is the element below sulphur in the periodic table. One would expect selenium to

A. be a metal with a high boiling point.
B. form a potassium oxy-salt of formula K_3SeO_4.
C. burn in air to form an oxide SeO.
D. dissolve in nitric acid to form a salt $Se(NO_3)_4$.
E. form a compound H_2Se which is weakly acidic in aqueous solution.

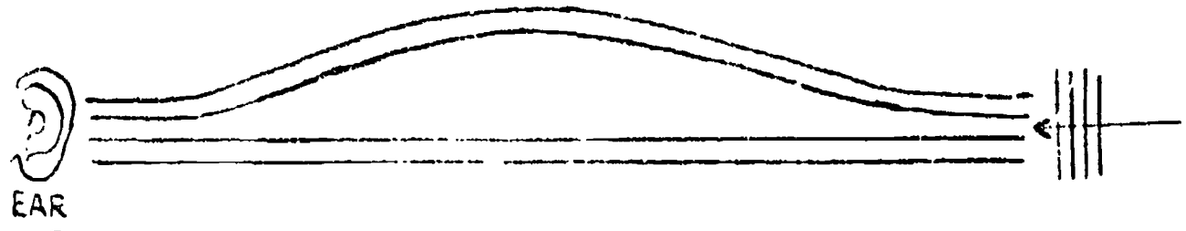
29. A ball was released at the position K on the rail shown in the figure. On the rail the part MN is a straight line, and the part N O P is a circular arc with its center at X. The ball moved along the rail and then went off from the rail at the position P, which is lower than K.



Assuming that the friction between the ball and the rail, the rotation of the ball and the air resistance are all negligible, which one of the alternatives is correct?

A. The ball moved as shown in the curve 1 in the figure running off from the circular path owing to the gravitation.
B. As there is not any resistance, it reached the same height as the point K, but that actual path cannot be determined.
C. As the mechanical energy of the ball changed owing to contact with the rail, it did not reach quite the same height as the point K.
D. As the direction of the ball going off from the point P is inclined to the vertical, it moved as shown in the curve 2 in the figure.
E. As the mechanical energy is conserved, it moved as the curve 3 in the figure.

30. Sound waves 1 m. in length are carried to a man's ear by two rubber tubes. With which of the following combinations of tube-lengths will the man hear no sound?



A. $\frac{2}{4}$ m., $1\frac{1}{4}$ m.
B. $\frac{1}{4}$ m., $\frac{1}{4}$ m.
C. 1 m., $\frac{3}{4}$ m.
D. $1\frac{1}{2}$ m., $\frac{3}{4}$ m.
E. 3 m., 4 m.

IEA SIX-SUBJECT SURVEY INSTRUMENTS

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	IEA/M3	Manual for Test Administrators
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	IEA/M3/Stage 3	Manual for Test Administrators

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2 = All Stage 2 Subjects
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4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Advanced Science Rotating Items, Set Q

Data Bank Instrument Number ESCQ

Note that six separate booklets were prepared. The first 24 items in each were those found in instrument E4SB, and items 25-30 were those found in instrument E4SP, E4SQ, E4SR, E4SS, E4ST, or E4SU, respectively.

IEA/M3
Pop IV, p. 5-6

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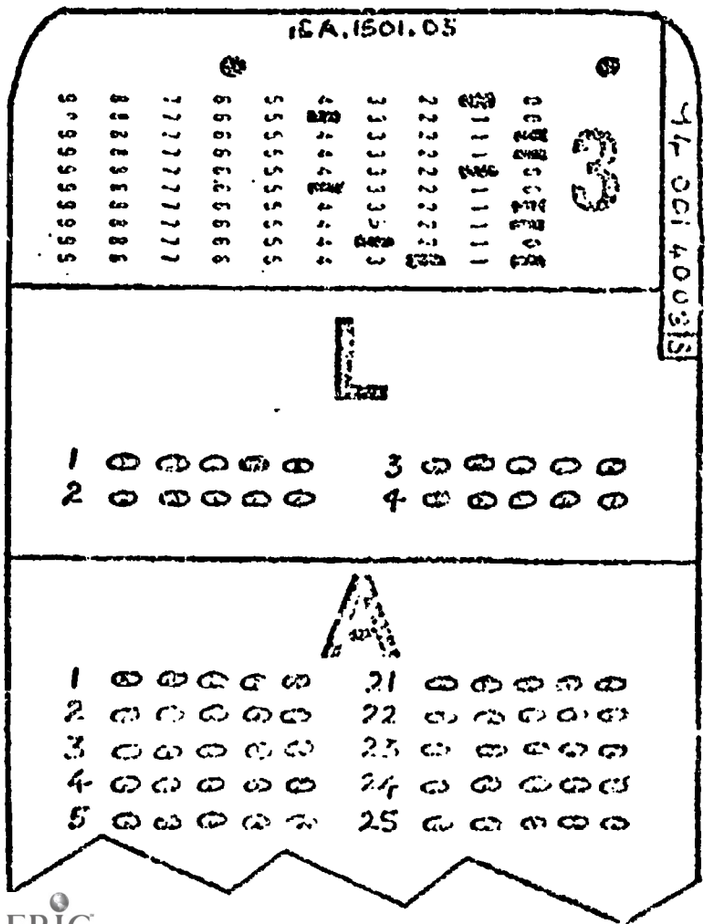

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IEA/M3) continued
Pop IV, p. 5-6)

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Then say:-
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Indicate Section B on the answer card. Then say:-
"You will have sixty minutes for Section B of the test. Remember do not waste time if you cannot answer a question, but leave it and go on to the next. Are there any questions?"

SCIENCE - Test 11B Set Q

25. In many breeds of cattle the polled condition (absence of horns) is dominant over the presence of horns, and homozygous red crossed with homozygous white produces roan (intermingled red and white hairs) colour. Which of the following crosses will produce only horned roan offspring?

A. Polled red x horned white.
B. Horned roan x horned roan.
C. Horned red x horned white.
D. Polled roan x horned roan.
E. Polled white x horned roan.

26. Which of the following does NOT provide evidence of evolution?

A. Green plants can be arranged in order from simple to complex.
B. Embryos of birds, reptiles, and mammals have gill clefts resembling those of a fish embryo.
C. The ancestry of animals like the horse can be traced through the fossil record.
D. The caecum is present in all mammals including man but is only functional in some.
E. The individuals within a species differ considerably one from another.

27. In the periodic table group beginning with nitrogen, which one of the following changes can be noted as the elements are considered in the order of their increasing atomic weight?

A. The elements become more metallic.
B. The elements become less metallic and the heaviest element in the group is non-metallic.
C. The elements have about the same metallic properties.
D. The elements show no trend in their metallic properties, which vary periodically and not by groups.
E. The elements show no trend in their metallic properties because the periodic table gives no guide to metallic and non-metallic properties.

28. When a small speck of lead monoxide was added to a concentrated solution of hydrogen peroxide, the solution became hot and eventually erupted violently. In this process large amounts of oxygen were given off. Which of the following is the best explanation?

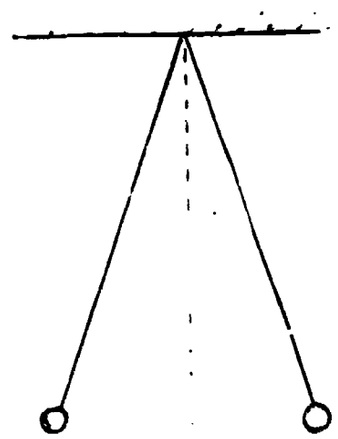
A. The great amount of heat is due to the release of oxygen by the decomposition of lead monoxide; no catalysis is involved.
B. The reaction is catalysed by lead monoxide but unaffected by a rise in temperature.
C. The reaction is not catalysed by lead monoxide but is accelerated by a rise in temperature.
D. The reaction is unaffected by a rise in temperature but catalysed by products.
E. The reaction is catalysed by lead monoxide and accelerated by a rise in temperature.

29. Sound is not an electromagnetic radiation. The best evidence for the truth of the statement is the fact that

A. audible sounds have a wavelength (in air) of about 1 m (about middle E).
B. diffraction effects can be observed.
C. sound can be produced by vibrating solids.
D. sound travels at 330 m/s in air.
E. sound can be refracted.

30. Two electrically charged spheres are suspended from the same point by insulating threads of equal length and repel each other so that the threads make equal angles with the vertical. What can be said of the balls?

A. Their masses and charges are equal.
B. Their masses are equal, the charges may or may not be.
C. Their charges are equal, the masses may or may not be.
D. The ratio of charge to mass is the same for both.
E. The repulsive force on each must be equal to its weight.



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4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Arithmetic and Science - Rotating Items, Set K

Data Bank Instrument Number E4SK

Note that six separate booklets were prepared. The first 24 items in each were those found in instrument E4SB, and items 25-30 were those found in instrument E4SP, E4SQ, E4SR, E4SS, E4ST, or E4SU, respectively.

IEA/M3
Pop IV, p. 5-6

"Take out Booklet 11 from your envelope. Also, take out the small envelope of answer cards and remove the yellow answer card No. 3. On the front of Booklet 11 is a letter. It will be either a "P", a "Q", an "R", an "S", a "T" or a "U". Also on your answer card there is a column of letters and numbers at the top right hand edge by the large number 3. The last of these will also be a "P", a "Q", an "R", an "S", a "T" or a "U". Make sure this letter is the same as the one on your test booklet."
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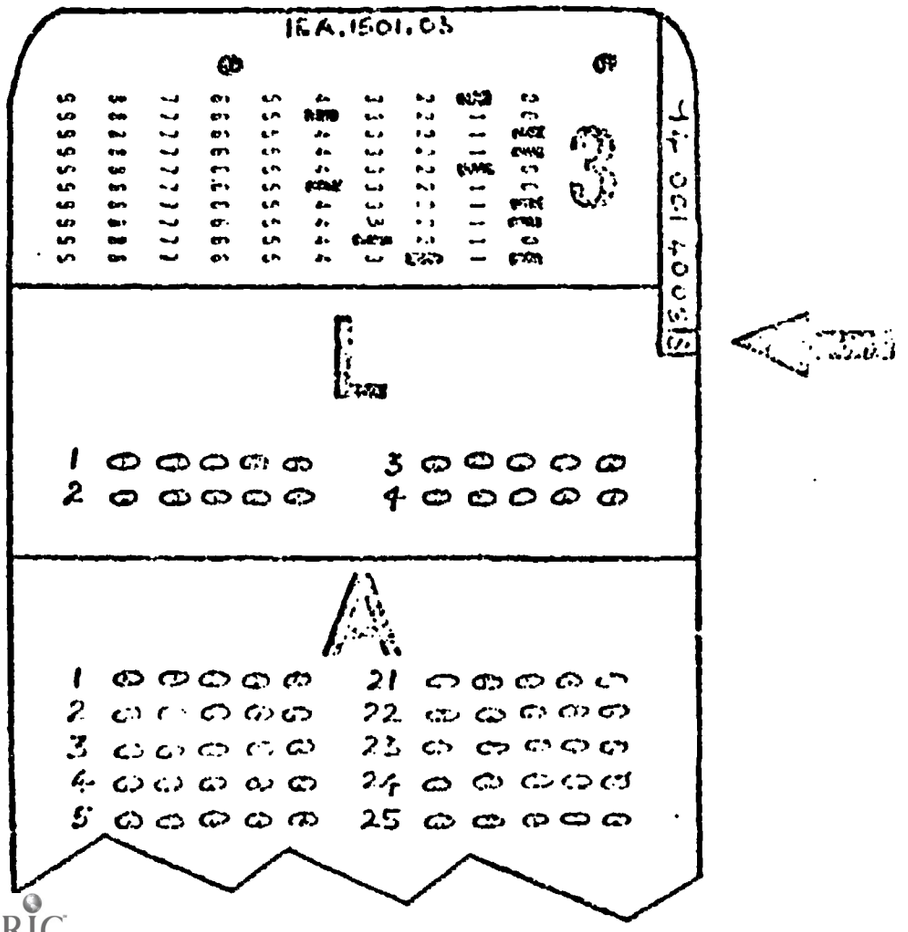

IEA/M3) continued
Pop IV, p. 5-6)

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SCIENCE - TEST 11B Set R

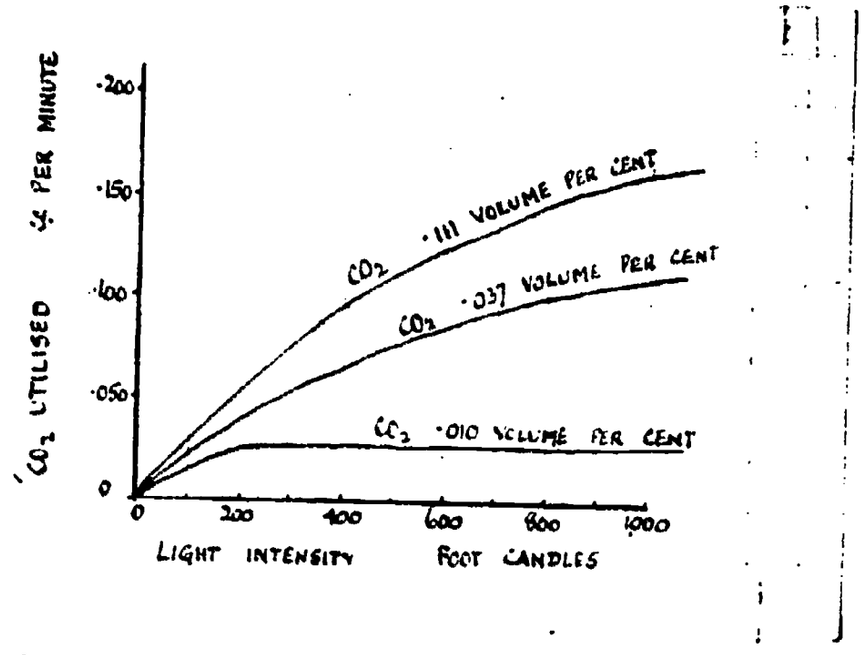
25. What is the minimum weight of NaCl that is needed to prepare 7.1 g of chlorine? (Approximate atomic weights: Na= 23, Cl= 35.5).

A. 5.9 g.
B. 7.1 g.
C. 11.7 g.
D. 12.7 g.
E. 14.2 g.

26. On the basis of the periodic table, which of the following would be described best as an oxide which is only basic?

A. Al_2O_3.
B. CO.
C. P_2O_5.
D. NO_2.
E. CaO.

27. The graph shows the relationships between the carbon-dioxide (CO_2) utilisation by wheat plants, the carbon-dioxide concentration (volume per cent) in the outside air and the light intensity (foot candles) respectively.



It has been stated that the data shown by the graph indicate that one of the factors which limit carbon-dioxide utilisation under the range of conditions covered by the graph is the concentration of carbon-dioxide present in the air. Which of the following is correct?

A. The statement is true according to the graph.
B. The statement is false according to the graph.
C. The statement cannot be judged by the graph but is in accord with an established biological principle.
D. The statement cannot be judged by the graph and is not in accord with an established biological principle.
E. The statement cannot be judged by the graph or by an established biological principle.

[illegible] an electric [illegible] generator [illegible] the motor [illegible] The motor remains [illegible]

[illegible] produced in the [illegible]

[illegible] rotation.

[illegible] that would be set up.

[illegible] motor, some energy would always [illegible]

[illegible] In [illegible] water, the small marine worm [illegible] swells [illegible] oxygen and shrinks again when oxygen is supplied. [illegible] most likely explanation?

A. [illegible] in an incomplete oxidation of [illegible]

B. The [illegible] increases water absorption.

C. Ex[illegible]ous to the organism.

D. When [illegible] available, there is not enough energy to op[illegible]tic entry of water.

E. An increase [illegible] area gives a better means of oxygen [illegible]

3[illegible]. A [illegible] through a stack of three parallel-sided [illegible] different materials. The path of the beam is [illegible] which of the three blocks is the velocity of [illegible]

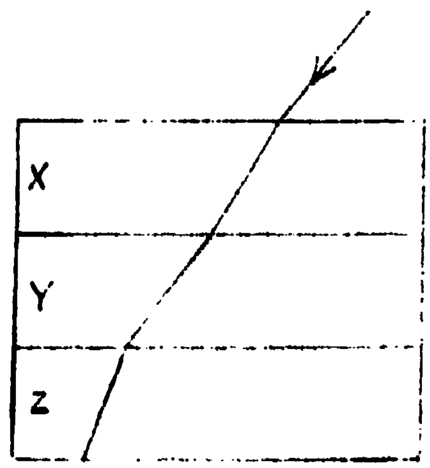
A. X.

B. Y.

C. [illegible]

D. Th[illegible] same in all [illegible]

E. The [illegible] is in[illegible] e to say.



The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
Stage 3	IEA/M1/Stage 3	Manual for National Centers
	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators

These manuals are available from ERIC Clearinghouse.

The following extracts from these manuals have been appended to this particular IEA instrument to provide researchers with the minimum necessary test instruction information (e.g., such things as the instructions on the practice items and the warnings concerning the amount of time left for the test have been omitted here). For full details, please consult the appropriate manuals.

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E = Examination (student)
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1 = I	6 = II and IV
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4 = IV	S = IV Specialist
5 = I and II	N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
F = French as a Foreign Language
C = Civic Education
2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Advanced Science Rotating items, Set S

Data Bank Instrument Number E4SS

Note that six separate booklets were prepared. The first 24 items in each were those found in instrument E4SB, and items 25-30 were those found in instrument E4SP, E4SQ, E4SR, E4SS, E4ST, or E4SU, respectively.

IEA/M3
Pop IV, p. 5-6

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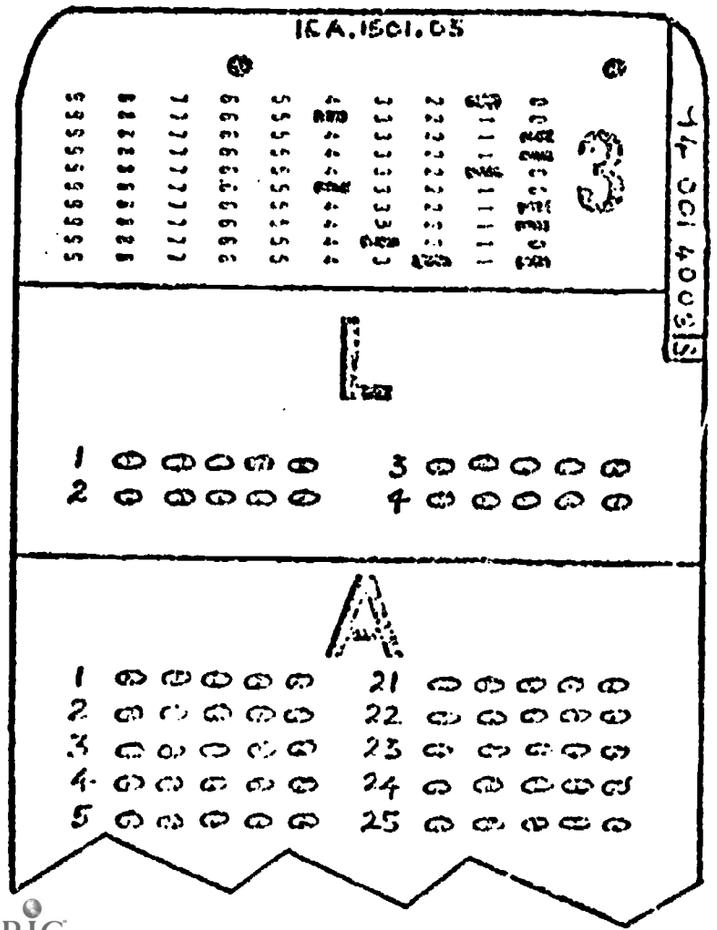

This is the letter that should match the letter on the front of the test booklet.

IEA/M3) continued
Pop IV, p. 5-6)

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Indicate Section B on the answer card. Then say:
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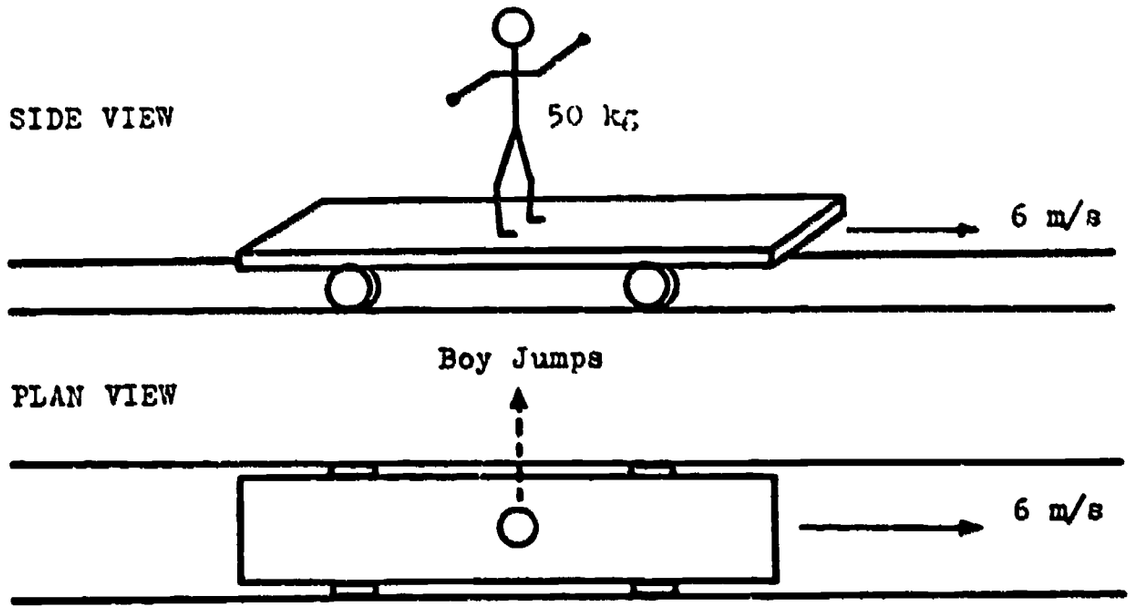
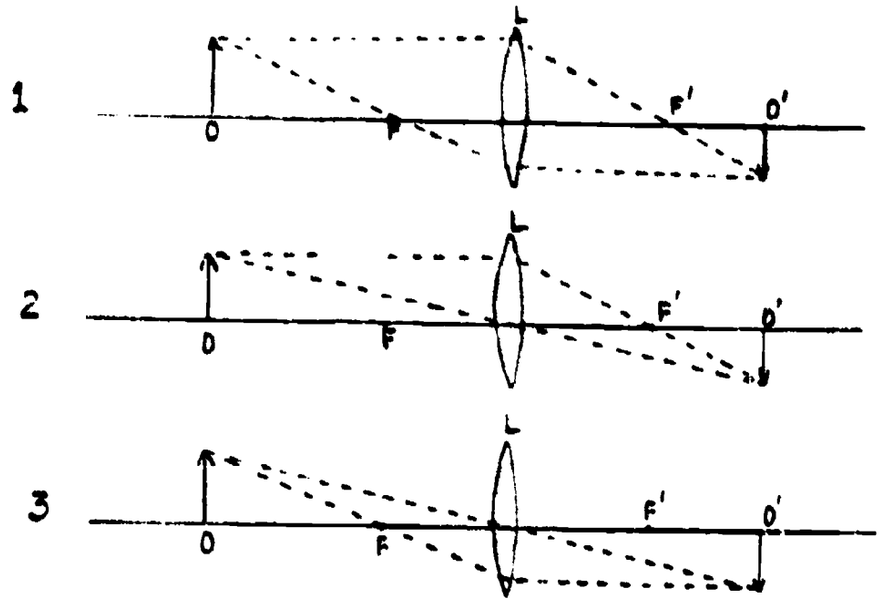
25. A 50 kg boy stands on a trolley of mass 100 kg. The trolley is travelling to the right on rails at a constant speed of 6 m/s.



After the boy jumps sideways off the trolley pushing off at right angles to it, the speed of the trolley is about

A. 3 m/s.
B. 4 m/s.
C. 6 m/s.
D. 9 m/s.
E. 12 m/s.

5. The three figures 1, 2, and 3 give the graphical construction for the image O' of the object O as produced by the thin lens L with foci F and F'.



Which, if any, of these three figures are correct?

A. Figures 2 and 3 are correct.
B. Figures 1 and 3 are correct.
C. Figures 1 and 2 are correct.
D. None of the figures are correct.
E. All three figures are correct.

7. The presence of ions in an aqueous (water) solution of a substance is most directly detected by

A. finding out if it conducts electricity.
B. measuring the density of the solution and comparing it with those of the pure solute and water.
C. seeing if the solution has an electric charge.
D. evaporating the solution and testing the residue for conductivity.
E. adding an ionic substance and seeing if there is a reaction.

8. The electronegativity (electron attracting power) of a given element on Pauling's scale can be estimated from the electronegativities of the neighbouring elements in the periodic table. In estimating the electronegativity of chlorine from those of the elements to the left and right of it in period III, the data mining factor is that, in going to the right in the period

A. chemical reactivity decreases.
B. the number of filled energy levels per atom increases.
C. the van der Waals radius increases.
D. the density decreases.
E. the nuclear charge increases.

[illegible]. X and Y represent two forms of the same moth, a light speckled form and a predominantly dark, or melanic, form.

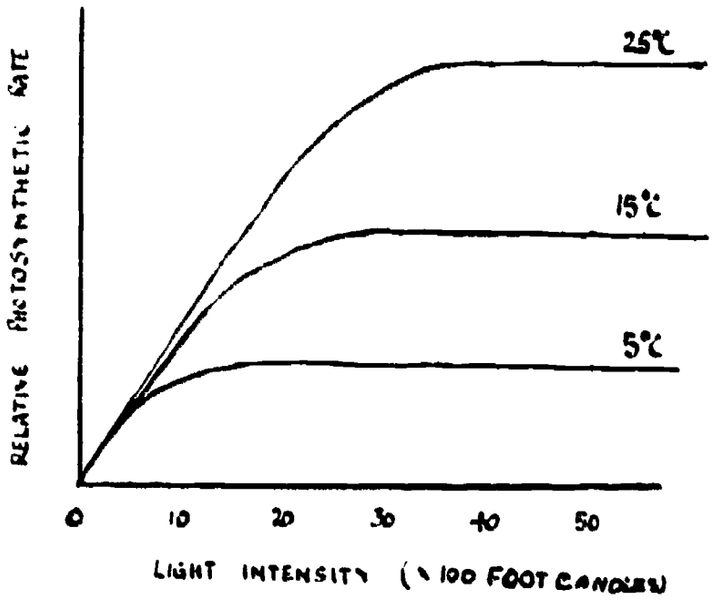
[illegible] some parts of [illegible] polluted with soot [illegible] the [illegible] of coal. [illegible] effect of this [illegible] that [illegible] longer grow on the trunks [illegible] of trees as these became blackened with soot.

[illegible] the only form of this moth that had been recorded was the light form [illegible] 1850 the dark form Y was reported from one of these industrial areas. By the end of the [illegible] century the dark form had become quite common [illegible], the commoner of the two forms, especially in the vicinity of large towns, where it often comprises as much as [illegible] of the total population, [illegible] the light form [illegible] areas away from [illegible] of population.

Which of the following best explains the appearance of the dark specimen in 1850?

A. The colour change was induced by air pollution.
B. The organisms adapted themselves to the change in external environment.
C. Air pollution affected the moths directly after their emergence from the pupal stage.
D. A mutation, that had occurred before but had failed to become established, became established because it was favoured by changed in the external environment.
E. The caterpillars ate soot contaminated leaves and dark moths developed from them.

80. In an experiment with a certain plant, the photosynthetic rate per unit of leaf area was measured at different light intensities. The experiment was repeated at three different temperatures, 5°C, 15°C and 25°C. An adequate supply of carbon-dioxide was maintained throughout the experiments. The graph shows the results.



On the basis of the data given in the graph, what factor or factors determine the photosynthetic rate in light intensities more than 3,000 foot-candles?

A. Light intensity.
B. Temperature.
C. Temperature and light intensity.
D. Water status of plant.
E. No factor can be ascertained from the graph.

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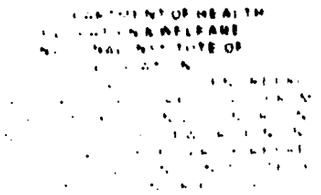

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4-5: Instrument Within Type

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Instrument Name Advanced Science Rotating items, Set T

Data Bank Instrument Number E4ST

Note that six separate booklets were prepared. The first 24 items in each were those found in instrument E4SB, and items 25-30 were those found in instrument E4SP, E4SQ, E4SR, E4SS, E4ST, or E4SU, respectively.

IEA/M3
Pop IV, p. 5-6

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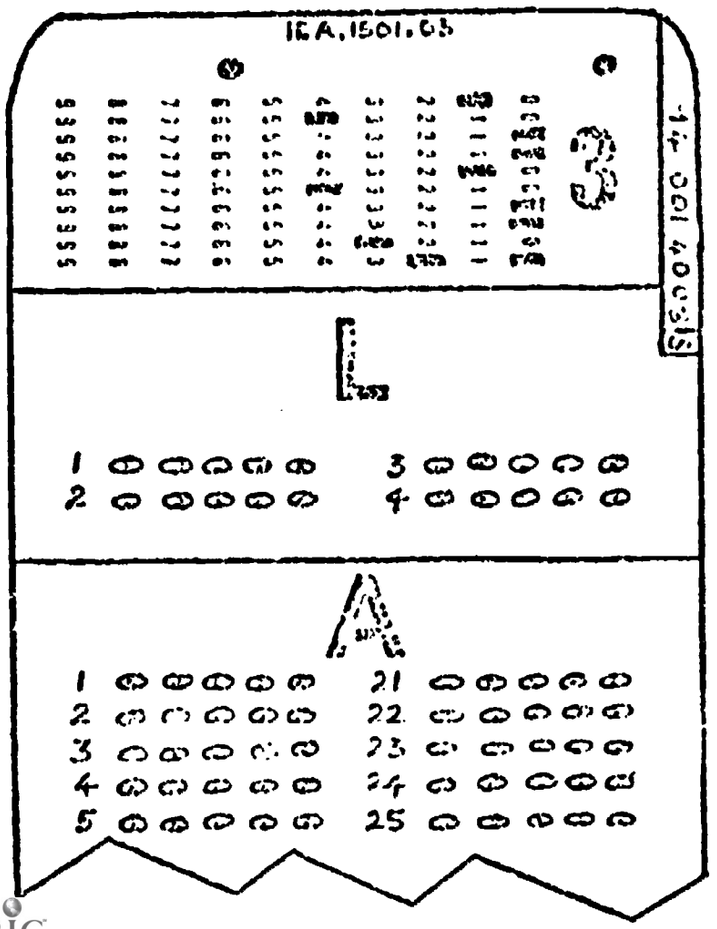

This is the letter that should match the letter on the front of the test booklet.

IEA/M3) continued
Pop IV, p. 5-6)

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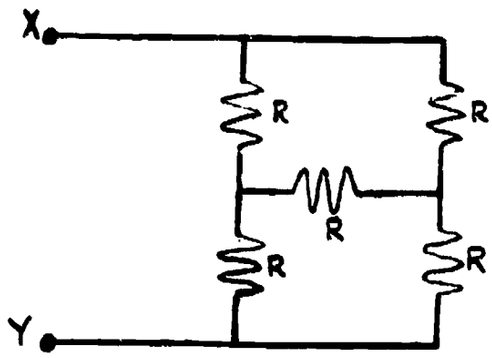
SCIENCE - TEST 11B Set T

25. Each resistor in the diagram has the same resistance R. What resistance will be measured between terminals X and Y?

A. 2R.
B. $\frac{4R}{3}$.
C. R.
D. $\frac{R}{2}$.
E. $\frac{R}{3}$.



26. A jar of oxygen gas and a jar of hydrogen gas are at the same temperature. The molecules of the two gases have on average the same

A. velocity.
B. momentum.
C. force.
D. potential energy.
E. translational kinetic energy.

27. The rate of reaction of two substances X and Y is measured at several concentrations of X and Y as shown in the table.

Rate of reaction millimoles/litre second	12	36	24
Concentration of X moles/litre	5	15	10
Concentration of Y moles/litre	5	5	10

The rate of reaction is

A. proportional to the concentration of X but independent of the concentration of Y.
B. proportional to the concentration of X and Y.
C. proportional to the concentration of Y but independent of the concentration of X.
D. dependent on the concentrations of X and Y but not satisfactorily expressed in A, B or C.
E. dependent on some unspecified factors other than concentration.

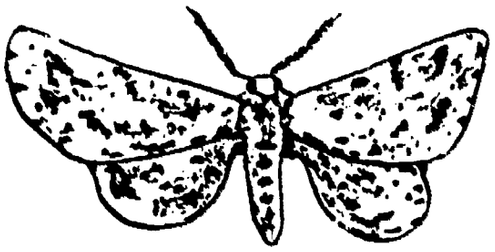
5. Which of the following best describes the egg cell in the embryo sac of a plant?

A. It is formed by mitosis.
B. It gives rise to the endosperm.
C. It is analogous to a pollen grain.
D. It is a zygote.
E. It is a female gamete.

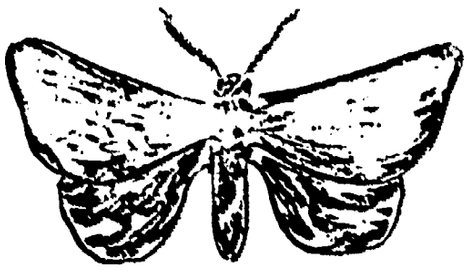
6. Which one of the following formulae represents a substance which you would NOT expect to exist under normal laboratory conditions?

A. NaH.
B. H_2S.
C. SiO_2.
D. $AlCl_3$.
E. O_3.

30. X and Y represent two forms of the same moth, a light speckled form and a predominantly dark, or melanic, form.



X



Y

During the 19th century the air in some parts of England became increasingly polluted with soot through the growth of industry based on the buring of coal. One effect of this pollution was that lichens would no longer grow on the trunks and branches of trees as these became blackened with soot.

Until 1850 the only form of this moth that had been recorded was the light form X. Then in 1850 the dark form Y was reported from one of these industrial areas. By the end of the 19th century the dark form had become quite common and now it is, in many localities, the commoner of the two forms, especially in the vicinity of large towns, where it often comprises as much as 95% of the total population, although the light form predominates in areas away from large centres of population.

The papagraph describes a case of evolution through

A. sexual selection.
B. natural selection.
C. intra-specific competition.
D. geographical isolation.
E. the inheritance of acquired characters.

IEA SIX-SUBJECT SURVEY INSTRUMENTS

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4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Advanced Science Rotating items, Set U

Data Bank Instrument Number E4SU

Note that six separate booklets we prepared. The first 24 items in each were those found in instrument E4SB, and items 25-30 were those found in instrument E4SP, E4SQ, E4SR, E4SS, E4ST, or E4SU, respectively.

IEA/M3
Pop IV, p. 5-6

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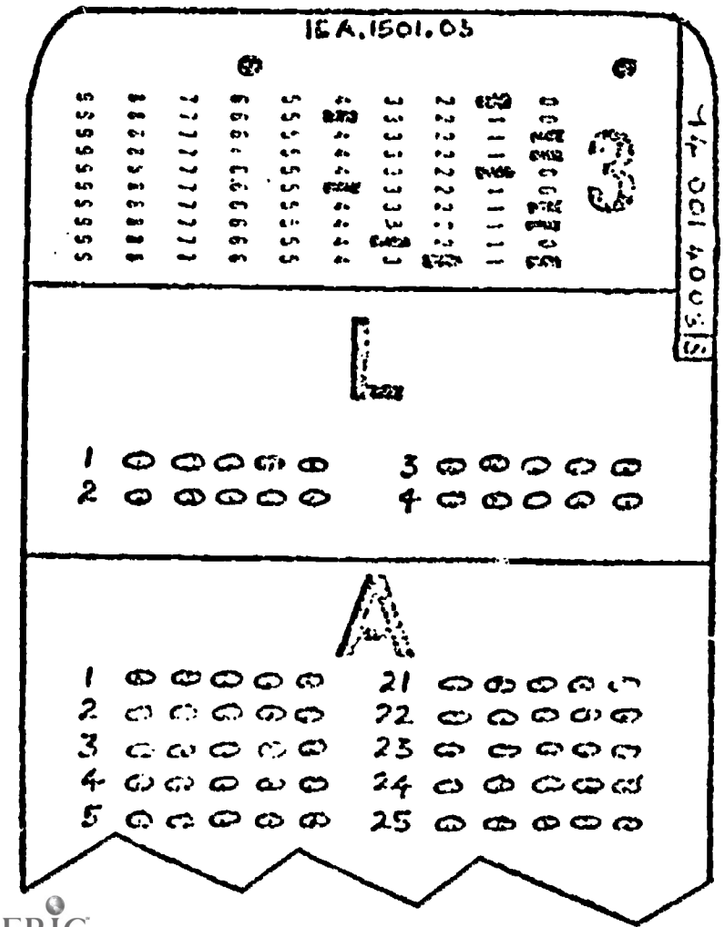

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Then say:-

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Indicate Section B on the answer card. Then say:-

"You will have sixty minutes for Section B of the test. Remember do not waste time if you cannot answer a question, but leave it and go on to the next. Are there any questions?"

SCIENCE - TEST 11B Set U

25. If a photon collides with a free electron

A. energy is conserved; momentum is not.
B. momentum is conserved; energy is not.
C. both energy and momentum are conserved.
D. neither energy nor momentum need be conserved.
E. momentum is conserved; the nature of the collision determines whether energy is conserved.

26. If, in an imaginary situation, a 1 kg block of ice at 0°C is dropped from such a height that all of it is melted by the heat generated on impact with the ground, from what height would a 25 kg block of ice have to be dropped to melt completely, assuming that in both cases all of the heat is absorbed by the ice?

A. 25 times as high.
B. 5 times as high.
C. 1/5 as high.
D. 1/25 as high.
E. The same height.

27. A student wishes to see how temperature affects the solubility of a salt in water. His method is as follows:

He shakes an excess of the salt with water at a known temperature until no more appears to dissolve. He then filters to obtain a clear solution. After weighing a portion of this solution, he evaporates the water and weighs the dry salt. He then repeats the procedure at the same temperature as a check before proceeding to another temperature.

Which of the following is apt to cause the greatest error during determination of the solubility at a given temperature.

A. Allowing solution temperature to change prior to filtration.
B. Allowing solution temperature to change during evaporation.
C. Allowing solution temperature to change at any time during the procedure.
D. Not using the same size of salt crystals in the check determinations.
E. Not adding the same excess of salt in the check determinations.

28. The maintenance of a constant body temperature in man involves a balance between production of heat and loss of heat. Which of the factors given below least affects this balance?

A. The circulation of the blood.
B. Evaporation of water from the body surfaces.
C. Muscular contraction.
D. Dilation of blood vessels in the skin.
E. The heating of cold air in the lungs.

29. A compound X, of the formula C_3H_8O, on partial oxidation gives C_3H_6O. From this information, X is most likely to be

A. an alkanal (aldehyde).
B. a tertiary alkanol (alcohol).
C. an alkene (olefin).
D. a secondary alkanol (alcohol).
E. an ether

30. Some organisms are difficult to classify as plants or animals because they are

A. decomposers.
B. capable of acting as both producers and consumers.
C. microscopic and thus too difficult to study.
D. able to build up complex foods, by making use of light energy.
E. producers.

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Stage 3	IEA/M1/Stage 3	Manual for National Centers
	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators

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E = Examination (student)
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T = Teacher questionnaire
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1 = I	6 = II and IV
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3 = III	8 = I and IV
4 = IV	S = IV Specialist
5 = I and II	N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
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4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Specialist Biology

Data Bank Instrument Number ESSB

One hour was allowed for this exam

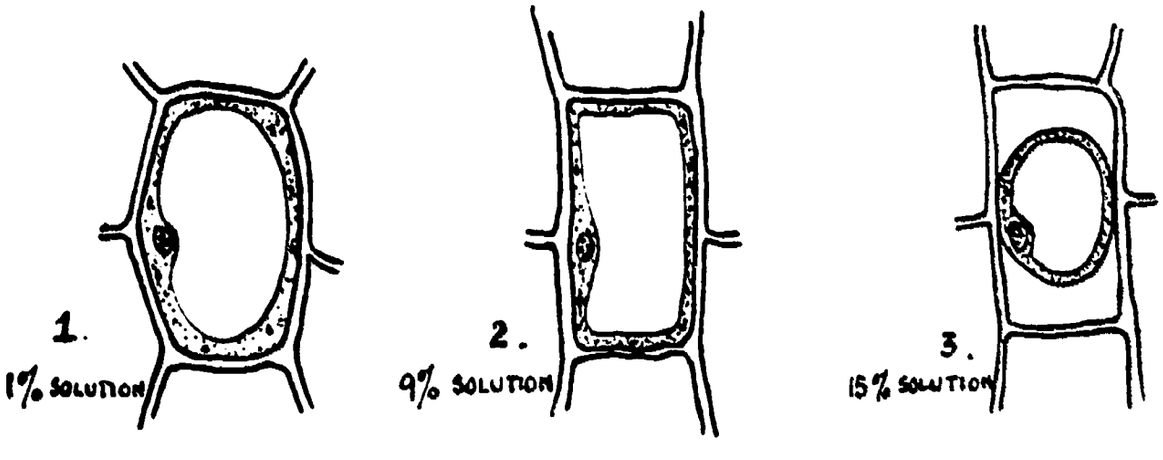
NATIONAL OPTION BIOLOGY

1. In which of the following mature cell types are nuclei typically present?

   A. Mammalian erythrocytes.
   B. Stomatal guard cells.
   C. Tracheids.
   D. Bacterial cells.
   E. Sieve tube elements.

Questions 2, 3, 4 and 5 refer to the following statement and the accompanying diagrams.

Similar fragments of a certain plant tissue were placed in 1%, 9% and 15% sugar solutions respectively. When viewed under the microscope after they had reached equilibrium with the bathing solution, single cells appeared as shown in the diagrams for the three solutions.



[illegible] (Y).

[illegible]

4. Which of the three cells shown has the highest turgor pressure?

   A. 1.
   B. 2.
   C. 3.
   D. It is the same for all three.
   E. It is impossible to say.

5. What fills the space between the cell wall and the protoplast when a plant cell is plasmolyzed with a salt solution?

   A. Water.
   B. Air.
   C. Salt solution.
   D. Ectoplasm.
   E. Cell sap.

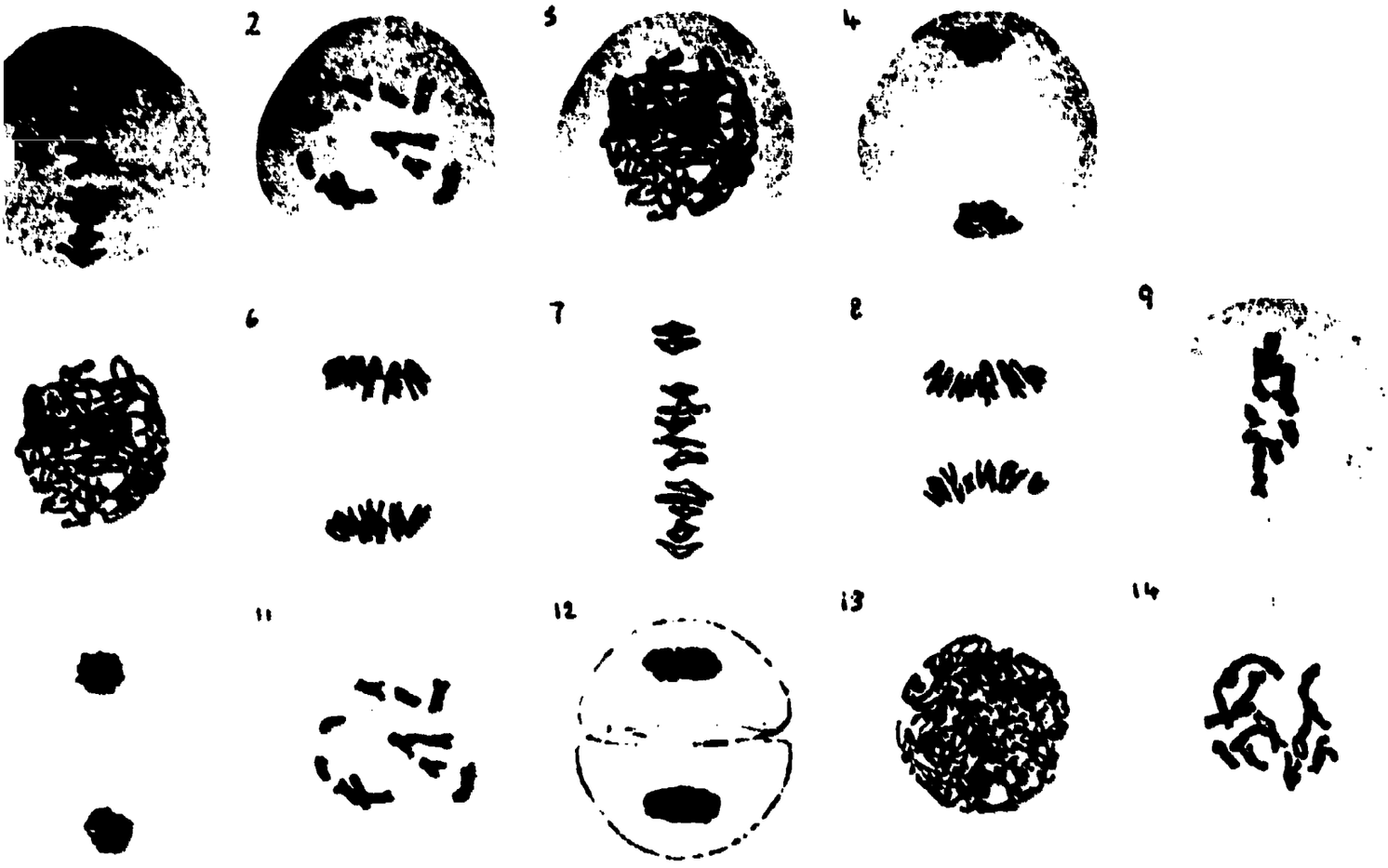
6. In a certain species each of two gene pairs is located on a different chromosome. For each pair, the gene may exist in either of its two allelic forms, one of which is completely dominant over the other. In which of the following crosses would all the offspring be of the same phenotype?

   A. Individuals both heterozygous for the two gene pairs.
   B. Individuals both heterozygous for one and the same gene pair, and homozygous recessive for the other pair.
   C. An individual heterozygous for both gene pairs, and an individual homozygous recessive for both pairs.
   D. An individual heterozygous for one gene pair and homozygous dominant for the other pair, and an individual homozygous recessive for both pairs.
   E. An individual homozygous dominant for both gene pairs and an individual heterozygous for both pairs.

7. In many breeds of cattle the polled condition (absence of horns) is dominant over the presence of horns, and homozygous red crossed with homozygous white produces roan (intermingled red and white hairs) colour. Which of the following crosses will produce only horned roan offspring?

   A. Polled red x horned white.
   B. Horned roan x horned roan.
   C. Horned red x horned white.
   D. Polled roan x horned roan.
   E. Polled white x horned roan.

Items 8, 9 and 10 refer to the following photomicrographs of dividing cells from an anther taken from a flower bud, and stained to show chromosomes. Some of the stages are duplicated.



8. When the photomicrographs are arranged in the order in which the events they depict occur, which of the following processes do they illustrate?

   A. Fusion of nuclei in fertilization.
   B. Meiosis.
   C. Mitosis.
   D. Zygote formation.
   E. Binary fission.

9. Number the photomicrographs in their most probable order and then select from the choices below the one that corresponds most nearly to yours. Bear in mind that some of the stages are duplicated.

   A. 3, 4, 8, 7, 11, 12, 13, 7, 9, 6, 1.
   B. 13, 9, 12, 4, 10, 6, 8, 7, 3, 2, 1.
   C. 1, 7, 8, 6, 9, 14, 2, 5, 13, 9, 4.
   D. 13, 9, 14, 11, 4, 1, 7, 7, 4, 10, 12.
   E. 9, 10, 7, 8, 7, 11, 1, 13, 3, 2, 1.

...hat is the probable haploid number of chromosomes for this plant?

A. 21.
B. 10.
C. 15.
D. 30.
E. 20.

11. All the offspring from a hooded/hooded x white/white cross in rats are found to be hooded. If these F_1 hooded rats are mated together and produce litters totalling 50 rats, which of the following proportions is most likely?

A. 50 hooded : nil white.
B. 50 white : nil hooded.
C. 38 white : 12 hooded.
D. 24 white : 26 hooded.
E. 10 white : 40 hooded.

12. In a living plant cell chlorophyll absorbs light and as a result

A. carbon dioxide is fixed into phosphoglyceric acid.
B. carbohydrates are formed
C. ATP is converted into ADP.
D. ADP is converted into ATP and hydrogen is released from water.
E. oxygen is released from CO_2.

13. In slightly diluted sea water, the small marine worm Gunda swells when deprived of oxygen and shrinks again when oxygen is supplied. What is the most likely explanation?

A. Lack of oxygen results in an incomplete oxidation of waste products.
B. The lack of oxygen increases water absorption.
C. Excess water is poisonous to the organism.
D. When less oxygen is available, there is not enough energy to oppose osmotic entry of water.
E. An increase of surface area gives a better means of oxygen absorption.

14. Grazing beef cattle utilise only about 1/7th of the plant food they eat. The intensive rearing of animals in buildings can improve greatly on this. Which of the following factors is <u>least</u> likely to affect this?

A. Competition for food by other animals is prevented.
B. The animals receive less light.
C. There is less loss of body weight.
D. Less energy is used in movement.
E. Special additions can be made to the diet.

15. Which of the following would be the best way of testing the hypothesis that two given enzymes affect the rate of a certain reaction?

A. Try the reaction with a mixture of the enzymes at different temperatures.
B. Purify the enzymes and then try them out on the reaction.
C. Try the enzymes separately and together on the reaction.
D. Try inhibiting one enzyme by dialysis.
E. Try mixtures of the enzymes in different proportions on the reaction.

16. Secretions of endocrine organs are not directly responsible for

A. calcium metabolism.
B. secretion by the adrenal cortex.
C. changes in the uterine lining.
D. changes of body temperature.
E. general body growth.

17. Cobalt chloride paper is blue when dry. It gradually changes colour to pink in the presence of water vapour. Three 1 cm square dry cobalt chloride papers were treated as follows:

The first was fastened to the upper surface of a leaf by means of a clip, the second to the lower surface in a similar way, and the third hung free in the air. The time taken for the papers to achieve a standard pink colour was noted. The first took 9 minutes, the second 10.5 minutes, the third 18.0 minutes.

Which of the following conclusions is justified on this evidence alone?

A. There are more stomata on the lower surface of the leaf than on the upper.
B. No water vapour is given off from the lower surface of the leaf.
C. The upper leaf surface gives off more water vapour than the lower.
D. Both leaf surfaces give off water vapour at the same rate.
E. There are no stomata on the upper surface of the leaf.

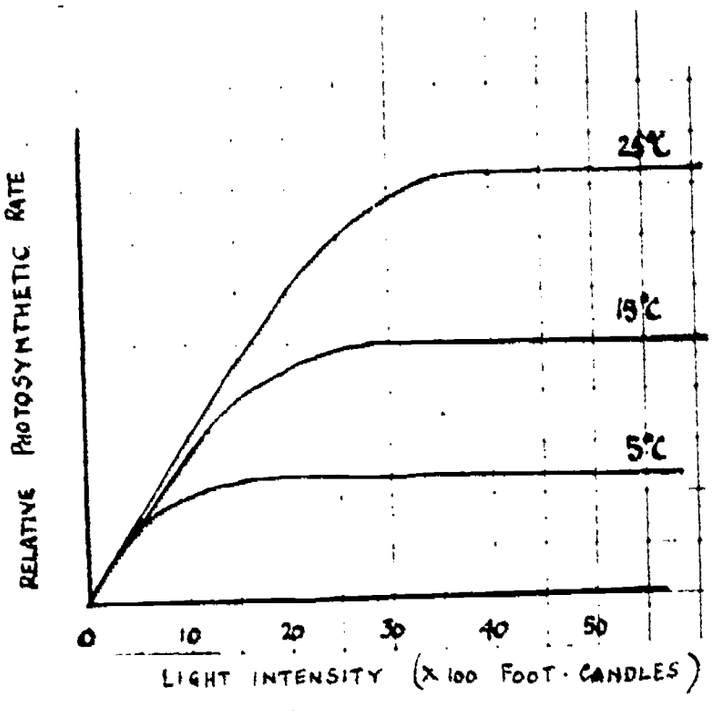
18. The maintenance of a constant body temperature in man involves a balance between production of heat and loss of heat. Which of the factors given below <u>least</u> affects this balance?

A. The circulation of the blood.
B. Evaporation of water from the body surfaces.
C. Muscular contraction.
D. Dilation of blood vessels in the skin.
E. The heating of cold air in the lungs.

19. Lymph is forced into the tissues by

A. blood pressure.
B. the action of the liver.
C. intestinal villi.
D. the action of the kidney.
E. a diffusion gradient.

20. In an experiment with a certain plant, the photosynthetic rate per unit of leaf area was measured at different light intensities. The experiment was repeated at three different temperatures, 5°C, 15°C and 25°C. An adequate supply of carbon dioxide was maintained throughout the experiments. The graph shows the results.



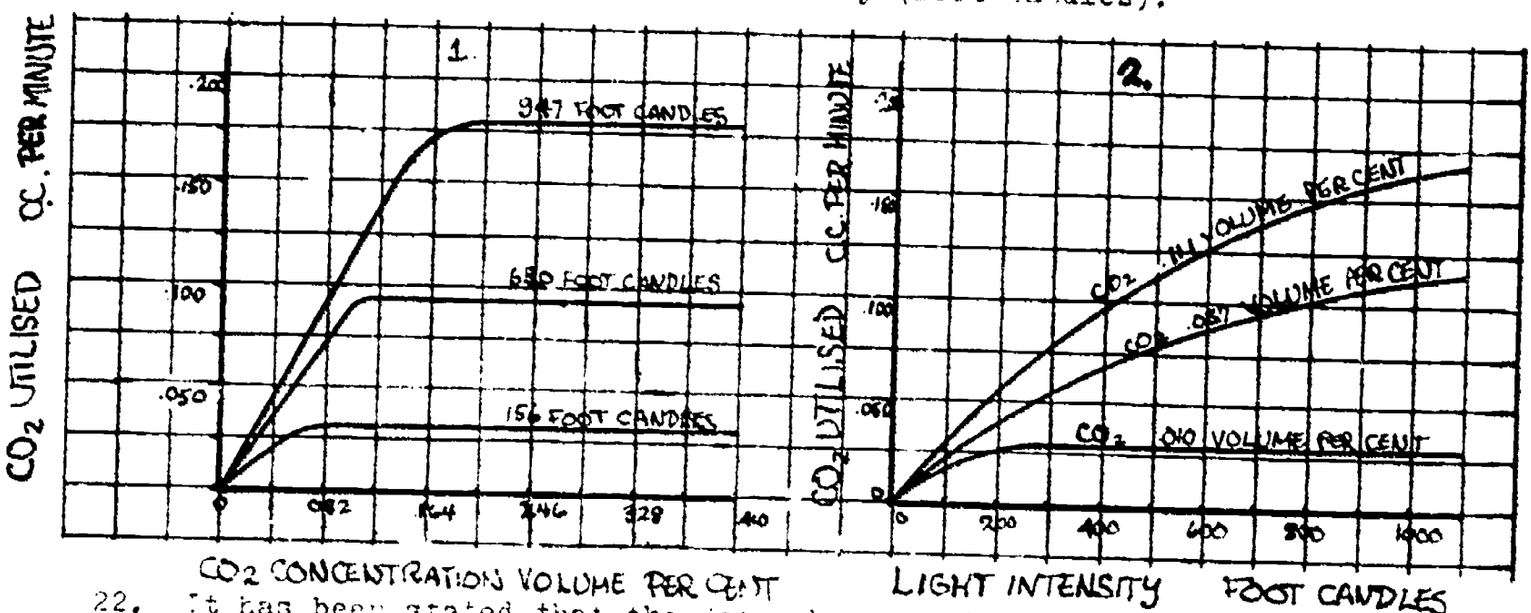
On the basis of the data given in the graph, what factor or factors determine the photosynthetic rate at light intensities more than [illegible] foot-candles?

. light intensity.
. temperature.
. temperature and light intensity.
. water status of plant.
. [illegible] given in the graph.

21. Two students carried out the following procedure to find out whether they were of the same A.B.O. blood type. Each drew a small sample of blood; the samples were diluted with physiological salt solution and then mixed. Observations under a microscope showed no clumping of the corpuscles. The students came to the conclusion that they were of the same blood type. Which of the following is the best comment on their conclusion?

A. The conclusion is wrong.
B. The conclusion is not in agreement with the facts of the experiment.
C. There are not enough facts revealed by the experiment to make the conclusion valid.
D. Owing to the employment of poor experimental techniques, the observations prompted a conclusion in disagreement with accepted biological science.
E. The conclusion is justified.

Questions 22,23,24 and 25 refer to the following graphs, which show the relationships between the carbon dioxide (CO_2) utilisation by wheat plants, the carbon dioxide concentration (volume per cent) in the outside air and the light intensity (foot candles).



22. It has been stated that the data shown in fig. 2 indicate that **one of the factors which limit** carbon-dioxide utilisation under the range of conditions covered by the graph, is the concentration of carbon-dioxide present in the air.
Which of the following is correct?

A. The statement is true according to the graph.
B. The statement is false according to the graph.
C. The statement can not be judged by the graph but is in accordance with an established biological principle.
D. The statement can not be judged by the graph and is not in accordance with an established biological principle.
E. The statement can not be judged by the graph or by an established biological principle.

[illegible]. It has also been stated that fig. 1 shows that if the amount of carbon dioxide is decreased from .1% by volume and the light intensity held constant, there is an increase in carbon [illegible].
Which of the following is correct?

A. The statement is true according to the graph.
B. The statement is false according to the graph.
C. The statement cannot be judged by the graph but is in accord with an established biological principle.
D. The statement cannot be judged by the graph and is not in accord with an established biological principle.
E. The statement cannot be judged by the graph or by an established biological principle.

24. The carbon dioxide content of the layer of air next to the wheat in a cornfield on a clear warm summer day will be less than on a still warm night.
Which of the following is correct?

A. The statement is true according to the graphs.
B. The statement is false according to the graphs.
C. The statement cannot be judged completely by the graphs but is in accord with an established biological principle.
D. The statement cannot be judged completely by the graphs and is not in accord with an established biological principle.
E. The statement cannot be judged completely by the graphs or by an established biological principle.

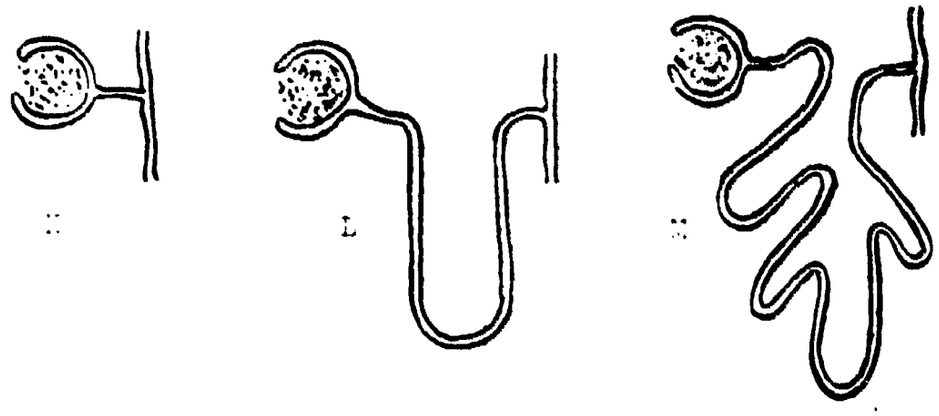
25. The carbon dioxide content of the air is approximately 0.03% by volume. The light intensity at noon on a clear summer day is in the neighbourhood of 8,000 to 10,000 foot candles. On the basis of the data given in fig. 1, will the rate of carbon dioxide utilisation be limited on a warm clear summer day by the carbon dioxide content of the air rather than the intensity of the light?
Which of the following answers to this question is correct?

A. Yes. The data make this quite clear.
B. No. The data show this is not true.
C. It can not be determined from the data given, but is in accord with an established biological principle.
D. It can not be determined from the data given and is not in accord with an established biological principle.
E. It cannot be determined from the data given or by an established biological principle.

26. Which one of the following is not controlled by hormones?

A. Water rise in the stem.
B. Outward growth of the radicle.
C. Flower formation under the influence of increasing day length.
D. Falling of the leaves of deciduous trees in autumn.
E. Bending of shoots towards lateral light.

Questions 27 and 28 refer to the following. The primary function of a kidney tubule is to reabsorb water. The diagrams show three types of kidney tubules (nephrons).



27. Which kidney tubule (nephron) is most likely to occur in a desert animal?

A. K.
B. L.
C. M.
D. It is impossible to say.
E. It will depend upon whether the animal is a herbivore or a carnivore.

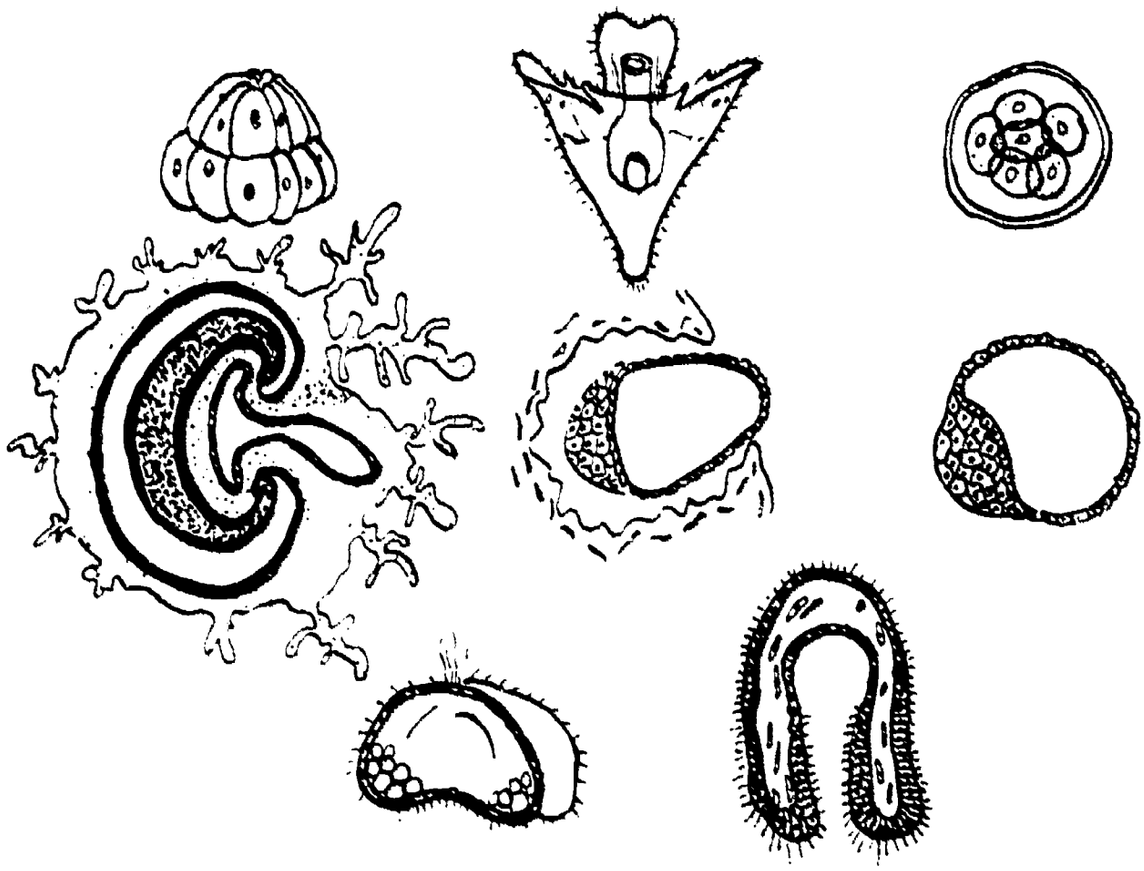
28. Which kidney tubule (nephron) is most likely to occur in fresh-water animals?

A. K.
B. L.
C. M.
D. It is impossible to say.
E. It will depend upon whether the animal is cold-blooded or warm-blooded.

29. Which of the following best describes the egg cell in the embryo sac of a plant?

A. It is formed by mitosis.
B. It gives rise to the endosperm.
C. It is analogous to a pollen grain.
D. It is a zygote.
E. It is a female gamete.

30. The diagrams show the external appearance or sections of embryonic stages of two kinds of animals. Which two kinds are they?



A. Amphibia and reptiles.
B. Echinoderms and mammals.
C. Fish and mammals.
D. Coelenterates and birds.
E. Insects and birds.

31. In order to obtain two crops in one growing season a farmer planted some seeds which he had harvested the previous week but the seeds failed to germinate. What can be concluded from this observation?

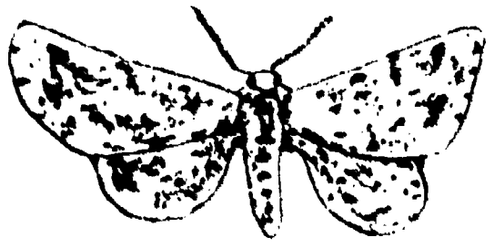
A. The farmer did not provide the right conditions for germination.
B. The seeds needed a longer period of maturation.
C. The farmer had not removed inhibiting substances.
D. The seeds required a period of low temperature.
E. The data are inadequate for a conclusion to be reached.

32. Some organisms are difficult to classify as plants or animals because they are

A. decomposers.
B. capable of acting as both producers and consumers.
C. microscopic and thus too difficult to study.
D. able to build up complex foods, by making use of light energy.
E. producers.

Questions 33, 34, 35 and 36 refer to the following drawing and the descriptive paragraph.

X and Y represent two forms of the same moth, a light speckled form and a predominantly dark, or melanic, form.



X

Y

During the 19th century the air in some parts of England became increasingly polluted with soot through the growth of industry based on the burning of coal. One effect of this pollution was that lichens would no longer grow on the trunks and branches of trees as these became blackened with soot.

Until 1850 the only form of this moth that had been recorded was the light form X. Then in 1850 the dark form Y was reported from one of these industrial areas. By the end of the 19th century the dark form had become quite common and now it is, in many localities, the commoner of the two forms, especially in the vicinity of large towns, where it often comprises as much as 95% of the total population, although the light form predominates in areas away from large centres of population.

33. [illegible] appearance of the dark moth [illegible]

- [illegible] air pollution.
- [illegible] to the change in [illegible].
- [illegible] to the moths directly after their [illegible].
- [illegible] before it had failed [illegible], became established because it [illegible] over its environment.
- [illegible] between light moths and dark [illegible].

34. Which one of the following hypotheses would be of **little value** when designing experiments to investigate the problem described in the paragraph.

A. Caterpillars from eggs laid by pure-breeding light-coloured moths will emerge as dark-coloured moths if fed on leaves contaminated with industrial soot.
B. The dark form of moths can be obtained by irradiating, by means of X rays, the eggs laid by pure-breeding light-coloured moths.
C. When bred in captivity under extreme conditions of temperature or humidity the dark form proves hardier than the light form.
D. The dark-coloured adults fly more strongly than the light-coloured ones.
E. If paper models of the two forms are exposed in equal numbers on a dark tree trunk, birds will peck off more of the light ones than the dark ones.

35. The paragraph describes a case of evolution through

A. sexual selection,
B. natural selection.
C. intra-specific competition.
D. geographical isolation.
E. the inheritance of acquired characters.

36. Which one of the following statements is probably **NOT** true of this species of moth?

A. It usually frequents woodland habitats.
B. It rests during the daytime on exposed tree trunks and branches.
C. It is apparently distasteful to birds.
D. The caterpillars feed on the leaves of trees.
E. It will often be caught in moth traps near large towns.

37. The Galapagos Islands in the Pacific are believed never to have been connected to the mainland. In the Islands there are 14 species of finch-like birds with no obvious relatives elsewhere in the world. The finches vary from island to island. There is a close resemblance between species in plumage, calls, nests, and eggs, but each species differs greatly in beak modifications according to the diet. The species do not interbreed and do not compete for food. It is stated on this evidence that isolation is an important factor in the production of new species.

A. The statement is supported by the information given.
B. The statement is not supported by the information given.
C. The statement is contradicted by the information given.
D. The statement is known to be false but this is not supported by the information given.
E. No relevant information is given.

38. It has been noticed in recent years that the proportion of insects surviving after exposure to certain insecticides has shown a gradual increase with succeeding generations. Of the following, which is the best explanation?

A. World changes in climate have provided a new environment.
B. Insects which have been exposed to the insecticide and have recovered have passed on an immunity to their offspring.
C. Elimination of the less resistant strains gives the resistant ones a greater chance of success.
D. Changes in the habits of the insects have enabled them to survive.
E. The insecticide causes favourable mutations.

39. An adaptation one might expect to find in some "successful" desert plants would be a

A. large leaf area and a thick impermeable cuticle.
B. large leaf area and a large absorbing root surface.
C. small leaf area and a large absorbing root surface.
D. small leaf area and a thin, permeable cuticle.
E. small leaf area and a small absorbing root surface.

40. Which of the following does NOT provide evidence of evolution?

A. Green plants can be arranged in order from simple to complex.
B. Embryos of birds, reptiles, and mammals have gill clefts resembling those of a fish embryo.
C. The ancestry of animals like the horse can be traced through the fossil record.
D. The caecum is present in all mammals including man but is only functional in some.
E. The individuals within a species differ considerably one from another.

IEA SIX-SUBJECT SURVEY INSTRUMENTS

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
Stage 3	IEA/M1/Stage 3	Manual for National Centers
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	IEA/M3/Stage 3	Manual for Test Administrators

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2 = All Stage 2 Subjects
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4-5: Instrument Within Type

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Instrument Name Specialist Chemistry

Data Bank Instrument Number ESSC

One hour was allowed for this exam

1. Which of these solutions is one-molar, that is, 1 M ?

   A. A solution containing 1 molecule of solute per unit volume of water.
   B. A solution containing 1 molecule of substance dissolved in 1 mole of water.
   C. A solution containing 0.1 formula weight in grams of a substance in 100 millilitres of solution.
   D. A solution containing 0.1 gram of solute in 100 millilitre of solution.
   E. A solution containing 1 formula weight of solute in 1 millilitre of water.

2. Which one of the following formulae represents a substance which you would NOT expect to exist under normal laboratory conditions?

   A. NaH.
   B. H_2S.
   C. SiO_2.
   D. $AlCl_2$.
   E. O_3.

3. If N is Avogadro's number, and the gram molecular weight or molar weight of a compound is A, the weight of one molecule of the compound is

   A. N/A.
   B. A x N.
   C. 2A x N.
   D. A/N.
   E. 2A/N.

4. What is the change in oxidation number (oxidation state, valency) of manganese in the reaction represented by the equation

   $$MnO_2 + 4\,HCl \longrightarrow MnCl_2 + Cl_2 + 2\,H_2O\ ?$$

   A. 2.
   B. 3.
   C. 4.
   D. 5.
   E. 6.

5. When an aqueous solution of sodium iodide is electrolysed with platinum electrodes, the main product at the cathode (negative electrode) is

   A. oxygen molecules.
   B. iodine molecules.
   C. hydroxyl ions (OH^-).
   D. sodium atoms.
   E. hydrogen molecules.

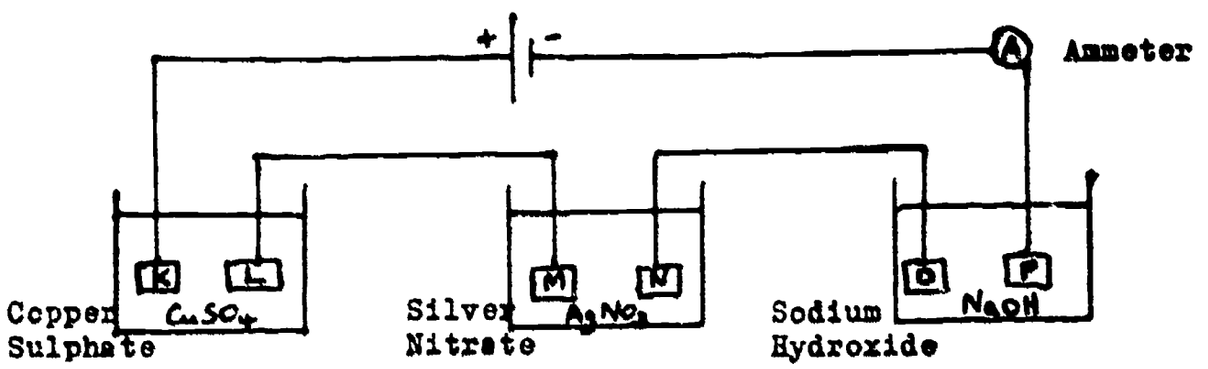
6. [illegible] g of a substance X is dissolved in 40 g of camphor, the freezing point of the camphor is lowered (depressed) by 50°C. The molecular depression of freezing point for camphor (1000 g solvent) is 40°C. The molecular weight of the substance is

A. 10.
B. 60.
C. 80.
D. 100.
E. 120.

7. What is the minimum weight of NaCl that is needed to prepare 7.1 g of chlorine? (Approximate atomic weights: Na = 23, Cl = 35.5)

A. 5.9 g.
B. 7.1 g.
C. 11.7 g.
D. 12.7 g.
E. 14.2 g.

8.



Copper strips K and L, silver strips M and N and platinum strips O and P, which are equal to each other in surface area and weight, are hung opposite each other in aqueous solutions of copper sulphate, silver nitrate and dilute sodium hydroxide respectively. They are connected in series as the figure shows, and a constant current of 0.5 amp is sent through for 30 minutes.

Approximate atomic weights : Ag = 108 Cu = 63.5 Pt = 195
N = 14.0 O = 16.0 H = 1.00
Na = 23.1 S = 32.0

1 Faraday = 96,500 coulombs; Avogadro's number = 6.02×10^{23} molecules/ g mole.

Which strip gained most weight?

A. Copper strip K.
B. Copper strip L.
C. Silver strip M.
D. Silver strip N.
E. Platinum strip P.

9. In the periodic table progression from nitrogen, which one of the following changes can be noted as the elements are considered in the order of their increasing atomic weight?

   A. The elements become more metallic.
   B. The elements become less metallic and the heaviest element in the group is non-metallic.
   C. The elements have about the same metallic properties.
   D. The elements show no trend in their metallic properties, which vary periodically and not by groups.
   E. The elements show no trend in their metallic properties because the periodic table gives no guide to metallic and non-metallic properties.

10. If an atom of a radioactive element first emits an alpha particle and then emits a beta particle, the nuclear charge will

   A. decrease by 1 unit.
   B. increase by 1 unit.
   C. decrease by 2 units.
   D. decrease by 3 units.
   E. decrease by 4 units.

11. The word "covalent" is correctly used to describe all the strong bonds between the atoms in

   A. magnesium oxide.
   B. copper sulphate.
   C. sodium chloride.
   D. carbon disulphide.
   E. nickel.

12. The presence of ions in an aqueous (water) solution of a substance is most directly detected by

   A. finding out if it conducts electricity.
   B. measuring the density of the solution and comparing it with those of the pure solute and water.
   C. seeing if the solution has an electric charge.
   D. evaporating the solution and testing the residue for conductivity.
   E. adding an ionic substance and seeing if there is a reaction.

13. Which of the following series of numbers represents the electronic structure of an element with a variable valency (oxidation state)?

   A. 2, 8, 7.
   B. 2, 8, 15, 2.
   C. 2, 8, 18, 2.
   D. 2, 8, 8, 1.
   E. 2, 8, 18, 7.

Questions 14 and 15 refer to a portion of the periodic table

I	III		VII	VIII
T	U		V	W
			X	

Hypothetical elements T, U, V, W and X are located in the upper half of the periodic table of elements shown above. Elements T, U, V and W are all in the same period, with element T a member of group I, element U a member of group III, element V a member of group VII and element W the last element in the period. Element X is in the same group as element V and is immediately below it.

14. Which of the following comparisons of elements T and V is correct?

A. V is more electronegative than T.
B. V is more metallic than T.
C. Atoms of V have fewer valence electrons than do those of T.
D. Atoms of V have fewer electrons than do those of T.
E. The usual valence (combining capacity) of V is greater than that of T.

15. Which of the following comparisons of elements V and X is correct?

A. Atoms of V have fewer valence electrons than atoms of X.
B. Atoms of V are smaller than those of X.
C. V is more metallic than X.
D. V is much less reactive than X.
E. V has a much higher melting point than X.

16. The boiling point of sodium chloride (formula weight 58.5) is 1413°C whereas the boiling point of carbon tetrachloride (formula weight 154) is 77°C. On considering the formula weights it might be expected that carbon tetrachloride would have the higher boiling point. The reason for the observed result is that sodium chloride is

A. a solid and carbon tetrachloride is a liquid.
B. ionic and carbon tetrachloride is covalent.
C. an inorganic substance whereas carbon tetrachloride is an organic substance.
D. soluble in water whereas carbon tetrachloride is not.
E. based upon a cubic unit lattice but carbon tetrachloride has a tetrahedral unit structure.

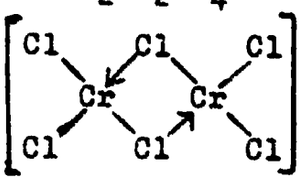
17. Chromic chloride hexahydrate has the empirical formula $CrCl_3.6H_2O$. It exists in several isomeric forms and when one of these isomers is allowed to react with excess of silver nitrate in aqueous solution 2 moles of silver chloride are precipitated for every mole of the chromium salt. The nature of this [illegible] can be represented as

A. $Cr(H_2O)_6^{3+} + 3Cl^-$.

B. $CrCl_3(H_2O)_3 + 3H_2O$.

C. $(CrCl(H_2O)_5)^{2+} + 2Cl^- + H_2O$.

D. $(CrCl_2(H_2O)_4)^+ + Cl^- + 2H_2O$.

E.  $+ 12H_2O$.

18. The half life of the radioactive isotope potassium, K^{42}, is 12.4 hours. The activity of a sample will be reduced to 3% of its original value after an estimated time of

A. 12.4 hours.
B. 37.2 hours.
C. 42 hours.
D. 63 hours.
E. 124 hours.

19. Selenium is the element below sulphur in the periodic table. One would expect selenium to

A. be a metal with a high boiling point.
B. form a potassium oxy-salt of formula K_3SeO_4.
C. burn in air to form an oxide SeO.
D. dissolve in nitric acid to form a salt $Se(NO_3)_4$.
E. form a compound H_2Se which is weakly acidic in aqueous solution.

20. Which one of the following compounds can exist in optically active forms?

A. $CH_3\overset{OH}{\overset{|}{C}}HCH_3$.

B. $CH_3.CH=CH.CH_3$.

C. $HOCH_2-\overset{OH}{\overset{|}{C}}H-CH_2OH$.

D. $CH_3.CH=CH_2$.

E. $CH_3-\overset{OH}{\overset{|}{C}}H-CH_2CH_3$.

Questions 21 and 22 refer to the following.

You are given five bottles, each containing a different [illegible] compound, together with the following information:

Bottle Label	Melting Point°C	Boiling Point°C	State at Room Temperature
(i)	-183	-89	gas
(ii)	- 20	9	gas
(iii)	-130	36	liquid
(iv)	- 78.5	138	liquid
(v)	284	290	solid

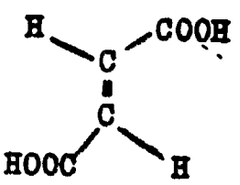
Considering the factors which influence the strength of intermolecular (van der Waals) forces, hydrogen bonding and solubility, select one of the following compounds (A to E) in answer to questions 21 and 22.

A. $CH_3-CH_2-CH_2-CH_2-CH_3$.

B. $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-CH_3$.

C. $CH_3-CH_2-CH_2-CH_2-CH_2OH$.

D. CH_3-CH_3.

E. 

21. Which of these compounds is contained in bottle (i)?

22. Which of these compounds is contained in bottle (v)?

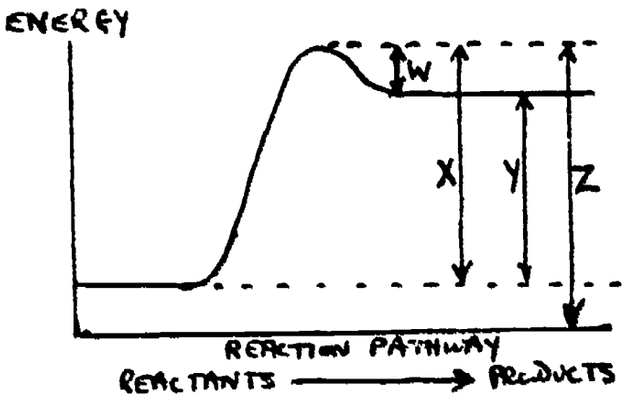
23. The electronegativity (electron attracting power) of a given element on Pauling's scale can be estimated from the electronegativities of the neighbouring elements in the periodic table. In estimating the electronegativity of chlorine from those of the elements to the left and right of it in period III, the determining factor is that, in going to the right in the period,

A. chemical reactivity decreases.
B. the number of filled energy levels per atom increases.
C. the van der Waals radius increases.
D. the density decreases.
E. the nuclear charge increases.

24. In a similar manner to that described in the previous question an electronegativity value for radium (Ra) can be obtained by using the electronegativity values of the neighbouring elements in Group II. The determining factor in this case is that in going down group II

A. melting point increases.
B. the number of filled energy levels per atom increases.
C. atomic radius decreases.
D. nuclear radius decreases.
E. electrical conductivity decreases.

Questions 25 to 27 relate to the following potential energy diagram for the reaction $Br + H_2 \longrightarrow HBr + H$.



25. The heat of reaction is represented by

A. W.
B. X.
C. Y.
D. Z.
E. Z minus W.

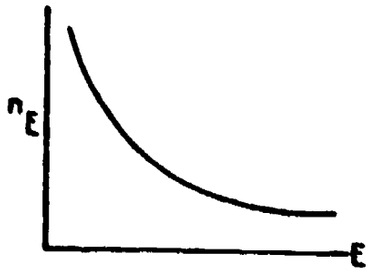
26. The energy of activation for the above reaction is represented by

A. W.
B. X.
C. Y.
D. Z.
E. Z minus W.

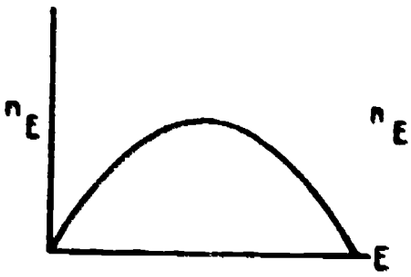
27. The activation energy for the reverse of the reaction given above (i.e. for the reaction, $HBr + H \longrightarrow Br + H_2$) is represented by

A. W.
B. X.
C. Y.
D. Z.
E. Z plus X.

28. Which of the following represents the variation of the number of molecules or atoms, n_E, having energy E in a sample of a gas at room temperature?

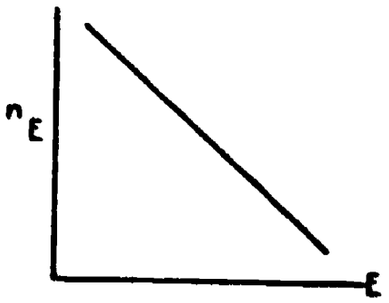


A.

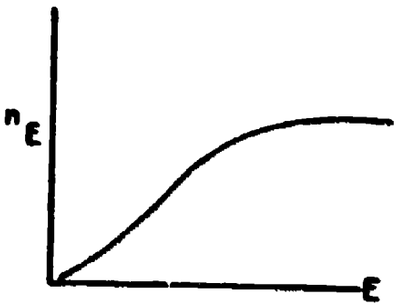


B.

C.



D.



E.

29. A reaction does not take place in the dark but proceeds explosively as soon as exposed to light. Which is the best explanation of this fact?

A. Light provides the energy which is released as heat in the explosion.
B. Light initiates the reaction which then proceeds very rapidly.
C. Light acts as a catalyst, being regenerated during the explosion.
D. Light heats the unstable reactant(s) which then explode.
E. The total reaction is endothermic and light initiates it by supplying much more than the required energy.

30. Assuming equilibrium is reached in the reaction

$$2CO + O_2 \rightleftharpoons 2CO_2 \qquad \Delta H = -135 \text{ kcal}$$

(The reaction to the right is exothermic.)

a greater yield of CO_2 will be obtained by

A. raising the temperature and pressure.
B. lowering the temperature and pressure.
C. raising the temperature and lowering the pressure.
D. lowering the temperature and raising the pressure.
E. adding a catalyst and raising the pressure.

31. When a small speck of lead monoxide was added to a concentrated solution of hydrogen peroxide, the solution became hot and eventually erupted violently. In this process large amounts of oxygen were given off. Which of the following is the best explanation?

A. The great amount of heat is due to the release of oxygen by decomposition of lead monoxide; no catalysis is involved.
B. The reaction is catalysed by lead monoxide but unaffected by a rise in temperature.
C. The reaction is not catalysed by lead monoxide but is accelerated by a rise in temperature.
D. The reaction is unaffected by a rise in temperature but catalysed by products.
E. The reaction is catalysed by lead monoxide and accelerated by a rise in temperature.

32. The rate of reaction of two substances X and Y is measured at several concentrations of X and Y as shown in the table.

Rate of reaction millimoles/litre second	12	36	24
Concentration of X moles/litre	5	15	10
Concentration of Y moles/litre	5	5	10

The rate of reaction is

A. proportional to the concentration of X but independent of the concentration of Y.
B. proportional to the concentrations of X and Y.
C. proportional to the concentration of Y but independent of the concentration of X.
D. dependent on the concentrations of X and Y but not satisfactorily expressed in A, B or C.
E. dependent on some unspecified factors other than concentration.

33. Aluminium is extracted from bauxite by

A. heating bauxite in a plentiful supply of air.
B. reducing bauxite with coke in a furnace.
C. reducing bauxite with water gas in a furnace.
D. electrolysing bauxite dissolved in sulphuric acid.
E. electrolysing bauxite dissolved in melted cryolite.

34. Which of the following elements is most likely to yield the highest oxidation state of a transition metal when combining with it?

A. Iodine.
B. Sulphur.
C. Fluorine.
D. Phosphorus.
E. Hydrogen.

35. On the basis of the periodic table, which of the following would be described best as an oxide which is only basic?

A. Al_2O_3.
B. CO.
C. P_2O_5.
D. NO_2.
E. CaO.

36. A compound X, of the formula C_3H_8O, on partial oxidation gives C_3H_6O. From this information, X is most likely to be

A. an alkanal (aldehyde).
B. a tertiary alkanol (alcohol).
C. an alkene (olefin).
D. a secondary alkanol (alcohol).
E. an ether.

37. The reaction represented by the equation $CH_3CH(OH)NH\text{-}NH_2 \longrightarrow CH_3CH\text{=}N\text{-}NH_2 + H_2O$ is an example of what kind of reaction?

A. Addition.
B. Polymerisation.
C. Rearrangement.
D. Substitution.
E. Elimination.

38. A liquid compound behaves as follows :

It reacts with sodium.
It reacts with acetic acid in the presence of sulphuric acid to give a sweet smelling ester.
It is completely miscible with water.
It contains only the elements carbon, hydrogen and oxygen.

The compound is

A. definitely ethyl alcohol. (ethanol)
B. probably an ether.
C. probably an alcohol.
D. probably an organic base.
E. probably a carboxylic acid.

39. A student wishes to see how temperature affects the solubility of a salt in water. His method is as follows :

He shakes an excess of the salt with water at a known temperature until no more appears to dissolve. He then filters to obtain a clear solution. After weighing a portion of this solution, he evaporates the water and weighs the dry salt. He then repeats the procedure at the same temperature as a check before proceeding to another temperature.

Which of the following is apt to cause the greatest error during determination of the solubility at a given temperature.

A. Allowing solution temperature to change prior to filtration.
B. Allowing solution temperature to change during evaporation.
C. Allowing solution temperature to change at any time during the procedure.
D. Not using the same size of salt crystals in the check determinations.
E. Not adding the same excess of salt in the check determinations.

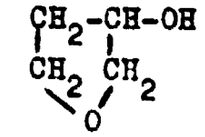
40. The molecular formula for an organic compound is found to be $C_4H_8O_2$. The following properties of the compound were experimentally determined.

I. 0.1 mole of sodium metal reacts with 0.1 mole of the compound to liberate 0.05 mole of H_2 gas.
II. The compound forms an ester by one step.
III. The compound is not easily oxidised.

On the basis of the above information, which of the following is the most likely structural formula for the compound?

A. $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-OCH_3$

B. $CH_3-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-OH$

C. 

D. $CH_3-\overset{OH}{\overset{|}{C}}H-CH_2\overset{O}{\overset{\|}{C}}H$

E. $HO-CH_2-CH = CH-CH_2OH$

IEA SIX-SUBJECT SURVEY INSTRUMENTS

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
Stage 3	IEA/M1/Stage 3	Manual for National Centers
	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators

These manuals are available from ERIC Clearinghouse.

The following extracts from these manuals have been appended to this particular IEA instrument to provide researchers with the minimum necessary test instruction information (e.g., such things as the instructions on the practice items and the warnings concerning the amount of time left for the test have been omitted here). For full details, please consult the appropriate manuals.

The Data Bank Instrument Number which appears below is a new number, assigned since the instruments were administered for the purpose of easily linking items in the instruments with the resultant variables in the Data Bank holdings. Each such variable is named in the codebook using the new instrument number and (usually) the number of the item within the instrument from which the variable is derived. The key to the new instrument numbers is as follows:

1: Type of Instrument

E = Examination (student)
Q = Questionnaire (student)
T = Teacher questionnaire
S = School questionnaire

2: Student Population

1 = I	6 = II and IV
2 = II	7 = I, II and IV
3 = III	8 = I and IV
4 = IV	S = IV Specialist
5 = I and II	N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
F = French as a Foreign Language
C = Civic Education
2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Specialist Physics

Data Bank Instrument Number ESSP

One hour was allowed for this exam

NATIONAL OPTION PHYSICS

1. Which of the following statements involves vector quantities only?

   A. Gravitational field strength is 9.8 N/kg.
   B. Each solid body has weight and inertial mass.
   C. Water freezes at 273°K and boils at 373° K.
   D. The charge on an electron is: $e = 1.6 \times 10^{-19}$C.
   E. The kinetic energy of a free falling body is equal to the difference between its potential energy at the start and the end of fall.

2. The ratio of the mass of the sun to that of the earth can be calculated from

$$\frac{Ms}{Me} = \frac{Re^3}{Rm^3} \cdot \frac{Tm^2}{Te^2}$$

where Ms = mass of sun

Me = mass of earth

Re = radius of earth's orbit about the sun

Rm = radius of moon's orbit about the earth

Te = period for 1 revolution of earth around the sun

Tm = period for 1 revolution of moon around the earth

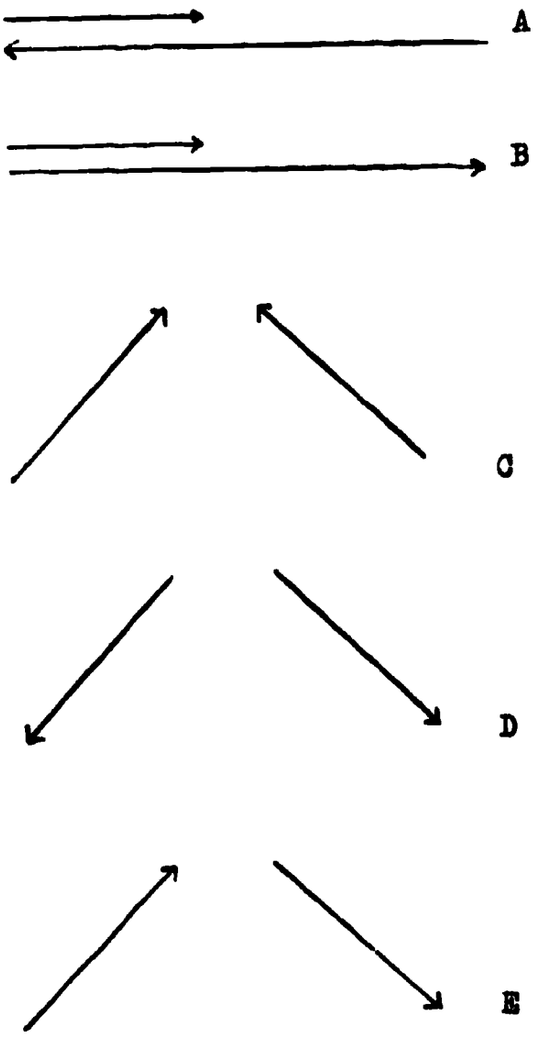
The following list gives values for these quantities, with estimates for the errors of measurement for each.

Re	149,500,000 km	±	16,000 km
Rm	384,420 km	±	160 km
Te	365.3 days	±	0.1 days
Tm	27.32 days	±	0.01 days

Which quantity contributes most to the error in calculating the value of the ratio $\frac{Ms}{Me}$?

   A. Re.
   B. Rm.
   C. Tm.
   D. Te.
   E. All contribute approximately equally.

3. Which of the five systems of vectors shown has the resultant represented by ⟶ ?



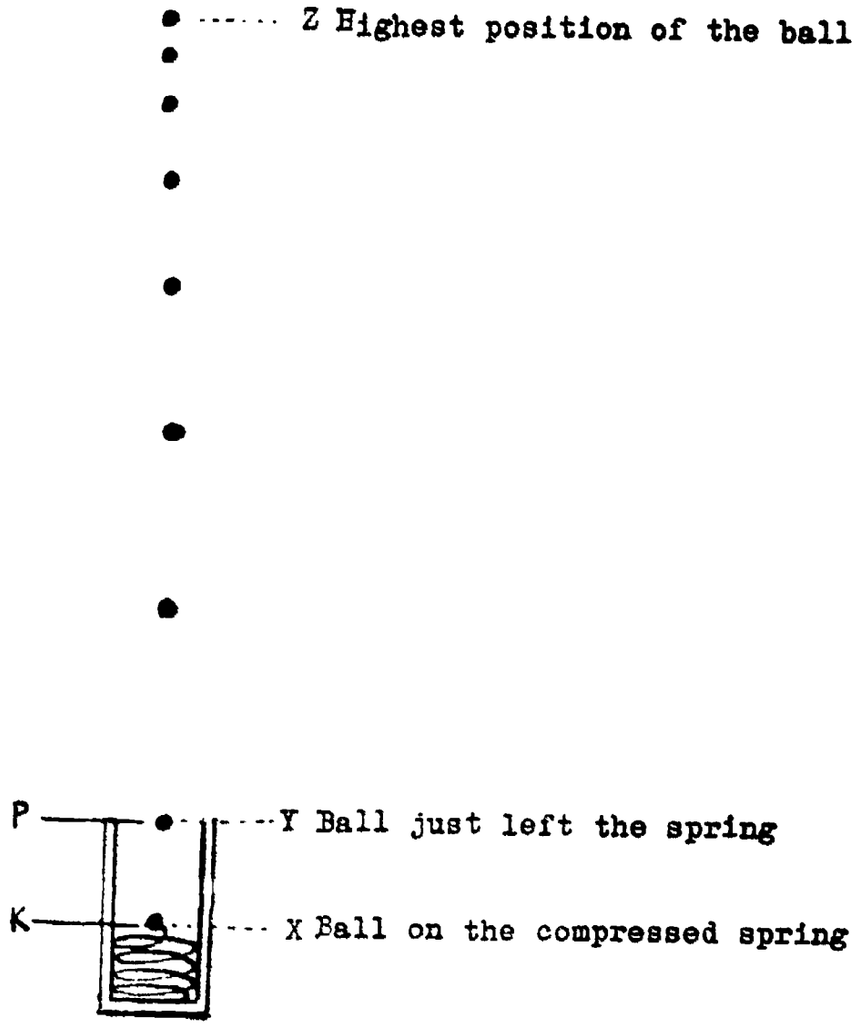
4. If the earth's mass were twice as great as it is, its period of revolution about the sun (assuming it stayed in the same orbit) would

A. increase 4 times.
B. increase 2 times.
C. decrease by a factor of 2.
D. decrease by a factor of 4.
E. remain the same.

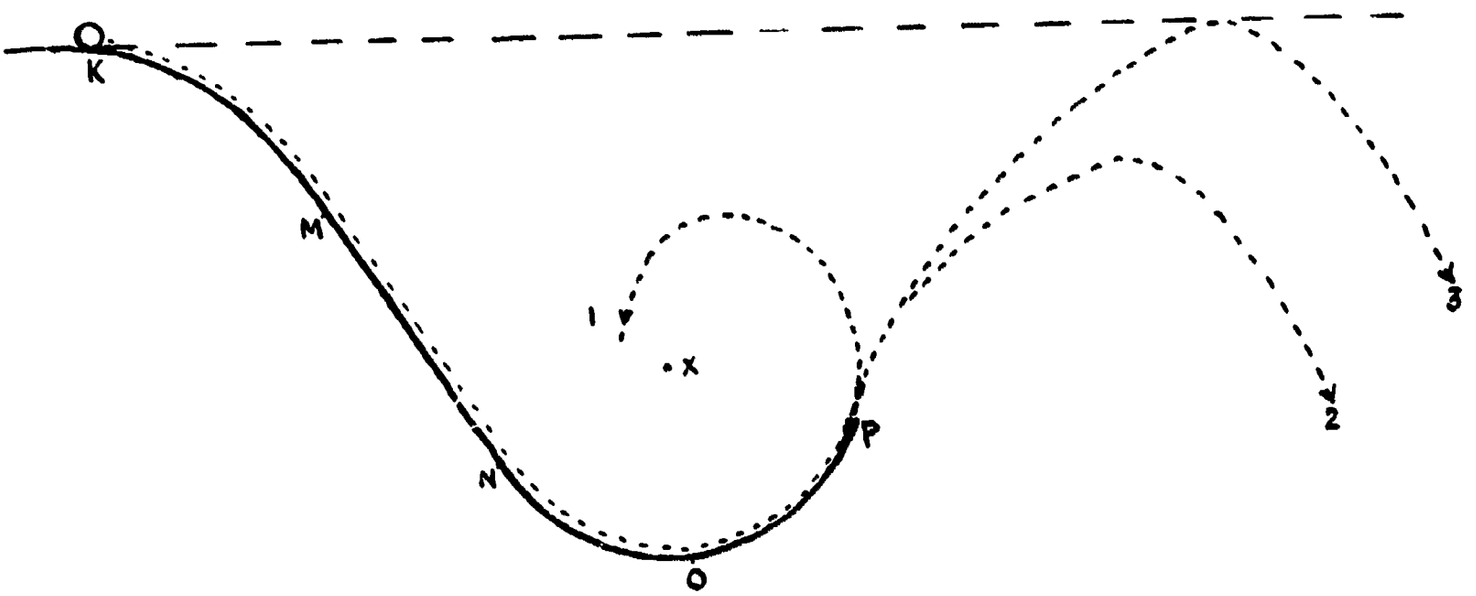
5. The figure shows the respective positions which a small ball occupied every 1/7 second after it had been shot up vertically by a spring. Assume that the spring is compressed to the point K and then released, and that the ball leaves the spring at P. Z is the highest position that the ball reaches. Assume air resistance to be negligible.

Assuming that the acceleration due to gravity is 9.8 m/s^2, what is the acceleration of the ball at the position Y?

A. Zero.
B. Less than 9.8 m/s^2.
C. 9.8 m/s^2.
D. Greater than 9.8 m/s^2.
E. It is impossible to say unless the height the ball rises is given.



6. A ball was released at the position K on the rail shown in the figure. On the rail the part MN is a straight line, and the part N O P is a circular arc with its centre at X.The ball moved along the rail and then went off from the rail at the position P, which is lower than X.



Assuming that the friction between the ball and the rail, the rotation of the ball and the air resistance are all negligible, which one of the alternatives is correct?

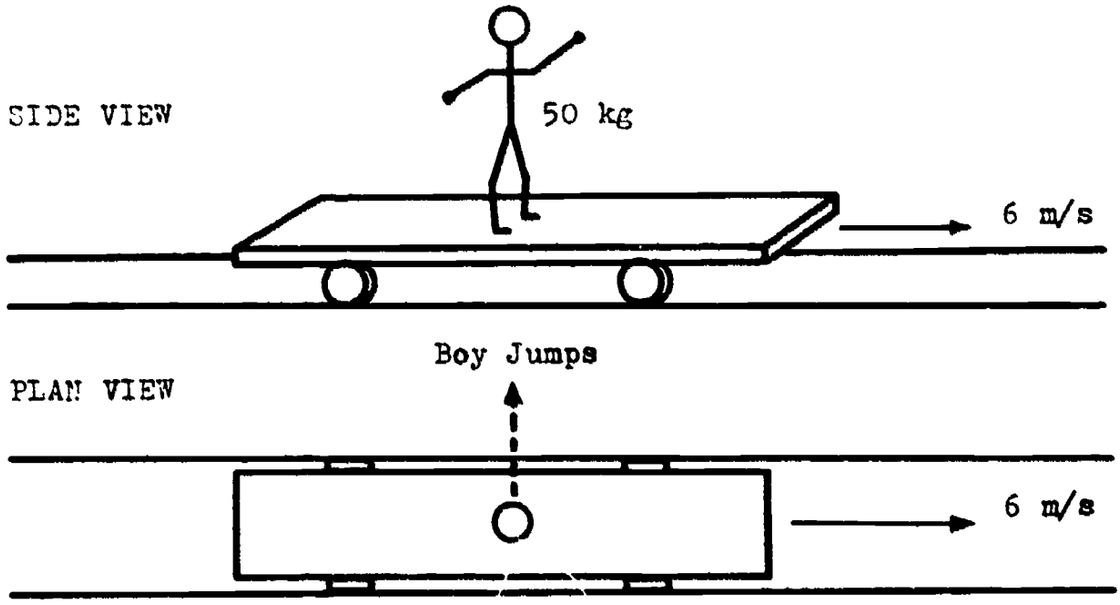
A. The ball moved as shown in the curve 1 in the figure running off from the circular path owing to the gravitation.
B. As there is not any resistance, it reached the same height as the point K, but the actual path cannot be determined.
C. As the mechanical energy of the ball changed owing to contact with the rail, it did not reach quite the same height as the point K.
D. As the direction of the ball going off from the point P is inclined to the vertical, it moved as shown in the curve 2 in the figure.
E. As the mechanical energy is conserved, it moved as the curve 3 in the figure.

7. A 5 kg ball moving at 20 m/s collides with a ball of unknown mass moving at 10 m/s in the same direction. After collision, the 5 kg ball moves at 14 m/s and the other ball at 15 m/s, both still in the same direction.

The mass of the second ball is

A. 2 kg.
B. 6 kg.
C. 10 kg.
D. 12 kg.
E. 30 kg.

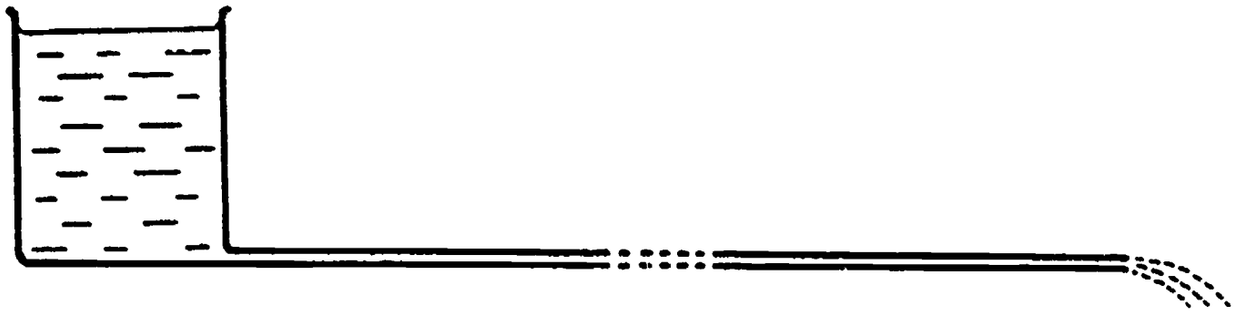
8. A 50 kg boy stands on a trolley of mass 100 kg. The trolley is travelling to the right on rails at a constant speed of 6 m/s.



After the boy jumps sideways off the trolley pushing off at right angles to it, the speed of the trolley is about

A. 3 m/s.
B. 4 m/s.
C. 6 m/s.
D. 9 m/s.
E. 12 m/s.

9. Water at a depth of 4.0 m in a constant-head reservoir flows with friction through a horizontal tube and issues from the open end with a speed of 6.0 m/s. About what fraction of the mechanical energy of the water is lost in friction?



A. Zero.
B. 0.33.
C. 0.45.
D. 0.55.
E. 0.67.

.. If, in an imaginary situation, a 1 kg block of ice at $0^{o}C$ is dropped from such a height that all of it is melted by the heat generated on impact with the ground, from what height would a 25 kg block of ice have to be dropped to melt completely, assuming that in both cases all of the heat is absorbed by the ice?

A. 25 times as high.
B. 5 times as high.
C. 1/5 as high.
D. 1/25 as high.
E. The same height.

11. A boat loaded with rocks floats in a small swimming pool. If the rocks are thrown overboard into the water, the level of the water in the pool

A. rises.
B. remains the same.
C. falls.
D. the result depends on the density of the boat.
E. the result depends on the relative densities of the rocks and the material of the boat.

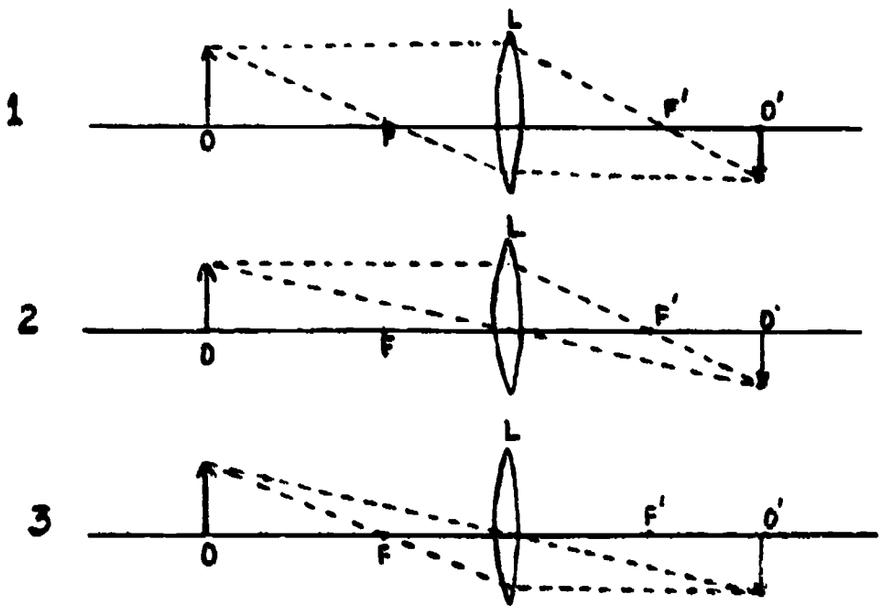
12. 2 g of hydrogen are in a rigid container exerting a pressure P on the walls. 2 g of another gas are introduced, temperature remaining constant. The pressure in the container, assuming no chemical reaction occurs, is now

[illegible]. between P and 2P.
[illegible]. 2P.
[illegible]. greater than 2P.
D. still P.
[illegible]. smaller or greater than P depending on the deviation of the mixture from the ideal.

[illegible] jar of oxygen gas a[illegible] jar of hydrogen gas are at the same temperature. The molecules of the two gases have o[illegible] [illegible] the same

[illegible]. velocity.
[illegible]. momentum.
[illegible]. force.
[illegible]. potential energy.
[illegible]. translational kinetic energy.

14. The three figures 1, 2, 3, give the graphical construction for image O' of object O as produced by the thin lens L with foci F and F'.



Which, if any, of these three figures are correct?

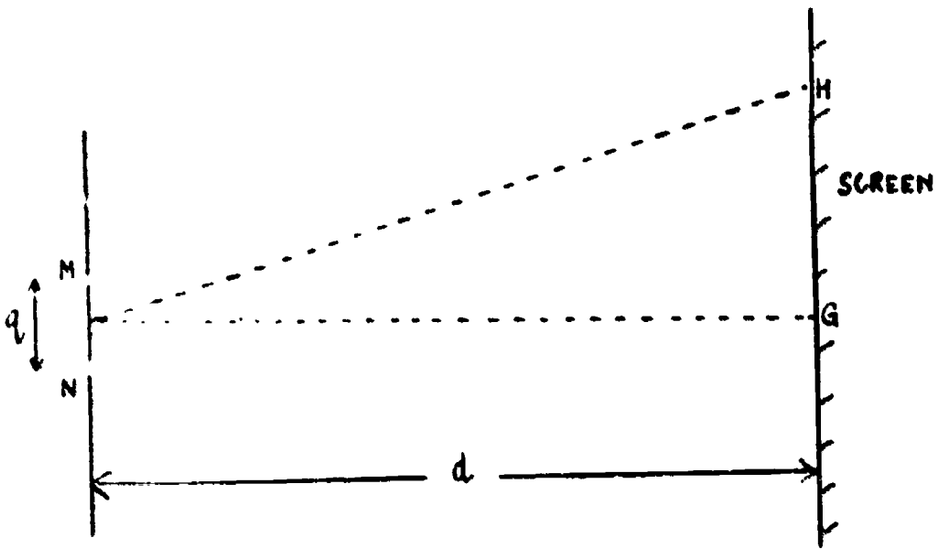
A. Figures 2 and 3 are correct.
B. Figures 1 and 3 are correct.
C. Figures 1 and 2 are correct.
D. None of the figures are correct.
E. All three figures are correct.

15. Sound is not an electromagnetic radiation. The best evidence for the truth of this statement is the fact that

A. audible sounds have a wavelength (in air) of about 1 m (about middle E).
B. diffraction effects can be observed.
C. sound can be produced by vibrating solids.
D. sound travels at 300 m/s in air.
E. sound can be refracted.

16. Two long narrow slits, M and N, are sources of monochromatic light and the light waves emerging from them are in phase.

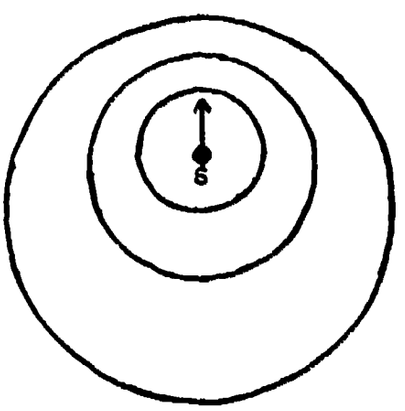
A screen is placed parallel to the slits and at a distance d from them, where d is very large compared to q, the distance between them. The point G on the screen is equidistant from the mid-points of the two slits.



If there is a point H on the screen such that the difference between the distances from each slit to H is equal to λ, where λ is the wavelength of the light, one would expect to see in in the vicinity of H

A. no interference pattern.
B. a boundary between a bright and a dark band, passing through H.
C. a dark band, centred on H.
D. a bright band centred on H.
E. a white band near H.

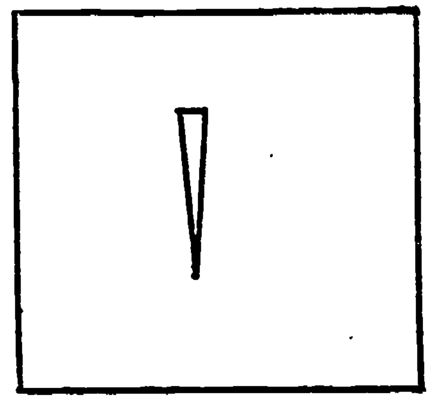
17. The sketch shows the pattern of circular waves produced by a moving source S in a tank of water. Given that sound can be described as a wave motion and that the pitch of a particular sound increases with frequency, which of the following phenomena might be predicted from this pattern?



A. The intensity of sound from a moving source varies inversely as the square of the distance from the source.
B. The pitch of a musical note from a vibrating string varies with the tension of the string.
C. The sound of a passing automobile horn to an observer by the side of a road drops in pitch as the car passes.
D. The velocity of propagation of sound waves increases without a change in pitch as the sound passes into a denser medium.
E. The second harmonic is equal to twice

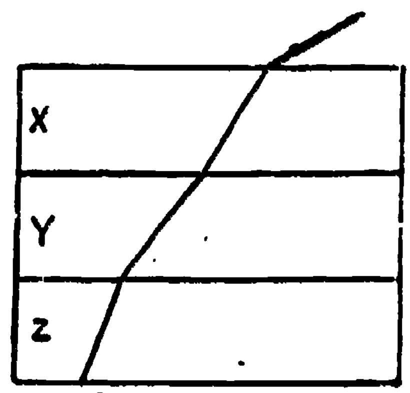
[illegible] [illegible] wedge-shaped slit (see sketch) is set up [illegible] parallel to a photographic plate. [illegible] narrow beam of [illegible] [illegible] light is sent through the slit and falls on the plate. [illegible] exposed area of the plate is [illegible]

A. of the same shape and size as the wedge used.
B. widened uniformly by diffraction.
C. narrowed uniformly by diffraction.
D. widened most at the bottom by diffraction.
E. narrowed most at the bottom by diffraction.

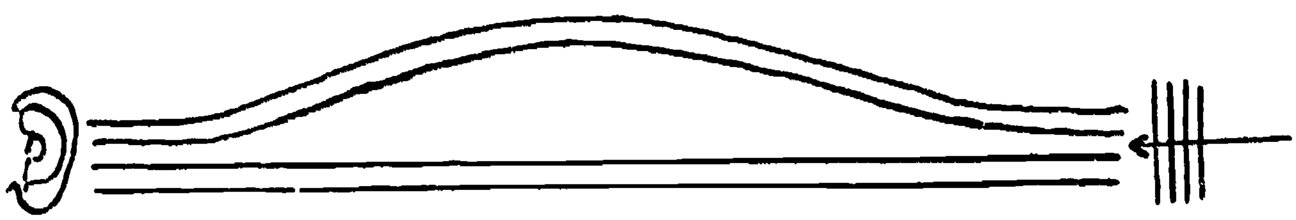


19. A ray of blue light passes through a stack of three parallel-sided blocks made of different materials. The path of the beam is shown. In which of the three blocks is the velocity of blue light greatest?

A. X.
B. Y.
C. Z.
D. The velocity is the same in all the blocks.
E. the information given is insufficient to be able to say.



20. Sound waves 1 m in length are carried to a man's ear by two rubber tubes. With which of the following combinations of tube-lengths will the man hear no sound?



A. $\frac{3}{4}$ m , $1\frac{3}{4}$ m.
B. $\frac{3}{4}$ m , $2\frac{1}{4}$ m.
C. 1m , $2\frac{3}{4}$ m.
D. $1\frac{1}{2}$ m , $2\frac{3}{4}$ m.
E. 2 m , 4m.

21. Hertz detected radiations by means of a spark detector. On placing his receiver between the source of radiation and a metal sheet, he found that the strongest sparks resulted at multiples of a certain distance from the reflecting sheet.This suggests that the radiations [illegible]

A. transverse waves.
B. longitudinal waves.
C. waves, but gives no indication as to whether they are transverse or longitudinal.
D. ultrasonic radiation.
E. some form of energy moving through air with the speed of light.

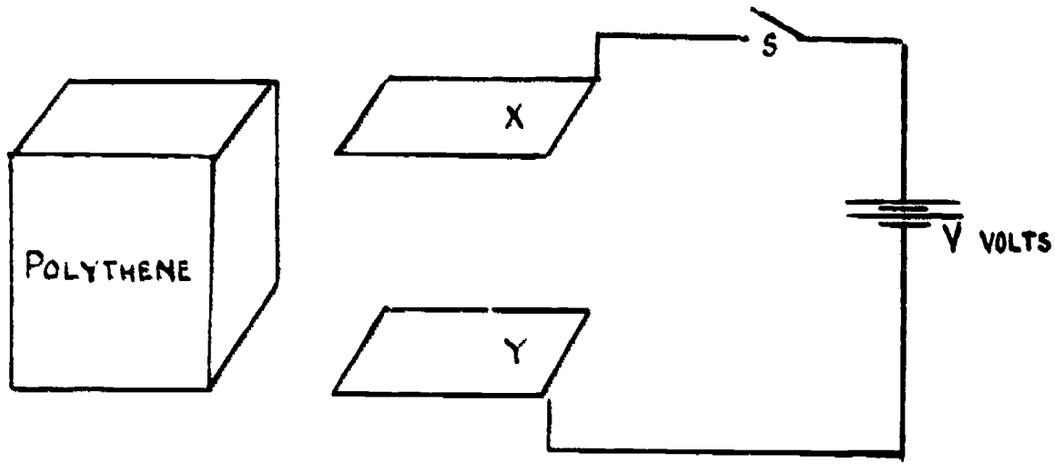
22. In the spectrum of the sun a continuous spectrum is crossed by many black lines (Fraunhofer lines). Which of the following statements is correct?

A. The black lines are caused by Fraunhofer diffraction at the telescope.
B. The black lines are caused by the absorption of light in the gases of the sun's atmosphere.
C. The spectrum of the sun lacks the spectral lines of all the elements present in the sun.
D. The black lines come from the combustion of elements at the sun.
E. The spectrum of the sun is changed in the space between sun and earth by cosmic radiation.

23. From observations that Vega is a bright blue-white star while Regulus is a bright orange star, we can conclude

A. that Vega has a higher surface temperature than Regulus.
B. that Regulus has a higher surface temperature than Vega.
C. nothing about their surface temperatures.
D. that both stars generate energy by the proton-proton reaction to form helium.
E. that Vega is cooler than the sun.

24. The figure shows a circuit in which the switch S is closed for a few seconds and then opened. The two plates, X and Y act as a capacitor which acquires a charge Q, with a potential difference V and stored energy W. Switch S is now opened and a block of polythene is slid between X and Y. It is a close fit but does not touch either of them.

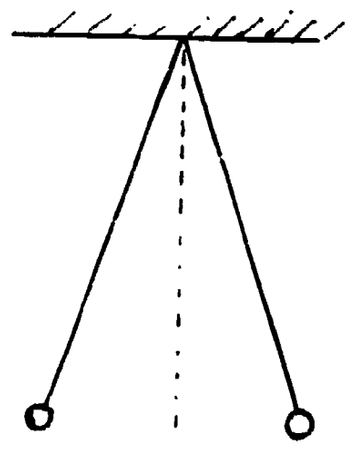


Which of the following statements is true?

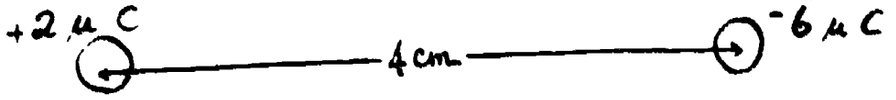
- The capacitance, the potential difference and the stored energy all increase.
- The capacitance, the charge, and the potential difference all increase.
- The capacitance increases but the potential difference and the stored energy both decrease.
- The charge remains the same but the stored energy and the potential difference both increase.
- Since the switch is open, all remain unchanged.

25. Two electrically charged spheres are suspended from the same point by insulating threads of equal length and repel each other so that the threads make equal angles with the vertical. What can be said of the balls?

A. Their masses and charges are equal.
B. Their masses are equal, the charges may or may not be.
C. Their charges are equal, the masses may or may not be.
D. The ratio of charge to mass is the same for both.
E. The repulsive force on each must be equal to its weight.



26. Two small charges of $+2\mu$ C and -6μ C respectively are placed 4 cm apart as shown. Where should a third charge -8μ C be placed so that there is no net force on the -6μ C charge?



A. 4 cm left of the -6μ C charge.
B. 16 cm left of the -6μ C charge.
C. 16 cm right of the -6μ C charge.
D. 8 cm left of the -6μ C charge.
E. 8 cm right of the -6μ C charge.

27. Three parallel metal plates of equal area, equally spaced apart as shown, can be arranged either as in fig.1 or as in fig.2 to a supply of V volts.

Fig. 1

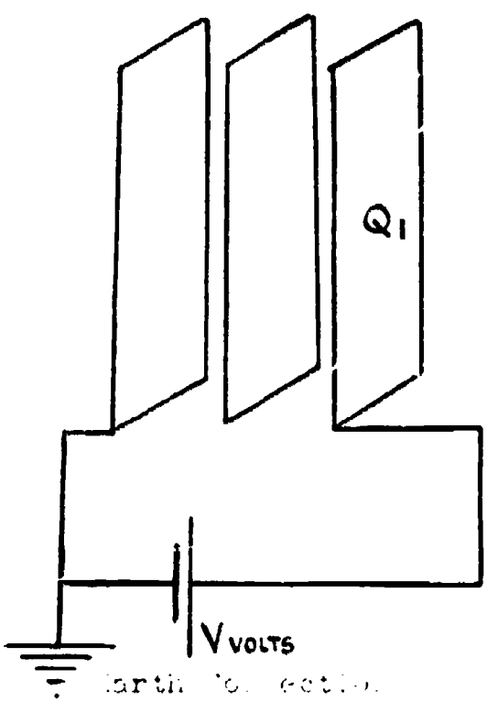
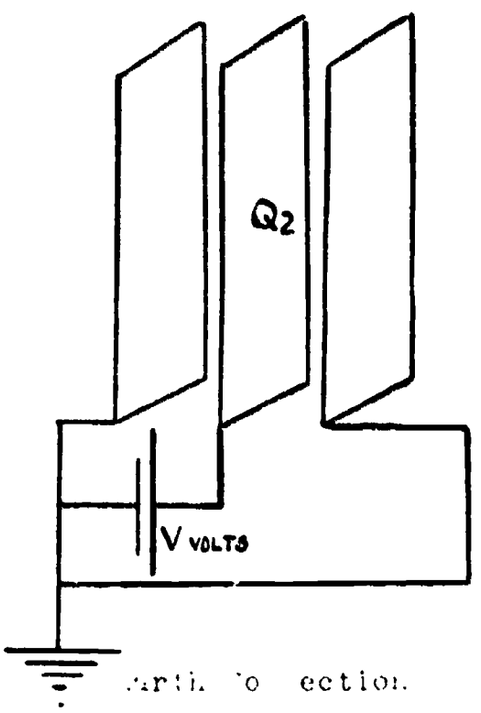


Fig. 2



If Q_1 is the charge stored when connected as in fig.1, and Q_2 the charge stored when connected as in fig. 2, the ratio $Q_1 : Q_2$ is equal to

A. 1 : 4.
B. 1 : 2.
C. 1 : 1.
D. 2 : 1.
E. 4 : 1.

28. If a sphere suspended by an insulating thread is attracted by a charged object, one can state with certainty that

A. the sphere had a net opposite charge.
B. the sphere is a good conductor.
C. the sphere has acquired a net opposite charge by induction.
D. the sphere is a good conductor and had a net opposite charge.
E. none of the above can be definitely concluded.

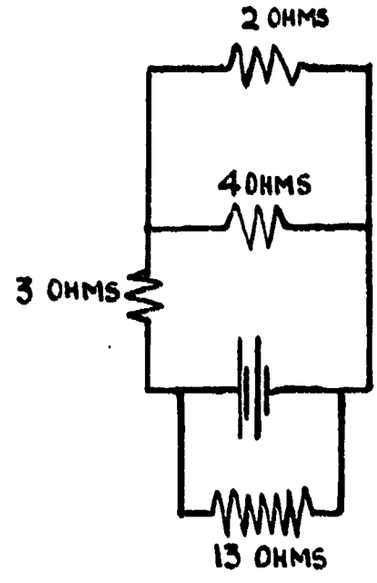
---

29. **To convert a galvanometer into a voltmeter, a resistance R is connected to the galvanometer. What is the value of R in relation to the internal resistance of the galvanometer and how is it connected?**

A. **R is low and connected in parallel across the galvanometer.**
B. **R is low and connected in series with the galvanometer.**
C. **R is high and connected in parallel across the galvanometer.**
D. **R is high and connected in series with the galvanometer.**
E. **Any of the above may be correct, depending on the desired sensitivity.**

30. **In the circuit shown, the current through the 2 ohm resistor is 2 amp. What is the potential difference across the 13 ohm resistor?**

A. 13 volts.
B. 17 volts.
C. 26 volts.
D. 27 volts.
E. The data are insufficient.

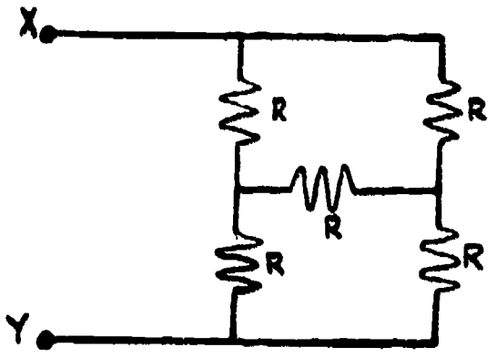


31. An electric water heater, which is thermally well-insulated so that no heat is lost to the surroundings, takes 20 minutes to boil a certain quantity of water when the power supply voltage is 240 volts. Suppose the power supply voltage is 200 volts instead. How long will the heater now take to boil the same quantity of water if the resistance of the heating element remains approximately constant?

A. About 14 minutes
B. About 17 minutes
C. About 20 minutes
D. About 24 minutes
E. About 29 minutes

32. Each resistor in the diagram has the same resistance R. What resistance will be measured between terminals X and Y?

A. 2R.
B. $\frac{4R}{3}$
C. R.
D. $\frac{R}{2}$.
E. $\frac{R}{3}$.



33. Someone proposes to design a electric motor so that it can be used to operate a electric generator which will, in turn, alone provide the voltage to drive the motor in such a way that the frequency of rotation of the motor remains constant. His proposal would not work because

1. more current would be produced in the generator than the motor can use.
2. of the direction of rotation.
3. of the induced voltage.
4. of the magnetic field that would be set up.
5. in the generator and motor, some energy would always be transformed to heat.

34. **Under which of the following circumstances is an e.m.f. NOT induced in a conductor in a uniform magnetic field?**

A. The magnetic field is moving at right angles to the conductor.
B. The conductor is moving at right angles to the magnetic field.
C. The magnetic field and the conductor do not move relative to each other, but the magnetic field is increasing.
D. The conductor is moving parallel to the magnetic field.
E. The magnetic field and the conductor are stationary relative to each other, but the magnetic field in dying away to zero.

35. The following data are provided for the operation of a T.V. tube.

Electron beam current	=	$100\mu A$
Final anode potential	=	10 kV
Mass of electron (m)	=	9×10^{-31} kg
Charge on the electron (e)	=	1.6×10^{-19} C

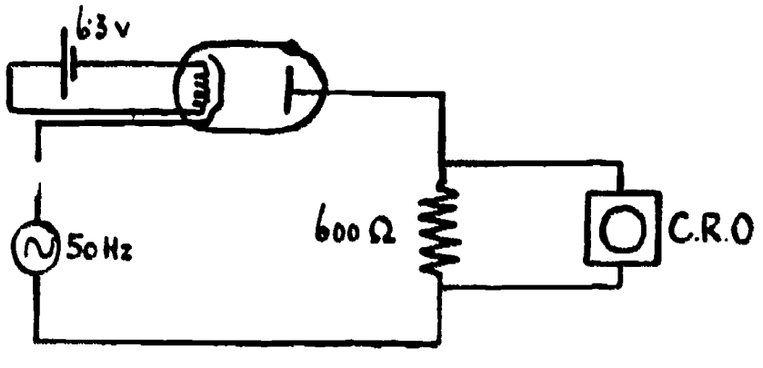
If the electrons take a spot of area 10^{-2} cm^2 on the screen, what is the pressure exerted by the electrons absorbed there? For calculation use the value of $\frac{m}{e}$ of the electron as 6×10^{-12} $\frac{kg}{C}$ approximately

A. 4.6×10^{-4} N/m^2.
B. 5.3×10^{-3} N/m^2.
C. 3.5×10^{-2} N/m^2.
D. 6.1×10^{-1} N/m^2.
E. 8.2 N/m^2.

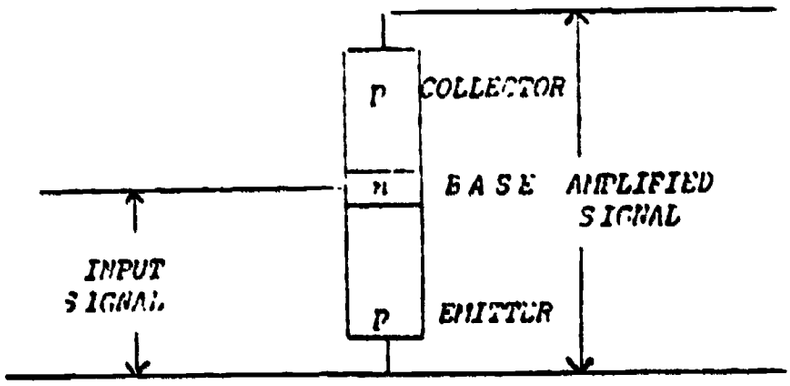
36. A thermionic diode valve is connected in the circuit shown.

Which of the following would appear on the screen of the oscilloscope?

A
B
C
D
E



37. The p-n-p transistor shown below is to be used to amplify an input signal



Which row in the following table is correct?

	The base voltage with respect to the emitter is	The base voltage with respect to the collector is
A	positive	positive
B	negative	negative
C	positive	negative
D	negative	positive
E	negative	zero

38. Suppose there is an isolated mercury atom, initially at rest, which emits a photon of frequency ν and wavelength λ. Immediately after emission of the photon, it is certain that the mercury atom will

A. be ionised.
B. be in the ground state.
C. have at least one electron in the highest energy level.
D. emit an electron.
E. have at least one electron which is in a lower energy level than it was before.

- - - - - - - - - - - - - - - - - -

39. An atom with atomic number Z and atomic mass (mass number) W changes into one with atomic number Z + 1 and atomic mass W. Which of the following nuclear changes could have taken place?

A. The emission of an alpha particle.
B. The emission of a beta particle.
C. The emission of gamma rays.
D. The absorption of a deuteron and then emission of a neutron.
E. The absorption of a neutron and the emission of a gamma photon.

40. If a photon collides with a free electron

A. energy is conserved; momentum is not.
B. momentum is conserved; energy is not.
C. both energy and momentum are conserved.
D. neither energy nor momentum need be conserved.
E. momentum is conserved; the nature of the collision determines whether energy is conserved.

END OF BOOKLET 17

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
Stage 3	IEA/M1/Stage 3	Manual for National Centers
	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators

These manuals are available from ERIC Clearinghouse.

The following extracts from these manuals have been appended to this particular IEA instrument to provide researchers with the minimum necessary test instruction information (e.g., such things as the instructions on the practice items and the warnings concerning the amount of time left for the test have been omitted here). For full details, please consult the appropriate manuals.

The Data Bank Instrument Number which appears below is a new number, assigned since the instruments were administered for the purpose of easily linking items in the instruments with the resultant variables in the Data Bank holdings. Each such variable is named in the codebook using the new instrument number and (usually) the number of the item within the instrument from which the variable is derived. The key to the new instrument numbers is as follows:

1: Type of Instrument

E = Examination (student)
Q = Questionnaire (student)
T = Teacher questionnaire
S = School questionnaire

2: Student Population

1 = I	6 = II and IV
2 = II	7 = I, II and IV
3 = III	8 = I and IV
4 = IV	S = IV Specialist
5 = I and II	N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
F = French as a Foreign Language
C = Civic Education
2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Science Practical II

Data Bank Instrument Number E2SX

Practical tests were used only in Japan Population II and England Populations II and IV. These data will not be documented in the Six-Subject Data Bank.

POPULATION II SCIENCE PRACTICAL (National Options)

This test is concerned with some of the practical abilities that are important in science, such as being able to read instructions and carry out simple manipulations, to observe accurately and record observations in an appropriate way, and to select the best method and equipment for a particular purpose.

The questions will ask you to carry out instructions and to observe and record the results.

In most questions you are asked to choose the best answer from a number of alternatives and to circle the letter corresponding to it.

Here is an example.

Which one of the following would you use to weigh a large crystal of copper sulphate to an accuracy of 0.01 gram?

A. A measuring cylinder.
B. A compression spring balance reading in 0.5 Kg. to 10.0 Kg.
C. A set of household (kitchen) scales.
(D) A chemical balance.
E. A milliammeter.

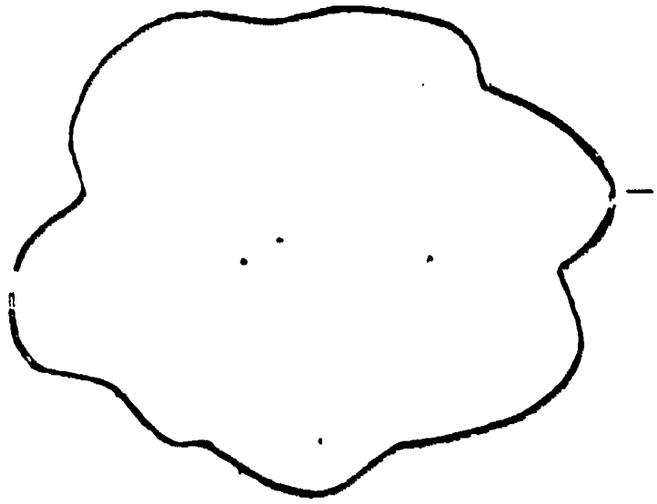
A measuring cylinder is used to measure volume, not weight. Similarly, a milliammeter is used to measure small electric currents. Hence we are left with B, C, and D, all of which are used for measuring weight. But, of these, only the chemical balance would be capable of weighing a crystal to 0.01 gram, so that is the correct answer and the D should be circled as shown.

In these questions you will have to make measurements or other observations and record the results in a different way. All you have to do is to follow the instructions carefully.

You will h ve plenty of time, so do not hurry. But you will have to plan your work and to organise your time efficiently as, of course, the ability to do this is an important part of laboratory work.

Do not waste time on questions you do not understand or cannot do. Leave them and pass on to the next ones; you can always come back to those you leave later if there is time.

Questions 1, 2 and 3 refer to the following outline shape.



The outline shown above represents a leaf, the area of which is to be determined.

Using the scissors provided, cut out the shape very carefully so that the cut-out has a thin black margin all round the edge.

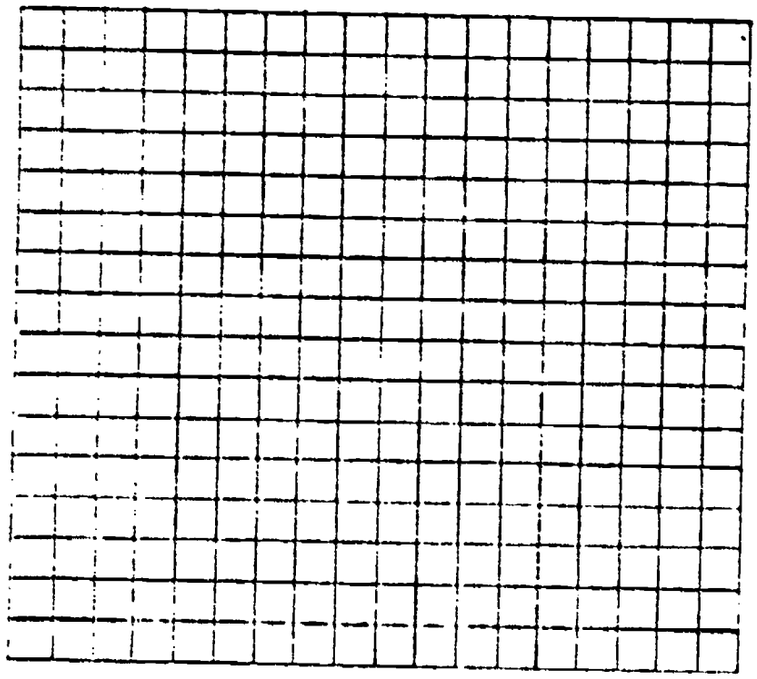
Place the cut-out shape on the graph paper which is printed at the end of this question. Hold it flat. Use a sharp pencil to draw a thin line round the shape as close as you can to its edge. The pencil should be touching the edge of the cut-out shape all the time as you draw round it.

1. Count the number of complete squares inside the outline and circle the letter corresponding to the number you obtain. The number of complete squares inside the outline is between

   A. 67 and 76
   B. 77 and 86
   C. 87 and 96
   D. 97 and 106
   E. 107 and 116

2. Count the number of part squares inside the outline and circle the letter corresponding to the number you obtain. The number of part squares inside the outline is between

   A. 35 and 44
   B. 45 and 54
   C. 55 and 64
   D. 65 and 74
   E. 75 and 84



3. Add the number of complete squares which you counted for question 1, to <u>half</u> the number of part squares you counted for question 2. Circle the letter corresponding to the resulting sum.

   The resulting sum, which represents the area of the leaf shape is between

   A. 121 and 125 square units
   B. 126 and 130 square units
   C. 131 and 135 square units
   D. 136 and 140 square units
   E. 141 and 145 square units

   Leave your cut-out shape pinned to the graph paper.

The photographs show two fruit flies of the same species. Photograph 1 is of a normal fly and photograph 2 shows a fly that had developed from an egg which had been irradiated before it hatched.

1. Which one of the following lists gives <u>only</u> the features in which the two flies are different?

A. Number of joints in the legs, body colour, eyes.
B. Size of head, number of joints in the legs, body colour.
C. Length of the thorax, eyes, shape of wings.
D. Size of head, length of thorax, body colour.
E. Eyes, shape of the wings, body colour.

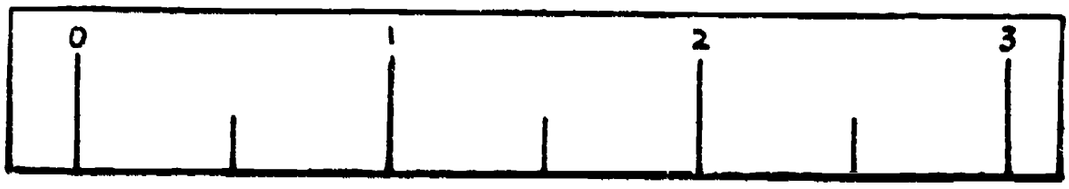
In question 5 select from the following list of observations those which you believe are most appropriate to the experiments which you are asked to carry out.

A. Solid dissolves
B. Solid does not dissolve
C. Black precipitate forms
D. White precipitate forms
E. Red-brown precipitate forms
F. Green-grey precipitate forms
G. Precipitate dissolves later
H. Precipitate does not dissolve
I. Colourless solution forms
J. Greenish yellow solution forms
K. White needle-shaped crystals form
L. No residue
M. Black residue
N. Pale yellow residue
O. Colourless droplets form
P. White steamy fumes evolved
Q. Solid sublimes
R. Pungent gas evolved
S. Brown gas evolved
T. Green-yellow gas evolved
U. Inflammable gas evolved
V. Gas evolved which relights a glowing splint

5. Add dilute sodium hydroxide solution <u>slowly</u> to each of tubes X, Y and Z until it is present in excess in each case. Complete the following table for each tube; one letter selected from A to V above is to appear in each blank space, each pair representing what you think are the <u>two</u> most appropriate observations in each case.

Tube	Observations	
X		
Y		
Z		

Questions 6, 7 and 8 refer to the printed scale shown below.



Cut out the scale and use it to measure the distance between the ends, X and Y, of the two lines drawn below.

6. The distance between the two ends is

   A. 0.7 scale units
   B. 0.73 scale units
   C. 0.75 scale units
   D. 0.77 scale units
   E. 0.8 scale units

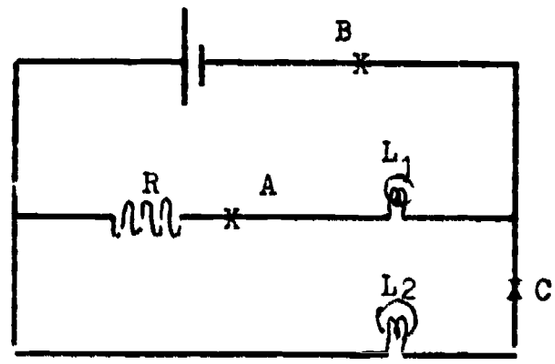
7. The unreliability of the measurement just given is

   A. 0.1
   B. 0.07
   C. 0.05
   D. 0.03
   E. 0.01

8. It is suspected that the paper scale you have used shrinks and expands with atmospheric humidity, that is the amount of moisture in the air. The best way to investigate whether or not this happens would be to

   A. measure the distance between the two ends referred to in 6 every day for a month and see how the result varied.
   B. soak the scale in water and check its length against a metal ruler.
   C. check the length of the scale against a wooden ruler.
   D. soak the scale in water and check its length against a wooden ruler.
   E. check the length of the scale each day for a month against a metal ruler.

9. Set up the circuit as shown in the diagram from the apparatus provided.



By inserting the ammeter at position A, B, or C in the circuit measure the following and record your results in the spaces provided.

I. The current taken from the accumulator _____

II. The current through L_1 _____

III. The current through L_2 _____

PRACTICAL TESTS

The limited pre-testing of practical items (ST 2 and 3) we were able to do and the comments we have received from National Centers and the other sources have confirmed the view that certain practical skills and abilities desirable in science education can be tested by our testing instruments.

Accordingly, as you know, we have included some "pencil and paper practical items" in tests IIA (IEA/4A), IIB (IEA/4B) and IVA (IEA/10A) Science, and we are offering further lists, which require a very modest amount of equipment, as a national or school option. In this way we hope to obtain information, not only about achievement in science under varying school conditions, but also about the effectiveness of different kinds of test items.

The tests being offered as National Options are

II	Science Practical	1 1/2	hours
IV	Science Practical	1 1/2	hours
IV	Biology Practical	1	hour
IV	Chemistry Practical	1	hour
IV	Physics Practical	1	hour

More time has been allowed than is likely to be needed by the students to carry out the actual operations. This has been done to allow time for the general organisation of the test and to remove from the students any sense of pressure.

The behavioural categories of the practical items can be expressed as follows.

I The ability to use simple apparatus and to implement simple procedures.

II The ability to observe changes/differences in structures or systems under investigation and to record such changes/differences in ways that yield maximum relevant information.

III The ability to select appropriate apparatus and/or procedures for a novel experimental problem.

The attached note sets out the information that should be given to schools concerning the conditions and materials required for the tests and the conduct of the actual testing.

The tests should be scored by the schools and the scores checked by National Centers.

We shall be grateful if you will let us know as soon as possible if you intend to carry out science testing in practical abilities.

Note on practical tests to be send by National Centers to participating schools:

These tests of practical abilities important in the learning of science are part of an international study and have been so designed as to require only the simplest of facilities and materials and to need very little in the way of preparation by the teacher.

The provision of a laboratory or a practical room is not essential, but each student should have an adequate area of suitable, flat-topped working space and to have reasonable access to water (for washing up etc.) and to places for the disposal of solid and liquid wastes.

For some tests gas (or some equivalent) for heating will be required.

In some cases, marked * in the appended lists, one set of apparatus can be used for up to five or six students, but if this is done the apparatus must be disconnected and restored to its original position before each new student begins that section of the test. The student should not, of course, be told what the various substances and materials are.

There should be a clock with a sweep second hand (not a stop clock) so placed that all students can see it.

The tests should be marked according to the given schedules and returned to the National Centers.

Requirements for II Science Practical

Each student to have

a sharp pencil

a pair of scissors

pins

a bunsen burner or similar source of heat

one tube containing 1 cm^3 of solution (approximately 1 M iron III chloride $FeCl_3$) labelled X

one tube containing 1 cm^3 of solution (approximately 1 M zinc sulphate $ZnSO_4$) labelled Y

one tube containing 1 cm^3 of solution (approximately 1 M magnesium sulphate $MgSO_4$) labelled Z

a small lipped beaker containing about 100 cm^3 of approximately 2 M sodium hydroxide NaOH solution and labelled as such

4.

a splint for testing for oxygen

* a 2 volt accumulator

a resistor

an ammeter

wire connections

2 lamps in holders with suitable terminals

} any combinations that are suitable for the question may be used

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
Stage 3	IEA/M1/Stage 3	Manual for National Centers
	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators

These manuals are available from ERIC Clearinghouse.

The following extracts from these manuals have been appended to this particular IEA instrument to provide researchers with the minimum necessary test instruction information (e.g., such things as the instructions on the practice items and the warnings concerning the amount of time left for the test have been omitted here). For full details, please consult the appropriate manuals.

The Data Bank Instrument Number which appears below is a new number, assigned since the instruments were administered for the purpose of easily linking items in the instruments with the resultant variables in the Data Bank holdings. Each such variable is named in the codebook using the new instrument number and (usually) the number of the item within the instrument from which the variable is derived. The key to the new instrument numbers is as follows:

1: Type of Instrument

E = Examination (student)
Q = Questionnaire (student)
T = Teacher questionnaire
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2: Student Population

1 = I	6 = II and IV
2 = II	7 = I, II and IV
3 = III	8 = I and IV
4 = IV	S = IV Specialist
5 = I and II	N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
F = French as a Foreign Language
C = Civic Education
2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Science Practical IV

Data Bank Instrument Number E4SX

Practical tests were used only in Japan Population II and England Populations II and IV. These data will not be documented in the Six-Subject Data Bank.

POPULATION IV SCIENCE PRACTICAL (National Option)

This test is concerned with some of the practical abilities that are important in science, such as being able to read instructions and carry out simple manipulations, to observe accurately and record observations in an appropriate way, and to select the best method and equipment for a particular purpose.

The questions will ask you to carry out instructions and to observe and record the results.

In most questions you are asked to choose the best answer from a number of alternatives and to circle the letter corresponding to it.

Here is an example.

Which one of the following would you use to weigh a large crystal of copper sulphate to an accuracy of 0.01 gram?

A. A measuring cylinder
B. A compression spring balance reading in 0.5 Kg to 10.0 Kg
C. A set of household (kitchen) scales
(D) A chemical balance
E. A milliammeter

A measuring cylinder is used to measure volume, not weight. Similarly, a milliammeter is used to measure small electric currents. Hence we are left with B, C and D, all of which are used for measuring weight. But, of these, only the chemical balance would be capable of weighing a crystal to 0.01 gram, so that is the correct answer and the D should be circled as shown.

In these questions you will have to make measurements or other observations and record the results in a different way. All you have to do is to follow the instructions carefully.

You will have plenty of time, so do not hurry. But you will have to plan your work and to organise your time efficiently as, of course, the ability to do this is an important part of laboratory work.

Do not waste time on questions you do not understand or cannot do. Leave them and pass on to the next ones; you can always come back to those you leave later if there is time.

Questions 1 to 5 refer to the following experiment which you are required to do.

You are provided with a small quantity of organism F, a beaker of warm water (roughly 45°C), and three labelled tubes. One of these tubes contains a liquid that is poisonous to the organism, one contains a nutrient solution and the third contains distilled water but you are not told which.

Read carefully through the whole of the question before you begin work.

Divide the sample of organism F into three approximately equal portions. Place one portion in each of the tubes P, Q and R. Shake each tube vigorously for a few seconds so that the organisms are evenly dispersed in the liquid. (It is best to place your thumb over the mouth of the tube while doing this, but wipe it dry before moving from one tube to another).

Stand all three tubes in the beaker of warm water.

Shake the tubes gently occasionally but take care that none of the mixture spills out. After five minutes examine each tube.

Select from the following list of observations the one which you think best describes what you observed in each case.

A. No observable change occurred in the solution.
B. The solution became hot.
C. Gas bubbles were produced.
D. Gas bubbles were produced and the solution markedly changed colour.
E. The solution became hot and gas bubbles were produced.

1. The statement that best describes what happened in tube P is

   A. B. C. D. E.

2. The statement that best describes what happened in tube Q is

   A. B. C. D. E.

3. The statement that best descibes what happened in tube R is

   A. B. C. D. E.

Now take tube Q and put half its contents into tube P and half into tube R. Again stand the tubes in the warm water in the beaker, shaking them gently occasionally. After five minutes examine the contents.

4. The statement that best describes what has now happened in tube P is

   A. B. C. D. E.

5. The statement that best describes what has now happened in tube R is

   A. B. C. D. E.

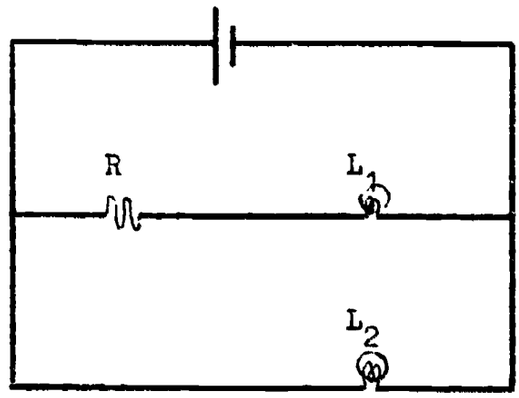
In question 6 select from the following list of observations those which you believe are most applicable to the experiments which you are asked to carry out:

A. Solid dissolves
B. Solid does not dissolve
C. Black precipitate forms
D. White precipitate forms
E. Red-brown precipitate forms
F. Green-grey precipitate forms
G. Precipitate dissolves later
H. Precipitate does not dissolve
I. Colourless solution forms
J. Greenish yellow solution forms
K. White needle-shaped crystals form
L. No residue
M. Black residue
N. Pale yellow residue
O. Colourless droplets form
P. White steamy fumes evolved
Q. Solid sublimes
R. Pungent gas evolved
S. No gas evolved
T. Green-yellow gas evolved
U. Inflammable gas evolved
V. Gas evolved which relights a glowing splint

6. Heat separately each of the substances X and Y with liquid W until no further change occurs and then cool. Do not boil. Use about as much of X or Y as will pile on this circle ○ and about 0.5 cm^3 of W. Complete the following table for both X and Y 4 letters selected from A to V above are to appear in each blank space, representing what you think are the 4 most appropriate observations in each case.

Substance treated with solution W	Observations
X	
Y	

7. Set up the circuit as shown in the diagram from the apparatus provided.



Using the voltmeter or the ammeter as necessary, measure the following and record your results in the spaces provided.

I The voltage across L_1 _____
II The voltage across L_2 _____
III The voltage across R^2 _____
IV The voltage across the accumulator _____
V The current taken from the accumulator _____
VI The current through L_1 _____
VII The current through L_2 _____

PRACTICAL TESTS

The limited pre-testing of practical items (ST 2 and 3) we were able to do and the comments we have received from National Centers and the other sources have confirmed the view that certain practical skills and abilities desirable in science education can be tested by our testing instruments.

Accordingly, as you know, we have included some "pencil and paper practical items" in tests IIA (IEA/4A), JIP (IEA/4B) and IVA (IEA/10A) Science, and we are offering further lists, which require a very modest amount of equipment, as a national or school option. In this way we hope to obtain information, not only about achievement in science under varying school conditions, but also about the effectiveness of different kinds of test items.

The tests being offered as National Options are

II	Science Practical	1 1/2 hours
IV	Science Practical	1 1/2 hours
IV	Biology Practical	1 hour
IV	Chemistry Practical	1 hour
IV	Physics Practical	1 hour

More time has been allowed than is likely to be needed by the students to carry out the actual operations. This has been done to allow time for the general organisation of the test and to remove from the students any sense of pressure.

The behavioural categories of the practical items can be expressed as follows.

I The ability to use simple apparatus and to implement simple procedures.

II The ability to observe changes/differences in structures or systems under investigation and to record such changes/differences in ways that yield maximum relevant information.

III The ability to select appropriate apparatus and/or procedures for a novel experimental problem.

The attached note sets out the information that should be given to schools concerning the conditions and materials required for the tests and the conduct of the actual testing.

The tests should be scored by the schools and the scores checked by National Centers.

We shall be grateful if you will let us know as soon as possible if you intend to carry out science testing in practical abilities.

Note on practical tests to be send by National Centers to participating schools

These tests of practical abilities important in the learning of science are part of an international study and have been so designed as to require only the simplest of facilities and materials and to need very little in the way of preparation by the teacher.

The provision of a laboratory or a practical room is not essential, but each student should have an adequate area of suitable, flat-topped working space and to have reasonable access to water (for washing up etc.) and to places for the disposal of solid and liquid wastes.

For some tests gas (or some equivalent) for heating will be required.

In some cases, marked * in the appended lists, one set of apparatus can be used for up to five or six students, but if this is done the apparatus must be disconnected and restored to its original position before each new student begins that section of the test. The student should not, of course, be told what the various substances and materials are.

There should be a clock with a sweep second hand (not a stop clock) so placed that all students can see it.

The tests should be marked according to the given schedules and returned to the National Centers.

Requirements for IV Science Practical

Each student to have

a tube containing 10 cm^3 distilled water labelled P

a tube containing 10 cm^3 12% sucrose solution labelled Q

a tube containing 10 cm^3 saturated sodium chloride (NaCl) solution labelled R

about 10 g fresh yeast labelled Organism F

a large beaker or jar of warm water (45° - 50°C at the beginning of the experiment)

rack for test tubes

a bunsen (or similar) burner

a tube containing a small quantity of substance (lead II oxide PbO) labelled substance X

a tube containing a small quantity of substance (lead IV oxide PbO_2) labelled substance Z

a lipped beaker (about 100 cm^3) containing approximately 5M HCl and labelled liquid W

* a 2 volt accumulator
  a resistor
  an ammeter
  a voltmeter
  wire connections
  2 lamps in holders with suitable terminals

any combinations that are suitable for the question may be used

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

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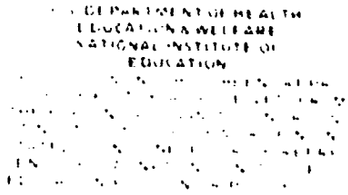

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4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Biology Practical IV

Data Bank Instrument Number E4SXB

Practical tests were used only in Japan Population II and England Populations II and IV. These data will not be documented in the Six-Subject Data Bank.

POPULATION IV BIOLOGY PRACTICAL (National Option)

This test is concerned with some of the practical abilities that are important in science, such as being able to read instructions and carry out simple manipulations, to observe accurately and record observations in an appropriate way, and to select the best method and equipment for a particular purpose.

The questions will ask you to carry out instructions and to observe and record the results.

In most questions you are asked to choose the best answer from a number of alternatives and to circle the letter corresponding to it.

Here is an example.

Which one of the following would you use to weigh a large crystal of copper sulphate to an accuracy of 0.01 gram?

A. A measuring cylinder
B. A compression spring balance reading in 0.5 Kg to 10.0 Kg
C. A set of household (kitchen) scales
(D) A chemical balance
E. A milliammeter

A measuring cylinder is used to measure volume, not weight. Similarly, a milliammeter is used to measure small electric currents. Hence we are left with B,C and D, all of which are used for measuring weight. But, of these, only the chemical balance would be capable of weighing a crystal to 0.01 gram, so that is the correct answer and the D should be circled as shown.

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You are provided with a small quantity of organism F, a beaker of warm water (roughly 45° C), and three labelled tubes. One of these tubes contains a liquid that is poisonous to the organism, one contains a nutrient solution and the third contains distilled water but you are not told which.

Read carefully through the whole of the question before you begin work.

Divide the sample of organism F into three approximately equal portions. Place one portion in each of the tubes, P, Q and R. Shake each tube vigorously for a few seconds so that the organisms are evenly dispersed in the liquid. (It is best to place your thumb over the mouth of the tube while doing this, but wipe it dry before moving from one tube to another.)

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A. No observable change occurred in the solution
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C. Gas bubbles were produced
D. Gas bubbles were produced and the solution markedly changed colour
E. The solution became hot and gas bubbles were produced

1. The statement that best describes what happened in tube P is

   A. B. C. D. E.

2. The statement that best describes what happened in tube Q is

   A. B. C. D. E.

3. The statement that best describes what happened in tube R is

   A. B. C. D. E.

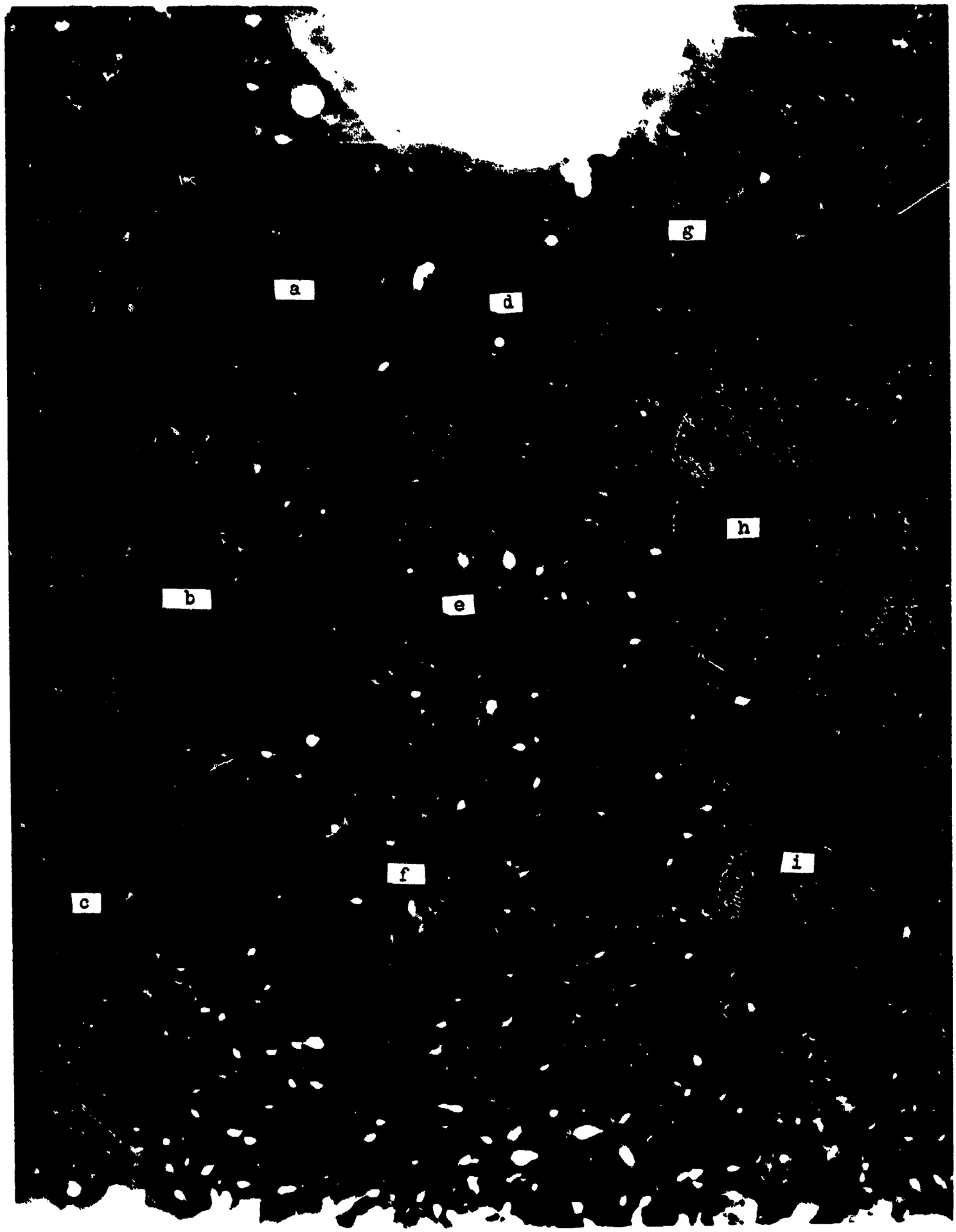
Now take tube Q and put half its contents into tube P and half into tube R. Again stand the tubes in the warm water in the beaker, shaking them gently occasionally. After five minutes examine the contents.

4. The statement that best describes what has <u>now</u> happened in tube P is

   A. B. C. D. E.

5. The statement that best describes what has <u>now</u> happened in tube R is

   A. B. C. D. E.



Questions 6, 7 and 8 refer to the photograph.

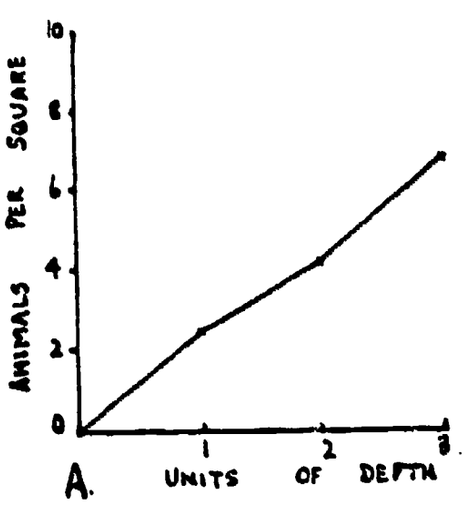
The photograph on page 3 shows the distribution of small organisms in a container of water when illuminated from above by a bright source of light.

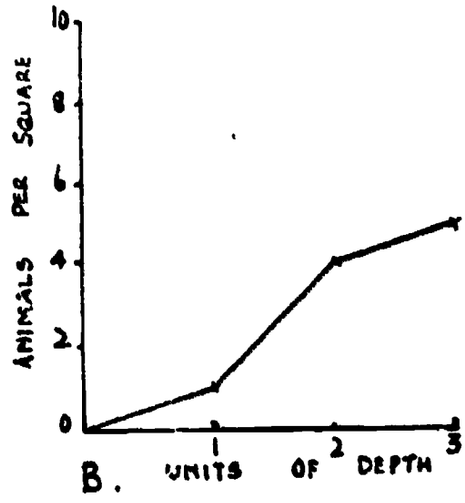
6. In order to obtain the best estimate of the numbers of organisms at different light intensities it would be necessary to count the numbers present per unit area on the photograph at the following positions: (circle one)

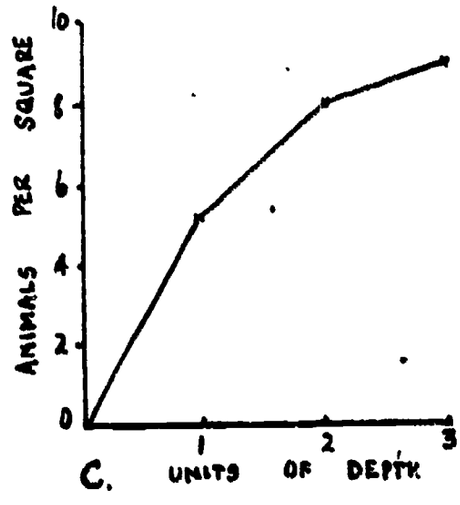
   A. Either points a, b and c, or points d, e and f or points g, h and i.
   B. At three points chosen at random from a, b, c, d, e, f, g, h, or i.
   C. Along the diagonals points a, e, and i, or points g, e, and c, that is, across the rows but at different distances from the light source.
   D. At positions a, d and g; positions b, e and h and at positions c, f, and i.
   E. None of these.

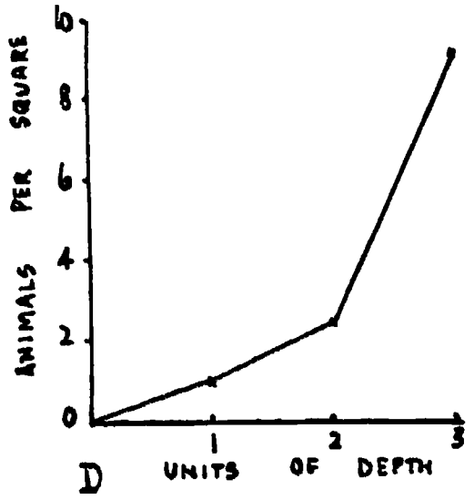
7. Cut a 2.5 cm square hole in a piece of paper. Place the top left-hand corner of the square hole against the bottom right-hand corner of the label b on the photograph so that the sides of the hole are parallel to the sides of photograph. Count the number of organisms in the square hole. (N.B. Any light spot is an individual animal).
   Repeat this process at positions e and h.
   The average number of animals per 2.5 cm square of photograph at these points is

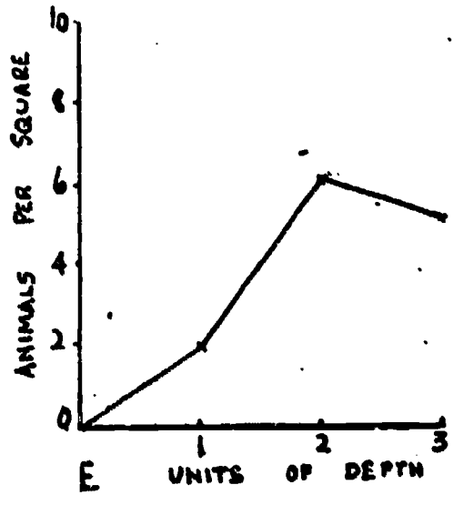
   A. 3.
   B. 5.
   C. 7.
   D. 9.
   E. 12.









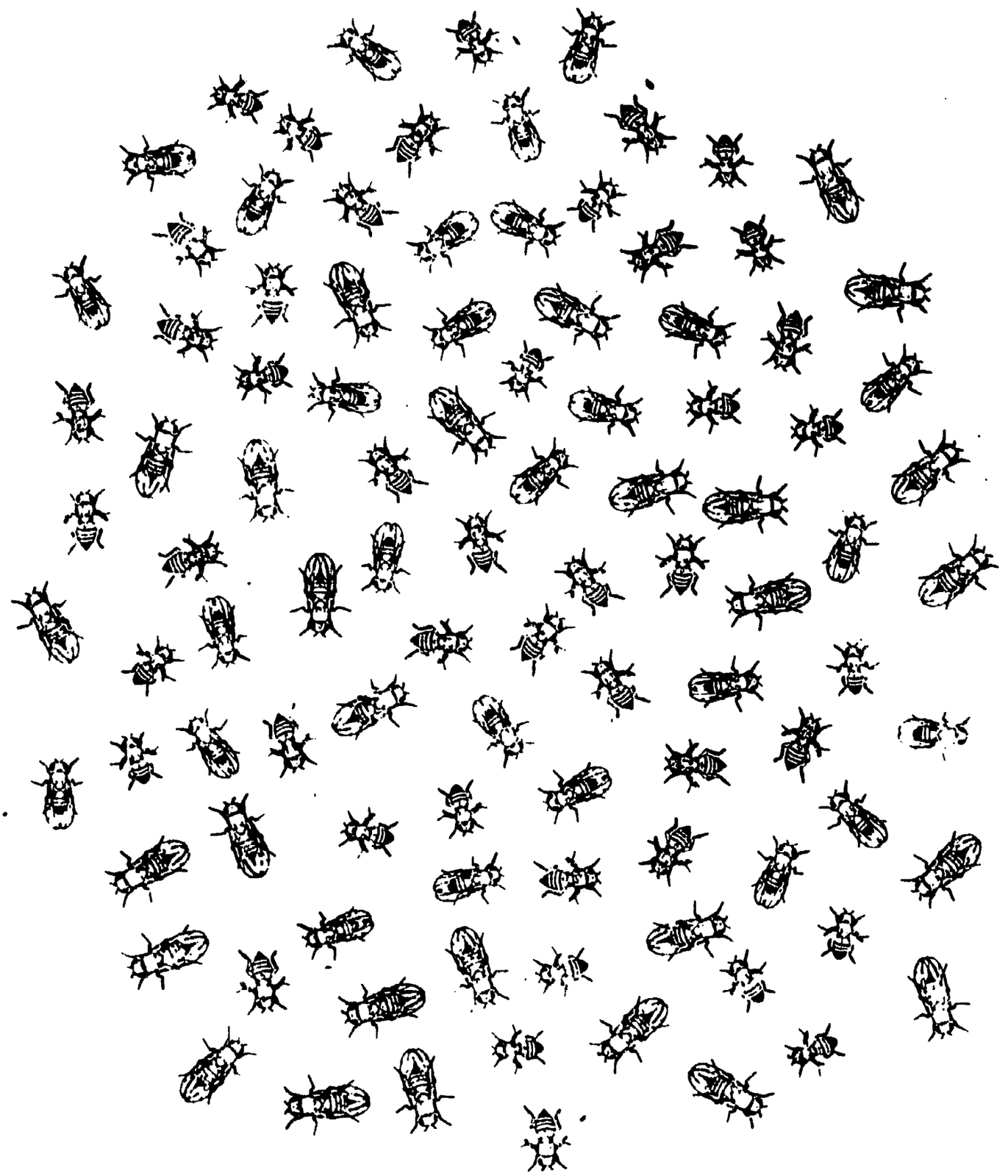


8. Which of the above graphs most accurately represents the variation of density of animals (measured as number of animals per unit area) at different depths. The position of a is at 1 unit of depth, the position of b at 2 units of depth and the position c at 3 units of depth.

A. Graph A
B. Graph B
C. Graph C
D. Graph D
E. Graph E

[illegible] 9, 10 and 11 refer to the photograph of [illegible] fruit flies.

Examine the photograph carefully and you will see that there are four types, each of which can be distinguished from all the others by a combination of features. Select what these [illegible] are from the three sets of lists, one each from [illegible].

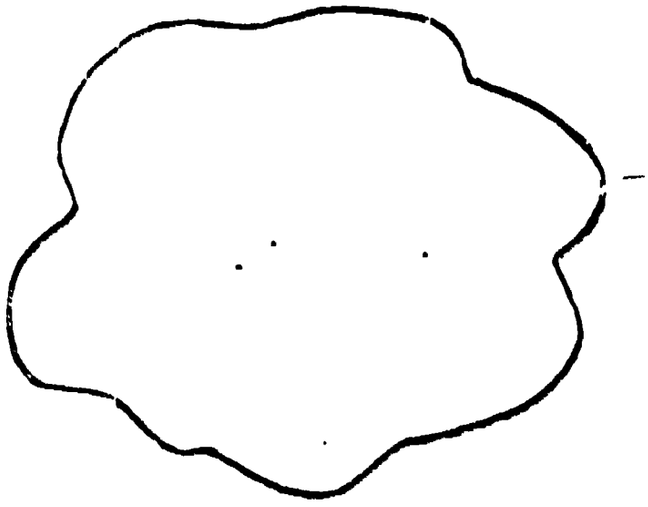


9. A. Black tip to abdomen + stripes on abdomen
   B. Small wings + stripes on abdomen
   C. Rounded tip to abdomen + two stripes on abdomen
   D. Rounded tip to abdomen + small wings
   E. Pointed tip to abdomen + four stripes on abdomen

10. A. Distinct head + two eyes
    B. Two stripes on abdomen + pointed abdomen
    C. Two stripes on abdomen + large wings
    D. Four stripes on abdomen + pointed abdomen
    E. Large wings + three pairs of legs

11. A. Large wings + four stripes on abdomen
    B. Four stripes on abdomen + two eyes
    C. Black eyes + rounded abdomen
    D. Wings with veins + rounded abdomen
    E. Three pairs of legs + two stripes on abdomen

[illegible] and [illegible] refer to the following shape.



The outline shown above represents a leaf, the area of which is to be determined.

Using the scissors provided, cut out the shape very carefully so that the cut-out has a thin black margin all round the edge.

Place the cut-out shape on the graph paper which is printed at the end of this question. Hold it flat. Use a sharp pencil to draw a thin line round the shape as close as you can to its edge. The pencil should be touching the edge of the cut-out shape all the time as you draw round it.

12. Count the number of complete squares inside the outline and circle the letter corresponding to the number you obtain. The number of complete squares is between

A. 67 and 76
B. 77 and 86
C. 87 and 96
D. 97 and 106
E. 107 and 116

13. Count the number of part squares inside the outline and circle the letter corresponding to the number you obtain. The number of part squares inside the outline is between

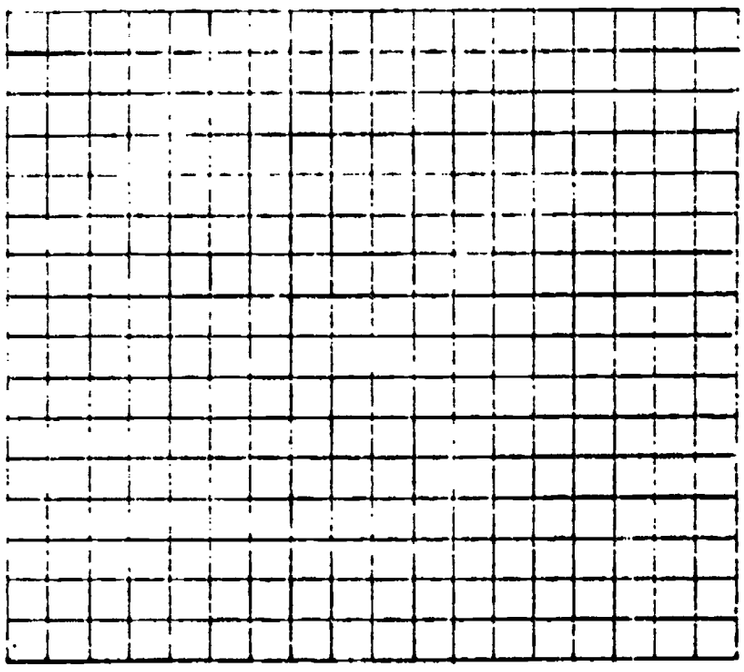
A. 35 and 44
B. 45 and 54
C. 55 and 64
D. [illegible]
E. [illegible]

14. Add the number of complete squares which you counted for question 12, to <u>half</u> the number of part squares you counted for question 13. Circle the letter corresponding to the resulting sum.

The resulting sum, which represents the area of the leaf shape is between

A. 121 and 125 square units.
B. 126 and 130 square units.
C. 131 and 135 square units.
D. 136 and 140 square units.
E. 141 and 145 square units.

Leave your cut-out shape pinned to the graph paper.



15. In which of the following investigations would the general technique for measuring the areas of leaves used above, adapted where necessary, not be appropriate?

A. Testing the hypothesis that plants growing in partial shade have larger leaf areas than plants of the same species growing in sunny positions.
B. Determining the average number of stomata per unit area of a leaf.
C. Measuring the rate of loss of water per unit area of leaf surface due to transpiration.
D. Comparing the rate of loss of water due to transpiration between leaves with waxy cuticles and leaves without waxy cuticles.
E. Studying the rate of growth of a given leaf on a living plant.

END OF BOOKLET 21

PRACTICAL TESTS

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IV	Science Practical	1 1/2	hours
IV	Biology Practical	1	hour
IV	Chemistry Practical	1	hour
IV	Physics Practical	1	hour

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There should be a clock with a sweep second hand (not a stop clock) so placed that all students can see it.

The tests should be marked according to the given schedules and returned to the National Centers.

Requirements for IV Practical Biology

Each student to have

a tube containing 10 cm^3 distilled water labelled P

a tube containing 10 cm^3 12% sucrose solution labelled Q

a tube containing 10 cm^3 saturated solution sodium chloride (NaCl) labelled R

about 10 g fresh yeast labelled Organism P

a large beaker or jar of warm water (45° - 50°C at the beginning of the experiment)

rack for test tubes

ruler graduated in cm to 0.1 cm

pair of fine scissors

sheet of plain paper or thin card

sharp pencil

pins

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

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	IEA/M3/Stage 3	Manual for Test Administrators

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3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
F = French as a Foreign Language
C = Civic Education
2 = All Stage 2 Subjects
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5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Chemistry Practical IV

Data Bank Instrument Number E4SXC

Practical tests were used only in Japan Population II and England Populations II and IV. These data will not be documented in the Six-Subject Data Bank.

POPULATION IV CHEMISTRY PRACTICAL (National Option)

This test is concerned with some of the practical abilities that are important in science, such as being able to read instructions and carry out simple manipulations, to observe accurately and record observations in an appropriate way, and to select the best method and equipment for a particular purpose.

The questions will ask you to carry out instructions and to observe and record the results.

In most questions you are asked to choose the best answer from a number of alternatives and to circle the letter corresponding to it.

Here is an example.

Which one of the following would you use to weigh a large crystal of copper sulphate to an accuracy of 0.01 gram?

A. A measuring cylinder
B. A compression spring balance reading in 0.5 Kg to 10.0 Kg
C. A set of household (kitchen) scales
(D) A chemical balance
E. A milliammeter

A measuring cylinder is used to measure volume, not weight. Similarly, a milliammeter is used to measure small electric currents. Hence we are left with B, C and D, all of which are used for measuring weight. But, of these, only the chemical balance would be capable of weighing a crystal to 0.01 gram, so that is the correct answer and the D should be circled as shown.

In these questions you will have to make measurements or other observations and record the results in a different way. All you have to do is to follow the instructions carefully.

You will have plenty of time, so do not hurry. But you will have to plan your work and to organise your time efficiently as, of course, the ability to do this is an important part of laboratory work.

Do not waste time on questions you do not understand or cannot do. Leave them and pass on to the next ones; you can always come back to those you leave later if there is time.

In questions 1, 2 and 3 select from the following list of observations those which you believe are most appropriate to the experiments which you are asked to carry out.

A. Solid dissolves
B. Solid does not dissolve
C. Black precipitate forms
D. White precipitate forms
E. Red-Brown precipitate forms
F. Green-grey precipitate forms
G. Precipitate dissolves later
H. Precipitate does not dissolve
I. Colourless solution forms
J. Greenish yellow solution forms
K. White needle-shaped crystals form
L. No residue
M. Black residue
N. Pale yellow residue
O. Colourless droplets form
P. White steamy fumes evolved
Q. Solid sublimes
R. Pungent gas evolved
S. Brown gas evolved
T. Green-yellow gas evolved
U. No gas evolved
V. Gas evolved which relights a glowing splint

1. Heat separately each of the substances α and β with liquid W until no further change occurs and then cool. Do not boil. Use about as much of α or β as will pile on this circle ( ) and about 0.5 cm^3 of W. Complete the following table for both α and β; 4 letters selected from A to V above are to appear in each blank space, representing what you think are the 4 most appropriate observations in each case.

Substance treated with solution W	Observations
α	
β	

2. Heat solid substance Y carefully in an ignition tube until no further change occurs. Use about the quantity of crystals which would pile on this circle 

Circle the four most appropriate letters which represent your observations, that is 4 of the following letters should be circled.

A B C D E F G H I J K

L M N O P Q R S T U V

3. Add dilute sodium hydroxide solution slowly to each of tubes X, Y and Z until it is present in excess in each case. Complete the following table for each tube; one letter selected from A to V above is to appear in each blank space, each pair representing what you think are the two most appropriate observations in each case.

Tube	Observations	
X		
Y		
Z		

END OF BOOKLET 22

PRACTICAL TESTS

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Accordingly, as you know, we have included some "pencil and paper practical items" in tests IIA (IEA/4A), IIP (IEA/4B) and IVA (IEA/10A) Science, and we are offering further lists, which require a very modest amount of equipment, as a national or school option. In this way we hope to obtain information, not only about achievement in science under varying school conditions, but also about the effectiveness of different kinds of test items.

The tests being offered as National Options are

II	Science Practical	1 1/2	hours
IV	Science Practical	1 1/2	hours
IV	Biology Practical	1	hour
IV	Chemistry Practical	1	hour
IV	Physics Practical	1	hour

More time has been allowed than is likely to be needed by the students to carry out the actual operations. This has been done to allow time for the general organisation of the test and to remove from the students any sense of pressure.

The behavioural categories of the practical items can be expressed as follows.

I The ability to use simple apparatus and to implement simple procedures.

II The ability to observe changes/differences in structures or systems under investigation and to record such changes/differences in ways that yield maximum relevant information.

III The ability to select appropriate apparatus and/or procedures for a novel experimental problem.

The attached note sets out the information that should be given to schools concerning the conditions and materials required for the tests and the conduct of the actual testing.

The tests should be scored by the schools and the scores checked by National Centers.

We shall be grateful if you will let us know as soon as possible if you intend to carry out science testing in practical abilities.

Note on practical tests to be send by National Centers to participating schools

These tests of practical abilities important in the learning of science are part of an international study and have been so designed as to require only the simplest of facilities and materials and to need very little in the way of preparation by the teacher.

The provision of a laboratory or a practical room is not essential, but each student should have an adequate area of suitable, flat-topped working space and to have reasonable access to water (for washing up etc.) and to places for the disposal of solid and liquid wastes.

For some tests gas (or some equivalent) for heating will be required.

In some cases, marked * in the appended lists, one set of apparatus can be used for up to five or six students, but if this is done the apparatus must be disconnected and restored to its original position before each new student begins that section of the test. The student should not, of course, be told what the various substances and materials are.

There should be a clock with a sweep second hand (not a stop clock) so placed that all students can see it.

The tests should be marked according to the given schedules and returned to the National Centers.

Requirements for IV Practical Chemistry

Each student to have

one ignition tube

a bunsen (or similar) burner

a tube containing a small quantity of substance (lead II oxide PbO) labelled substance α

a tube containing a small quantity of substance (lead IV oxide PbO_2) labelled substance β

a tube containing a small quantity of substance (lead II nitrate $Pb(NO_3)$ crystals) labelled substance γ

a lipped beaker (about 100 cm^3) containing approximately 5 M HCl and labelled liquid W

a tube containing 1 cm^3 of solution (approximately 1 M iron III chloride $FeCl_3$) labelled X

a tube containing 1 cm^3 of solution (approximately 1 M zinc sulphate $ZnSO_4$) labelled Y

a tube containing 1 cm³ of solution (approximately 1 M magnesium sulphate $MnSO_4$) labelled Z

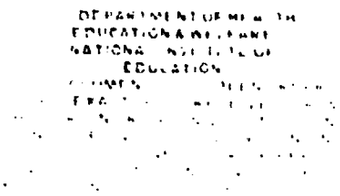
a small lipped beaker containing about 100 cm^3 of approximately 2 M sodium hydroxide solution labelled as such

a rack for test tubes

a splint for testing for oxygen

The basic procedures to be followed in the main testing of the IEA Six-Subject Survey were set out in a series of manuals:

Stage 2	IEA/M1	Manual for National Centers
	IEA/M2	Manual for School Coordinators
	IEA/M3	Manual for Test Administrators
Stage 3	IEA/M1/Stage 3	Manual for National Centers
	IEA/M2/Stage 3	Manual for School Coordinators
	IEA/M3/Stage 3	Manual for Test Administrators



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4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name Physcics Practical IV

Data Bank Instrument Number E4SXP

Practical tests were used only in Japan Population II and England Populations II and IV. These data will not be documented in the Six-Subject Data Bank.

POPULATION IV PHYSICS PRACTICAL (National Option)

This test is concerned with some of the practical abilities that are important in science, such as being able to read instructions and carry out simple manipulations, to observe accurately and record observations in an appropriate way, and to select the best method and equipment for a particular purpose.

The questions will ask you to carry out instructions and to observe and record the results.

In most questions you are asked to choose the best answer from a number of alternatives and to circle the letter corresponding to it.

Here is an example.

Which one of the following would you use to weigh a large crystal of copper sulphate to an accuracy of 0.01 gram?

A. A measuring cylinder
B. A compression spring balance reading in 0.5 Kg to 10.0 Kg
C. A set of household (kitchen) scales
(D) A chemical balance
E. A milliammeter

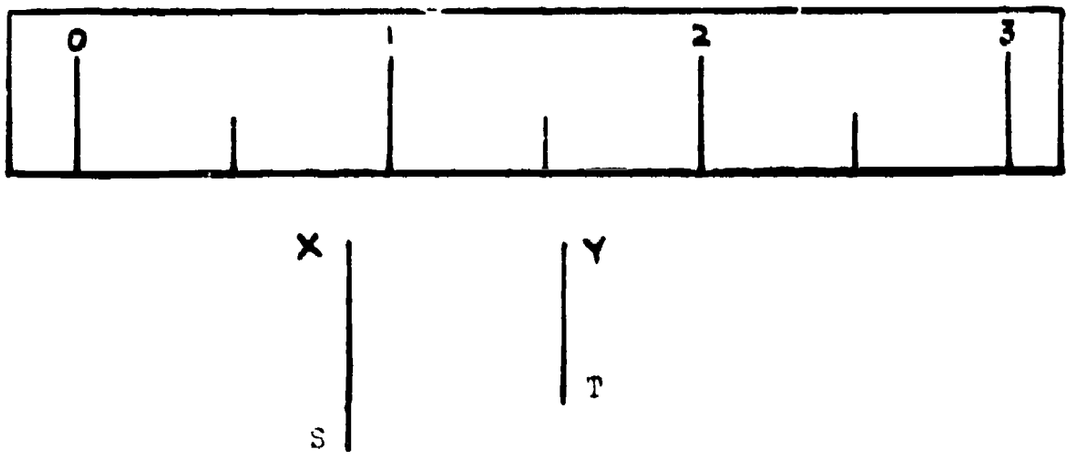
A measuring cylinder is used to measure volume, not weight. Similarly, a milliammeter is used to measure small electric currents. Hence we are left with B, C and D, all of which are used for measuring weight. But, of these, only the chemical balance would be capable of weighing a crystal to 0.01 gram, so that is the correct answer and the D should be circled as shown.

In these questions you will have to make measurements or other observations and record the results in a different way. All you have to do is to follow the instructions carefully.

You will have plenty of time, so do not hurry. But you will have to plan your work and to organise your time efficiently as, of course, the ability to do this is an important part of laboratory work.

Do not waste time on questions you do not understand or cannot do. Leave them and pass on to the next ones; you can always come back to those you leave later if there is time.

Questions 1, 2, 3 and 4 refer to the printed scale shown below.



Cut out the scale and use it to measure the distance between the ends, X and Y, of the two lines drawn above.

1. The distance between the two ends is

   A. 0.7 scale units
   B. 0.73 scale units
   C. 0.75 scale units
   D. 0.77 scale units
   E. 0.8 scale units

2. The unreliability of the measurement just given is

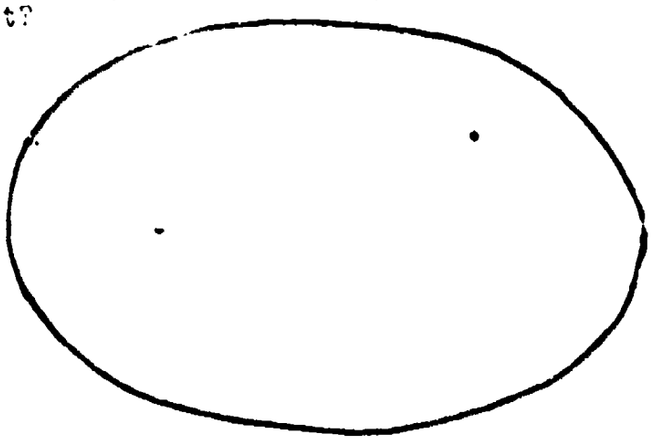
   A. 0.1
   B. 0.07
   C. 0.05
   D. 0.03
   E. 0.01

3. It is suspected that the paper scale you have used shrinks and expands with atmospheric humidity, that is the amount of moisture in the air. The best way to investigate whether or not this happens would be to

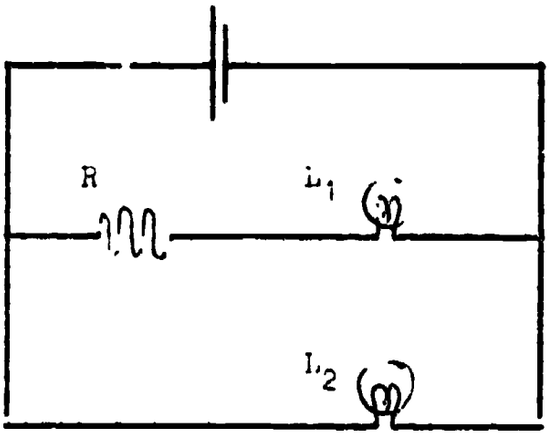
   A. measure the distance between the two ends referred to in the question every day for a month and see how the result varied.
   B. soak the scale in water and check its length against a metal ruler.
   C. check the length of the scale against a wooden ruler.
   D. soak the scale in water and check its length against a wooden ruler.
   E. check the length of the scale each day for a month against a metal ruler.

4. Which of the given areas do you consider to be the best estimate of the area enclosed by this outline, using the scale you have cut out?

A. 1.5 square units
B. 2.0 square units
C. 2.5 square units
D. 3.0 square units
E. 3.5 square units



5. Set up the circuit as shown in the diagram from the apparatus provided



Using the voltmeter or the ammeter as necessary, measure the following and record your results in the spaces provided.

I The voltage across L_1 _____
II The voltage across L_2 _____
III The voltage across R _____
IV The voltage across the accumulator _____
V The current taken from the accumulator _____
VI The current through L_1 _____
VII The current through L_2 _____

Using the apparatus provided set up a simple pendulum with a length of 50 cm. Now find the period of oscillation of the pendulum. The period of oscillation is the time it takes to make one complete swing, that is from one extreme of the swing to the other, and back again. It can also be taken from the time the pendulum passes through its central position until it passes through this position again moving in the same direction.

You have 20 minutes to choose one of the following methods and to complete the experiment and you should use the most accurate and reliable method of finding the period of oscillation within this available time.

Method A. Find the time of 25 swings. Repeat this process as many times as possible and work out the average time for one swing from the results.

Method B. Find the number of swings in one minute. Repeat as many times as possible and work out the time for one swing from the results.

Method C. Find the time for 100 swings. Repeat this a second time and then work out the average time for one swing.

Method D. Find the time for 1 swing. Repeat this 50 times, and then work out the average time for one swing.

Method E. Find the number of swings in 3 minutes. Repeat this twice more and then work out the average time of a swing from the results.

6. Which method did you choose?

A. B. C. D. E.

7. Underline the value closest to that you obtained

1.00	1 02	1.04	1.06	1.08	sec.
1.10	1.12	1.14	1.16	1.18	"
1.20	1.22	1.24	1.26	1.28	"
1.30	1.32	1.34	1.36	1.38	"
1.40	1.42	1.44	1.46	1.48	"
1.50	1.52	1.54	1.56	1.58	"
1.60	1.62	1.64	1.66	1.68	"
1.70	1.72	1.74	1.76	1.78	"

PRACTICAL TESTS

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There should be a clock with a sweep second hand (not a stop clock) so placed that all students can see it.

The tests should be marked according to the given schedules and returned to the National Centers.

Requirements for IV Practical Physics

Each student to have

a sharp pencil

a pair of scissors

* a 2 volt accumulator

a resistor

an ammeter

a voltmeter

wire connections

2 lamps in holders with suitable terminals

} any combinations that are suitable for the question may be used

a pendulum bob tied to 100 cm of fine thread

a meter rule

a retort stand with boss and clamp

two strips of metal to act as jaws of the pendulum support

IEA SIX-SUBJECT SURVEY INSTRUMENTS

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	IEA/M3	Manual for Test Administrators
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4-5: Instrument Within Type

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Instrument Name TOUS-Understanding the Nature of Science

Data Bank Instrument Number E2SN

"We are now ready to start Section T. The questions in this section deal with how scientists work. In answering the questions, read each question, choose the best answer and mark your choice in Section T on the answer card. Are there any questions?"

Make sure that students understand what they are to do.

Then say:-

"Begin working."

After 10 minutes say:-

"About half the time has gone. Remember, do not waste time on the questions you do not know how to do."

After 15 minutes says:-

"Stop working and put your pencils down."

UNDERSTANDING THE NATURE OF SCIENCE

1. Modern scientists can solve more complicated problems than the scientists of the past because they

   A. know that many of the ideas of earlier scientists were wrong.
   B. have more imagination than earlier scientists.
   C. can build on the ideas and discoveries of earlier scientists.
   D. are more intelligent than earlier scientists.
   E. receive a better education than earlier scientists.

2. Betty is planning an experiment on the conditions required for seeds to germinate. She knows that they need water and air and thinks that warmth and light may also be necessary. She plans to set up one experiment in which seeds of various kinds are given water and air in a warm light place.
   What other experiments should she set up?

   A. One other in which the seeds are without water and air and are kept in a cold, dark place.
   B. One other in which the seeds are without water and air and are kept in a cold, light place.
   C. One other in which the seeds have water and air and are kept in a cold, dark place.
   D. Two others; one in which the seeds have water and air and are kept in a cold, light place, and one in which the seeds have water and air and are kept in a warm, dark place.
   E. Two others, one in which the seeds have water and air and are kept in a cold, dark place and one in which the seeds are without water and air and are kept in a warm, light place.

3. All the following play some part in scientific discovery, but one of them is more characteristic of scientific investigation than the others. Which one is it?

   A. Measurement and calculation.
   B. Using complicated apparatus.
   C. Making experimental measurements more accurate.
   D. Checking through the work of earlier scientists.
   E. Testing ideas by observation and experiment.

4. Scientific discoveries have come from
   A. many countries of the world.
   B. only countries with big industries.
   C. only countries with large populations.
   D. almost all the countries with free education for all.
   E. only countries where the governments finance research.

5. In the past, important scientific discoveries were made by clergymen, statesmen, businessmen, and others who worked on science as amateurs. Why is this less true today?

A. Men in other professions are less interested in science today than they used to be.
B. Scientific research today requires many years of specialised preparation and training.
C. Important discoveries cannot be made today without expensive equipment, which only scientists possess.
D. Only professional scientists have the abilities needed to make important discoveries.
E. Everyone now has to work so hard at his own job that there is not time to work on science as an amateur.

6. We do experiments when we are learning science because

A. experiments are used to test ideas by experience.
B. experiments enable us to learn better.
C. experiments make learning more interesting.
D. we can show that we all get the same results.
E. it is important to learn to handle apparatus skilfully.

7. Why should one make a written note of all the observations made when carrying out a scientific investigation?

A. One might forget them, and they may turn out to be important later.
B. It is a good way to train powers of observation.
C. It trains one to think clearly and write accurately.
D. Good scientists always do it.
E. One is supposed to have a complete record of what one has done.

8. Which of the following is the most complete statement of what scientists <u>study?</u>

A. Atoms, radiations, life.
B. Substances, energy, living things.
C. Matter, space, waves.
D. Plants, animals, micro-organisms.
E. Molecules, earth, stars.

9. Which one of the following is the best description of a scientific experiment?

A. Measurements made to find the value of a physical constant to a greater degree of accuracy.
B. Observations made to learn more about natural phenomena.
C. Observations made under controlled conditions to test a given hypothesis.
D. Studies made with scientific equipment to verify natural laws.
E. Measurements made under specified conditions to support crude, unaided observations.

10. A scientist predicted that an experiment would come out in a certain way. When he did the experiment, the result was different from what he expected. As a scientist, which of the following would be his most likely reaction?

A. "I should not have made a prediction before trying out the experiment."
B. "I will improve the experiment and made it come out in the way I predicted."
C. "If I had better equipment for the experiment, I would get the right results."
D. "If I practise long enough, it will come out in the way I want it to."
E. "Something was wrong either with my prediction, the experiment, or my observations."

11. When new evidence that does not fit into a well-established scientific theory appears, which one of the following do scientists usually do?

A. Discard the theory and produce a new one.
B. Modify the evidence in such a way that it does fit the theory.
C. Keep the theory because it has proved useful and ignore the new evidence.
D. Change the theory in such a way that the evidence can fit it.
E. Design experiments to refute the new evidence.

12. The test of the validity of a scientific theory is that the theory

A. makes it easy to understand the world we live in.
B. stimulates further scientific investigation.
C. gives a simple picture of a complicated pattern of natural events.
D. makes a clear distinction between what are facts and what are beliefs.
E. explains all the known facts related to certain phenomena.

13. An astronomer in Australia reports that he has seen evidence of plant growth on the planet Venus. Scientists will accept this report as important evidence if

A. other independent observations confirm the report.
B. the species of plants have been identified.
C. the Australian government certifies the observation as correct.
D. other astronomers agree that there is oxygen on Venus.
E. the astronomer in Australia is a biologist as well as an astronomer.

14. Which of the following is the principal aim of scientific investigation?

A. To verify what has already been discovered about the physical universe.
B. To describe and explain natural phenomena in terms of principles and theories.
C. To discover, collect and classify as many facts as possible about inanimate and animate nature.
D. To provide the people of the world with the means for leading happier lives.
E. To make the world more technologically advanced and so do without hard physical labour.

15. John Smith is a very imaginative young person. If he does not become a scientist, what is the most likely explanation?

A. He might not want to give up his freedom of thought.
B. Imaginative people usually become artists or writers.
C. He might like some other field of work better than science.
D. Science is too factual and gives no scope for the imagination.
E. A scientist has to be objective which is impossible if one is imaginative.

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IEA/M2 Manual for School Coordinators
IEA/M3 Manual for Test Administrators

Stage 3 IEA/M1/Stage 3 Manual for National Centers
IEA/M2/Stage 3 Manual for School Coordinators
IEA/M3/Stage 3 Manual for Test Administrators

These manuals are available from ERIC Clearinghouse.

The following extracts from these manuals have been appended to this particular IEA instrument to provide researchers with the minimum necessary test instruction information (e.g., such things as the instructions on the practice items and the warnings concerning the amount of time left for the test have been omitted here). For full details, please consult the appropriate manuals.

The Data Bank Instrument Number which appears below is a new number, assigned since the instruments were administered for the purpose of easily linking items in the instruments with the resultant variables in the Data Bank holdings. Each such variable is named in the codebook using the new instrument number and (usually) the number of the item within the instrument from which the variable is derived. The key to the new instrument numbers is as follows:

1: Type of Instrument

E = Examination (student)
Q = Questionnaire (student)
T = Teacher questionnaire
S = School questionnaire

2: Student Population

1 = I
2 = II
3 = III
4 = IV
5 = I and II
6 = II and IV
7 = I, II and IV
8 = I and IV
S = IV Specialist
N = NA: Teacher or School questionnaire

3: Subject

S = Science
R = Reading Comprehension
L = Literature
M = Mother Tongue (Reading Comprehension and Literature)
E = English as a Foreign Language
F = French as a Foreign Language
C = Civic Education
2 = All Stage 2 Subjects
3 = All Stage 3 Subjects
5 = All Stage 2 and Stage 3 Subjects

4-5: Instrument Within Type

One or two characters used when necessary to uniquely identify each instrument when there is more than one instrument of the same type.

Instrument Name TOUS-Understanding the Nature of Science

Data Bank Instrument Number E4SN

"We are now ready to start Section T. The questions in this section deal with how scientists work. In answering the questions, read each question. Choose the best answer and mark your choice in Section T on the answer card. Are there any questions?"
Make sure that the students understand what they are to do. Then say:-
"Begin working."
After 10 minutes say:-
"About half the time has gone. Remember, do not waste time on the questions you do not know how to do."
After 15 minutes say:-
"Stop working and put your pencils down."

UNDERSTANDING THE NATURE OF SCIENCE

1. Which of the following is the most complete statement of what scientists study?

   A. Atoms, radiations, life.
   B. Substances, energy, living things.
   C. Matter, space, waves.
   D. Plants, animals, micro-organisms.
   E. Molecules, earth, stars.

2. Which of the following is the best description of a scientific law?

   A. A good guess about how things happen in nature.
   B. A rule that a scientist follows when he is working.
   C. A statement that summarises similar events in nature.
   D. A concise summary of the results of an experiment in mathematical terms.
   E. A description of natural events by the use of theoretical ideas.

3. Gay-Lussac carried out many experiments with gases and observed that when gases are heated, their volumes always increase in the same way provided that the pressure remains the same. Gay-Lussac expressed this by saying, "at constant pressure, the volume of a given mass of gas varies directly with the temperature." His statement is an example of

   A. the formulation of a scientific theory.
   B. the testing of a scientific hypothesis.
   C. the statement of a scientific law.
   D. a deduction from kinetic theory.
   E. stating the result of a scientific experiment.

4. Which on of the following is the best description of a scientific experiment?

   A. Measurements made to find the value of a physical constant to a greater degree of accuracy.
   B. Observations made to learn more about natural phenomena.
   C. Observations made under controlled conditions to test a given hypothesis.
   D. Studies made with scientific equipment to verify natural laws.
   E. Measurements made under specified conditions to support crude, unaided observations.

5. If a botanist wants to determine the factors that contribute to the growth of a certain plant, which of the following things would be <u>least</u> likely to help him?

   A. To formulate an hypothesis based on what he thinks the factors are.
   B. To find the mathematical equation that fits the plant's growth curve.
   C. To think about the factors that contribute to the growth of other plants.
   D. To look the subject up in the library.
   E. To talk his problem over with other botanists.

6. A scientist predicted that an experiment would come out in a certain way. When he did the experiment, the result was different from what he expected. As a scientist, which of the following would be his most likely reaction?

   A. "I should not have made a prediction before trying out the experiment."
   B. "I will improve the experiment and make it come out in the way I predicted."
   C. "If I had better equipment for the experiment, I would get the right results.
   D. "If I practise long enough, it will come out in the way I want it to."
   E. "Something was wrong either with my prediction, the experiment, or my observations."

7. When new evidence that does not fit into a well-established scientific theory appears, which one of the following do scientists usually do?

   A. Discard the theory and produce a new one.
   B. Modify the evidence in such a way that it does fit the theory.
   C. Keep the theory because it has proved useful and ignore the new evidence.
   D. Modify the theory in such a way that the evidence can fit it.
   E. Design experiments to refute the new evidence.

8. Which one of the following best describes the purpose of a scientific theory?

   A. It provides the final answer to a scientific question.
   B. It gives directions for making use of scientific discoveries.
   C. It relates facts and explains different natural events.
   D. It suggests good methods for carrying out scientific experiments.
   E. It implies the questions that lead to further important experiments.

9. In the 17th century, Newton formulated his laws of motion and the theory of universal gravitation, which were eventually accepted by all physicists. In the 20th century, Einstein proposed the much broader theory of relativity, which physicists have now generally accepted. Physicists today consider Newton's ideas as

   A. mistaken because of Newton's limited experience.
   B. concepts that can be contained within Einstein' theory.
   C. applicable only to physical events in the solar system.
   D. superior to Einstein's because they can be used to solve many physical problems.
   E. historically interesting but no longer of much value.

10. An astronomer in Australia reports that he has seen evidence of plant growth on the planet Venus. Scientists will accept this report as important evidence if

A. other independent observations confirm the report.
B. the species of plants have been identified.
C. the Australian government certifies the observation as correct.
D. other astronomers agree that there is oxygen on Venus.
E. the astronomer in Australia is a biologist as well as an astronomer.

11. Which of the following is the principal aim of scientific investigation?

A. To verify what has already been discovered about the physical universe.
B. To describe and explain natural phenomena in terms of principles and the theories.
C. To discover, collect and classify as many facts as possible about inanimate and animate nature.
D. To provide the people of the world with the means for leading happier lives.
E. To make the world more technologically advanced and so do without hard physical labour.

12. If we ask an astronomer to explain why some stars vary in their apparent brightness, he will most likely give his explanation in terms of

A. the logical necessity for some stars at least to vary in brightness.
B. accepted scientific laws and principles.
C. precise mathematical formulae and equations.
D. verified astronomical data.
E. the theory of the expanding universe.

13. John Smith is a very imaginative young person. If he does not become a scientist, what is the most likely explanation?

A. He might not want to give up his freedom of thought.
B. Imaginative people usually become artists or writers.
C. He might like some other field of work better than science.
D. Science is too factual and gives no scope from the imagination.
E. A scientist has to be objective which is impossible if one is imaginative.

14. Today, physicists of several countries are working on experiments to determine whether or not one of Einstein's theories correctly predicts the effect of gravity on light. This work best illustrates the fact that

A. an important function of a theory is to stimulate research.
B. it is important to have an accurate value for the velocity of light.
C. space travel has uncovered new facts that need explanation.
D. it takes a long time before a theory is found to be generally acceptable.
E. some people will always doubt the value of any theory.

15. The word model has a special meaning in science and models play an important part in scientific thinking. An example of a scientific model is "the atom is like a miniature solar system composed of electrons in orbits round a nucleus containing protons and neutrons". Which of the following statements about scientific models is NOT correct?

A. Models are mental images and may not represent reality.
B. Models contain as few assumptions as possible.
C. Models represent what scientists could see with very powerful instruments.
D. Models are only tentative and may be modified or discarded.
E. Models are useful because they express the unknown in terms of the known.