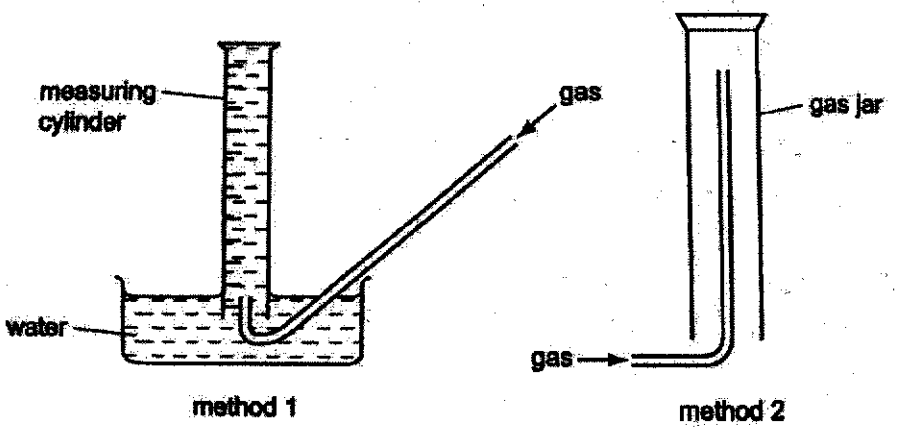
1 The diagrams show two methods of collecting gases.



Which row gives the properties of a gas which can be collected by both methods?

	property 1	property 2
A	insoluble in water	denser than air
B	insoluble in water	less dense than air
C	soluble in water	denser than air
D	soluble in water	less dense than air

2 A liquid boils at a temperature of 100°C.

Which other property of the liquid proves that it is pure water?

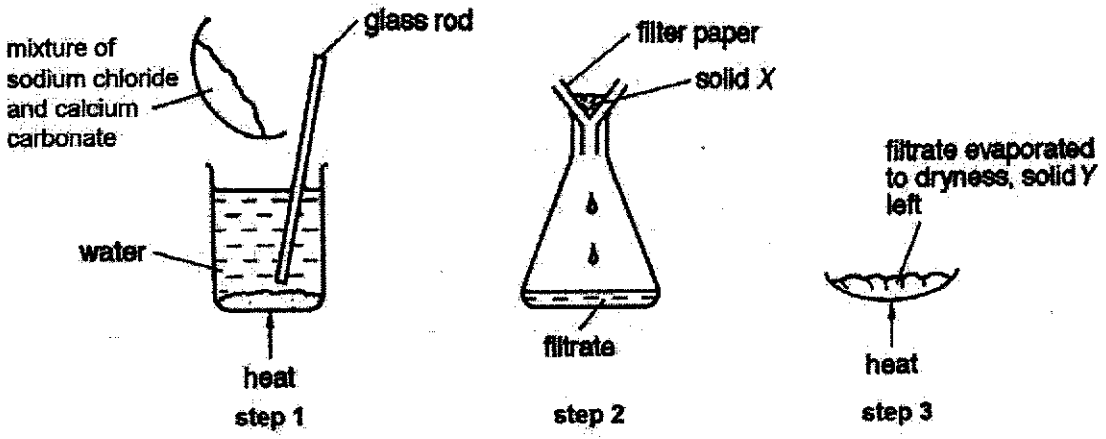
A It does not leave a residue when boiled.

B It freezes at 0°C.

C It is neither acidic nor alkaline.

D It turns white anhydrous copper(II) sulfate blue.

3 The apparatus shown below can be used in the order 1, 2 and 3 to separate a mixture of sodium chloride and calcium carbonate.



Which one of the following would be X and Y in the diagram?

	residue X	solid Y
A	calcium carbonate	sodium chloride
B	calcium carbonate	calcium chloride
C	sodium chloride	sodium carbonate
D	sodium chloride	calcium carbonate

4 Which of the following cations does not give a precipitate with either aqueous ammonia or sodium hydroxide solution?

A Ca^{2+}

B Zn^{2+}

C Fe^{2+}

D NH_4^+

5 A white crystalline solid, X, is heated with aqueous sodium hydroxide and aluminium.

A piece of red litmus paper, held near the mouth of the test-tube, turns blue while the mixture is heated for several minutes.

Which salt **cannot** be X?

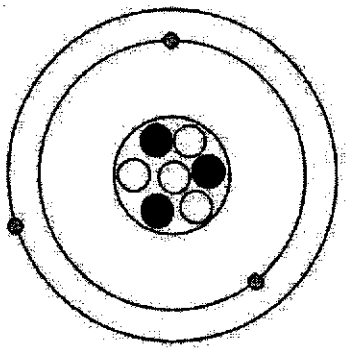
A ammonium chloride

B ammonium nitrate

C iron(III) chloride

D iron(III) nitrate

6 The diagram represents an atom of element X.



Which of the following represents the symbol of this element?

A $^{7}_{4}X$

B $^{7}_{3}X$

C $^{3}_{7}X$

D $^{4}_{7}X$

7 The structure of five particles are given in the following table.

atom	number of neutrons	number of electrons	number of protons
P	16	15	15
Q	18	16	16
R	17	15	15
S	17	18	17
T	18	18	16

Which pair of particles are isotopes?

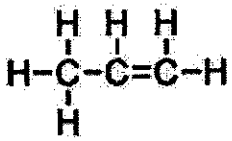
A P and R

B Q and T

C R and S

D S and T

8 The diagram shows the molecule of propene.



How many electrons are involved in bonding in this molecule?

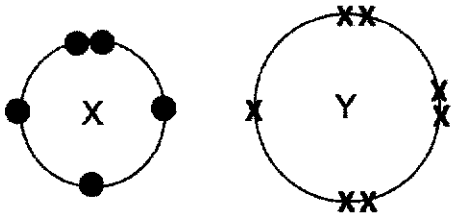
A 8

B 9

C 16

D 18

9 The diagram below shows the arrangement of outer shell electrons in atoms X and Y.



What is the formula of the compound between X and Y?

A XY_2

B XY_3

C X_2Y

D X_3Y

10 20 cm^3 of ethene, C_2H_4, was reacted with oxygen.

The equation for the reaction is shown.

$$C_2H_4\,(g) + 3O_2\,(g) \rightarrow 2CO_2\,(g) + 2H_2O\,(l)$$

All volumes are measured at r.t.p.

What is the volume of gas produced at the end of the reaction?

A 40 cm^3

B 60 cm^3

C 70 cm^3

D 80 cm^3

11 Which of the following statements about endothermic reactions are correct?

1 Energy is released to the surroundings.

2 Energy is absorbed from the surroundings.

3 The temperature of the surroundings rises.

4 The temperature of the surroundings falls.

A 1 and 3

B 2 and 3

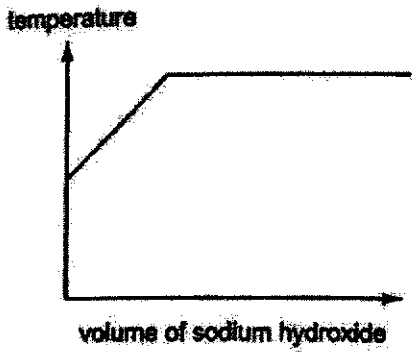
C 1 and 4

D 2 and 4

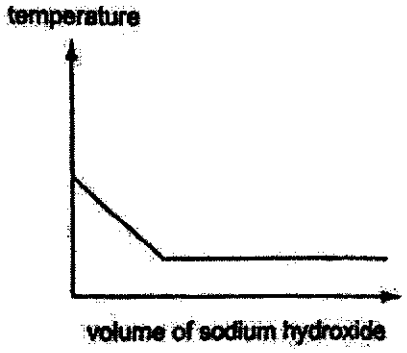
12 The reaction between aqueous sodium hydroxide and hydrochloric acid is known as neutralisation.

Which graph shows the change in temperature when aqueous sodium hydroxide is added to hydrochloric acid until the alkali is present in excess?

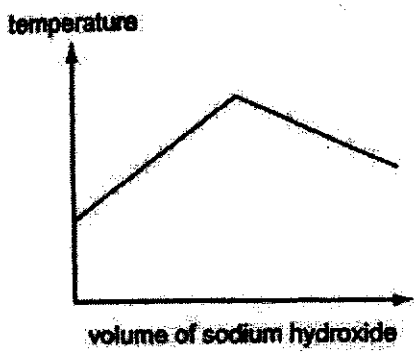
A



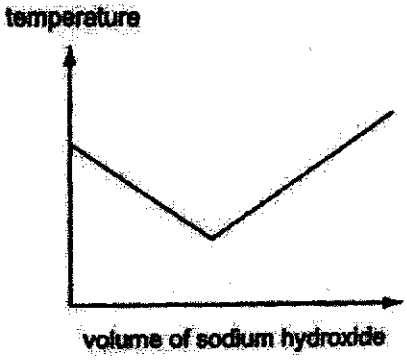
B



C



D



13 Which of the following represents oxidation?

A Cl_2 (g) → 2Cl^- (aq)

B CuO (s) → Cu (s)

C Fe^{2+} (aq) → Fe^{3+} (aq)

D N_2 (g) → NH_3 (g)

14 Oxides of elements may be classified as acidic, basic, amphoteric and neutral.

Which of the following oxides shows the correct classification?

	acidic	basic	neutral
A	carbon dioxide	copper(II) oxide	carbon monoxide
B	copper(II) oxide	carbon dioxide	nitrogen monoxide
C	carbon monoxide	copper(II) oxide	carbon dioxide
D	nitrogen monoxide	copper(II) oxide	carbon dioxide

15 Which of the following substances will produce a precipitate when mixed together?

A barium nitrate and potassium chloride

B calcium chloride and sodium sulfate

C sodium carbonate and ammonium chloride

D silver sulfate and nitric acid

16 What property of an element decreases as we move across a Period in the Periodic Table?

A number of electron shells

B metallic character

C proton number

D number of valence electrons

17 What property of a Group VII element decreases as we move down Group VII in the Periodic Table?

A boiling point

B melting point

C reactivity

D colour intensity

18 An element P has the following properties.

- It does not react with cold water.
- It reacts slowly with acids.

What could P be?

A copper

B iron

C magnesium

D zinc

19 Rubidium, Rb, is an element in the same group of the Periodic Table as lithium, sodium and potassium.

Which statement about rubidium is likely to be correct?

A It forms a sulfate, Rb_2SO_4.

B It forms an insoluble hydroxide.

C It can be extracted from its ore by reduction with carbon.

D It reacts slowly with water at 20°C.

20 Carbon monoxide, sulfur dioxide and carbon dioxide are gases which affect the atmosphere and the environment.

In what ways do these gases affect the environment?

	carbon monoxide	sulfur dioxide	carbon dioxide
A	acid rain	global warming	acid rain
B	global warming	depletion of the ozone layer	acid rain
C	poisonous to humans	global warming	depletion of the ozone layer
D	poisonous to humans	acid rain	global warming

END OF PAPER 1

Colours of Some Common Metal Hydroxides

calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										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 –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	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 thullum 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	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 –

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

Section A

Answer **all** the questions in the spaces provided.

1 Name the substances below:

(a) a green – yellow gas which reacts with sodium to produce a white crystalline solid,

..... [1]

(b) an element **X** which forms an amphoteric oxide with a chemical formula XO.

..... [1]

[Total : 2 m]

2 The pie chart illustrates the composition by volume of dry, unpolluted air.

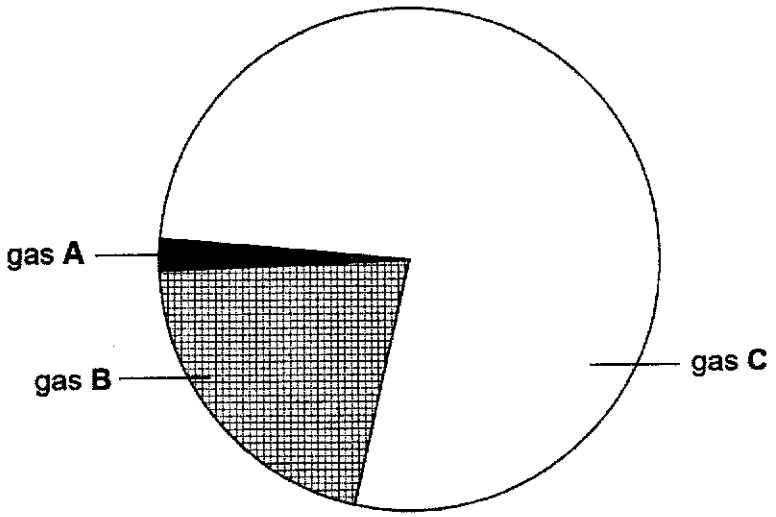


Fig. 2.1

(a) What are the names of gases **B** and **C**?

(i) gas **B** ..... [1]

(ii) gas **C** ..... [1]

(b) Two gases that cause air pollution are nitrogen dioxide and carbon monoxide.

Give the source of these pollutants.

(i) name of pollutant – carbon monoxide

source of pollutant .....

(ii) name of pollutant – nitrogen dioxide

source of pollutant ..... [2]

[Total: 4 m]

3 The apparatus shown below is used to separate a miscible mixture of two colourless, volatile and flammable liquids **X** (boiling point of 55 °C) and **Y** (boiling point of 68 °C). Substance **Y** was coloured with a blue dye.

The mixture was heated in a hot water bath.

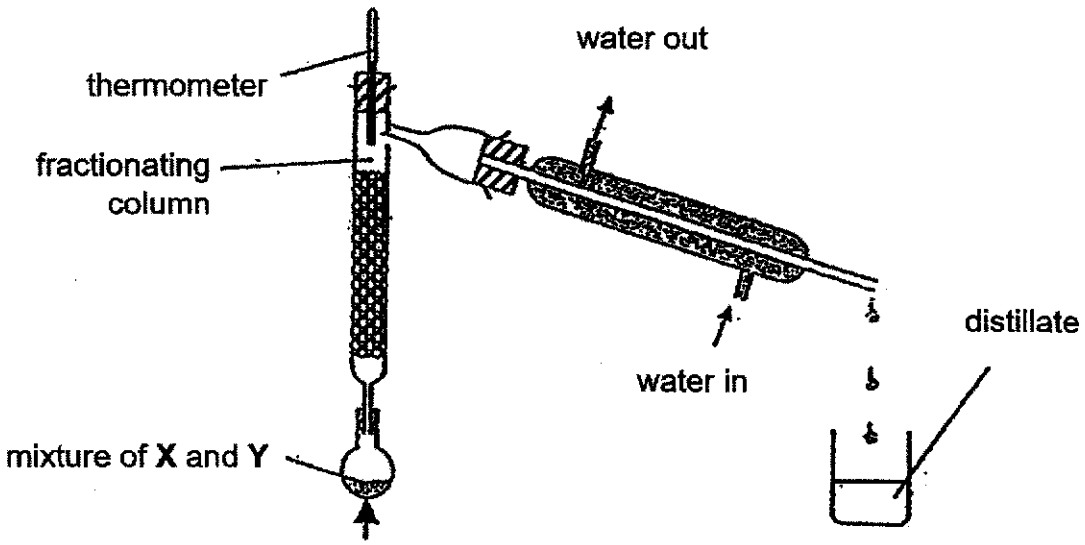


Fig. 3.1

(a) Which of the above two substances will be collected as distillate first?

Explain your answer.

.....

..... [1]

(b) When the first substance is completely collected, state the colour of the distillate collected.

..... [1]

(c) Suggest a reason for placing the water inlet at the bottom of the condenser.

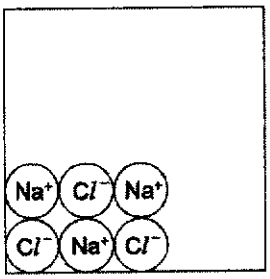
.....

..... [1]

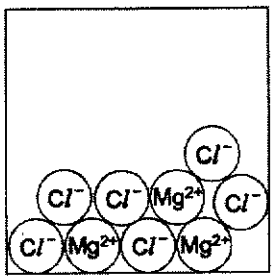
[Total: 3 m]

4 The diagrams below (**A**, **B**, **C**, **D**, **E** and **F**) represent the particles in several substances.

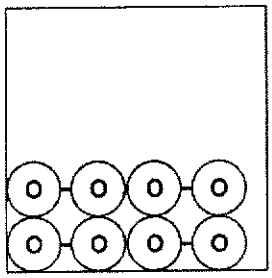
A



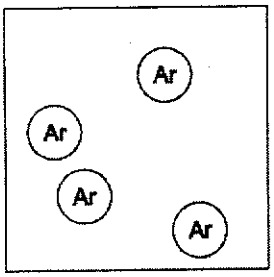
B



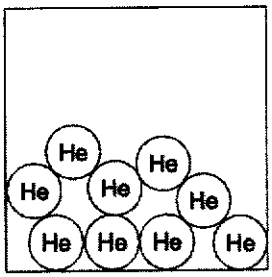
C



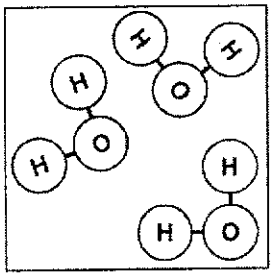
D



E



F



(a) Which diagram (**A**, **B**, **C**, **D**, **E** or **F**) best represents the following description?

(i) a solid element ..... [1]

(ii) a liquid ionic compound ..... [1]

(iii) a gaseous molecule ..... [1]

(b) Comparing substances **A** and **B**, only one substance can conduct electricity.

Identify which substance is the electrical conductor and explain the difference in electrical conductivity.

.....

.....

..... [2]

(c) Potassium oxide shares the same type of bonding as substances **A** and **B**.

Draw a 'dot and cross' diagram to show the arrangement of electrons in potassium oxide. Only the outer shells of electrons need to be shown.

[2]

[Total: 7 m]

5 A student wanted to test the rate of corrosion of metals with acid rain. He decided to react some zinc sheets with nitric acid.

(a) **(i)** In order to mimic acid rain, he dissolved 12.6 g of nitric acid in water and made the volume up to 250 cm^3.

Calculate the concentration, in g/dm^3, of this solution.

concentration = ... g/dm^3 [1]

(ii) Calculate the concentration, in mol/dm^3, of this solution.

[Relative atomic masses: A_r: H, 1; N, 14; O, 16]

concentration = ... mol/dm^3 [1]

(b) Describe the measurements that the student needs to make in order to determine the average speed of reaction between zinc and nitric acid.

.....

.....

..... [2]

[Total : 4 m]

6 Describe how you would prepare a pure, dry sample of magnesium sulfate using dilute sulfuric acid as one reagent.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 4 m]

7 Fig. 7.1 describes some of the substances that result from the chemical reactions of metal **R**.

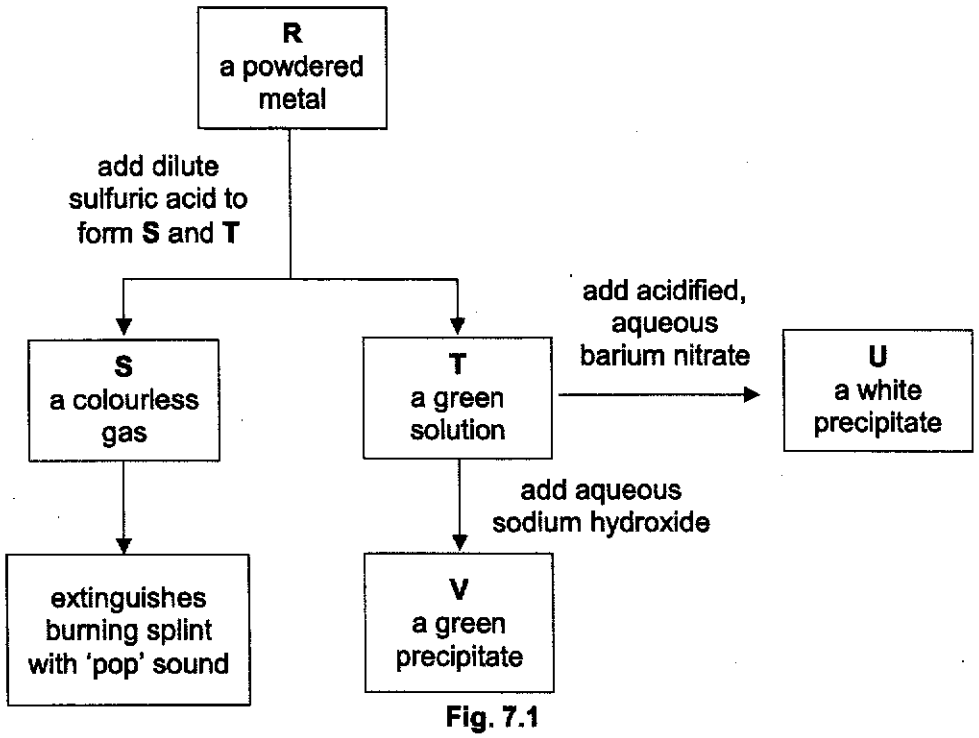


Fig. 7.1

(a) Identify **R**, **S**, **T**, **U** and **V**.

R ..... [1]

S ..... [1]

T ..... [1]

U ..... [1]

V ..... [1]

(b) Write a balanced equation for any one of the reactions in Fig. 7.1

..... [1]

[Total : 6 m]

8 Lithium is a Group I metal. Lithium is the essential element in the making of rechargeable batteries which are present in almost all personal electronics and electric vehicles. Its production has greatly increased since the end of World War II, the largest producer being South America.

(a) In the table below, circle the words that would best describe the physical properties of lithium.

melting point	**density**	**electrical conductivity**
high / low	high / low	conductor / non-conductor

[1]

(b) Lithium, magnesium and copper metals were added to a beaker of cold water. Fig.8.1 shows the observations from the experiment.

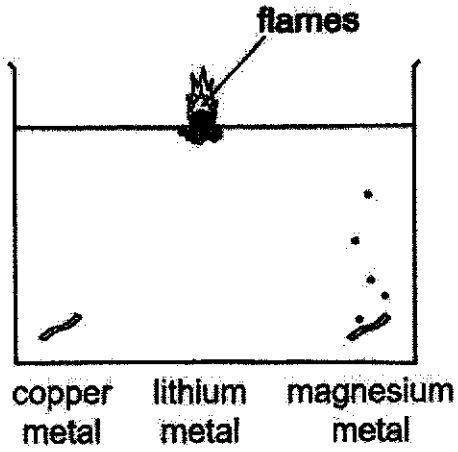


Fig. 8.1

(i) Identify the products formed when lithium metal reacts with cold water.

..... [1]

(ii) With reference to the diagram, arrange the three metals in increasing reactivity.

least reactive ⟶ **most reactive**

....., ..., ... [1]

(iii) Suggest a method for the extraction of lithium metal from lithium ore.

..... [1]

(c) Lithium is usually recycled from lithium batteries. Lithium batteries usually contain many other useful metals like iron, aluminium and copper.

An old method of recycling lithium from lithium batteries is to first crush the lithium batteries into smaller pieces. An excess of concentrated sulfuric acid is then added to the crushed batteries. The lithium sulfate is then separated from the mixture.

$$2Li + H_2SO_4 \rightarrow Li_2SO_4 + H_2$$

1000 kg of crushed batteries were recycled based on the method described above. Through this method, 1.32 kg of lithium sulfate was formed.

(i) Calculate the relative formula mass of lithium sulfate.

[Relative atomic masses: A_r: H, 1; Li, 7; O, 16; S, 32]

relative formula mass = ... [1]

(ii) Calculate the mass of lithium present in the crushed batteries.

mass = ... kg [2]

(d) Currently, lithium recycling from batteries is not common and nearly 95 % of all lithium are mined. If lithium is continuously mined, the finite quantities of lithium ore will be depleted.

Suggest another issue that may arise when lithium metal is not recycled but mined instead.

.....

..... [1]

[Total : 8 m]

9 Iodine is an important element for medical and agricultural application. Most of the iodine compounds can be found in ocean water as sodium iodide but it is difficult to extract due to the extremely low concentration. Iodine production from ocean water occurs in two main steps.

Step 1 – Ocean water is heated to increase the concentration of sodium iodide.

Step 2 – Chlorine gas is passed through the concentrated solution of sodium iodide to produce solid iodine crystals. The solid iodine crystals are then separated from the rest of the mixture.

(a) (i) The equation below shows the chemical equation for the reaction in **Step 2**.

Complete the equation by filling in the missing state symbols.

Cl_2 (.....) + 2NaI (.....) → I_2 (.....) + 2NaC*l* (.....) [1]

(ii) Suggest with reasons if chlorine gas in **Step 2** can be used to extract fluorine from sodium fluoride.

.....

..... [1]

(iii) State a method to separate the solid iodine crystals from the rest of the mixture.

..... [1]

(b) (i) Draw a 'dot and cross' diagram to show the arrangement of electrons in a chlorine molecule. Only the outer shells of electrons need to be shown.

[2]

(ii) Explain, in terms of bonding, why Group VII elements have low boiling points.

.....

.....

..... [2]

[Total : 7 m]

Section B

Answer any **two** questions in this section.

Write your answers in the spaces provided.

10 Iron is usually produced in a blast furnace from iron ore.

(a) Explain, including chemical equations, how the following processes occur in a blast furnace:

(i) iron is extracted from the ore,

.....

.....

.....

.....

.....

..... [4]

(ii) impurities are removed.

.....

.....

.....

.....

..... [3]

(b) Iron is usually not used directly as a pure metal. One reason is that pure iron is prone to corrosion.

(i) Explain why coating iron with grease prevents iron from rusting.

.....

..... [1]

(ii) Another way to prevent rusting is to combine iron with another element to form an alloy.

Give an example of an alloy and provide **another** reason why alloys are preferred to pure metals.

.....

..... [2]

[Total: 10 m]

11 A student investigated the rate of reaction when dilute hydrochloric acid reacts with excess copper(II) carbonate powder.

$$2HCl + CuCO_3 \rightarrow CuCl_2 + CO_2 + H_2O$$

He used the same volume of acid each time. He measured the time taken to collect 10 cm^3 of gas at room temperature and pressure. He also measured the total volume of gas at the end of the experiment at room temperature and pressure.

Table 11.1 shows his results.

Table 11.1

experiment	concentration of HCl in mol/dm^3	time taken to collect 10 cm^3 of gas / s	total volume of gas / cm^3
1	0.5	15	150
2	1.0	6	300
3	0.5	7	150

(a) (i) Out of the above three experiments, the student carried out two experiments using acid at room temperature and one experiment using acid at a higher temperature.

Which experiment was carried out at a higher temperature?

Explain your reasoning.

.....

.....

.....

..... [2]

(ii) Explain, in terms of collisions between reacting particles, how a higher temperature affects the rate of reaction.

.....

.....

.....

..... [2]

(b) **(i)** With reference to the data from experiment 1, calculate the number of moles of carbon dioxide produced.

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure.

number of moles = ... mol [1]

(ii) Hence or otherwise, calculate the volume of hydrochloric acid that was added in experiment 1.

volume of hydrochloric acid = ... dm^3 [2]

(c) The student carried out a further experiment at room temperature using the same volume of 0.5 mol/dm^3 hydrochloric acid as experiments 1, 2 and 3. However, in this experiment, he used excess copper(II) carbonate **granules** instead of powder.

Complete the table to predict what results he should expect and explain how you arrived at your answers.

experiment	**concentration of HCl in mol/dm^3**	**time taken to collect 10 cm^3 of gas / s**	**total volume of gas / cm^3**
4	0.5		

.....

.....

.....

.....

.....

..... [3]

[Total : 10 m]

12 This is a dummy question.

Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School

(a) **(i)** *Chua Chu Kang Secondary School Chua Chu Kang Secondary School*
Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School

.....

.....

.....

..... [3]

(ii) *Chua Chu Kang Secondary School Chua Chu Kang Secondary School*
Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School

.....

.....

.....

..... [3]

(b) *Chua Chu Kang Secondary School Chua Chu Kang Secondary School*
Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School
Chua Chu Kang Secondary School Chua Chu Kang Secondary School

.....

.....

.....

.....

.....

..... [4]

[Total : 10 m]

END OF PAPER 3

Colours of Some Common Metal Hydroxides

calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white

The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										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 –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	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
actinoids	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 –

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

Secondary 4E5N
Science (Chemistry)
Preliminary Examination 2020

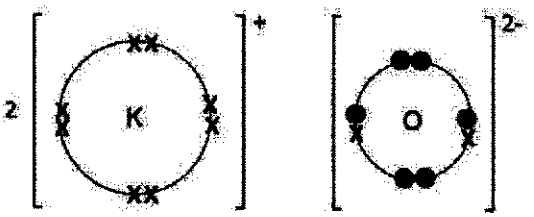
Mark Scheme

Paper 1 (20 marks)

1	B	**11**	D
2	B	**12**	C
3	A	**13**	C
4	D	**14**	A
5	C	**15**	B
6	B	**16**	B
7	A	**17**	C
8	D	**18**	B
9	B	**19**	A
10	A	**20**	D

A – 5, B – 7, C – 4, D - 4

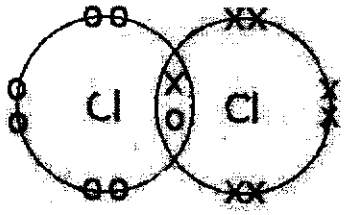
Paper 3
Section A (45 marks)

1(a)	chlorine	1
(b)	lead or zinc (reject lead(II), lead(II) oxide, zinc oxide)	1
		Total: 2
2(a)(i)	oxygen (reject chemical formula)	1
(ii)	nitrogen	1
(b)(I)	incomplete combustion of fuels	1
(ii)	lightning activity/internal combustion engine/overheated engines	1
		Total: 4
3(a)	X Lower boiling point	1
(b)	colourless	1
(c)	ensure that the condenser is fully filled with water/effective cooling of the condenser	1
		Total: 3
4(a)(i)	C	1
(ii)	B	1
(iii)	F	1
(b)	B conducts electricity. Ions in A are held in fixed positions, no mobile ions. (reject mobile electrons) Ions in B are mobile and move throughout the liquid.	1 1
(c)	 1 m for each ion	2
		Total: 7
5(a)(i)	$250cm^3 = 0.25dm^3$ 12.6 / 0.25 = **50.4 g/dm^3**	1

(ii)	allow for ecf from (a)(i) $Mr(HNO_3) = 1 + 14 + 3(16)$ $= 63$ $50.4g/dm^3 / 63$ $= \mathbf{0.8mol/dm^3}$	1
(b)	time taken for total volume of gas to be produced / total mass to be loss	1 1
		Total: 4
6	1. Add magnesium/magnesium carbonate/magnesium oxide to sulfuric acid 2. Add until no more can dissolve/until excess/until no more bubbles are formed (for $Mg/MgCO_3$ but not MgO) 3. Filter undissolved solids 4. Heat filtrate and leave to crystallise 5. Filter, Wash crystals with cold water and dry between filter paper. 5 pts – 4 m, 4,3 pts – 3m, 2 pts – 2m, 1pt – 1m	4
		Total: 4

7 (a)	R	Iron or Fe	1
	S	Hydrogen or H_2	1
	T	Iron(II) sulfate or $FeSO_4$	1
	U	barium sulfate or $BaSO_4$	1
	V	Iron (II) hydroxide $Fe(OH)_{2+}$	1
(b)	Any ONE		
	$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$		1
	$FeSO_4 + Ba(NO_3)_2 \rightarrow BaSO_4 + Fe(NO_3)_2$		
	$FeSO_4 + 2NaOH \rightarrow Fe(OH)_2 + 2NaCl$		
	$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$		
			Total: 6

8(a)	**melting point**	**density**	**electrical conductivity**	1
	high / **low**	high / **low**	**conductor** / non-conductor	
	All 3 for 1m			
(b)(i)	lithium hydroxide and hydrogen			1
(ii)	copper, magnesium, lithium			1
(iii)	electrolysis			1

(c)(i)	2(7) + 32 + 4(16) = 110 (reject if student adds units)	1
(ii)	allow ecf from (c)(i) mol(Li_2SO_4) = 1320 / 110 (accept even if student did not convert) **= 12 mol** 1Li_2SO_4: 2Li → 12mol:24mol mass(Li) =24x7 = 168g **=0.168kg**	1 1
(d)	1. mining for metal ore leads to clearing of forest and damage to habitats 2. Extraction of metal ores require a lot of energy that cause more fossil fuels to be burnt which leads to the release of greenhouse gases 3. Extraction of metal ores may involve the use of toxic chemicals/release harmful air pollutants	1
		Total: 6
9(a)(i)	Cl_2 (g) + 2NaI (aq) → I_2 (s) + 2NaC*l* (aq)	1
(ii)	fluorine is more reactive than chlorine, chlorine is unable to displace fluorine	1
(iii)	filtration	1
(b)(i)	 1m- bonding electron, 1m – non-bonding electron	2
(ii)	weak intermolecular forces of attraction (reject if there is factual error) small amount of energy required to overcome (reject: easy to overcome, force to overcome, break)	1 1
		Total: 7

Section B (10 marks)

10(a)(i)	coke reacts with oxygen to form carbon dioxide. carbon dioxide reacts with more coke to form carbon monoxide. carbon monoxide reduces iron ore/iron(III) oxide to form iron. $C + O_2 \rightarrow CO_2$ $CO_2 + C \rightarrow 2CO$ $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ 6pts – 4 m, 5,4 pts – 3m, 3 pts – 2m, 2,1 pts – 1m	4

(ii)	limestone decomposes to form calcium oxide calcium oxide combines with silicon dioxide to form slag $CaCO_3 \rightarrow CaO + CO_2$ $CaO + SiO_2 \rightarrow CaSiO_3$ 4 pts – 3m 3, 2 pts – 2m 1 pts – 1m	3
(b)(i)	prevents contact with water/moisture and air/oxygen	1
(ii)	steel/brass/bronze/pewter stronger and harder/appearance/lower melting point (reject corrosion)	1 1
		Total: 10
11(a)(i)	Experiment 3 Experiment 3 takes the shortest time to collect 10cm^3 of gas although it has a lower concentration than experiment 2.	1 1
(ii)	increase in kinetic energy of the particles increase frequency of effective collisions increase in rate of reaction 3 points – 2 m, 2,1 points – 1 m	2
(b)(i)	150 cm^3 = 0.15 dm^3 mol(CO_2) = 0.15 /24 = **0.00625 mol**	1
(ii)	allow for ecf from (b)(i) 1CO_2:2HCl 0.00625mol:**0.0125mol** vol(HCl) = 0.0125/0.5 =0.025dm^3	1 1
(c)	<table><tr><th>experiment</th><th>concentration of HCl in mol/dm^3</th><th>time taken to collect 10 cm^3 of gas / s</th><th>total volume of gas / cm^3</th></tr><tr><td>4</td><td>0.5</td><td>more than 15 (1)</td><td>150 (2)</td></tr></table> (3) same number of moles/amount of hydrochloric acid used, total volume of gas remain the same. (4) granule smaller surface area to volume ratio, lower frequency of effective collisions, slower speed of reaction 4 – 3 m, 3,2 – 2m, 1 – 1m	3
		Total: 10