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AUSTRALIAN COUNCIL FOR EDUCATIONAL RESEARCH
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COMMONWEALTH SECONDARY SCHOLARSHIPS

EXAMINATION FOR TWO-YEAR SCHOLARSHIP 1969-70

COMPREHENSION AND INTERPRETATION
(SCIENCE)

Afternoon Session, Wednesday, 24th July, 1968

Time allowed : Two hours

TEST BOOKLET. TO BE HANDED IN WITH YOUR ANSWER SHEET.

INSTRUCTIONS TO CANDIDATES

This is a test of your ability to read and understand material of a scientific nature. It will be possible for you to do well on this test even though you may have studied only a little science in your school course.

The test consists of 12 units with an average of 5 to 6 questions in each unit. You are strongly advised to observe the following points :

- (1) Work carefully through the questions in the order in which they are given.
- (2) Do not waste time ; if, after making a genuine effort, you still find the question too difficult, go on to the next question and come back to the difficult ones later.
- (3) If you think you know an answer, give it, even if you are not certain that you are correct.
- (4) Make sure that you mark each answer in the correct space on the Answer Sheet.

ANSWERING

For each question you will be given four alternative answers. These alternative choices will be represented by the letters A B C D. You are required to select one answer from these alternatives. Indicate your answer by putting a black pencil mark between the dotted lines across the letter representing your choice.

If you wish to change your answer you must erase your first mark completely. Try to avoid the necessity for making erasures by not answering hastily. Take care that your pencil mark does NOT CROSS into another row or column, that is, it does not go outside one dotted space, and that there are no marks or smudges on your answer sheet.

For example, if you choose D you should mark your answer sheet as follows :

~~A~~ ~~B~~ ~~C~~ **D**

Now look through this examination paper, but DO NOT START WRITING until the supervisor tells you to do so.

UNIT 1

According to one theory, the formation of a star or a planet begins when a cloud of interstellar dust and gas condenses and begins to contract under the inward force of its own gravity. As this cloud contracts, individual atoms within it fall towards its centre. As they fall, their speed increases and they collide with one another more frequently and violently. These collisions raise the temperature of the interior of the cloud.

If the cloud is of a sufficiently large mass, the heating effect of these atomic collisions is extremely great, and the temperature at some point or points at the centre of the cloud may reach a value of 20 million degrees. At this temperature, nuclear reactions in which hydrogen is transformed to helium become self-sustaining. When the reaction becomes self-sustaining the mass which has condensed is termed a star.

If the cloud is of relatively small mass, the heating effect is not sufficient to raise the temperature at the centre of the cloud to 20 million degrees. In this case, self-sustaining nuclear reactions do not occur and the object is a planet.

Among the giant planets, Jupiter is the one whose properties have been most extensively studied. Its interior is very hot, with an estimated temperature of about half a million degrees. There seems to be some evidence for considering Jupiter to be a small star rather than a planet. It was discovered recently for example that Jupiter is emitting more energy into space than it absorbs from the sun.

According to the most accurate calculations available, the mass of Jupiter is at least 30 times too small to produce temperatures needed to start self-sustaining nuclear reactions. There must therefore be another explanation for the fact that Jupiter is emitting more energy than it absorbs.

One such explanation is that Jupiter is still contracting at a very low rate due to its mass, and as it contracts it releases energy.

1. According to the theory outlined in paragraphs 1 to 3 a star may be formed when
 - A. a temperature of 20 million degrees in interstellar matter causes a cloud of dust and gas to contract.
 - B. self-sustaining nuclear reactions raise the temperature of a cloud of interstellar gas and dust to 20 million degrees.
 - C. as a result of atomic collisions in a contracting cloud of interstellar dust and gas, the temperature at the centre of the cloud rises to at least 20 million degrees.
 - D. the interior of a giant planet reaches a temperature of 20 million degrees as a result of self-sustaining nuclear reactions.
2. A theory of the formation of stars is advanced in paragraphs 1 to 3. Which one of the following facts concerning the *sun* provides the best evidence for the view that it is a star?
 - A. The sun is the largest body in our solar system.
 - B. The sun radiates energy produced from self-sustaining nuclear reactions.
 - C. The sun absorbs little or no energy from external sources.
 - D. A number of bodies such as the earth revolve around the sun.
3. Which one of the following is true for most objects called planets and stars?
 - A. A planet does not emit energy ; a star does.
 - B. A planet has no external source of energy ; a star has.
 - C. A planet emits energy ; a star absorbs it.
 - D. A star emits more energy than it absorbs ; a planet absorbs more energy than it emits.
4. Which one of the following statements may be inferred from the information given?
 - A. The interior of Jupiter will eventually reach a temperature of 20 million degrees and Jupiter will become a star.
 - B. Jupiter will never become a star as its mass is too small.
 - C. The contraction of Jupiter is due to self-sustaining nuclear reactions.
 - D. The mass of Jupiter is steadily increasing as it shrinks, so Jupiter may eventually become a star.
5. According to the information given, the observed fact about Jupiter which requires a scientific explanation is that it
 - A. is a planet with a self-sustaining nuclear reaction.
 - B. is a small star in a solar system which already has one star.
 - C. absorbs less energy than it emits.
 - D. is a star although its internal temperature is less than 20 million degrees.

UNIT 2

When the response of a human or other animal to a stimulus is involuntary, the stimulus is called an unconditioned stimulus (UCS), and the response is called an unconditioned response (UCR). The stimulus is said to have brought about or elicited the response. The rapid involuntary withdrawal of the hand from the hot surface is an example of an UCR to the UCS of a large temperature difference. A second example of an UCR is the production of tears when an onion is held close to the eyes.

Humans and other animals can be conditioned to respond in a specific way to a previously neutral stimulus, that is one to which they have not responded in this way. The response is then called a conditioned response (CR), and the neutral stimulus becomes a conditioned stimulus (CS).

Both glandular and muscular responses can be conditioned.

The following experiment describes a process by which a response may be conditioned.

- (i) A bell is rung, and while it is still ringing, or immediately it ceases to ring, some meat powder is placed on a dog's tongue. The UCR of salivation is elicited by the meat powder.
- (ii) After a number of repetitions (called trials) of this procedure, the bell is rung but no meat powder is presented to the dog. The dog salivates, thus making a CR to the CS of the bell ringing.
- (iii) If the bell is rung many times and the dog repeatedly not rewarded with meat powder, the dog will eventually cease to salivate at the sound of the bell, and the CR is said to be extinguished.

The experiment may be repeated many times using the same dog.

6. When a doctor taps a patient just below the knee with a hammer and the patient's foot jerks upward, the movement of the foot may be described in this situation as
 - A. a conditioned response.
 - B. an unconditioned stimulus.
 - C. an unconditioned response.
 - D. a conditioned stimulus.
7. Before stage (i) in the experiment outlined above, the bell could be classed as
 - A. an UCR.
 - B. a CS.
 - C. a CR.
 - D. none of the above.
8. In stage (ii) of the experiment the experimenter observed that the dog
 - A. responded to a previously neutral stimulus.
 - B. confused the bell with the meat powder.
 - C. turned a neutral stimulus into an unconditioned stimulus.
 - D. learned to salivate on presentation of meat powder.
9. An extinguished CR can be restored. From the information given this could probably be done by repeatedly
 - A. presenting the UCS.
 - B. presenting the UCS followed by the former CS.
 - C. withholding the reward until the CR recurs.
 - D. presenting the former CS followed immediately by the UCS.
10. Below are a number of sentences connected with the experiment described.
 - L. The bell is rung and the dog salivates.
 - M. Meat powder is given to the dog and the dog salivates.
 - N. The bell is rung and the dog does not salivate.
 - O. Meat powder is given to the dog, the dog salivates, and a bell is rung.
 - P. The bell is rung, meat powder is given to the dog, and the dog salivates.

You are to arrange *three* of the above sentences into a sequence which best describes how you could demonstrate the process of conditioning outlined in the experiment. Of the following arrangements (A, B, C, D) the best one is

| | |
|-------------|-------------|
| A. N, P, L. | C. N, M, L. |
| B. P, L, N. | D. M, P, L. |

UNIT 3

Blood consists of plasma, blood cells, and minute cell-like bodies called platelets. The plasma, a liquid, has suspended in it the blood cells and the platelets and contains dissolved substances. The substances dissolved in the plasma include prothrombin (the formation of which requires an adequate supply of vitamin K), fibrinogen, and calcium salts. The platelets, though usually stable within the bloodstream, disintegrate in the presence of air.

A blood clot is composed of a tangled mass of an insoluble substance, fibrin, in which blood cells and platelets are trapped. It is important that clotting should not take place within a blood vessel such as an artery or a vein. Fibrin is not normally present in the blood but it is formed during clotting by the series of reactions described below.

- (i) When bleeding occurs, the platelets disintegrate at the site of the wound, causing substances known as thromboplastins to be released into the plasma.
 - (ii) Then, depending on the presence of calcium salts in the plasma, thromboplastin converts prothrombin to thrombin.
 - (iii) The formation of thrombin sets off a chain of reactions which changes all the fibrinogen at the site of the wound into fibrin. Thrombin, or a substance derived from it, remains at the end of these reactions.
11. A sample of blood is removed from an animal and allowed to clot. The fluid remaining after blood has clotted is called serum. Only one of the following substances is *not* present in serum. Which one?
- A. Prothrombin.
 - B. Calcium salts.
 - C. Fibrinogen.
 - D. Fibrin.
12. The fact that blood does not normally clot in veins and arteries is evidence that within the bloodstream
- A. thrombin is not usually present.
 - B. vitamin K is present.
 - C. fibrinogen is present.
 - D. prothrombin is present.
13. Which one of the following statements is correct?
- A. Thromboplastin is not normally present in blood plasma.
 - B. Thromboplastin requires vitamin K for its production.
 - C. Thromboplastin releases calcium for the production of thrombin.
 - D. Thromboplastin reacts with both calcium and thrombin to produce another substance.
14. The statements below describe the events which take place following bleeding from a minor wound.
- L. Thrombin and fibrinogen react to form fibrin.
 - M. Thromboplastin is released from the platelets.
 - N. Clotting at the site of the wound prevents further loss of blood.
 - O. Calcium, thromboplastin and prothrombin react to form thrombin.
 - P. Platelets disintegrate when they escape from blood vessels.

Select from the following alternatives (A, B, C, D) the one which represents the sequence in which the events actually occur :

- A. N, P, M, O, L
- B. P, M, O, L, N
- C. P, L, O, M, N
- D. L, N, M, P, O

15. Under abnormal circumstances blood may clot inside a blood vessel, forming a plug (called a thrombus), which stops the flow of blood through the blood vessel at that site. On the information given, there must be
- A. a lack of vitamin K in the body.
 - B. excess fibrinogen in the blood due to lack of prothrombin.
 - C. disintegration of unstable platelets at the site of the clot.
 - D. a blood disease causing excess production of blood platelets.
16. Sodium citrate prevents blood from clotting as it prevents calcium salts from reacting with other substances. Clotting does not proceed. This is due to the absence from the blood of
- A. thromboplastin.
 - B. thrombin.
 - C. fibrinogen.
 - D. platelets.

UNIT 4

| | Y | B | V | R | G | YY | BB | VV | RR | GG | YB | BR |
|----|---|---|---|---|---|----|----|----|----|----|----|----|
| Y | | | | | | | | | | | | |
| B | | | | | | | | | | | | |
| V | | | | | | | | | | | | |
| R | | | | | | | | | | | | |
| G | | | | | | | | | | | | |
| YY | | | | | | | | | | | | |
| BB | | | | | | | | | | | | |
| VV | | | | | | | | | | | | |
| RR | | | | | | | | | | | | |
| GG | | | | | | | | | | | | |
| YB | | | | | | | | | | | | |
| BR | | | | | | | | | | | | |

In any flock of domestic hens, each hen occupies a set place in an ascending hierarchy or "ladder" of dominance. The hen on the lowest "rung" of the ladder must submit to all the other hens. Higher up the ladder, a hen dominates those below it and submits to those above. The top hen dominates all the others.

Dominance carries privileges. Thus the more dominant hens in a flock get first chance at the food trough, the dusting areas, the roost and the nest boxes, whilst the less dominant hens must give way and take what is left of the food and shelter.

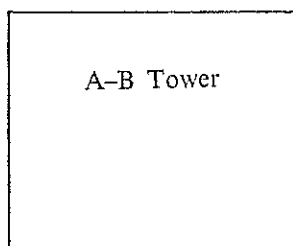
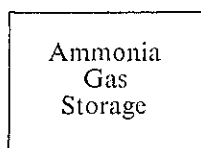
The order of dominance in a flock is deduced from observations of the hens pecking one another.

The chart opposite illustrates the peck-order of an experimental flock of twelve Rhode Island Red hens. Each hen in the flock is marked with either one or two colours; yellow (*Y*), blue (*B*), violet (*V*), red (*R*), and green (*G*). The hen with a yellow marking (column at far left) pecked all eleven of the other hens and was pecked by none of them. The number of times it pecked each one of them is indicated by the numbers in the columns. The hen with the blue marking (second column) pecked ten of the other hens but was pecked by the hen with a yellow marking. The hen with a blue and red marking pecked none of the other hens and was pecked by all.

A hen submits to all hens which peck it, and dominates all hens which it may peck.

17. To find out how many hens peck the hen labelled *RR* we
- count the number of light-shaded hens in the 9th column.
 - add the numbers in the 9th column.
 - subtract the number of light-shaded hens in the 9th row from 12.
 - subtract the number of light-shaded hens in the 9th column from 12.
18. How many hens could the hen labelled *GG* peck ?
- 2
 - 3
 - 9
 - 12
19. What was the label of the hen pecked by four other hens ?
- VV*
 - G*
 - B*
 - RR*
20. The hen labelled *BB* would *not* peck the hen labelled
- BR*
 - RR*
 - YY*
 - VV*
21. The most dominant hen in the flock
- pecks all the hens and is pecked by all of them.
 - pecks no hens and is pecked by none.
 - pecks all the hens and is pecked by none.
 - pecks no hens and is pecked by all the others.
22. The letters *H*, *J*, *K*, *L*, *M* and *N* represent different birds in a flock of six hens. The following instances of pecking were observed :
- | | |
|--------------------------|--------------------------|
| <i>K</i> pecked <i>H</i> | <i>H</i> pecked <i>J</i> |
| <i>L</i> pecked <i>N</i> | <i>J</i> pecked <i>N</i> |
| <i>M</i> pecked <i>L</i> | <i>L</i> pecked <i>K</i> |
- The most dominant hen in the flock
- was *J*.
 - was *L*.
 - was *M*.
 - cannot be determined.

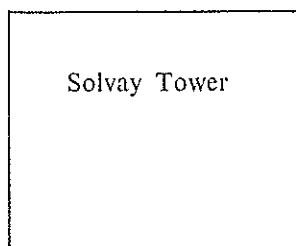
UNIT 5



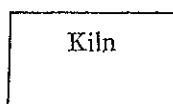
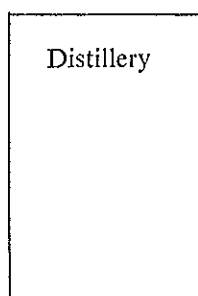
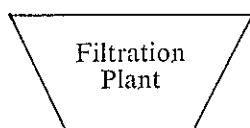
The diagrams at the left represent some of the equipment used in the Solvay process for the industrial preparation of washing soda (sodium carbonate). This process is one by which sodium carbonate can be continuously produced.

Ammonia gas, which dissolves readily in water (and in brine) is pumped into the *A-B Tower* which contains brine. The brine, a solution of sodium chloride in water, has present in it impurities including magnesium salts and calcium salts.

These impurities are removed from the brine solution, in the *A-B tower*, by adding a small quantity of sodium bicarbonate dissolved in water. This forms insoluble calcium carbonate and magnesium carbonate.



The purified solution now passes to the *Solvay Tower* into which carbon dioxide gas is pumped. This results in the formation of sodium bicarbonate. Sodium bicarbonate is less soluble in water than sodium carbonate i.e. less of it dissolves in the same mass of water at the same temperature.



All the materials in the *Solvay Tower* are piped to the *Filtration Plant* where the solid (undissolved) sodium bicarbonate is removed. This solid is heated in the *Oven* where it decomposes into sodium carbonate and carbon dioxide gas. The solution remaining in the *Filtration Plant* is passed into the *Distillery* where calcium oxide (lime) is added. Steam is then pumped in, and ammonia, given off as a gas, is collected for re-use in the process.

The carbon dioxide and the lime used for the preparation of sodium carbonate are obtained by heating calcium carbonate (limestone) in the *Kiln* where it decomposes into calcium oxide and carbon dioxide.

Two essential reactions in the Solvay process can be written :

- (i) ammonia + water + carbon dioxide \rightleftharpoons ammonium bicarbonate.
- (ii) ammonium bicarbonate + sodium chloride \rightleftharpoons ammonium chloride + sodium bicarbonate.

23. Which of the following statements is true ?
- A. Reaction (i) occurs in the *A-B* Tower and reaction (ii) in the Solvay Tower.
 - B. Reaction (i) occurs in the Solvay Tower and reaction (ii) in the *A-B* Tower.
 - C. Reactions (i) and (ii) both occur in the *A-B* Tower.
 - D. Reactions (i) and (ii) both occur in the Solvay Tower.
24. Except for steam, all the materials used in the Distillery come directly from
- A. the *A-B* Tower and the Filtration Plant.
 - B. the Kiln and the Filtration Plant.
 - C. the Oven and the *A-B* Tower.
 - D. the Solvay Tower and the Oven.
25. The gas produced in the Distillery is recirculated for use in the
- A. Oven.
 - B. Kiln.
 - C. Filtration Plant.
 - D. Solvay Tower.
26. The gas produced in the Kiln is used in the
- A. *A-B* Tower.
 - B. Solvay Tower.
 - C. Ammonia Gas Storage.
 - D. Filtration Plant.
27. Washing soda is most likely collected from the
- A. Oven.
 - B. Kiln.
 - C. Distillery.
 - D. Filtration Plant.
28. Ammonia is far more expensive than the limestone, brine and carbon dioxide used in the Solvay process. In which part of the process is the ammonia recovered for further use ?
- A. Solvay Tower
 - B. Filtration Plant
 - C. Kiln
 - D. Distillery
29. Intermediate products can be defined as those which are formed during the process and are then used in the formation of the final product.
- Which one of the following substances is an intermediate product in the Solvay process ?
- A. sodium chloride
 - B. calcium chloride
 - C. sodium bicarbonate
 - D. sodium carbonate

UNIT 6

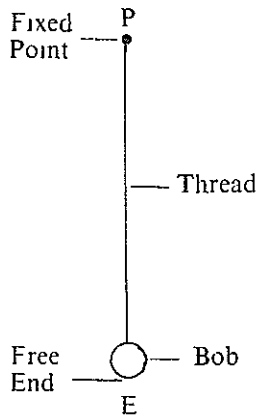


FIG. 1

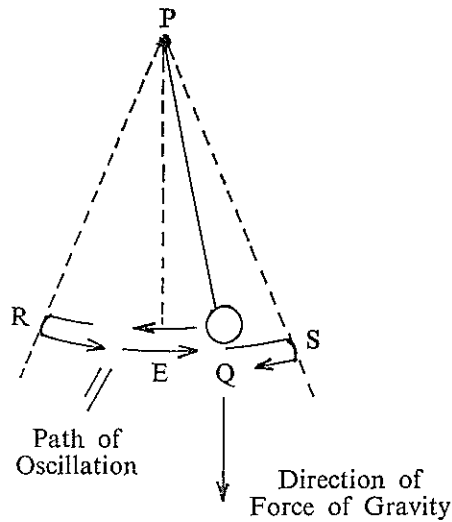


FIG. 2

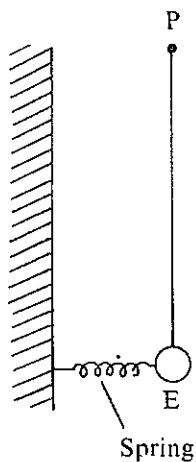


FIG. 3

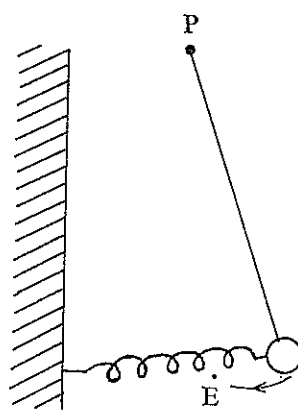


FIG. 4

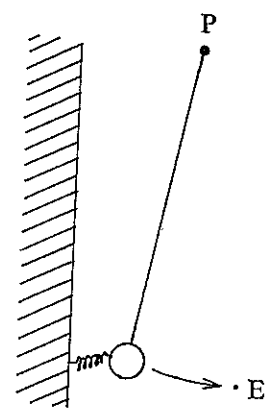


FIG. 5

The simple pendulum, consisting of a thread with a weight (bob) at one end and attached to a fixed point P at the other end, is an example of an oscillating system. Figure 1 shows a pendulum in its equilibrium position.

If the bob is pulled aside and allowed to swing, the pendulum will oscillate to and fro about its equilibrium position, as shown in Figure 2.

In all oscillating systems there is a *restoring force*, which tends to return the system to its equilibrium position (E). In any simple pendulum, the force of gravity, which acts vertically downwards, determines the magnitude of the restoring force. The number of oscillations in a specified period of time is called the frequency of oscillation. The path traced by the bob in moving from Q to R , to S and back to Q in Figure 2 is an example of one complete oscillation.

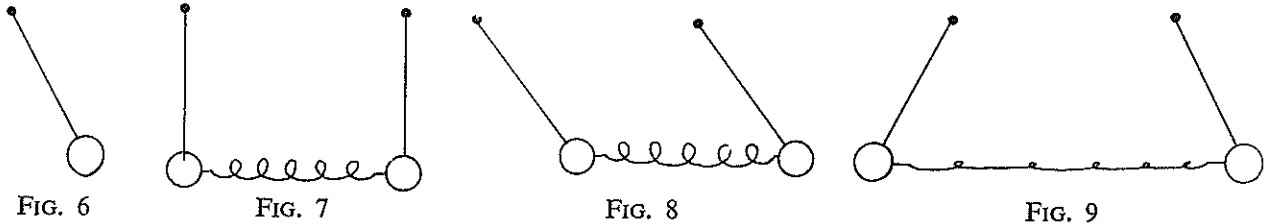
If two oscillating systems are identical except in their restoring forces, the one with the larger restoring force will have the greater frequency of oscillation.

A force additional to the gravity force can be applied to the pendulum by means of a spring. When the spring is relaxed and the thread is hanging vertically (Figure 3) there is no restoring force acting on the bob. When the spring is in a stretched position it pulls the bob which then moves in the direction shown by the arrow (Figure 4). When the spring is compressed it pushes the bob in the direction shown by the arrow (Figure 5).

The restoring force can be increased, for example, by using a stiffer spring.

30. Two pendulums like the ones shown in Figures 1 and 3 of the same length and with identical bobs are set into oscillation by pulling the bobs aside and letting them go. The frequency of oscillation of the pendulum in Figure 3
- is always greater than that of the pendulum in Figure 1.
 - is always less than that of the pendulum in Figure 1.
 - is always the same as that of the pendulum in Figure 1.
 - is either *A*, *B*, or *C* above, depending on the stiffness of the spring.

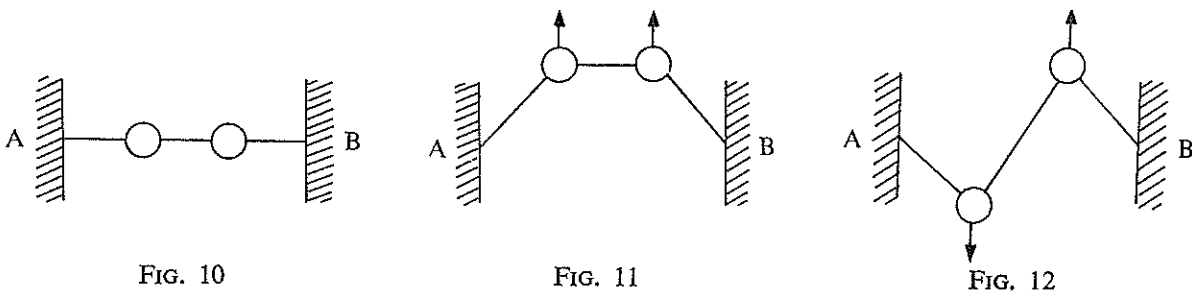
31. Two simple pendulums identical with the one shown in Figure 6 are coupled, as shown in Figure 7 below, to a spring which may be considered weightless. Both the bobs are pulled in the same direction, the same distance from their equilibrium positions (Figure 8).



- The frequency of oscillation of the left-hand pendulum shown in Figure 8
- is always greater than that of the oscillating system shown in Figure 6.
 - is always less than that of the oscillating system shown in Figure 6.
 - is always the same as that of the oscillating system shown in Figure 6.
 - is either *A*, *B*, or *C* above, depending on the stiffness of the spring.

32. The bobs of the pendulums shown in Figure 7 are now pulled from their equilibrium positions the same distance in *opposite* directions (Figure 9) and then released. The frequency of oscillation of the left-hand pendulum in Figure 9
- is always greater than that of the oscillating system shown in Figure 6.
 - is always less than that of the oscillating system shown in Figure 6.
 - is always the same as that of the oscillating system shown in Figure 6.
 - is either *A*, *B*, or *C* above, depending on the stiffness of the spring.

Two identical bobs are strung on a rubber band between two pegs *A* and *B* mounted on a horizontal table. The bobs slide smoothly on the surface of the table (Figure 10). They are set in oscillation by pulling them in the *same* direction as shown in Figure 11 and then releasing them. After coming to rest, they are again set into oscillation by pulling them aside in *opposite* directions, as shown in Figure 12 and letting go.



33. Consider the left-hand bob. The frequency of its oscillation is
- greater in the first situation (Figure 11) than in the second (Figure 12).
 - less in the first situation (Figure 11) than in the second (Figure 12).
 - the same in the first situation (Figure 11) as in the second (Figure 12).
 - either *A*, *B* or *C*, depending on the stiffness of the rubber band.
34. If the bobs are set in motion as shown in Figure 11, the frequency of oscillation of the right-hand bob is
- greater than that of the left-hand bob.
 - less than that of the left-hand bob.
 - the same as that of the left-hand bob.
 - either *A*, *B* or *C*, depending on the stiffness of the rubber band.

UNIT 7

In a number of different species of insects the population consists of several different types of individuals, each adapted for some particular function.

The honey bee colony consists of a single queen, a few hundred drones (males) and thousands of workers (sterile females). Young adult workers act as nurses to feed the larvae which emerge from the eggs laid by the queen. Older workers act as guards at the entrance of the hive ; they receive and store nectar, secrete wax for new cells and keep the hive clean. The oldest workers fly from the hive and search for water, pollen and nectar.

The passage below and the diagrams refer to the observations made by an Austrian scientist who found that bees can communicate with each other to describe the location, and distance from the hive, of a food supply.

A scout that has located food, returns to the hive loaded with pollen and performs the "waggle" dance on the wall of the honeycomb. (The dance is called a "waggle" dance because the bee's abdomen "waggles" during the performance of the dance.) Two distinct types of waggle dance have been identified. If the food is less than 10 metres away the pattern of the scout's dance consists of small circles made first to the left and then to the right. However, if the food is 300 metres, or more, away the dance includes a short "straight" series of steps between each semi-circle made to the left and to the right. The angles these "straight" runs make with the vertical describe the position of the food relative to the sun. For instance if the food is in the direction of the sun from the hive, the straight run is vertically upward on the side of the comb. The bee then semi-circles around and repeats the straight run. If the food is in the direction away from the sun, the straight run is vertically downward; if the food is located 60 degrees to the left of the sun from the hive, the straight run is 60 degrees to the left of the vertical, and so on, as illustrated in the following diagrams.

FIG. 1

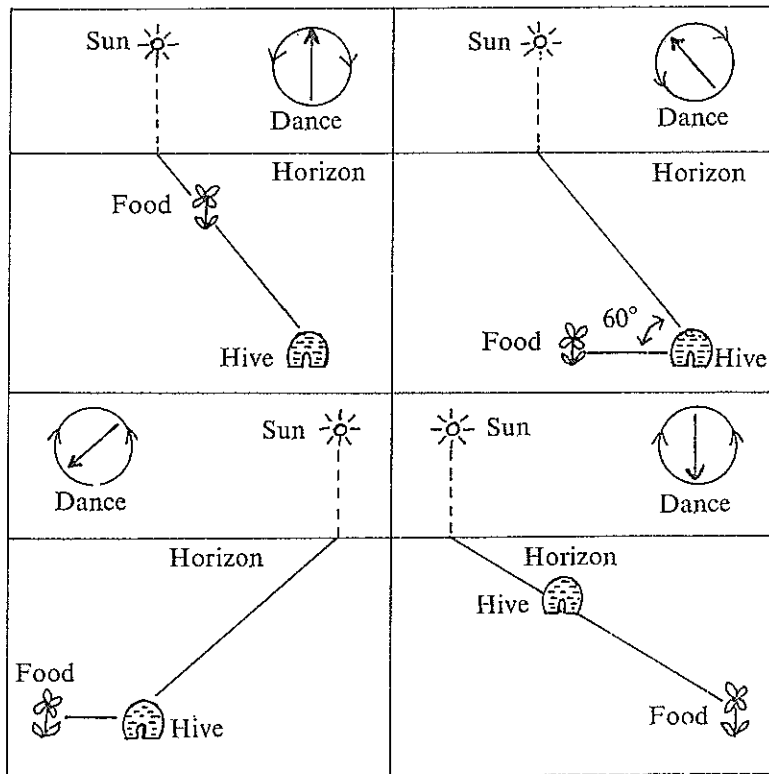
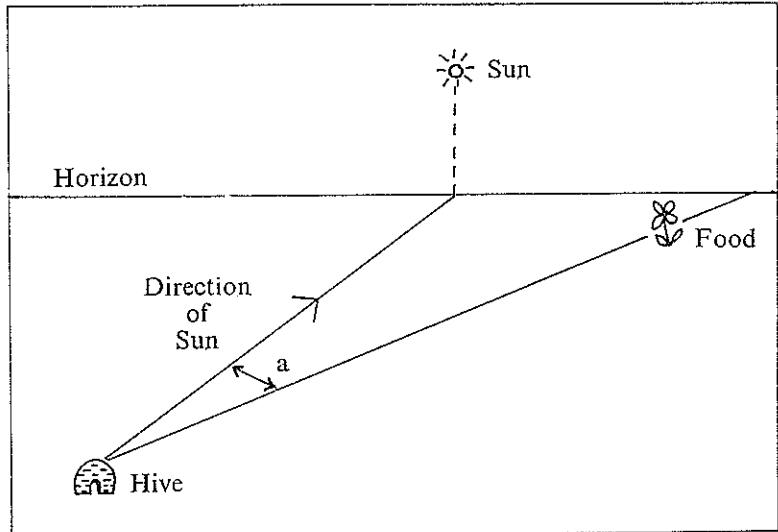


FIG. 2

35. The bee scout is
- A. a young worker.
 - B. one of the oldest males.
 - C. a sterile female.
 - D. a mature drone.
36. The waggle dance is performed
- A. on the ground.
 - B. in the hive.
 - C. at the food source.
 - D. between the food source and the hive.

37. Which one of the figures *A* to *D* below could represent a waggle dance of a scout, when the food source, the hive and the sun were in the same relative positions as those shown in Figure 3 ?

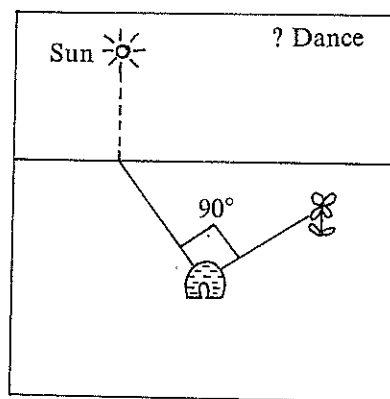
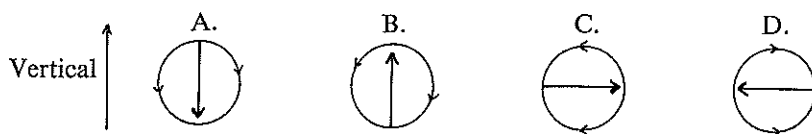
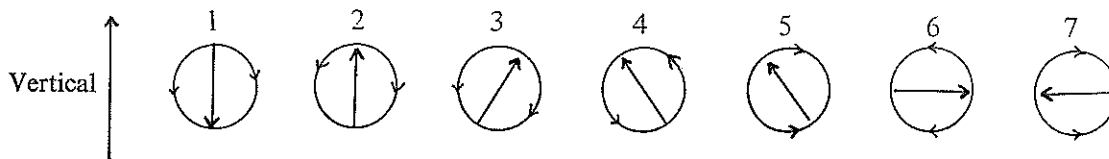


FIG. 3



38. The diagrams 1-7 represent waggle dances, two of which are *not* typical dance patterns.



From the following alternatives (*A*, *B*, *C*, *D*) choose the one which lists the two which are *not* typical dance patterns.

- A. 1, 4.
- B. 6, 7.
- C. 4, 5.
- D. 2, 3.

39. Here are five conclusions which might be drawn from the pattern of a waggle dance

1. The food source is at a distance greater than 300 metres from the hive.
2. The food source is in the direction of the sun from the hive.
3. The food source is more than 10 metres from the hive.
4. The food source is directly above the face of the honeycomb.
5. The waggle dance is performed at least 50 metres from the food source.

Figure 4 shows the stages of a particular waggle dance.



FIG. 4

Which two of the above conclusions are correct for this particular waggle dance? Select the correct pair of conclusions from the following alternatives.

- A. 1, 2
- B. 1, 3
- C. 2, 3
- D. 3, 5

UNIT 8

Figure 1 below represents a view from above of the rocks occurring on the surface of a level piece of ground.

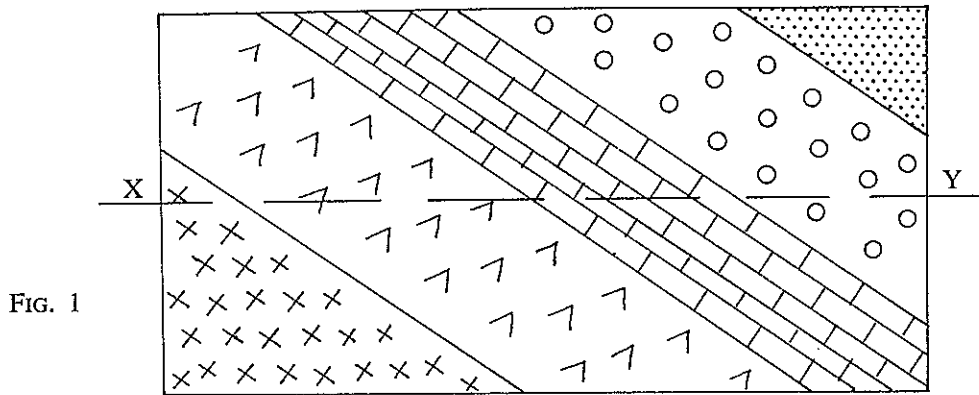
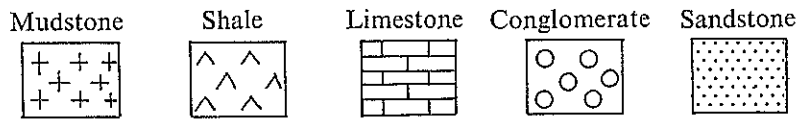
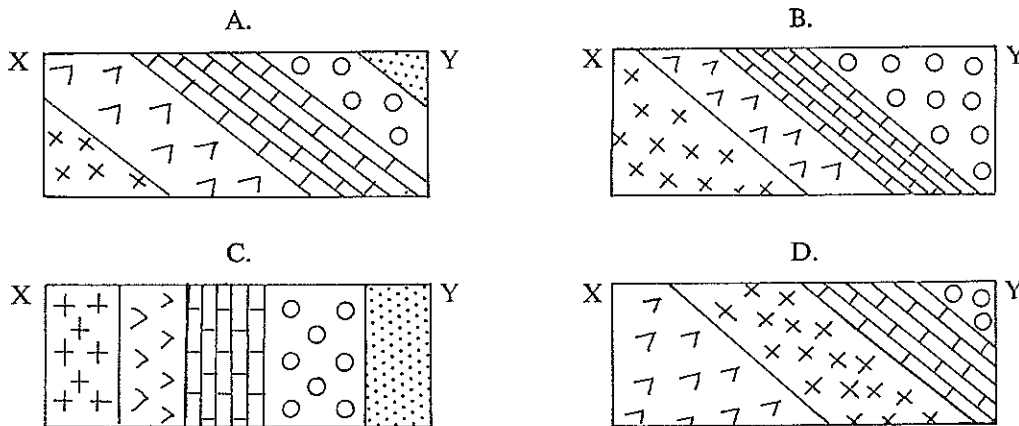


FIG. 1



40. If a vertical cutting was produced along the line *XY*, which one of the following could represent the rocks on the side of the cutting ?



41. If the rocks on the side of a cutting through the area mapped in Figure 1 appeared as in Figure 2, along which of the directions in Figure 3 (which is a reproduction of Figure 1) was the cutting ?

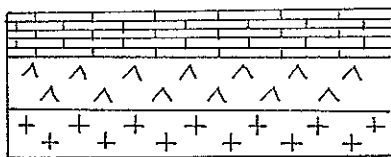


FIG. 2

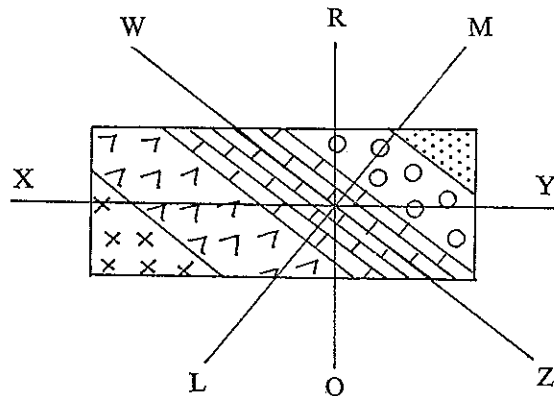


FIG. 3

- A. *LM*
- B. *OR*
- C. *XY*
- D. *WZ*

42. Rocks are deposited in layers on top of one another with the oldest rocks on the bottom. Which of the following could be the oldest rock of the 5 in Figure 1 ?
- A. limestone
 - B. conglomerate
 - C. shale
 - D. mudstone

The following information refers to questions 43 to 45 but not necessarily to questions 40 to 42.

Sometimes layers of rock are folded due to pressures caused by earth movements, so that flat layers of rock become bent or "folded" as in Figure 4 which shows folded rocks in the earth's crust.

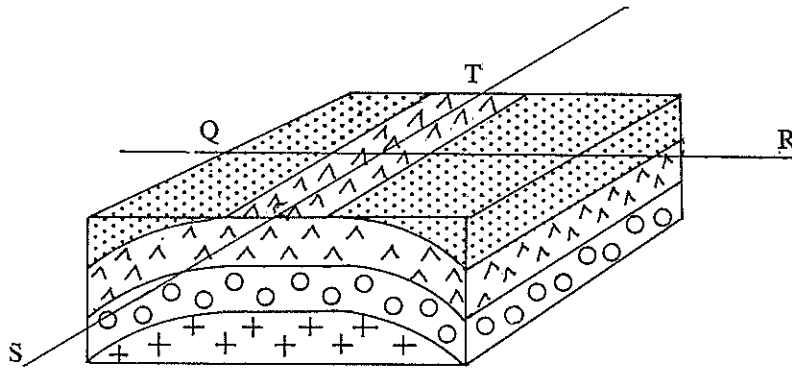
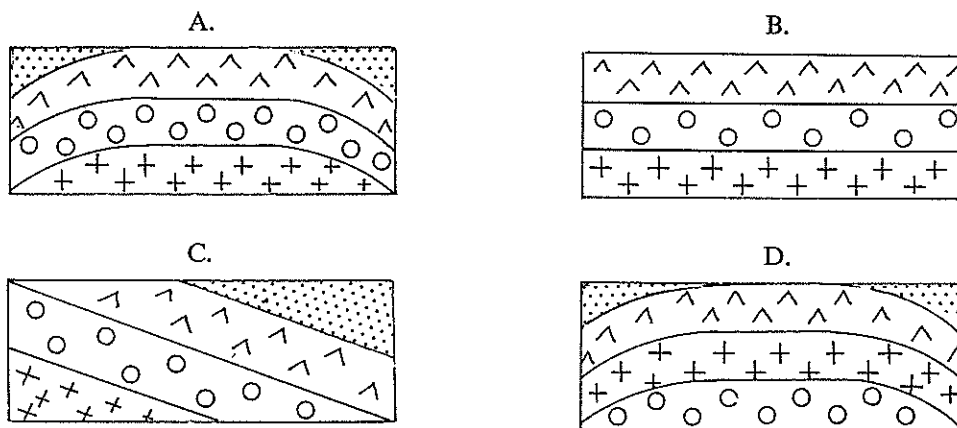


FIG. 4

43. Which of the rocks in Figure 4 is most likely the oldest ?

- A. sandstone
- B. conglomerate
- C. limestone
- D. mudstone

44. If a vertical cutting was made through the area represented in Figure 4 along the direction of QR and downwards, which of the following would represent the rocks on the side of the cutting ?



45. Which of the alternatives A to D would represent the side of a cutting along the line ST and downwards in Figure 4 ?

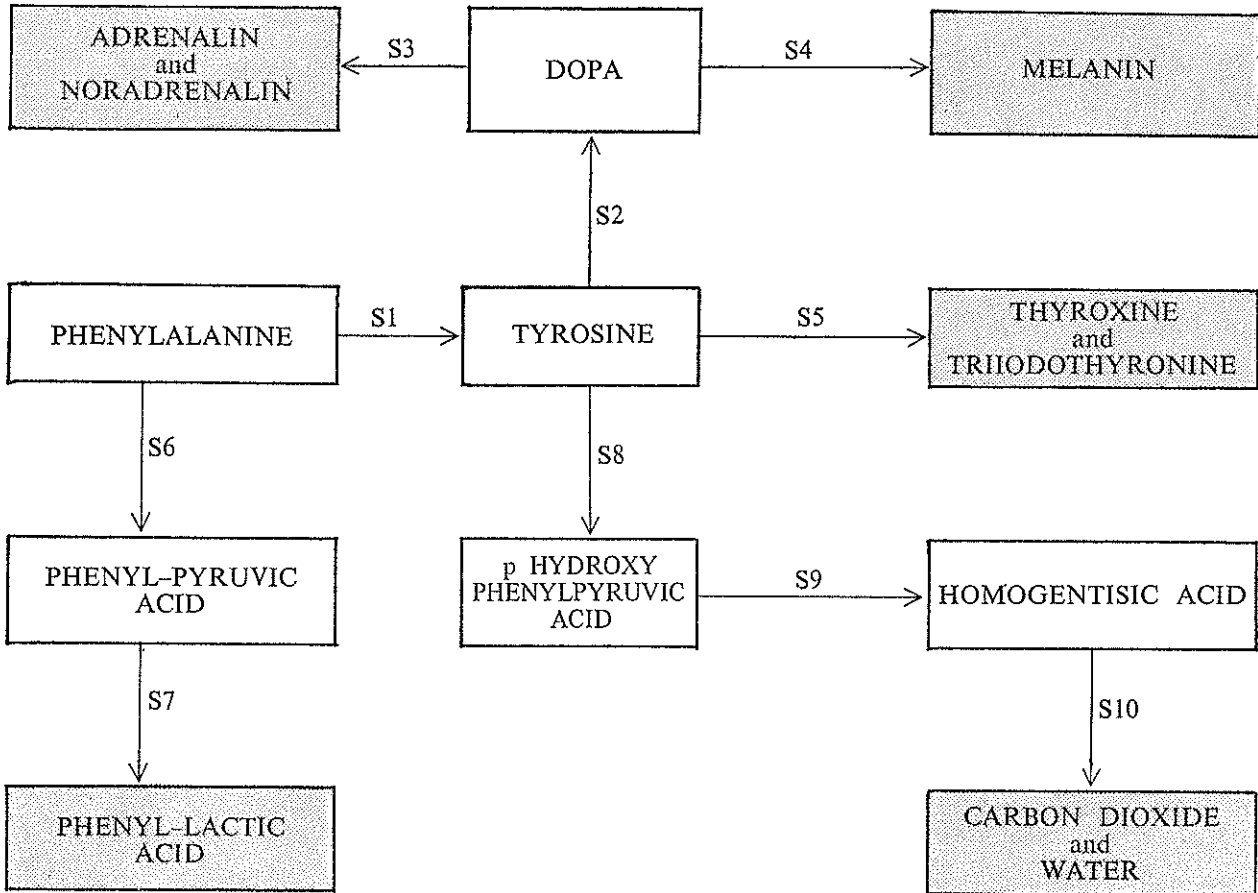
UNIT 9

K, *L*, *X*, *Y*, *N* and *M* are different substances. *K* is completely converted to *L* by treatment with *X*. If *Y* is used instead of *X*, *K* is converted to equal amounts of *M* and *N*. *M*, when heated to 800 °C. decomposes to *L*, releasing a gas *G*. Other than becoming hotter, neither *K* nor *N* is affected on being heated to 800 °C. Of the four solids *K*, *L*, *M* and *N*, only *L* does not dissolve in water.

46. To prepare *N* from *K*
- X* is needed.
 - K* must be heated to 800 °C.
 - L* is needed.
 - Y* is needed.
47. Which one of the following statements is certainly true ?
- X* decomposes immediately when heated to 800 °C.
 - L* does not decompose immediately when heated to 800 °C.
 - G* is a liquid at temperatures below 800 °C.
 - X* is soluble in water.
48. A sample of material is known to be one of *K*, *L*, *M* or *N*. One could be sure that it was *M* if
- it contained an equal amount of *N*.
 - it was converted to *K* on treatment with *Y*.
 - it was unchanged when heated to 800 °C.
 - a substance insoluble in water was formed when it was heated to 800 °C.
49. When *M* is prepared from *K*
- X* is used.
 - some *N* is formed in the process.
 - some *G* is formed in the process.
 - the temperature is raised to 800 °C.
50. Starting with *K*, a number of operations are carried out to prepare *N* free from the substances *M*, *K*, *L* and *G*. Select, and list in order the operations that would need to be performed. Use the Key *A* to *D* below to indicate your answer.
- Dissolve the product in water.
 - Filter and collect any residue left on the filter paper.
 - Treat *K* with excess *X*.
 - Heat *K* to 800 °C.
 - Treat *K* with excess *L*.
 - Filter and collect the liquid that comes through the filter paper.
 - Heat the product to 800 °C.
 - Treat *K* with excess *Y*.
- | | |
|---------------|-----------------|
| A. 8, 7, 1, 6 | C. 8, 7, 6, 1 |
| B. 8, 7, 1 | D. 8, 7 3, 1, 6 |

UNIT 10

The way in which a substance called phenylalanine is broken down in the body into simpler substances can be represented by the following diagram. The conversion of one or more substances to another has been indicated by the arrows. The numbers S1–S10 represent different substances which, if absent, prevent certain conversions taking place. For example if S4 were absent, melanin could not be formed from DOPA.



A number of disorders in man are known to be caused by a lack of the substances S1, S2, S3, S4, S5, S6, S7, S8, S9, S10. Only 4 of these disorders will be mentioned by name.

| <i>Substance absent</i> | <i>Resulting disorder</i> |
|-------------------------|---------------------------|
| S1 | Phenylketonuria |
| S4 | Albinism |
| S9 | Tyrosinosis |
| S10 | Alcaptonuria |

51. The absence of *one* of the substances S1–S10 is most serious in that it prevents (directly or indirectly) the formation of the largest number of substances mentioned by name in the diagram. Which substance is this?

- A. S1
- B. S2
- C. S5
- D. S8

52. In which of the four disorders mentioned would you expect there to be an abnormal accumulation of homogentisic acid ?
- A. Phenylketonuria
 - B. Tyrosinosis
 - C. Alcaptonuria
 - D. Albinism
53. All individuals unable to form thyroxine in the way shown above, lack
- A. S5.
 - B. S1.
 - C. either S1 or S5 but not both of these.
 - D. either S1 or S5 or both of these.
54. It is likely that individuals suffering from phenylketonuria exhibit symptoms of
- A. tyrosinosis and phenylketonuria only.
 - B. thyroxine deficiency, phenylketonuria, alcaptonuria and albinism only.
 - C. phenylketonuria, tyrosinosis, alcaptonuria, albinism and thyroxine deficiency.
 - D. phenylketonuria only.
55. If S1 could not be used in the treatment of a child suffering from phenylketonuria and it was known that phenylpyruvic acid produced toxic (poisonous) effects, which of the following diets would seem to be of greatest value in his treatment ? A diet with
- A. decreased phenylalanine content.
 - B. decreased phenylalanine content but increased tyrosine content.
 - C. increased phenylalanine content but decreased tyrosine content.
 - D. decreased phenylpyruvic acid content.

UNIT 11

That part of the eye which responds to light is called the retina. It contains two types of light-sensitive cells—*rods* and *cones*.

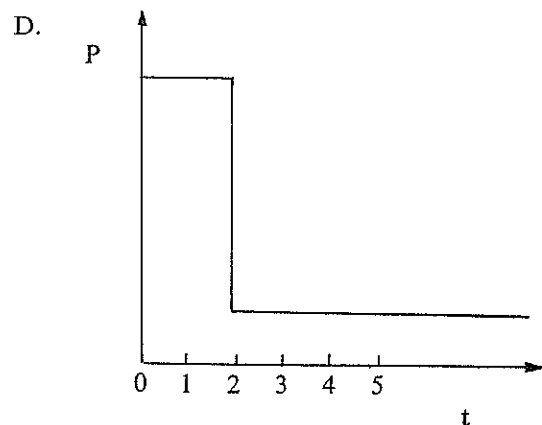
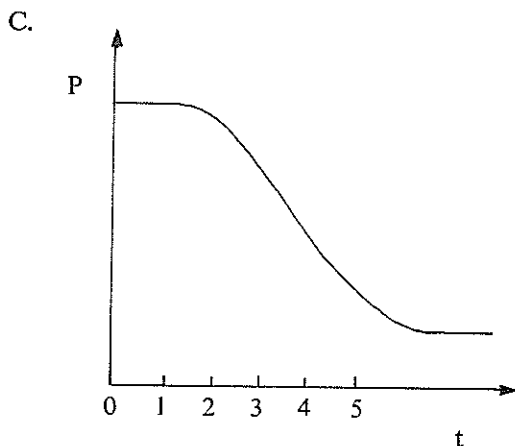
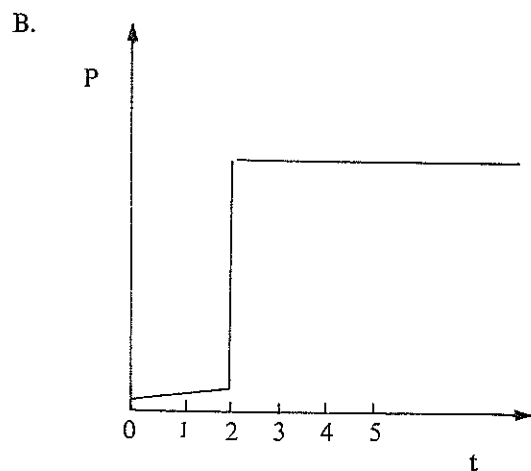
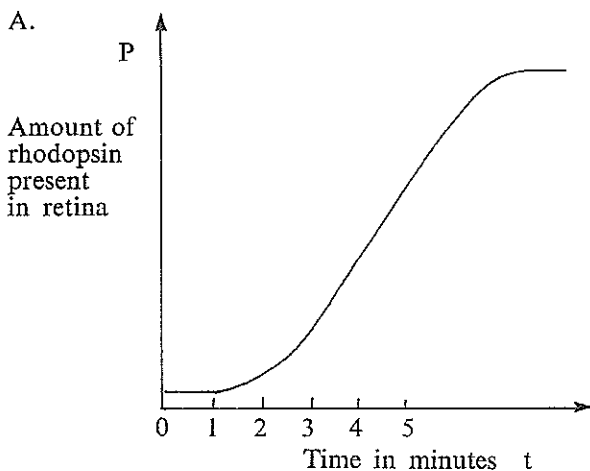
When we look directly at an object, light reaching the eye from the object is focused on the central part of the retina—the *fovea*. There is a high concentration of cones in this region, but no rods. Cones respond to intense (bright) light, and are responsible for bright light vision, perception of fine detail, and colour vision. They are only very slightly sensitive to dim light.

Outside the foveal region, the concentration of cones in the retina decreases, and rods are interspersed with the cones. At the outer edge of the retina there is a high concentration of rods, but no cones. Rods are very sensitive to dim light ; they function in such a way that we can distinguish the shapes but not the fine detail of dimly lit objects. Yet they do not respond to bright light nor do they permit us to distinguish different colours. The sensitivity of the rods to dim light is due to a substance called rhodopsin which is not present in the cones. Rhodopsin is formed in the rods in the dark, but is changed into another substance and is thus inactivated by bright light.

When we move from a brightly lit to a dimly lit room we cannot see anything at first. Shortly afterwards, we can distinguish vague shapes but not colours ; gradually the outlines of objects become clearer. When the eye is completely adjusted to the dim light, it is many thousand times more sensitive to light.

If the light gradually fades in a brightly lit room, the eye responds differently to different colours in the room. At first reds and yellows appear grey, while blues and greens are still seen as distinct colours. Eventually, when the room is dimly lit, only shapes can be distinguished and all objects appear black, grey, or white.

56. At time $t = 2$ minutes, a person leaves a brightly lit room and enters a dimly lit room. Which of the graphs A, B, C and D below best shows the amount of rhodopsin present in that person's retinas ?



57. The foveal region responds only very slightly to light
- at any time ; this is the so-called "blind spot" of the eye.
 - which is coloured.
 - when the intensity of light is at a low level.
 - when the eye is looking straight at a bright lamp.

58. The intensity of light required to make rod cells respond is
- A. considerably less than the amount required to make cone cells respond.
 - B. equal to the amount required to make cone cells respond.
 - C. slightly greater than the amount required to make cone cells respond.
 - D. many thousand times as great as the amount required to make cone cells respond.
59. Four students observe that colours in a brightly lit room appear to fade at different rates when light is gradually dimmed. They each propose a research project. Which project is LEAST likely to provide an explanation of this observation.
- A. Noel : “I would like to investigate whether blue or green light carries more energy than red or yellow, and is therefore better able to produce a response in the retinal cells.”
 - B. Bernard : “I would like to investigate whether there are different kinds of cone cells receptive to the different colours, and, if so, whether they differ in the amount of light they need to make them respond.”
 - C. Jill : “I would like to try to extract a pure sample of rhodopsin, and investigate the effects of different colours of light on it.”
 - D. Ron : “I would like to find out whether cone cells contain a light-sensitive chemical substance, and, if so, investigate whether different colours of light affect this substance in different ways.”
60. In the war of 1939–45 pilots who flew at night sometimes stayed in a dim room or wore dark glasses for some time before take-off. This would ensure that
- A. their eyes were very sensitive to dim light.
 - B. they could distinguish fine details of dimly lit targets.
 - C. they would be better able to distinguish the colours of dimly lit targets.
 - D. they would not be temporarily blinded by bright flares and searchlights.

UNIT 12

Liquids which can be blended with each other are called miscible liquids. When two miscible liquids of different densities are placed in a container (Figure 1) with the less dense liquid on top of the denser one, the boundary between the liquids slowly disappears as the liquids blend together.

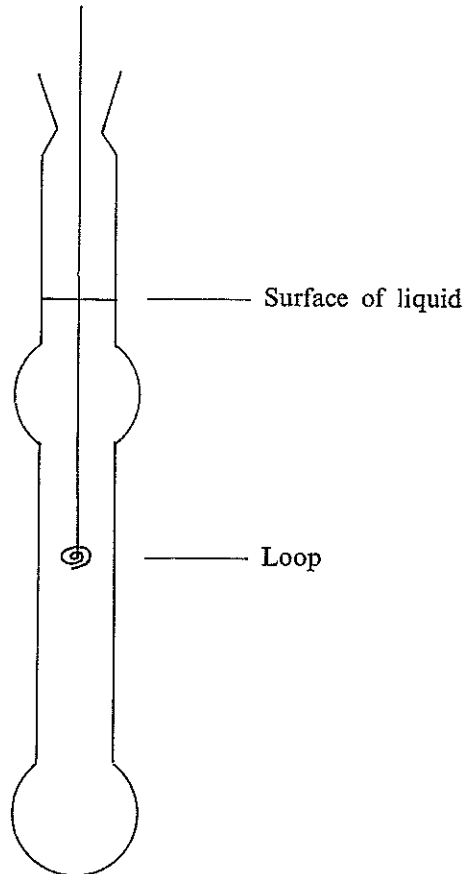


FIG. 1

Techniques are available to determine the density of liquid at different levels in the container. The blending process may take a long time ; in order to hasten it, the loop shown in Figure 1 is used to stir the liquid with smooth up and down strokes.

Figure 2 shows the effect of stirring, on a mixture of benzene (the less dense liquid) and bromobenzene, under the conditions stated.

X represents the original density distribution.

Y represents the density distribution after 25 strokes with the mixing loop.

Z represents the density distribution after 50 strokes with the mixing loop and standing for 10 hours.

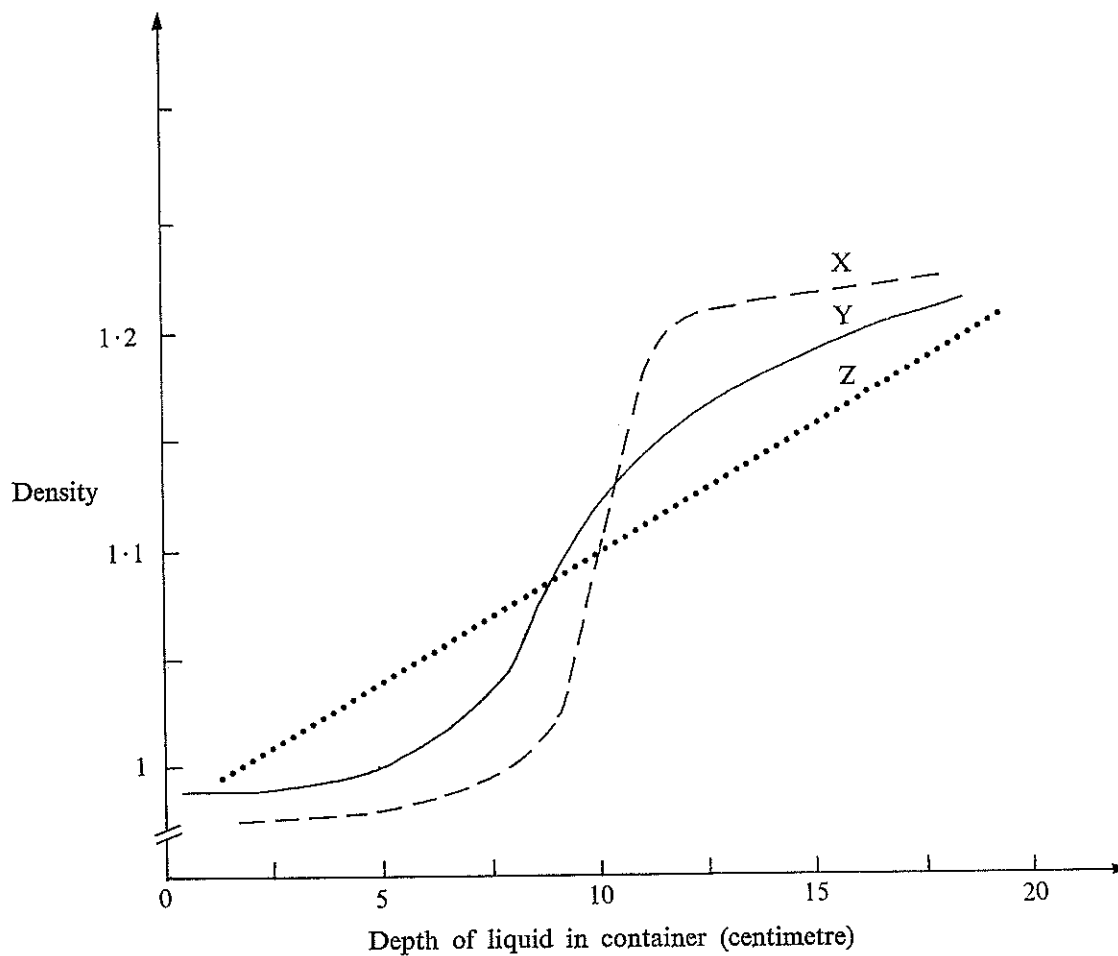
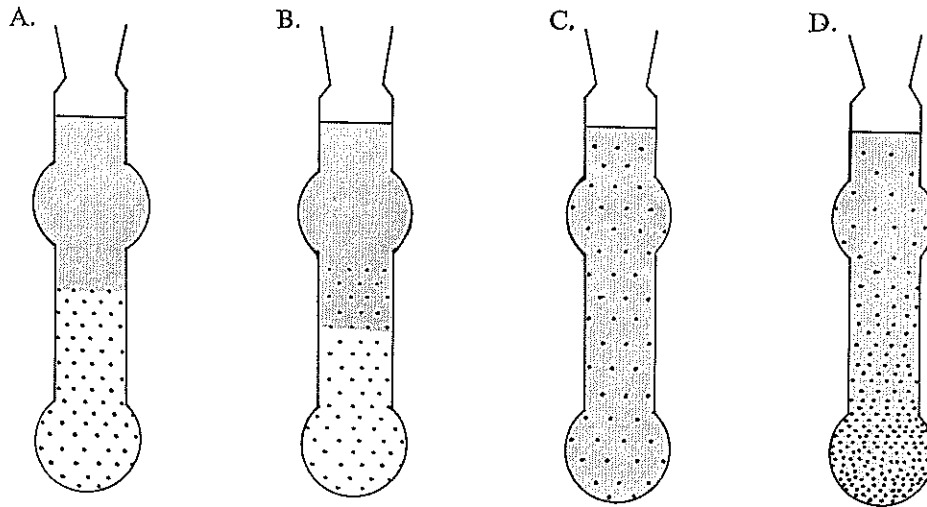


FIG. 2

61 The ratio of the density of bromobenzene to that of benzene

- A. is exactly 1.
- B. lies between $\frac{1.1}{1.0}$ and $\frac{1.2}{1.0}$.
- C. is less than 1.
- D. is greater than $\frac{1.2}{1.0}$.

62. Which of the following diagrams best represents the boundary between the two liquids under the conditions shown in Graph X? (Figure 2.)



63. Graph Y indicates

- A. the formation of a boundary similar to the original one but at a lower depth.
- B. that the density throughout the container is nearly the same.
- C. the lack of any well-defined boundary between the liquids.
- D. a decrease in density throughout the container.

64. After 50 strokes of the mixing loop and standing for 10 hours, the density of liquid in the container

- A. is the same throughout the container.
- B. rises gradually, then sharply, then gradually again, when measured at decreasing depths of liquid in the container.
- C. doubles whenever we double the depth of liquid in the container.
- D. increases steadily when measured at increasing depths of the liquid in the container.

65. The liquid mixture in the container is stirred one thousand times. The density at various depths in the container is then measured and the density pattern is observed.

Which one of the following graphs is most likely to represent the density at various depths in the container ?

