



HIGHER SCHOOL CERTIFICATE EXAMINATION

1995
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 Periodic Table and a Data Sheet are provided as a tear-out sheet at the back of this paper.

SECTION I

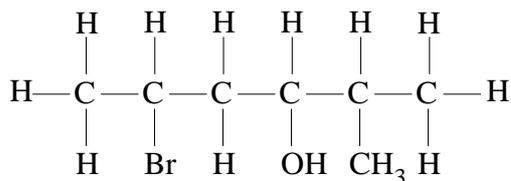
Attempt ALL questions.

Questions 1–10 are worth 1 mark each.

Mark your answers in pencil on the Answer Sheet provided.

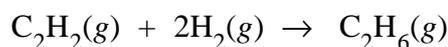
Select the alternative A, B, C, or D that best answers the question.

1.



The name for this structural formula is

- (A) 2-methyl-5-bromo-3-pentanol.
 (B) 5-bromo-2-methyl-3-hexanol.
 (C) 5-methyl-2-bromo-4-hexanol.
 (D) 2-bromo-4-hydroxy-5-methyl-heptanol.
2. 10 L of ethyne and 30 L of hydrogen are mixed. The reaction occurs in the presence of a platinum catalyst.



Assume that all gas volumes are measured at the same temperature and pressure. After complete reaction, the final volume of the gas mixture would be

- (A) 40 L
 (B) 30 L
 (C) 20 L
 (D) 10 L
3. The set of oxides that are all gases at room temperature and pressure is
- (A) B_2O_3 , CO_2 , NO
 (B) CO_2 , SiO_2 , NO_2
 (C) H_2O , N_2O , Cl_2O
 (D) CO_2 , NO_2 , SO_2

4. 2.00 g zinc is reacted with excess dilute hydrochloric acid. The mass of zinc chloride formed is
- (A) 0.24 g
 - (B) 3.08 g
 - (C) 4.17 g
 - (D) 7.48 g

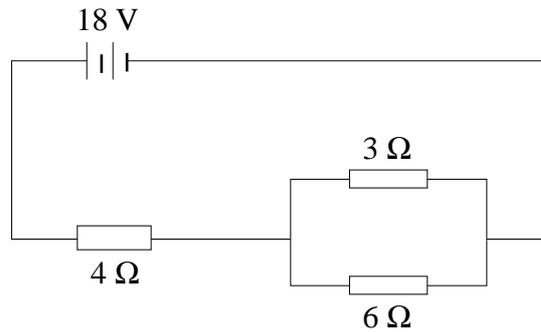
5. The percentage composition by mass of a compound containing carbon, chlorine, and fluorine is given as

<i>Element</i>	<i>Percentage</i>
carbon	10.0
chlorine	58.6
fluorine	31.4

The empirical formula of the compound is

- (A) CClF
 - (B) CCl_2F_2
 - (C) $\text{C}_2\text{Cl}_2\text{F}_2$
 - (D) CClF_2
6. A speedboat is driven over a smooth lake at constant velocity. The most correct explanation of its motion is that
- (A) the resultant force on the boat is zero, although the motor is working.
 - (B) a net resultant force is being exerted on the boat owing to water friction.
 - (C) a constant resultant force on the boat must exist to maintain constant velocity.
 - (D) no work is being done by the engine because the kinetic energy of the boat is constant.
7. An 80 kg explorer is stranded in a 2000 kg truck in the middle of a smooth frozen lake. He tries to push the truck in the direction he wants to go. As a result of his action, the truck will
- (A) not move, because it is too massive.
 - (B) move slowly, but he will slide in the opposite direction.
 - (C) not move, because the force he exerts on the truck is equal to the force the truck exerts on him.
 - (D) not move, because his feet slip on the ice.

8. A battery of negligible internal resistance and an e.m.f. of 18 V is connected to three resistors as shown.



The current in amperes through the 6-ohm resistor is

- (A) 2
(B) 3
(C) 6
(D) 1
9. Anaerobic respiration in cells
- (A) releases less energy than aerobic respiration.
(B) occurs only in the dark.
(C) releases more energy than aerobic respiration.
(D) does not involve enzyme activity.
10. A geologist carried out some heat-flow measurements. The highest heat-flow measurement recorded would be associated with
- (A) subduction zones.
(B) mid-ocean ridges.
(C) fold mountain ranges.
(D) shield areas.

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.

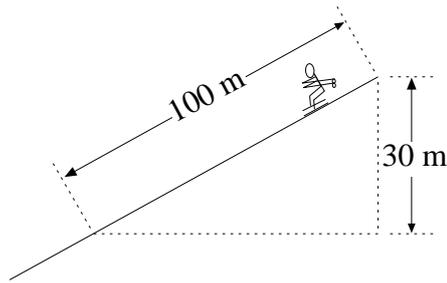
Marks may be awarded for relevant working.

- 11.** Antacid tablets act to neutralize acid in the stomach. Some antacid tablets contain magnesium hydroxide.
- Write a balanced equation for the reaction between magnesium hydroxide and hydrochloric acid.
 - If the stomach contained 400 mL of $1.0 \times 10^{-2} \text{ mol L}^{-1}$ hydrochloric acid, calculate the mass of magnesium hydroxide needed for complete neutralization.
- 12.** Ammonium bromide is a white solid.
- Calculate the relative formula mass of the solid.
 - Name the type of bonding in the ammonium ion.
 - Would an aqueous solution of ammonium bromide conduct an electric current? Explain.
- 13.** Crystals of silver can be produced when certain metals are placed in an aqueous solution of silver nitrate.
- Using a suitable metal, write the two half-equations and the overall equation to show how silver crystals could be produced.
 - Name the species that acts as the oxidant in the reaction.
- 14.** Carbon compounds have a widespread importance to people.

Complete the table *in your Answer Book*.

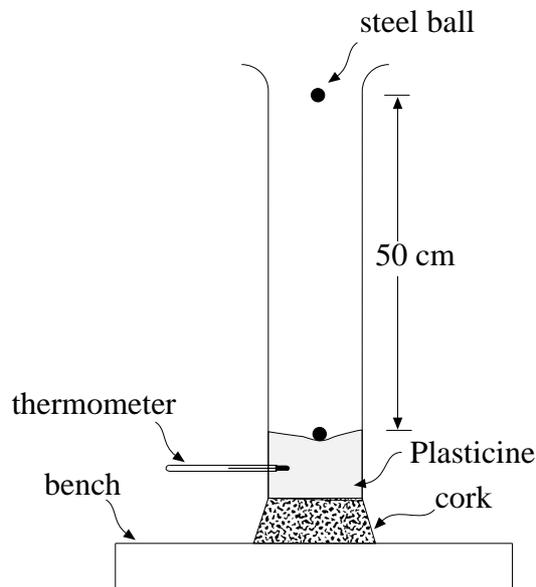
<i>Formula</i>	<i>Name of compound or compound group</i>	<i>Importance</i>
$\text{C}_2\text{H}_5\text{OH}$		solvent, fuel
	octane	
$\text{H}_2\text{NCH}_2\text{COOH}$		

15. A skier of mass 50 kg starts from rest and accelerates steadily downhill.



After she has travelled a distance of 100 m down the slope, she has descended 30 m vertically. Her speed at this point is 10 m s^{-1} .

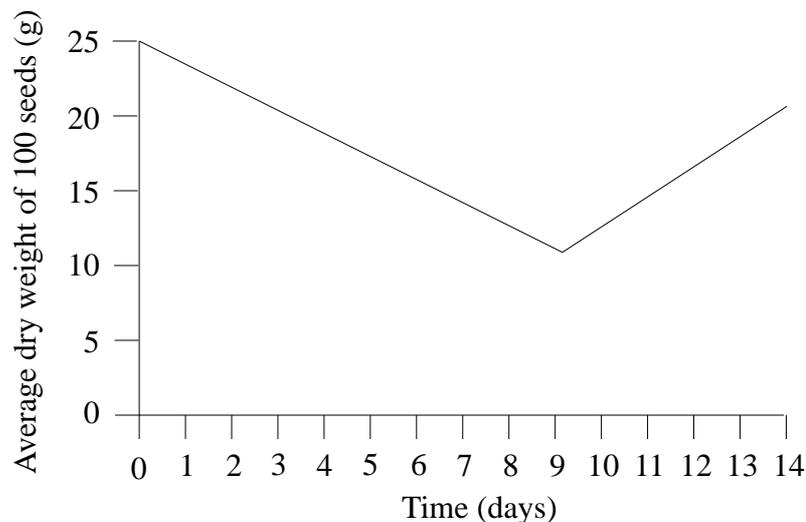
- (a) Calculate the change in her:
- potential energy;
 - kinetic energy.
- (b) Calculate the average opposing-force acting on her during her descent.
16. The diagram shows an experiment with a steel ball and Plasticine.



A 10 g steel ball is dropped 50 cm down a tube onto a lump of Plasticine. The experiment is carried out 100 times. A thermometer indicates that the temperature of the Plasticine rises. The temperature increases because the Plasticine has gained 2.9 joules of heat energy. Not all the available energy has been converted to heat.

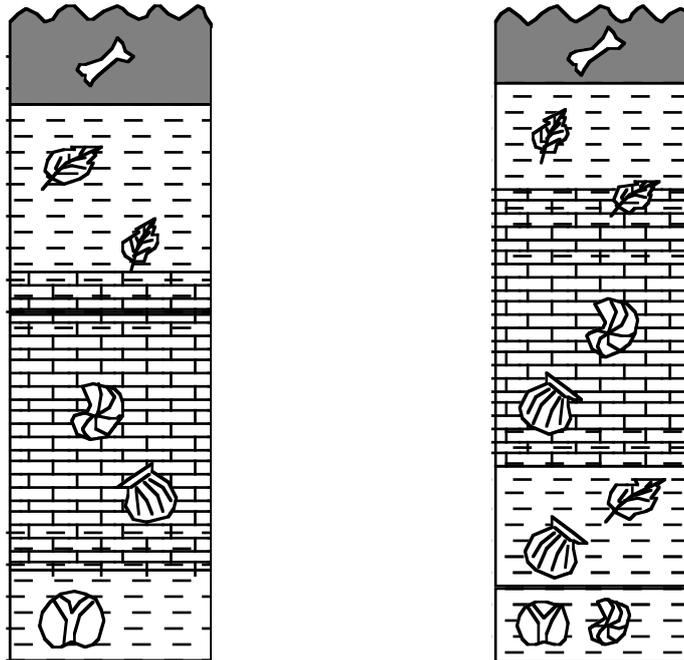
- (a) How much of the available energy has been lost?
- (b) Give TWO possible explanations for this loss in energy.

17. A 12 V, 48 W car headlamp is to be connected to a 16 V laboratory supply. A store of suitable resistors is available.
- Draw a circuit diagram to show how the headlamp and one resistor may be connected to the supply so that the headlamp does not burn out.
 - Calculate the value of the resistor that allows the lamp to operate at 48 W.
18. A driver and a car have a mass of 1100 kg. The car is travelling at 36 km h^{-1} when it collides with a stationary van of mass 2200 kg.
- Calculate the kinetic energy of the car just before impact.
 - If the car and the van are locked together on impact, calculate their combined velocity just after the collision. Ignore other external forces.
 - How much kinetic energy has been lost in the collision?
19. A scientist took a large number of bean seeds and placed them on wet filter paper in the light. Every day a sample of the seeds was taken, dried in an oven, and then weighed. The filter paper was kept constantly wet. After fourteen days the changes in dry weight were as shown.



- Explain why the dry weight of the seeds changes *during* the first nine days of the experiment.
- Explain why the dry weight of the seeds changes *after* the ninth day.
- Why is it necessary to obtain the dry weight of the seeds rather than weighing them immediately after removing them from the filter paper?

20. Below are two stratigraphic columns.



KEY TO FOSSILS

-  mammal bone
-  leaf
-  marine gastropod
-  marine mollusc
-  echinoid

KEY TO SEDIMENTS

-  mudstone
-  limestone
-  sandstone

- (a) The two stratigraphic columns can be correlated using the fossil evidence. Draw lines between the two columns in your Answer Book showing the beds that can be correlated.
- (b) Name ONE geological principle that allows you to correlate these beds.
- (c) Is the echinoid an index fossil? Explain your answer.

SECTION III

Attempt ALL questions.

Questions 21–28 are worth 5 marks each.

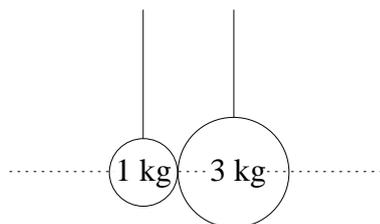
Answer this Section in the Section III Answer Book.

Show all necessary working in questions involving calculations.

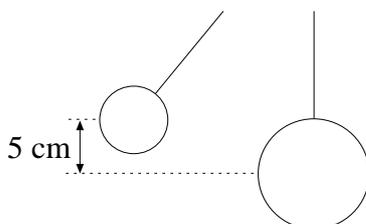
Marks may be awarded for relevant working.

- 21.** Nicotine, $C_{10}H_{14}N_2$, is a naturally occurring substance. When the substance is completely burnt in oxygen, the products are carbon dioxide, nitrogen (IV) oxide, and water.
- Write a balanced equation for this reaction.
 - Calculate the mass of nicotine needed to be burnt to produce 4.90 L of carbon dioxide at 298 K and 101.3 kPa.
 - Predict the likely pH of the solution produced if the products are bubbled through water. Explain your answer.
- 22.**
- Give the structural formula of sulfur trioxide.
 - Arrange the compounds SO_3 , SiO_2 , and CaO in order of increasing melting points.
 - Explain your answer for part (b) (i) in terms of *structure* AND *bonding* for EACH of the compounds.
- 23.** An acidic oxide, P_2O_5 , dissolves in water to produce a solution of H_3PO_4 .
- For solid P_2O_5
 - name this oxide;
 - write the equation for the production of H_3PO_4 from P_2O_5 .
 - In an experiment, a base is required to neutralize the acid H_3PO_4 .
 - 1.42 g of P_2O_5 is dissolved in enough water to make 100 mL of solution. Calculate the molar concentration of the H_3PO_4 solution. (The molar mass of P_2O_5 is 141.9 g mol^{-1} .)
 - Calculate the volume of $1.0 \times 10^{-1} \text{ mol L}^{-1}$ NaOH needed to completely neutralize 25 mL of this acid.

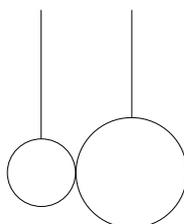
24. Two balls of mass 1 kg and 3 kg are suspended from light strings and hang just touching one another.



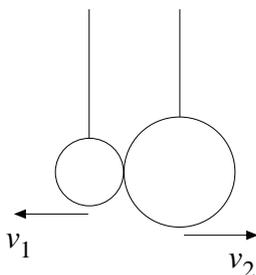
The lighter ball is drawn aside, so that its centre is 5 cm above its resting position.



It is now released and makes an *elastic* collision with the stationary ball.



- (a) (i) Determine the velocity of the lighter ball at the moment of impact by applying the principle of conservation of mechanical energy.
- (ii) Why can the above principle be applied to this situation?
- (b) After the collision, the balls separate with velocities of *equal magnitude* but opposite directions.

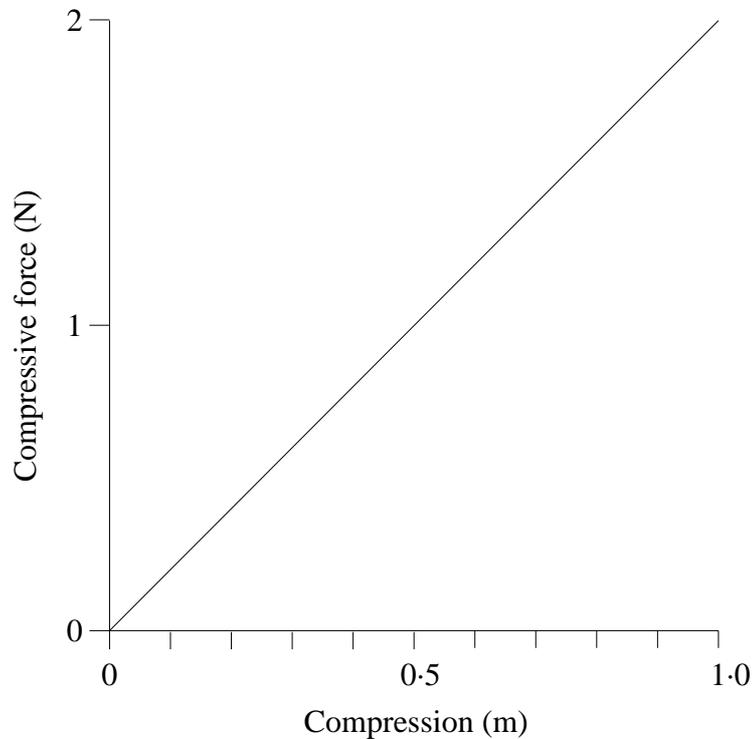


- (i) Determine the velocity of one of the balls immediately after impact by applying the principle of conservation of momentum.
- (ii) Justify your answer to part (b) (i) by using conservation of kinetic energy in this elastic collision.

25. A bullet of mass 3.0 g travelling horizontally at 600 m s^{-1} strikes and embeds itself in a 2.0 kg block of wood resting on a smooth horizontal surface as shown.

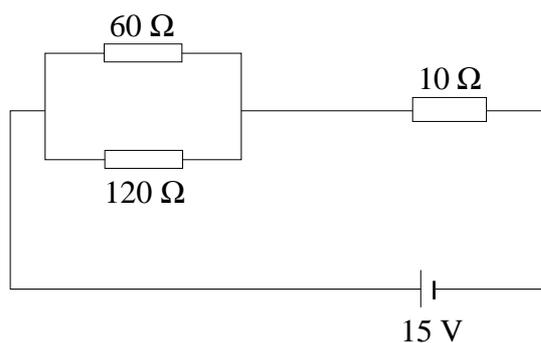


A strong spring resists the motion of the block with the embedded bullet. The graph shows how the compressive force varies with the compression of the spring.



- (a) Calculate:
- the *velocity* of the block and bullet immediately after impact;
 - the *kinetic energy* of the block and bullet immediately after impact.
- (b) What does the area under the line on the graph represent?
- (c) There is a loss of mechanical energy during the collision. Explain.

26. A student connects three resistors to a 15 V supply as shown in the circuit diagram.



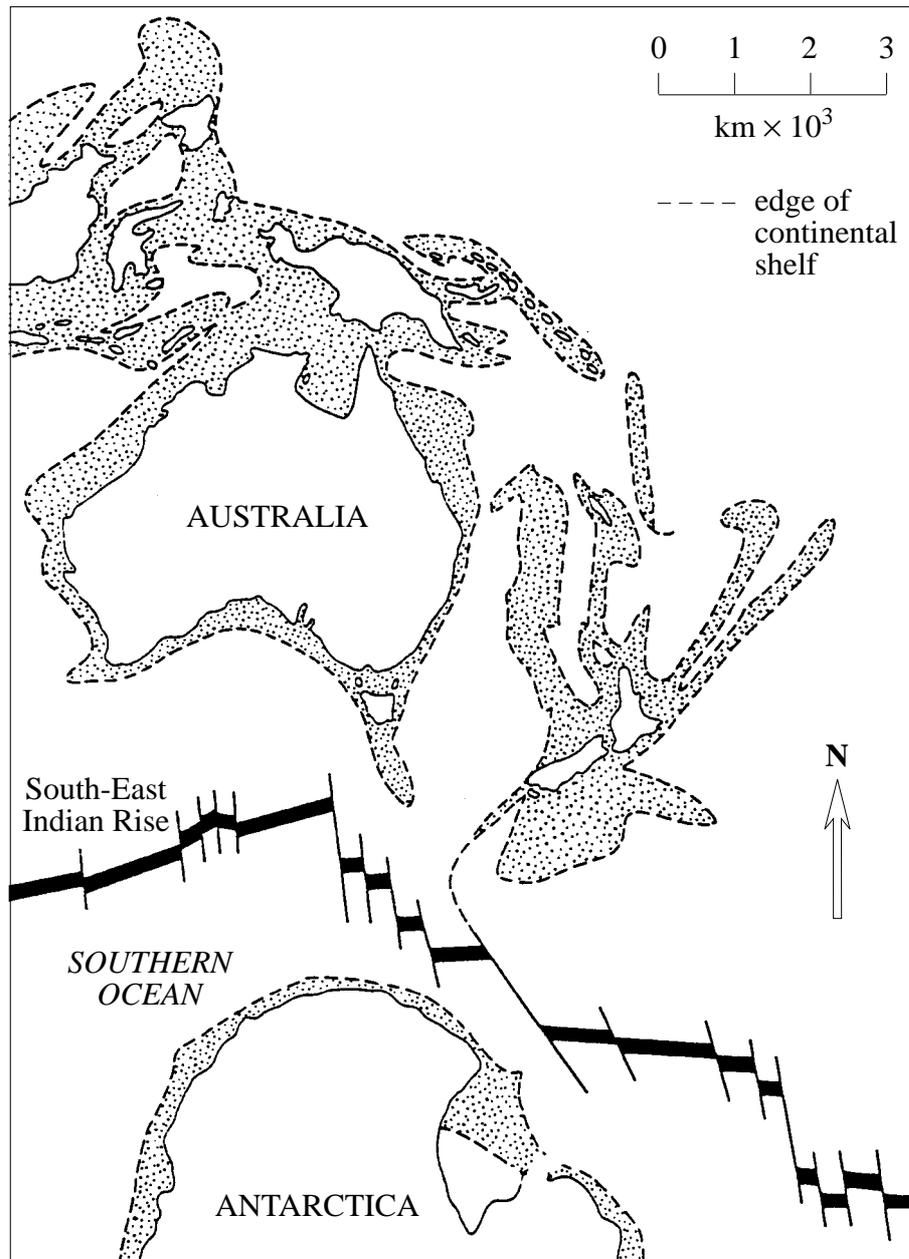
Calculate:

- the total resistance of the circuit;
 - the voltage drop across each resistor;
 - the energy given out each second from each of the resistors.
27. A scientist grows samples of a water plant in a laboratory. The samples are maintained under bright light conditions in solutions at different temperatures. The rate of oxygen production by photosynthesis is measured. The results are summarized as shown.

<i>Temperature</i> (°C)	<i>Rate of O₂ production</i> (mg h ⁻¹)
5	3
10	15
15	21
20	26
25	29
30	29
35	25

- Plot the data and draw a graph on the graph paper provided in your Answer Book.
 - Describe the relationship between temperature and photosynthesis.
- Name two factors that would need to be controlled in this experiment.
- If these plants were growing in a creek rather than the laboratory, name another factor that could affect the production of new plant matter.

28. The diagram shows the present position of Australia and Antarctica.



It has been suggested that Australia and Antarctica were joined 55 million years ago. Whilst Antarctica has remained almost stationary since that time, Australia has moved steadily northwards.

- Explain THREE pieces of evidence that you would look for in the Southern Ocean to support the hypothesis that Australia and Antarctica have moved apart.
- Name the kind of structure that would have developed between Australia and Antarctica just prior to parting 55 million years ago?
- What is the average rate (speed) at which Australia has moved northwards from Antarctica?

SECTION IV

Attempt ALL questions.

Questions 29–30 are worth 10 marks each.

Answer this Section in the Section IV Answer Book.

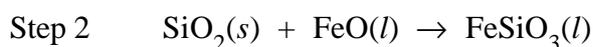
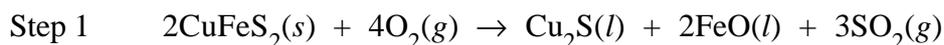
Show all necessary working in questions involving calculations.

Marks may be awarded for relevant working.

29. (a) Aluminium, copper, magnesium, and tin are each reacted with dilute sulfuric acid.
- (i) Which of these metals is most easily oxidized?
 - (ii) For the metal chosen in part (i) above, write the two half-equations and the overall equation for the metal's reaction with dilute sulfuric acid.
 - (iii) Name the salt produced by this reaction.

- (b) To obtain copper from the ore CuFeS_2 , several steps are involved: concentrating, smelting, and electrorefining.

There are usually three chemical changes in the extraction process.



Step 3 $\text{Cu}_2\text{S}(l)$ is reacted with oxygen to produce copper metal.

- (i) By referring to Step 1, write the half-equation for the reduction of copper ions in CuFeS_2 .
 - (ii) Write the balanced equation for Step 3.
 - (iii) In Step 1, is the sulfur in CuFeS_2 being oxidized or reduced in forming SO_2 ? Explain.
 - (iv) In 1991, Australia extracted 180 000 tonnes of copper. In that year, how many tonnes of sulfur dioxide were produced by Step 3? (1 tonne = 1000 kg)
 - (v) Oxides of sulfur dissolve in water. What type of solution is formed?
- (c) Tin is a metal that can be extracted from its ore, tin(IV) oxide. This is done with the use of carbon in a series of steps.

Step 1. Carbon, in the form of coal, reacts with carbon dioxide to produce carbon monoxide.

Step 2. The tin(IV) oxide reacts with the carbon monoxide to produce tin and carbon dioxide (which is then recycled to be used in Step 1).

Write balanced equations to represent each of Steps 1 and 2.

30. (a) Describe briefly ONE generally accepted scientific theory for the origin of life on earth.
- (b) A number of different radioactive isotopes are used to estimate the ages of rocks and fossils. The half-lives of the isotopes ^{14}C and ^{40}K are shown in the table.

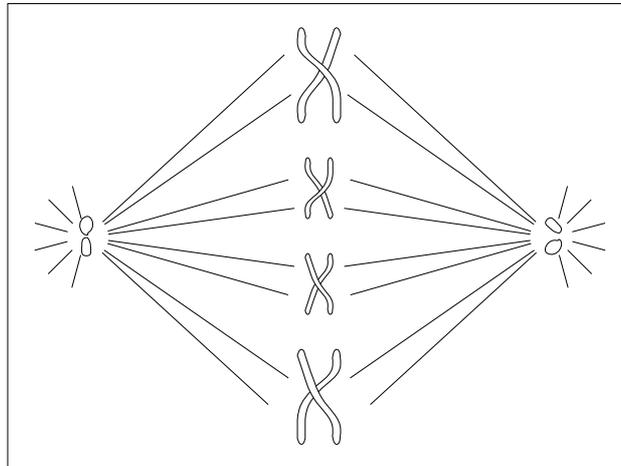
<i>Isotope</i>	<i>Half-life</i>
^{14}C	5600 years
^{40}K	1300 million years

A jawless fish was one of the first vertebrates. Which isotope would be used to estimate the age of a fossil of a jawless fish? Explain your answer.

- (c) Charles Darwin explained the current diversity of lifeforms. He suggested that populations of individual species become adapted to their local environments through the mechanism of natural selection. Darwin supported his theory of evolution with evidence, and subsequent discoveries have provided further evidence.

Discuss THREE pieces of evidence that support the theory of evolution. Give an example in each case.

- (d) The diagram shows a cell undergoing cell division.



- (i) Name this type of cell division.
- (ii) State the significance of this type of cell division.
- (iii) What is the limitation of this type of cell division?

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PERIODIC TABLE

											2 He 4.003 Helium																												
											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																							
											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.06 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon																							
3 Li 6.941 Lithium	4 Be 9.012 Beryllium	11 Na 22.99 Sodium	12 Mg 24.31 Magnesium	19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.90 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 58.71 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 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	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140

KEY

Atomic Number

79

Au

197.0

Gold

Symbol of element

Name of element

1

H

1.008

Hydrogen

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.



STUDENT NUMBER

CENTRE NUMBER

HIGHER SCHOOL CERTIFICATE EXAMINATION

1995

SCIENCE

3/4 UNIT

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.

EXAMINER'S USE ONLY

Marker	Total	Checked

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

EXAMINER'S
USE ONLY

11. (a)
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(b)
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12. (a)
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(b)

(c)
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13. (a)
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- (b)
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14.

<i>Formula</i>	<i>Name of compound or compound group</i>	<i>Importance</i>
C_2H_5OH		solvent, fuel
	octane	
H_2NCH_2COOH		

15. (a) (i)
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- (ii)
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- (b)
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EXAMINER'S
USE ONLY

16. (a)

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(b)

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17. (a)

(b)

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18. (a)

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19. (a)

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(b)

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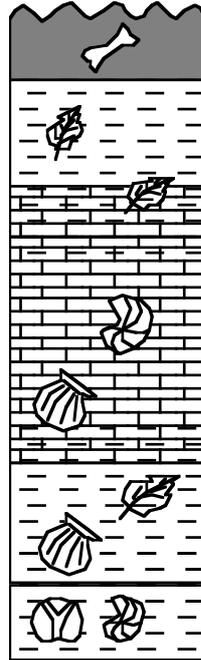
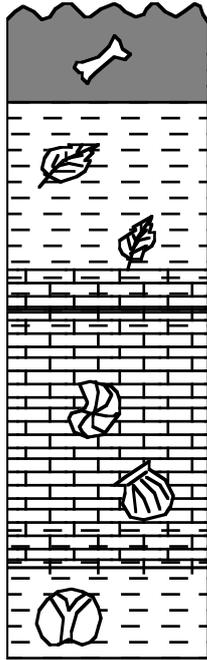
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(c)

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20. (a)



(b)

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(c)

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STUDENT NUMBER

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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.

EXAMINER'S USE ONLY

Marker	Total	Checked

22. (a)

(b) (i) Order of increasing melting points:

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(ii)

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EXAMINER'S
USE ONLY

- 23.** (a) (i)
- (ii)
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- (b) (i)
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- (ii)
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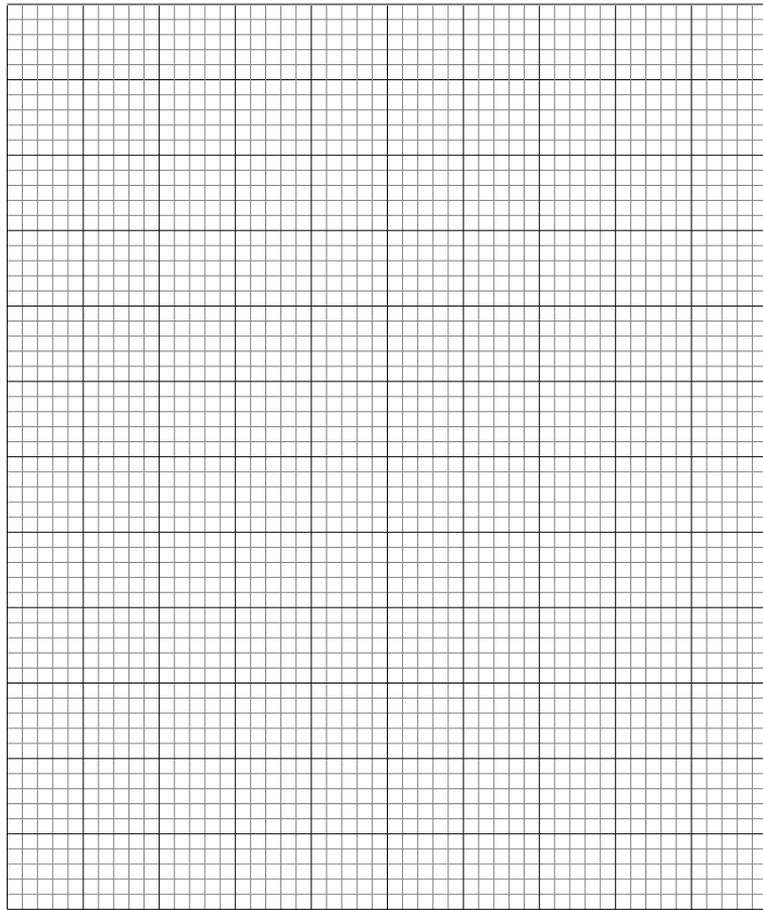
EXAMINER'S
USE ONLY

- 24.** (a) (i)
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- 25.** (a) (i)
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- 26.** (a)
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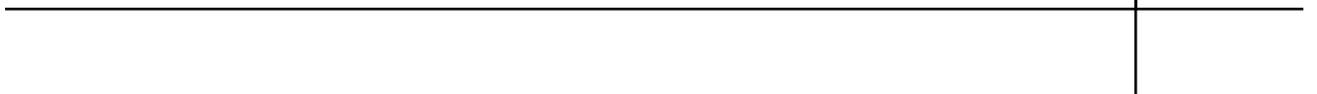
27. (a) (i)



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(b)
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EXAMINER'S
USE ONLY

28. (a)
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STUDENT NUMBER

CENTRE NUMBER

HIGHER SCHOOL CERTIFICATE EXAMINATION

1995

SCIENCE

3/4 UNIT

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 to 30 in this Answer Book.
- Each question is worth 10 marks.

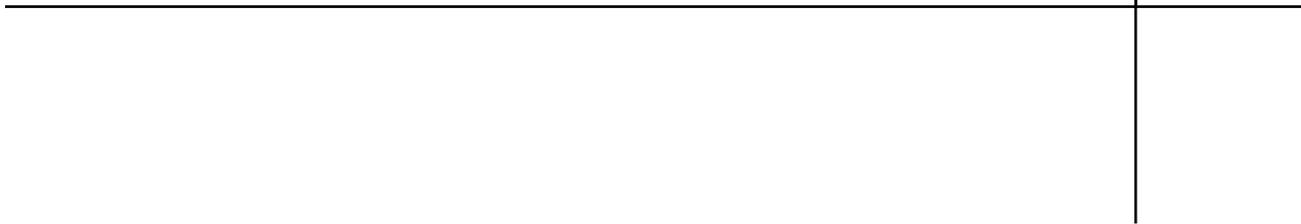
EXAMINER'S USE ONLY

Marker	Total	Checked

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

EXAMINER'S
USE ONLY

- 29.** (a) (i)
- (ii)
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- (iii)
- (b) (i)
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- (ii)
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- (iii)
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- (iv)
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- (v)
- (c)
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30. (Continued)

EXAMINER'S
USE ONLY

- (d) (i)
- (ii)
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- (iii)
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