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Comprehension and interpretation (sciences) 1969

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COMMONWEALTH SECONDARY SCHOLARSHIPS
EXAMINATION FOR TWO-YEAR SCHOLARSHIP
1970–71

COMPREHENSION AND INTERPRETATION

(SCIENCE)

Afternoon session: Wednesday 30th July 1969

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 11 units.

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 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 that it is 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

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

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

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

A B C D

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

Australian Council for Educational Research

UNIT 1

An optical system has a high resolving power to the extent that it can be used to distinguish objects as separate when they are very close together. This resolving power may be measured according to the distance between objects which can just be distinguished. Thus a microscope using white light for illumination can resolve to 2500 Ångstrom units (Å); the electron microscope has a greater resolving power—it can resolve to about 5Å; i.e. objects which can just be distinguished are *very* close together. If two objects are closer than 5Å, they will appear as one and not as two distinct objects on examination with the electron microscope.

The resolving power of a microscope is limited by the kind of illumination used and for many microscopes this is white light. For certain purposes light may be considered as having wave-like properties. The range of wavelength for white light is 4500Å to 6100Å. Objects cannot be distinguished as separate if their outlines are closer together than one half the wavelength of the illuminating radiation.

The electron microscope provides increased resolving power using a beam of high-speed electrons instead of light. The electron beam has, like a wave, a characteristic range of wavelengths. As the electrons pass through the specimen being viewed, the parts of the specimen absorb electrons differentially and an image of the specimen can be formed on a screen.

1 The electron beam for a particular electron microscope has an average wavelength of 12Å. This electron microscope can, in theory, distinguish objects as close together as

A 24Å. **C** 6Å.
B 12Å. **D** 1·2Å.

2 An electron microscope which can resolve to 5Å is able to distinguish objects

A which are separated by less than 5Å.
B which are separated by more than 5Å.
C provided they are less than 5Å from the lens near the object.
D which are smaller than 5Å.

3 In a crystal, particular rows of atoms are separated by 1·06Å. On the evidence given, two of these rows which are adjacent could be distinguished by

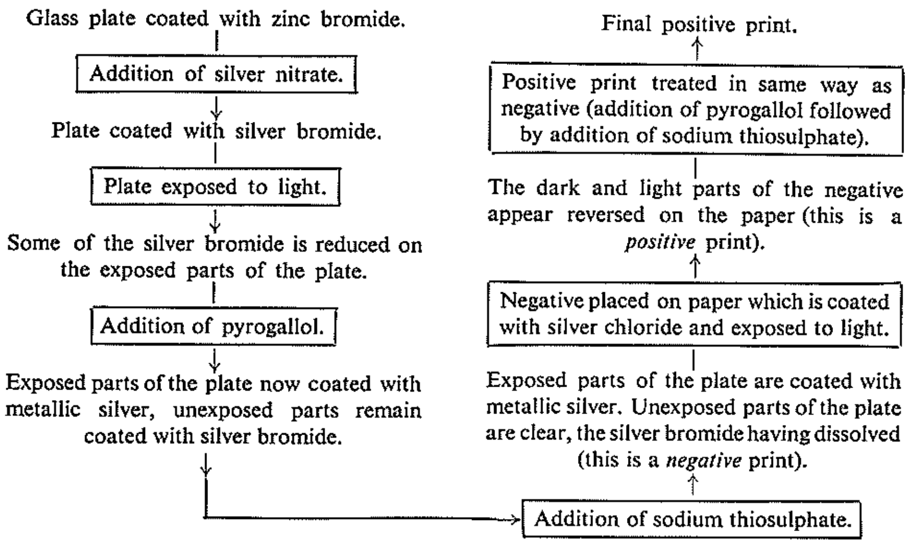
A the naked human eye.
B a microscope using white light for illumination.
C an electron microscope.
D none of the above.

UNIT 2

The process of photography makes use of the following facts:

1. Silver halides (e.g. silver chloride, silver bromide and silver iodide) are white solids which are reduced to black metallic silver on exposure to light. Under otherwise constant conditions, the extent of reduction depends on the duration of exposure.
2. Sodium thiosulphate dissolves any silver halide which has not been reduced to metallic silver.
3. Violet light is very effective in reducing silver halides. The effect lessens as the light used is further from the violet end of the spectrum and closer to the red end. Red light has practically no reducing effect.

A nineteenth century photographic process is outlined on page 3. In those days the photographer did not use a *roll* of film; instead *one glass plate* was used each time a photograph was taken.



4 The function of the zinc bromide on the plate was to

- **A** provide the halide for the formation of silver halide.
- **B** provide the metallic zinc which formed the final positive print.
- **C** reduce the silver bromide to metallic silver.
- **D** reduce the zinc halide to metallic silver.

5 If the glass plate were **not** treated with sodium thiosulphate after exposure to light,

- **A** the metallic silver remaining would be easily washed away.
- **B** further light exposure would reduce some of the silver halide in the previously unexposed portion of the film.
- **C** further light exposure would result in reduction of the metallic silver.
- **D** the metallic silver remaining would form silver halide on further light exposure.

6 Which of the following best summarizes, in the correct order, the processes in the formation of a negative print?

- **A** Unreduced halide is dissolved; silver halide decomposes to metallic silver.
- **B** Silver halide decomposes to metallic silver; unreduced metallic silver is dissolved.
- **C** Silver halide decomposes to metallic silver; unreduced halide is dissolved.
- **D** Unreduced metallic silver is dissolved; silver halide decomposes to metallic silver.

7 In the last step of the photographic process outlined, the positive print is treated in the same way as the negative (addition of pyrogallol followed by addition of sodium thiosulphate). If the positive print were **not** treated in this way, it would

- **A** be exactly the same as the negative print.
- **B** darken on further exposure to light.
- **C** fade on further exposure to light.
- **D** always be moist.

8 In a laboratory used for developing a photograph, the most suitable light to have on during the process would be

- **A** very dim white light.
- **B** violet light.
- **C** red light.
- **D** white light without the red component.

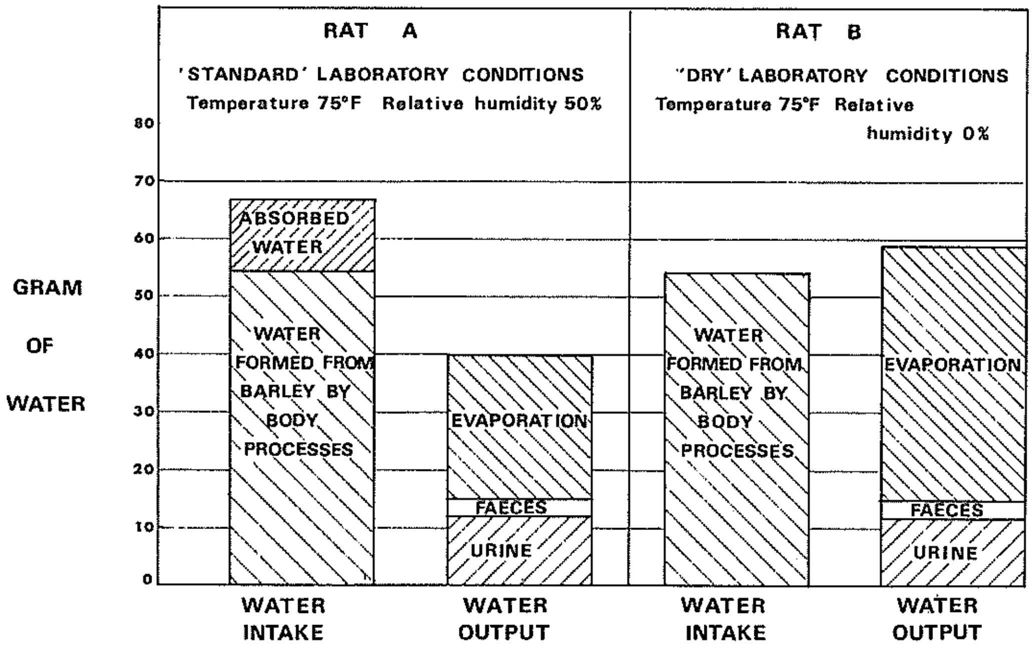
UNIT 3

The bannertailed kangaroo rat of Arizona thrives in very dry regions. In its natural environment it feeds entirely on seeds and other dry material, drinking no water. Water constitutes 65 per cent of its body weight, and it has been shown that this percentage does not change significantly when the rat is living in its normal habitat—a waterless desert.

Water is formed from the dry food by body processes; and, for example, from each 100 gram of dry barley consumed, the rat obtains 54 gram of water. Since the rat consumes only about 100 gram of barley in five weeks, the total amount of water available to it is very small. The rat maintains its water balance by excreting urine with very high concentrations of salt and urea. Because it can excrete urine with such a high salt concentration, the rat can drink sea water and survive.

The following information refers to a particular experiment comparing bannertailed kangaroo rats under different conditions. During eight weeks on a diet of dry barley in 'standard' laboratory conditions, some of these rats increased their body weight and increased the total *amount* of water in their bodies. Others of these rats in 'dry' laboratory conditions could not survive indefinitely because under these conditions there is a water deficit.

The diagrams below show water intake and water output for two rats under different conditions. 100 gram (dry weight) of barley was exposed to the atmosphere in 'standard' laboratory conditions and then fed to rat A; the term 'absorbed water' refers to the amount of water this barley absorbed from the atmosphere. Similarly 100 gram (dry weight) of barley was exposed to the atmosphere in 'dry' laboratory conditions and then fed to rat B.



9 The total water intake for rat A in the experiment described is closest to

A 13 gram.
B 27 gram.
C 54 gram.
D 67 gram.

10 Referring to rat A and rat B in the experiment described, which one of the following statements is **false**?

A For rat A water intake exceeds water output.
B For rat B water intake exceeds water output.
C Water intake for rat A exceeds water intake for rat B.
D Water output for rat B exceeds water output for rat A.

11 The water deficit for rat B in the experiment described is closest to

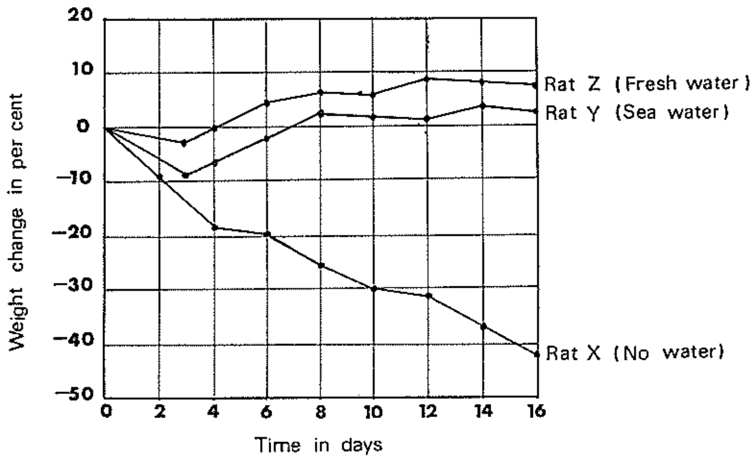
- **A** 5 gram.
- **B** 12 gram.
- **C** 15 gram.
- **D** 59 gram.

12 If the moisture content of the air in the 'standard' conditions laboratory were increased, and other factors (i.e. diet, temperature) were unchanged, the rats would

- **A** excrete urine with a higher salt concentration.
- **B** excrete urine with a higher urea concentration.
- **C** lose more water by evaporation.
- **D** lose less water by evaporation.

Questions 13 and 14 refer to the following additional information:

In the experiment referred to in the graph below, three bannertailed rats X, Y and Z were each given the same special diet with the result that, although they would not normally do so, they drank water if it was available. Rat Z was provided with fresh water and rat Y with sea water, but no water was provided for rat X.



13 If the no-water diet were continued for rat X, it would most probably

- **A** regain the weight lost.
- **B** die from dehydration.
- **C** maintain the weight reached at the 16th day.
- **D** thrive, since these rats do not normally drink water.

14 If rat Y were given, after day 16, the 'standard' laboratory diet of dry barley seed, it would most probably

- **A** continue to drink water.
- **B** die.
- **C** experience a very rapid increase in weight.
- **D** experience a weight change of less than 10 per cent.

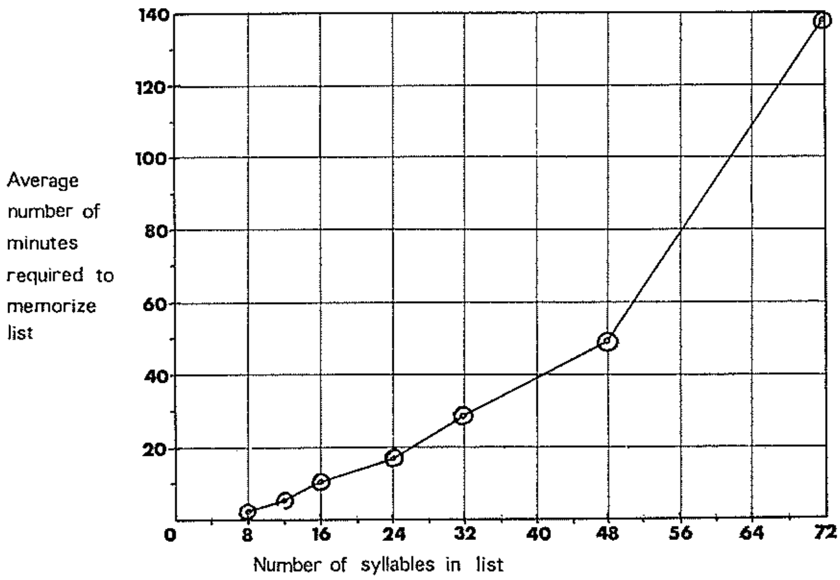
UNIT 4

The factors known to influence the process of learning can be classified into three groups:

1 those characteristic of the learner, e.g. interest, ability, fitness;
2 those characteristic of the learning task, e.g. amount of material, type of material;
3 those characteristic of the conditions in which learning occurs, e.g. use of rewards and punishments in training, amount of practice.

To study how variations in one factor affect learning, it is necessary for the experimenter to eliminate or to control the effects of other factors which might influence results.

In one of the earliest experiments ever undertaken on learning, the aim was to determine the relationship between the amount of material to be learned and the amount of practice required to learn it. The task was to memorize sets of nonsense syllables. A nonsense syllable consists of two consonants with a vowel between them so chosen that the syllable formed is not a meaningful word, e.g. XOM, QON. Ten volunteers participated in the experiment and the average time required to memorize a given amount of material was determined. Seven lists of different lengths were used. The results of the experiment are shown in the graph below.



15 The most important assumption for the use of nonsense syllables in this learning experiment is that they

- **A** can be learned more easily since they are short.
- **B** are equally unfamiliar to all subjects.
- **C** are learned in the same way as meaningful words.
- **D** are harder to learn than meaningful words.

16 In the learning experiment described, the experimenter was investigating

- **A** how long it takes to learn 72 nonsense syllables.
- **B** which nonsense syllables a subject can learn in a specified time.
- **C** the times taken to learn given numbers of nonsense syllables.
- **D** the maximum number of nonsense syllables that each subject can learn in 140 minutes.

17 Which one of the following lists of factors which influence the process of learning contain only factors characteristic of the conditions of practice or training?

- **A** age of subjects, familiarity of material, use of punishments
- **B** use of punishments, amount of noise in room, amount of practice
- **C** amount of material, type of material, health of subjects
- **D** familiarity of material, use of punishments, amount of practice

18 In another learning experiment one group of 10 subjects memorized a list of 20 nonsense syllables, whilst another group of 10 subjects memorized a list of 20 three-letter meaningful words. The average times taken to memorize the lists were recorded. This experimenter was varying the

- **A** amount of material to be memorized.
- **B** ability of the subjects.
- **C** type of material to be memorized.
- **D** amount of practice required to memorize the lists.

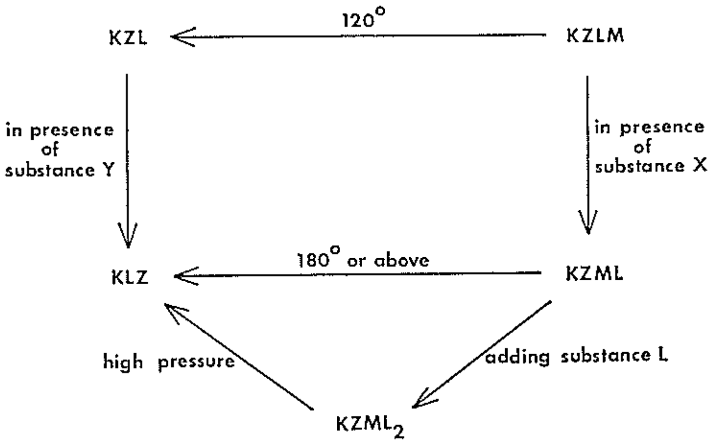
19 Another experimenter asked a group of subjects to memorize two lists of 20 nonsense syllables. The first list was memorized before the day's work and the second at the end of the day's work. The experimenter recorded the average times taken to memorize the lists. He was probably investigating the effect of

- **A** fatigue on the amount of practice required.
- **B** the type of material memorized on fatigue.
- **C** the subjects' ability on the amount of material memorized.
- **D** the amount of practice on fatigue.

GO STRAIGHT ON TO UNIT 5

UNIT 5

A number of reactions involving compounds of the elements *K*, *Z*, *L* and *M* are outlined below. The formulae in the diagram indicate the proportions of *K*, *Z*, *L* and *M* in each compound. For example, the formula $KZML_2$ indicates that there are 2 units of *L*, one unit of *K*, one unit of *Z* and one unit of *M* in that compound. Compounds *KZL* and *KLZ* have different arrangements of the elementary units in a particle of compound and these compounds do not have identical characteristics. Assume that no reactions other than those indicated take place involving the substances shown, and that in all reactions all of the reacting compounds are completely used up.



20 If we add substance *X* to *KZLM* and heat to 200°, we obtain

A *KZML*. **C** *KLZ*.
B $KZML_2$. **D** *KZLM*.

21 A mixture containing *KZML* and substances *L* and *Y* is subjected to high pressure. Which one of the following remains in the reaction vessel?

A *KLZ* **C** *KZML*
B *KZL* **D** $KZML_2$

22 *KZL* is heated to 125° in the presence of substance *X*. Which of the following remain/s in the reaction vessel?

A *KZL* only **C** *KLZ* and *X* only
B *KLZ* only **D** *KZL* and *X* only

23 A quantity of substance *Y* is added to one gram of *KZL*. This results in the formation of

A one gram of *KLZ*. **C** more than one gram of *KLZ*.
B less than one gram of *KLZ*. **D** one gram of *KZLY*.

24 One hundred gram of $KZML_2$ is subjected to high pressure. At the completion of reaction how much KLZ is in the vessel?

- **A** one hundred gram
- **B** less than one hundred gram but not zero
- **C** more than one hundred gram
- **D** none

25 $KZML$ is heated from 25° to 250° and at one point in the course of heating some substance L is added. Which one of the following statements is true?

- **A** Equal quantities of KLZ and $KZML_2$ are formed.
- **B** Only KLZ is formed.
- **C** KLZ and $KZML_2$ are both formed but there is insufficient evidence to decide in what proportions.
- **D** There is insufficient evidence to decide what would be formed.

GO STRAIGHT ON TO UNIT 6

UNIT 6

Organisms vary in their requirements for growth, and in a varied environment different groups of organisms will become established at particular regions. The table below shows the conditions required by some groups of organisms found in freshwater lakes and rivers. If any of the required conditions are absent, the region is not a suitable one for the survival of the particular group of organisms.

Group	Conditions required
Chromatium (photosynthetic bacteria)	Dissolved oxygen but in a concentration not greater than 0·1 milligram per litre Sulphide Light
Anabaena (blue-green algae)	Dissolved oxygen Light
Desulfovibrio	Dissolved oxygen but in a concentration not greater than 0·1 milligram per litre Sulphate Organic matter
Facultative anaerobic bacteria	Organic matter

A river containing sulphate in solution flows into a particular lake. Towards the bottom of the lake where the river enters, some sulphate is converted to sulphide. The concentration of sulphide is zero down to 14 metre below the surface throughout the lake, but is 12 milligram per litre at all depths greater than 20 metre where sulphide and sulphate are both present in fixed proportions. A number of factors combine to prevent a uniform distribution of dissolved substances throughout the lake.

Organic matter enters the lake from the river and is also formed in the lake from plant and animal remains. This organic matter is found throughout the lake at all depths. Various facultative anaerobic bacteria use the organic matter and in the process reduce the amount of oxygen in the lake water. The concentration of dissolved oxygen in the water at the surface of the lake is 8 milligram per litre and this decreases by half every 2 metre below the surface. Accordingly, the concentration is 4 milligram per litre at a depth of 2 metre, 2 milligram per litre at a depth of 4 metre, and so on.

Light useful to photosynthetic bacteria (i.e. bacteria which require light for photosynthesis) penetrates to a depth of about 20 metre. Blue-green algae can use light penetrating to a depth of about 10 metre, but not light penetrating below that depth.

26 At a depth of 0 to 10 metre in the lake, conditions are suitable for the survival of

- **A** *Anabaena* only.
- **B** *Anabaena* and facultative anaerobic bacteria only.
- **C** facultative anaerobic bacteria only.
- **D** *Desulfovibrio*, *Anabaena* and facultative anaerobic bacteria.

27 The lake becomes quite shallow at its northern end, the depth being 14 metre. The organism/s likely to be present at this end of the lake is/are

- **A** *Anabaena* only.
- **B** *Desulfovibrio* only.
- **C** facultative anaerobic bacteria only.
- **D** *Desulfovibrio*, *Anabaena* and facultative anaerobic bacteria.

28 At a depth of 14 to 20 metre in the middle of the lake, conditions are suitable for the survival of

A *Chromatium* and *Desulfovibrio* only.

B *Chromatium*, *Desulfovibrio* and *Anabaena*.

C *Chromatium*, *Desulfovibrio* and facultative anaerobic bacteria.

D *Chromatium*, *Desulfovibrio*, *Anabaena* and facultative anaerobic bacteria.

29 In the middle of the lake the depth of water exceeds 20 metre. In a sample of water taken from the region below 20 metre, you would expect to find living samples of

A *Desulfovibrio* only.

B facultative anaerobic bacteria only.

C *Desulfovibrio* and facultative anaerobic bacteria only.

D neither *Desulfovibrio* nor facultative anaerobic bacteria.

30 Which two groups of organisms are unlikely to be found within three and a half metre of each other?

A *Anabaena* and *Chromatium*

B *Chromatium* and *Desulfovibrio*

C facultative anaerobic bacteria and *Chromatium*

D *Anabaena* and *Desulfovibrio*

31 Samples taken at all depths of 0 to 12 metre in the lake yield no *Chromatium*. Of the following the best explanation for this is that, although all other conditions are suitable,

A the oxygen concentration is not suitable.

B the sulphide required is absent.

C the joint conditions of correct oxygen concentration and the presence of sulphide are not met.

D the light which penetrates to 14 metre is unsuitable.

GO STRAIGHT ON TO UNIT 7

UNIT 7

The atoms of some elements can emit a sub-atomic particle, in this way becoming atoms of a different element. This process is known as radioactive decay. The activity of a sample of a radioactive element can be defined as the number of sub-atomic particles it gives off per unit time. It can be assumed that equal numbers of particles are emitted in all directions.

The half-life of a radioactive element is a constant for that element and is the time required for the activity to fall to half of what it was initially. The different radioactive elements display an enormous range of half-lives. For example, a sample of uranium-238 has a half-life of 4,500,000,000 years; iodine-131 has a half-life of only 8 days. Some other elements have half-lives of a second or a fraction of a second.

The activity of a radioactive element can be measured by means of photographic film placed perpendicular to a line from the source. A sub-atomic particle, upon striking the film, affects it in such a way that, when the film is developed, it shows a black spot. The film can be placed under a microscope, and the black spots counted.

32 A piece of film was placed in a dark room, 1 foot from a sample of iodine-131. After an exposure of 15 minutes, and development, the film showed 320 spots per square inch. The experiment was repeated 16 days later, using the same sample of iodine, a similar experimental arrangement, and a fresh piece of film. The number of spots on this piece of film would be approximately

- **A** 640 per sq in.
- **B** 320 per sq in.
- **C** 160 per sq in.
- **D** 80 per sq in.

33 It is found experimentally that the distance that the film is placed from the radioactive source is an important factor which affects the number of spots on the film. Film 1 was placed 1 foot to the left of a source of uranium-238; Film 2 was placed 2 feet to the right. Both films were exposed for 1 hour. The results obtained from this and many similar experiments lead to the generalization that N, the number of spots per unit area of film, is inversely proportional to the square of d, the distance of the film from the source; i.e. if this distance is made x times as large, N decreases to $\frac{1}{x^2}$ times its original value.

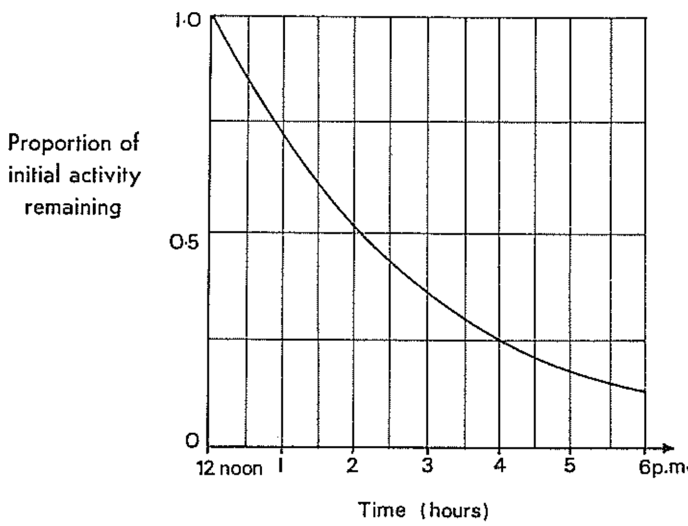
Film 1, when developed, showed 480 spots per sq in.

Film 2 would show approximately

- **A** 960 spots per sq in.
- **B** 480 spots per sq in.
- **C** 240 spots per sq in.
- **D** 120 spots per sq in.

Questions 34 to 36 refer to the following graph:

Activity of Element Z



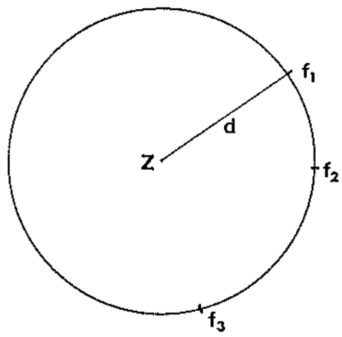
34 The best estimate of the half-life of element Z is approximately

A 1 hour.
B 2 hours.
C 2·5 hours.
D 3 hours.

Questions 35 and 36 refer to the following diagram and information in addition to the graph:

Point Z represents a sample of the radioactive element Z. Points f_1, f_2 and f_3 represent films placed at the circumference of a circle of radius d and centre at Z.

f_1 was exposed to radiation from Z from 12 noon to 1 p.m. On development, it showed 400 spots per sq in. f_2 was exposed from 12 noon to 2 p.m. on the same day. f_3 was exposed from 4 p.m. to 5 p.m. on the same day.



35 When developed, film f_2 would show about

A 200 spots per sq in.
B 500 spots per sq in.
C 700 spots per sq in.
D 800 spots per sq in.

36 When developed, film f_3 would show about

A 100 spots per sq in.
B 200 spots per sq in.
C 300 spots per sq in.
D 400 spots per sq in.

GO STRAIGHT ON TO UNIT 8

UNIT 8

Figure 1 below represents a sealed, rectangular tank. Its top, bottom and sides are of a transparent material. It is initially at rest on a horizontal table.

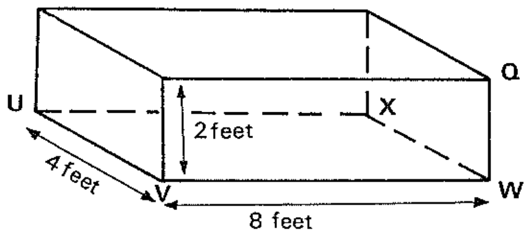


Figure 1

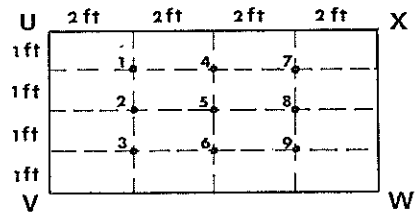
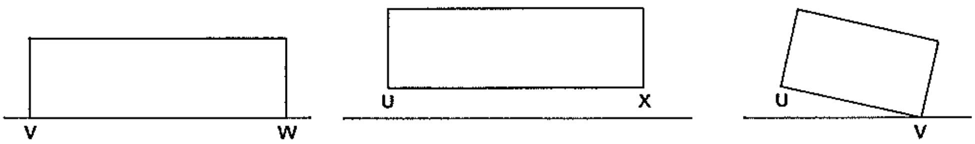


Figure 2

Gauges are placed at 9 positions in the tank, as shown in Figure 2 above. Each gauge extends from the top to the bottom of the tank so that it is parallel to the edge *QW* of the tank. The reading on a gauge is that fraction of the gauge immersed in liquid. For example, the reading on a gauge which is half-immersed is 0·50. The location of these 9 gauges is shown in Figure 2.

Water is added to the tank so that it is half-full of water. The reading on each gauge is therefore 0·50. The water surface is horizontal regardless of the slope of the tank.

37 The tank is tilted so that the edges *VW* and *UX* are horizontal, but *VW* is slightly lower than *UX*, as indicated in the following three diagrams of the tank.

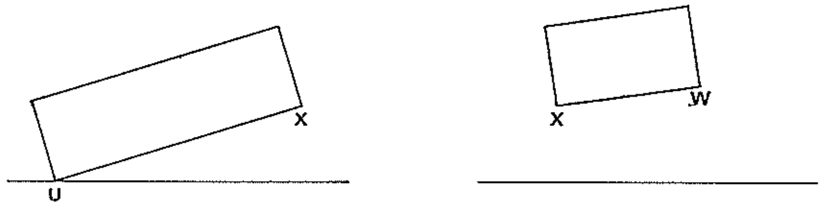


NB The diagrams of the tank when tilted are designed to indicate relative positions of the edges and *are not drawn to scale.*

Which gauges now give a reading of 0·50?

A 1, 4 and 7
B 2, 5 and 8
C 3, 6 and 9
D 4, 5 and 6

38 The tank is tilted as indicated in the following two diagrams; i.e. the tilt on edge *UX* is different from the tilt on edge *XW*.

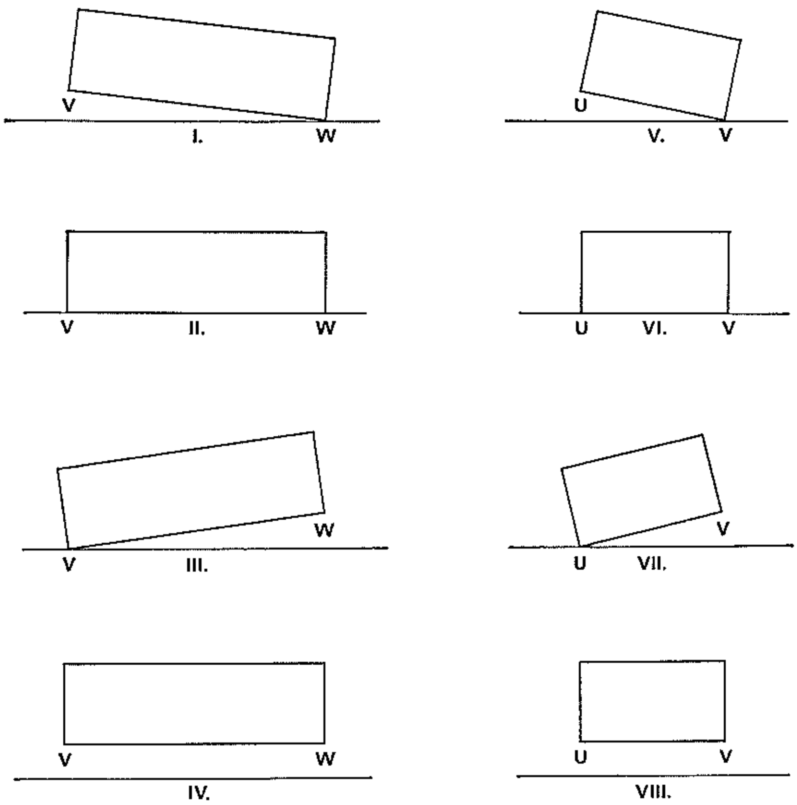


Which gauge/s will read 0·50?

A 1, 5 and 9
B 2, 5 and 8
C 4, 5 and 6
D gauge 5 only

Questions 39 and 40 refer to the following table and diagrams of the tank:
The table shows the readings on the 9 gauges when the tank is in 2 positions.

Gauge no.	Gauge reading	
	Position 1	Position 2
1	0·55	0·50
2	0·50	0·55
3	0·45	0·60
4	0·55	0·45
5	0·50	0·50
6	0·45	0·55
7	0·55	0·40
8	0·50	0·45
9	0·45	0·50



39 The two diagrams which together indicate position 1 are

A II and VII.
B IV and V.
C II and V.
D IV and VII.

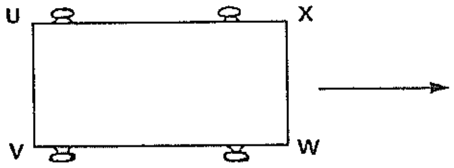
40 The two diagrams which together indicate position 2 are

A III and V.
B I and V.
C III and VIII.
D I and VI.

Questions 41 and 42 refer to the following additional information:

When a tank containing water is moving at constant speed in a straight line, the surface of the water remains horizontal. When the tank is speeded up or slowed down rapidly, the water surface does not remain horizontal, but the water tends to remain travelling at its same speed and in the original direction. For example, the water surges forward when the tank is rapidly slowed down and it tends to surge back in the tank when the tank is rapidly accelerated.

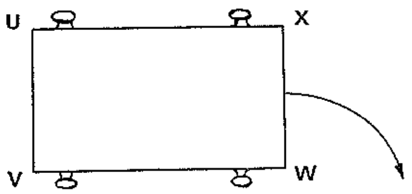
The tank is now mounted on a trolley so that it can be moved in a direction parallel to the sides *UX* and *VW* of the tank. The bottom of the tank is horizontal and the trolley is moving on a horizontal track. The trolley is initially moving along in the direction shown in the diagram below.



41 The trolley is rapidly accelerated. For which of the 9 gauges would the reading rise above 0·50 during the acceleration?

A 1, 2 and 3
B 1, 4 and 7
C 3, 6 and 9
D 7, 8 and 9

42 The trolley, initially moving at constant speed, corners sharply to the right as shown, without changing its speed.



While cornering, one gauge reading is seen to be 0·45. Which of these gauges could it be?

A gauge 7
B gauge 5
C gauge 3
D gauge 1

UNIT 9

The pumping action of a heart (see Figure 1) follows an orderly sequence : contraction of the atria (*atrial systole*) is followed by contraction of the ventricles (*ventricular systole*). Then there is a period when all four heart chambers are relaxed (*diastole*). One complete sequence as described is called a *cardiac cycle*.

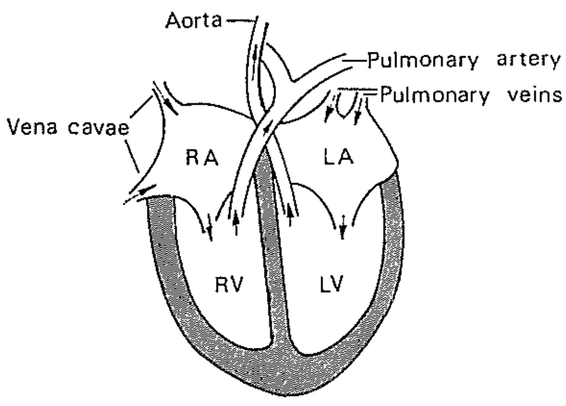
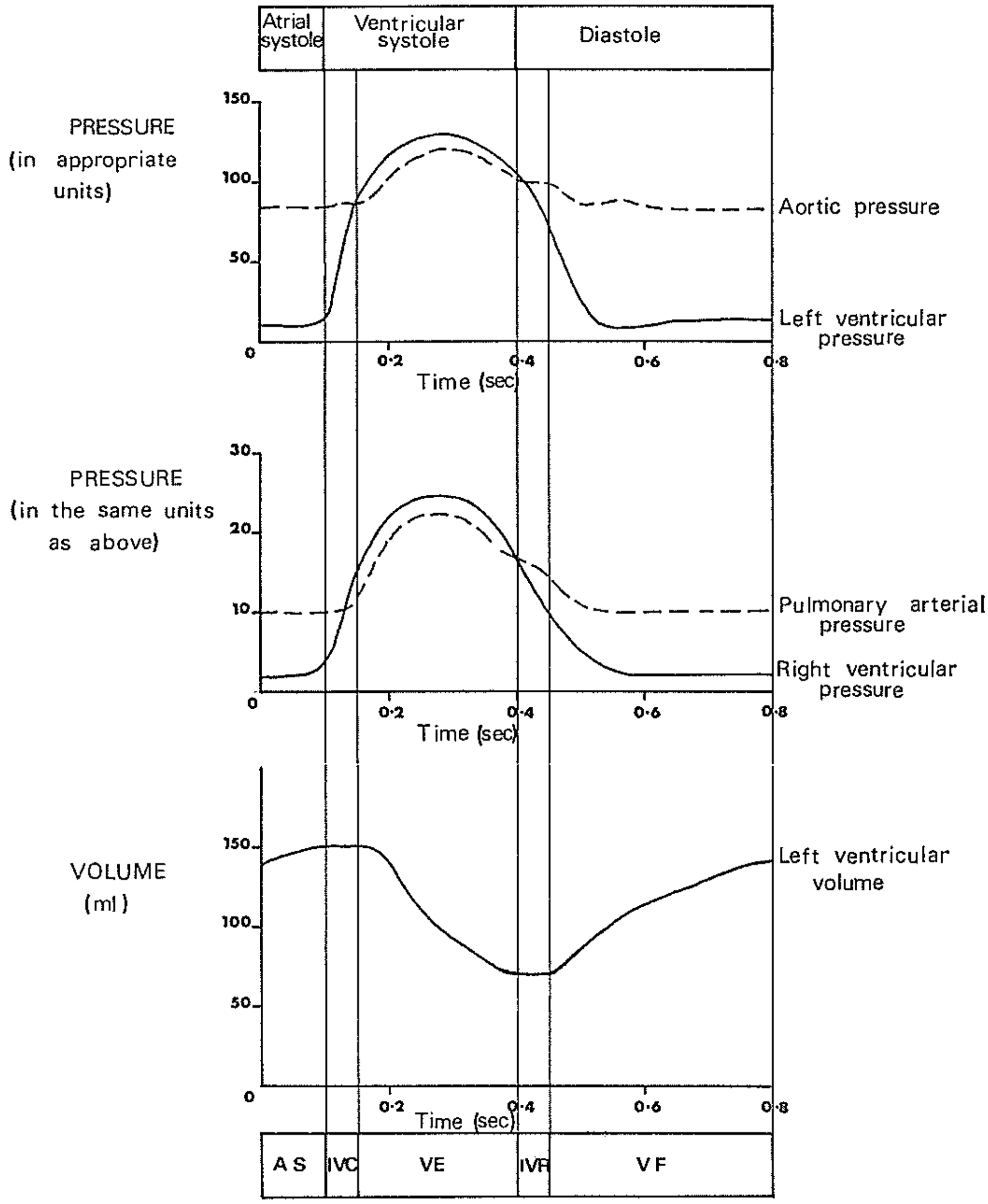


Figure 1

RA = right atrium
LA = left atrium
RV = right ventricle
LV = left ventricle

The arrows show the direction in which the blood flows through the heart.

The following graphs show the events of the cardiac cycle for a heart beating at the rate of 75 cycles per minute. All the graphs are drawn on the same time scale.



The stages of the cardiac cycle are:
AS = atrial systole
IVC = isometric ventricular contraction
VE = ventricular ejection
IVR = isometric ventricular relaxation
VF = ventricular filling

43 During one cardiac cycle, diastole lasts for a total time of

- **A** 0·1 sec.
- **B** 0·3 sec.
- **C** 0·4 sec.
- **D** 0·8 sec.

44 Which one of the following occurs during ventricular ejection?

- **A** Left ventricular volume increases uniformly.
- **B** Pulmonary arterial pressure exceeds right ventricular pressure.
- **C** Left ventricular pressure exceeds aortic pressure.
- **D** Aortic pressure remains constant.

45 The most rapid increase in left ventricular pressure occurs during

A atrial systole.
B isometric ventricular contraction.
C ventricular ejection.
D isometric ventricular relaxation.

46 A decrease in the volume of the ventricles is the result of the ejection of an equal volume of blood. From the graph the best estimate of the volume of blood ejected by the left ventricle in one minute is

A 80 ml.
B 6000 ml.
C 8000 ml.
D 12000 ml.

Questions 47 and 48 refer to the following additional information:

The heart has a number of valves, each of which allows blood to flow in one direction only. The valves are open and permit blood to flow through them when the pressure of the blood behind is greater than the pressure in front, and closed when the greater pressure of blood is in front. The location of the valves is shown in Figure 2.

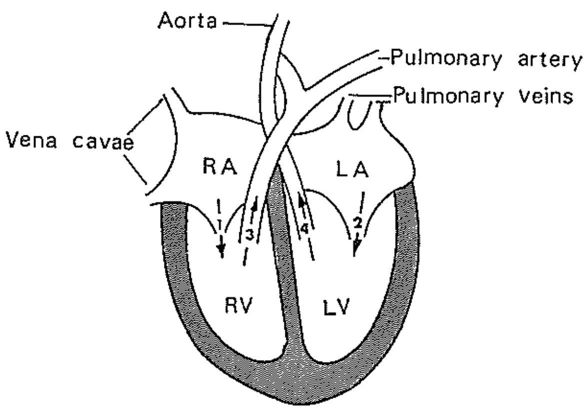


Figure 2

Valves
1 atrio-ventricular valve
2 atrio-ventricular valve
3 pulmonary valve
4 aortic valve

The arrows show the *only* direction in which blood can flow through the valves.

47 Ventricular filling begins when

A ventricular pressure falls below atrial pressure and the atrio-ventricular valves open.
B ventricular pressure falls below atrial pressure and the atrio-ventricular valves close.
C atrial pressure falls below ventricular pressure and the atrio-ventricular valves open.
D atrial pressure falls below ventricular pressure and the atrio-ventricular valves close.

48 The aortic valve is open when

A the pressure in the left atrium is less than the left ventricular pressure.
B the pressure in the left atrium exceeds the left ventricular pressure.
C the pressure in the aorta exceeds the left ventricular pressure.
D the pressure in the aorta is less than the left ventricular pressure.

UNIT 10

Hydrocarbons are chemical substances consisting of particles called molecules. Each molecule consists of atoms of carbon and hydrogen only, and each hydrocarbon contains a fixed and definite number of carbon and hydrogen atoms per molecule. A sample of a hydrocarbon may contain many millions of identical molecules. The linking of carbon and hydrogen atoms into molecules is described by the following rules:

1 Each carbon atom (*C*) can be linked directly to no more than four hydrogen atoms.

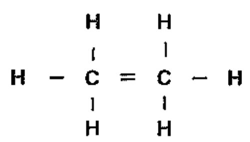
2 Each hydrogen atom (*H*) can be linked directly to only one other atom.

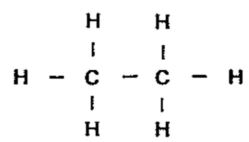
3 One carbon atom may be linked to another carbon atom by one, two or three links, represented by one, two or three strokes (—) respectively ; i.e. two carbon atoms may be linked by a single, double or triple link.

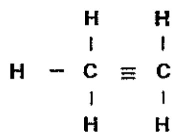
4 In molecules in which carbon atoms link directly to other carbon atoms, the number of hydrogen atoms per molecule may be determined by the fact that any one carbon atom must have a total of four direct links, i.e. 4 single, 2 single and 1 double, 1 single and 1 triple, or 2 double links.

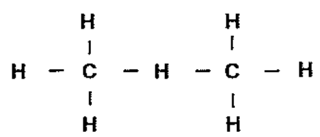
In the following questions hydrocarbon molecules are represented by formulae using the symbols *C*, *H* and —. The molecules are to be regarded as free to rotate or turn, but the positions of the atoms relative to one another in a molecule do not change. In most of the questions the links between the atoms in a molecule are represented for convenience as being in a straight line or at right angles to each other.

49 The only one of the following formulae which conforms to the rules outlined is

A.


C.


B.


D.


50 The following 'skeleton' formula of a hydrocarbon molecule shows only the carbon atoms and the links between them:

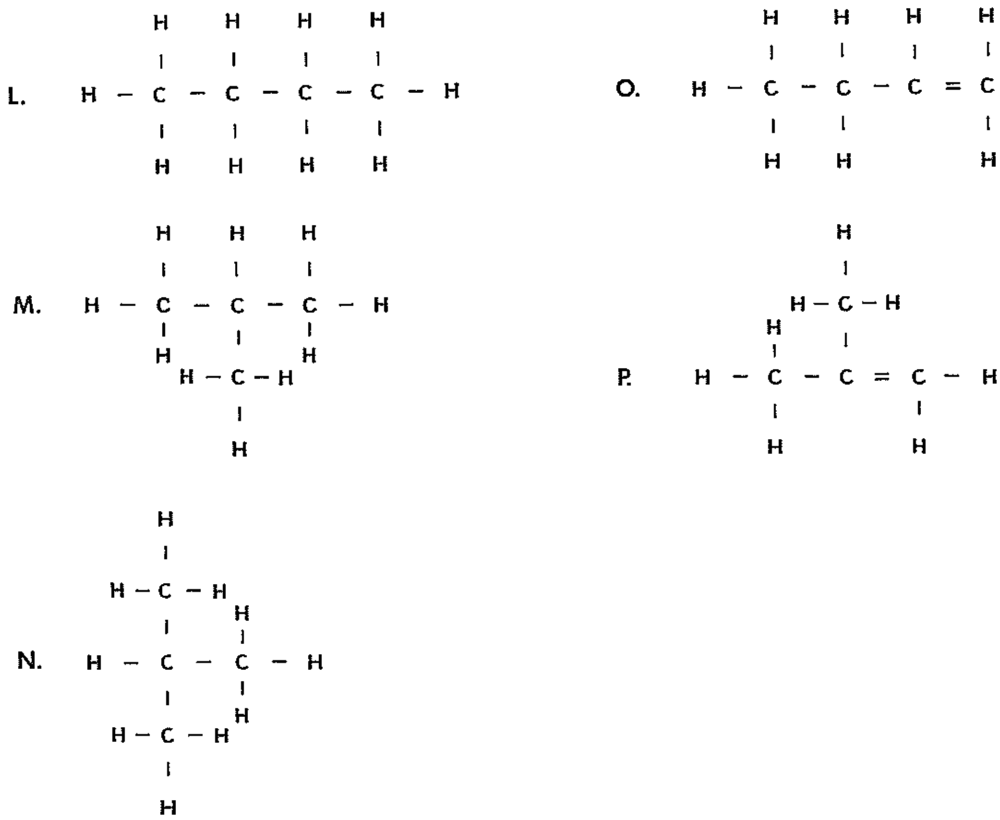
C = C − C = C

The total number of carbon-hydrogen links which must be added to complete the formula is

A 4. **C** 6.

B 5. **D** 7.

51 Two of the formulae *L, M, N, O* and *P* below represent the same hydrocarbon.



The two formulae which represent the same hydrocarbon are

A *M* and *N*.
B *M* and *P*.
C *O* and *P*.
D *O* and *L*.

52 Consider hydrocarbons which have **four** carbon atoms in each molecule and in which the carbon atoms are in a straight line. Of the following the one with the **least** number of hydrogen atoms per molecule is a hydrocarbon with

A one double link and two single links between the carbon atoms.
B only single links between the carbon atoms.
C two double links and one single link between the carbon atoms.
D one triple link, one double link and one single link between the carbon atoms.

53 The carbon atoms in hydrocarbons can link together to form a closed ring. One such ring-hydrocarbon has 6 carbon atoms per molecule, joined by alternate double and single links. The number of hydrogen atoms per molecule is

A 4.
B 6.
C 12.
D 24.

Questions 54 and 55 refer to the following additional information:
A ring-hydrocarbon with seven atoms in the ring can have single, double or triple links between the carbon atoms or any combination of these. Assume that it conforms to the rules outlined.

54 The minimum number of hydrogen atoms per molecule is

A 2.
B 4.
C 14.
D 20.

55 The maximum number of hydrogen atoms per molecule is

A 7.
B 14.
C 20.
D 28.

56 A particular hydrocarbon is represented by the formula in Figure 1.

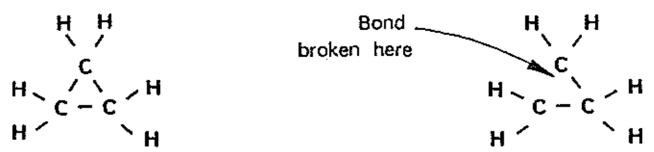


Figure 1 Figure 2

The link between two of the carbon atoms is broken (see Figure 2) and a new hydrocarbon can be formed. This new hydrocarbon would conform to the rules outlined if there were

A two additional hydrogen atoms per molecule, all atoms in the molecule being joined by single links.
B four additional hydrogen atoms per molecule, all atoms in the molecule being joined by single links.
C two double links between the carbon atoms.
D one double link between two carbon atoms and two additional hydrogen atoms per molecule.

GO STRAIGHT ON TO UNIT 11

UNIT 11

In *zone melting*, a molten zone is formed along a solid cylindrical rod by a heating coil which moves slowly along the rod. The heating coil is so arranged that the molten zone is one tenth the length of the rod. The process is illustrated in Figure 1.

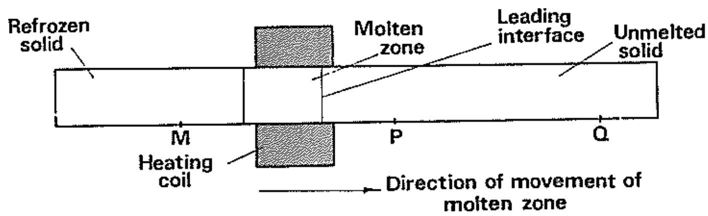


Figure 1

If zone melting is repeated numerous times, with several molten zones passing one after the other along the rod, the process is termed *zone refining* and is used to obtain a solid of high degree of purity from a solid which initially was contaminated by an impurity.

Consider the passage of a molten zone along a cylindrical rod of substance Y which contains an impurity X. Let the initial proportion of X in Y be represented by C_0. As the molten zone advances, the first solid to freeze behind it has a proportion of X in Y less than C_0; i.e. the newly frozen solid contains less X than the original impure rod. The excess X passes into the molten zone, raising the proportion of X in Y in that zone. At the same time, solid with a proportion of X in Y of C_0 is being melted into the molten zone at the leading interface.

After an initial drop the proportion of X in Y in the molten zone and in the refrozen solid increases as the molten zone advances along the rod (see Figure 2). When the proportion of X in Y in the molten zone reaches a value K, which is a constant, the proportion of X in Y in the refrozen solid remains constant at C_0 until the molten zone reaches the last zone length of the rod, when the proportion of impurity X increases greatly.

A graph of the proportion of X in Y against distance along the rod after the passage of a single molten zone through the rod is shown in Figure 2. The points P and Q are the same points in Figures 1, 2 and 3.

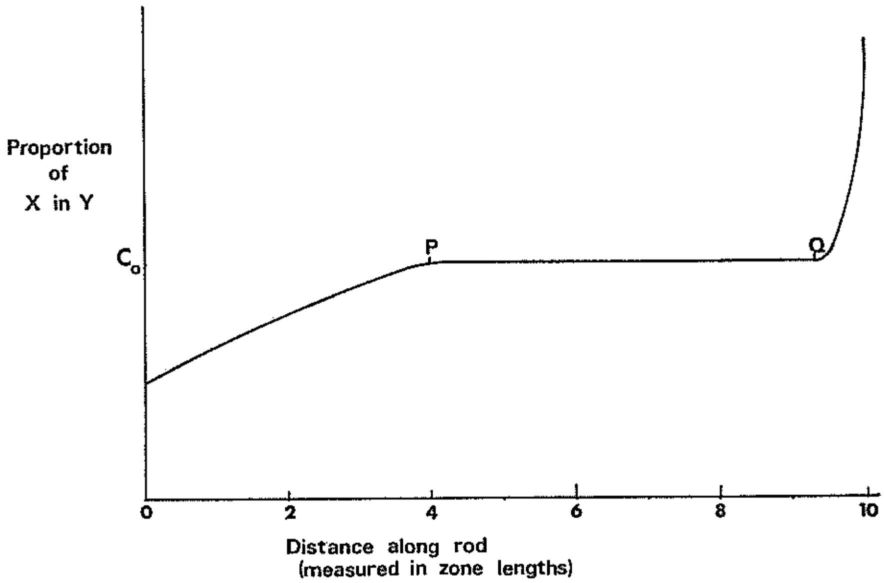


Figure 2

Figure 3 below shows the proportions of X in Y against distance along the rod for different numbers (n) of repetitions of the zone melting procedure. In the experiment illustrated the rod initially contained X and Y in the proportion 1 to 10.

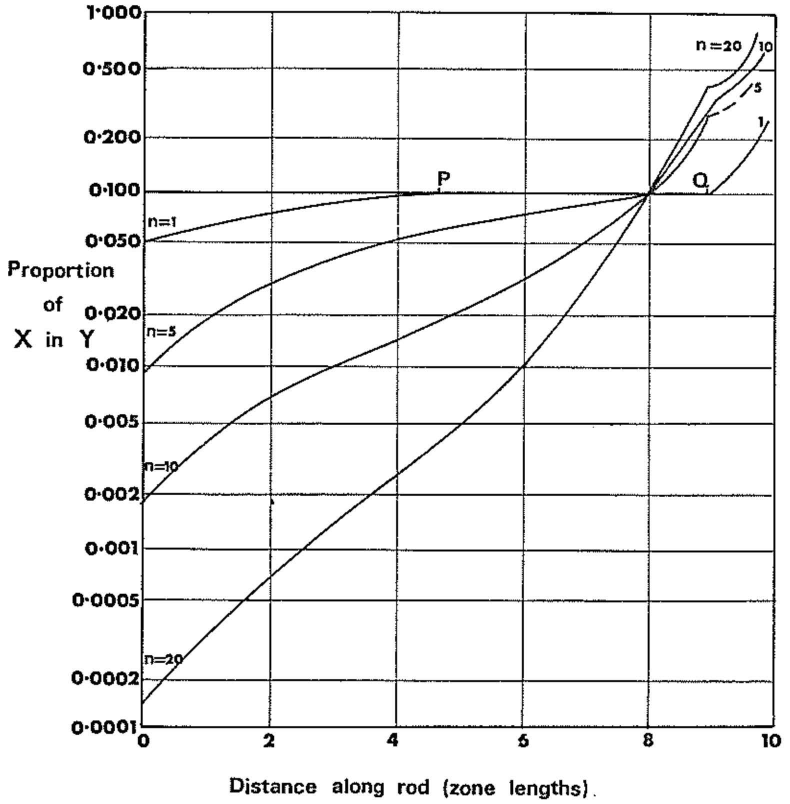


Figure 3

Note: a special scale is used for the vertical axis so that differences in small proportions of impurity can be distinguished.

57 The proportion of X in Y between the points P and Q in the rod before the refining process has begun is

A K.

B $K - C_0$.

C KC_0.

D C_0.

58 The proportion of X in Y at point M in the rod after the passage of the heating coil *once* must be

A less than C_0.

B C_0.

C greater than C_0.

D K.

59 After a single passage of a molten zone along the rod, pure Y can be obtained

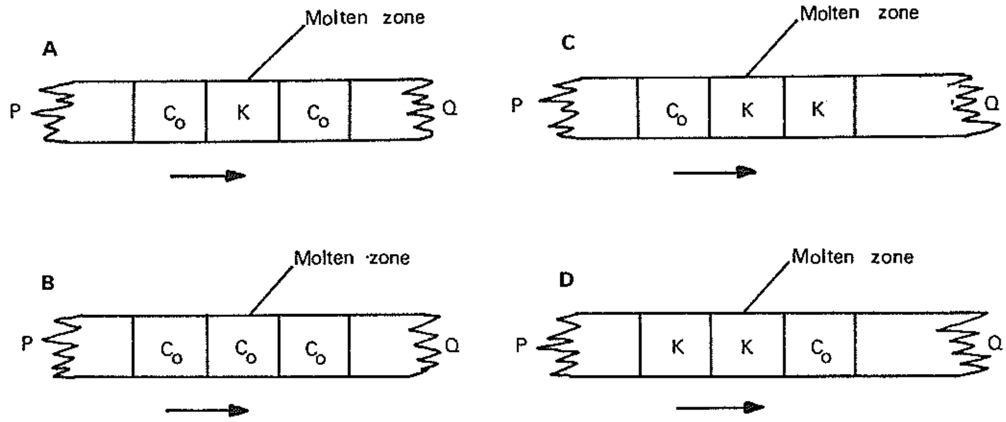
A at the end that was first melted.

B anywhere before point P.

C between points P and Q.

D nowhere along the rod.

60 A molten zone is passed along the rod once. Which diagram below represents the proportions of X in Y in a section of the rod when the molten zone is half-way between points P and Q?



61 The proportion of X in Y in the rod after 20 repetitions of the zone melting process becomes 1 to 100

- **A** about 3 zone lengths along the rod.
- **B** about 6 zone lengths along the rod.
- **C** about 8 zone lengths along the rod.
- **D** nowhere along the rod.

62 In zone refining, only in the case of the **first** passage of the molten zone along the rod

- **A** is there a steep increase in the proportion of impurity near the end of the rod.
- **B** does the proportion of impurity remain constant over a large section of the rod.
- **C** is there a substantial immediate reduction in the proportion of impurity.
- **D** does the proportion of impurity rise after the initial drop.

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