



HIGHER SCHOOL CERTIFICATE EXAMINATION

**2000**  
**SCIENCE**  
**3/4 UNIT**  
**PAPER 2—ELECTIVES**

*3 UNIT CANDIDATES: Time allowed—One hour and a half*

*4 UNIT CANDIDATES: Time allowed—Three hours*

*(Plus 5 minutes reading time)*

**DIRECTIONS TO CANDIDATES**

**3 Unit Candidates**

- Attempt TWO questions. These questions may be chosen from ANY Group.

**4 Unit Candidates**

- Attempt FOUR questions. These questions MUST be chosen from AT LEAST THREE Groups.

**All Candidates**

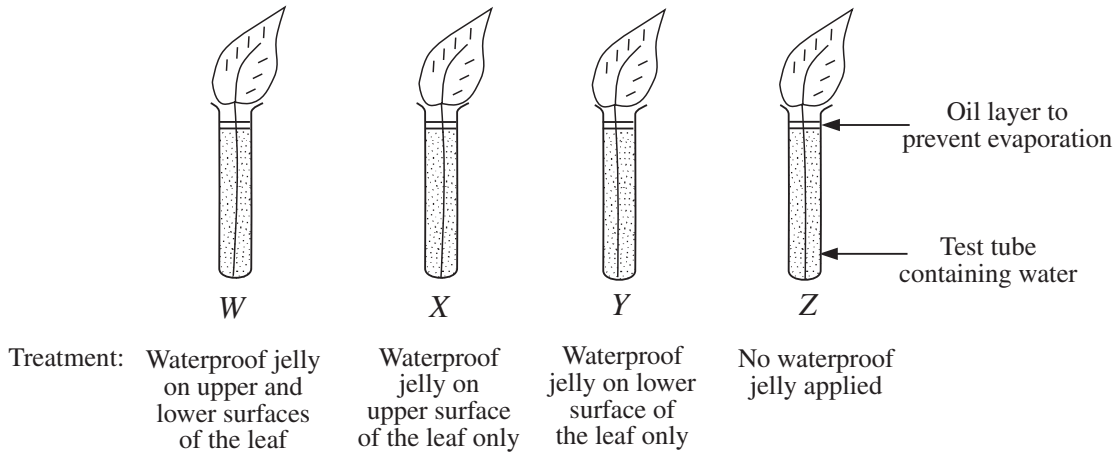
- Each question is worth 25 marks.
- Answer each question in a separate Elective Answer Book.
- The answer to Question 11 must include the graph paper provided on page 45 of this paper.
- Write your Student Number and Centre Number on the cover of each Elective Answer Book.
- Write the Course, Elective Name, and the Question Number on the cover of each Elective Answer Book.
- You may ask for extra Elective Answer Books if you need them.
- A Data Sheet and Periodic Table are provided as a tear-out sheet at the back of this paper.
- Board-approved calculators may be used.

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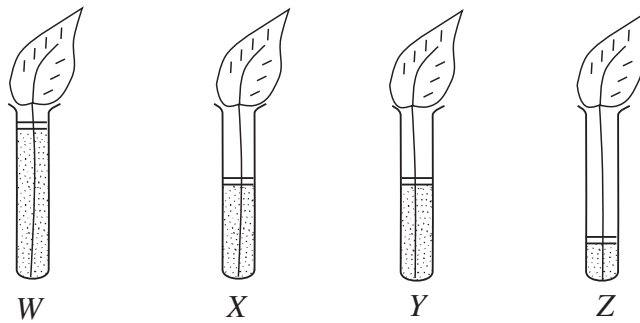
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**GROUP 1—BIOLOGY ELECTIVES****Marks****QUESTION 1 Flowering Plants and Mammals**

(a) Four identical leaves were set up as shown below.

**4**

Initially all test tubes contained the same amount of water. The diagrams below show the results after five days.



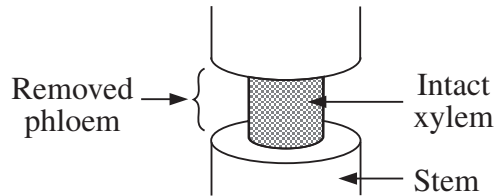
- (i) What name is given to:
- 1 the process of water loss from a leaf;
  - 2 the structure that regulates this process?
- (ii) Why was Z included in the experiment?
- (iii) What conclusion about the structure of these leaves could you draw from these results?

**Question 1 continues on page 4**

## QUESTION 1 (Continued)

Marks

- (b) (i) In an experiment, the absorption of substances by the roots of plants is to be investigated. The phloem is removed from part of the stem as shown in the diagram. 3



Predict and explain the effect that the removal of phloem will have on the capacity of the roots to absorb:

- 1 water;
  - 2 potassium ions.
- (ii) State ONE major function of roots other than the absorption of water and ions.
- (c) Carbon atoms enter a potato plant as carbon dioxide by the process of diffusion. The carbon is incorporated into different compounds as it moves through different parts of the plant. Finally it becomes part of a molecule in a potato tuber. These events are summarised in the partly completed table below. 3

<i>Location in plant</i>	<i>Carbon compound</i>	<i>Process</i>
leaf	carbon dioxide	diffusion
chloroplast	<i>P</i>	<i>Q</i>
<i>R</i>	<i>S</i>	transport
potato tuber	<i>T</i>	<i>U</i>

In your Answer Book, assign names alongside the letters *P*, *Q*, *R*, *S*, *T* and *U*.

**Question 1 continues on page 5**

QUESTION 1 (Continued)	Marks
(d) (i) Define <i>phototropism</i> .	2
(ii) Give an example of conditions under which phototropism may occur.	
(e) Post-operative patients are often classified as 'Nil by Mouth', and are not allowed to eat. An intravenous drip is used to deliver nutrition in a dilute salt solution.	4
(i) What are the TWO main food groups that would be supplied, and in what chemical form would each be administered?	
(ii) Why are they administered in those chemical forms?	
(iii) Why would these be given in a dilute salt solution rather than in water?	
(f) Exercise results in several changes in the body's processes. These include reddening of the skin and increases in heart rate, breathing rate, blood pressure and sweat production.	4
(i) What is meant by the term <i>homeostasis</i> ?	
(ii) Choose any THREE of the changes listed. Explain how each contributes to homeostasis in response to exercise.	
(g) Reflex actions are vital in ensuring the safety of the individual.	3
(i) Draw a diagram to show the arrangement of neurones, and the direction of travel of an impulse in a reflex arc.	
(ii) Give ONE example to show the importance of this type of nerve pathway.	
(h) Name ONE hormone you have studied. State the target organ, and briefly describe the effect of the hormone on that organ.	2

**End of question**

<b>QUESTION 2 Reproduction and Genetics</b>	<b>Marks</b>
(a) Describe how viruses reproduce.	<b>4</b>
(b) State ONE way in which binary fission in bacteria is:	<b>2</b>
(i) similar to mitotic division in eukaryotic cells;	
(ii) different from mitotic division in eukaryotic cells.	
(c) Distinguish between the terms <i>gene</i> and <i>allele</i> .	<b>2</b>
(d) Explain, in terms of human inheritance, how the male parent, rather than the female parent, determines the sex of the offspring.	<b>3</b>
(e) (i) Use a diagram to explain the term <i>crossing over</i> .	<b>3</b>
(ii) List TWO advantages of asexual reproduction and TWO advantages of sexual reproduction.	
(f) Describe how the structure of a DNA molecule provides an explanation for the mechanism of inheritance.	<b>4</b>
(g) Genetic engineering involves the production of recombinant DNA in the laboratory.	<b>3</b>
(i) Describe, using an annotated diagram, how recombinant DNA is made.	
(ii) Give ONE example of the use of this type of technology.	
(h) In rose plants, the length of the stems is determined by a single gene. Individual plants can grow with either long stems or short stems. A rose grower crossed two long-stem plants and grew the seeds to maturity. He noticed that, of 120 plants, 33 had short stems.	<b>4</b>
(i) Explain, using appropriate symbols, the pattern of inheritance shown here.	
(ii) One of the original long-stem plants was crossed with one of the new short-stem plants.	

What proportion of the next generation of plants would have long stems?

**End of question**

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**QUESTION 3 Micro-organisms and Disease****Marks**

- (a) A direct flight from Los Angeles to Sydney takes 14 hours. Within one day of arrival, several passengers report to their doctors suffering from severe diarrhoea and vomiting. Following a report to the Department of Health, the Infectious Diseases Unit undertakes an investigation. **5**
- (i) If you were conducting the investigation for the Unit, what steps would you take to determine the causative agent in each patient?
  - (ii) What tests would you use to establish whether the same agent was the cause of illness in all patients?
  - (iii) If the same agent was the cause of illness in all patients, what would have been the most likely mode of transmission of the disease?
- (b) A number of your friends have just been sick with influenza, and now you seem to have become infected too. **6**
- (i) What is the first stage of the immune response to this infection, and which type of cell is involved?
  - (ii) You have completely recovered from this bout of the 'flu'. You are again exposed to the same virus but do not become sick. Explain why.
  - (iii) Could your infection have been prevented by using antibiotics? Give ONE reason for your answer.
  - (iv) You can be protected from some diseases by immunisation. This commonly involves a course of two or three vaccinations over a period of weeks or months. Explain, in terms of your immune response, why several vaccinations are necessary.
- (c) What are the differences in structure between fungi, bacteria and viruses? **4**
- (d) Suggest a reason why all carpets imported into Australia are subjected to radiation treatment. **1**

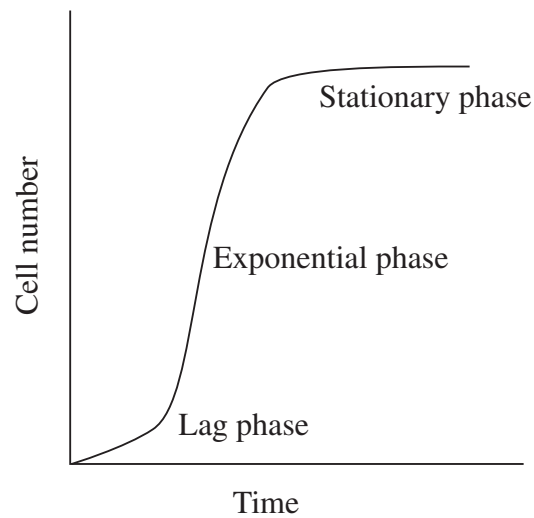
**Question 3 continues on page 9**



## QUESTION 3 (Continued)

Marks

- (e) The graph depicts a typical growth curve for a bacterial species in liquid culture. **2**

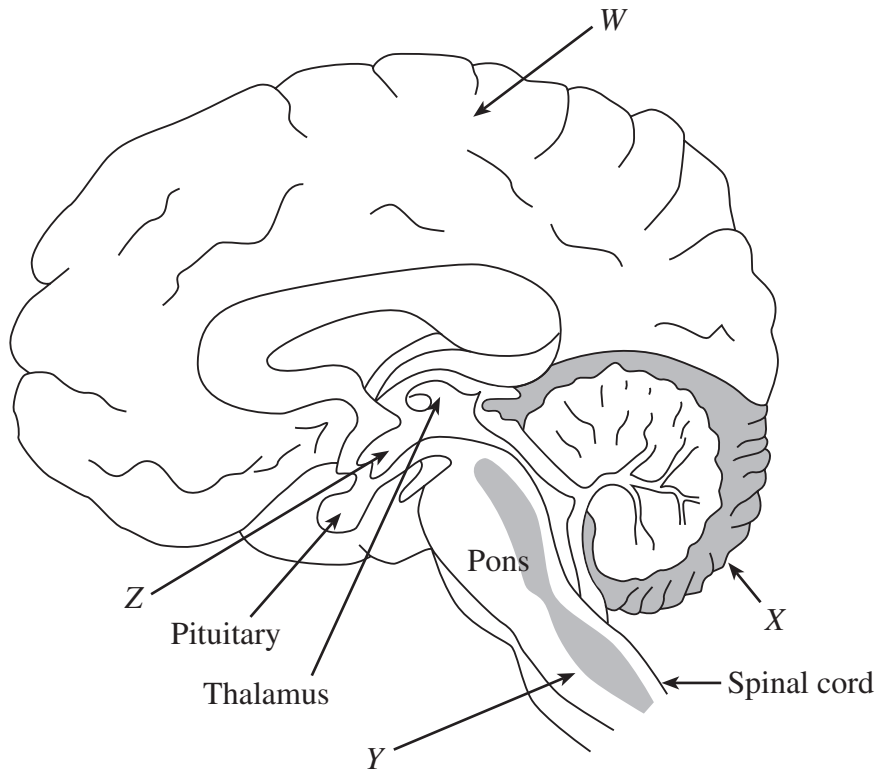


- (i) What is happening during the exponential phase?
- (ii) Explain the reason for the onset of the stationary phase.
- (f) Name TWO important economic uses of micro-organisms. **1**
- (g) Give ONE piece of evidence that can be provided *for* the classification of viruses as living organisms and ONE piece of evidence *against* that classification. **2**
- (h) You are given culture samples of the following: **2**
- white blood cells
  - bread mould fungus
  - *Escherichia coli* bacteria
  - common cold virus.
- (i) Which of the above samples could be cultured on nutrient agar to produce colonies?
- (ii) Compare the appearances of the colonies identified in part (i).
- (i) A patient reports to a doctor with a sore throat. Part of the doctor's examination involves feeling the soft tissue under the patient's jaw. What physical symptom is the doctor trying to find, and what is the cause of that symptom? **2**

**End of question**

**QUESTION 4 Coordination and Control****Marks**

- (a) (i) Identify the parts of the brain labelled W, X, Y and Z in the diagram. **5**



*Snyder et al, Biology: The Spectrum of Life, Oxford University Press, Oxford, 1999, p 118.  
Reproduced by permission of Oxford University Press Australia, www.oup.com.au.*

- (ii) Give the main functions of the parts labelled W, X and Y. **5**
- (b) In a wire, an electrical current gradually loses energy. However, the strength of a nerve impulse 'current' is maintained along the whole length of a nerve fibre. At the end of a fibre, the impulse can 'cross' the synaptic gap between two neurones so that the impulse continues along a second nerve fibre. **5**
- How is the strength of a nerve impulse maintained along nerve fibres?
  - How is the nerve impulse transmitted between nerve cells?
  - Most insecticides are nerve toxins that work by acting at a particular site on one side of the synaptic gap between nerve cells to inhibit inter-neurone transmission. Explain how this inhibition might occur.

**Question 4 continues on page 11**

## QUESTION 4 (Continued)

**Marks**

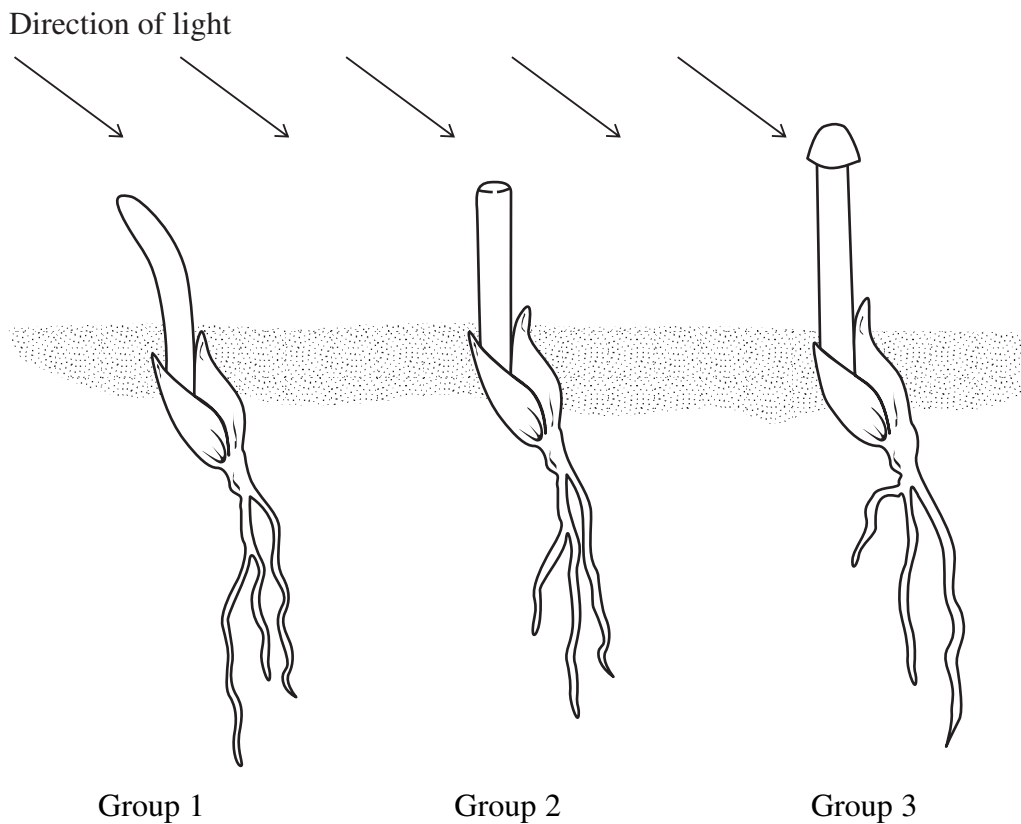
- (c) Hormones are produced by the endocrine system in order to stimulate or inhibit processes that govern the normal functioning of an organism. **6**
- (i) Using examples that you have studied, describe:
- 1 a short-term effect caused by a hormone;
  - 2 a long-term effect caused by a hormone;
  - 3 a physiological process that is affected by the interaction of two or more hormones.
- (ii) Explain why the pituitary gland is often described as the ‘master gland’. Use an example in your answer.
- (d) Homeostasis in mammals is often achieved through the interaction of nervous and hormonal control. Using an example, describe a homeostatic response that demonstrates this interaction of nerves and hormones. **4**

**Question 4 continues on page 12**

## QUESTION 4 (Continued)

Marks

- (e) The diagrams show the results of an historical experiment in which the researcher was investigating growth responses of plants to the direction of light. 5



Intact seedling.  
Shoots grew and bent  
towards light.

Tip removed.  
Shoots did not grow or  
bend towards light.

Tip covered.  
Shoots grew but did  
not bend towards light.

*Tobin A J & Dusheck J, Asking about Life, sounders College Publishers, Fort Worth 1988*

- (i) What name is given to the plant behaviour under investigation?
- (ii) What hormone is associated with this response?
- (iii) What TWO conclusions can be drawn from these results?
- (iv) Name another hormone involved in plant growth. Describe its effect.

**End of question**

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**GROUP 2—CHEMISTRY ELECTIVES****Marks****QUESTION 5 Energy**

- (a) A spirit burner used 26.6 g of ethanol to change 200 mL of water at 23.5°C to water vapour at 100°C. The enthalpy of combustion of ethanol is 1367 kJ mol<sup>-1</sup>. Calculate the heat of vaporisation of water, in kilojoules per mole, assuming that 70% of the heat produced by the combustion of the ethanol was absorbed by the water. Show all working. **5**
- (b) Coal, petrol and propane are commonly used fuels. Compare these fuels, referring to: **6**
- their ignition temperature, vaporisation temperature and volatility;
  - how the rate and evenness of their combustion are controlled;
  - the precautions that should be taken so that the fuels may be used safely.
- (c) Consider the enthalpies of fusion, vaporisation and atomisation for the elements sodium and sulfur. **3**

<i>Element</i>	$\Delta_{\text{fus}}H^\ominus$ kJ mol <sup>-1</sup> ( <i>t<sub>m</sub></i> )	$\Delta_{\text{vap}}H^\ominus$ kJ mol <sup>-1</sup> ( <i>t<sub>b</sub></i> )	$\Delta_{\text{at}}H^\ominus$ kJ mol <sup>-1</sup> (25°C)
Sodium	2.6	99	107
Sulfur	1.2	9.6	277

Compare the structures of the solid elements sodium and sulfur. Use the data in the table to justify this comparison.

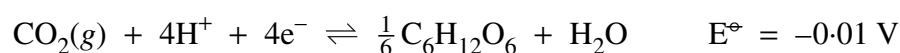
**Question 5 continues on page 15**

## QUESTION 5 (Continued)

Marks

(d) The reaction of glucose,  $C_6H_{12}O_6$ , with oxygen to produce carbon dioxide, water and energy occurs frequently in nature. 5

- (i) Write a balanced chemical equation to describe the reaction between glucose and oxygen.
- (ii) Calculate the standard heat of combustion of glucose, given the standard heats of formation of solid glucose ( $-1273 \text{ kJ mol}^{-1}$ ), carbon dioxide gas ( $-394 \text{ kJ mol}^{-1}$ ) and liquid water ( $-286 \text{ kJ mol}^{-1}$ ).
- (iii) It is theoretically possible to construct an electrochemical cell using oxygen and glucose, and to produce an electric current from this cell. Given the following half-equation:



write equations to describe the:

- 1 oxidation half-cell reaction;
  - 2 reduction half-cell reaction;
  - 3 overall reaction of the cell.
- (iv) Calculate the potential for the cell described in part (iii).

(e) A beaker containing a  $1 \text{ mol L}^{-1}$  solution of sodium iodide was connected by a salt bridge to a second beaker containing a  $1 \text{ mol L}^{-1}$  solution of iron(III) nitrate. A platinum electrode was placed in each beaker, and the electrodes were connected through a voltmeter. 6

Draw a labelled diagram of the cell and on the diagram show the:

- anode
- cathode
- oxidation half-reaction, using a half-equation
- reduction half-reaction, using a half-equation
- direction of flow of electrons
- potential of the cell.

**End of question**

**QUESTION 6 Atomic Structure and the Periodic Table****Marks**

- (a) Identify and name each element described below. **3**
- (i) Element *A* is a non-metal element from the third period. It forms an ionic compound by bonding with sodium atoms in a ratio of two sodium ions to each ion of Element *A*.
  - (ii) Element *B* is a fourth period element with 8 electrons in the 3d-subshell.
  - (iii) Element *C* is an actinide with 3 electrons in the f-subshell.
- (b) A scientific theory usually consists of a number of ideas put forward by a few scientists. It is common for these ideas to be modified by other scientists. ‘The Modern Atomic Theory’, proposed by John Dalton, consisted of a number of ideas about the nature and behaviour of atoms. **6**
- State **THREE** propositions that are part of Dalton’s Atomic Theory, and describe the changes that have been made to these ideas by other scientists. For each proposition, identify the scientist responsible for the modification to Dalton’s theory, and state the experimental evidence used by that scientist.
- (c) The electron configuration of lithium can be represented symbolically as  $1s^2 2s^1$ . **5**
- (i) Use a similar symbolic representation to show the electron configuration of nitrogen.
  - (ii) Use a pictorial representation to show the electron configuration of nitrogen.
  - (iii) When nitrogen is in its ground state, how many orbitals in the second shell of nitrogen contain electrons?
  - (iv) Compare the two ways of representing electron configurations in parts (i) and (ii) by listing **ONE** advantage of each method.

**Question 6 continues on page 17**



## QUESTION 6 (Continued)

Marks

- (d) The periodic table lists all known elements. **5**
- (i) Which property was originally used to rank the elements in order from the first to the last?
  - (ii) Which property is now used to place the elements in order?
  - (iii) How is the electron configuration of an element in a period related to the electron configuration of the other elements in the same period?
  - (iv) How is the electron configuration of an element in a group related to the electron configuration of the other elements in the same group?
  - (v) Explain why the most reactive element in group I is found at the bottom of the group, while the most reactive element in group VII is at the top of the group.
- (e) Heisenberg, Schrödinger and Pauli all made important contributions to our understanding of atomic structure. Briefly outline the contribution of each of these scientists, and explain how this contribution has increased our understanding of atomic structure. **6**

**End of question**

**QUESTION 7 Carbon Chemistry****Marks**

- (a) Benzene,  $C_6H_6$ , is an aromatic hydrocarbon, whereas 1-hexene,  $C_6H_{12}$ , is aliphatic. **6**
- (i) Explain, by referring to the structural formulae for these two compounds, why benzene is classified as an aromatic hydrocarbon and 1-hexene is classified as an aliphatic hydrocarbon.
- (ii) Write equations, using structural formulae, to describe one reaction of chlorine with:
- 1 benzene;
  - 2 1-hexene.
- In each case, name the compounds formed in the reaction.
- (b) Identify one industrial or domestic use for each of the following hydrocarbons: **3**
- (i) ethylene;
  - (ii) propane;
  - (iii) benzene.
- (c) Alkanols, with molecular formula  $C_4H_{10}O$ , can be oxidised by reagents, such as acidified potassium dichromate, to three different compounds. **5**
- (i) Name the three possible oxidation products and the alkanols that produce them.
  - (ii) Write the structural formula for the alkanol, with the same molecular formula, that is not oxidised by acidified potassium dichromate.
  - (iii) What term is used to describe different compounds having the same molecular formula?

**Question 7 continues on page 19**

## QUESTION 7 (Continued)

Marks

- (d) Consider the boiling points of the three substances listed in the table.

4

<i>Substance</i>	<i>Boiling point (°C)</i>
water	100
ethanol	78.3
1,2-ethanediol	198

- (i) Draw the structural formula for 1,2-ethanediol.
- (ii) Explain why the boiling point of 1,2-ethanediol is greater than the boiling point of water.
- (iii) Predict the solubility of 1,2-ethanediol in water. Justify your prediction.
- (iv) State one use for 1,2-ethanediol.
- (e) Compound *A* has the empirical formula  $\text{CH}_2$  and a molecular mass of 56. When compound *A* was refluxed with dilute hydrochloric acid, a mixture of two compounds, identified as compound *B* and compound *C*, was produced. Compounds *B* and *C* were oxidised separately to produce compound *D* and compound *E*, respectively. Of compounds *D* and *E*, only compound *E* reacted when placed into a dilute solution of sodium carbonate.

5

Name the compounds *A*, *B*, *C*, *D* and *E*.

- (f) A vegetable oil is heated under reflux with potassium hydroxide solution for several hours. The reaction mixture is then cooled, and two substances, a water-soluble liquid *A* and a soft, waxy solid *B* are separated.
- (i) Write an expanded structural (graphic) formula for *A* and name this substance.
- (ii) Describe one important use of compound *B*.

2

**End of question**

**GROUP 3—GEOLOGY ELECTIVES****Marks****QUESTION 8 Regional Geology**

In this elective you have studied one of the following regions:

- North-western Fold Belt
- Central and Southern Fold Belt (northern areas)
- Central and Southern Fold Belt (southern areas)
- New England Fold Belt
- Sydney Basin.

Your answers for parts (b) to (i) must relate to the region you name in part (a).

- (a) Name the region you have studied.
- (b) Draw a labelled cross-section of the region you have studied or part of the region that you have studied in detail. In your cross-section, show the sequence of the major units or formations present in the area. **2**
- (c) (i) Name ONE adjoining region. **3**
- (ii) Describe the type of boundary between this region and the one you have studied.
- (iii) Give the relative age of the two regions.
- (d) (i) Name ONE geological period in which major sedimentation took place in the region you have studied. **6**
- (ii) Construct a table to list:
- 1 the major rock formations formed during this period of sedimentation;
  - 2 the main lithologies in each of these formations;
  - 3 the environment of deposition represented by each formation.

**Question 8 continues on page 21**

## QUESTION 8 (Continued)

Marks

- (e) For ONE igneous or metamorphic lithology present in the region you have studied: 3
- (i) name the lithology, and outline its major features;
  - (ii) describe in detail the formation of this lithology;
  - (iii) describe in detail its origin.
- (f) All geological regions contain deposits of major geological economic resources. 3
- (i) Name ONE such economic resource found in the region you have studied.
  - (ii) Name ONE location where this resource is extracted in the region you have studied.
  - (iii) Explain how the resource at this location was formed.
- (g) In the region you have studied, there are features of special geological interest other than economic resources. 3
- (i) Name ONE such feature of special geological interest, and state where it is located.
  - (ii) Describe why this feature is of special geological interest.
- (h) Suppose that you are going to visit another country that has geological regions similar to those in New South Wales. For ONE of the geological regions you would expect to find: 3
- (i) name the type of region;
  - (ii) name and show, using a labelled diagram, TWO structural features that could be present;
  - (iii) explain what each of these structural features indicates about the geological evolution of this region.
- (i) In studying your region, you have used field work, laboratory investigations, map, air photo and library studies. Choose ONE of these methods, and indicate how it has helped you to more fully understand the geology in the region. 2

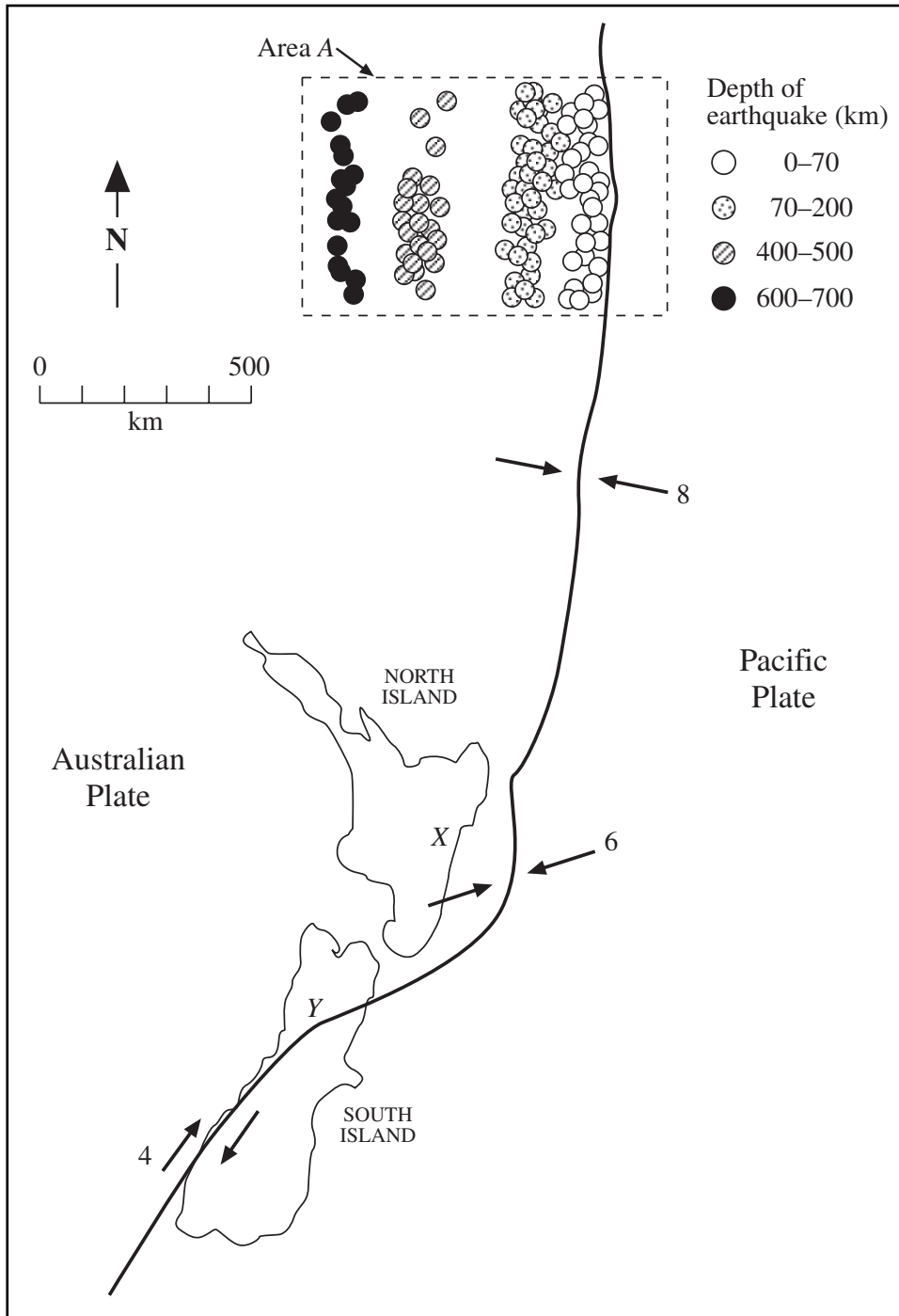
**End of question**

## QUESTION 9 Mountains

Marks

- (a) The map shows New Zealand, with the location of the boundary between the Pacific and Australian Plates. The relative motion along the boundary is shown in  $\text{cm year}^{-1}$ . The sites and depths of earthquakes are shown for the section of the boundary labelled Area A, with the maximum depth of earthquakes being around 700 km.

13



Question 9 continues on page 23

## QUESTION 9 (Continued)

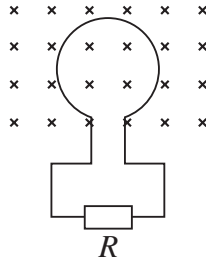
Marks

- (i) A series of volcanoes has developed along the plate margin near location *X*. Describe the type of eruption that is likely to occur, and the composition of the erupted material.
- (ii) 1 Describe the type of recent faulting that you would expect to find in the vicinity of locations *X* and *Y*.
- 2 The South Island of New Zealand contains a high alpine region with intense deformation of the rocks. What does this indicate about changes in relative plate movement at *Y* over time?
- (iii) Area *A* indicates the location of earthquake foci along part of the Australian-Pacific plate boundary.
- 1 Which plate is being subducted, and what is the evidence for this?
- 2 What is the approximate angle of dip from the horizontal for the Benioff Zone along this part of the boundary?
- (iv) 1 What progressive changes occur in an oceanic plate undergoing subduction?
- 2 What is the approximate depth of the total melting of the subducting ocean plate at Area *A*?
- (v) Name ONE geological hazard you would expect at location *X*, and explain how plate movement would have caused this hazard.
- (b) (i) Explain why the thickness of the crust is greater in modern tectonic mountain ranges, such as the Andes or Himalayas, than in ancient mountain belts in continental shield areas. **6**
- (ii) Describe the mechanisms that permit crustal shortening across continent-continent collision boundaries.
- (iii) Why does the ocean depth increase away from mid-ocean ridges?
- (c) (i) Why does volcanic activity of the type associated with the Hawaiian Islands or Iceland generally cause less of a risk to life and property than volcanism of the type commonly associated with the Indonesian or the Philippine chains of islands? **6**
- (ii) With the aid of a diagram, outline the key features of a composite volcano.
- (iii) The east coast of Australia is characterised by a series of basalt flows that are much younger than the underlying rock units. What is a possible origin of such basalt flows?

**End of question**

**GROUP 4—PHYSICS ELECTIVES****Marks****QUESTION 10 Electromagnetism**

- (a) The diagram shows a loop of wire with 75 turns in a magnetic field. The loop has an area of  $2.5 \times 10^{-2} \text{ m}^2$ . **3**



The flux density of the magnetic field changes from 0.10 T to 0.35 T in 1.5 s.

Calculate the e.m.f. induced in the loop.

- (b) A student set up two demonstrations, as in the diagrams shown. **4**

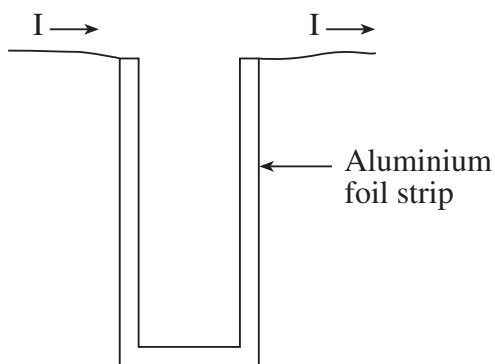


Diagram 1

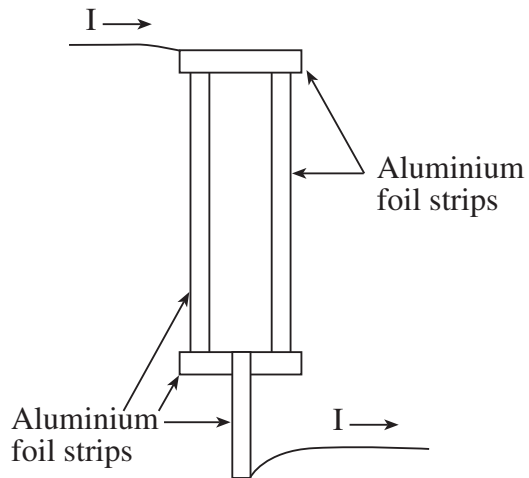


Diagram 2

When the current flows, as shown, explain (with the aid of a diagram) the effect observed in:

- (i) diagram 1;
- (ii) diagram 2.

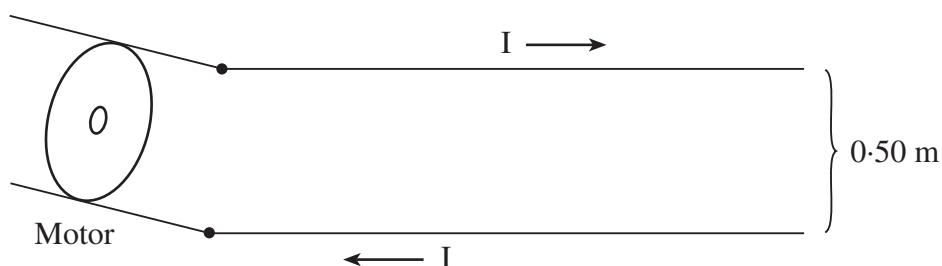
**Question 10 continues on page 25**



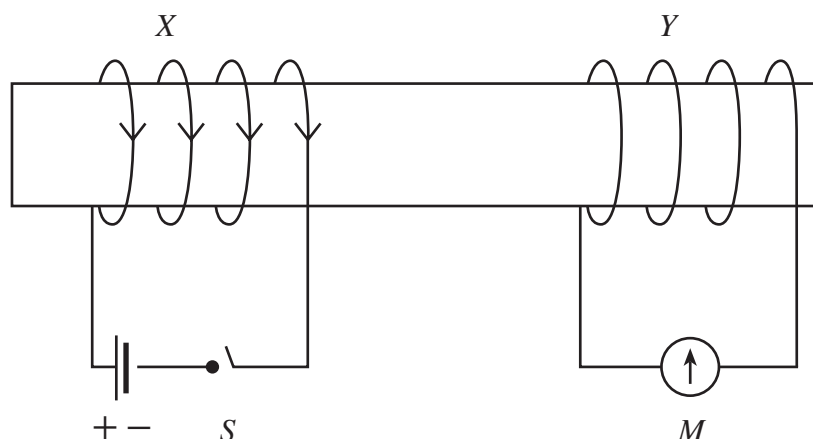
## QUESTION 10 (Continued)

Marks

- (c) Two long straight wires, 0.50 m apart, deliver a steady current of 15 A to a motor. 4



- (i) Calculate the magnitude of the force exerted on a 2 m length of each wire.
- (ii) What is the magnetic induction  $\mathbf{B}$  produced at one wire by the current in the other wire?
- (d) The diagram shows two short solenoids  $X$  and  $Y$  which are wound on a hollow cardboard form. For  $X$ , the switch is open and the arrows on the windings represent the direction in which the current will flow when the switch  $S$  is closed. The meter  $M$  is a centre-zero moving-coil instrument. 8

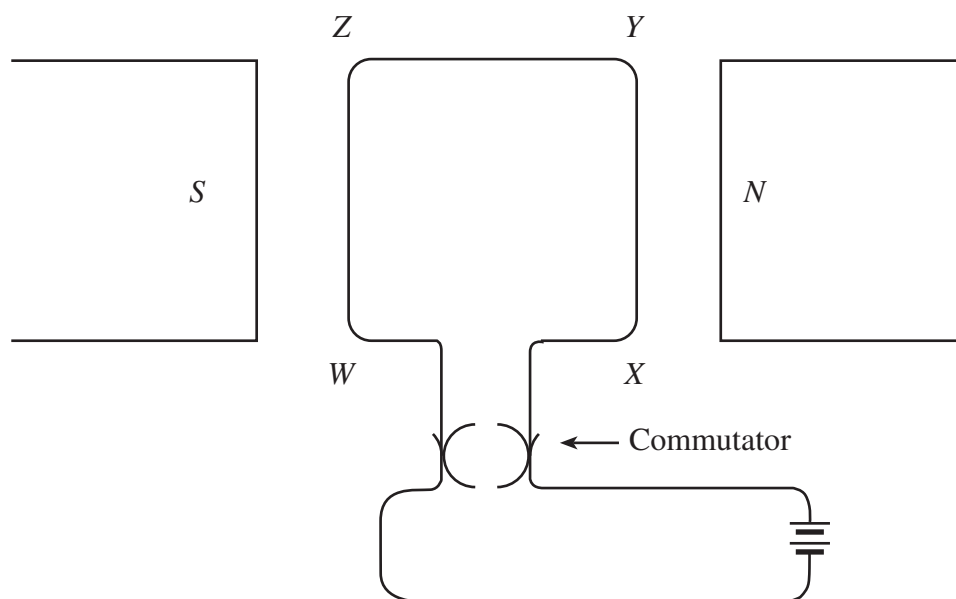


- (i) When  $S$  is closed the meter deflects 5 divisions to the right. Explain this observation.
- (ii) What is observed when  $S$  is subsequently opened? Explain your answer.
- (iii) Explain the effect, if any, on the meter readings if the coils are moved closer together and  $S$  is closed.
- (iv) If a 50 Hz AC voltage was applied across  $X$ , what effect would this have on the meter  $M$ ? Explain your answer.
- (v) Give TWO ways that this arrangement could be changed to make a useful transformer. Give reasons for the changes.

## QUESTION 10 (Continued)

Marks

- (e) The diagram shows a simple DC electric motor circuit. The coil lies flat between the poles of the magnet. 6



The square coil  $WXYZ$  has a single turn with sides  $0.030\text{ m}$  long. A current of  $4.0\text{ A}$  flows through the coil and a uniform magnetic field of  $0.80\text{ T}$  exists between the poles of the magnet.

- (i) Determine the magnitude and direction of the magnetic force on the side  $XY$  when it is in the position shown in the diagram. Show your working.
- (ii)
  - 1 Calculate the torque on the coil in this position. Show your working.
  - 2 Why is the torque in this position a maximum?
- (iii) Why does a DC motor coil have many turns, rather than the single turn as shown in this diagram?

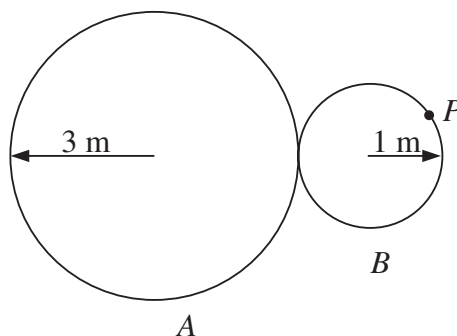
**End of question**

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**Please turn over**

**QUESTION 11 Oscillations and Waves****Marks**

- (a) Two wheels, *A* and *B*, are in contact and are rotating without slipping. Wheel *A* turns with a frequency of 15 revolutions per second and has a radius of 3 metres. Wheel *B* has a radius of 1 metre. Wheel *B* has a point *P* that rotates on its outside rim. **3**



- (i) Determine the linear speed of point *P*. Show your working.
- (ii) Determine the acceleration of *P* (magnitude and direction). Show your working.
- (iii) Determine the angular velocity of *P*. Show your working.
- (b) A guitar string is tuned so that when plucked it sounds the note *C* of frequency 256 Hz. **3**
- (i) If the string is vibrating in its simplest mode and the length of the vibrating string is measured to be 48 cm, calculate the speed of the wave along the string.
- (ii) The note is heard at the back of the auditorium, a distance of 40 m away, 0.12 s later.

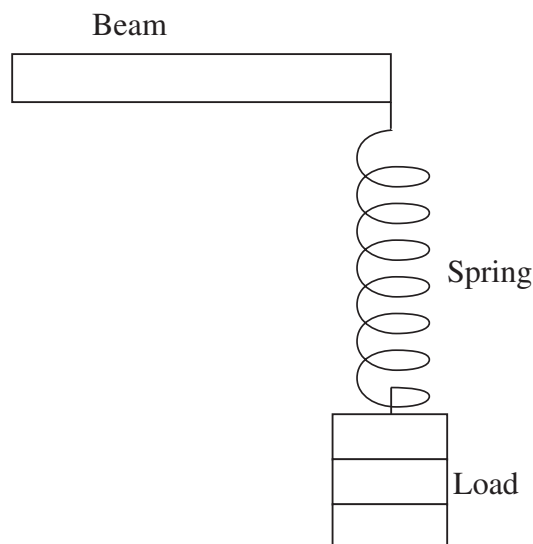
What is the wavelength of the sound wave?

**Question 11 continues on page 29**

## QUESTION 11 (Continued)

Marks

- (c) The diagram shows a spring suspended from a beam with a load attached to the spring. Various masses are placed on the spring, causing it to elongate. The elongation for each mass is shown in the table. 7



<i>Mass added</i> (kg)	<i>Elongation</i> (m)
0.0	0.00
1.0	0.30
2.0	0.55
3.0	0.90
4.0	1.20
5.0	1.56

- (i) Using the graph paper provided on page 45 of this Question Book, draw a graph of the elongation of the spring as a function of the force applied to the spring.

Detach the graph sheet, fill in your Student Number and Centre Number, and include this sheet in your Elective Answer Book for Question 11.

- (ii) The equation relating force,  $F$ , to extension,  $x$ , for an ideal spring is

$$F = -kx$$

where  $k$  is the spring constant.

Use your graph to determine  $k$  for this spring. Show your working.

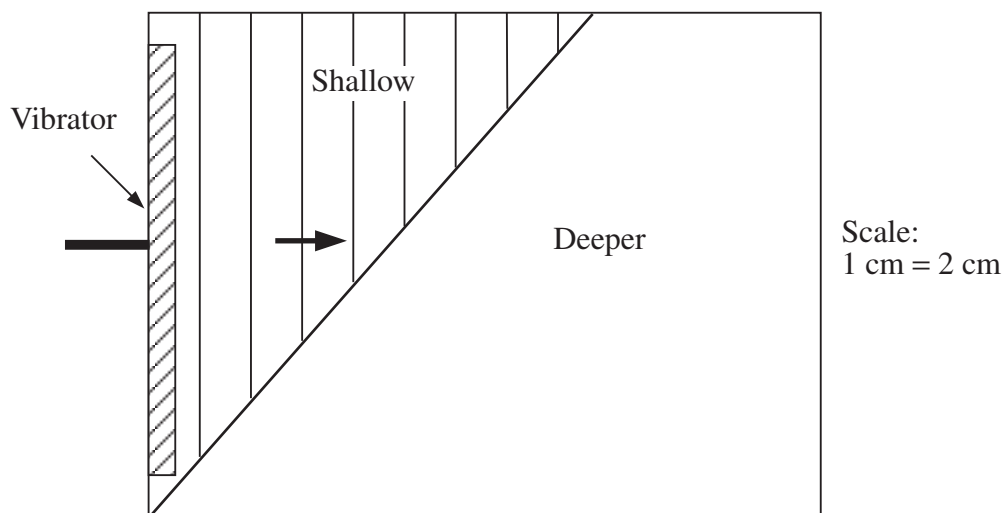
- (iii) After the 5.0 kg reading was taken, the spring was pulled down vertically and then released.

Calculate the period of oscillation of the system after the load was released. Show your working.

## QUESTION 11 (Continued)

Marks

- (d) The diagram shows a scale drawing of a ripple tank with water waves moving from shallow into deeper water. The vibrator producing the waves operates at 25 Hz. Wavefronts in shallow water are shown as straight lines. 4



- (i) What is the wavelength of the waves in the shallow region?
- (ii) Determine the speed of the waves in the shallow region. Show your working.

The wavelength of the waves in the deeper region is twice that in the shallow region.

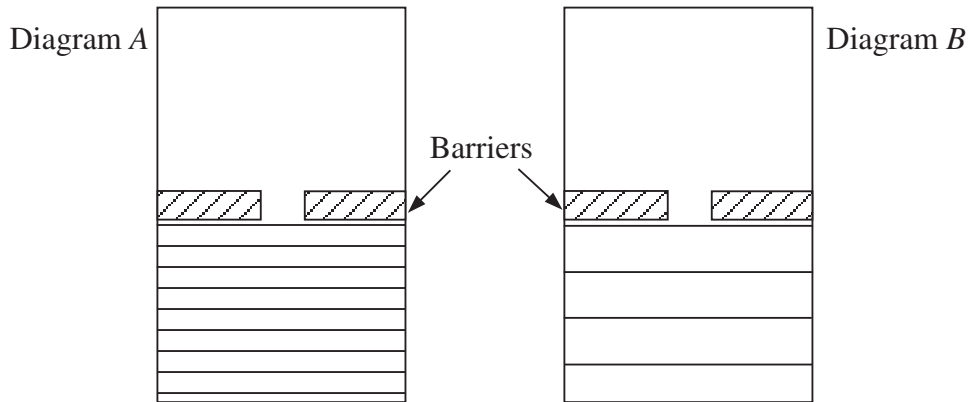
- (iii) Determine the speed of the waves in the deeper region.
- (iv) In your Answer Book, sketch the general pattern of the waves in the ripple tank.

**Question 11 continues on page 31**

## QUESTION 11 (Continued)

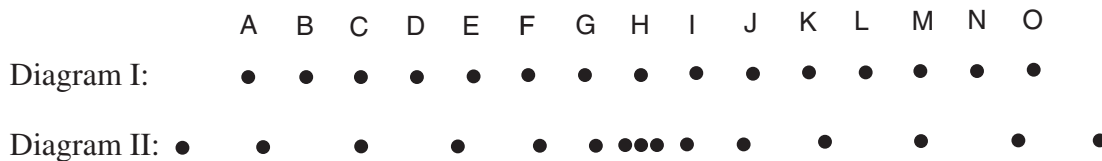
Marks

- (e) The diagrams show two identical ripple tanks in which plane water waves of different wavelengths are approaching a barrier. 4



- (i) Which wave property is demonstrated by these wavefronts after they have passed through the gap?
- (ii) What factor is critical in determining the shape of the wavefronts after they pass through the gap?
- (iii) In your Answer Book, sketch diagrams showing the pattern produced by the wavefronts after they pass through the gap in each barrier.
- (f) Diagram I shows a set of particles in air in their equilibrium positions before any wave motion passes through them. 4

Diagram II shows the same particles at an instant of time when a wave is propagating through their region of air.



- (i) What kind of periodic travelling wave is represented by the particles in Diagram II?
- (ii) Describe the motion of particles C and M, as shown in diagram II.
- (iii) Identify TWO particles, shown in diagram II, which have a distance of *one wavelength* between them. Justify your answer.
- (iv) Identify a particle, shown in diagram II, that is  $180^\circ$  out of phase with particle C.

**End of question**

**QUESTION 12 Light****Marks**

- (a) (i) Beyond the visible part of the electromagnetic spectrum lie X-rays, ultraviolet light and  $\gamma$ -rays. Explain the essential difference between each of these three categories of electromagnetic radiation, and arrange them in order based on this difference. **5**
- (ii) The photoelectric effect was discovered by Hertz in 1887 by shining ultraviolet light onto a zinc surface. A minimum energy of  $6.8 \times 10^{-19}$  J is needed for the photoelectric effect to be observed in zinc.
- 1 What was the minimum frequency of the ultraviolet light used by Hertz?
  - 2 What is the wavelength corresponding to that frequency?
- (b) (i) What is meant by the phrase *wave-particle dilemma*? **11**
- (ii) During the debate between Newton and Hooke over the nature of light, each explained the bending of light as it passed from one medium into another by using different models. Newton proposed a particle model of light, while Hooke proposed a wave model.
- 1 What name is given to the bending of light as it passes from one medium to another?
  - 2 How does the wave model of light explain this phenomenon?
  - 3 The speed of light in water has now been measured to be less than the speed of light in air. What is the significance of this measurement in relationship to the wave-particle debate?
- (iii) At the beginning of the nineteenth century, Young carried out some experiments which revived the wave theory of light.
- 1 Describe Young's double-slit experiment.
  - 2 Why did that experiment appear to contradict the particle nature of light?
- (iv) At the time of Young's work, the photoelectric effect had not been discovered. Name ONE piece of physical evidence which was available at that time to support the *particle theory of light*.

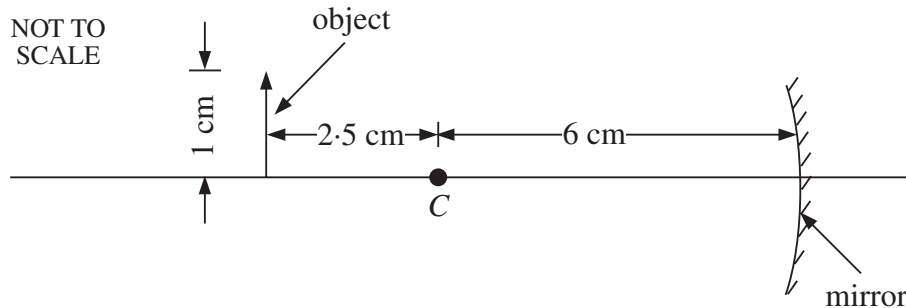
**Question 12 continues on page 33**



## QUESTION 12 (Continued)

Marks

- (c) (i) Draw a sketch showing how a concave spherical mirror forms an image of an object placed as shown in the diagram.  $C$  is the centre of curvature of the mirror. 4



- (ii) In terms of forming an image of distant objects, spherical mirrors have a problem that can be avoided by using a parabolic mirror. Name the problem, and explain why the parabolic mirror does not have that defect.
- (d) You are given a collection of four lenses with the following focal lengths: 5

$$f_1 = 4.5 \text{ mm}, \quad f_2 = -40 \text{ mm}, \quad f_3 = 100 \text{ mm} \text{ and } f_4 = 1200 \text{ mm}.$$

Two of these lenses can be used to make a microscope and the other two lenses can be used to make a telescope.

- (i) Select a pair of lenses that is suitable for making a microscope. Justify your choice by drawing a sketch showing how the microscope forms its image.
- (ii) What is the name given to the type of telescope that can be made with the other pair of lenses?

**End of question**

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**GROUP 5—INTERDISCIPLINARY ELECTIVES****Marks****QUESTION 13 Biochemistry**

- (a) The nucleotide sequence represents one strand of a DNA molecule that contains part of a gene sequence. **5**

G A T G T T T T C G A T C T A A C T

- (i) Write down the nucleotide sequence of the second or complementary strand of this sequence.
- (ii) Write down the nucleotide sequence of the messenger RNA that would be specified by the sequence you have written in part (i).
- (iii) Explain the role of messenger RNA.
- (iv) How many amino acids would be specified by the nucleotide sequence above?
- (b) An enzyme is a biological catalyst. In order to function correctly in metabolic cell processes, enzymes have *specificity* and require *optimum conditions*. **6**
- (i) Explain what is meant by an enzyme's specificity.
- (ii) How is enzyme specificity achieved in terms of protein structure?
- (iii) Explain what is meant by the term *optimum conditions* for enzyme activity.
- (iv) The browning of cut fruit is due to the production of certain compounds by enzymic action in ruptured plant cells. To prevent this browning during the preparation of fruit salad, it is usual to squeeze some lemon juice (an acid) over the cut fruit. Explain why this works to stop the browning.
- (c) Cellular respiration comprises distinct stages that occur in different parts of the cell. **9**
- (i) Name the THREE stages, and state where they occur in the cell.
- (ii) Describe the contribution of each stage to the overall respiration process.
- (iii) State the relative yield of ATP from the anaerobic and aerobic phases.
- (d) As part of their metabolism, plants are able to manufacture amino acids. **5**
- (i) What chemical elements are present in amino acids?
- (ii) In what form does each of these elements enter the plant?
- (iii) Describe a chemical test for a polymer of amino acids.

**End of question**

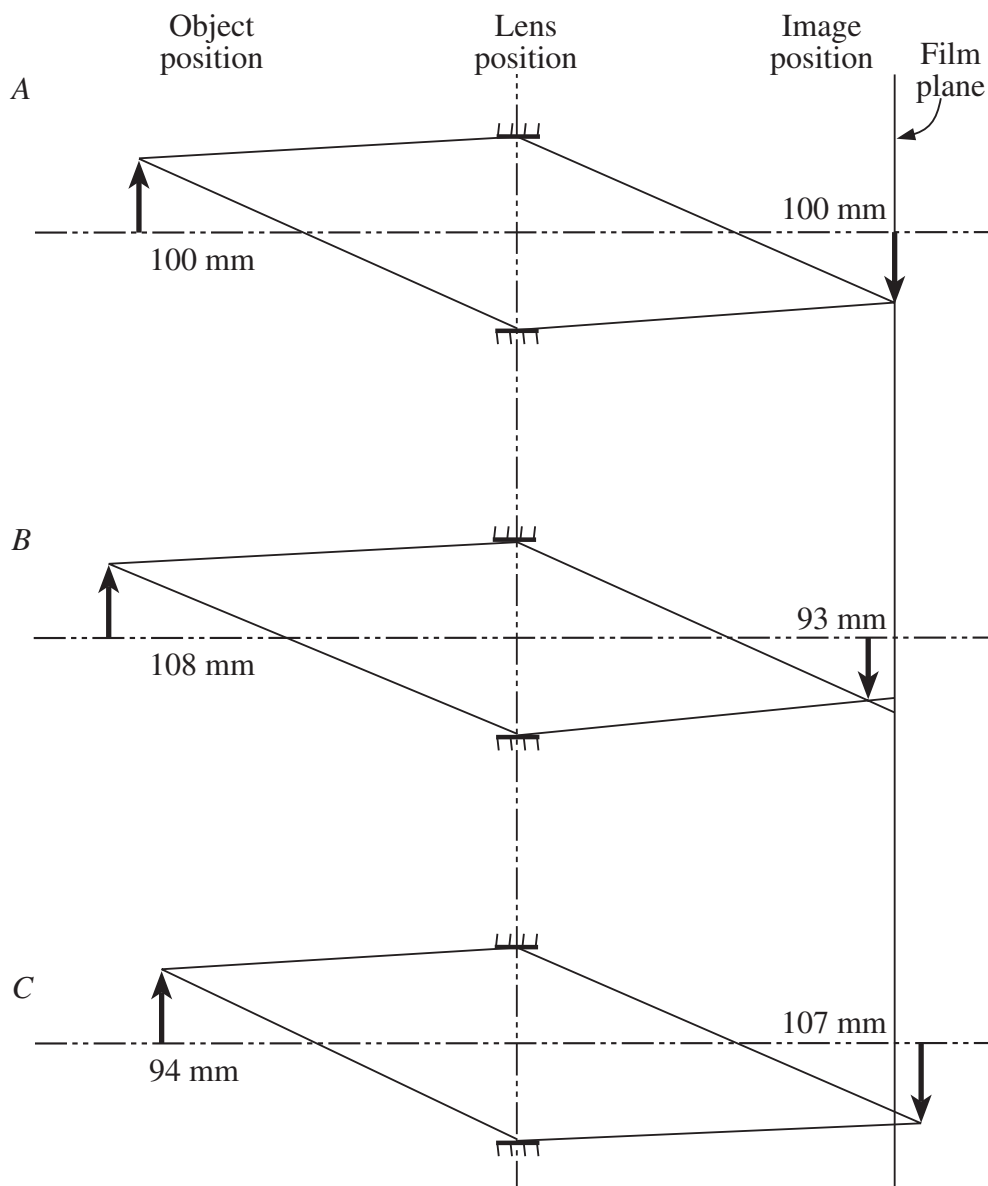
**QUESTION 14 Photography****Marks**

(a) Images can be altered by altering settings on the camera.

**12**

(i) Define the terms:

- 1  $f$  number;
- 2 depth of focus.

(ii) Figures *A*, *B* and *C* show ray diagrams for a 50 mm lens with aperture set at  $f/2$ . Each of the diagrams is drawn to scale, but the vertical and horizontal scales are different;**Question 14 continues on page 37**

## QUESTION 14 (Continued)

Marks

The diagrams show how rays from the tip of a 1 cm-high object pass through the lens and its iris, and where they hit the film plane in the camera.

Figure *A* shows the lens when it is properly focussed so that, when the object is 100 mm from the lens, there is a sharp image in the film plane.

Figure *B* shows what happens when the lens is not refocussed and the object is 108 mm from the lens. Similarly, figure *C* shows what happens when the object is 94 mm from the lens.

Use these figures to explain how depth of field arises.

- (iii) Lenses in cameras are usually coated.
- 1 State TWO purposes for such coatings.
  - 2 A lens has a single-layer coating. How should the refractive index of the coating relate to the refractive indices of air and glass?
- (iv) You are about to take a photograph of a scene in bright daylight, using a single-lens reflex camera. You have manual control of both shutter speed and aperture.
- 1 Given that you already have film loaded in your camera, discuss the factors that can affect your choice of settings.
  - 2 How would your choices be altered if the scene were dimly lit and a flash gun were not available?

**Question 14 continues on page 38**

## QUESTION 14 (Continued)

Marks

(b) Various materials reflect infra-red radiation to the following extents:

3

- broad-leaved trees reflect quite strongly;
- conifers reflect poorly;
- water reflects poorly.

The two photographs below were taken of the same region. Photograph A was taken with panchromatic film. Photograph B was taken with infra-red film. You can see the different tree types quite clearly by comparing the two photographs. In the photographs you can also see a road and a feature that is either a river or a canal.



Photograph A

*Avery, T E & Berlin, G L, Interpretation of Aerial Photographs, Burgess Publishing Co, Minneapolis, 1985, p 11.*



Photograph B

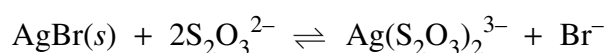
*Avery, T E & Berlin, G L, Interpretation of Aerial Photographs, Burgess Publishing Co, Minneapolis, 1985, p 11.*

## QUESTION 14 (Continued)

**Marks**

- (i) Locate the river or canal. In your Answer Book, draw a rectangle that represents the photograph. Sketch on the rectangle the path followed by the river or canal. (Do NOT sketch any other features.)
- (ii) Explain why you identified this feature as a waterway.
- (iii) Suggest a characteristic that could be used to identify the waterway as a canal rather than as a river.

- (c) The reaction, described by the equation

**6**

is part of the process of producing a negative from an exposed film.

- (i) During which step in the processing of exposed film does this reaction occur?
  - (ii) Explain the purpose of carrying out this step and how the reaction achieves this purpose.
  - (iii) Why is the product of this process referred to as the negative?
  - (iv) Why are negatives produced on transparent materials?
  - (v) How do black and white or colour transparencies differ from negatives?
- (d) In the past it was common for black and white prints to be treated by a process known as 'toning'. This process is still carried out, but is used less frequently than in previous times.
- (i) Give TWO reasons why prints were toned.
  - (ii) Name ONE method of toning black and white prints.
  - (iii) Outline the steps in carrying out the method you identified in part (ii).

**4****End of question**

**QUESTION 15 Physics in Medicine****Marks**

- (a) (i) What does the acronym 'NMR' mean? Describe ONE application of NMR in diagnostic medicine. **6**
- (ii) What is the difference between the physical principles of a traditional mercury-based clinical thermometer and a resistance-based thermometer?
- (iii) In the past, sphygmomanometers contained significant amounts of mercury. Why was mercury used in sphygmomanometers, and why do government regulations in many countries now prohibit its use?
- (b) (i) How do Geiger counters and film badges differ in the way they measure exposure to radiation? What advantage might a Geiger counter offer over a film badge when a person is working with equipment that can produce large bursts of ionising radiation? **7**
- (ii) Both  $\alpha$ -particles and X-rays can rapidly alter unexposed film.
- 1 What is ONE characteristic difference between these two types of radiation?
  - 2 Why would X-rays be used rather than  $\alpha$ -particles to detect a partially-fractured bone within a patient's arm?
- (iii) Prior to X-ray examination of the digestive tract, a patient is often fed with a foodstuff containing high quantities of barium. What characteristic of barium makes it useful in such a situation?
- (iv) List FOUR ways in which patients and radiologists can be protected from unnecessary exposure to ionising radiation during diagnostic radiological procedures.

**Question 15 continues on page 42**



## QUESTION 15 (Continued)

Marks

- (c) A wide variety of radioactive isotopes was released into the local environment following the 1986 Chernobyl nuclear disaster. A selection of these isotopes is listed in Table A. 6

TABLE A

Isotope	Half life	Released in 1986 ( $\times 10^{15}$ Bq)	Present in 1996 ( $\times 10^{15}$ Bq)	Decay mechanism	Daughter product	Particle energy (MeV/decay)
$^{131}\text{I}$	8 days	1500	0.0	$\beta$	$^{131}\text{Xe}$	0.38
$^{134}\text{Cs}$	2.1 years	44.5	1.6	$\beta$	$^{134}\text{Ba}$	1.56
$^{239}\text{Pu}$	24 100 years	0.03	0.03	$\alpha$ series	$^{207}\text{Pb}$	0.0001

$^{131}\text{I}$  and  $^{134}\text{Cs}$  undergo simple  $\beta$ -decay.  $^{239}\text{Pu}$  decays to  $^{207}\text{Pb}$  via a succession of  $\alpha$ -decay reactions.

Discuss the relative exposure risks to humans that might be associated with these three isotopes.

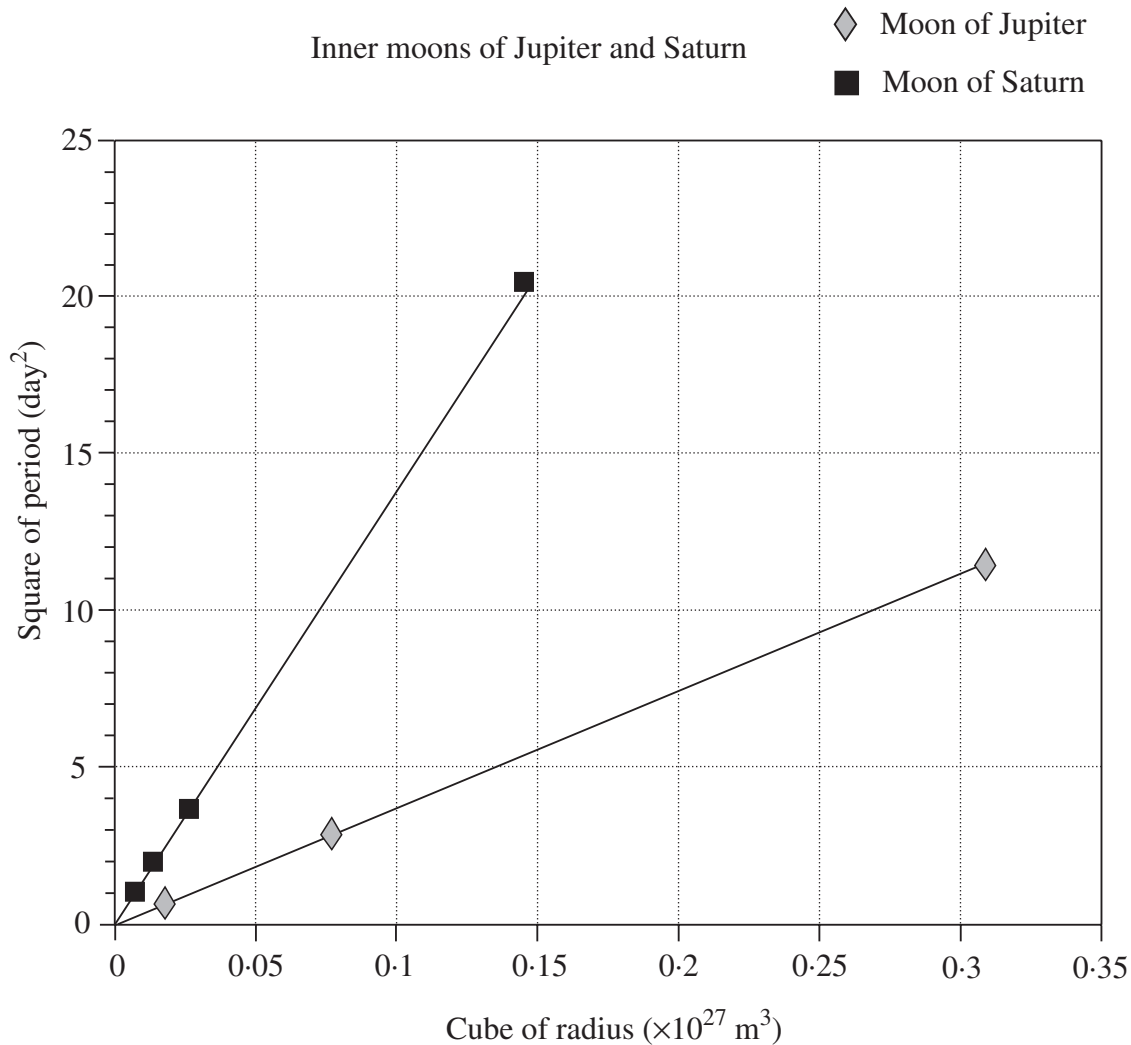
- (d) (i) Optical fibres are commonly used in endoscopy. What phenomenon permits light to be transmitted along the length of glass fibres, even when the fibres are moderately bent? 6
- (ii) Traditional evaluation of vision characteristics by optometrists has involved fitting a patient with a series of different lens types, and the patient determining whether this has improved vision. New technology uses computer-controlled, low-powered lasers, in which the travel path of the laser beam through the eye is accurately determined. How might this provide a more objective evaluation of the vision characteristics of a patient?
- (iii) 1 Define the term *ultrasound*.
- 2 What is the main factor that determines the strength of reflection of ultrasound from different types of body tissues?

**End of question**

## QUESTION 16 Space Science

Marks

- (a) (i) The following graph shows a relationship between the orbital radius and period for a number of inner moons of both Jupiter and Saturn. 7



The straight lines illustrate a particular physical law.

Name that law, and explain why the straight lines have different slopes.

- (ii) Radioactive dating of rocks retrieved from the Moon shows that the oldest ones are about  $4.48 \times 10^9$  years old. There is another piece of evidence which suggests that the age of the solar system is at least  $4.6 \times 10^9$  years. What is that evidence?
- (iii) Describe TWO pieces of knowledge that have been obtained about planetary ring systems from exploration of the outer planets (Jupiter, Saturn, Uranus and Neptune).
- (iv) Describe TWO ways in which the *nature* of the terrestrial planets differs from that of the Jovian (outer) planets.
- (v) Name ONE major element present in the:
- 1 terrestrial planets;
  - 2 Jovian planets.

Question 16 continues on page 45

## QUESTION 16 (Continued)

Marks

- (b) Reusable space vehicles, such as the space shuttle, are considered to be more useful to long range plans for space exploration and development than single-use space vehicles. **3**
- (i) Outline TWO advantages of reusable vehicles over their single-use counterparts.
  - (ii) Explain ONE factor that posed a problem in the development of reusable vehicles.
- (c) (i) Discuss the structure of a modern rocket, such as the Apollo lunar rocket, including the concept of multiple stages. **3**
- (ii) Explain how the reaction motor in this type of rocket involves the principle of rocket propulsion.
- (d) Liquid hydrogen is often used as a fuel for rockets. **2**
- (i) Describe why liquid hydrogen is suitable as a fuel for rockets.
  - (ii) Name ONE disadvantage of liquid hydrogen as a fuel for rockets.
- (e) Biosphere II was an attempt to create a closed, life-sustaining system, like that found on Earth. It failed because of unanticipated problems. **2**
- (i) What is a *closed ecological system*?
  - (ii) Describe TWO problems that would be faced by humans in colonising another planet in our solar system.

**Question 16 continues on page 44**

## QUESTION 16 (Continued)

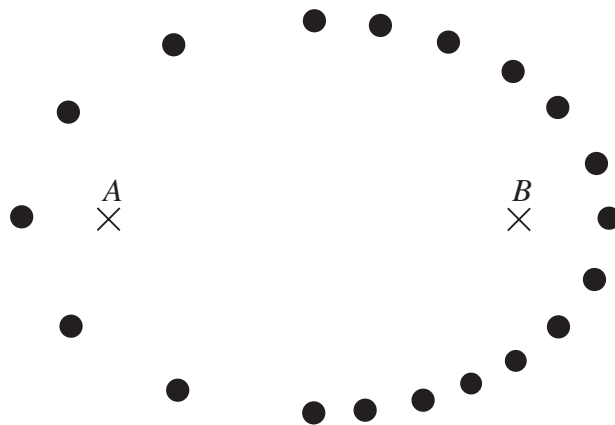
Marks

- (f) It is theoretically possible to put a satellite into an orbit so that it will remain in a fixed position over any point on the Earth's equator. To do this, the satellite must obtain an orbital velocity,  $v$ , given by 4

$$v^2_{\text{orbital}} = G \frac{M_{\text{Earth}}}{R_{\text{Orbit}}}$$

where  $G$  is the universal gravitational constant,  $M_{\text{Earth}}$  is the mass of the Earth and  $R_{\text{orbit}}$  is the radius of the satellite's orbit.

- (i) Determine the height of this satellite above the Earth. Show your working.
- (ii) Why must the point selected for the satellite's position be directly above the equator?
- (g) The diagram shows a comet orbiting a star. The positions were recorded 50 days apart.  $A$  and  $B$  are the foci of the ellipse of the orbit. 2



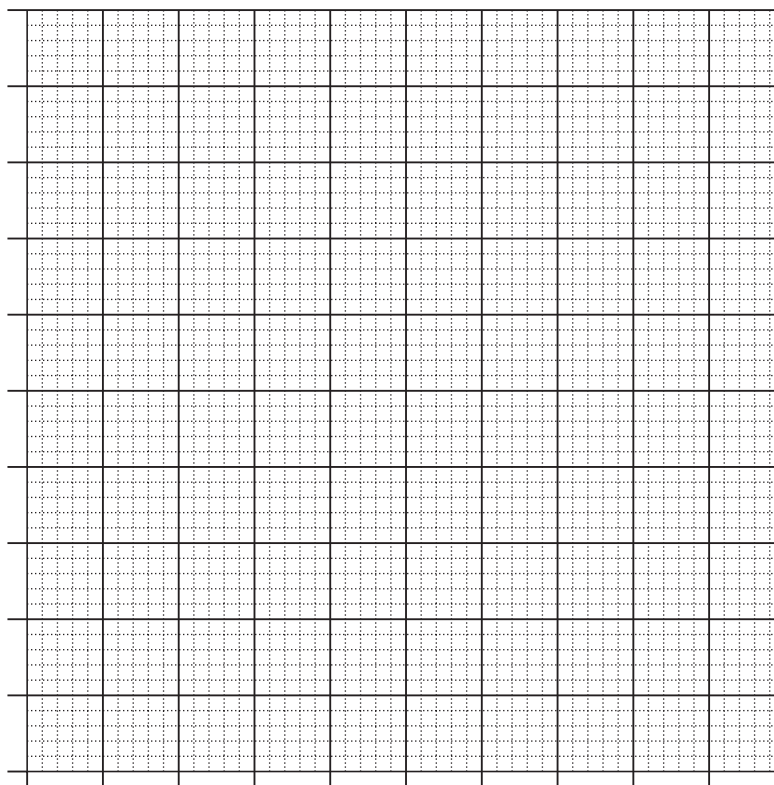
Using Kepler's laws, explain why the star would be located at  $A$  rather than at  $B$ .

- (h) The existence of the TWO outermost planets, Neptune and Pluto, was predicted prior to their discoveries. What was the basis of the predictions? 2

**End of paper**

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**QUESTION 11**

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## SCIENCE 3/4 DATA SHEET

*Values of several numerical constants*

Avogadro's constant, $N_A$	$6.022 \times 10^{23} \text{ mol}^{-1}$	Earth's gravitational acceleration, $g$	$9.8 \text{ m s}^{-2}$
Elementary charge, $e$	$1.602 \times 10^{-19} \text{ C}$	Speed of light, $c$	$3.00 \times 10^8 \text{ m s}^{-1}$
Faraday constant, $F$	$96\,490 \text{ C mol}^{-1}$	Coulomb's constant, $k$	$9.0 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$
Gas constant, $R$	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$	Permeability constant, $\mu_0$	$4\pi \times 10^{-7} \text{ A}^{-2}$
	$0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$	Universal gravitation constant, $G$	$6.7 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Mass of electron, $m_e$	$9.109 \times 10^{-31} \text{ kg}$	Mass of Earth	$6.0 \times 10^{24} \text{ kg}$
Mass of neutron, $m_n$	$1.675 \times 10^{-27} \text{ kg}$	Radius of Earth	6378 km
Mass of proton, $m_p$	$1.673 \times 10^{-27} \text{ kg}$	Planck's constant, $h$	$6.626 \times 10^{-34} \text{ J s}$
Volume of 1 mole ideal gas:		Density of water	$1.00 \times 10^3 \text{ kg m}^{-3}$
at 101.3 kPa (1 atm) and		Specific heat capacity of water	$4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
at 273 K (0°C)	22.41 L	Speed of sound in air	$340 \text{ m s}^{-1}$
at 298 K (25°C)	24.47 L		

*Some standard potentials*

$\text{K}^+ + \text{e}^-$	$\rightleftharpoons$	$\text{K(s)}$	-2.94 V
$\text{Ba}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Ba(s)}$	-2.91 V
$\text{Ca}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Ca(s)}$	-2.87 V
$\text{Na}^+ + \text{e}^-$	$\rightleftharpoons$	$\text{Na(s)}$	-2.71 V
$\text{Mg}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Mg(s)}$	-2.36 V
$\text{Al}^{3+} + 3\text{e}^-$	$\rightleftharpoons$	$\text{Al(s)}$	-1.68 V
$\text{Mn}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Mn(s)}$	-1.18 V
$\text{H}_2\text{O} + \text{e}^-$	$\rightleftharpoons$	$\frac{1}{2}\text{H}_2(\text{g}) + \text{OH}^-$	-0.83 V
$\text{Zn}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Zn(s)}$	-0.76 V
$\text{S(s)} + 2\text{e}^-$	$\rightleftharpoons$	$\text{S}^{2-}$	-0.45 V
$\text{Fe}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Fe(s)}$	-0.44 V
$\text{Ni}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Ni(s)}$	-0.24 V
$\text{Sn}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Sn(s)}$	-0.14 V
$\text{Pb}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Pb(s)}$	-0.13 V
$\text{H}^+ + \text{e}^-$	$\rightleftharpoons$	$\frac{1}{2}\text{H}_2(\text{g})$	0.00 V
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$	$\rightleftharpoons$	$\text{SO}_2(\text{aq}) + 2\text{H}_2\text{O}$	0.16 V
$\text{Cu}^{2+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Cu(s)}$	0.34 V
$\frac{1}{2}\text{O}_2(\text{g}) + \text{H}_2\text{O} + 2\text{e}^-$	$\rightleftharpoons$	$2\text{OH}^-$	0.40 V
$\text{Cu}^+ + \text{e}^-$	$\rightleftharpoons$	$\text{Cu(s)}$	0.52 V
$\frac{1}{2}\text{I}_2(\text{s}) + \text{e}^-$	$\rightleftharpoons$	$\text{I}^-$	0.54 V
$\frac{1}{2}\text{I}_2(\text{aq}) + \text{e}^-$	$\rightleftharpoons$	$\text{I}^-$	0.62 V
$\text{Fe}^{3+} + \text{e}^-$	$\rightleftharpoons$	$\text{Fe}^{2+}$	0.77 V
$\text{Ag}^+ + \text{e}^-$	$\rightleftharpoons$	$\text{Ag(s)}$	0.80 V
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^-$	$\rightleftharpoons$	$\text{NO(g)} + 2\text{H}_2\text{O}$	0.96 V
$\frac{1}{2}\text{Br}_2(\text{l}) + \text{e}^-$	$\rightleftharpoons$	$\text{Br}^-$	1.08 V
$\frac{1}{2}\text{Br}_2(\text{aq}) + \text{e}^-$	$\rightleftharpoons$	$\text{Br}^-$	1.10 V
$\frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^-$	$\rightleftharpoons$	$\text{H}_2\text{O}$	1.23 V
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^-$	$\rightleftharpoons$	$2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	1.36 V
$\frac{1}{2}\text{Cl}_2(\text{g}) + \text{e}^-$	$\rightleftharpoons$	$\text{Cl}^-$	1.36 V
$\frac{1}{2}\text{Cl}_2(\text{aq}) + \text{e}^-$	$\rightleftharpoons$	$\text{Cl}^-$	1.40 V
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^-$	$\rightleftharpoons$	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	1.51 V
$\frac{1}{2}\text{F}_2(\text{g}) + \text{e}^-$	$\rightleftharpoons$	$\text{F}^-$	2.89 V

## PERIODIC TABLE

1		2		KEY																3		4			
H 1.008 Hydrogen		He 4.003 Helium		Atomic Number		Symbol of element		Name of element		Atomic Mass		Name of element		Atomic Number		Symbol of element		Name of element		Atomic Mass		Name of element			
79 Au 197.0 Gold		10 Ne 20.18 Neon		79 Au 197.0 Gold		F 19.00 Fluorine		O 16.00 Oxygen		N 14.01 Nitrogen		C 12.01 Carbon		B 10.81 Boron		5 B 10.81 Boron		6 C 12.01 Carbon		7 N 14.01 Nitrogen		8 O 16.00 Oxygen		9 F 19.00 Fluorine	
11 Na 22.99 Sodium		18 Ar 39.95 Argon		11 Na 22.99 Sodium		17 Cl 35.45 Chlorine		S 32.07 Sulfur		P 30.97 Phosphorus		Si 28.09 Silicon		Al 26.98 Aluminium		13 Al 26.98 Aluminium		14 Si 28.09 Silicon		15 P 30.97 Phosphorus		16 S 32.07 Sulfur		17 Cl 35.45 Chlorine	
19 K 39.10 Potassium		36 Kr 83.80 Krypton		19 K 39.10 Potassium		35 Br 79.90 Bromine		Se 78.96 Selenium		As 74.92 Arsenic		Ge 72.59 Germanium		Ga 69.72 Gallium		30 Zn 65.39 Zinc		31 Ga 69.72 Gallium		32 Ge 72.59 Germanium		33 As 74.92 Arsenic		34 Se 78.96 Selenium	
37 Rb 85.47 Rubidium		54 Xe 131.3 Xenon		37 Rb 85.47 Rubidium		53 I 126.9 Iodine		Te 127.6 Tellurium		Sb 121.8 Antimony		Sn 118.7 Tin		In 114.8 Indium		48 Cd 112.4 Cadmium		49 In 114.8 Indium		50 Sn 118.7 Tin		51 Sb 121.8 Antimony		52 Te 127.6 Tellurium	
55 Cs 132.9 Cesium		86 Rn — Radon		55 Cs 132.9 Cesium		85 At — Astatine		Po — Polonium		Bi 209.0 Bismuth		Pb 207.2 Lead		Tl 204.4 Thallium		80 Hg 200.6 Mercury		81 Tl 204.4 Thallium		82 Pb 207.2 Lead		83 Bi 209.0 Bismuth		84 Po — Polonium	
87 Fr — Francium		89 Ac — Actinium		87 Fr — Francium		89 Ac — Actinium		106 — — —		105 — — —		104 — — —		103 — — —		80 Hg 200.6 Mercury		79 Au 197.0 Gold		78 Pt 195.1 Platinum		77 Ir 192.2 Iridium		76 Os 190.2 Osmium	
20 Ca 40.08 Calcium		38 Sr 87.62 Strontium		20 Ca 40.08 Calcium		47 Ag 107.9 Silver		Cu 63.55 Copper		Ni 58.69 Nickel		Co 58.93 Cobalt		Fe 55.85 Iron		44 Ru 101.1 Ruthenium		45 Rh 102.9 Rhodium		46 Pd 106.4 Palladium		47 Ag 107.9 Silver		48 Cd 112.4 Cadmium	
21 Sc 44.96 Scandium		39 Y 88.91 Yttrium		21 Sc 44.96 Scandium		78 Pt 195.1 Platinum		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		76 Os 190.2 Osmium		77 Ir 192.2 Iridium		78 Pt 195.1 Platinum		79 Au 197.0 Gold		80 Hg 200.6 Mercury	
22 Ti 47.88 Titanium		40 Zr 91.22 Zirconium		22 Ti 47.88 Titanium		79 Au 197.0 Gold		Dy 162.5 Dysprosium		Ho 164.9 Holmium		Er 167.3 Erbium		Tm 168.9 Thulium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
23 V 50.94 Vanadium		41 Nb 92.91 Niobium		23 V 50.94 Vanadium		79 Au 197.0 Gold		Ho 164.9 Holmium		Er 167.3 Erbium		Fm — Fermium		Md — Mendelevium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
24 Cr 52.00 Chromium		42 Mo 95.94 Molybdenum		24 Cr 52.00 Chromium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
25 Mn 54.94 Manganese		43 Tc 98.91 Technetium		25 Mn 54.94 Manganese		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
26 Fe 55.85 Iron		44 Ru 101.1 Ruthenium		26 Fe 55.85 Iron		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
27 Co 58.93 Cobalt		45 Rh 102.9 Rhodium		27 Co 58.93 Cobalt		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
28 Ni 58.69 Nickel		46 Pd 106.4 Palladium		28 Ni 58.69 Nickel		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
29 Cu 63.55 Copper		47 Ag 107.9 Silver		29 Cu 63.55 Copper		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
30 Zn 65.39 Zinc		48 Cd 112.4 Cadmium		30 Zn 65.39 Zinc		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
31 Ga 69.72 Gallium		49 In 114.8 Indium		31 Ga 69.72 Gallium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
32 Ge 72.59 Germanium		50 Sn 118.7 Tin		32 Ge 72.59 Germanium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
33 As 74.92 Arsenic		51 Sb 121.8 Antimony		33 As 74.92 Arsenic		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
34 Se 78.96 Selenium		52 Te 127.6 Tellurium		34 Se 78.96 Selenium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
35 Br 79.90 Bromine		53 I 126.9 Iodine		35 Br 79.90 Bromine		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
36 Kr 83.80 Krypton		54 Xe 131.3 Xenon		36 Kr 83.80 Krypton		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
37 Rb 85.47 Rubidium		55 Cs 132.9 Cesium		37 Rb 85.47 Rubidium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
38 Sr 87.62 Strontium		56 Ba 137.3 Barium		38 Sr 87.62 Strontium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
39 Y 88.91 Yttrium		57 La 138.9 Lanthanum		39 Y 88.91 Yttrium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
40 Zr 91.22 Zirconium		58 Ce 140.1 Cerium		40 Zr 91.22 Zirconium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
41 Nb 92.91 Niobium		59 Pr 140.9 Praseodymium		41 Nb 92.91 Niobium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
42 Mo 95.94 Molybdenum		60 Nd 144.2 Neodymium		42 Mo 95.94 Molybdenum		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
43 Tc 98.91 Technetium		61 Pm — Promethium		43 Tc 98.91 Technetium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
44 Ru 101.1 Ruthenium		62 Sm 150.4 Samarium		44 Ru 101.1 Ruthenium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
45 Rh 102.9 Rhodium		63 Eu 152.0 Europium		45 Rh 102.9 Rhodium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
46 Pd 106.4 Palladium		64 Gd 157.3 Gadolinium		46 Pd 106.4 Palladium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
47 Ag 107.9 Silver		65 Tb 158.9 Terbium		47 Ag 107.9 Silver		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
48 Cd 112.4 Cadmium		66 Dy 162.5 Dysprosium		48 Cd 112.4 Cadmium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
49 In 114.8 Indium		67 Ho 164.9 Holmium		49 In 114.8 Indium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
50 Sn 118.7 Tin		68 Er 167.3 Erbium		50 Sn 118.7 Tin		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
51 Sb 121.8 Antimony		69 Tm 168.9 Thulium		51 Sb 121.8 Antimony		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 168.9 Thulium		70 Yb 173.0 Ytterbium	
52 Te 127.6 Tellurium		70 Yb 173.0 Ytterbium		52 Te 127.6 Tellurium		79 Au 197.0 Gold		Tb 158.9 Terbium		Gd 157.3 Gadolinium		Eu 152.0 Europium		Sm 150.4 Samarium		66 Dy 162.5 Dysprosium		67 Ho 164.9 Holmium		68 Er 167.3 Erbium		69 Tm 			





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**SECTION II ANSWER BOOK**

**DIRECTIONS TO CANDIDATES**

- Write your Student Number and Centre Number at the top right-hand corner of this page.
- You should receive this Answer Book with an Answer Sheet for Section I, a Section III Answer Book, and a Section IV Answer Book.
- Answer Questions 11 to 20 in this Answer Book.
- Each question is worth 3 marks.

**MARKER'S USE ONLY**

Marker	Total	Checked

Questions 11 to 20 are worth 3 marks each.  
Answer the questions in the spaces provided.

MARKER'S  
USE ONLY

- 11** (a) (i) .....  
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- (ii) .....  
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.....
- (b) .....  
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MARKER'S  
USE ONLY

**12** (a) .....

(b) .....

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(c) .....

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**13** (a) .....

(b) (i) .....

(ii) .....

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**14** .....

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MARKER'S  
USE ONLY

**15** (a) .....  
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(b) .....  
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**16** (a) .....  
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(b) .....  
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**17** (a) .....  
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(b) .....  
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MARKER'S  
USE ONLY

**18** (a) .....

(b) .....

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**19** (a) .....

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(b) (i) .....

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(ii) .....

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MARKER'S  
USE ONLY

**20** (a) Type 1: Name – .....

Purpose – .....

Type 2: Name – .....

Purpose – .....

(b) (i) .....

.....

.....

(ii) .....

.....

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SECTION III ANSWER BOOK

**DIRECTIONS TO CANDIDATES**

- Write your Student Number and Centre Number at the top right-hand corner of this page.
- You should receive this Answer Book with an Answer Sheet for Section I, a Section II Answer Book, and a Section IV Answer Book.
- Answer Questions 21 to 28 in this Answer Book.
- Each question is worth 5 marks.

**MARKER'S USE ONLY**

Marker	Total	Checked

Questions 21 to 28 are worth 5 marks each.  
Answer the questions in the spaces provided.

MARKER'S  
USE ONLY

- 21** (a) .....  
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- (b) .....  
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- (c) .....  
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- (d) .....  
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- (e) .....  
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22 (a)

<i>Metal</i>	<i>Solution of the chloride of X (XCl)</i>	<i>Solution of the chloride of Y (YCl<sub>2</sub>)</i>	<i>Solution of the chloride of Z (ZCl<sub>3</sub>)</i>
<i>X</i>			
<i>Y</i>			
<i>Z</i>			

(b) .....

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(c) .....

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23

<i>Formula of carbon compound</i>	<i>Name of carbon compound</i>	<i>Use or function of carbon compound</i>
$C_6H_{12}O_6$		
		Component of vinegar
$C_2H_2$		
$CH_3(CH_2)_6CH_3$		
	Ethanol	

MARKER'S  
USE ONLY

**24** (a) .....  
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(b) .....  
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(c) (i) .....  
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(ii) .....  
.....  
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MARKER'S  
USE ONLY

- 25 (a) .....
- .....
- .....
- .....
- .....
- .....
- (b) .....
- .....
- .....
- (c) .....
- .....
- .....
- .....
- (d) .....
- .....
- .....

MARKER'S  
USE ONLY

- 26** (a) .....  
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- (b) .....  
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- (c) .....  
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- (d) .....  
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- (e) .....  
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**Please turn over**

MARKER'S  
USE ONLY

- 27** (a) .....
- .....
- (b) .....
- .....
- .....
- .....
- .....
- (c) .....
- .....
- .....
- .....
- .....

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- 28** (a) (i) .....
- (ii) .....
- (iii) .....
- .....
- .....
- .....
- (b) (i) .....
- .....
- (ii) .....
- .....
- .....
- .....





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**SECTION IV ANSWER BOOK**

**DIRECTIONS TO CANDIDATES**

- Write your Student Number and Centre Number at the top right-hand corner of this page.
- You should receive this Answer Book with an Answer Sheet for Section I, a Section II Answer Book, and a Section III Answer Book.
- Answer Questions 29 and 30 in this Answer Book.
- Each question is worth 10 marks.

**MARKER'S USE ONLY**

Marker	Total	Checked

Questions 29 and 30 are worth 10 marks each.  
 Answer the questions in the spaces provided.

MARKER'S  
 USE ONLY

29 (a) .....

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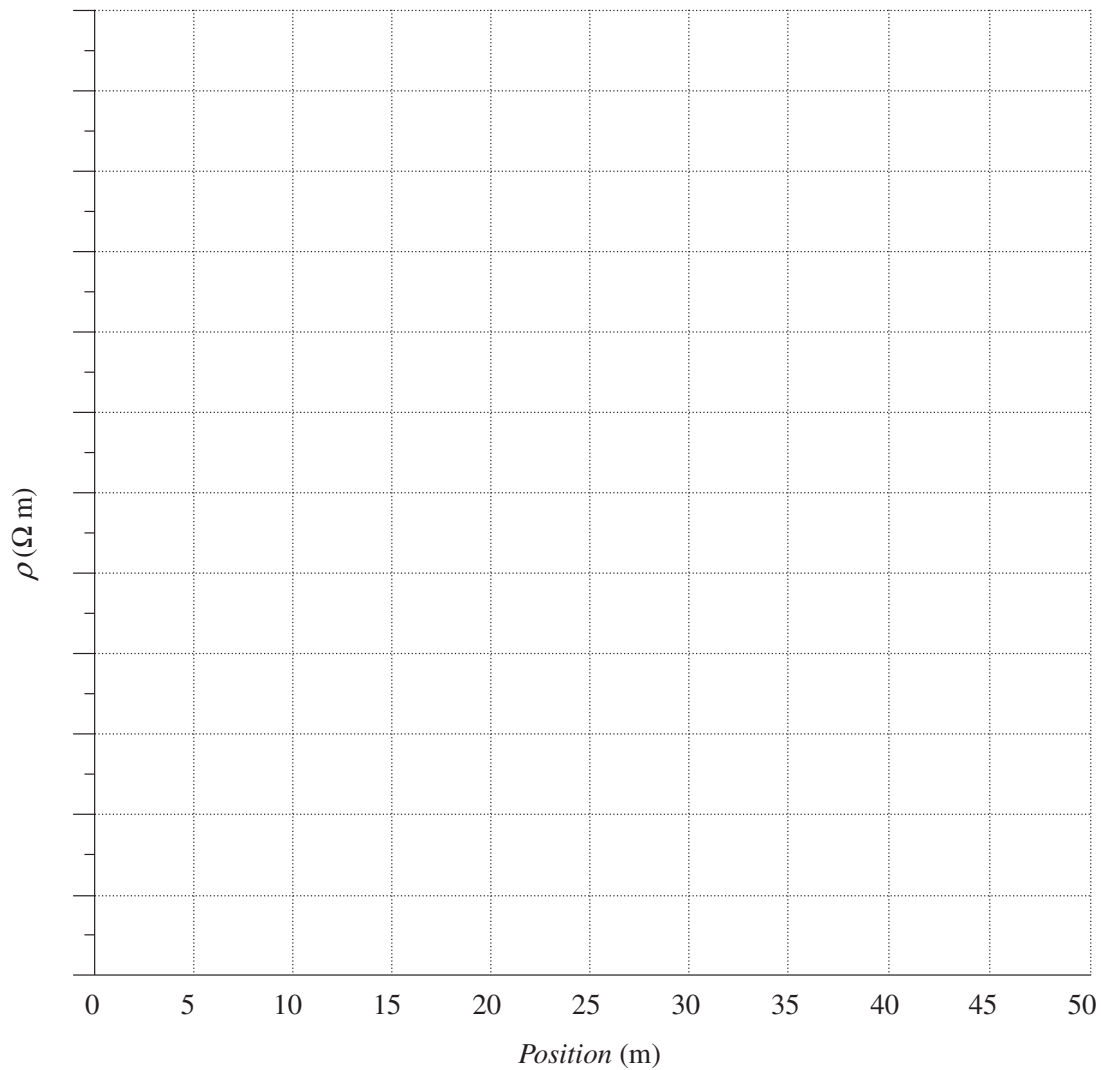
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(b) (i)

Position m	0	5	10	15	20	25	30	35	40	45	50
$V$ mV	10.6	10.6	10.6	7.07	9.84	2.86	3.01	3.16	2.70	2.70	2.70
$\rho$ $\Omega$ m											

(ii)



QUESTION 29 (Continued)

MARKER'S  
USE ONLY

(b) (iii) .....

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(iv) .....

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**Please turn over**

- 30** (a) (i) .....
- (ii) .....
- (b) .....
- .....
- .....
- .....
- (c) .....
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- .....
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- (d) .....
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- (e) .....
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- .....
- (f) .....
- .....
- .....
- (g) .....
- .....
- .....