

- 1 A student wrote four statements about the Kinetic Particle Theory in his notebook.

- I At the melting point, the particles can slide and roll over one another.
- II In a solid, the particles are stationary and held in fixed positions due to strong forces of attraction.
- III When a solid is heated, the particles expand and become larger.
- IV When the boiling point is reached, evaporation and boiling start to take place and the gas is formed.

Which statement(s) are correct?

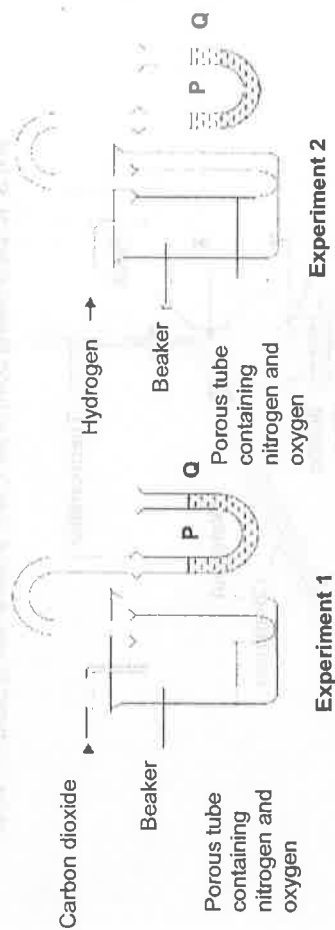
- A I only
- B I and II only
- C I, II and III only
- D I, II, III and IV

- 2 For which of the following processes will there be a decrease in the internal energy for the same substance?

- A boiling at a constant temperature
- B condensing at a constant temperature
- C evaporating at a constant temperature
- D melting at a constant temperature

[Turn over

- 3 The diagram shows two experiments used to demonstrate the diffusion of gases.



What would you expect to observe during the first few minutes of each experiment?

	Experiment 1	Experiment 2
A	P is higher than Q	Q is higher than P
B	P and Q remain the same	P and Q remain the same
C	P and Q remain the same	Q is higher than P
D	Q is higher than P	P is higher than Q

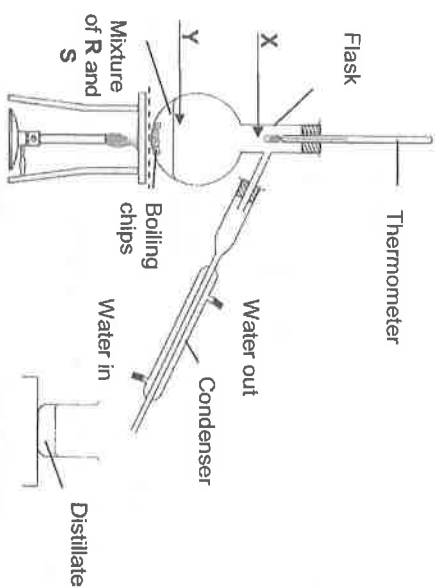
- 4 The properties of three dyes found in a food sample are shown.

Dye	Solubility in solvent X	Solubility in solvent Y	Boiling point/ $^{\circ}\text{C}$
1	soluble	soluble	84
2	soluble	insoluble	92
3	soluble	insoluble	84

Which of the following methods is used to separate dye 1 in a 50 g food sample?

- A chromatography using solvent X
- B chromatography using solvent Y
- C dissolve sample in solvent Y followed by filtration
- D fractional distillation and condensation of the vapour

- 5 The diagram below shows the fractional distillation of a mixture of two liquids **R** and **S**. **R** has a boiling point of 80°C and **S** has a boiling point of 110°C .



Which statement about this experiment is correct?

- A The boiling chips are added to increase the rate of reaction.
- B The liquid left in the flask contains more **S** than **R**.
- C The temperature at point **X** is higher than the temperature at point **Y**.
- D The vapour at point **X** contains more **S** than **R**.

- 6 Which of the following has a giant covalent molecular structure?

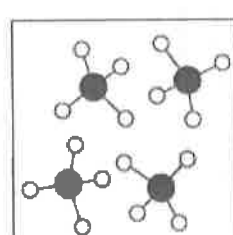
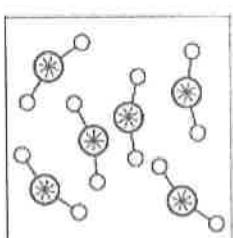
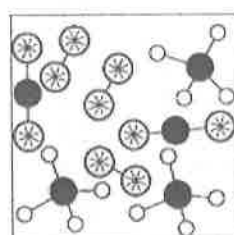
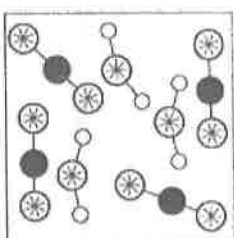
- A diamond
- B ice
- C iodine
- D magnesium oxide

[Turn over

- 7 Which of the substances **A** to **D** is likely to be an element?

- A Substance **A** burns in air to form carbon dioxide and water.
- B On heating substance **B**, a gas is evolved and a solid residue is left.
- C When an electric current is passed through substance **C**, it does not decompose.
- D Substance **D** produces different fractions when distilled.

- 8 The figures below are students' drawings of the particles in gases. Which of the students' drawings, **A**, **B**, **C** or **D**, best represents a mixture of compounds and an element?



- 9 An isotope of element X has 17 protons and 20 neutrons in its nucleus. Which symbol is correct for the ion of X?

A ${}^{20}_{17}\text{X}^{+}$
 B ${}^{20}_{17}\text{X}^{-}$
 C ${}^{37}_{17}\text{X}^{+}$
 D ${}^{37}_{17}\text{X}^{-}$

- 10 When 20 cm³ of a gaseous hydrocarbon were completely burnt in an excess of oxygen, 60 cm³ of carbon dioxide and 40 cm³ of water vapour were formed, all volumes being measured at the same temperature and pressure.

What is the formula of this hydrocarbon?

A C₂H₆
 B C₃H₄
 C C₃H₆
 D C₃H₈

- 11 What volume of water must be added to 100cm³ of 2 moldm⁻³ solution to obtain a new concentration of 0.5 moldm⁻³?

A 250 cm³
 B 300 cm³
 C 400 cm³
 D 500 cm³

[Turn over

- 12 N₂O₄ is a poisonous gas. It can be disposed off safely by reacting with sodium hydroxide.



What is the minimum volume of 0.5 moldm⁻³ NaOH(aq) needed to dispose of 0.02 mol of N₂O₄?

A 0.08 cm³
 B 20 cm³
 C 40 cm³
 D 80 cm³

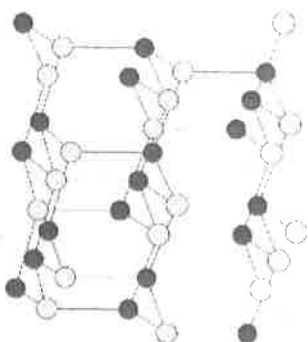
- 13 An element R has two isotopes, ¹⁶R and ¹⁸R. Its relative atomic mass is 16.4. In what proportion is the heavier isotope present in the environment?

A 20%
 B 30%
 C 40%
 D 50%

- 14 The proton numbers of elements, X, Y and Z are 4, 6 and 8 respectively. Which of the following lists gives the correct formulae of the compounds formed between X, Y and Z?

A XZ YZ₂ XYZ₃
 B XZ YZ₂ XYZ₄
 C XZ YZ₂ XYZ₆
 D X₂Z YZ XYZ₃

- 15 The compound silicon carbide has the structure shown in the diagram.



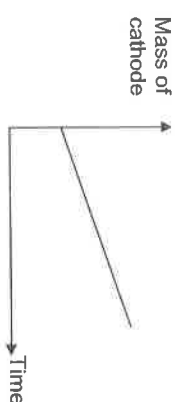
Silicon carbide

Which set of properties will silicon carbide have?

	Physical state	When strongly heated in oxygen
A	hard solid	melts at high temperature, no chemical change
B	soft plastic	solid burns slowly, giving a solid residue
C	soft slippery	solid burns, leaving no solid residue
D	very hard solid	burns slowly, leaving a solid residue and a colourless gas

[Turn over

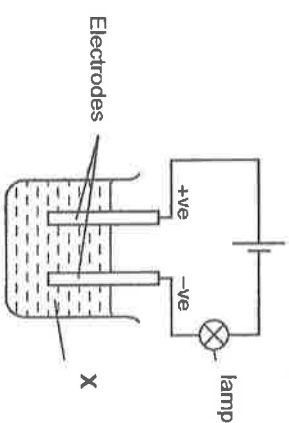
- 16 An aqueous solution T is electrolysed. The current is constant, and the cathode is weighed at regular intervals. The graph below is obtained when the mass of cathode is plotted against time.



Which of the following will **not** produce the graph above?

	Cathode	Anode	Solution T
A	copper	copper	copper(II) nitrate solution
B	graphite	graphite	copper(II) nitrate solution
C	graphite	graphite	dilute sulfuric acid
D	graphite	silver	silver nitrate solution

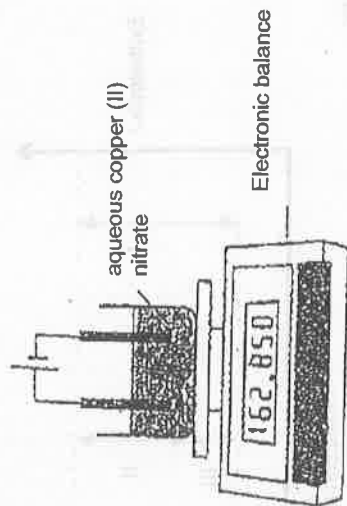
- 17 When the circuit is closed in the set-up below, the bulb lights up, but there are no observable changes at the electrodes.



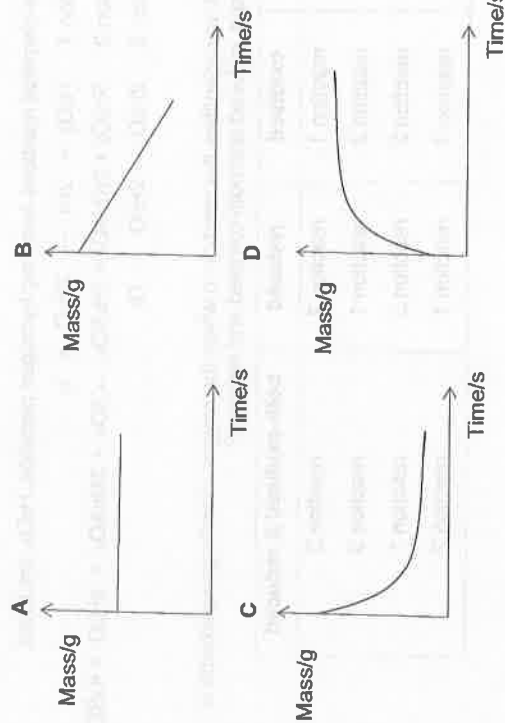
What is X?

- A Aqueous silver nitrate
 B Concentrated potassium nitrate solution
 C Lead (II) iodide
 D Mercury

- 18 The diagram shows the electrolysis of aqueous copper (II) nitrate using carbon electrodes.



Which of the following graphs represents the change in mass over time for this experiment?



[Turn over

- 19 Three electrochemical cells are set up using copper metal which is paired with three unknown metals, U, V and W as electrodes. Each cell is immersed in dilute sulfuric acid of the same concentration.

Figure 19.1 shows the set-up of electrochemical cell 2.

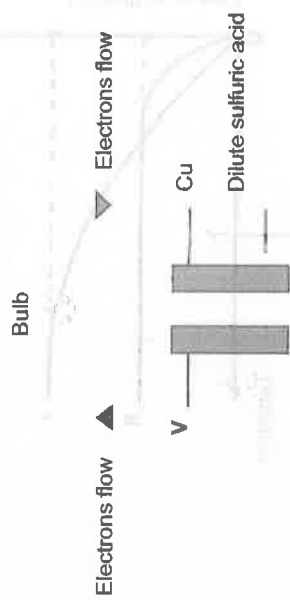


Fig 19.1

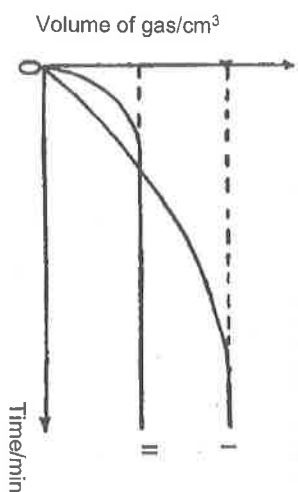
The voltage produced in each cell is given in the table below.

Electrochemical cell	Metals used	Voltage / V
1	Cu, U	-0.45
2	Cu, V	+1.11
3	Cu, W	+2.71

From these results, deduce which of the following lists the metals in the correct order of increasing ease of oxidation.

- A U V Cu W
B U Cu V W
C W Cu V U
D W V Cu U

- 20 In the graph, curve I represents the results of reacting 1.0 g of magnesium granules with an excess of acid at 40°C



Which of the following changes could produce curve II?

- A Using 0.5 g of magnesium granules and an excess of acid at 30°C.
- B Using 0.5 g of magnesium powder and an excess of acid at 50°C.
- C Using 1.0 g of magnesium granules and an excess of acid at 30°C.
- D Using 1.0 g of magnesium powder and an excess of acid at 30°C.

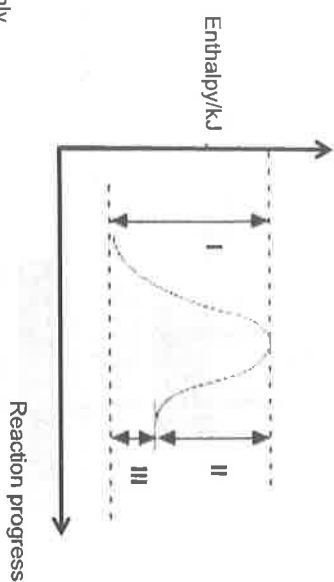
- 21 A piece of zinc foil dissolved completely in 20 cm³ of a dilute sulfuric acid solution, with the volume of hydrogen evolved noted at equal, short time intervals. Another piece of zinc foil of the same surface area and mass was added to 40 cm³ of the same solution of dilute sulfuric acid.

How will the initial rate of reaction and the total volume of hydrogen evolved in this second experiment compare to the first experiment?

	Initial rate of reaction	Total volume of hydrogen evolved
A	increase	increase
B	increase	no change
C	no change	no change
D	no change	increase

Turn over

- 22 Which of the quantities in the enthalpy profile diagram below is/are affected using a catalyst?



- A II only
- B III only
- C I and II only
- D I and III only

- 23

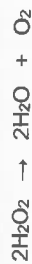
Three chemical reactions involving hydrogen peroxide, H_2O_2 , are listed.



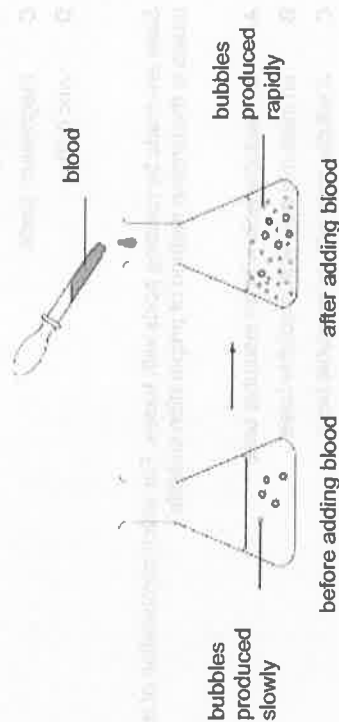
Which row identifies the reaction in which the oxygen of hydrogen peroxide is oxidised, reduced and both oxidised and reduced?

	oxidised	reduced	both oxidised & reduced
A	reaction 1	reaction 2	reaction 3
B	reaction 2	reaction 1	reaction 3
C	reaction 2	reaction 3	reaction 1
D	reaction 3	reaction 1	reaction 2

- 24 A solution of hydrogen peroxide releases oxygen slowly at room temperature.



The illustration below shows the effect of adding blood to the solution



What could be the reason for the observed change?

- A Blood contains an enzyme.
- B Blood contains water.
- C The hydrogen peroxide becomes more concentrated.
- D The hydrogen peroxide is neutralised by blood.

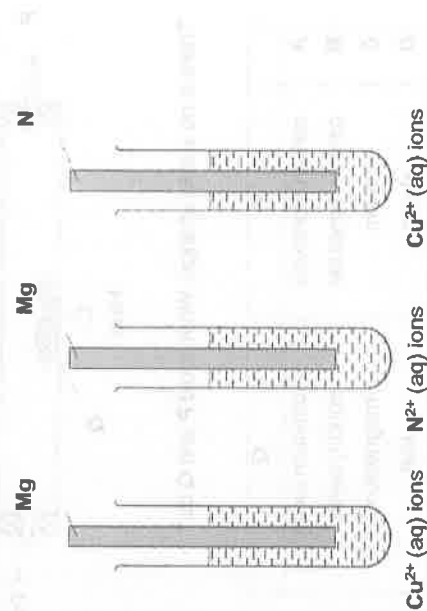
- 25 The propellant used in the solid rocket booster for a space shuttle is a mixture of aluminium and compound X. Compound X contains chlorine with an oxidation state of +7.

Which of the following could be compound X?

- A NaClO_3
- B NH_4Cl
- C NH_4ClO_3
- D NH_4ClO_4

[Turn over]

- 26 Three test tubes were arranged as in the diagram below. Each test tube contained a piece of one metal, half-immersed in an aqueous solution containing the ions of one of the other two metals. A deposit was formed in all three test tubes.



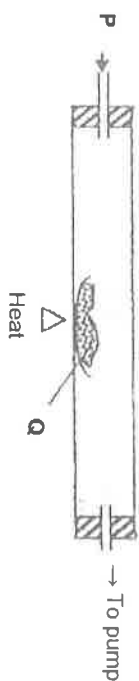
Metal N could be

- A aluminium
- B calcium
- C silver
- D zinc

- 27 A metal X, has the same number of valence electron as sodium. X is expected to

- A displace hydrogen from cold water.
- B form an insoluble chloride.
- C form an acidic oxide.
- D form a nitrate of formula $\text{X}(\text{NO}_3)_2$.

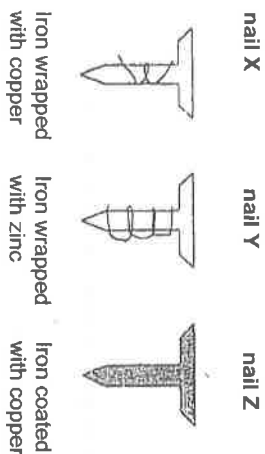
- 28 Examine the apparatus shown below.



There is no visible change. What could **P** and **Q** be?

	P	Q
A	carbon monoxide	aluminium oxide
B	carbon monoxide	iron(III) oxide
C	steam	magnesium
D	steam	iron

- 29 The diagram below shows an experiment used to investigate rusting in iron nails.



Which nail(s) will rust in air after some time?

- A X only
B X and Y
C Y and Z
D X and Z

[Turn over

- 30 Which of the following does **not** dissolve in excess sodium hydroxide?

- A carbon dioxide
B lead(II) hydroxide
C magnesium oxide
D zinc oxide

- 31 Salts are made by reacting acids with bases. For which combination of acids and bases is the titration method of preparation suitable?

- A an insoluble acid with an insoluble base
B an insoluble acid with a soluble base
C a soluble acid with an insoluble base
D a soluble acid with a soluble base

- 32 An element **X** burns in oxygen to produce a white oxide, which is sparingly soluble in water, giving an alkaline solution.
Which of the following could be **X**?

- A calcium
B copper
C phosphorus
D sulfur

- 33 Which of the following statements correctly describes a trend in the properties of the elements, going from left to right of Period 2 of the Periodic Table?

- A The ability of the elements to conduct electricity increases.
B The number of neutrons in the atoms decreases.
C The melting point of the elements increases.
D The ability to form positive ions decreases.

- 34 Astatine is a halogen which has a greater atomic mass than iodine. It is expected that astatine

- A displaces iodine from potassium iodide solution.
- B has a darker colour than iodine.
- C has a lower melting point than iodine.
- D is more reactive than iodine.

- 35 The results of some tests on fertiliser X are listed below.

- Warming X with aqueous sodium hydroxide gave a gas which turned damp red litmus paper blue.
- Mixing aqueous X with acidified barium chloride did not give a white precipitate.
- Mixing aqueous X with acidified silver nitrate gave a white precipitate.

Which ions does fertiliser X contain?

- A ammonium and chloride
- B ammonium and nitrate
- C ammonium and sulfate
- D potassium and chloride

- 36 Compound X has the following properties.

- Compound X is an ionic solid at room temperature.
- Compound X consists of ions in aqueous state.
- Compound X decomposes into covalent compounds when heated.

What is X?

- A ammonium chloride
- B barium chloride
- C sodium oxide
- D zinc carbonate

[Turn over

- 37 Calcium carbonate is formed by mixing 10 cm^3 of 0.2 mol/dm^3 solution calcium chloride with 20 cm^3 of 0.2 mol/dm^3 potassium carbonate.

What are the ions present in the resulting solution?

- A K^+ and Cl^-
- B K^+ , Cl^- and Ca^{2+}
- C K^+ , Cl^- and CO_3^{2-}
- D K^+ , Cl^- , Ca^{2+} and CO_3^{2-}

- 38 Which fraction and its respective use is correct?

	Fraction	Use
A	diesel	Fuel in lamps
B	paraffin (kerosene)	Aircraft fuel
C	lubricating fraction	As feedstock for chemical industry
D	naphtha	As sources for polishes

- 39 Compounds X and Y are both alkanes.

Compound X has a higher boiling point than Y.

What could be the formula of X and Y?

	compound X	compound Y
A	C_8H_{16}	C_9H_{18}
B	C_8H_{18}	C_9H_{20}
C	C_9H_{18}	C_8H_{16}
D	C_9H_{20}	C_8H_{18}

A	C_2H_6
B	C_3H_6
C	C_4H_8
D	C_4H_{10}

Group																		
I	II											III	IV	V	VI	VII	0	
		1 H hydrogen 1 Key proton (atomic) number atomic symbol name relative atomic mass																2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —	
87 Fr francium —	88 Ra radium —	89 – 103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —		114 Fl flerovium —		116 Lv livermorium —			

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np 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 —

act\nolds

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

SECTION A

Answer all questions in this section in the spaces provided.

The total mark for this section is 50

- A1** The analysis of samples of river water from three different countries **P**, **Q** and **R** is given below in Table 1.1.

Table 1.1

Ion Present	Country P concentration (mg/dm ³)	Country Q concentration (mg/dm ³)	Country R concentration (mg/dm ³)
magnesium, Mg ²⁺	32	67	2
sodium, Na ⁺	0	12	11
potassium, K ⁺	2	3	0
hydrogen, H ⁺	30	12	13
chloride, Cl ⁻	14	28	43
sulfate, SO ₄ ²⁻	31	82	0
nitrate, NO ₃ ⁻	3	5	7
phosphate, PO ₄ ³⁻	0	0	10

- (a) State, with reason, the country

(i) which has the most acidic water.

country _____ [1]

reason _____

_____ [1]

(ii) which has water that is contaminated by sea water.

country _____ [1]

reason _____

_____ [1]

[Turn over

- (b) Describe a simple test to distinguish between the water from country **P** and the water from country **R**.

_____ [2]

- (c) Phosphate ions are contaminants discharged from factories. One way of treating the river water to remove these phosphate ions is by adding calcium ions which form a precipitate.

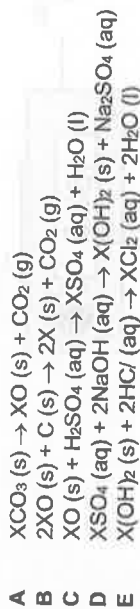
(i) Write an ionic equation, with state symbols, to show the reaction between calcium ions and phosphate ions.

_____ [2]

(ii) Name a calcium salt that can be added to remove the phosphate ions.

_____ [1]

- A2** The equations **A**, **B**, **C**, **D** and **E** show some reactions involving compounds of **X**.



Use the letters **A**, **B**, **C**, **D** and **E** to answer the following questions.

(a) (i) Which equation shows a change in the oxidation state of **X**?

_____ [1]

(ii) With the use of oxidation state explain if **X** is reduced or oxidized in the equation in (a)(i).

_____ [1]

- (b) Two of the reactions are exothermic reactions. Give the letters for the equations of these reactions.

[2]

- (c) When reaction D is carried out, a blue precipitate which is insoluble in excess aqueous sodium hydroxide is observed.

State the expected observation when aqueous ammonia is added dropwise in excess into a portion of aqueous XSO_4 .

[2]

- A3 A student investigated the conditions that will alter the speed of reaction between 4.0 g of calcium carbonate and 100 cm³ of dilute hydrochloric acid. All the solids dissolved in the acid.

Fig 3.1 shows the apparatus used.

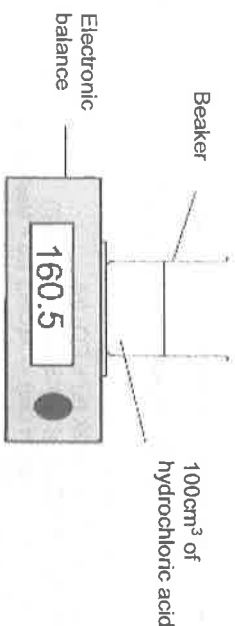


Fig 3.1

Details of the four experiments are given below in Table 3.2.

Table 3.2

Experiment	Form of calcium carbonate	Concentration of acid in moles per dm ³	Temperature of acid / °C
A	powder	2	25
B	lump	1	15
C	lump	2	25
D	powder	2	30

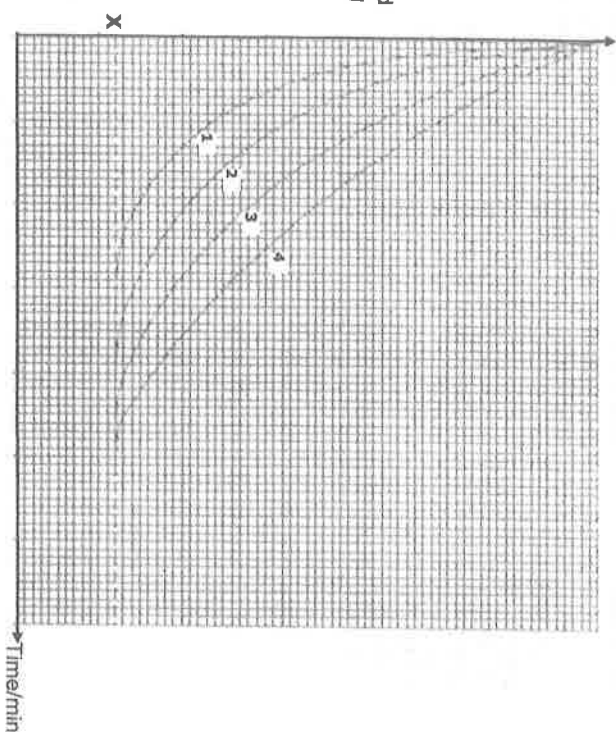
[Turn over

- (a) The student recorded the loss in mass of the beaker and its contents every 5 seconds as shown in Table 3.2. Explain why there was a mass loss in each experiment.

[1]

- (b) The results of the four experiments were plotted on graph paper.

Graph 3.3



Refer to Graph 3.3. Match up the graph plots with the correct experiment (A, B, C or D).

Line 1 is experiment _____ Line 2 is experiment _____

Line 3 is experiment _____ Line 4 is experiment _____ [2]

- (c) Explain why the reaction stopped in all the experiments at point X in each experiment.

_____ [2]

- (d) Calculate the maximum mass loss for the experiment.

[2]

- A4 Potassium reacts with water to form potassium hydroxide and hydrogen gas. A sample of 2g of potassium was added to 10cm^3 of cold water. When the reaction was completed, 100cm^3 of 0.1mol dm^{-3} hydrochloric acid was added to form solution X.

Suggest the probable pH of solution X. Explain your answer showing all relevant calculation.

[3]

[Turn over

- A5 Fig 5.1 illustrates the electrolysis of aqueous copper(II) sulfate of concentration 1 mol/dm^3 using carbon electrodes. Gas Z was evolved at electrode Y and was collected over water.

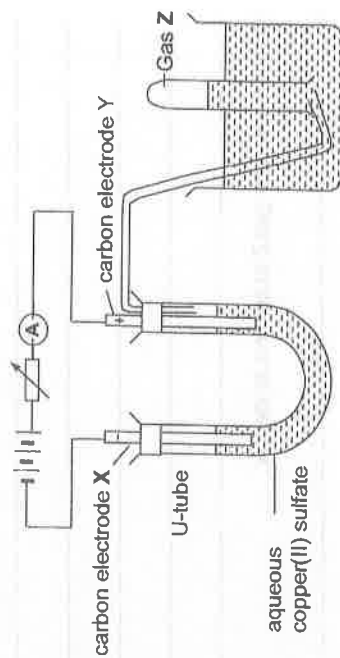


Fig 5.1

- (a) Write down the formulae of the ions which are attracted to the carbon electrode X.

[1]

- (b) What changes can you see on electrode X?

[1]

- (c) With the use of an equation, explain your observation at electrode Y.

 _____ [3]

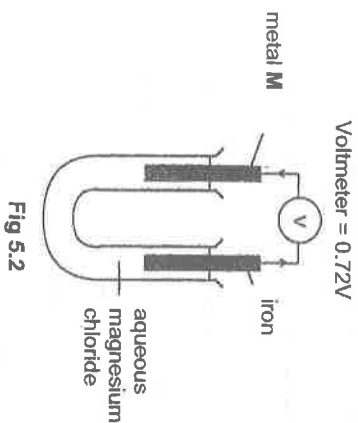
- (d) As electrolysis proceeds, describe and explain what happens to the electrolyte.

[3]

- (e) Describe a test for gas Z to confirm its identity.

[1]

- (f) Fig 5.2 shows a simple electric cell. The direction of flow of electron is indicated.



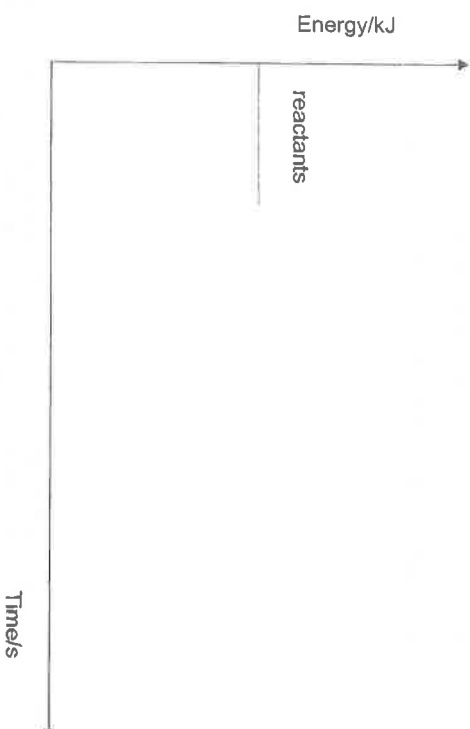
Explain why metal M cannot be zinc.

[2]

[Turn over]

- A6 Silver bromide was used to coat photographic films during the era of black and white photography. It is a light sensitive solid and breaks down into black silver and bromine vapour when light, a form of energy, is absorbed.

- (a) The diagram below shows the energy level of the reactants for the reaction.



- Complete the diagram by
- drawing in the reaction pathway for the reaction,
 - showing the activation energy, E_a ,
 - showing the energy change for the reaction, ΔH .

[3]

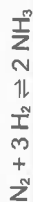
- (b) The equation for the reaction between hydrogen gas and iodine vapour is given below.



The energy required to break one mole of hydrogen, iodine vapour and hydrogen iodide are 436 kJ, 151 kJ and 299 kJ respectively. Calculate the enthalpy change in the reaction.

[2]

- A7** Ammonia is manufactured in Haber Process. This reaction is a reversible reaction. The reaction equation for Haber Process is as below.



- (a) (i) With reference to the making of ammonia, explain what is meant by a reversible reaction.

[2]

- (ii) This reaction required iron catalyst. What is the effect of iron on the rate of reaction?

[1]

- (iii) Does the catalyst have an effect on the yield of the ammonia produced? Explain.

[2]

[Turn over

- (b) The percentage yield of the reaction between nitrogen and hydrogen is 15%. Fig 7.1 shows how this reaction takes place commercially.

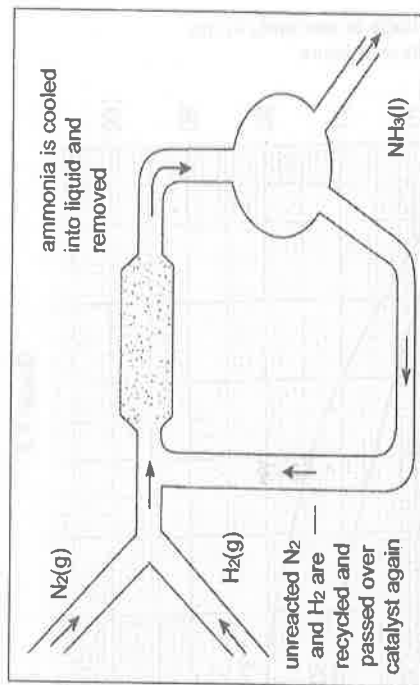


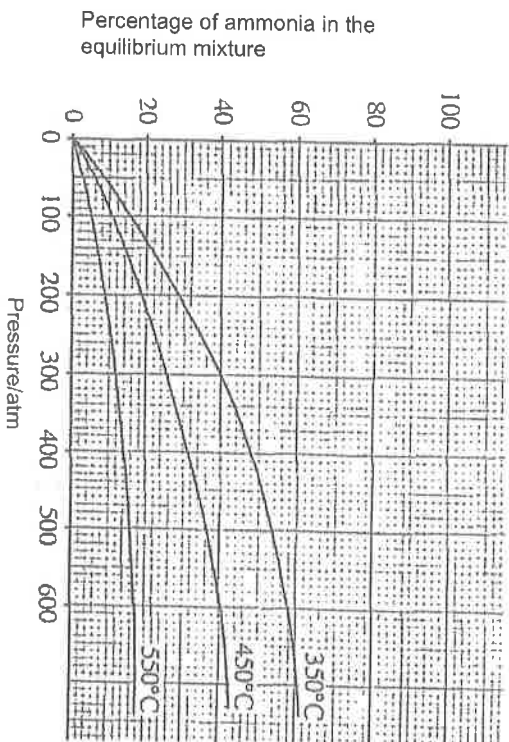
Fig 7.1

Suggest two reasons, why it is necessary to recycle the two gases in this commercial process.

[2]

- (c) **Graph 7.2** shows the ammonia present in the equilibrium mixture under different conditions of temperature and pressure.

Graph 7.2



By reference to the graph, explain the effect of increasing the temperature on the percentage of ammonia in the equilibrium mixture.

[2]

[Turn over

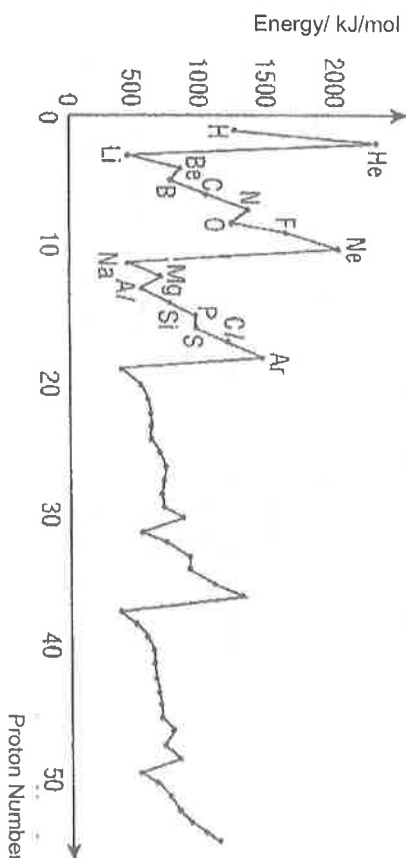
Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

- B8** **Graph 8.1** below shows the first ionisation energy of the atoms of elements in the Periodic Table.

Graph 8.1



The ionisation energy of elements is defined as the energy required for one mole of atoms to lose one mole of electrons forming one mole of gaseous ions with a charge of +1, from the outermost shell of the atoms.

Examples of the first three elements are given below :



- (a) Suggest why the ionisation energy of Helium (He) is much higher than that of Lithium (Li).

[2]

- (b) State the trend in ionisation energies across the third Period of the Periodic Table.

[1]

- (c) Based on Graph 8.1, what can you conclude about the ionisation energy of the elements in the 2nd Period as compared to the 3rd Period?
Suggest an explanation for the conclusion you have made.

[1]

- (d) Table 8.2 below shows various properties of the chlorides of the elements in the third period.

Table 8.2

Chemical Formula of Chloride	NaCl	MgCl ₂	Al ₂ Cl ₆	SiCl ₄	PCl ₃	S ₂ Cl ₂	Cl ₂
State at r.t.p	Solid	Solid	Solid	Liquid	Liquid	Liquid	Gas
Boiling Point/°C	1465	1418	423	57	74	136	-35
Electrical Conductivity in molten or liquid state	good	good	Very poor	nil	nil	nil	nil

- (i) How do the boiling points of the chlorides change across the period?

[1]

- (ii) Explain, using structures and bonding, the variation in (d)(i).

[4]

[Turn over]

- (iii) Draw a "dot-and-cross" diagram to represent the bonding in S₂Cl₂.
Show electrons in the valence shell only.

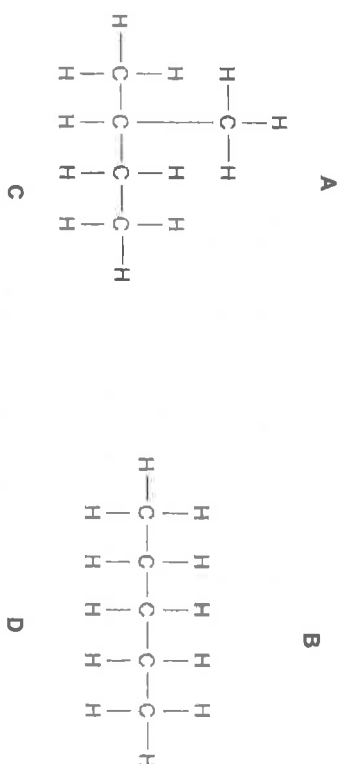
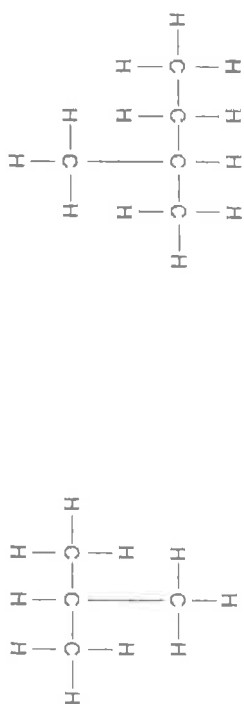
[1]

- B9 Crude oil can be separated into fractions using fractional distillation.

- (a) Explain why it is possible to separate crude oil using this process.

[3]

- (b) A-D are the structural formulae for some organic compounds that are obtained from crude oil either by fractional distillation or by cracking.



- (i) Give the letters of the two compounds that are identical.

_____ and _____ [1]

- (ii) Draw the structural formula of the isomer of C_6H_{12} not shown in A to D.

[1]

Turn over

- (iii) Structure D reacted with halogen, X_2 to form products. State the conditions needed for the reaction to take place.

[2]

- (iv) Draw in the space provided, the full structural formula of the non-organic product from the above reaction.

[1]

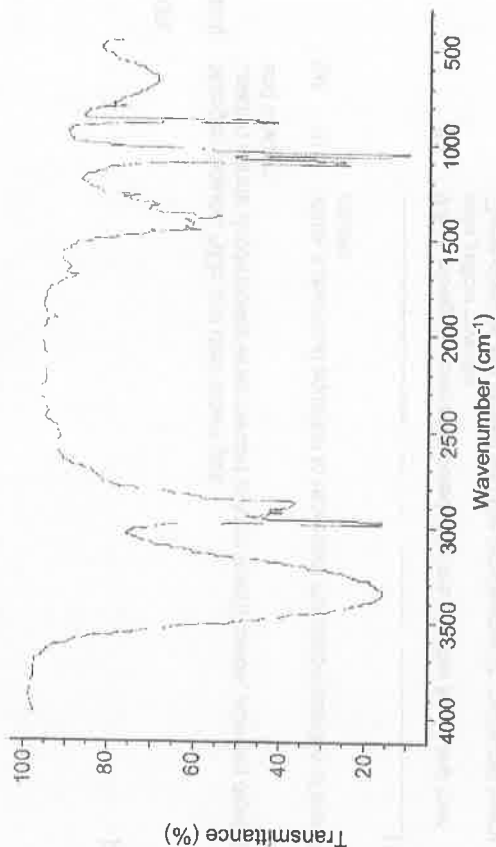
- (c) Infrared spectroscopy is a method used to identify bonds present in organic compounds. Table 9.1 below shows the wavenumber range at which some bonds absorb infrared light.

Table 9.1

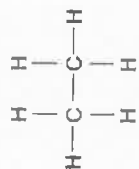
Bond	Wavenumber(cm^{-1})
O-H	3700 – 3200
C-H	3200 – 2800
C=O	1800 – 1650
C=C	1700 – 1600
C-O	1250 – 1000

The downward stretch or trough of the spectrum matches the wavenumber of the bonds.
Compound E gave the following infrared spectrum in Graph 9.2.

Graph 9.2



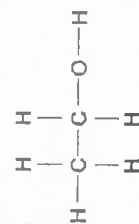
With reference to Graph 9.2, state which of the following compounds could E be. Give two reasons for your choice.



Ethane



Ethene



Ethanol

[2]

[Turn over]

EITHER

B10 A student conducted two experiments to find out about the relative reactivity of copper and three other solid metals, X, Y and Z.

In Experiment I, he heated each of the oxides of the metals in a test-tube.

In Experiment II, he tested the action of metals X, Y and Z on aqueous copper(II) sulfate.

He then tabulated the results of both experiments in Table 10.1 and 10.2 as follows.

Table 10.1

Experiment I	CuO	Oxide of X	Oxide of Y	Oxide of Z
Action of heat	No reaction	No reaction	No reaction	Metal Z is formed

Table 10.2

Experiment II	X	Y	Z
Action on aqueous copper(II) sulphate	Copper deposited	A gas is evolved	No reaction

(a) Based on the experimental results in Table 10.1 and 10.2, arrange the four metals, Cu, X, Y and Z in descending order of reactivity.

[1]

(b) (i) Suggest from the reactivity series, the possible identity of metals, X and Z.

Metal X is _____

Metal Z is _____

[2]

- (ii) Describe **one** observation that would be obtained in the reaction between **X** and aqueous copper(II) sulfate.

[1]

- (iii) Predict and explain the method that would be used to extract metal **Y** from its chloride.

[2]

- (c) A possible new way to mine metal ores called phytomining was developed in the 20th century. Some plants absorb and concentrate metals when they are grown on soils rich in metal compounds. Hence, metals can be extracted from these plants.

In California, the plant *Streptanthus polygaloides* can contain up to 1% of its dry mass as nickel. When the plant is burned, nickel oxide is produced. The chemistry of the metal, nickel shows a distinct resemblance to that of copper.

- (i) Suggest why *Streptanthus polygaloides* is burned before transport to the extraction factory.

[1]

- (ii) What mass of nickel is contained in 1 tonne dry mass of *Streptanthus polygaloides*? Give your answer in kg.
[1 tonne = 1 000 kg]

[1]

[Turn over

- (iii) What is the maximum mass of nickel oxide, NiO that could be obtained from this nickel? Give your answer in kg.

[2]

OR

B10

Nitrogen dioxide, NO₂, is a dark brown gas.

Lead(II) nitrate decomposes when heated to form lead(II) oxide, nitrogen dioxide and oxygen.

- (a) (i) Write a chemical equation to represent the decomposition of lead(II) nitrate.

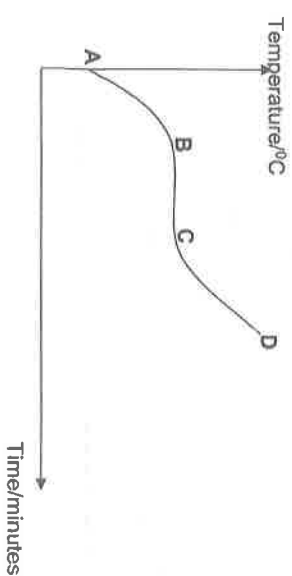
[1]

- (ii) When nitrogen dioxide is cooled, it forms a yellow liquid and then pale yellow crystals.

These crystals are heated and the temperature is measured every minute.

Graph 10.3 shows the change of temperature over time.

Graph 10.3



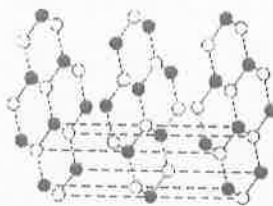
- (ii) Describe the arrangement and movement of the particles in the region C–D.

[2]

- (iii) Name the change that occurs in the region B–C. In terms of the kinetic particle theory, explain why the temperature remains unchanged between points B and C even though the crystals are heated.

[2]

- (b) Boron nitride, BN, exists in two physical forms as shown below.



Structure A



Structure B

These two forms of boron nitride resemble two allotropes of carbon.

- (i) What type of structure is boron nitride?

[1]

- (ii) Suggest why boron nitride with structure A can be used as a lubricant.

[2]

- (iii) Suggest why boron nitride with structure B can be used in cutting tools and drill bits.

[2]

[Turn over]

