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Comprehension and interpretation (sciences) 1967

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Multi-Aptitude Batteries - 26(b)

(19)

Candidate's Number

Centre Number

COMMONWEALTH SECONDARY SCHOLARSHIPS

EXAMINATION FOR TWO-YEAR SCHOLARSHIP 1968-69

COMPREHENSION AND INTERPRETATION (SCIENCE)

Afternoon Session
Wednesday, 26th July

UNIT I

1		A B C D
2		A B C D E
3		A B C D E F G
4		A B C D E H J
5		A B C D E H
6		A B C D

UNIT II

7					A B C D E F G H J
8		A B C D			
9		A B C D E			
10		A B C D			
11		A B C D			

UNIT III

12		A B C D
13		A B C D
14		A B C D
15		A B C D E

UNIT IV

16		A B C D
17		A B C D
18		A B C D
19		A B C D
20		A B C D E

UNIT V

21		A B C D
22		A B C D
23		A B C D
24		A B C D E
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UNIT VI

26		A B C D E
27		A B C D E
28		A B C D E
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UNIT X

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UNIT VII

30		A B C D E
31		A B C D E
32		A B C D E
33		A B C D E

UNIT XI

50		A B C D E
51		A B C D E F G
52		A B C D E F G
53		A B C D
54		A B C D E
55		A B C D

UNIT VIII

34		A B C D
35		A B C D
36		A B C D E
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UNIT XII

56		A B C D
57		A B C D E F
58		A B C D
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UNIT IX

38		A B C D
39		A B C D E
40		A B C D
41		A B C D
42		A B C D E F

UNIT XIII

60		A B C D E
61		A B C D
62		A B C D E F G
63		A B C D
64		A B C D E

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COMMONWEALTH SECONDARY SCHOLARSHIPS

EXAMINATION FOR TWO-YEAR SCHOLARSHIP 1968–69

COMPREHENSION AND INTERPRETATION

(SCIENCE)

Afternoon Session, Wednesday, 26th July, 1967

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 13 units with an average of 4 to 5 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 print each answer in the correct space on the Answer Sheet.

ANSWERING

You are required to select an answer from a number of choices and to indicate your answer by—

(*a*) writing the appropriate letter or letters in the box on your answer sheet ; and

(*b*) putting a circle around the appropriate letter or letters.

For example, if your answer is choice D you would mark your answer sheet as follows :

[D]   A   B   C   (D)   E

If you wish to change an answer, put a cross through both the letter in the box, and the circle you have made previously. Then write your new answer in the box, and circle the letter which indicates your new answer.

[~~D~~ B]   A   (B)   C   (~~D~~)   E

In items 43 to 49 you are required to write a numerical answer in the appropriate spaces in the answer sheet.

Make any notes or calculations on this Test Booklet. Write only your answers on the Answer Sheet.

NOW look through this examination paper, but do not start writing until the supervisor tells you to do so.

Prepared by the Australian Council for Educational Research

UNIT I

By observing the light from distant stars we can obtain an estimate of the speed at which the stars appear to be travelling away from the earth; this is called their recession velocity.

Light travels through space at a speed of 186,000 miles per second, or it would travel the incredibly large distance of 5,900,000,000,000 miles or $5 \cdot 9 \times 10^{12}$ miles in one year. The distances from the earth to the stars are frequently expressed in light years, where one light year is the distance travelled through space by light in one year.

In the following table the distances of three stars from the earth, and their recession velocities are given.

Star	*Distance from Earth*	*Recession Velocity*
ϵ Indi	11·5 light years	270 km per second
Capella	46 light years	1,080 km per second
Fomalhaut	23 light years	540 km per second

1. Which of the following statements is consistent with the information in the table?

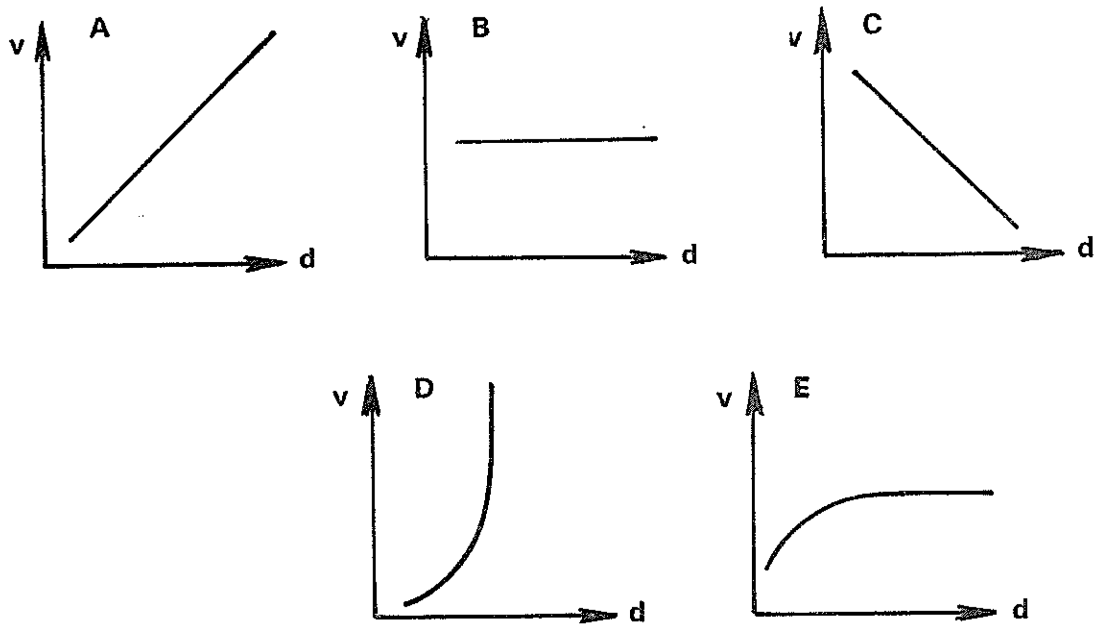
A. The closer the star, the greater the recession velocity.

B. The more distant the star, the greater the recession velocity.

C. The recession velocity is independent of the distance of the star from the earth.

D. None of the above.

2. Which of the following graphs representing the graph of recession velocity (v) against distance from the earth (d) is consistent with the data in the table?



3. The star β Centauri is a distance of 200 light years from the earth. How far is it from the earth in miles?

A. $1 \cdot 18 \times 10^{13}$ miles (11,800,000,000,000 miles)

B. $1 \cdot 18 \times 10^{14}$ miles (118,000,000,000,000 miles)

C. $1 \cdot 18 \times 10^{15}$ miles (1,180,000,000,000,000 miles)

D. $2 \cdot 95 \times 10^{10}$ miles (29,500,000,000 miles)

E. $2 \cdot 95 \times 10^{12}$ miles (2,950,000,000,000 miles)

F. $2 \cdot 95 \times 10^{14}$ miles (295,000,000,000,000 miles)

G. $5 \cdot 90 \times 10^{12}$ miles (5,900,000,000,000 miles)

4. The star Pollux is at a distance of 34·5 light years from the earth. What would you expect to be its recession velocity ?

A. 270 km per second.

B. 540 km per second.

C. 1,080 km per second.

D. 135 km per second.

E. 405 km per second.

H. 810 km per second.

J. 27 km per second.

5. A star is discovered to have a recession velocity of 400 km per second. What would you expect to be its distance from the earth ?

A. 11·5 light years.

B. 30 light years.

C. 23 light years.

D. 17 light years.

E. 20 light years.

H. 12 light years.

6. Which of the following is true when we observe the star ϵ Indi ?

A. We see the star as it is at the instant we look at it.

B. We see the star as it was 11·5 years ago.

C. We see the star as it was a few minutes before the light reached us because light takes some time to travel from the star to us.

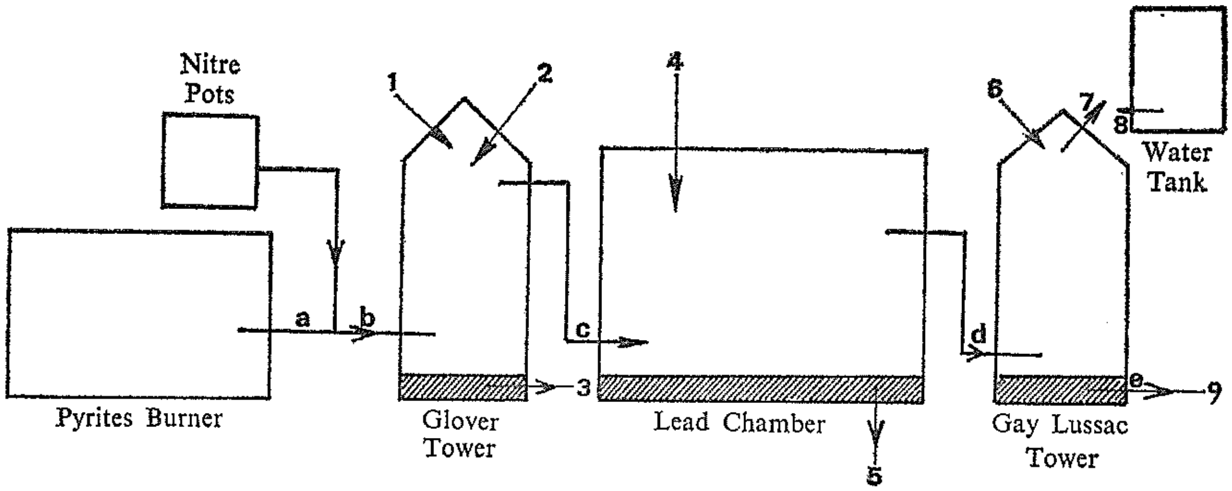
D. We see the star as it will be 11·5 years after we observe it.

UNIT II

Concentrated sulphuric acid (i.e. acid containing very little water) can be made from iron pyrites (iron sulphide). Pyrites is burned to form a gas—sulphur dioxide. A white solid—nitre—is distilled in nitre pots to form another gas—nitrogen dioxide. The two gases are mixed and passed to the Glover Tower. From the top of the tower there is a trickle of dilute sulphuric acid and nitrosulphonic acid which mixes with the gases. Concentrated sulphuric acid forms at the base of the tower. The nitrosulphonic acid forms sulphuric acid and loses its nitrogen as gaseous oxides of nitrogen (nitrogen dioxide and nitric oxide).

These oxides, together with unreacted sulphur dioxide pass to a lead chamber where they are sprayed with water. Dilute sulphuric acid is formed leaving only nitric oxide. This oxide passes to the Gay Lussac Tower, where concentrated sulphuric acid trickles down and reacts with all the nitric oxide forming nitrosulphonic acid which collects at the base of the tower. This acid is then recirculated and used as already described.

The following is a schematic representation of this process. Lines with arrows represent *possible* interconnecting pipe-lines, the arrows indicating the direction in which materials travel in the pipe. Numbered 1 to 9 are valves which allow one-way passage of gases or liquids in the direction indicated. These valves and pipes may be interconnected in any combination desired.



For items *7, 8, 9* assume that any products formed in one part of the process may be used directly in any other part.

7. Which *four* of the following are connected ?

A. 7 to 1
B. 9 to 1
C. 8 to 4
D. 3 to 4
E. 5 to 2
F. 7 to 2
G. 3 to 6
H. 8 to 6
J. 7 to 4

8. The major product of the process should be tapped at

A. 3 B. 5 C. 7 D. 9

9. An alternative method of producing nitrogen dioxide is by the controlled burning of ammonia in an Ammonia Burner. The Ammonia Burner would then replace

A. the Glover Tower.
B. the Gay Lussac Tower.
C. the Lead Chamber.
D. the Nitre Pots.
E. the nitrosulphonic acid generator.

The following items involve the composition of the mixture of substances present in different parts of the process.

Key :

A. Between *a* and *b*

B. Between *b* and *c*

C. Between *c* and *d*

D. Between *d* and *e*

Samples of the material passing various points (marked by the letters *a*, *b*, *c*, *d*, and *e* on the diagram) are taken, and their compositions compared. Use the above KEY to answer the following questions :

10. Between which two points has the amount of sulphur dioxide gas in the sample been reduced to zero ?

11. Between which two points has the amount of nitrogen dioxide gas in the sample been reduced to zero ?

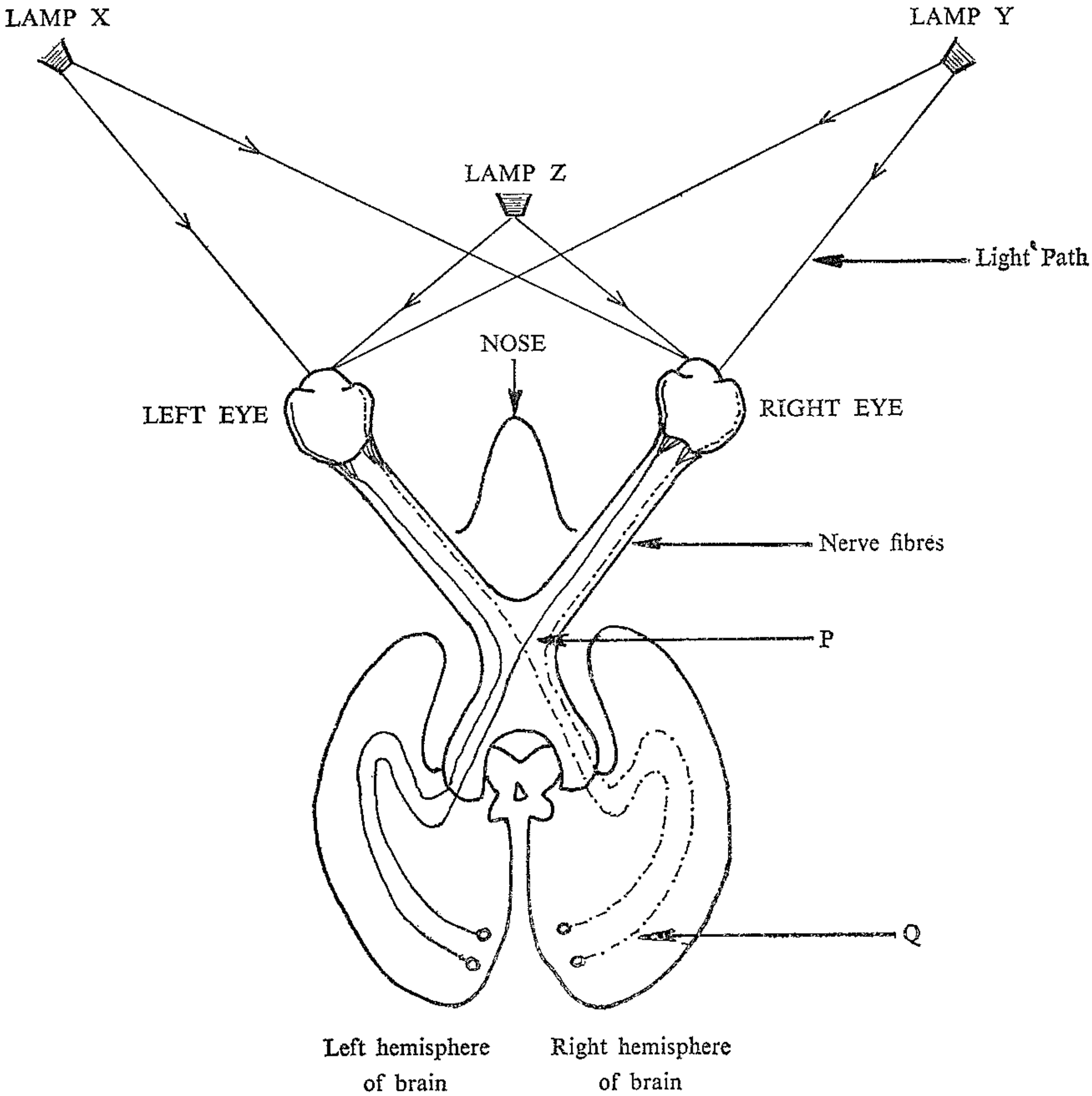
UNIT III

An essential feature of the process of vision is the conversion of light energy to electrical energy. It is in the latter form that signals are sent along nerves from the eye to the brain. The nervous system responsible for vision begins at the retina at the back of the eye. Each retina is divided vertically down the middle. Nerve fibres from the outer side are connected to the same side of the back of the brain (see diagram) ; fibres from the inner, nasal (nose) sides of the retinas cross just behind the eyes—at the optic chiasma—and go to the opposite side of the back of the brain. This visual region at the back of the brain is called the area striata.

The brain as a whole is partly divided down the middle forming two hemispheres, each containing an independent visual region. The hemispheres are joined by a massive bundle of nerve fibres, known as the corpus callosum, and the smaller optic chiasma.

Recently, experiments have been performed (on voluntary human patients) in which electrodes (thin metal wires) have been applied to the area striata. When a tiny electrical signal is applied, the patient reports seeing a flash of light. If the electrode is moved to a different part of the area striata, the patient reports that the flash appears in a different position. Thus it seems likely that there is a relationship between positions in the retina and positions in the brain.

The figure shows some of the parts of the optical nervous system mentioned in the article. X and Y are two lamps emitting light which reaches the eyes. No other light reaches the eye (i.e. lamp Z is not switched on at this stage).



12. The part labelled *P* is the

A. retina.

B. optic chiasma.

C. corpus callosum.

D. area striata.

13. The part labelled *Q* is the

A. retina.

B. optic chiasma.

C. corpus callosum.

D. area striata.

14. Light coming from lamp *X* stimulates nerve fibres in

A. the left eye only.

B. the right eye only.

C. the right side of each retina.

D. the left side of each retina.

15. Lamp *Y* is switched off and lamp *Z* is switched on. The information you have been given implies that the light from the two lamps *X* and *Z* will

A. cause electrical signals to arrive at the optic chiasma at different times.

B. not cause electrical signals to pass through the optic chiasma at all, since both are on the left of the viewer.

C. stimulate different parts of the area striata in the right hemisphere only.

D. stimulate the nerve endings in the left retina only.

E. stimulate a part of the area striata in each hemisphere.

UNIT IV

Radio-carbon is a radio-active form of the element carbon, consisting of atoms slightly heavier (in the ratio 14 to 12) than ordinary carbon. It is usually called carbon–14 (or C^{14}) to distinguish it from ordinary carbon, carbon–12. A radio-active form of an element is unstable and as soon as it is formed begins to change into another element by a process we call radio-active decay. Carbon–14 atoms are being continuously formed in the earth's upper atmosphere from nitrogen atoms which are hit by cosmic rays from outer space, and as soon as they are formed they begin to change, in this case, back to nitrogen.

The half-life of C^{14} is about 5,700 years. This means that in 5,700 years half the original number of radio-carbon atoms change to nitrogen, and that in each succeeding period of 5,700 years, half those remaining change back to nitrogen. Moreover, it has been found that as fast as C^{14} atoms are transformed to nitrogen by radio-active decay, additional C^{14} is being created in the atmosphere by cosmic ray bombardment. Thus the concentration of C^{14} in the atmosphere remains constant.

As part of the growth process, plants absorb carbon dioxide containing C^{14} atoms along with ordinary carbon dioxide containing C^{12} atoms, and build their tissues out of it. When animals eat plants they absorb C^{14} and C^{12} in about the same proportion as they exist in the plants. As long as a plant or animal lives, the proportion of C^{14} to C^{12} in its tissues remains almost constant, as it is in the atmosphere, because the C^{14} lost by radio-active decay is replaced by C^{14} from the environment.

As soon as a plant or animal dies, however, the absorption of C^{14} ceases, and from then on the amount of this form of carbon in the remains of the plant or animal steadily decreases at a rate indicated by the half-life of 5,700 years.

So it is possible to determine when a plant or animal died by measuring the amount of C^{14} in its fossilized remains and comparing it with the amount normally present at death in similar plants or animals living today.

16. Which one of the following assumptions must be made in using this method of determining the age of a fossilized plant or animal ?

   A. No carbon has been lost from the fossilized plant or animal since its death occurred.

   B. The amount of C^{14} in the fossilized plant or animal has remained constant since its death occurred.

   C. The proportion of C^{14} to C^{12} has remained constant in the fossilized plant or animal since its death occurred.

   D. The proportion of C^{14} to C^{12} in present day plants and animals is similar to what it was when the fossilized plant or animal died.

17. In this method of determining the age of a fossilized plant or animal, which one of the following assumptions must be made about the rate of bombardment of nitrogen atoms in the atmosphere by high energy cosmic rays ?

   A. The rate has been constant from the time when the animal or plant died to the present.

   B. The rate is the same at present as it was when the plant or animal died.

   C. The rate was much greater when the plant or animal died than it is at present.

   D. The rate was much smaller when the plant or animal died than it is at present.

18. Which one of the following assumptions must be made in this method of determining the age of a fossilized plant or animal concerning the rate of radio-active decay of C^{14}, as indicated by the half-life.

   A. The half-life is the same now as when the animal or plant died, but may have varied in the intervening period.

   B. The half-life has remained constant from the time the animal died to the present.

   C. The half-life is much greater now than when the plant or animal died.

   D. The half-life is much smaller now than when the plant or animal died.

19. A piece of fossilized wood was found to have only half the proportion of C^{14} to C^{12} that a piece of living wood has. How old is the fossilized wood ?

A. 2,850 years

B. 5,700 years

C. 11,400 years

D. 17,100 years

20. A piece of fossilized bone was found to contain only one-quarter the proportion of C^{14} to C^{12} as a piece of bone from a similar present day animal. How old is the fossilized bone ?

A. 1,425 years

B. 2,850 years

C. 5,700 years

D. 11,400 years

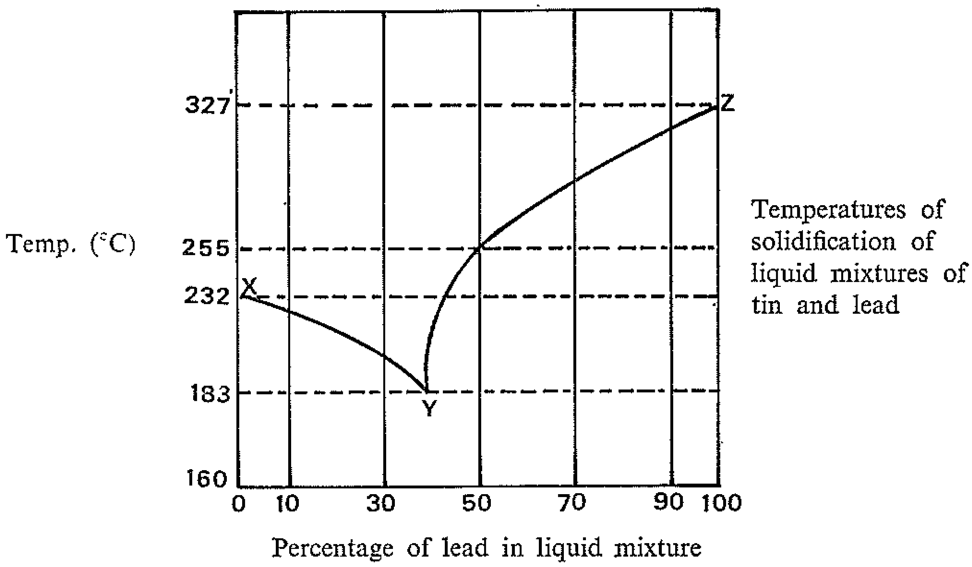
E. 22,800 years

UNIT V

Two liquids (such as alcohol and water) which completely dissolve in each other in all proportions are said to be *miscible,* whereas liquids which are not mutually soluble (such as oil and water) are described as *immiscible.*

Tin melts at 232 °C, and lead at 327 °C. Mixtures of these two metals are completely miscible when melted together, but on cooling the pure metals separate. If a molten (liquid) mixture of tin and lead is cooled, lead deposits first if the mixture contains more than 36 per cent. lead, and tin deposits first if the mixture contains less than 36 per cent. lead.

The graph below shows the variation in temperatures of solidification of liquid mixtures of tin and lead in various proportions. Points on the curve *XYZ* represent the temperatures at which solid appears when mixtures of different composition are cooled. As soon as any solid forms it is removed from the system.



Items 21, 22 and 23 refer to a mixture of 50 per cent. lead and 50 per cent. tin being cooled from an initial temperature of 350 °C.

21. When the mixture has been cooled until some solid has deposited from the liquid, the remaining liquid contains

A. a greater percentage (than 50) of lead.

B. a greater percentage of tin than lead.

C. equal percentages of lead and tin.

D. either more lead or more tin, depending on the temperature at which solid begins to form.

22. The first solid formed

A. will be pure tin.

B. will be pure lead.

C. will have a composition of 50 per cent. tin and 50 per cent. lead.

D. will have a composition of 36 per cent. lead and 64 per cent. tin.

23. When the first solid has formed, and while some liquid remains,

A. the temperature remains constant and the composition of the remaining liquid stays unchanged.

B. the temperature will fall continuously and the composition of the remaining liquid stays unchanged.

C. the temperature remains constant and the remaining liquid will change in composition continuously.

D. the temperature will fall continuously during solidification and the remaining liquid will change in composition continuously.

For *items 24 and 25*, which refer to any mixture containing both lead and tin in any proportions which have been allowed to stand for some time at the given temperature, use the following key. Write :

A. if it is possible for only solid to exist,

B. if it is possible for only liquid to exist,

C. if it is possible for solid tin and a liquid to exist together,

D. if it is possible for solid lead and a liquid to exist together,

E. if it is possible for either solid to exist with liquid,

24. At a temperature below 183 °C.

25. At a temperature above 327 °C.

UNIT VI

Imagine a planet remote from our solar system where the chemists have found only seven elements in all the materials they have examined. Research has shown that the atoms of the seven elements combine to form molecules according to a simple set of rules.

To each element the chemists have been able to assign a number called its combining power. These numbers range from 1 to 4 and may be positive or negative. The symbols for the elements and the combining power of each is given in the table.

Symbol for Element	R	L	M	N	X	Y	Z
Combining Power	+1	−1	−2	+2	−3	+3	+4

The number of atoms of a particular element in a molecule is indicated by a *suffix*, e.g. R_2M_1 means a molecule formed of two atoms of R and one of M. Usually, if only one atom is present, the figure one is omitted. Thus R_2M_1 is written R_2M.

Equations can be written to indicate reactions between elements and compounds and in this case a *prefix* indicates the number of molecules. Thus three molecules of R_2M is written $3R_2M$. The *prefix* 3 is called a *coefficient*.

Two laws of combination are useful to write formulae and equations on this planet.

Law 1 : The total number of atoms of any element must be the same on two sides of an equation.

Law 2 : For any molecule the sum of the product *combining power* × *number of atoms of an element* must be zero if we take positive and negative products into account.

For example R_2L :

For R the product is $+1 \times 2 = 2$

For L the product is $-1 \times 1 = -1$

The sum $+2 - 1 = +1$

and R_2L is *not* a possible formula for a molecule.

26. Chemists have analysed a compound and found it consists of atoms of the elements Z, M, R. A formula (or formulae) for this compound (there may be more than one) consistent with Law 2, is/are

A. Z_2MR
B. ZMR_2
C. ZR_2M_3
D. R_4ZM_4
E. ZR_4M_2

27. In the following equation, the formulae are correct but the equation is unbalanced, i.e. it does not meet the requirements of Law 1.

$$R_2M + NL_2 \rightarrow RL + NM$$

What is the smallest coefficient which can stand in front of RL to balance the equation ?

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

28. A chemist claims that the elements can form molecules consisting only of atoms of that element. Such molecules must

A. consist of only two atoms, for example Z_2.

B. consist of even numbers of atoms, for example R_4.

C. be inconsistent with Law 1.

D. be inconsistent with Law 2.

E. be inconsistent with Law 1 and Law 2.

29. The relative masses of the elements (on the scale $R = 1$) are :

Element	*Mass* (Scale $R = 1$)
R	1 Unit
L	3 Units
M	7 Units
N	12 Units
X	9 Units
Y	5 Units
Z	2 Units

In a reaction 24 units of mass of a compound R_3X are produced according to the equation

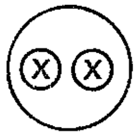
$$3R_2M + 2XY \rightarrow 2R_3X + Y_2M_3$$

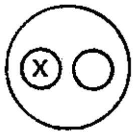
Assuming no loss or gain in mass in the course of a reaction, the sum of the number of units of mass of R_2M and XY needed to produce 24 units of mass of R_3X is

A. 55 B. 5 C. 27 D. 41 E. 33

UNIT VII

Certain factors (usually occurring in pairs) present in the nuclei of living cells determine characteristics which are inherited. Whether an organism will be male or female depends on the number of sex factors present in the cell. In fowls, males carry two sex factors, females one.

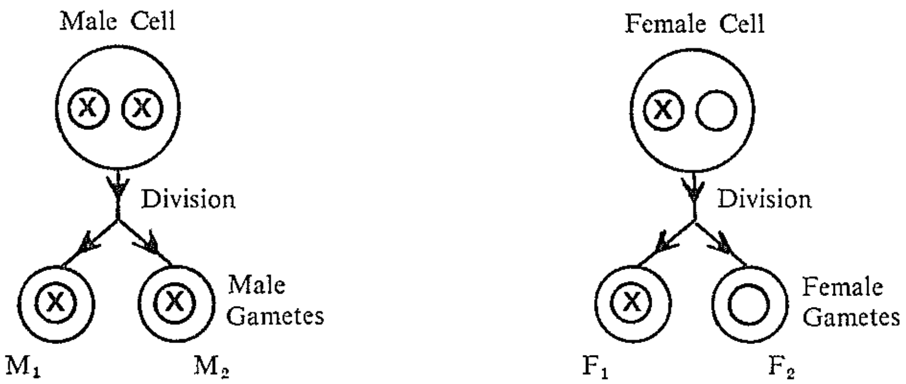
We can represent male cells by : 

and female cells by : 

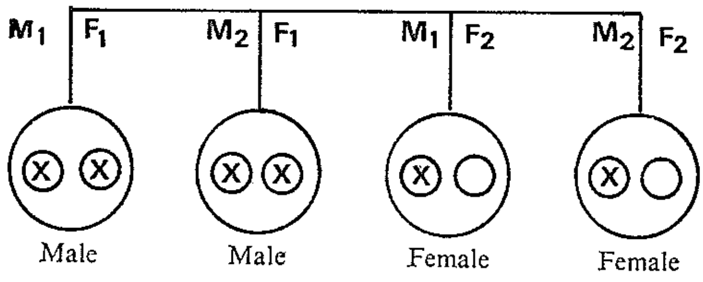
where  represents a sex factor and  represents the absence of a sex factor.

In the course of reproduction, certain cells divide, splitting up the paired inheritance factors and forming gametes. Fertilization involves the union of male and female gametes to form zygotes which therefore again contain paired inheritance factors.

The process of division and union, in so far as it affects the inheritance factors may be illustrated as follows :



During fertilization M_1 could combine with either F_1 or F_2 and so could M_2. The zygotes formed by these four possible pairings are shown below :



Thus sex is determined at fertilization, for under suitable circumstances these zygotes give rise to new individuals.

As in other animals, the characteristics of the adult fowl (in a given environment) depend upon the inheritance factors with which the zygote is provided.

Black plumage is determined by a factor not associated with the sex factor.

Barred plumage (a pattern of white bars on a black background) is determined by a factor always associated with the sex factor.

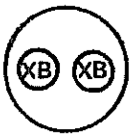
We may represent this in symbols.

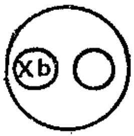
The presence of the factor for barred plumage is represented by 

The absence of the factor for barred plumage is represented by 

The presence in a pair of appropriate factors of even one factor for barred plumage will *always* cause barred plumage to appear in the adult, but it is impossible to determine from the appearance of the barred adult whether it carries one or two factors for barred plumage.

The fowl populations to be discussed are either black or barred and carry only black and/or barred plumage factors. In each of the items the results of the matings described refer to very large numbers of progeny (i.e. offspring).

30. Males 

are mated with females 

Which of the following statements about the birds mated is correct ?

A. Males are barred, females barred.

B. Males are black, females barred.

C. Males are barred, females black.

D. Males are black, females black.

E. Impossible to say.

31. The progeny (i.e. offspring) of the previous mating, when adult, are as follows :

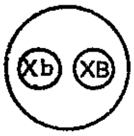
A. Males all barred, females black.

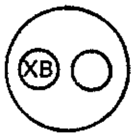
B. Males all barred, approximately half the females black.

C. All birds barred.

D. No birds barred.

E. Impossible to say.

32. Males 

are mated with females 

The progeny when adult are as follows :

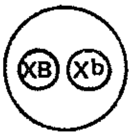
A. All birds black.

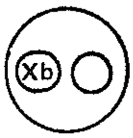
B. Barred and black in no definite proportions.

C. Approximately half the males barred, the remainder of the males black, all females black.

D. Approximately half the females barred, the remainder of the females black, all males barred.

E. Impossible to say.

33. Males 

are mated with females 

The progeny when adult are as follows :

A. All birds black.

B. All birds barred.

C. All males barred, all females black.

D. None of these.

E. Impossible to say.

UNIT VIII

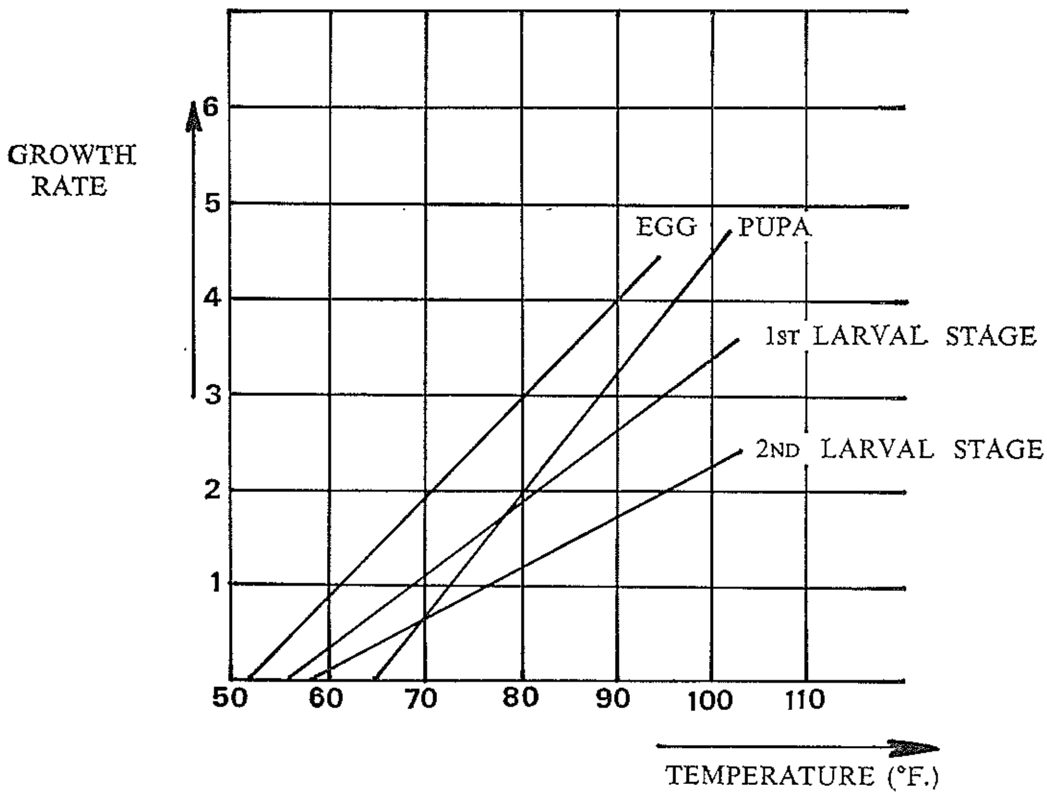
When a certain insect was accidentally introduced into Australia it was found that it was destructive to the leaves, blossoms, and fruits of more than 275 varieties of plants, shrubs and trees. The larvae feed in the ground on the roots of various plants and often cause serious damage to grass in lawns, parks and pastures. The larvae spend about 8 months in the soil. They then go through an inactive pupal stage of a little less than 4 months and emerge from the soil as adult beetles in summer (about January). The adult females lay eggs in the soil almost immediately and these hatch in a few weeks.

The larval stages are the only stages to suffer from a disease (called milky disease) caused by bacteria which they take in as they feed on the plant roots. This disease kills a high percentage of larvae when the temperature is about 86 °F. but has no effect below 62 °F. or above 95 °F. because the bacteria are inactive outside this temperature range. The following common temperatures might be of interest—

Normal temperature of the human body, 98·4 °F.

Freezing temperature of water, 32 °F.

The activities and growth of organisms depend on numerous chemical reactions and the rates of these reactions are affected by changes in temperature. The rate of change of size of different stages of the insects (i.e. the growth rate) has been studied and the results are plotted on the graphs shown.



34. As shown on the graph the growth rate of the pupa

A. fluctuates with increased temperature.

B. decreases with increased temperature.

C. remains constant with increased temperature.

D. increases with increased temperature.

35. For which one of the following does the growth rate change by the greatest amount when the temperature is increased from 70 °F. to 80 °F. ?

A. Pupa.

B. The egg.

C. The first larval stage.

D. The second larval stage.

36. To reduce the numbers of these insects it is possible to apply dust containing milky disease bacteria to lawns. These bacteria can survive in the soil for only about 2 weeks under adverse conditions. At which one of the following times would it be most effective to apply milky disease bacteria in the soil ?

A. In the summer when the temperature is about 95 °F.

B. In the winter when the temperature is about 57 °F.

C. In the early summer when the temperature is about 82 °F.

D. In the autumn when the temperature is about 82 °F.

E. At any time of the year when the temperature is about 86 °F.

37. It is known that it is safe to spread dust containing milky disease bacteria in an area inhabited by man. Using only the information given above, which one of the following would be the most reasonable explanation to offer ?

A. These bacteria do not increase in numbers in the human body.

B. We have antibiotics which can cure the disease in man.

C. Man has natural antibodies to counteract this disease.

D. Milky disease in man produces only mild symptoms.

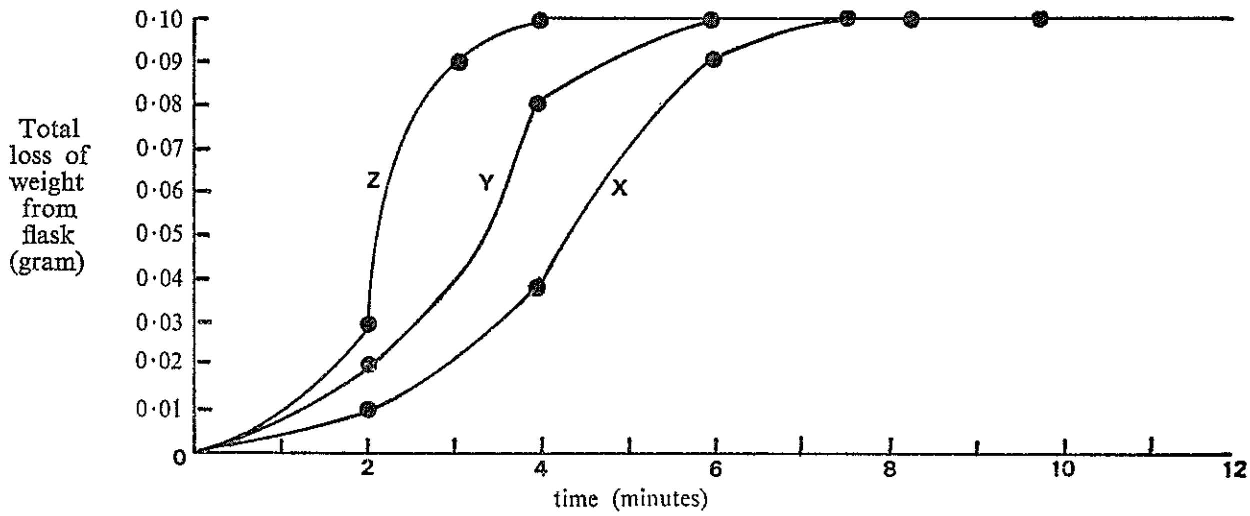
UNIT IX

In describing solutions, chemists use the term "concentration" to refer to the weight of material dissolved per unit volume. Thus if two containers are taken, a litre of water poured into each, and 10 gram of sugar is stirred into the first container and 20 gram into the second, then the concentration of the second sugar solution is twice that of the first.

A certain chemistry student knows that when a solution of acetic acid in water is added to magnesium metal in a flask, bubbles of hydrogen gas are given off and escape from the flask ; a solution of magnesium acetate remains in the flask. He is interested to find out what effects may be observed when different concentrations of acetic acid are used. He obtains three flasks, adds the same weight of magnesium to each, and then adds 1 litre of acetic acid solution of different concentration to each flask. At intervals, he notes the weight of the flask and its contents, and calculates the loss in weight from each flask.

Flask	*Original Weight of Magnesium Metal*	*Concentration of Acetic Acid Solution Added*	*Volume of Acetic Acid Solution Added*	*Weight of Magnesium Metal at time* $t = 12$ *minutes*
X	1·200 gm.	6 gm. /litre	1 litre	0
Y	1·200 gm.	12 gm. /litre	1 litre	0
Z	1·200 gm.	18 gm. /litre	1 litre	0

The results of the experiment are summarized in the following graph :



38. From the graph, we may deduce that in each flask the student would have observed bubbles of gas coming off

A. relatively slowly at first, then more quickly then slowly again, until no more bubbles came off.

B. very quickly at first, then more slowly until all the magnesium had been used up.

C. slowly at first, then more and more quickly.

D. quickly at first, then more slowly, then more quickly again.

39. The greatest change in the weight of the contents of flask *X* occurred during the two minutes that elapsed between

A. $t = 0$ and $t = 2$.

B. $t = 2$ and $t = 4$.

C. $t = 4$ and $t = 6$.

D. $t = 6$ and $t = 8$.

E. $t = 8$ and $t = 10$.

40. After 3 minutes, the loss in weight of the contents of flask *Y* was

A. 0·030 gm.

B. 0·040 gm.

C. 0·085 gm.

D. 1·140 gm.

41. A conclusion that can be drawn from this experiment is that higher concentrations of acid result in

A. greater weights of hydrogen being obtained.

B. more complete reactions of the magnesium metal.

C. greater losses in weight from the flask.

D. less time being required for the reaction to occur completely.

42. Chemical calculations show that whenever 1·200 gm. of magnesium reacts with acetic acid, 6 gm. of acetic acid is used up. If a solution contained, for example, 10 gm. of acetic acid, then 6 gm. of it would be used up, and 4 gm. of acetic acid would remain unchanged.

We may deduce that at time $t = 12$ minutes, the ratio of

$$\frac{\text{concentration of acetic acid in flask } Z}{\text{concentration of acetic acid in flask } Y} =$$

A. 1

B. $\frac{2}{1}$

C. $\frac{1}{2}$

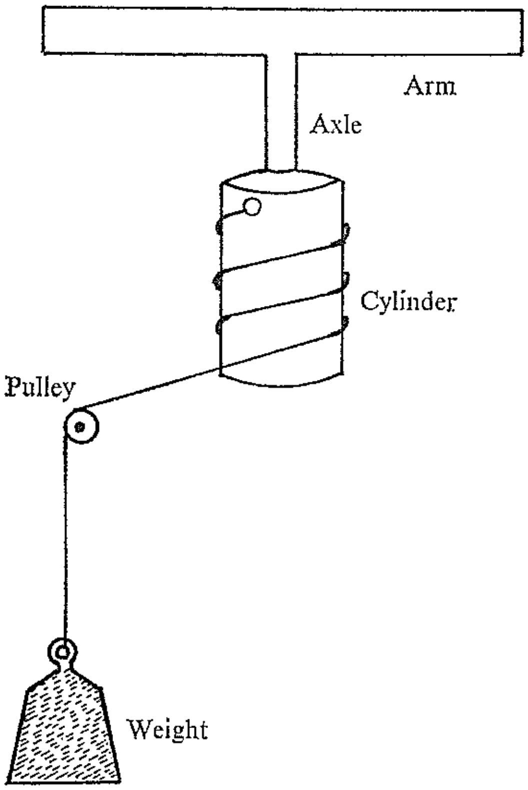
D. $\frac{3}{2}$

E. $\frac{2}{3}$

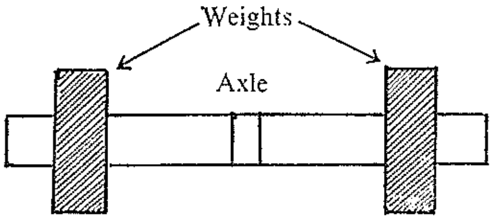
F. 0

UNIT X

A machine which consists of a light arm supported horizontally on a vertical axle is set up. The arm can be rotated by the application of a uniform force supplied by the weight and pulley system as shown.



Two equal weights are placed on each end of the arm at equal distances from the axle as shown.



The times taken for the arm to reach a certain rate of rotation on its axle are measured for objects of various weight at various distances from the axle. Some of the results obtained are listed in the following table :

Total Weight of Objects on Arm	Distance of Objects from Axle	Time
10 lb. wt.	3 ft.	9 sec.
20 lb. wt.	2 ft.	8 sec.
20 lb. wt.	3 ft.	18 sec.
20 lb. wt.	4 ft.	32 sec.
30 lb. wt.	3 ft.	27 sec.

Use the information above to complete the seven blanks in the following table. Write each of your answers *on the answer sheet* next to the corresponding question number.

DO NOT WRITE ANY FIGURES IN THE TABLE BELOW

Total Weight of Objects on Arm	Distance of Objects from Axle	Time
10 lb. wt.	4 ft.	(Q.*43*) ..... sec.
30 lb. wt.	2 ft.	(Q.*44*) ..... sec.
40 lb. wt.	3 ft.	(Q.*45*) ..... sec.
10 lb. wt.	(Q.*46*) ..... ft.	25 sec.
10 lb. wt.	(Q.*47*) ..... ft.	4 sec.
(Q.*48*).... lb. wt.	3 ft.	54 sec.
(Q.*49*).... lb. wt.	2 ft.	20 sec.

UNIT XI

Hydrogen, a colourless, inflammable gas, reacts with iodine vapour, which is purple and non-inflammable, to form hydrogen iodide, a colourless, non-inflammable gas, the product in this reaction.

The reaction does not go to completion ; that is, if the contents of a flask containing hydrogen are mixed with those of another flask containing iodine, some hydrogen iodide is formed, but some of the original reactants (i.e. the hydrogen and iodine) remain.

Chemists have proposed the following theoretical explanation of this reaction. Gases are composed of enormous numbers of tiny particles called molecules ; molecules consist of one or more atoms. Hydrogen molecules, which consist of two hydrogen atoms joined together, collide with larger iodine molecules, similarly constructed of two iodine atoms. Rearrangements of atoms occur, and hydrogen iodide is formed, each molecule of the latter containing one hydrogen and one iodine atom. This process is called the *forward reaction.* However the hydrogen iodide molecule is not a particularly stable one, and the *reverse reaction*—in which hydrogen iodide molecules collide and form hydrogen and iodine again—can also occur.

The rate of a chemical reaction (i.e. the rate of formation of molecules of the product) depends on the concentration of the reactants ; this means that, if more molecules of the reactants are present in a given volume, there is a greater chance of collisions occurring involving those molecules, and the faster the reaction involving them will occur.

In the reaction described above, the forward reaction occurs rapidly at first ; the reverse reaction occurs slowly at first. The forward reaction slows down, the reverse reaction speeds up. Eventually, a state is reached in which hydrogen iodide is decomposing just as rapidly as hydrogen and iodine are combining ; chemists call this a state of *dynamic equilibrium.*

50. If each circle represents an atom drawn to scale, which of the following sets of diagrams best describes a hydrogen molecule, an iodine molecule, and a hydrogen iodide molecule, respectively ?

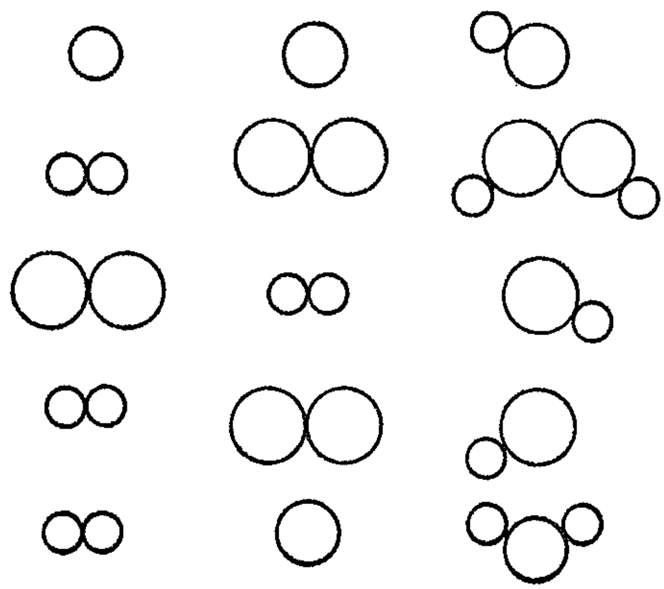
A

B

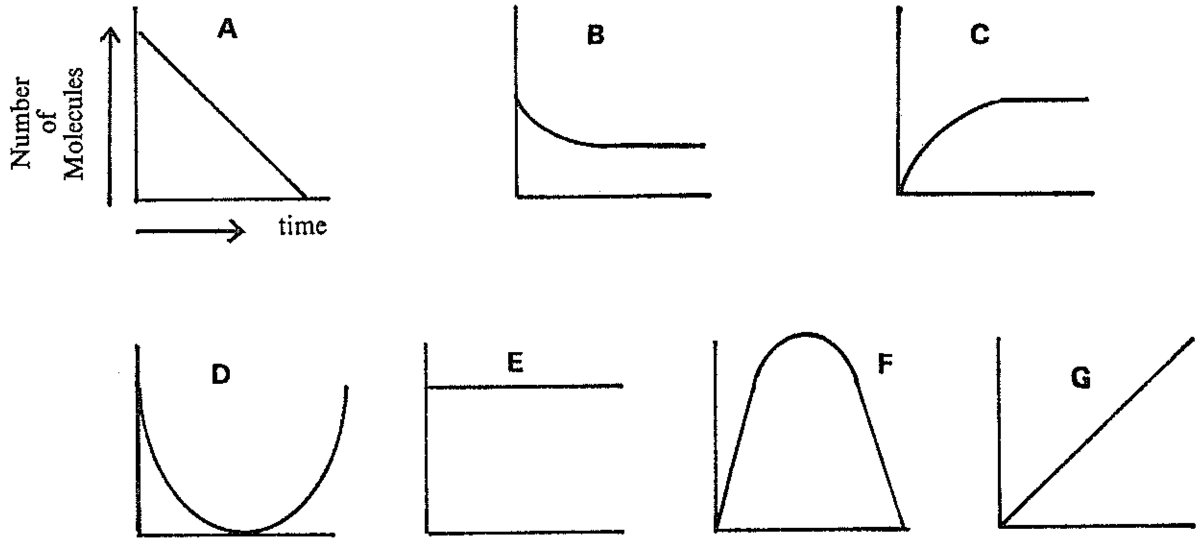
C

D

E



For items 51 and 52 you are to select from the graphs below the one which, for each item, represents the best answer.



51. Which of the graphs best represents the number of *hydrogen iodide molecules* present as time proceeds ?

52. Which of the graphs best represents the *total number of molecules* present as time proceeds ?

53. Chemists assume that in chemical reactions, *atoms* are rearranged into different molecular structures, but are not created or destroyed. If this assumption is true, then formation of ten molecules of hydrogen iodide would use up

A. five hydrogen molecules and five iodine molecules.

B. ten hydrogen molecules and ten iodine molecules.

C. twenty hydrogen molecules and twenty iodine molecules.

D. twenty hydrogen atoms and twenty iodine atoms.

54. That the reverse reaction occurs very slowly at first is best explained by the statement that

A. the hydrogen iodide molecule is not a particularly stable one.

B. the forward reaction is occurring very rapidly.

C. it is much easier for a hydrogen molecule to decompose than a hydrogen iodide molecule.

D. very few hydrogen iodide molecules are present, and so collisions between them are infrequent.

E. the system is then in dynamic equilibrium.

55. After the state of dynamic equilibrium has been reached,

A. no more collisions between hydrogen and iodine molecules can occur as they have been used up ;

B. the forward reaction slows down and the reverse reaction speeds up ;

C. the number of each kind of molecule present remains constant ;

D. hydrogen iodide, which has been formed before equilibrium, now begins to decompose and its concentration is therefore reduced.

UNIT XII

In dairy cows high butterfat production is desired, and in a series of experiments the effect of feeding conditions on butterfat production was tested. The results are given in the table below.

The characteristics of an individual are the result of the interaction of the environment with the heredity of the individual. The use of identical twins in such comparison experiments is of great value because identical twins have an identical inheritance in all respects and any differences between them must be due to the environment. If only the feeding conditions vary in the environment for a pair of twin cows then differences in butterfat production must be due to differences in the feeding conditions.

Identical twins were used in these experiments : A1 and A2 are twins, so are B1 and B2 and so on.

10 Acres Pasture per Cow + Additional Hand Feeding		10 Acres Pasture per Cow		6 Acres Pasture per Cow	
Twin No.	Butterfat Production (lb. per year)	Twin No.	Butterfat Production (lb. per year)	Twin No.	Butterfat Production (lb. per year)
A1 D1 J1	420 382 404	A2 D2 J2	330 270 315		
Average	402 (I)	Average	305 (II)		
		C1 E1 H1	264 272 304	C2 E2 H2	226 250 286
		Average	280 (III)	Average	254 (IV)
B1 F1 G1	392 402 364			B2 F2 G2	266 202 222
Average	386 (V)			Average	230 (VI)

56. Which of the following probably accounts for the difference between results I and V ?

A. Very small errors in measurement have combined to produce the difference.

B. A1, D1 and J1 were allotted to group I because they were known to be better producers of butterfat.

C. This is a result of the chance allocation of A1, D1 and J1 to group I, and B1, F1 and G1 to group V.

D. The group I cows were in a different pasture from the group V cows.

57. Comparison of which pair of results would suggest that the natural pastures are not sufficiently good to ensure maximum production of butterfat ?

A. I and II.
B. I and V.
C. II and III.
D. III and IV.
E. IV and VI.
F. V and VI.

58. Why were pairs of identical twins used in this experiment ?

A. The environment does not affect the similarity of identical twins.

B. The environment alone would be responsible for any differences appearing between identical twins.

C. Identical twins have the same environment.

D. The expected differences between individuals are due both to heredity and environment.

59. Both members of one pair of twins have a deformity of the mouth which makes it difficulty to eat grass which is short because of heavy grazing. Which pair of twins is this most likely to be ?

A. C1 and C2.
B. E1 and E2.
C. H1 and H2.
D. B1 and B2.
E. G1 and G2

UNIT XIII

Most reactions involving substances obtained from living things take place very slowly. Though the human digestive system digests a typical protein in four hours or less without high temperature or strong acids, protein must be boiled for 24 hours in a solution of 20 per cent. hydrochloric acid for the same thing to happen.

The difference is made possible by the action of enzymes, which are compounds which speed up chemical reactions in living matter. In the absence of the specific enzyme for a reaction, the reaction is extremely slow. Enzymes are not used up in the reactions they accelerate. A reaction can take place in the presence of very little of an enzyme ; for example a single molecule of the enzyme *peroxidase* can split 5 million hydrogen peroxide molecules every minute.

Most enzymes are *specific* ; that is, a particular enzyme usually acts only on selected compounds, called *substrates*, and leaves other molecules unaffected. The enzyme *urease* helps split the compound urea into ammonia which is a gas, and water, but has no effect on other compounds.

Penicillin-resistant staphylococci bacteria are now being studied. For several years penicillin has been used to control staphylococcal infections such as boils and carbuncles. However, by 1950, many bacteria were able to survive and multiply even when hundreds of times the usual dosage of penicillin was administered.

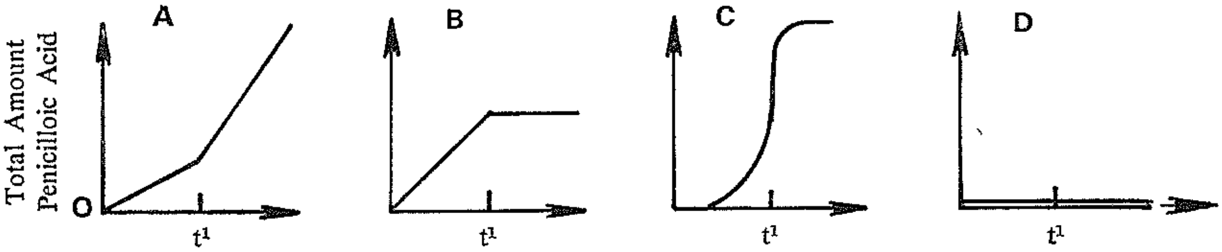
The reason for this was discovered in 1962. The pencillin-resistant varieties of staphylococcus produce an enzyme, called penicillinase which converts penicillin into penicilloic acid, which is inactive as an antibiotic. Penicillinase, by itself, does not harm the body, but simply counteracts the protective action of penicillin.

At present scientists are at work developing new antibiotics that are not decomposed by penicillinase. Methicillin, for example, is a new compound which is fairly resistant to the enzyme action of penicillinase.

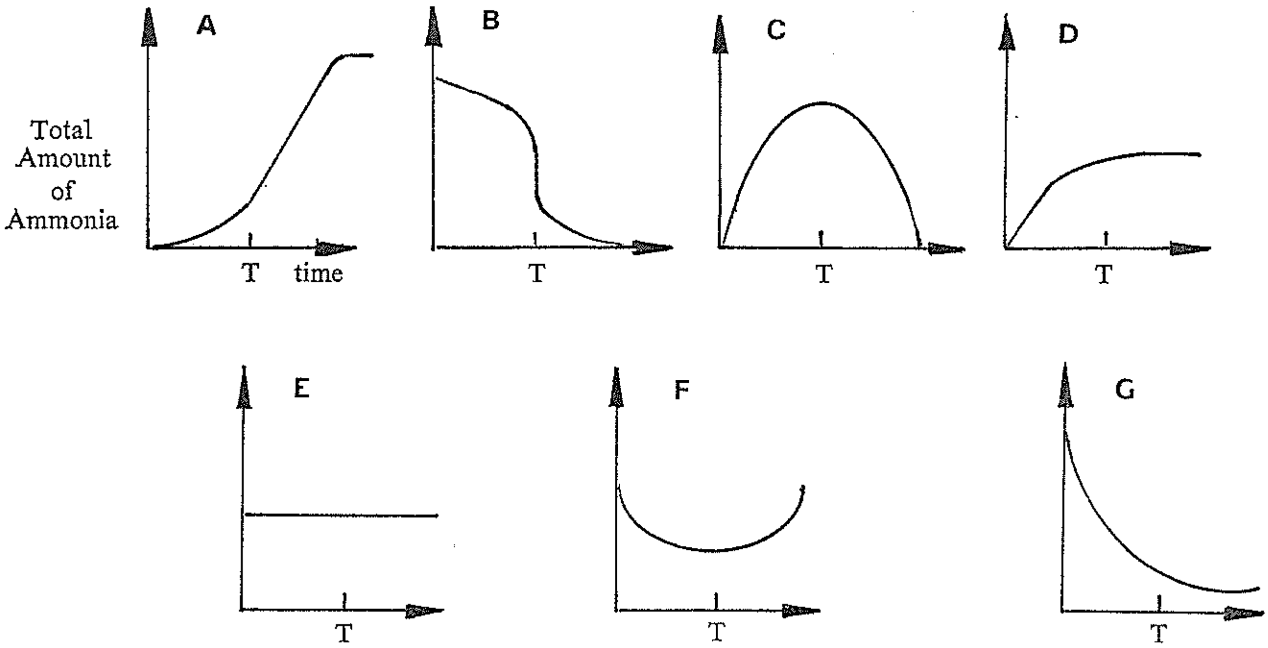
60. One thousand molecules of penicillinase are added to 200 million molecules of penicillin. At blood temperature (37° C.) the enzyme action is completed within one minute. At the end of this time, the best estimate of the number of penicillinase molecules remaining is

A. 200,001,000
B. 199,999,000
C. 1,000
D. 0
E. 200,000,000

61. At time $t = 0$, a test tube contains some penicillin. At time $t = t^1$ some *urease* is added to the test tube. Which graph best represents the total amount of *penicilloic acid* present in the tube at different times ?



62. At time $t = 0$, another test tube contains some urea. At time $t = T$, some urease is added. Which graph best represents the total amount of *ammonia* present in the tube at different times ?



63. Which of the following may be described as a substrate for one of the reactions mentioned in the passage ?

A. penicillin

B. penicillinase

C. staphylococcus

D. penicilloic acid.

64. Penicillinase may be described as :

A. An antibiotic to which staphylococcus bacteria have become resistant.

B. A substance which prevents the antibiotic effect of penicillin on staphylococcus bacteria.

C. A variety of penicillin which is effective against penicillin-resistant bacteria.

D. An enzyme which helps penicillin destroy staphylococcus bacteria more rapidly.

E. A substance which causes infections such as boils and carbuncles.

By Authority: A. J. Arthur, Cwealth Govt Printer, Canberra