BOARD OF STUDIES

NEW SOUTH WALES

HIGHER SCHOOL CERTIFICATE EXAMINATION

2000

SCIENCE

3/4 UNIT

PAPER 1—CORE

Time allowed—Three hours
(Plus 5 minutes reading time)

DIRECTIONS TO CANDIDATES

- Attempt ALL questions.
- **Section I** 10 multiple-choice questions, each worth 1 mark. Complete your answers in either blue or black pen on the Answer Sheet provided.
- **Section II** 10 questions, each worth 3 marks. Answer this Section in the Section II Answer Book.
- **Section III** 8 questions, each worth 5 marks. Answer this Section in the Section III Answer Book.
- **Section IV** 2 questions, each worth 10 marks. Answer this Section in the Section IV Answer Book.
- You may keep this Question Book. Anything written in the Question Book will NOT be marked.
- 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.

SECTION I

Attempt ALL questions.

Questions 1–10 are worth 1 mark each.

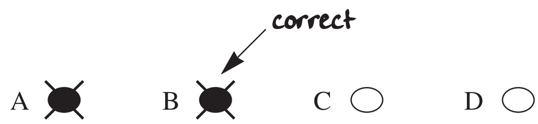
Instructions for answering multiple-choice questions

- Complete your answers in either blue or black pen.
- Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

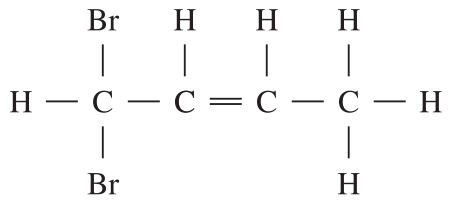
If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.



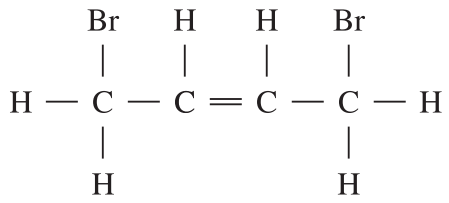
1 The IUPAC name for a carbon compound is 1,4-dibromobut-2-ene.

Which one of the following represents the correct structural formula of this compound?

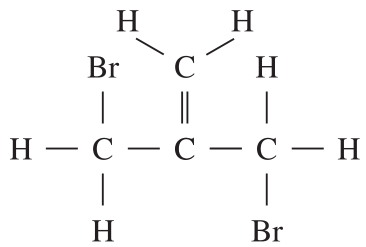
(A)



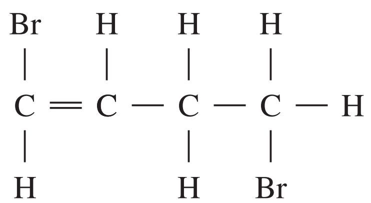
(B)



(C)



(D)



2 Barium chloride reacts with aluminium sulfate in solution to produce insoluble barium sulfate. What is the maximum amount of barium sulfate that can be produced from 28·0 g of aluminium sulfate?

(A) 172 g

(B) 115 g

(C) 61·0 g

(D) 57·3 g

3 Element *X* can combine with either element *Y* or element *Z*. Some properties of the compounds formed by element *X* are listed in the table.

Property	*Compound formed from element X and element Y*	*Compound formed from element X and element Z*
Melting point (°C)	801	–114
Boiling point (°C)	1465	–85
Solubility in water (g/100 g)	36·0	70
Conductivity of solution	High	High
Conductivity of melt	High	Low

Which of the following is most likely to be element *X*?

(A) Calcium

(B) Carbon

(C) Chlorine

(D) Chromium

4 A gaseous oxide of chlorine is used commercially as an agent for bleaching and maturing flour. Analysis has shown that this agent contains 47·4% oxygen and 52·6% chlorine. A 100 mL sample has a mass of 0·300 g at 101·3 kPa and 273 K. Which is the correct molecular formula for the compound?

(A) ClO_2

(B) ClO

(C) Cl_2O_4

(D) Cl_2O

5 During active exercise, pyruvate is converted to lactate in muscle tissue.

Pyruvate Lactate

Which of the following statements about the conversion of pyruvate into lactate is correct?

(A) It is not an oxidation-reduction process because it does not involve the transfer of electrons.

(B) It is not an oxidation-reduction process because it does not involve oxygen.

(C) It is an oxidation-reduction process in which lactate is produced as a result of the oxidation of pyruvate.

(D) It is an oxidation-reduction process in which pyruvate is reduced to lactate.

6 In a region where the acceleration due to gravity is 9·7 m s^{-2}, a hoist is used to lift a load of 1200 kg vertically through a height of 25 m. The total work done by the hoist in raising the load is $3{\cdot}23 \times 10^5$ J. What is the change in potential energy of the load?

(A) $2{\cdot}91 \times 10^5$ J

(B) $2{\cdot}94 \times 10^5$ J

(C) $3{\cdot}00 \times 10^5$ J

(D) $3{\cdot}23 \times 10^5$ J

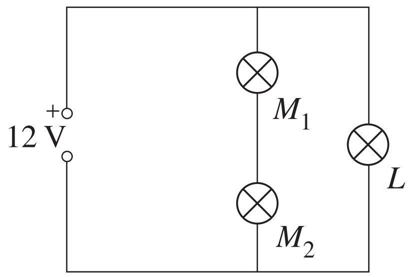
7 Three car light bulbs have the following specifications:

Bulb type	*Operating voltage*	*Operating resistance*
L	6·0 V	3·0 ohms
M_1	6·0 V	6·0 ohms
M_2	6·0 V	6·0 ohms

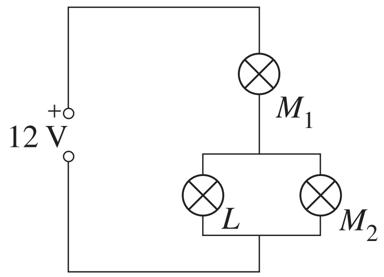
The bulbs are to be used in a circuit in a car with a 12 V supply.

Which circuit will function correctly?

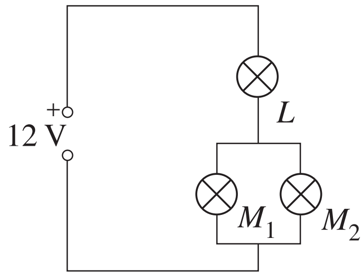
(A)



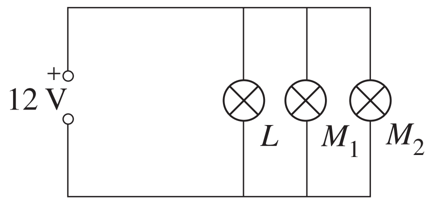
(B)



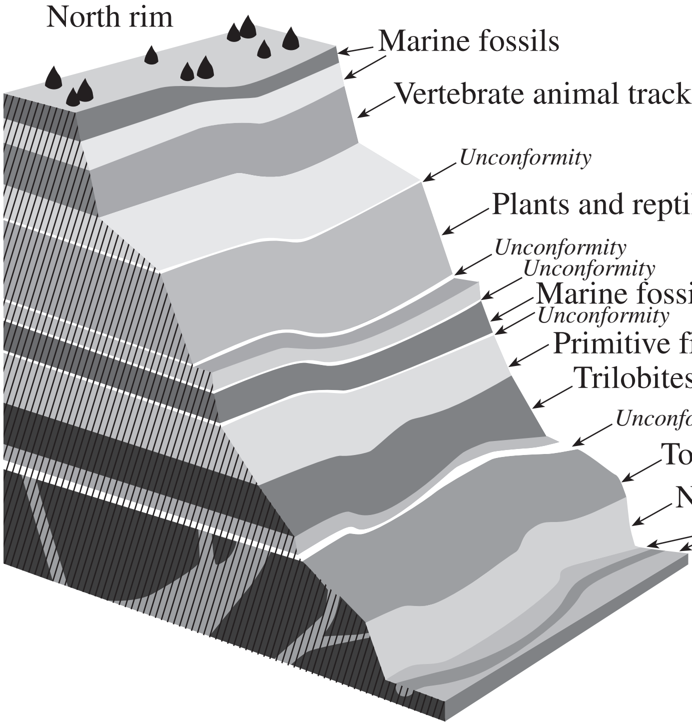
(C)



(D)



8 The diagram shows the sedimentary layers exposed along the North Rim of the Grand Canyon of the Colorado River in Arizona. Unconformities and some key fossil types are indicated.



Which of the following statements is a correct interpretation of the diagram?

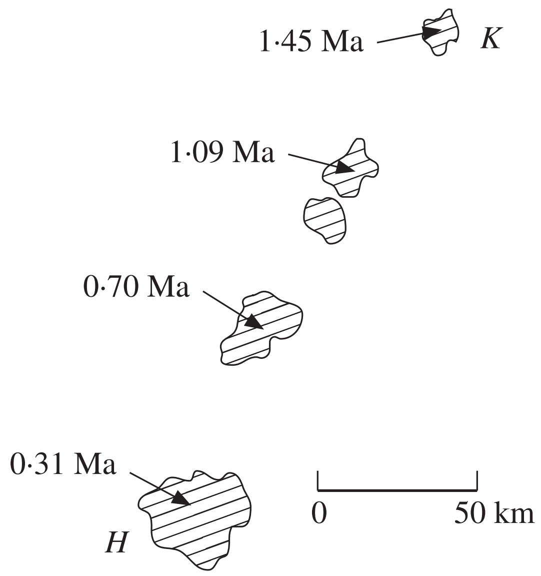
(A) Trilobites and primitive fish existed on Earth at the same time.

(B) The youngest layers were deposited in a marine environment.

(C) The plant fossils are older than the primitive fish bones.

(D) Trilobites are the youngest fossils indicated.

9 The diagram indicates the position of a chain of basaltic volcanic islands. Some lavas have been radiometrically dated as indicated.



What is the best description of the movement of the oceanic plate relative to the underlying hot spot?

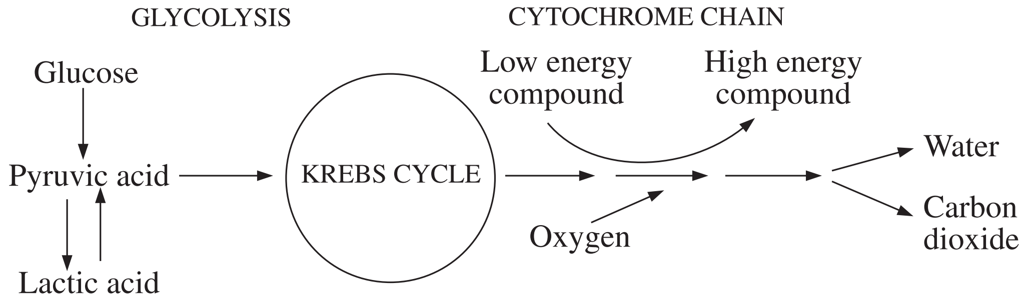
(A) 15 cm per year from *H* towards *K*

(B) 1·5 cm per year from *H* towards *K*

(C) 15 cm per year from *K* towards *H*

(D) 1·5 cm per year from *K* towards *H*

10 The diagram is an overview of a sequence of metabolic pathways in living cells.



What is the major purpose of the reactions in this sequence?

(A) To release energy

(B) To produce lactic acid

(C) To burn excess glucose in the diet

(D) To produce water for other metabolic processes

SECTION II

Attempt ALL questions.

Questions 11–20 are worth 3 marks each.

Answer these questions in the Section II Answer Book.

Show all necessary working in questions involving calculations.

Marks may be awarded for relevant working.

11 (a) Describe the structure of:

(i) solid sodium chloride;

(ii) liquid water.

(b) Explain, with the aid of a diagram, how water is able to dissolve sodium chloride.

12 Ammonia gas can be prepared in the laboratory by heating a paste of ammonium chloride and calcium hydroxide. Other products of this reaction are water and calcium chloride.

A student reacted 1·48 g of calcium hydroxide with excess ammonium chloride.

(a) Write a balanced equation for this reaction.

(b) What volume of ammonia gas would be produced at 298 K and 101·3 kPa?

(c) How many molecules of water were produced in this reaction?

13 A blast furnace uses iron ore (mainly the oxide of iron, Fe_2O_3) and coke (mainly carbon) to produce iron. Two of the oxidation-reduction reactions in the blast furnace are:

$$2C(s) + O_2(g) \rightarrow 2CO(g) \qquad \text{Reaction 1}$$

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g) \qquad \text{Reaction 2}$$

(a) Write a half equation to describe the change that has occurred to iron in Reaction 2.

(b) In terms of oxidation–reduction, what happens to:

(i) the carbon in Reaction 1;

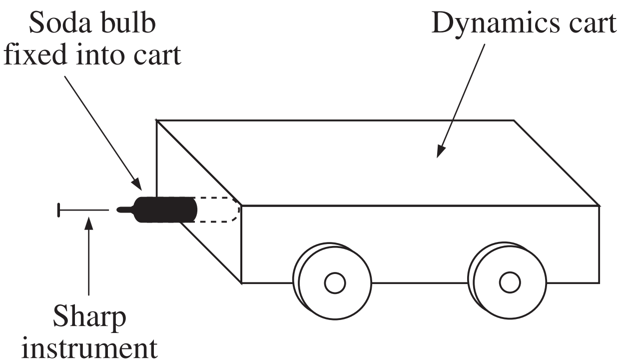
(ii) the oxygen in Reaction 2?

14 A method used commercially to peel potatoes involves soaking them in a solution of NaOH to break down the skin. The potatoes are then removed from the solution and the skin is sprayed off. The solution is regularly checked by titration with H_2SO_4 and is replaced if needed. The concentration of NaOH in the solution must be in the range 3–6 mol L^{-1}.

In one analysis, 45·7 mL of 0·500 mol L^{-1} H_2SO_4 is required to neutralise a 20·0 mL sample of the NaOH solution. Should the solution of NaOH be replaced? Justify your answer.

15 A student wanted to determine the average exhaust velocity for the carbon dioxide gas released from a 'soda bulb' (as used in charging soda siphons). He firmly fixed a soda bulb into the back of a dynamics cart. Using a sharp instrument, he punctured the end of the bulb, causing the cart and bulb to move off in a straight line.

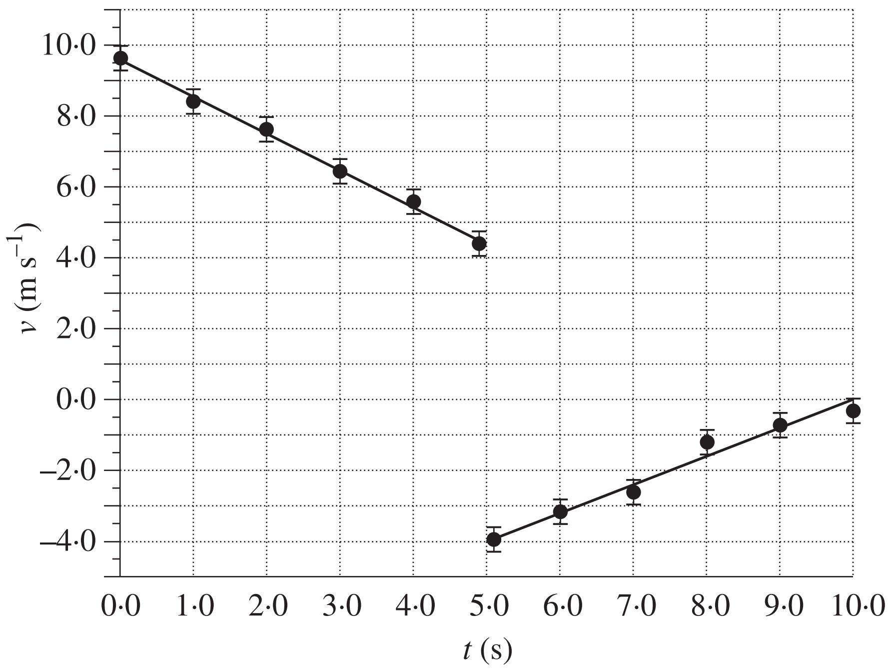
Mass of cart		=	400 g
Mass of bulb	undischarged	=	21·3 g
	discharged	=	20·0 g



(a) Without using the concept of force, explain why the cart moves when the bulb is punctured.

(b) If the cart/bulb was measured to move off at 50·0 cm s^{-1}, determine the exhaust velocity of the carbon dioxide gas. Assume that friction effects can be ignored and that the gas is discharged instantaneously.

16 The graph shows the variation of velocity with time for a soft ball of mass 0·25 kg. The ball is rolling on a horizontal surface in the vicinity of a wall.



(a) Describe the motion of the ball over the 10 second interval shown on the graph.

(b) Calculate the change in momentum of the ball at $t = 5{\cdot}0$ s.

17 A 240 V, 100 W incandescent light bulb has a tungsten filament that operates normally at a temperature of about 3200 K, thereby emitting light of an acceptably white colour. The room-temperature resistance of the filament is measured and is found to be 38·5 Ω.

(a) Calculate the resistance of the tungsten filament when the lamp is operating normally.

(b) Calculate the ratio of the current flowing at the instant when the lamp is switched on, to the current flowing when the bulb is operating normally.

18 In a stratigraphic column (Figure 1), rock layers ① to ④ contain the various index fossils indicated in Table *X*. Layers ① and ④ were also dated using the ^{40}K–^{40}Ar method. The dates, *P* and *Q,* determined by this method are indicated in Table *Y*.

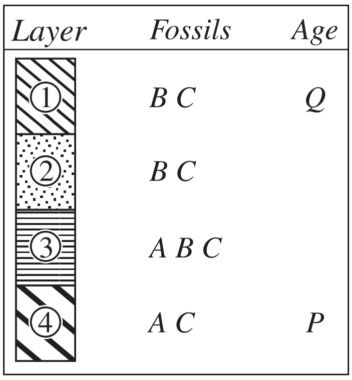


FIG. 1

TABLE *X*

Fossil	*Age range* (Ma)
A	392–375
B	384–362
C	381–356

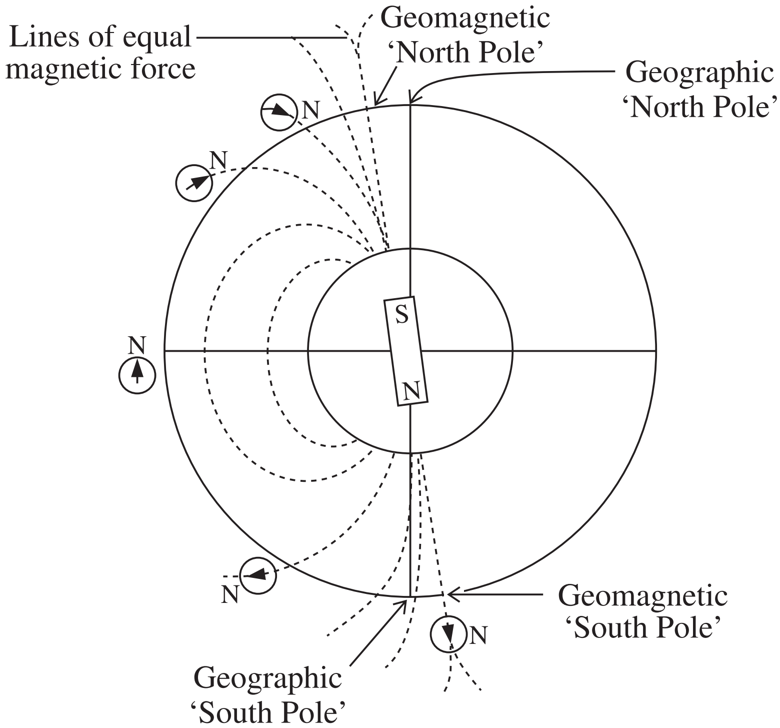
TABLE *Y*

^{40}K–^{40}Ar *dating*	*Age range* (Ma)
P	380–388
Q	356–364

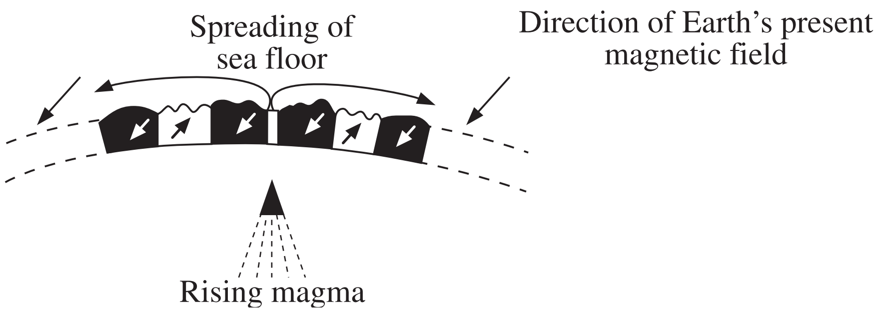
(a) What is the age difference between layers ① and ④?

(b) State TWO important characteristics that a fossil must have in order to be useful as an index fossil.

19 The present-day polarity of the Earth's magnetic field is due to the Earth's iron core acting like a bar magnet.



The following diagram shows a cross-section of part of the sea floor.



(a) Describe how variations in the Earth's magnetic field can be preserved in sea-floor rocks.

(b) Explain why the arrows shown on the segments of sea floor:

(i) point in opposite directions;

(ii) remain at the same angle.

20 There are two types of cell division in animal and plant cells.

(a) Name each type of cell division, and state ONE of its major purposes.

(b) Compare each type of cell division in regard to:

(i) number of cells produced;

(ii) genetic composition of cells produced.

SECTION III

Attempt ALL questions.

Questions 21–28 are worth 5 marks each.

Answer these questions in the Section III Answer Book.

Show all necessary working in questions involving calculations.

Marks may be awarded for relevant working.

21 The work of chemists involves discovering and identifying new compounds. Identifying the structure of a new compound includes the determination of the empirical formula and then the molecular formula.

(a) What is the empirical formula of a compound?

(b) How does the molecular formula of a compound differ from the empirical formula?

(c) What information must be determined before the molecular formula can be deduced from the empirical formula of a compound?

(d) The formula for sodium chloride is usually given as NaCl. What type of formula is this? Explain why it is used.

(e) Calculate the percentage, by mass, of sodium in sodium chloride.

22 A student investigated the reactions of three metals, *X* (the most reactive of the metals), *Y,* and *Z* (the least reactive metal of the three). The student placed pieces of the metals in various test tubes, each containing a solution of the chloride of one of the three metals. The student prepared a table to record the results of the experiment. The table is shown in your Section III Answer Book.

(a) Complete the table in your Section III Answer Book by indicating whether a reaction occurs between each of the metals and each of the solutions. In the spaces provided, write *R* if a reaction occurs and *NR* if no reaction occurs.

(b) In the table there is one reaction in which *Y* is oxidised. Write ionic equations to describe the oxidation and reduction half-reactions, and also the complete reaction.

(c) In the table there is one reaction in which *Y* is reduced. Write ionic equations to describe the oxidation and reduction half-reactions, and also the complete reaction.

23 Many carbon compounds have widespread importance to people. Complete the table in your Section III Answer Book.

24 (a) Why does a thin stream of water bend towards a charged plastic rod whereas a thin stream of liquid hexane does not?

(b) The average ratio of Na to Si (Na : Si) dissolved in seawater and in crustal rocks is as follows:

	Na : Si
Seawater	293·6 : 1
Crustal rocks	0·134 : 1

If the salt content of the oceans is mainly derived from the weathering of rocks, explain the difference in the Na:Si ratios for seawater and crustal rocks.

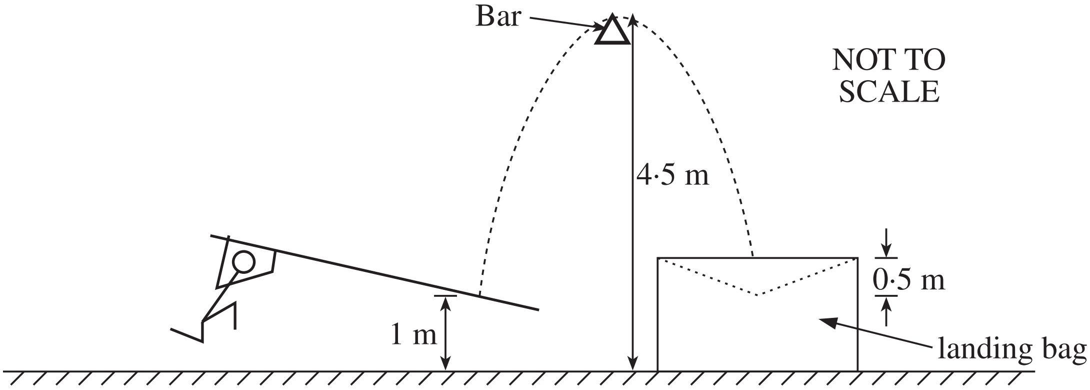
(c) Chemicals that are used as explosives tend to be solids or liquids that decompose rapidly to form gaseous products. The decomposition of nitroglycerin is shown in the equation:

$$4C_3H_5N_3O_9(l) \rightarrow 6N_2(g) + 12CO_2(g) + 10H_2O(g) + O_2(g).$$

(i) Name the type of bond within the molecules of the reactant, and describe how this type of bond forms.

(ii) Compare the relative strengths of the intermolecular bonds of the reactant and the products. Justify your answer.

25 A pole vaulter of mass 85 kg intends to clear a bar at a height of 4·5 m. The athlete's mass is centred at a point 1·0 m above the ground at the start of the jump, and follows the dotted path shown.



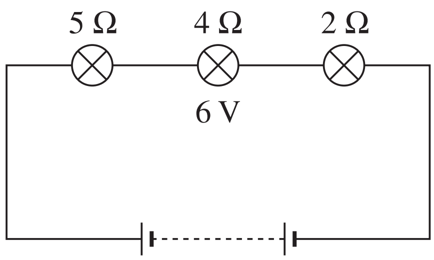
(a) If the fibreglass pole is 80% efficient at transferring the energy stored while it flexes, calculate the minimum velocity the vaulter needs to acquire on the runway to clear the bar.

(b) If the run-up lasts for 5·3 s, what is the power output of the athlete?

(c) What average force is exerted by the landing bag if it is 1·5 m high and deforms by 0·5 m when the athlete lands?

(d) If all masses, and therefore all athletes, fall with the same acceleration and have the same speed at impact, why does the landing bag deform more for heavier vaulters?

26 The diagram shows an electrical circuit containing three lamps connected to a battery. The lamps are of varying resistance, and there is a measured potential difference of 6 volts across the 4 Ω lamp.



Calculate:

(a) the current in each lamp;

(b) the current through the battery;

(c) the amount of electrical charge that moves through the 2 Ω lamp in 3 minutes;

(d) the energy dissipated in the 2 Ω lamp in 3 minutes;

(e) the potential difference between the battery terminals.

27 A study of the site of an abandoned copper mine revealed that, after ten years, it had become naturally colonised by grasses.

The table shows results from an experiment comparing germination of seed collected from the mine site (contaminated soil) and from the adjoining pasture (uncontaminated soil).

	Successful germination in mine-site soil	*Successful germination in pasture soil*
Seed collected from mine site	90%	99%
Seed collected from pasture	0·014%	99%

(a) What principle is illustrated by these experimental observations?

(b) How was it possible for the mine site to be naturally colonised by grasses?

(c) It was decided to restore the old mine site by removing the contaminated soil and replacing it with uncontaminated soil. Using the table, predict what effect this could have on the type of vegetation that would colonise the site.

28 (a) Photosynthesis is a process that results in the formation of sugar. It involves two sets of reactions, the light stage and the carbon fixation stage.

(i) In what form does energy enter this process?

(ii) In which organelle do photosynthetic reactions occur?

(iii) Briefly outline the events of each of the two stages.

(b) In animal and plant cells, protein synthesis depends on activities within the nucleus, even though the reactions of protein synthesis take place in the cytoplasm.

(i) What is the role of the nucleus in protein synthesis?

(ii) How does this role allow the nucleus to control cell differentiation?

SECTION IV

Attempt ALL questions.

Questions 29 and 30 are worth 10 marks each.

Answer these questions in the Section IV Answer Book.

Show all necessary working in questions involving calculations.

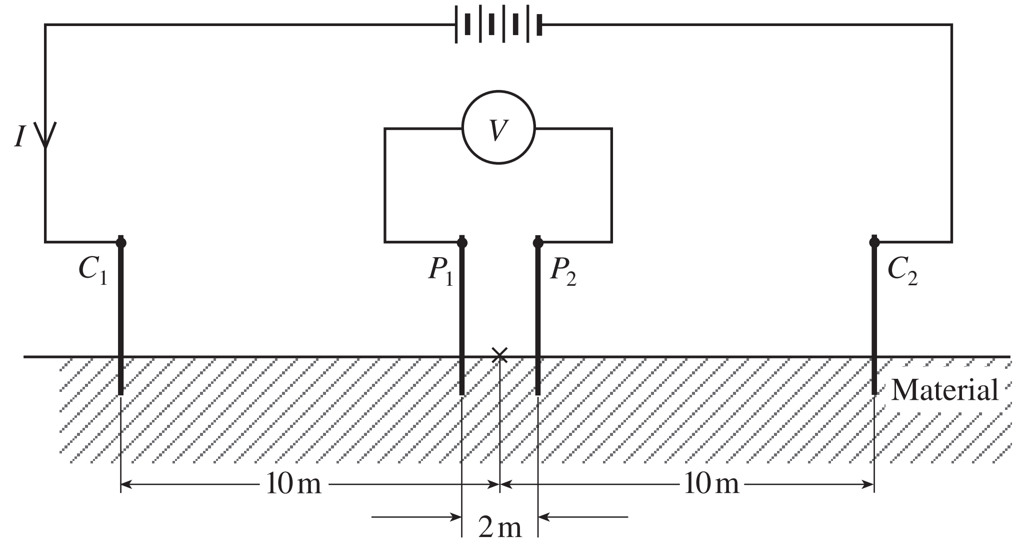
Marks may be awarded for relevant working.

29 (a) *Resistivity* is a characteristic electrical property of a material. It is usually denoted by the symbol ρ and it has the units of *ohm metres* (Ω m). A sample of material of length l and cross-sectional area A has a resistance R (in ohms) given by

$$R = \frac{\rho l}{A}\ .$$

A particular sample of soil is known to have a resistivity of 120 Ω m. The sample is cylindrical in shape, with a length of 48 cm and a diameter of 6·0 cm. Calculate the resistance of the sample.

(b) One method of geophysical mapping is the *electrical resistivity* method. One arrangement for doing this is shown in the diagram. Four electrodes, C_1, C_2, P_1 and P_2, are inserted into the earth material (soil, sediment or rock). A current I is passed between C_1 and C_2, and the electrical potential difference V is measured between P_1 and P_2.



The position at which the resistivity is measured is taken as the point midway between P_1 and P_2. The whole arrangement is moved to take measurements at different positions.

QUESTION 29 (Continued)

The resistivity is given by

$$\rho = K\frac{V}{I}$$

where K is a factor that takes into account the way the current spreads out in the underlying material.

An electrical-resistivity survey was carried out in an area where there was a suspected change in earth material. The parameters were: I = 15 mA and K = 155·5 m. The measured values of V at various positions, along a straight line, are given in the table.

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

(i) Complete the table in your Section IV Answer Book to show the value of ρ at each position.

(ii) On the grid supplied in your Section IV Answer Book, plot a graph of ρ versus position.

(iii) Use the graph you plotted in part (ii) to determine the likely position of the boundary between the two types of material. Justify your choice.

(iv) Use the following table to determine the likely composition of the material on each side of the boundary. Justify your answer.

Material	*Resistivity range* (Ω m)
Sandy soil with clay	60 – 100
Clayey-sand soil	30 – 60
Clay	10 – 50
Weathered biotite granite	50 – 100
Weathered granite (low biotite)	50 – 140
Fresh granite	750 – 8000

30 The shores of river estuaries are frequently composed of muddy sediments that are high in organic matter. These sediments are low in oxygen because they consist of fine particles that compact easily and are mostly under water. The combination of these factors creates reducing conditions. However, at low tide, oxygen penetrates the upper layers creating oxidising conditions. A number of important oxidation–reduction reactions occurs in the sediments.

SOME OXIDATION-REDUCTION PAIRS FOR REACTIONS OCCURRING IN ESTUARINE SEDIMENTS

S^{2-}	$\rightleftharpoons$	SO_4^{2-}
CH_4	$\rightleftharpoons$	CO_2
Fe^{2+}	$\rightleftharpoons$	Fe^{3+}
Mn^{2+}	$\rightleftharpoons$	Mn^{4+}
N_2	$\rightleftharpoons$	NO_3^-
H_2O	$\rightleftharpoons$	O_2

(a) Give the formula for a compound of iron that you would expect to find in:

(i) upper layers of the sediments at low tide;

(ii) lower layers of the sediments.

(b) Mangroves are trees that have adapted to live in tidal sediments. Even though they can grow to over 10 m tall, mangroves do not have deep roots but create a mat of surface roots. Suggest a reason for this adaptation and its possible advantage to the plants.

(c) In an analysis of lower-layer muddy sediment, methane liberated from 100 g of the mud was combusted to yield 0·06 g of CO_2. Calculate the mass of methane that was present in the original sample.

A sediment core has been collected from an area in which mangroves grow. Diagram *A* shows the stratigraphy of the core, the proportion of the radiogenic isotope ^{14}C at various locations down the core, the main species of Foraminifera (a small carbonate-shelled organism) found in each sediment layer, and its principal habitat. Diagram *B* shows a time-decay curve for ^{14}C.

QUESTION 30 (Continued)

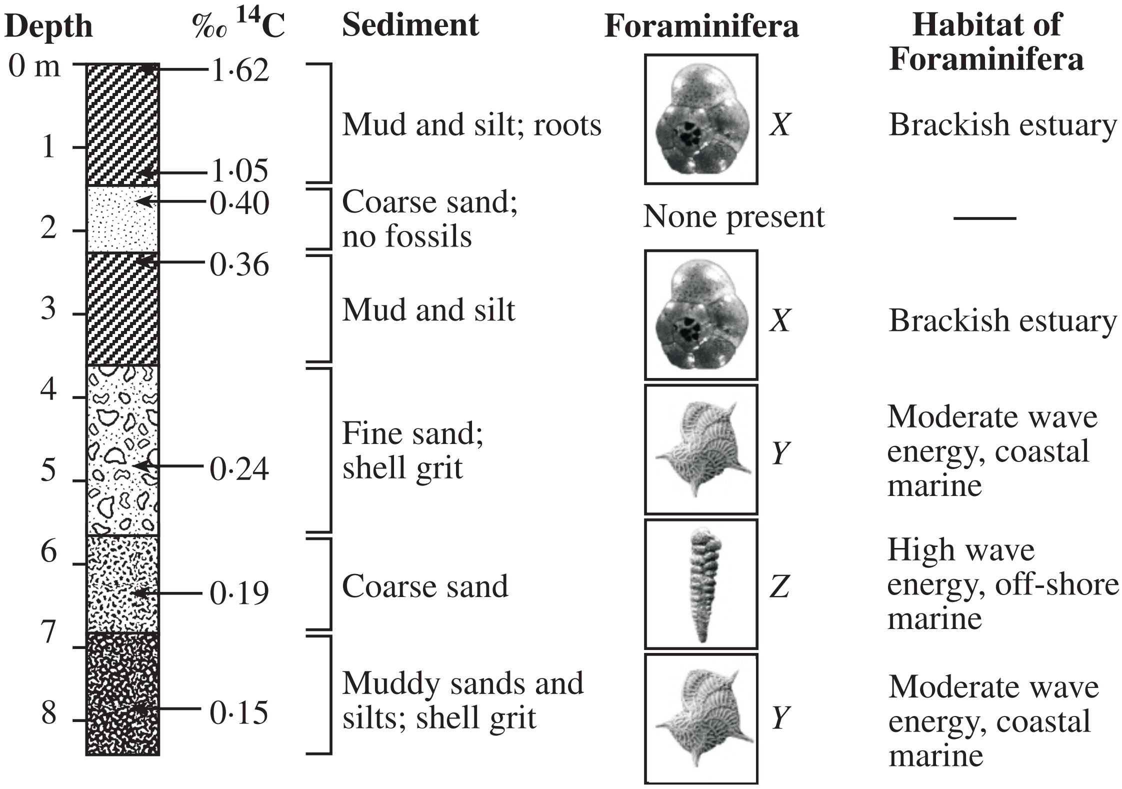


DIAGRAM *A*

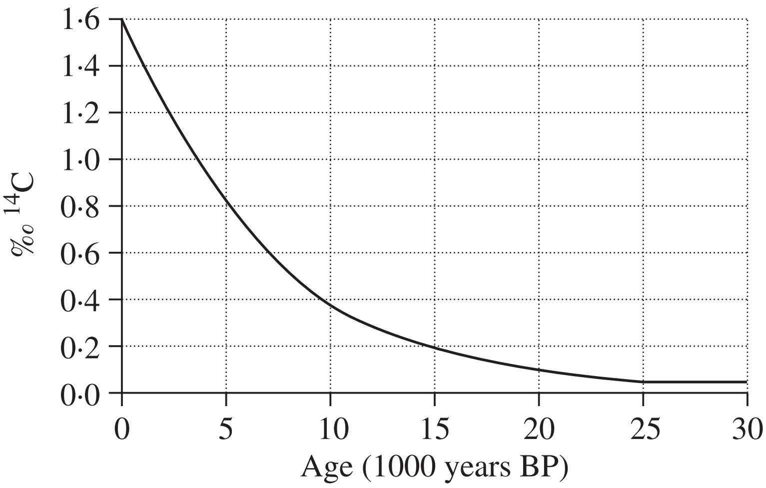


DIAGRAM *B*

(d) What progressive changes in sea level are indicated by the sequence of sediments and species of Foraminifera in this core?

(e) What indication is there that Foraminifera *Y* would be less adapted to high wave energy environments than Foraminifera *Z*?

(f) What evidence in the stratigraphic column indicates a major time break in the sedimentary record?

(g) What is the average rate of sediment deposition (in mm year^{-1}) in the top mud and silt layer?

End of Paper 1

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SCIENCE 3/4 DATA SHEET

Values of several numerical constants

Avogadro's constant, N_A	$6{\cdot}022 \times 10^{23}$ mol^{-1}
Elementary charge, e	$1{\cdot}602 \times 10^{-19}$ C
Faraday constant, F	96 490 C mol^{-1}
Gas constant, R	$8{\cdot}314$ J K^{-1} mol^{-1} $0{\cdot}0821$ L atm K^{-1} mol^{-1}
Mass of electron, m_e	$9{\cdot}109 \times 10^{-31}$ kg
Mass of neutron, m_n	$1{\cdot}675 \times 10^{-27}$ kg
Mass of proton, m_p	$1{\cdot}673 \times 10^{-27}$ kg
Volume of 1 mole ideal gas: at 101·3 kPa (1 atm) and	
at 273 K (0°C)	22·41 L
at 298 K (25°C)	24·47 L
Earth's gravitational acceleration, g	$9{\cdot}8$ m s^{-2}
Speed of light, c	$3{\cdot}00 \times 10^{8}$ m s^{-1}
Coulomb's constant, k	$9{\cdot}0 \times 10^{9}$ N m^2 C^{-2}
Permeability constant, μ_0	$4\pi \times 10^{-7}$ A^{-2}
Universal gravitation constant, G	$6{\cdot}7 \times 10^{-11}$ N m^2 kg^{-2}
Mass of Earth	$6{\cdot}0 \times 10^{24}$ kg
Radius of Earth	6378 km
Planck's constant, h	$6{\cdot}626 \times 10^{-34}$ J s
Density of water	$1{\cdot}00 \times 10^{3}$ kg m^{-3}
Specific heat capacity of water	$4{\cdot}18 \times 10^{3}$ J kg^{-1} K^{-1}
Speed of sound in air	340 m s^{-1}

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2·94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2·91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2·87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2·71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2·36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1·68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1·18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0·83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0·76 V
$S(s) + 2e^-$	$\rightleftharpoons$	S^{2-}	–0·45 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0·44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0·24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0·14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0·13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0·00 V
$SO_4{}^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0·16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0·34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0·40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0·52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0·54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0·62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0·77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0·80 V
$NO_3{}^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	0·96 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1·08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1·10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1·23 V
$Cr_2O_7{}^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	1·36 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1·36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1·40 V
$MnO_4{}^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1·51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2·89 V

Aylward and Findlay, *SI Chemical Data* (4th Edition) is the principal source of chemical data for this examination paper. Some data may have been modified for examination purposes.

PERIODIC TABLE

KEY

Atomic Number Atomic Mass	79 Au 197·0 Gold	Symbol of element Name of element

				1 H 1·008 Hydrogen													2 He 4·003 Helium
3 Li 6·941 Lithium	4 Be 9·012 Beryllium											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	10 Ne 20·18 Neon
11 Na 22·99 Sodium	12 Mg 24·31 Magnesium											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	18 Ar 39·95 Argon
19 K 39·10 Potassium	20 Ca 40·08 Calcium	21 Sc 44·96 Scandium	22 Ti 47·88 Titanium	23 V 50·94 Vanadium	24 Cr 52·00 Chromium	25 Mn 54·94 Manganese	26 Fe 55·85 Iron	27 Co 58·93 Cobalt	28 Ni 58·69 Nickel	29 Cu 63·55 Copper	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	35 Br 79·90 Bromine	36 Kr 83·80 Krypton
37 Rb 85·47 Rubidium	38 Sr 87·62 Strontium	39 Y 88·91 Yttrium	40 Zr 91·22 Zirconium	41 Nb 92·91 Niobium	42 Mo 95·94 Molybdenum	43 Tc 98·91 Technetium	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	49 In 114·8 Indium	50 Sn 118·7 Tin	51 Sb 121·8 Antimony	52 Te 127·6 Tellurium	53 I 126·9 Iodine	54 Xe 131·3 Xenon
55 Cs 132·9 Cesium	56 Ba 137·3 Barium	57 La 138·9 Lanthanum	72 Hf 178·5 Hafnium	73 Ta 180·9 Tantalum	74 W 183·9 Tungsten	75 Re 186·2 Rhenium	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	81 Tl 204·4 Thallium	82 Pb 207·2 Lead	83 Bi 209·0 Bismuth	84 Po — Polonium	85 At — Astatine	86 Rn — Radon
87 Fr — Francium	88 Ra 226·0 Radium	89 Ac — Actinium	104	105	106												

58 Ce 140·1 Cerium	59 Pr 140·9 Praseodymium	60 Nd 144·2 Neodymium	61 Pm — Promethium	62 Sm 150·4 Samarium	63 Eu 152·0 Europium	64 Gd 157·3 Gadolinium	65 Tb 158·9 Terbium	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	71 Lu 175·0 Lutetium
90 Th 232·0 Thorium	91 Pa 231·0 Protactinium	92 U 238·0 Uranium	93 Np 237·0 Neptunium	94 Pu — Plutonium	95 Am — Americium	96 Cm — Curium	97 Bk — Berkelium	98 Cf — Californium	99 Es — Einsteinium	100 Fm — Fermium	101 Md — Mendelevium	102 No — Nobelium	103 Lr — Lawrencium

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BOARD OF STUDIES
NEW SOUTH WALES

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.

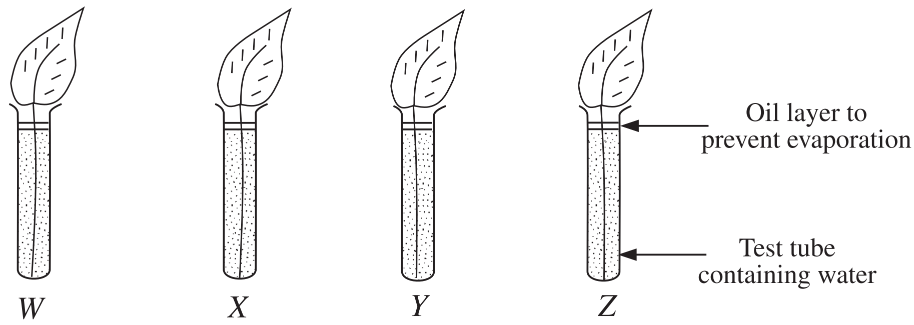
CONTENTS

GROUP 1—BIOLOGY ELECTIVES

Marks

QUESTION 1 Flowering Plants and Mammals

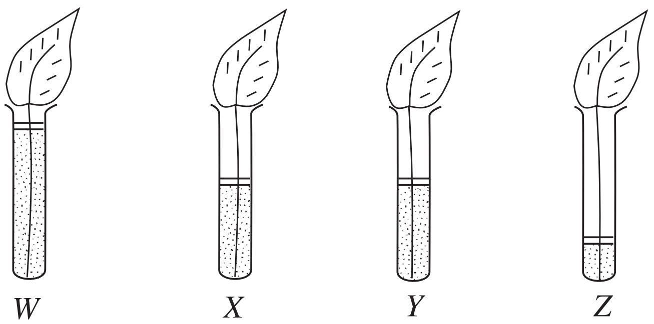
(a) Four identical leaves were set up as shown below. **4**



Treatment:

- W: Waterproof jelly on upper and lower surfaces of the leaf
- X: Waterproof jelly on upper surface of the leaf only
- Y: Waterproof jelly on lower surface of the leaf only
- Z: No waterproof jelly applied

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?

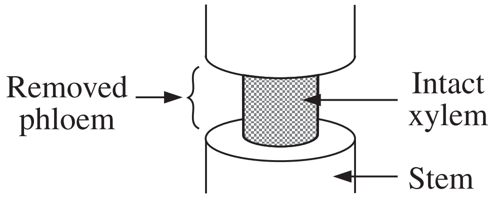
(ii) Why was *Z* included in the experiment?

(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**

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

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 *phototropism*. **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 *homeostasis*?

(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

QUESTION 2 Reproduction and Genetics **Marks**

(a) Describe how viruses reproduce. **4**

(b) State ONE way in which binary fission in bacteria is: **2**

(i) similar to mitotic division in eukaryotic cells;

(ii) different from mitotic division in eukaryotic cells.

(c) Distinguish between the terms *gene* and *allele*. **2**

(d) Explain, in terms of human inheritance, how the male parent, rather than the female parent, determines the sex of the offspring. **3**

(e) (i) Use a diagram to explain the term *crossing over*. **3**

(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. **4**

(g) Genetic engineering involves the production of recombinant DNA in the laboratory. **3**

(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. **4**

(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.

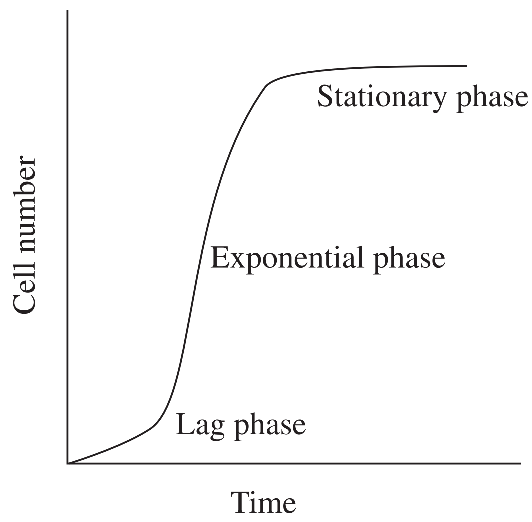
(c) What are the differences in structure between fungi, bacteria and viruses? **4**

(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?

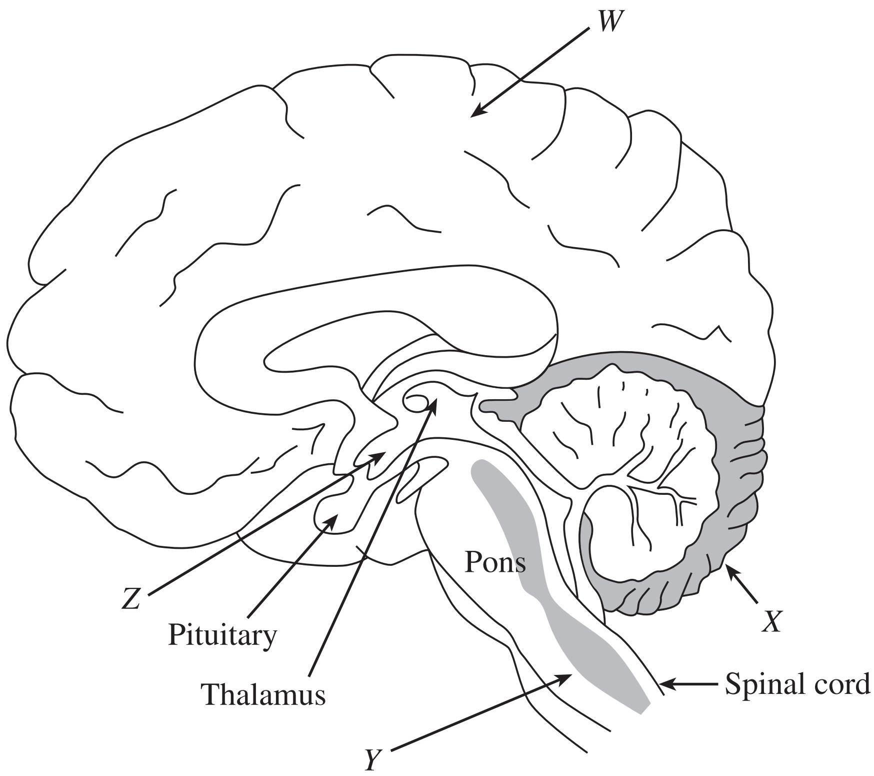
(ii) Compare the appearances of the colonies identified in part (i).

(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*.

(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**

(i) How is the strength of a nerve impulse maintained along nerve fibres?

(ii) How is the nerve impulse transmitted between nerve cells?

(iii) 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.

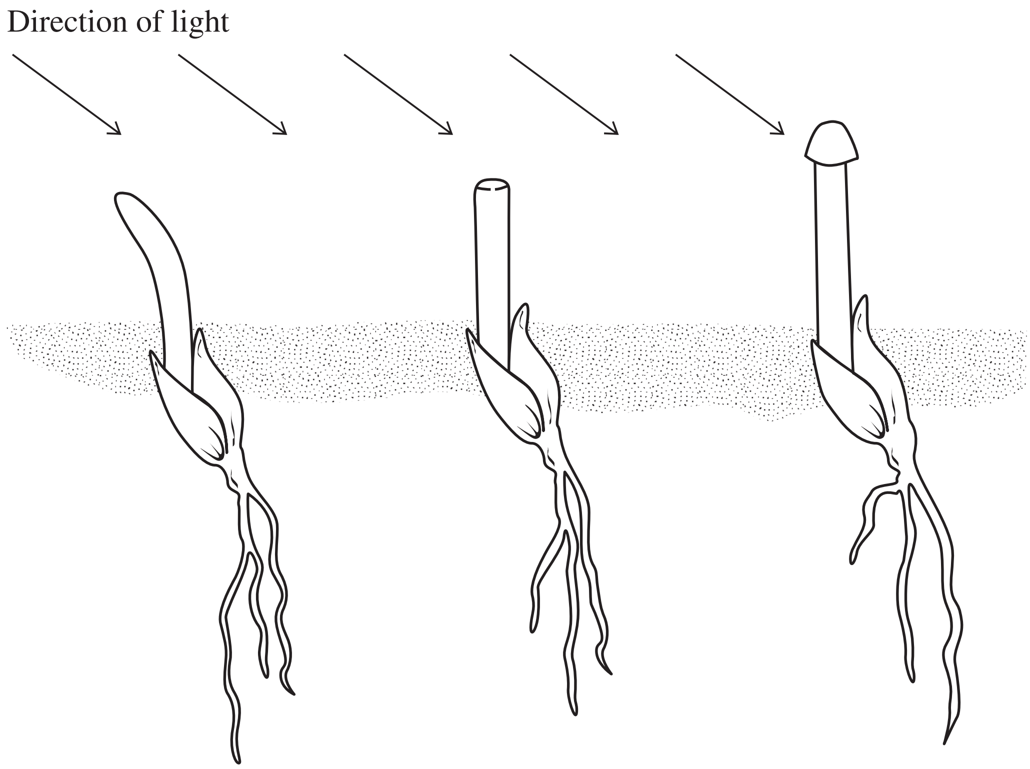
(ii) Explain why the pituitary gland is often described as the 'master gland'. Use an example in your answer.

(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**



<u>Group 1</u>

Intact seedling.
Shoots grew and bent towards light.

<u>Group 2</u>

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

<u>Group 3</u>

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^{-1}. 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**

(i) their ignition temperature, vaporisation temperature and volatility;

(ii) how the rate and evenness of their combustion are controlled;

(iii) 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**

Element	$\Delta_{fus}H^{\ominus}$ kJ mol^{-1} (t_m)	$\Delta_{vap}H^{\ominus}$ kJ mol^{-1} (t_b)	$\Delta_{at}H^{\ominus}$ kJ mol^{-1} (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 kJ mol^{-1}), carbon dioxide gas (–394 kJ mol^{-1}) and liquid water (–286 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:

$$CO_2(g) + 4H^+ + 4e^- \rightleftharpoons \tfrac{1}{6}C_6H_{12}O_6 + H_2O \qquad E^\ominus = -0{\cdot}01\ V$$

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 mol L^{-1} solution of sodium iodide was connected by a salt bridge to a second beaker containing a 1 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**

Substance	*Boiling point* (°C)
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 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. **2**

(i) Write an expanded structural (graphic) formula for *A* and name this substance.

(ii) Describe one important use of compound *B*.

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;

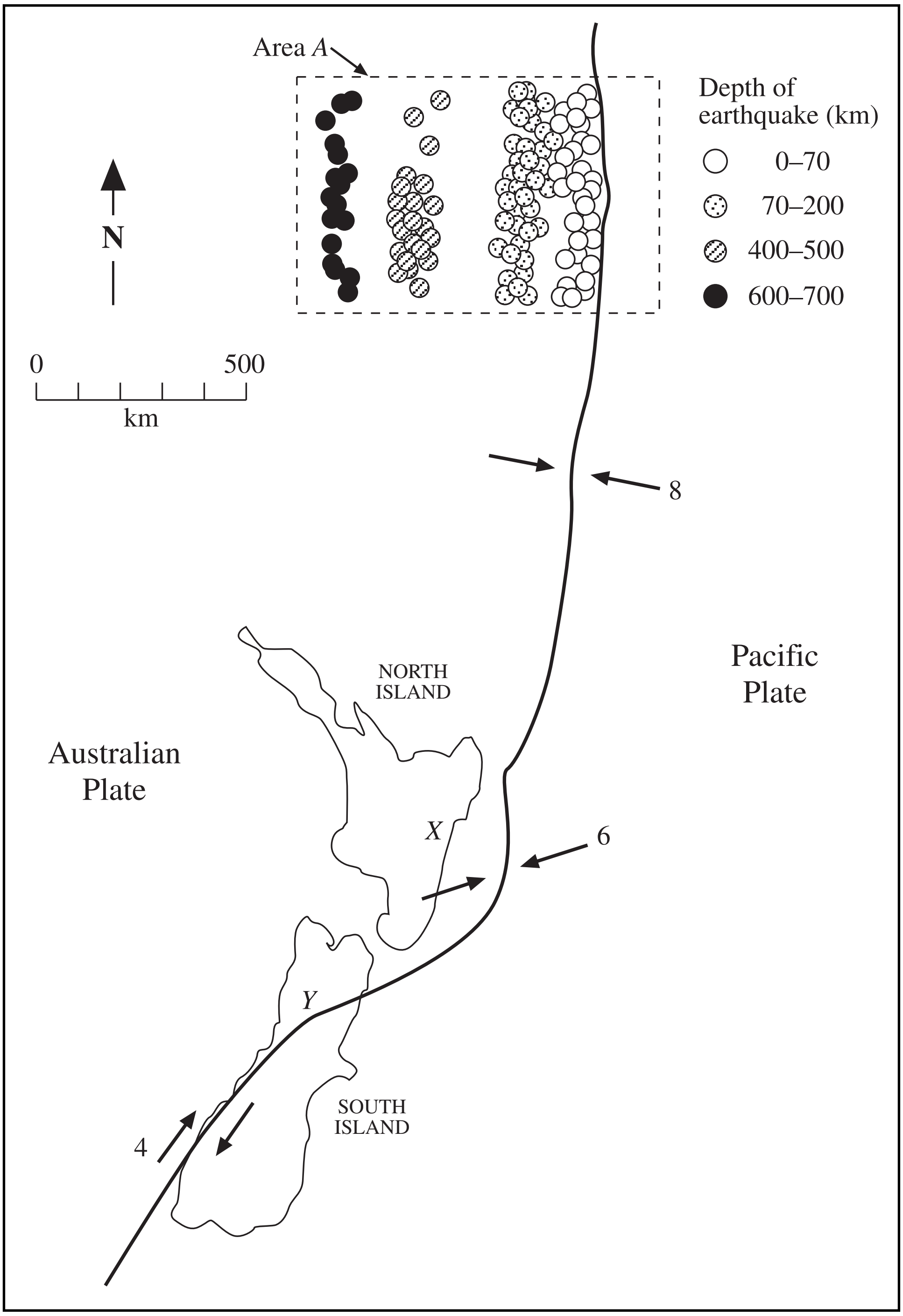
(iii) explain what each of these structural features indicates about the geological evolution of this region.

(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 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?

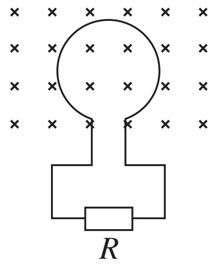
End of question

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 $2{\cdot}5 \times 10^{-2}$ 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**

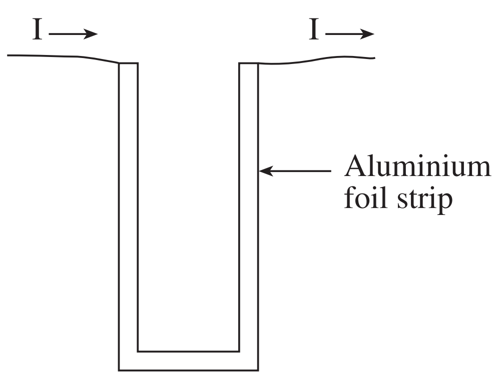


Diagram 1

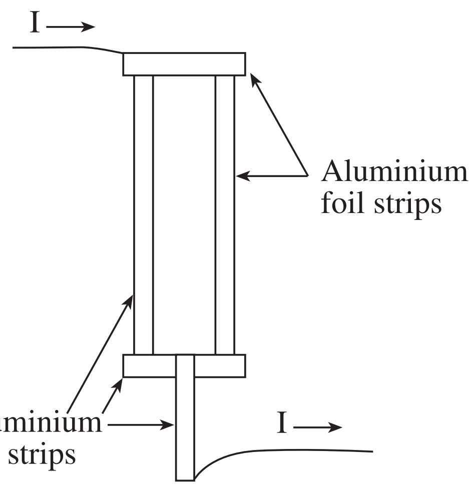


Diagram 2

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

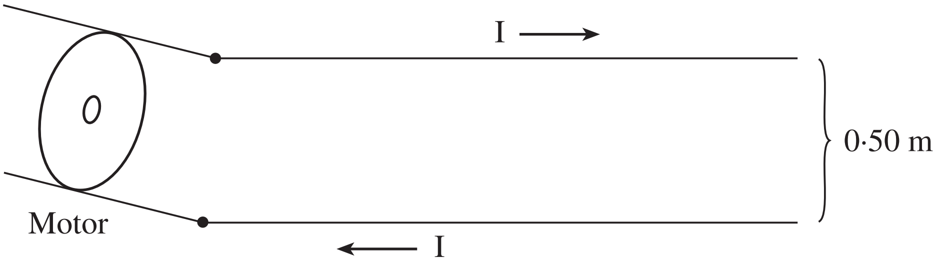
(i) diagram 1;

(ii) diagram 2.

Question 10 continues on page 25

QUESTION 10 (Continued) **Marks**

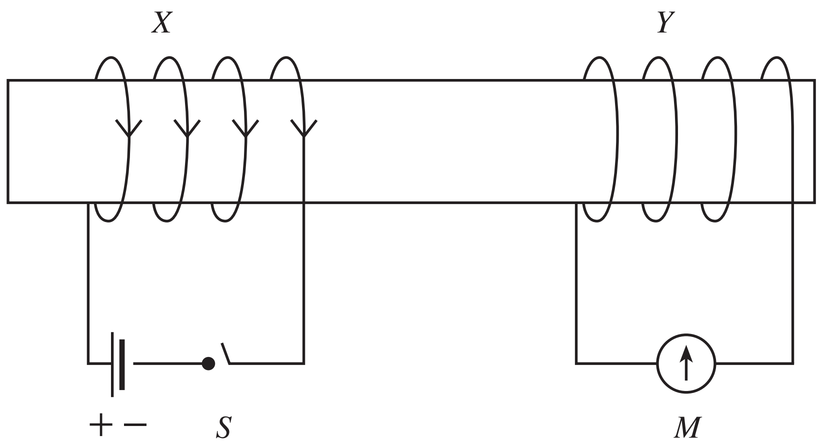
(c) Two long straight wires, 0·50 m apart, deliver a steady current of 15 A to a motor. **4**



(i) Calculate the magnitude of the force exerted on a 2 m length of each wire.

(ii) What is the magnetic induction **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.

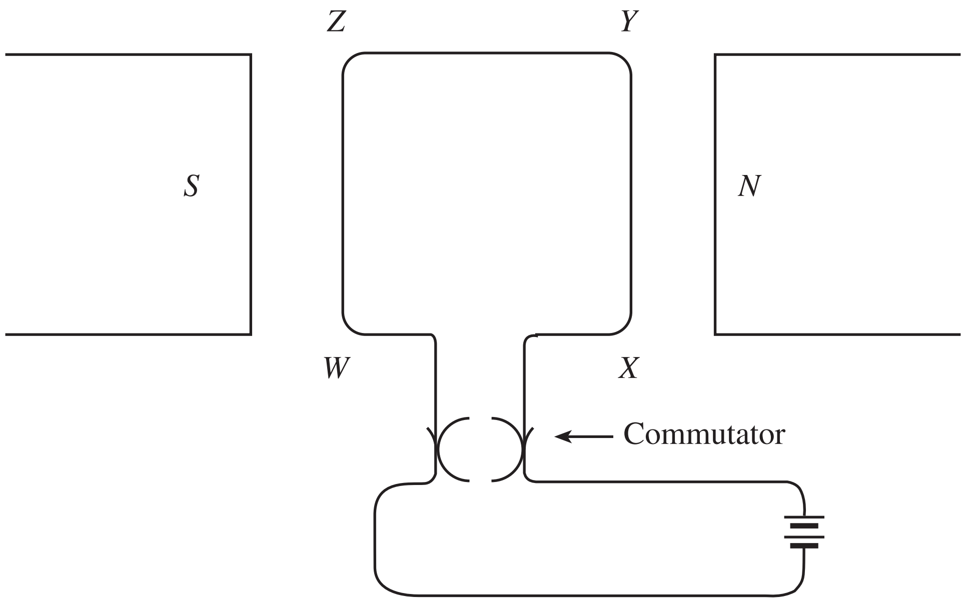
(iv) If a 50 Hz AC voltage was applied across *X*, what effect would this have on the meter *M*? Explain your answer.

(v) Give TWO ways that this arrangement could be changed to make a useful transformer. Give reasons for the changes.

Question 10 continues on page 26

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 m long. A current of 4·0 A flows through the coil and a uniform magnetic field of 0·80 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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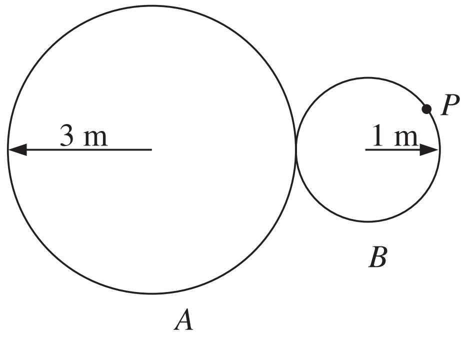
QUESTION 11 Oscillations and Waves **Marks**

(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.

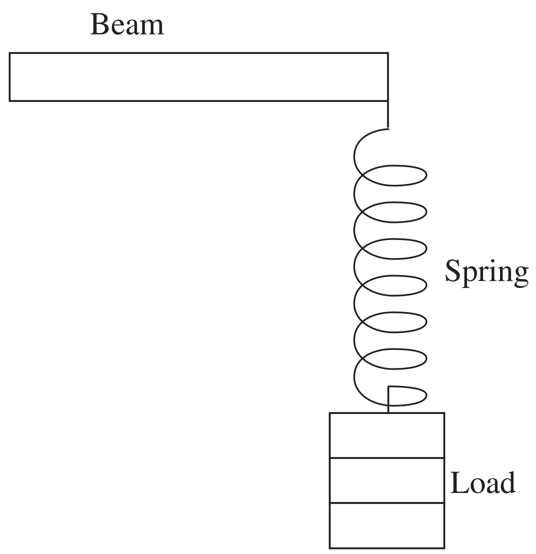
(ii) The note is heard at the back of the auditorium, a distance of 40 m away, 0·12 s later.

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**



Mass added (kg)	*Elongation* (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.

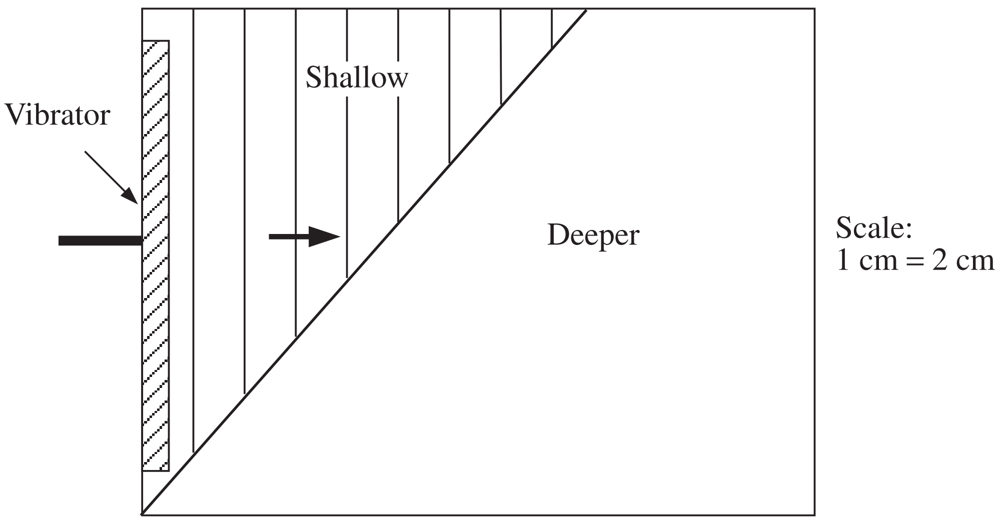
(iii) After the 5·0 kg reading was taken, the spring was pulled down vertically and then released.

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

Question 11 continues on page 30

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.

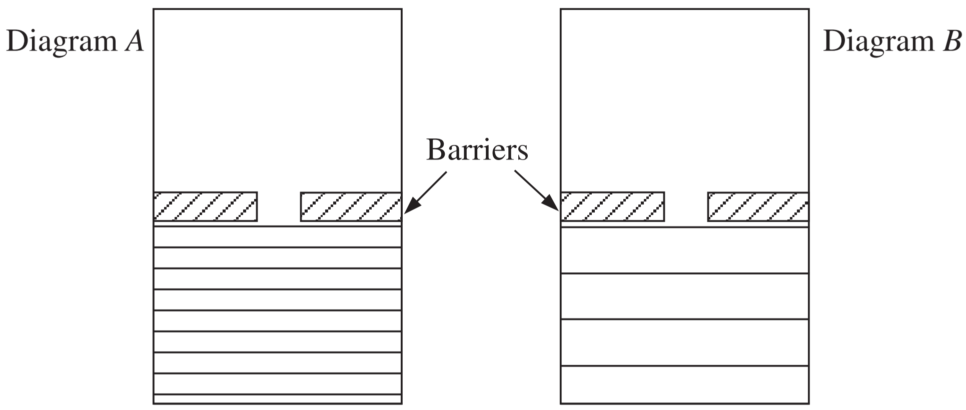
(iii) Determine the speed of the waves in the deeper region.

(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**



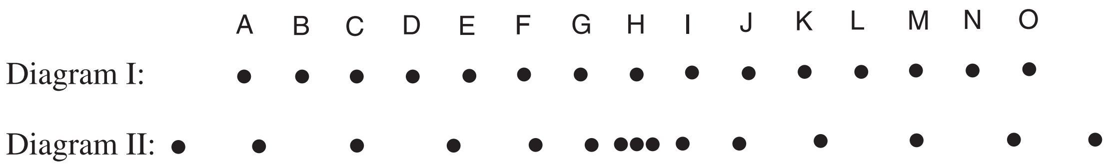
(i) Which wave property is demonstrated by these wavefronts after they have passed through the gap?

(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° 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 γ-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 $6{\cdot}8 \times 10^{-19}$ 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.

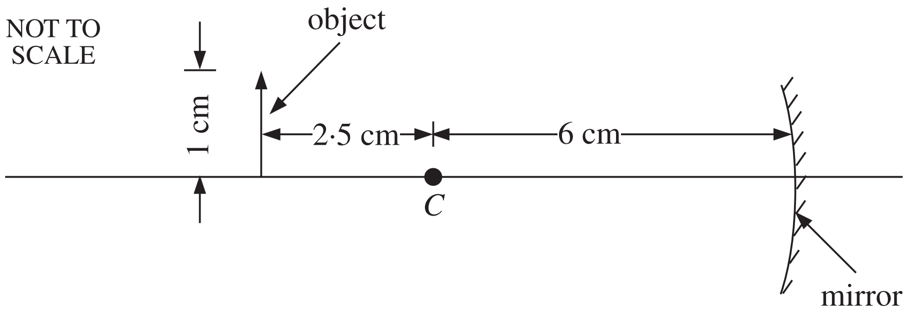
2 Why did that experiment appear to contradict the particle nature of light?

(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**

$f_1 = 4{\cdot}5$ mm, $f_2 = -40$ mm, $f_3 = 100$ mm and $f_4 = 1200$ 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**

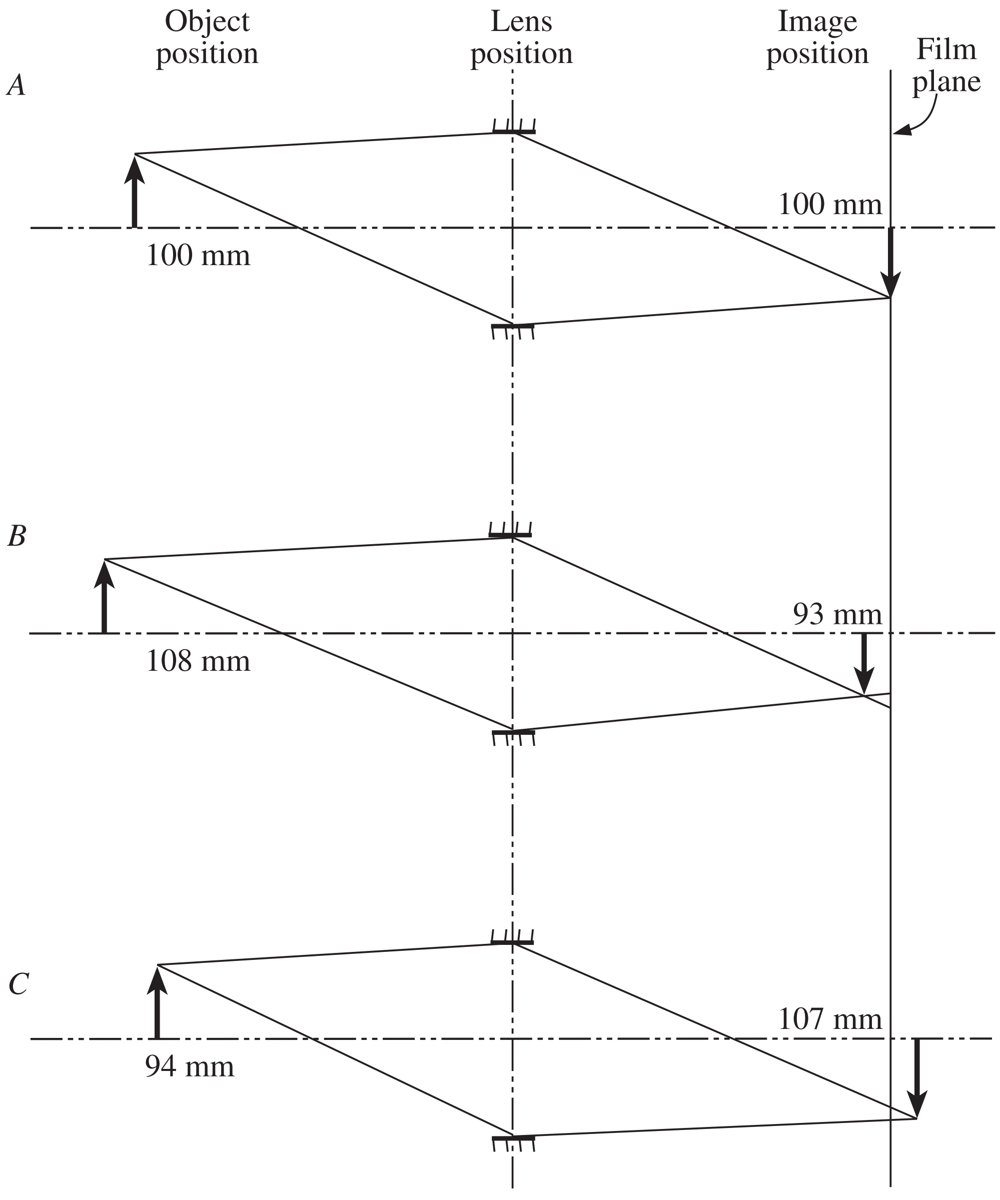
(a) Images can be altered by altering settings on the camera. **12**

(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 $f2$. 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-leafed 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 continues on page 39

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**

$$AgBr(s) + 2S_2O_3^{2-} \rightleftharpoons Ag(S_2O_3)_2^{3-} + Br^-$$

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. **4**

(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).

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 α-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 α-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}I	8 days	1500	0·0	β	^{131}Xe	0·38
^{134}Cs	2·1 years	44·5	1·6	β	^{134}Ba	1·56
^{239}Pu	24 100 years	0·03	0·03	α series	^{207}Pb	0·0001

^{131}I and ^{134}Cs undergo simple β-decay. ^{239}Pu decays to ^{207}Pb via a succession of α-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?

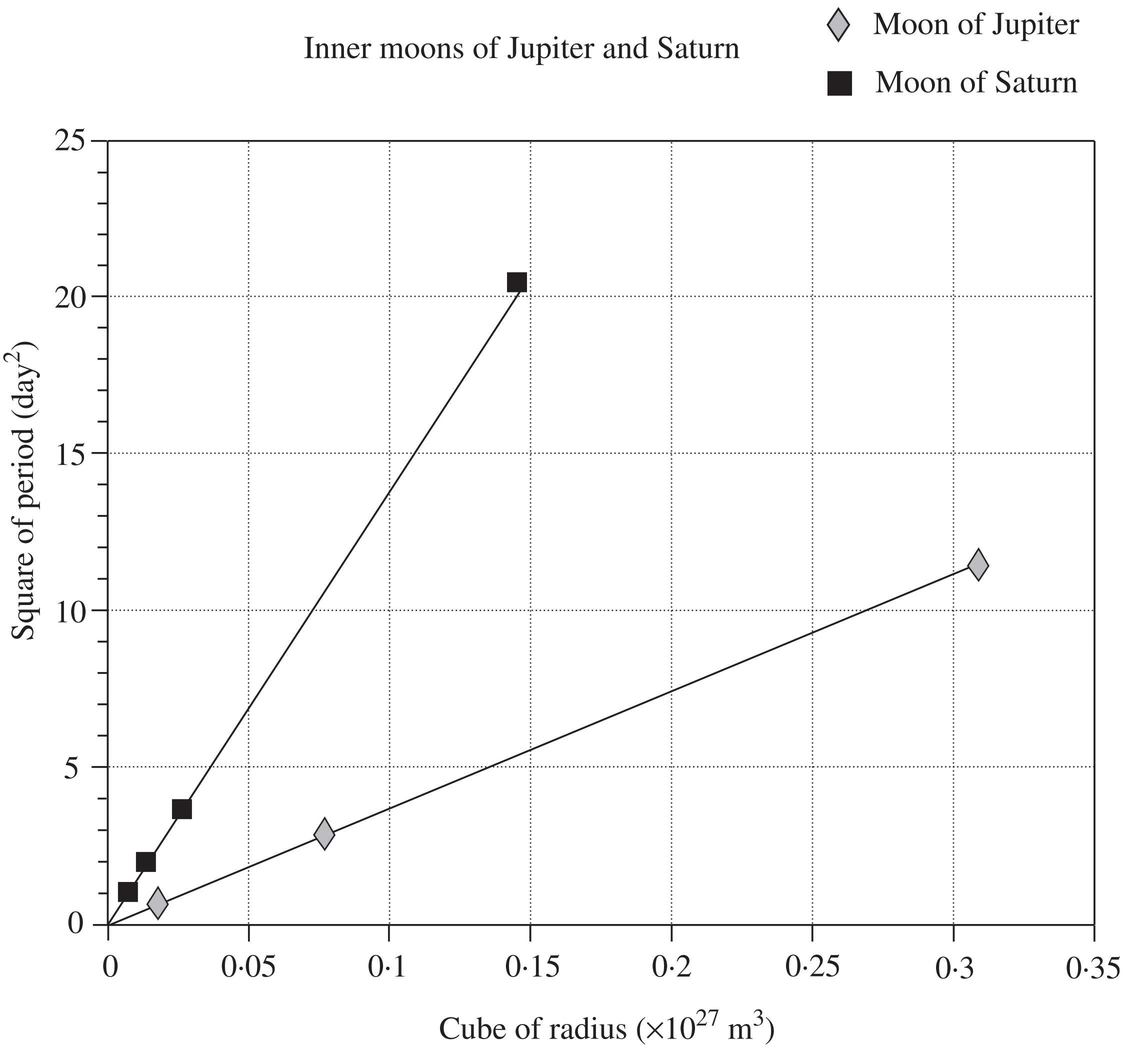
(iii) 1 Define the term *ultrasound*.

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 $4{\cdot}48 \times 10^9$ years old. There is another piece of evidence which suggests that the age of the solar system is at least $4{\cdot}6 \times 10^9$ 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**

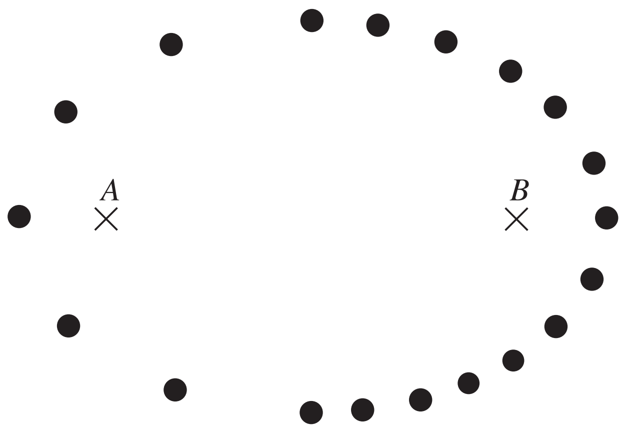
$$v^2{}_{orbital} = G\,\frac{M_{\text{Earth}}}{R_{\text{Orbit}}}$$

where G is the universal gravitational constant, M_{Earth} is the mass of the Earth and R_{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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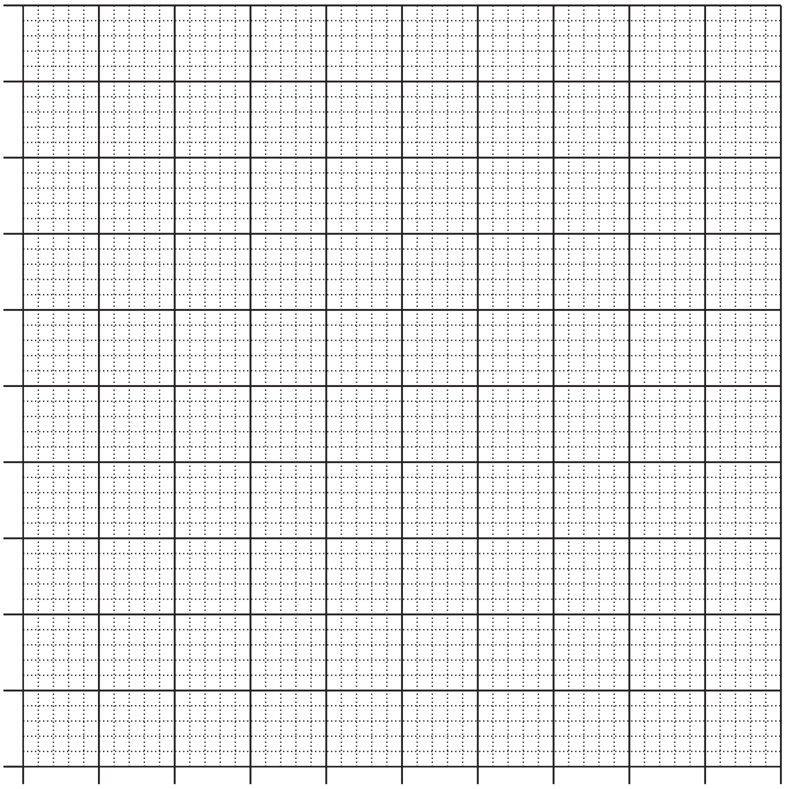
2000
HIGHER SCHOOL CERTIFICATE EXAMINATION
SCIENCE 3/4 UNIT
PAPER 2—ELECTIVES

CENTRE NUMBER

This page is to be detached, completed and attached to the inside front cover of your Elective Answer Book for Question 11.

QUESTION 11



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SCIENCE 3/4 DATA SHEET

Values of several numerical constants

Avogadro's constant, N_A	$6{\cdot}022 \times 10^{23}$ mol^{-1}
Elementary charge, e	$1{\cdot}602 \times 10^{-19}$ C
Faraday constant, F	96 490 C mol^{-1}
Gas constant, R	$8{\cdot}314$ J K^{-1} mol^{-1} $0{\cdot}0821$ L atm K^{-1} mol^{-1}
Mass of electron, m_e	$9{\cdot}109 \times 10^{-31}$ kg
Mass of neutron, m_n	$1{\cdot}675 \times 10^{-27}$ kg
Mass of proton, m_p	$1{\cdot}673 \times 10^{-27}$ kg
Volume of 1 mole ideal gas: at 101·3 kPa (1 atm) and at 273 K (0°C)	22·41 L
at 298 K (25°C)	24·47 L
Earth's gravitational acceleration, g	$9{\cdot}8$ m s^{-2}
Speed of light, c	$3{\cdot}00 \times 10^{8}$ m s^{-1}
Coulomb's constant, k	$9{\cdot}0 \times 10^{9}$ N m^2 C^{-2}
Permeability constant, μ_0	$4\pi \times 10^{-7}$ A^{-2}
Universal gravitation constant, G	$6{\cdot}7 \times 10^{-11}$ N m^2 kg^{-2}
Mass of Earth	$6{\cdot}0 \times 10^{24}$ kg
Radius of Earth	6378 km
Planck's constant, h	$6{\cdot}626 \times 10^{-34}$ J s
Density of water	$1{\cdot}00 \times 10^{3}$ kg m^{-3}
Specific heat capacity of water	$4{\cdot}18 \times 10^{3}$ J kg^{-1} K^{-1}
Speed of sound in air	340 m s^{-1}

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2·94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2·91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2·87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2·71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2·36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1·68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1·18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0·83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0·76 V
$S(s) + 2e^-$	$\rightleftharpoons$	S^{2-}	–0·45 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0·44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0·24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0·14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0·13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0·00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0·16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0·34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0·40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0·52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0·54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0·62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0·77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0·80 V
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	0·96 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1·08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1·10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1·23 V
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	1·36 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1·36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1·40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1·51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2·89 V

Aylward and Findlay, *SI Chemical Data* (4th Edition) is the principal source of chemical data for this examination paper. Some data may have been modified for examination purposes.

PERIODIC TABLE

KEY

Atomic Number Atomic Mass	79 Au 197·0 Gold
Symbol of element Name of element	

1 H 1·008 Hydrogen																	2 He 4·003 Helium
3 Li 6·941 Lithium	4 Be 9·012 Beryllium											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	10 Ne 20·18 Neon
11 Na 22·99 Sodium	12 Mg 24·31 Magnesium											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	18 Ar 39·95 Argon
19 K 39·10 Potassium	20 Ca 40·08 Calcium	21 Sc 44·96 Scandium	22 Ti 47·88 Titanium	23 V 50·94 Vanadium	24 Cr 52·00 Chromium	25 Mn 54·94 Manganese	26 Fe 55·85 Iron	27 Co 58·93 Cobalt	28 Ni 58·69 Nickel	29 Cu 63·55 Copper	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	35 Br 79·90 Bromine	36 Kr 83·80 Krypton
37 Rb 85·47 Rubidium	38 Sr 87·62 Strontium	39 Y 88·91 Yttrium	40 Zr 91·22 Zirconium	41 Nb 92·91 Niobium	42 Mo 95·94 Molybdenum	43 Tc 98·91 Technetium	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	49 In 114·8 Indium	50 Sn 118·7 Tin	51 Sb 121·8 Antimony	52 Te 127·6 Tellurium	53 I 126·9 Iodine	54 Xe 131·3 Xenon
55 Cs 132·9 Cesium	56 Ba 137·3 Barium	57 La 138·9 Lanthanum	72 Hf 178·5 Hafnium	73 Ta 180·9 Tantalum	74 W 183·9 Tungsten	75 Re 186·2 Rhenium	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	81 Tl 204·4 Thallium	82 Pb 207·2 Lead	83 Bi 209·0 Bismuth	84 Po — Polonium	85 At — Astatine	86 Rn — Radon
87 Fr — Francium	88 Ra 226·0 Radium	89 Ac — Actinium	104	105	106												

58 Ce 140·1 Cerium	59 Pr 140·9 Praseodymium	60 Nd 144·2 Neodymium	61 Pm — Promethium	62 Sm 150·4 Samarium	63 Eu 152·0 Europium	64 Gd 157·3 Gadolinium	65 Tb 158·9 Terbium	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	71 Lu 175·0 Lutetium
90 Th 232·0 Thorium	91 Pa 231·0 Protactinium	92 U 238·0 Uranium	93 Np 237·0 Neptunium	94 Pu — Plutonium	95 Am — Americium	96 Cm — Curium	97 Bk — Berkelium	98 Cf — Californium	99 Es — Einsteinium	100 Fm — Fermium	101 Md — Mendelevium	102 No — Nobelium	103 Lr — Lawrencium

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BOARD OF STUDIES
NEW SOUTH WALES

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HIGHER SCHOOL CERTIFICATE EXAMINATION

2000
SCIENCE
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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) ....

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) ....

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(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

MARKER'S USE ONLY

Questions 21 to 28 are worth 5 marks each.

Answer the questions in the spaces provided.

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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MARKER'S USE ONLY

22 (a)

Metal	*Solution of the chloride of X* (XCl)	*Solution of the chloride of Y* (YCl_2)	*Solution of the chloride of Z* (ZCl_3)
X			
Y			
Z			

(b) ....

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(c) ....

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MARKER'S USE ONLY

23

Formula of carbon compound	*Name of carbon compound*	*Use or function of carbon compound*
$C_6H_{12}O_6$		
		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) ....

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(b) ....

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(c) ....

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(d) ....

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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)

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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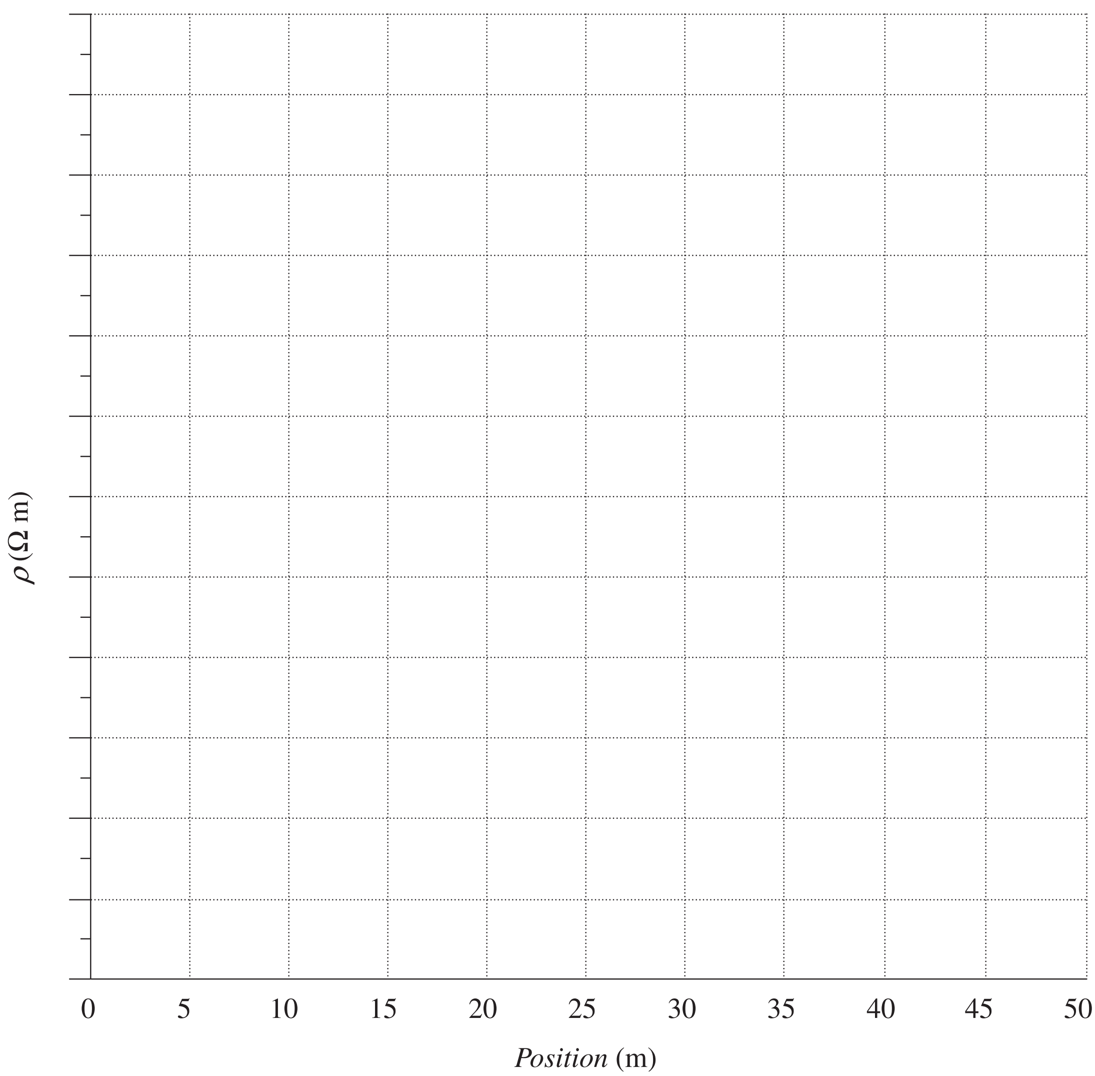
(b) (i)

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
ρ Ω m											

(ii)



QUESTION 29 (Continued)

MARKER'S USE ONLY

(b) (iii) ....

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(iv) ....

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Please turn over

MARKER'S USE ONLY

30 (a) (i) ....

(ii) ....

(b) ....

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(c) ....

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(d) ....

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(g) ....

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