7-29-1970

Comprehension and interpretation (sciences) 1970

ACER

Multi - Aptitude Batteries - 26(b)

(29)

commonwealth
secondary
scholarships
examination

afternoon session:
wednesday
29 july
1970

time allowed:
two hours

test booklet
to be handed
in with
your answer
sheet

comprehension & interpretation (science)

instructions to candidates

This is a test of your ability to read and understand material of a scientific nature. It is possible to do well on this test even if you have studied only a little science at school. The test consists of 11 units (60 questions in all) to be answered in two hours.
You will obtain the best possible score if you observe the following points: (1) Work carefully through the questions in the order in which they are given. (2) Don't waste too much time on any one question; if necessary, go on to the next question and come back to the difficult ones later. (3) If you think you know an answer, mark it—even if you are not certain you are correct. Marks will **not** be deducted for wrong answers. (4) Make sure that you mark the letter you have chosen in the correct line on your answer sheet.

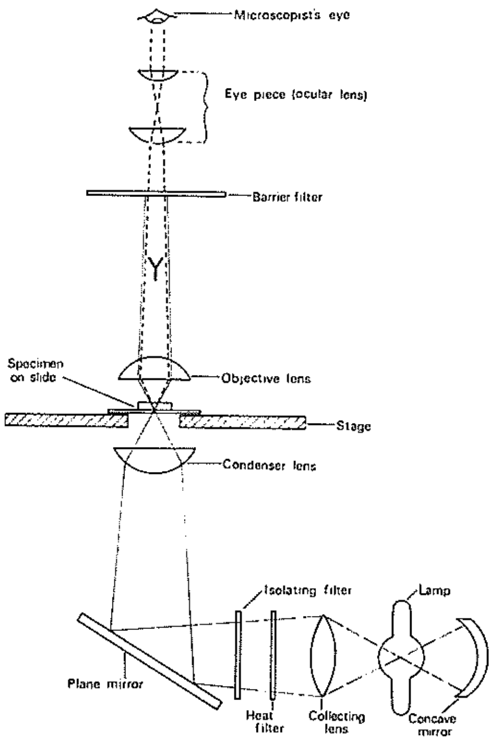
answering

Each question has four alternative answers, represented by the letters A B C D. You must choose one answer from these alternatives. Having done so, make sure you mark your answer correctly.
If you want to change an answer, erase your first mark completely. Try to avoid having to make erasures by not answering hastily. Take care that your pencil mark does **not cross** into another row or column, and that there are no marks or smudges on your answer sheet.
Now look through this booklet, but **don't start writing** until the supervisor tells you to do so.

UNIT 1

The passage and figure below are about the fluorescence microscope.

The three parts of a fluorescence microscope are (1) the source of radiation, (2) the filters and (3) the lenses. The radiation source is a lamp situated in front of a concave mirror. The concave mirror increases the intensity of the radiation reaching the specimen. The lamp is a useful source of green and blue light and of ultra-violet radiation. The light (which is a form of radiation) and the ultra-violet radiation pass through a collecting lens and through two filters—a heat filter and an isolating filter. The heat filter absorbs all the heat from the lamp, thus preventing damage to the microscope lenses; the isolating filter absorbs the visible light but not the ultra-violet radiation. This radiation is reflected by the plane mirror, and passes into the condenser which focusses it on the specimen. The ultra-violet radiation interacts with atoms in the specimen and as a result light is emitted. This light is called fluorescent light. The fluorescent light and any excess ultra-violet radiation pass through the objective lens to a barrier filter which absorbs all the ultra-violet radiation. The fluorescent light passes through to the eyepiece and the microscopist sees an image of a luminous object against a black background.



1 The isolating filter absorbs
- **A** ultra-violet radiation.
- **B** blue and green light.
- **C** heat from the lamp.
- **D** fluorescent light.

2 The concave mirror increases the brightness of the image by
- **A** absorbing radiation from the back of the lamp.
- **B** reflecting radiation from the back of the lamp in such a way that all radiation reaching the collecting lens is in parallel rays.
- **C** reflecting radiation from the back of the lamp away from the collecting lens.
- **D** reflecting radiation from the back of the lamp towards the collecting lens.

3 The radiation passing between the heat filter and the isolating lens is best described as
- **A** ultra-violet radiation.
- **B** fluorescent light.
- **C** green and blue light and ultra-violet radiation.
- **D** green and blue light.

4 The radiation at Y in the figure is best described as

- **A** fluorescent light.
- **B** ultra-violet radiation.
- **C** a mixture of fluorescent light and ultra-violet radiation.
- **D** pale blue visible light.

5 The human eye cannot use ultra-violet radiation for seeing, yet the barrier filter is included in order to prevent this radiation from reaching the eye. Which of the following is the most probable reason for the inclusion of the filter?

- **A** The ultra-violet radiation would damage the microscopist's eye.
- **B** If the ultra-violet radiation reached the microscopist's eye, the background would no longer appear black.
- **C** The mixture of the ultra-violet radiation and the fluorescent light would make the image appear black.
- **D** The ultra-violet radiation would damage the lens of the condenser.

6 The whole of a large specimen which is on a slide is within the microscopist's field of view. All the ultra-violet radiation emerging from the condenser interacts with the atoms of a part of the specimen. As a result the microscopist would see

- **A** nothing, since the entire field would be black.
- **B** a luminous object against a black background.
- **C** only the ultra-violet radiation emitted by the specimen.
- **D** only a background of green and blue light.

GO STRAIGHT ON TO UNIT 2

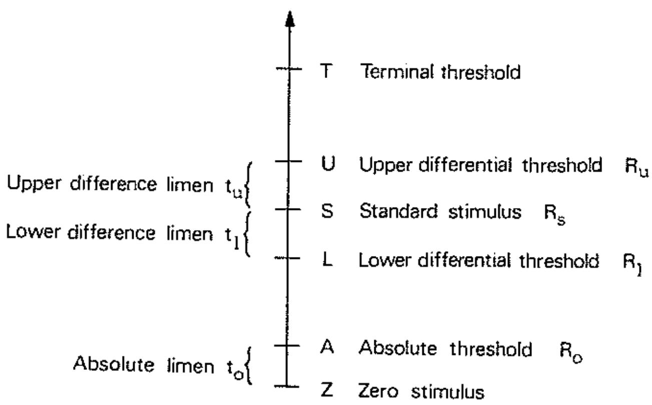
UNIT 2

In an experiment several people were asked to choose, from a range of objects, one midway in weight between two standard objects markedly different in weight from each other. Most people chose an object nearer in weight to the lighter of the two standard objects.

The experiment illustrates the fact that subjective estimates of the magnitude of a physical property (e.g. how heavy an object is, or how loud a noise is) are not identical with the actual physical magnitude of the property.

The total physical range of magnitudes of a property is called the *physical stimulus continuum*. When subjective estimates of the magnitude of a physical property are made, these occupy a *psychological stimulus continuum* which is not identical with the corresponding physical stimulus continuum.

The figure below shows the relationship between measurements in the physical stimulus continuum and estimates in the psychological stimulus continuum.



Explanation of the figure

1 The vertical line represents a physical stimulus continuum.

2 Point *Z* represents *zero stimulus* when none of the physical property is being considered (e.g. zero weight).

3 A distance measured along the line from the point *Z* to any other point on the line represents the magnitude of a physical stimulus.

4 Point *A* represents the *absolute threshold* (R_o) which is the least magnitude of a stimulus that a subject can perceive (e.g. the lowest musical note that he can hear).

5 Point *T* represents the *terminal threshold* which is the greatest magnitude of a stimulus that a subject can perceive (e.g. the highest musical note that he can hear).

6 Point *S* represents a given *standard stimulus* (R_s) which may be anywhere between *A* and *T*.

7 Point *U* represents the *upper differential threshold* (R_u) for the given standard stimulus. It is a stimulus greater in magnitude than R_s that the subject can just distinguish from R_s (e.g. a weight slightly heavier than a standard weight). Point *L* represents the *lower differential threshold* (R_l) which is just lower in magnitude than R_s.

8 The difference between the absolute threshold and the zero stimulus is the *absolute limen* (t_o).

9 The difference between a differential threshold (either upper or lower) and the standard stimulus is a *difference limen*.

10 The points *A*, *U*, *L* and *T* are different for different people since they are subjective judgments of a given property.

7 The magnitude of the absolute threshold is numerically equal to the magnitude of

A the upper differential threshold.
B a standard stimulus.
C the lower difference limen.
D the absolute limen.

8 The range of magnitudes of a physical stimulus that a subject can perceive is represented in the figure by the length of the line between the points

A Z and T.
B A and T.
C L and T.
D L and U.

9 The upper difference limen is equal in magnitude to

A $R_u - R_s$
B $R_s - R_o$
C R_u
D R_s

10 A person able to distinguish as different a colour which is nearly the same as a standard colour has a

A small absolute threshold for the standard colour.
B large absolute limen for the standard colour.
C small difference limen for the standard colour.
D small terminal threshold for the standard colour.

11 The stimulus magnitude of the pitch of the highest note a person can hear is his

A absolute limen for pitch.
B absolute threshold for pitch.
C upper differential threshold for pitch.
D terminal threshold for pitch.

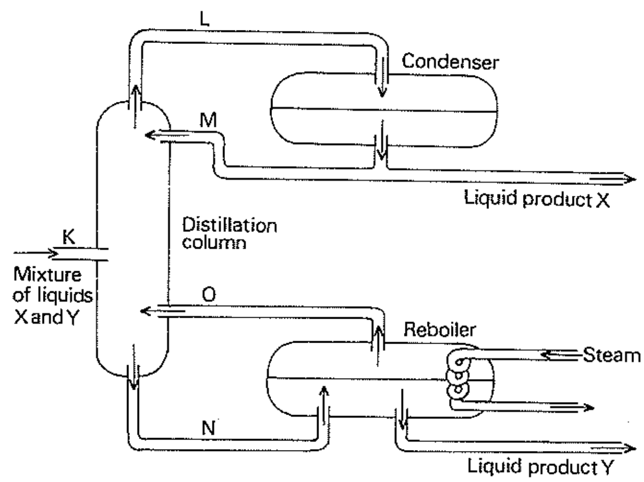
12 An experimenter flashed a very feeble white light onto a screen in a completely dark room. Susan reported that she saw the light, while Helen reported that she saw nothing. The experimenter then increased slightly the intensity of the light flashed onto the screen and Helen reported that she saw the light. The experimenter could conclude that Helen, compared to Susan, has a

A larger lower difference limen for white light.
B larger absolute limen for white light.
C smaller absolute limen for white light.
D smaller terminal threshold for white light.

GO STRAIGHT ON TO UNIT 3

UNIT 3

The separation of mixtures of liquids into their component parts is one of the major processes of the chemical and petroleum industries. The most widely used method is distillation, in which two liquids which boil at different temperatures may be separated. A typical distillation unit is illustrated below.



Liquid X and liquid Y can both be vaporized. X has a lower boiling-point temperature than Y.

The vapour in the column is supplied by the *reboiler*. Liquid is withdrawn from the bottom of the column and heated by steam in the reboiler so that some of the liquid is vaporized. The vapour formed is passed back into the column and the liquid is drawn off from the reboiler as liquid product Y.

All the vapour collected at the top of the column is condensed to a liquid in the *condenser*. Some of this liquid is drawn off as liquid product X and the rest is returned to the column.

The temperature is highest at the bottom of the column and some vaporization occurs there. As the vapour rises through the column its temperature drops and at the top it contains more of the component with the *lower* boiling point than the vapour at the bottom does. The liquid descending the column becomes hotter and therefore richer in the component with the *higher* boiling point.

13 The material in L is most accurately described as

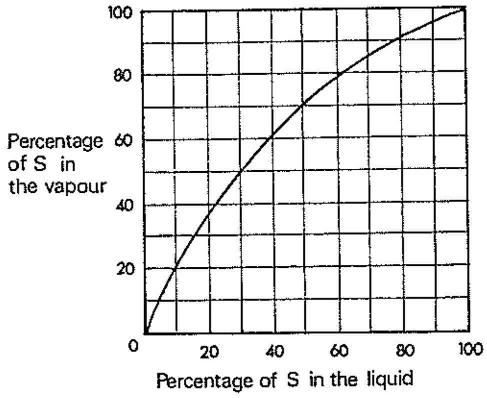
A a liquid mixture of X and Y.
B a vapour containing X and Y in almost equal amounts.
C a vapour containing mainly X.
D a liquid containing mainly X.

14 The material in N is most accurately described as

A a vapour containing mainly X.
B a liquid mixture of X and Y.
C a liquid mixture richer in X than the mixture at K.
D a vapour richer in X than the mixture at K.

Questions 15 to 17 refer to the following additional information:

The graph shows the percentages of substance S in the vapour and in the liquid when the two are in direct contact in a distillation column. The information applies to any mixture of S and T in any proportions.



15 In a mixture of S and T at one point in the column, 60 per cent of the liquid is S. The percentage of S in the vapour at this point is approximately

- **A** 20 per cent.
- **B** 40 per cent.
- **C** 60 per cent.
- **D** 80 per cent.

16 A liquid mixture of S and T at a point in the column contains 50 per cent S. The percentage of T in the vapour at this point

- **A** is less than 50 per cent.
- **B** is exactly 50 per cent.
- **C** is more than 50 per cent.
- **D** cannot be determined without knowing the temperature.

17 At one point in a distillation column containing a mixture of S and T, the percentage of S in the vapour is 30 per cent and of T in the liquid is 85 per cent. From this information we can conclude

- **A** that there was more S than T in the mixture fed into the column.
- **B** that there was more T than S in the mixture fed into the column.
- **C** that there was about the same percentage of S and T in the mixture fed into the column.
- **D** very little if anything concerning the relative proportions of S and T in the mixture fed into the column.

GO STRAIGHT ON TO UNIT 4

UNIT 4

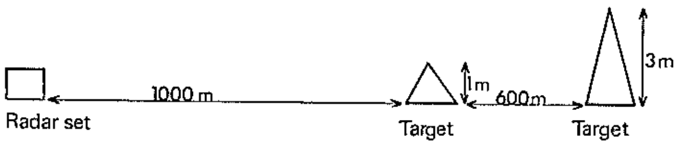
Most radars work by transmitting short pulses of radio energy rather like a torch which is switched on and off. The transmitter is switched on for anything between a fraction of a microsecond and ten or more microseconds. Energy reflected from a target is received back at the aerial of the radar set while the transmitter is switched off between pulses.

Radar waves travel at a speed of 3×10^8 metre per second or 300 metre per microsecond.

18 A transmitted pulse travels from a radar set to a target 900 metre away and then back to the aerial of the radar set. What is the time taken?

A 1·5 microsecond
B 3 microsecond
C 6 microsecond
D 30 microsecond

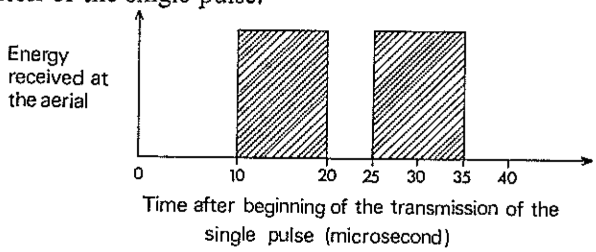
19 Two targets are at distances of 1000 metre and 1600 metre east of a radar set.



A single pulse is transmitted by the radar set and is reflected from both targets. What is the delay between the times when the two reflected pulses first reach the aerial?

A 2 microsecond
B 4 microsecond
C 6·6 microsecond
D 10·6 microsecond

20 A pulse of 10 microsecond duration was transmitted from a radar set. The graph below shows two reflected pulses which have returned to the aerial of the radar set. The time is taken from the beginning of transmission of the single pulse.



Both targets lie directly east of the radar set. What is the best estimate of the distance between the two targets?

A 750 metre
B 2250 metre
C 3000 metre
D 4500 metre

Questions 21 to 23 refer to the following additional information:

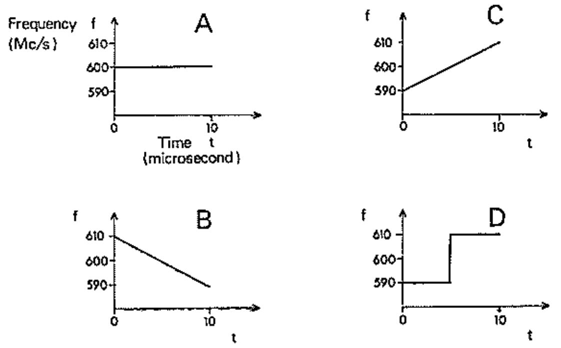
If normal targets are to be detected at long range and if small or poorly reflecting targets are to be detected at short range, the energy transmitted in each pulse must be as large as possible. This can be achieved by increasing the duration of the pulse. However, when a long pulse is used, the echoes from targets that are close together will overlap and it is then impossible to distinguish between them.

In the technique known as 'pulse-compression' the problem is solved by transmitting a long pulse and then, in effect, squeezing the received pulse so that the display receives only very short pulses.

This is achieved by sweeping the frequency of the transmitter over a small frequency range during the transmission of a pulse. A transmitter previously working on 600 megacycles per second (Mc/s) is modified so that its frequency increases continuously during the transmission of a ten-microsecond pulse from an initial frequency of 590 Mc/s to a final frequency of 610 Mc/s. The receiver is fitted with a special delay line through which the received pulses pass.

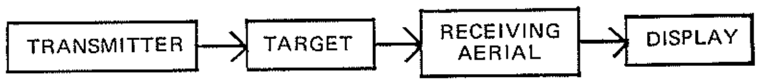
The time taken for a pulse to pass through this delay line depends upon frequency so that the earlier, lower-frequency part of the pulse takes longer to pass through than the later part of the pulse. In this way a transmitted pulse of long duration is received at the display as a considerably shortened pulse.

21 Which one of the following is the best graph of frequency of the transmitted pulse against time for a ten-microsecond pulse transmitted by a 'pulse-compression' radar set?



22 Which of the following best represents the stages in the detection of a target using the 'pulse-compression' radar technique?

A 

B 

C 

D 

23 Which one of the following most correctly explains the process of 'squeezing the pulse'?

A The lower frequency part of the transmitted pulse takes longer to travel to the target and back, so the pulse received at the aerial is of shorter duration than the transmitted pulse.

B The pulse received at the aerial is of the same duration as the transmitted pulse but the lower frequency part is delayed so that the pulse received at the display is shorter.

C The higher frequency part of the transmitted pulse takes longer to travel to the target and back, so the pulse received at the aerial is of shorter duration than the transmitted pulse.

D The higher frequency part of the transmitted pulse is delayed so that the transmitted pulse is shorter than the one received at the aerial since the higher frequency part travels more slowly.

UNIT 5

The most important factors which determine the sound of a spoken vowel are the amount of lip or mouth opening and the position of the tongue. The opening of the mouth can be open as in Fig. II or partly closed as in Fig. I. The tongue is used to divide the space between the lips and the vocal chords at the back of the throat into two sections. Fig. I below shows how the tongue *hump* can do this for two distinct vowels.

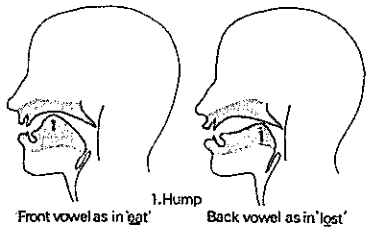


Fig. I

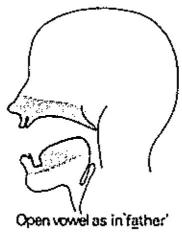


Fig. II

The following table indicates the tongue hump positions and degree of constriction of the mouth for 12 vowels used in common speech. A word in which the vowel is used is given, with the vowel underlined.

Degree of constriction	Tongue hump position		
	Front	Central	Back
Closed	heed hid	heard	who'd hood
Mid	haid head	hud	hoed hawed
Open	had		hod

Sound travels through air in the form of waves. Differences in the pitch of sounds can be distinguished by differences in the frequency (measured in cycles per second) of the waves, and these can be measured. The characteristic vowel frequency, i.e. the frequency with the greatest intensity, for some of the vowels in the table is listed below.

Vowel	hod	had	hud	hawed	head	heard	hood	hid	who'd	heed
Frequency (cycles /sec)	730	660	640	570	530	490	440	390	300	270

24 As the tongue hump moves from the front towards the back position, the frequency of the resulting vowel

A increases only.
B decreases only.
C remains the same.
D increases and decreases in an irregular way.

25 A change in the degree of constriction, from open towards closed, is accompanied by

- **A** a decrease in the vowel frequency.
- **B** an increase in the vowel frequency.
- **C** an increase in the vowel frequency followed by a decrease.
- **D** a decrease in the vowel frequency followed by an increase.

26 In the word 'motor', the first vowel is most probably spoken with the tongue hump in the

- **A** back position and an open degree of constriction.
- **B** back position and a mid degree of constriction.
- **C** front position and an open degree of constriction.
- **D** front position and a closed degree of constriction.

27 A vowel, represented by the symbol ∩, is pronounced with tongue hump in the front position and a closed degree of constriction. Which of the following underlined vowels is **least** likely to be the vowel represented by ∩?

- **A** pretty
- **B** mean
- **C** moon
- **D** lip

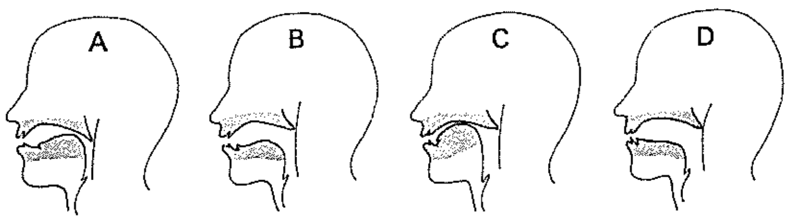
28 A spoken vowel is found to have a measured frequency of 400 cycles per second. It is the vowel in one of the following words. Which one is it most likely to be?

- **A** tub
- **B** pit
- **C** keep
- **D** mood

29 In terms of the information given which one of the following best summarizes the effect of changing the degree of constriction on the pronunciation of vowels?

- **A** A more open position tends to shorten the time for the vowel to be spoken.
- **B** As the degree of constriction becomes more closed, the vowel changes from 'a' through 'o' to 'u'.
- **C** The degree of constriction has no appreciable effect on the characteristics of the spoken vowel.
- **D** No regular pattern of change in the spoken vowel is evident as the degree of constriction changes.

30 Which one of the following diagrams most probably represents the tongue hump position and degree of constriction when the vowel 'oo' as in mood is spoken?



UNIT 6

Chemical activity in living cells maintains a separation of charges between the outside and the inside of the cell. There is normally an excess of positive charge on the outside of the cell surface or membrane, and an excess of negative charge inside the cell. The distribution of excess charges in the resting (unstimulated) cell is shown in Fig. I.

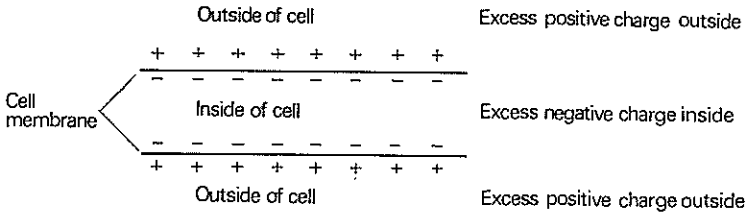


Fig. I

Inside the cell there are many particles (ions) with a negative charge, and there are also some positive ions of the element potassium and very few positive ions of the element sodium. The excess positive charge on the outside of the membrane results from the numerical excess of sodium ions, although there are also a few negative ions and a few positive potassium ions. When a small region of a nerve cell membrane is stimulated (e.g. by applying pressure momentarily on it), sodium ions move rapidly into the cell and potassium ions move slowly out. The difference in rates of movement results in a temporary reversal of the relative charges across the cell membrane in the stimulated region (see Fig. II). The ions return to their normal positions when the region is no longer stimulated.

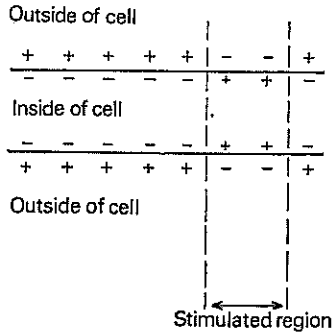


Fig. II

31 Compared with the **inside** of a cell in an unstimulated region, the **inside** of a cell in a stimulated region has

- **A** an increase in sodium ions, and a decrease in potassium ions.
- **B** an increase in sodium ions, and an increase in potassium ions.
- **C** a decrease in sodium ions, and a decrease in potassium ions.
- **D** a decrease in sodium ions, and an increase in potassium ions.

Questions 32 and 33 refer to the following additional information:
When there is a separation of charge, (i) the *nature* and (ii) the *extent* of this can be measured on an instrument which indicates

(i) whether the inside of the cell is negative or positive in relation to the outside, and
(ii) the relative excess of negative or positive charge (see Figs III and IV).

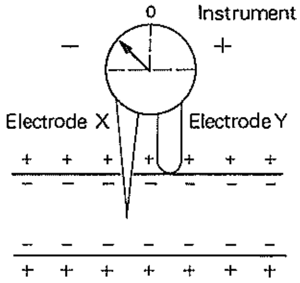


Fig. III

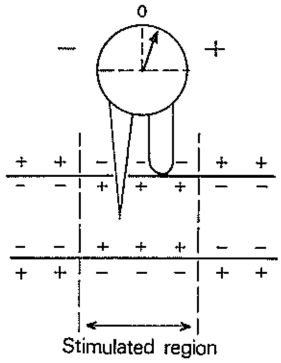


Fig. IV

Membrane at rest. Inside of cell is *negative* in relation to the outside.

Inside of cell is *positive* in relation to the outside at the stimulated region.

Electrodes X and Y do not themselves act as a stimulus.

32 A negative reading on the instrument becomes a positive reading when

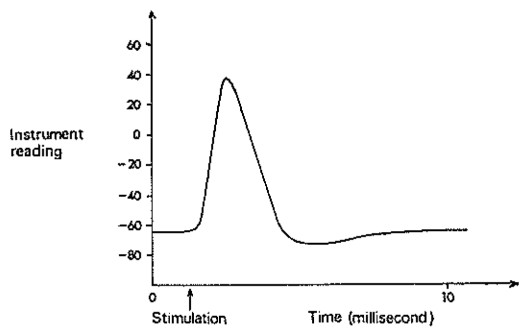
- **A** sodium ions move out of the cell.
- **B** there is a movement of ions along the surface of the cell membrane.
- **C** there is an identical distribution of charges inside and outside the cell.
- **D** a cell membrane is stimulated at a particular point.

33 A change in instrument reading from positive to negative is observed. This is associated with

- **A** potassium ions and sodium ions moving along the surface of the membrane.
- **B** sodium ions moving into the cell.
- **C** potassium and sodium ions moving in the same direction.
- **D** none of the above changes.

Questions 34 and 35 refer to the following additional information:

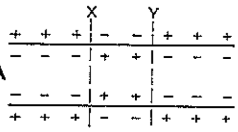
The changes which result from the stimulation of a cell membrane at a point cause a disturbance in the immediate neighbourhood of the stimulated region. In nerve cells this disturbance is the 'nerve impulse' which travels from the point of stimulation at speeds up to 100 metre per second. A recording from the instrument under conditions when the cell membrane is stimulated is shown in the graph on the right.

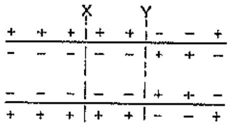


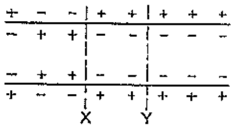
34 Electrode X is placed inside and electrode Y is placed outside a cell at a particular point. Some time later the cell membrane is stimulated. The reading on the instrument becomes temporarily

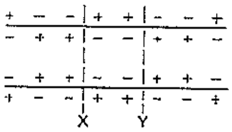
- **A** positive and larger in magnitude.
- **B** positive and smaller in magnitude.
- **C** negative and larger in magnitude.
- **D** negative and smaller in magnitude.

35 Region XY of a cell membrane was stimulated. The resulting impulse travelled **from left to right.** Which of the following diagrams best represents the distribution of excess charges when the resulting impulse **has just passed** out of region XY?

A 

C 

B 

D 

GO STRAIGHT ON TO UNIT 7

UNIT 7

Read quickly through the following material (on pages 15 and 16) to gain a general impression; then look at the questions before turning back to the material.

The Smithsonian Institution in the USA maintains a 'center' for recording and reporting on short-lived natural phenomena. Below is some information about the Center.

SMITHSONIAN INSTITUTION
CENTER FOR SHORT-LIVED PHENOMENA

INFORMATION ABOUT THE CENTER

The Purpose of the Center

The purpose of the Center is to act as an early alert system and clearing house for the collection and dissemination of information on short-lived natural phenomena. The Center uses an international communications system capable of reaching virtually any point on earth within minutes. This communications ability enables the Center to contact event areas quickly to obtain information on events while they are occurring or shortly after they occur.

Correspondents of the Center

The Center has established a global network of more than 2000 scientific correspondents in 122 countries. Correspondents are scientists, scientific institutions, and field stations that cooperate with the Center by reporting short-lived events that occur in their areas and in return receive reports of interest to them from the Center.

Event Notification and Information Cards

The Center notifies subscribers of the occurrence of short-lived events through the issuance of Event Notification and Event Information cards. These cards are issued within 24 hours of the receipt of the event information by the Center and are immediately dispatched to subscribers. Event Notification cards contain initial information on the occurrence of current or recent events. Event Information cards contain additional information and data and the current status of continuing events and/or preliminary results of field expeditions.

Two reports of a meteorite shower in Victoria were received by the Center and sent to interested persons. The reports are reproduced *exactly* as they were received

EVENT 125-69 VICTORIA METEORITE SHOWER — 9 OCTOBER 1969 — 783.

The following cable report was received by CFSLP on 9 October 1969:

"METEORITE OBSERVED BREAKING UP OVERHEAD NEAR MURCHISON, VICTORIA. LATITUDE: 36° 37' SOUTH. LONGITUDE: 145° 12' EAST. TIME: 1 15 AM 28TH SEPT. PUFFS OF SMOKE AND EXPLOSIONS. TRAVELLING FROM SOUTH EAST TO NORTH WEST. COMPLETE STONES AND FRAGMENTS FELL OVER 5 MILES ALONG A MILE WIDE TRACK EXTENDING FROM 5 MILES SOUTH EAST OF MURCHISON. MANY PICKED UP BY LOCAL RESIDENTS. THE STONES ARE CARBONCEAOUS CHONDRITE. I'VE GOT 2 SMALL STONES. PROFESSOR J.F. LOVERING, GEOLOGY DEPT, UNIVERSITY OF MELBOURNE IN CHARGE OF INVESTIGATION. HIS TEAM COLLECTED OR BORROWED A NUMBER OF SPECIMENS INCLUDING THE LARGEST SO FAR KNOWN AN INCOMPLETE MASS OF 1.5 LB."

EVENT INFORMATION REPORT :2

TYPE OF EVENT	ASTROPHYSICAL
DATE OF OCCURRENCE	28 SEPTEMBER
LOCATION OF EVENT	MURCHISON, VICTORIA, AUSTRALIA
REPORTING SOURCE	THE AUSTRALIAN MUSEUM, SYDNEY
SOURCE CONTACT	MR. R.O. CHALMERS THE AUSTRALIAN MUSEUM BOX A 285 SYDNEY SOUTH POST OFFICE N.S.W. 2000, AUSTRALIA

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EVENT 125-69 VICTORIA METEORITE FALL — 10 OCTOBER 1969 — 785.

1) The following report from Dr. Lovering was telephoned to CFSLP:

"The meteorite definitely is a chondritic meteorite of type 2 or 3 carbonaceous chondrite. It's fairly compact in most places but it's a frible in certain areas and appears to be at least somewhat heterogeneous. The correct time for the fall was sometime during the time period of 10:45 a.m. to 11:00 a.m. The area of the fall is five miles by one mile. The stone fragmented in the air. The fractured surfaces have incipient fusion crusts on them. A strong smell was reported associated with the meteorites when they were recovered. I didn't believe this but checked it out and found that indeed they had the odor of metholated spirits (denatured alcohol). I have collected and have in my possession, some of it on loan, 2.5 kg. of material. I know of another 4.5 lbs., approximately, in the hands of private individuals. It's a total of about ten pounds that has been recovered so far."

EVENT INFORMATION REPORT, 3

TYPE OF EVENT	ASTROPHYSICAL
DATE OF OCCURRENCE	28 SEPTEMBER '69
LOCATION OF EVENT	VICTORIA, AUSTRALIA
REPORTING SOURCE	AUSTRALIAN NATIONAL UNIVERSITY
SOURCE CONTACT	DR.J.F. LOVERING DEPT. OF GEOPHYSICS & GEOCHEMISTRY AUSTRALIAN NATIONAL UNIVERSITY P.O.BOX 4, CANBERRA, A.C.T., 2600 AUSTRALIA

This report is based on notifications received from the Center's correspondents and is disseminated for information purposes only. The Smithsonian Institution bears no responsibility for its accuracy.

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36 The first part of Dr Lovering's report was intended to

- **A** classify the meteorite according to a scientifically accepted system.
- **B** name the meteorite so that scientists could distinguish it from other meteorites of the same kind.
- **C** give a theory of formation of the meteorite.
- **D** suggest that the meteorite was formed from coal.

37 Of the following, the major point of disagreement in the two reports was concerned with the

- **A** composition of the meteorite.
- **B** reported time of sighting.
- **C** amount of material collected.
- **D** area and position of fall.

38 If Dr Lovering had delayed his arrival for another week, which of the following may **not** have been accepted by him as a fact?

- **A** The material was carbonaceous chondrite.
- **B** Fractured surfaces had incipient fusion crusts.
- **C** The material had an odour of denatured alcohol.
- **D** The material was heterogeneous.

39 Which of the following descriptions is consistent with that of the meteorite material described in the reports?

- **A** a hard stone with particles of the same size having patches of colour
- **B** a hard stone with patches of crumbly material containing particles of the same size
- **C** a black, coal-like stone with a uniform glassy appearance
- **D** a stone with patches of crumbly material containing particles of different size

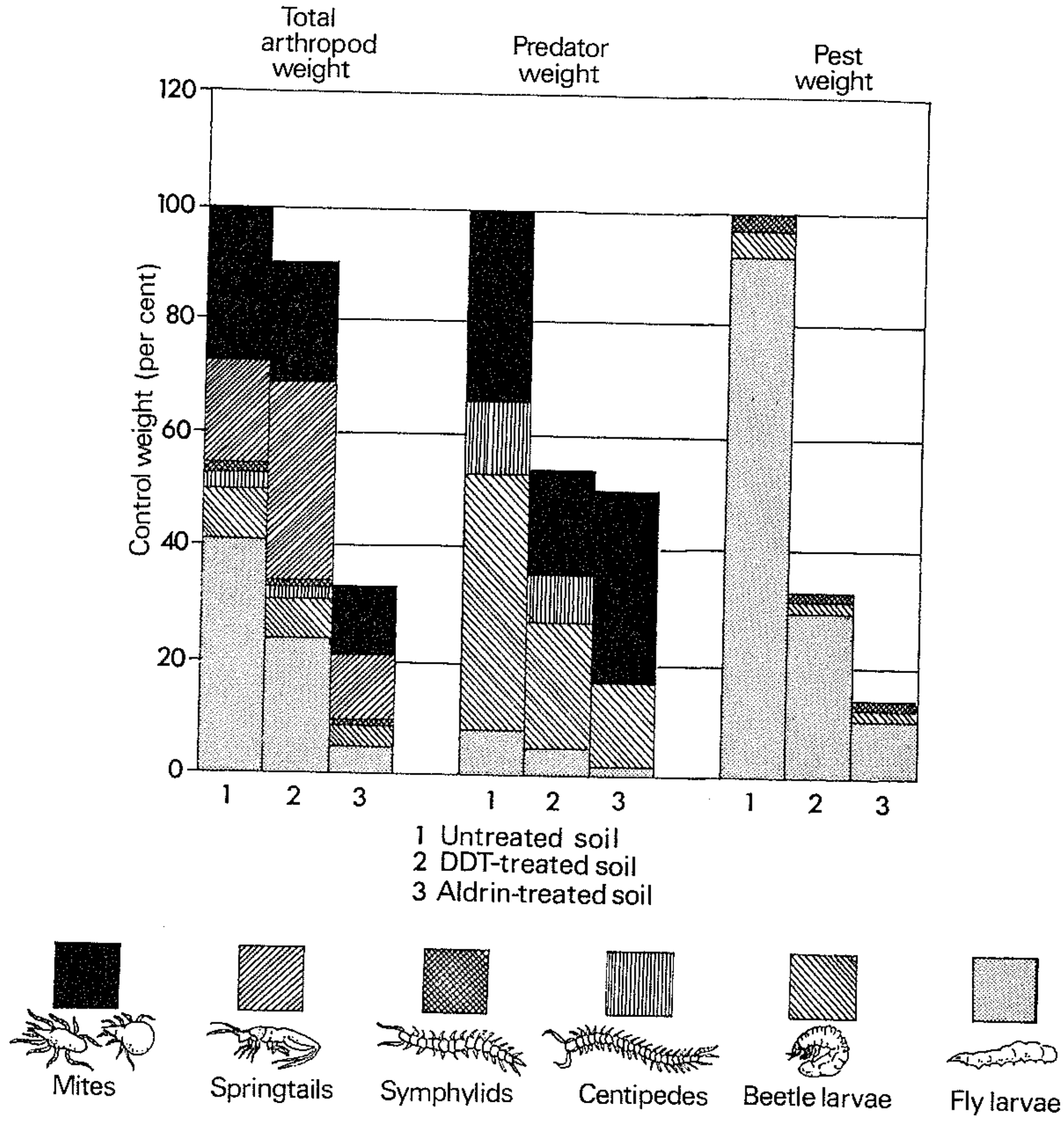
40 Which of the following events is most likely to claim the attention of the Smithsonian Institution?

- **A** a report that an earthquake struck a village in the centre of the Philippines
- **B** a report that the buildings of Venice are steadily sinking into the sea
- **C** a report that a small tribe of natives in South America use a poison which causes death within a few minutes of its coming in contact with broken skin
- **D** a report that a chemist has produced a sample of a new element, the sample existing for less than a millionth of a second

GO STRAIGHT ON TO UNIT 8

UNIT 8

A study of the effect of insecticides on certain soil animals called arthropods was made over a period of one year. In the figure below there are three sets of columns summarizing some of the results of this study. The animals studied are indicated below the columns. The first of the three columns in each set shows the average weight in untreated soil of the animals listed (expressed as a percentage of the whole); the second column shows the weights in soils treated with standard doses of the insecticide DDT; the third column is for soils treated with another insecticide called aldrin.



41 In soils treated with aldrin, the total weight of arthropods in the soil decreased in one year by approximately

A 10 per cent.
B 30 per cent.
C 70 per cent.
D 90 per cent.

42 Study the effects of the two chemicals on the total weight of soil arthropods. Which one of the following is **not** true?

- **A** All the kinds of arthropods shown survive dosage with DDT, but centipedes cannot tolerate aldrin.
- **B** The total weight of beetle larvae in the DDT-treated soil is more than that in untreated soil.
- **C** The proportion of springtails in the DDT-treated soil is greater than the proportion in the untreated soil.
- **D** The weight of fly larvae is reduced from approximately 40 per cent of the original population to 15 per cent of the aldrin-treated population.

43 Compare the weight of springtails expressed as a proportion of the total arthropod weight in both DDT-treated and untreated soils. In DDT-treated soils the proportion

- **A** is greater by about 50 per cent.
- **B** is less by about 50 per cent.
- **C** remains the same.
- **D** is greater by about 100 per cent.

44 Compare the weight of mites as a proportion of predator weight in DDT-treated soil, aldrin-treated soil and in untreated soil. Which one of the following is true?

- **A** DDT is more effective in killing mites than is aldrin.
- **B** The proportion in DDT-treated soil is greater than the proportion in aldrin-treated soil.
- **C** The proportion in DDT-treated soil is the same as the proportion in aldrin-treated soil.
- **D** The proportion in aldrin-treated soil is less than the proportion in untreated soil.

45 Which pest is **least** affected by treatment with aldrin?

- **A** symphylids
- **B** beetle larvae
- **C** fly larvae
- **D** centipedes

GO STRAIGHT ON TO UNIT 9

UNIT 9

Manufactured household gas is a mixture of several component gases. As the proportion of these components changes, the gas mixture burns in different ways. Three of the gases present in household gas are hydrogen, carbon monoxide and methane. Three characteristics determine the way these gases burn and their contribution when present to the way in which a mixture burns.

1 *The calorific value, CV,* of a gas is a measure of the amount of heat released when a given volume of gas burns. The quantity of air used when a gas burns depends on the *CV* of the gas—*the greater the CV the greater the quantity of air used.*

2 *The relative density, RD,* of a gas can be defined as a measure of its weight relative to the weight of an equal volume of air. Household gas is delivered at a certain pressure and under that condition the *RD* determines how much gas will pass through the opening of a given burner in a given time; at a given pressure *the greater the RD the smaller the volume of gas released.*

3 *The burning rate, S,* of a gas is a measure of the speed at which the flame is propagated in the gas. Household gas normally burns with a steady flame at the opening of the burner but *if the S value of the gas is increased sufficiently the condition known as 'burning back' occurs* and the flame burns inside the burner.

The ratio $\frac{CV}{RD}$ *is called the B number of a gas,* and is a useful way of expressing the heat produced by a given burner in a given time when the gas is at a given pressure. Under identical conditions two gases will produce the same amount of heat only if they have the same *B* number.

The table below gives the *CV*, *RD* and *S* values of hydrogen, carbon monoxide, methane and household gas.

Gas	*CV* (thermal units per cubic foot)	*RD* (based on *RD* of air = 1)	*S* (based on *S* of hydrogen = 100)
Hydrogen ..	320	0.07	100
Carbon monoxide	318	0.97	18
Methane ..	1000	0.55	14
Household gas ..	500	0.50	41

46 The *B* number of carbon monoxide is

A approximately the same as that of hydrogen.
B much larger than that of hydrogen.
C much smaller than that of hydrogen.
D approximately the same as that of methane.

47 Which one of the following lists shows the gases in order of increasing *B* numbers (starting with the lowest)?

A carbon monoxide, household gas, methane, hydrogen
B hydrogen, household gas, carbon monoxide, methane
C carbon monoxide, methane, household gas, hydrogen
D hydrogen, carbon monoxide, household gas, methane

48 A particular household gas was found to burn back. From the information given, which of the following changes would most certainly prevent the gas burning back?

- **A** a decrease in the calorific value of the gas mixture
- **B** replacement of some of the carbon monoxide with an equal proportion of methane
- **C** a decrease in the relative density of the gas mixture
- **D** an addition of a small amount of hydrogen to the gas mixture

49 Natural gas is similar in relative density to normal household gas but it has a calorific value of 1000. When converting appliances used for household gas to use natural gas it is necessary to

- **A** increase the pressure at which the gas is delivered.
- **B** increase the *S* value of the gas.
- **C** decrease the relative density of the gas.
- **D** increase the quantity of air available for a given quantity of gas.

50 Assume that the pressure at which gas is supplied is increased, without any other change. Which one of the following would be a result of the increased pressure?

- **A** The volume of gas burned in a given time would decrease.
- **B** The heat produced by a given mass of gas would increase.
- **C** The heat produced in a given time would increase.
- **D** The burning rate of the gas would increase.

GO STRAIGHT ON TO UNIT 10

UNIT 10

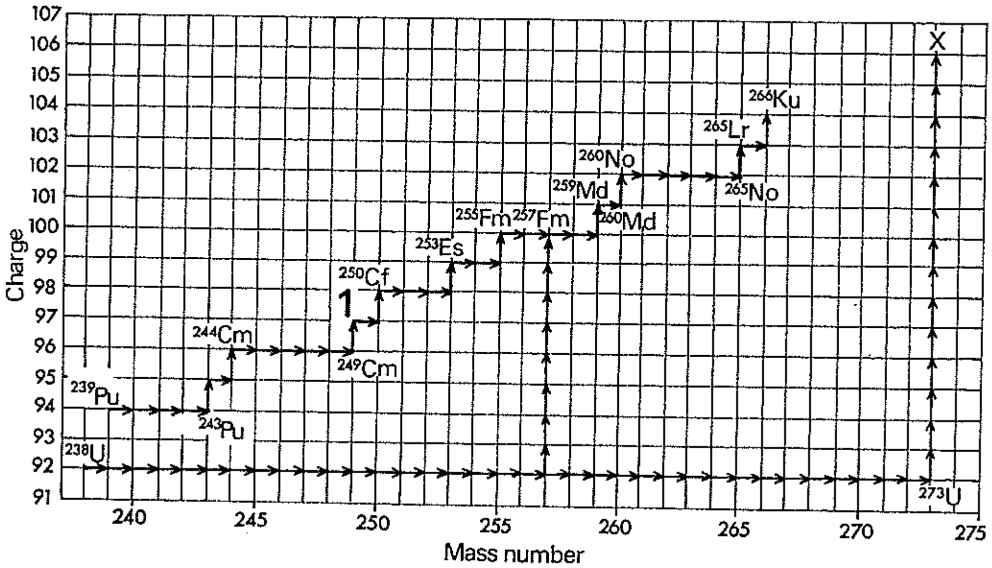
Assume that the nucleus of an atom consists of protons and neutrons only. Every atom can then be identified by the number of protons and the number of neutrons in its nucleus. Protons and neutrons can in turn be identified by their charge and mass number as shown below.

	Charge	*Mass number*
Proton	+1	1
Neutron	0	1

A nucleus can be identified by its charge and mass number. The mass number of a nucleus is the sum of the mass numbers of the protons and neutrons which make up the nucleus; its charge is the sum of the charges on the protons.

The diagram below shows how nuclei may be formed from other nuclei. Two types of nuclear reactions are illustrated. The first type occurs when a nucleus captures a neutron; the second type occurs when a nucleus gives off a *beta particle*. This particle is not a normal constituent of a nucleus. It has a charge of − 1 and a mass number of 0. Removal of a beta particle from a nucleus increases the charge of the nucleus by 1.

In the diagram each arrowhead represents a possible nucleus. Each nucleus is given a name according to its charge and is represented by a one- or two-letter symbol. The mass number is shown by the number superscript, e.g. ^{239}Pu has a mass number 239.



51 Nucleus 1 on the diagram can be identified as

A ^{249}Cm.

B ^{249}Cf.

C ^{97}Cm.

D none of the above nuclei.

52 Locate the following three transformations on the diagram:

I *Cf* to *Es*

II *Fm* to *Md*

III *No* to *Lr*

One beta particle per nucleus is lost by

A I only.

B II only.

C I and III only.

D I, II and III.

53 A nucleus of *Pu* (mass number 239) can be transformed to a nucleus of *Cm* (mass number 249). This involves

- **A** a succession of losses of beta particles only.
- **B** capture of ten neutrons only.
- **C** capture of ten neutrons in addition to the loss of two beta particles.
- **D** capture of ten beta particles in addition to the loss of two neutrons.

54 Imagine a nucleus of charge 96 and containing 159 neutrons. To form a nucleus of mass number 260 would require the capture of

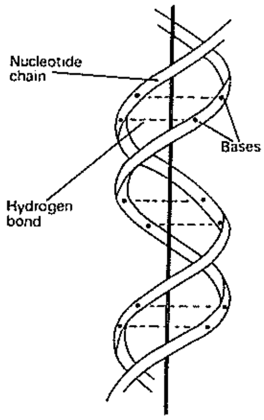
- **A** 5 neutrons.
- **B** 63 neutrons.
- **C** 101 neutrons.
- **D** 164 neutrons.

GO STRAIGHT ON TO UNIT 11

UNIT 11

In nearly every cell of living organisms there is a substance called DNA. The structure of the DNA molecules determines some of the characteristics of succeeding generations of the organisms. A DNA molecule is able to make exact copies of itself. When new cells are formed by an organism, each new cell contains duplicates of the DNA molecules from the parent cell.

A DNA molecule consists of two long, coiled chains of *nucleotides*. One chain is joined to the other by cross-linkages called *hydrogen bonds* as shown in Fig. I.



A portion of a DNA molecule

Fig. I

Each nucleotide consists of three units—a *phosphate*, a *sugar* and a *base*. Fig. II shows how 2 nucleotides are joined together in part of a nucleotide chain.

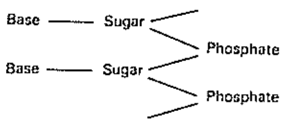


Fig II

In a DNA molecule there are two kinds of bases—*purines* and *pyrimidines*. A purine in one chain is joined by a hydrogen bond to a pyrimidine in the other chain and, similarly, a pyrimidine in one chain is joined by a hydrogen bond to a purine in the other chain. In DNA there are two purines (denoted by the letters *A* and *G*) and two pyrimidines (denoted by the letters *T* and *C*). *A* on one chain is always linked to *T* on the other chain, and *G* on one chain is always linked to *C* on the other chain.

In any cell of an organism there may be many DNA molecules which differ from each other by having different numbers of bases and by having different arrangements of the bases along the chains. DNA molecules in different organisms also differ from each other in the number and arrangement of bases.

In the process by which a DNA molecule makes a copy of itself, the hydrogen bonds break and the two chains unwind. As a result each chain is free to attach to itself nucleotides newly formed at other sites in the cell. Each chain serves as a 'mould' on which a new chain of nucleotides can be built up. This results in two DNA molecules in place of the original one, the two molecules being identical with the original one.

55 A hydrogen bond joins together

A two molecules of DNA.
B a sugar and a phosphate.
C a pyrimidine and a purine.
D two nucleotides in one chain.

56 Which one of the lists below contains the names of three substances present in a DNA molecule and linked in the same order as in a DNA molecule?

A *T* — sugar — *A*
B *T* — *A* — phosphate
C phosphate — *C* — *G*
D phosphate — sugar — *T*

57 One of the nucleotide chains in a DNA molecule must

A be identical with the other chain.
B contain as many purines as the other chain contains pyrimidines.
C contain the same number of purines as the other chain.
D contain either purines or pyrimidines but not both.

Questions 58 to 60 refer to the following additional information :
The bases on part of one chain of a DNA molecule occur in the following order:

1	2	3	4	5	6
A	*C*	*T*	*A*	*G*	*C*

58 On the corresponding parallel chain of the same DNA molecule the base linked to base 3 is

A *A*.
B *T*.
C *C*.
D phosphate.

59 The seventh base on the chain shown above is

A *A*.
B *G*.
C *T*.
D impossible to determine from the information given.

60 The part of one chain of a DNA molecule above reproduces and is now part of a whole DNA molecule. Which one of the following lists indicates the correct number of bases in this part of the whole DNA molecule?

A 2 bases of *A*, 2 of *C*, 1 of *T* and 1 of *G*
B 4 bases of *A*, 4 of *C*, 2 of *T* and 2 of *G*
C 3 bases of *A*, 3 of *C*, 3 of *T* and 3 of *G*
D 1 base of *A*, 1 of *C*, 2 of *T* and 2 of *G*

Prepared and published by Australian Council
for Educational Research, Frederick Street,
Hawthorn, Victoria 3122; June 1970.