BOARD OF STUDIES
NEW SOUTH WALES

HIGHER SCHOOL CERTIFICATE EXAMINATION

1996
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. Mark your answers in pencil 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.

Mark your answers in pencil on the Answer Sheet provided.

Select the alternative A, B, C, or D that best answers the question.

1 . Sodium hydrogen carbonate (baking soda or bicarb soda), is a commonly used household chemical. The correct formula for, and type of bonding within, the hydrogen carbonate species is

	Formula	*Type of bonding*
(A)	H_2CO_3	Ionic
(B)	HCO_3^-	Ionic
(C)	H_2CO_3	Covalent
(D)	HCO_3^-	Covalent

2 . Arsenic forms two oxides—arsenic (III) and (V) oxides. The correct percentages of oxygen in these compounds are

	%O in arsenic (III) oxide	*%O in arsenic (V) oxide*
(A)	24·3	34·8
(B)	24·3	51·6
(C)	64·1	34·8
(D)	64·1	51·6

3 . The overall chemical reaction that occurs during discharge of a car battery is

$$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

In this reaction, the oxidant is

(A) Pb

(B) PbO_2

(C) H_2SO_4

(D) $PbSO_4$

4 . A ball of mass 100 g is thrown at a wall at a speed of 30 m s^{-1}. It rebounds elastically. The work done by the wall on the ball is

(A) 0 kJ

(B) 6 kJ

(C) 45 kJ

(D) 90 kJ

5 . An arrow of mass 50 g is to be fired directly upwards from a bow. The stretched bow is able to store 150 J of energy. When released, the bow transfers all its stored energy to the arrow. What would be the speed of the arrow 15 m above the point of release (ignore air resistance)?

(A) 17·1 m s^{-1}

(B) 75·5 m s^{-1}

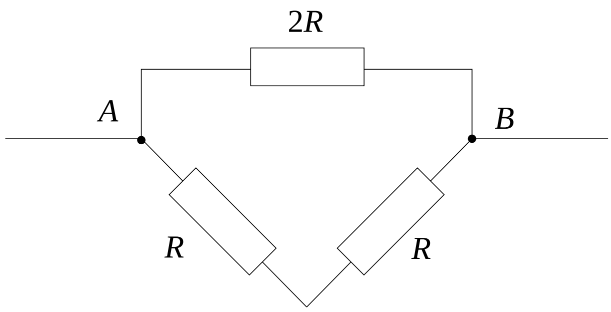
(C) 77·5 m s^{-1}

(D) 147 m s^{-1}

6 . The fossil record indicates that humans and jellyfish have existed on Earth for approximately

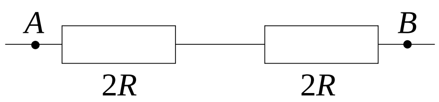
	Humans	*Jellyfish*
(A)	6×10^3 years	6×10^3 years
(B)	5×10^9 years	6×10^9 years
(C)	5×10^6 years	1×10^6 years
(D)	5×10^6 years	1×10^9 years

7 . A section of a circuit, including three resistors, is shown.

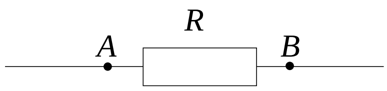


The section of circuit that has an equivalent resistance to that between points *A* and *B* is

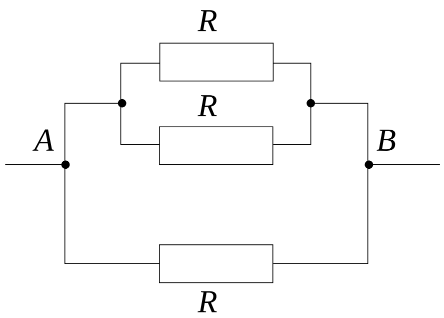
(A)



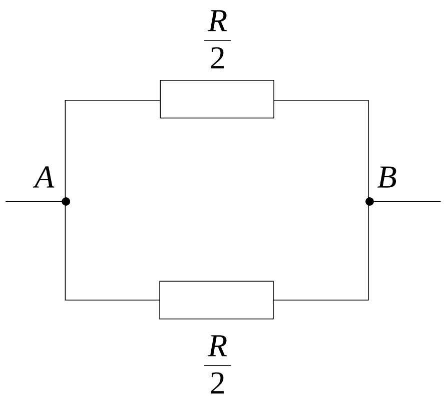
(B)



(C)



(D)



8 . Concern has been expressed that some disease-causing bacteria are now resistant to many antibiotics. The increase in resistance is due to

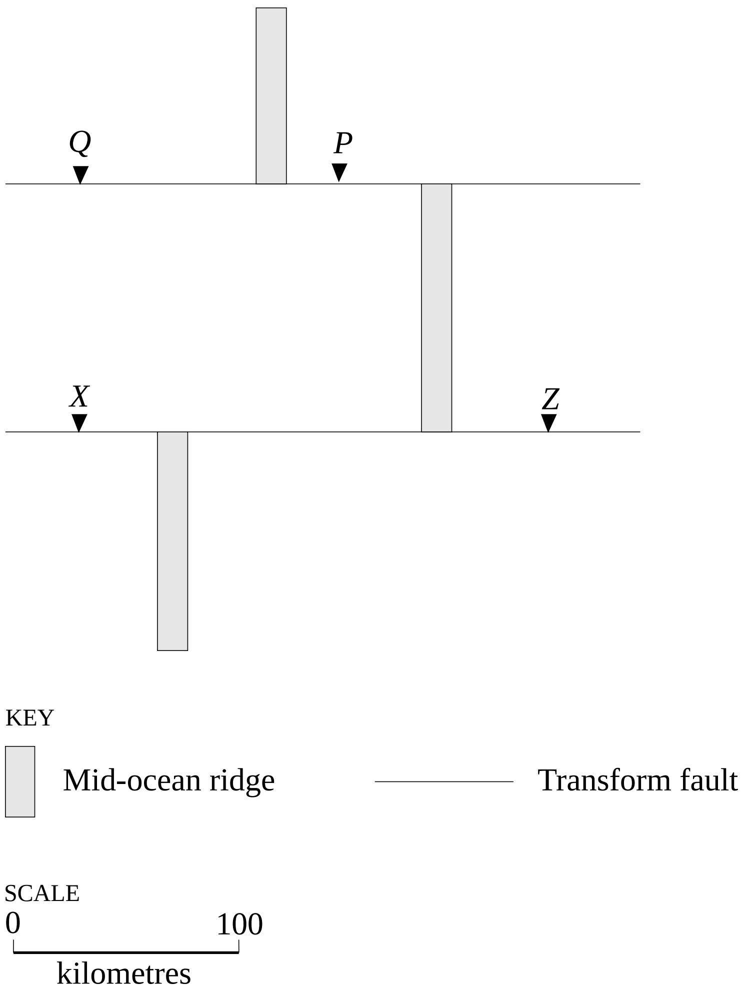
(A) antibiotics directly causing chemical changes to the bacteria's nucleic acid.

(B) breakdown in quality control in the production of antibiotics.

(C) natural selection of resistant bacteria previously present in low numbers in populations.

(D) inadequate freshwater supplies and waste disposal systems promoting spread of disease.

9 . The diagram shows part of a mid-ocean ridge.



At which point, *Q*, *P*, *X*, or *Z*, would earthquakes most likely be generated?

(A) *Q*

(B) *P*

(C) *X*

(D) *Z*

10 . The growth of a plant stem involves production of new cells by cell division. This cell division

(A) involves only meiosis and cytokinesis.

(B) involves both meiosis and mitosis.

(C) involves only mitosis and cytokinesis.

(D) does not involve cytokinesis.

SECTION II

Attempt ALL questions.

Questions 11–20 are worth 3 marks each.

Answer this Section in the Section II Answer Book.

Show all necessary working in questions involving calculations.

Marks may be awarded for relevant working.

11. Analysis of an organic compound showed that it contained 38·44% carbon, 4·84% hydrogen, and 56·72% chlorine by mass. The molar mass of the compound was found to be 124·99 g mol^{-1}.

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

(b) Determine the molecular formula of the compound.

(c) There are several isomers with this molecular formula. Name ONE of these isomers and give its structural formula.

12. (a) State the trend in bond type of the oxides of the elements in the third period of the periodic table (atomic numbers 11 to 17 inclusive).

(b) Write an equation for the reaction of an oxide of sodium with water.

(c) Write an equation for the reaction of an oxide of chlorine with water.

13. (a) Calculate the concentration (mol L^{-1}) of a solution when 0·220 g carbon dioxide is dissolved in sufficient water to produce 500·0 mL of solution.

(b) Calculate the volume of 0·500 mol L^{-1} potassium hydroxide required for complete neutralisation of the solution in part (a).

14. Each of four bottles contained one pure white compound, either N_2O_5, Li_2O, KBr, or $C_6H_{12}O_6$ (glucose). The only labels on the bottles were *A*, *B*, *C*, and *D*. Several tests were carried out on the contents of each bottle. The results of these tests are given in the table.

TEST	SUBSTANCE			
	A	*B*	*C*	*D*
Melting-point (°C)	30	734	146	>1700
Solubility in water	Soluble	Soluble	Soluble	Soluble
pH of aqueous solution	Less than 7	7	7	Greater than 7
Electrical conductivity in aqueous solution	High	High	Low	High

(a) Identify *each* of *A*, *B*, *C*, and *D*.

(b) Explain the high electrical conductivity in aqueous solution of *either A or B*.

15. An electric kettle contains 1 litre of water at room temperature. It takes 140 seconds to boil the water. The heating element of the kettle is labelled 10 A, 240 V. Assume that all the heat generated goes into the water.

Calculate:

(a) the electrical power of the kettle;

(b) the energy delivered to the water;

(c) the resistance of the heating element.

16. A sports car of mass 800 kg accelerates uniformly from 25 km h^{-1} to 110 km h^{-1} in 15 seconds.

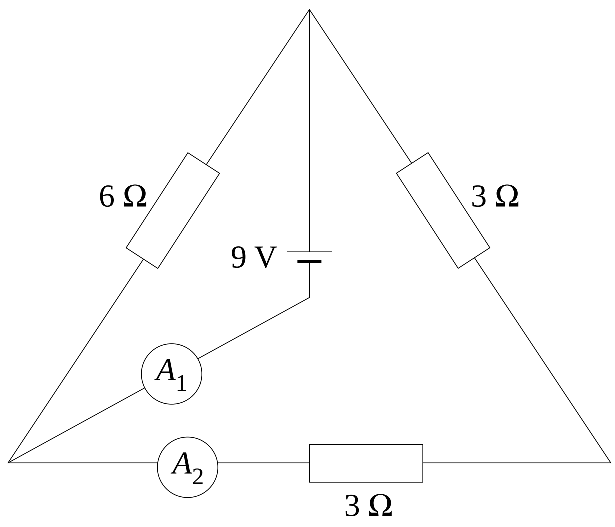
Calculate:

(a) the initial momentum of the car;

(b) the initial kinetic energy of the car;

(c) the average power provided by the car's engine during the acceleration.

17. This question refers to the circuit diagram shown. Assume that the ammeters (A_1 and A_2) have negligible resistance.



Calculate:

(a) the total resistance of the circuit;

(b) the current in ammeter A_1;

(c) the current in ammeter A_2.

18. (a) What is the main basis on which organisms are classified?

(b) How can the classification of living things be used to support the theory of evolution?

19. In 1960, Mason, Raff, and Vacquier discovered that the ocean floor off the west coast of North America was magnetised in a regular striped pattern with a north–south orientation. A careful study of part of the Mid-Atlantic ridge in 1965 showed that magnetic stripes were arranged parallel to the axis of the ridge.

(a) Why was the discovery of magnetic striping important for the development of modern ideas about the Earth's dynamic processes?

(b) What is the origin of the magnetism in the ocean floor, and why does it show a pattern of field reversals?

20. (a) What is meant by 'cell differentiation'?

(b) Name ONE site of cell differentiation in a multicellular plant or animal that you have studied.

(c) What is ONE advantage of cell differentiation to an organism?

SECTION III

Attempt ALL questions.
Questions 21–28 are worth 5 marks each.
Answer this Section in the Section III Answer Book.
Show all necessary working in questions involving calculations.
Marks may be awarded for relevant working.

21. (a) State whether a reaction would occur, and write any relevant equation(s) when:

(i) a piece of iron is placed in a solution of tin(II) chloride;

(ii) a piece of copper is placed in a solution of magnesium sulfate;

(iii) a piece of aluminium is placed in hydrochloric acid.

(b) In the extraction of iron from iron ore, magnetite (Fe_3O_4) is progressively reduced to iron metal according to the following equations:

$$Fe_3O_4(s) + CO(g) \rightarrow 3FeO(s) + CO_2(g)$$

$$FeO(s) + CO(g) \rightarrow Fe(s) + CO_2(g)$$

Calculate the mass of iron produced when 23·155 g of magnetite is reduced. Show all working.

22. (a) This question refers to carbon compounds containing FIVE carbon atoms.

Give:

(i) the molecular and structural formula for the unbranched alkane molecule;

(ii) the structural formula for a primary alkanol;

(iii) the structural formula of an alkene.

(b) (i) What are the elements present in nucleic acids?

(ii) Name the structural units in nucleic acids.

23. (a) Pyrite (FeS_2) is a mineral that can be used as a source of sulfur in the manufacture of sulfuric acid, H_2SO_4.

Calculate the maximum mass of H_2SO_4 that could be produced from 1 tonne of FeS_2, assuming the conversion of FeS_2 to H_2SO_4 occurs by the given sequence of chemical reactions:

$$4\,FeS_2(s) + 11\,O_2(g) \xrightarrow{\text{heat}} 2\,Fe_2O_3(s) + 8\,SO_2(g)$$

$$2\,SO_2(g) + O_2(g) \xrightarrow[\text{catalyst}]{V_2 0_5} 2\,SO_3(g)$$

$$SO_3(g) + H_2O(l) \longrightarrow H_2SO_4(l)$$

(b) When concentrated sulfuric acid (18 mol L^{-1}) is added to sodium chloride and the mixture heated gently, hydrogen chloride gas and sodium hydrogen sulfate are produced.

(i) Write a balanced equation to represent this reaction.

(ii) Calculate the volume of gas, measured at 101·3 kPa and 298 K, that could be produced when 4·0 mL of 18 mol L^{-1} sulfuric acid and 4·09 g of sodium chloride are reacted.

(iii) What mass of sodium hydrogen sulfate would be obtained from the reaction?

24. (a) A student determined the concentration of barium hydroxide in an aqueous solution by titration with hydrochloric acid, using a suitable indicator.

Experimental results:

- volume of barium hydroxide solution = 25·00 mL
- volume of hydrochloric acid required = 38·45 mL
- concentration of hydrochloric acid = 0·1060 mol L^{-1}.

(i) Write a balanced equation for the reaction.

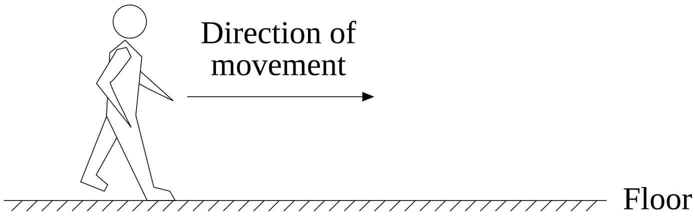
(ii) Calculate the concentration (mol L^{-1}) of the barium hydroxide solution.

(b) In another experiment, a student was asked to prepare insoluble calcium phosphate by reacting solid calcium oxide with phosphoric acid solution, $H_3PO_4(aq)$.

(i) Write a balanced equation for the reaction.

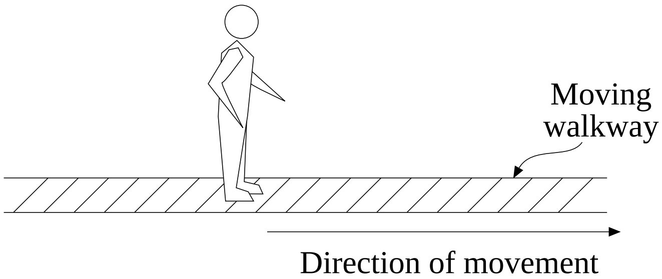
(ii) What volume of 0·156 mol L^{-1} phosphoric acid is required to react completely with 0·0200 mol of calcium oxide?

25. (a) A person of mass 50 kg walks 20 m across a floor at uniform speed in 6 s.



Are there any external forces doing work? Explain.

(b) The same person then stands on a moving walkway that travels 20 m in 6 s.



(i) In your Answer Book, draw and label all the external forces acting on the person (ignore the effect of the air).

(ii) Do any of these external forces do work? Explain.

(c) Account for any differences between your answers for part (a) and part (b)(ii).

26.

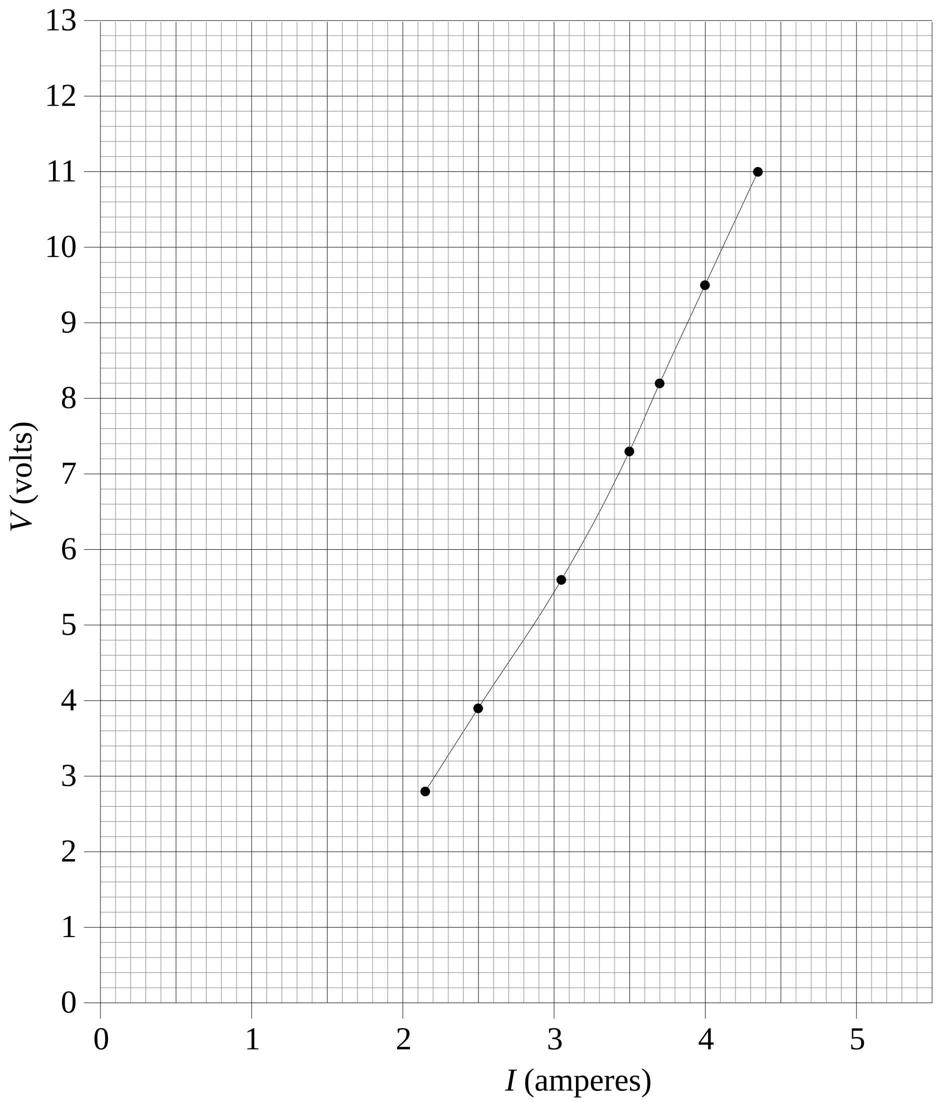
A ball of mass 100 g travelling at u m s^{-1}, on a frictionless surface, collides elastically with another ball of mass 300 g, which is travelling in the opposite direction with the same speed.

After the collision, the lighter ball rebounds, while the heavier ball remains stationary.

(a) Determine the speed of the lighter ball after the collision in terms of its initial speed (u) by applying the principle of conservation of momentum.

(b) Does the law of conservation of mechanical energy apply in this collision? Support your answer with calculations.

27. A student carried out an experiment to investigate the relationship between the voltage (V) and current (I) for a car headlamp. The student prepared the following graph from the results.



(a) Does this graph represent an ohmic device? Give a reason.

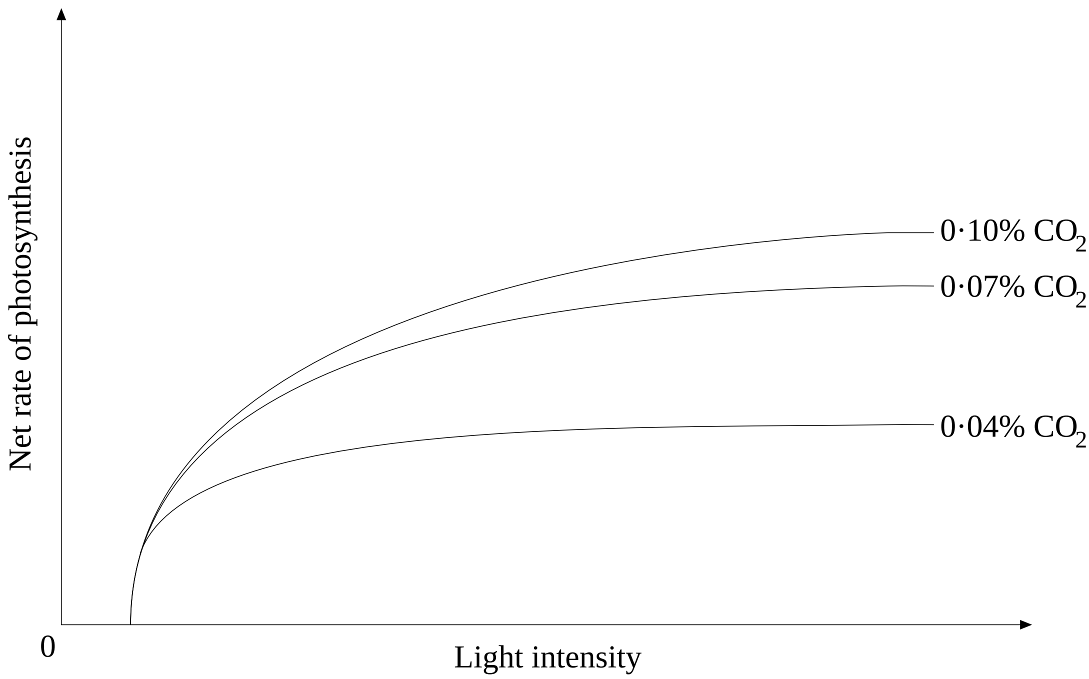
(b) What is the resistance of the headlamp when 4 V is applied?

(c) When a car battery of 12 V is connected to the headlamp, predict how much current is drawn from the battery.

(d) What is the power of the headlamp when it is operating at 12 V?

(e) How much energy is given out by the headlamp in 20 seconds if it is operating at 12 V?

28. A scientist calculated the net rate of photosynthesis of plants in environments of increasing light intensity at three different concentrations of carbon dioxide (CO_2). The results are shown in the graph below.



(a) What measurements would the scientist have to make to calculate the net rate of photosynthesis?

(b) Describe the relationship between light intensity and the net rate of photosynthesis for ONE carbon dioxide concentration.

(c) Describe the relationship between carbon dioxide concentration and the net rate of photosynthesis as light intensity increases.

(d) List TWO environmental factors that need to be maintained at constant levels in this experiment.

SECTION IV

Attempt ALL questions.

Questions 29–30 are worth 10 marks each.

Answer this Section in the Section IV Answer Book.

Show all necessary working in questions involving calculations.

Marks may be awarded for relevant working.

29. (a) Use the following table of data to answer this question.

Alkanol	*Boiling point* (°C)	*Molar mass* (g mol^{-1})
methanol	64·7	32
ethanol	78·3	46
1-propanol	97·2	60
1-butanol	117·7	74

(i) Plot the data and draw the line of best fit in your Answer Book.

(ii) Using only the information on the graph, predict the boiling point of water.

(iii) Account for the difference between the predicted and the actual boiling points of water.

(b) (i) State ONE property of water that allows it to be considered as the universal solvent.

(ii) Explain ONE way in which water is able to cause the weathering of rocks.

(iii) An experiment is carried out to determine the empirical formula of hydrated (blue) copper sulfate ($CuSO_4.xH_2O$).

A crucible and lid are heated to a constant mass. Hydrated copper sulfate is placed in the crucible and heated gently. Once the crackling and spitting have ceased, it is heated more strongly to remove the water only. The crucible and its contents are allowed to cool with the lid on. The mass of the crucible and its lid, and its contents is recorded.

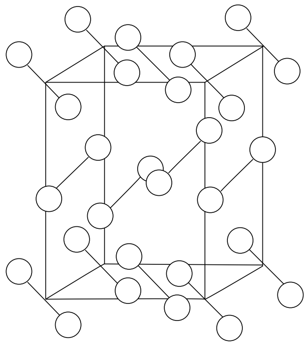
Data

Constant mass of crucible and lid	=	25·867 g.
Mass of hydrated copper sulfate	=	2·501 g.
Mass of crucible and lid, and contents	=	27·458 g after heating and cooling.

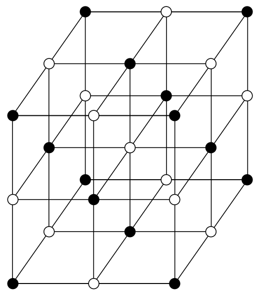
Calculate the value of x for the hydrated copper sulfate ($CuSO_4.xH_2O$).

29. (Continued)

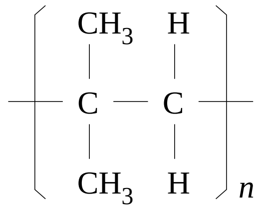
(c) Use the diagrams of the structures of the substances *P*, *Q*, and *R*, to answer this question.



P



Q



n = 100 to 20 000

R

(i) Which of the structures represents:

1. a molecular substance?

2. a polymer?

3. an ionic network?

(ii) Which of the substances is likely to be the most soluble in water? Explain your answer.

30. (a) Consider the following statements.

I. Organisms reproduce at a rate that could increase the population many times over during each generation. In natural populations though, numbers usually remain reasonably constant.

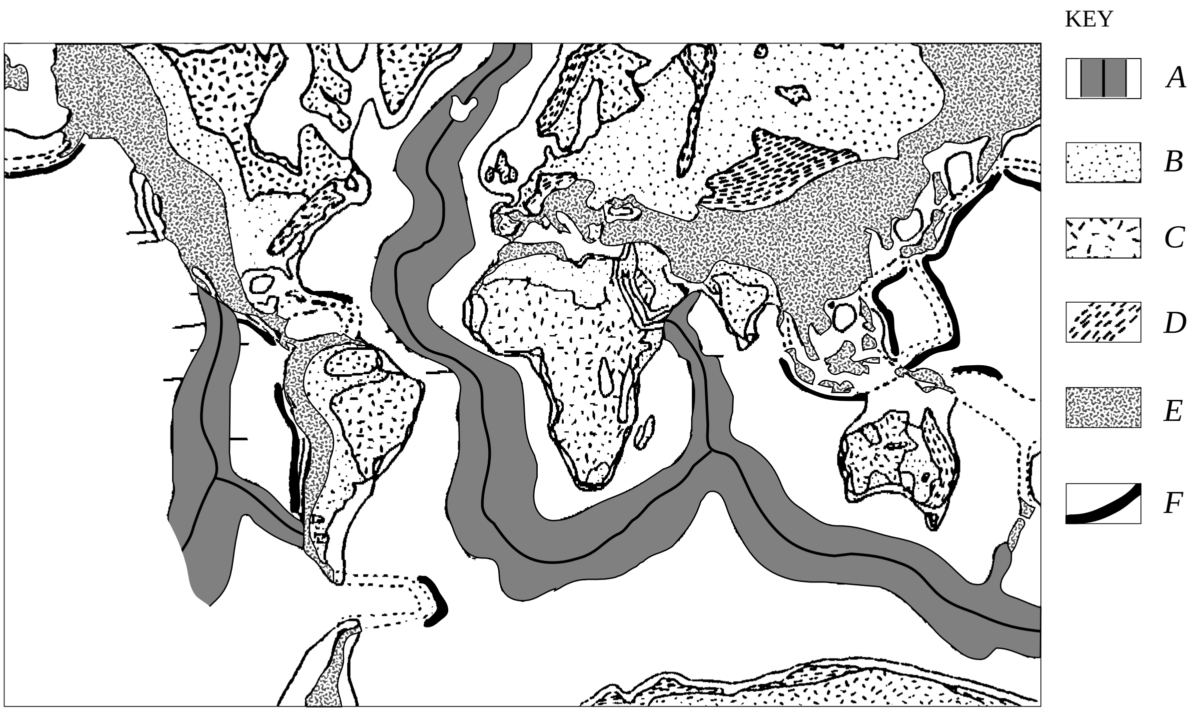
II. There is great variation between individuals within most species.

(i) Explain statement I in terms of natural selection.

(ii) How does the variation between individuals described in statement II come about?

(iii) Why is this variation important to the survival of a species?

(b) The following map shows the major structural regions of the ocean basins and continents. These regions have been labelled *A*, *B*, *C*, *D*, *E*, and *F* in the key.



(i) Select ONE of the regions *A*, *B*, *C*, *D*, *E*, or *F*.

1. Name the type of structural region.

2. Briefly explain the role that plate tectonics has played in the formation of the features of the region.

(ii) Crustal material moves from region *A* to region *F*. Describe, with the aid of a diagram, the mechanism that causes this motion.

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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	9·8 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	$4\pi \times 10^{-7}$ N 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-}	–0·57 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

Alyward and Findlay, *SI Chemical Data* (3rd 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	79	
	Au	Symbol of element
Atomic Mass	197·0	
	Gold	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

This sheet should be REMOVED for your convenience.