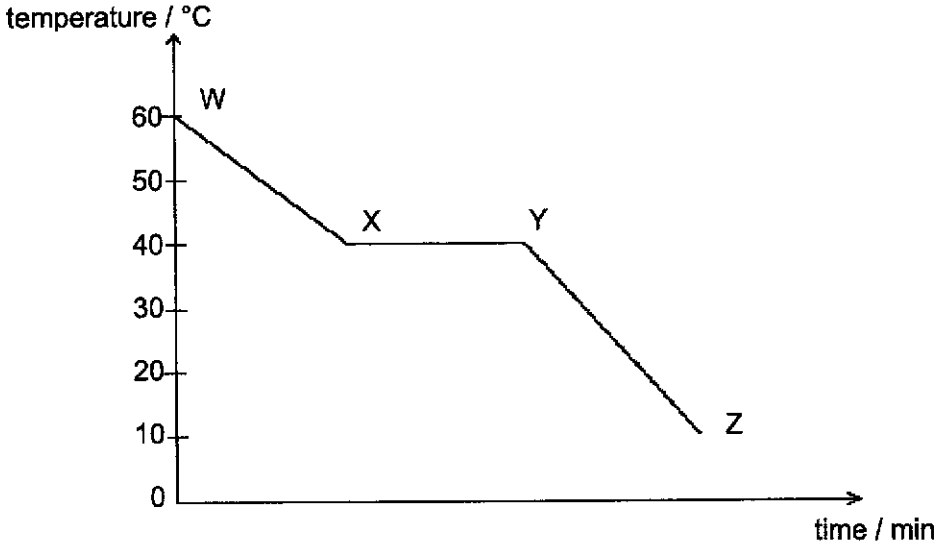
21 The curve below shows the temperature changes as liquid **Q** was cooled from 60 °C to 10 °C.



Which statement correctly describes the particles of liquid **Q** at various regions of the curve?

A Heat energy is gained by the particles at region XY to overcome the forces of attraction.

B The particles exist as a mixture of gas and liquid at region XY.

C The particles are vibrating about fixed positions at region YZ.

D The particles are arranged far apart and in a disorderly manner at region WX.

22 Some hexane has been added to a beaker of copper(II) sulfate solution. Hexane is a non-polar solvent that has a boiling point of 69 °C and is immiscible with water.

Which of the two methods can you use to obtain samples of hexane and copper(II) sulfate crystals?

	method 1	method 2
A	fractional distillation	crystallisation
B	simple distillation	evaporation
C	using a separating funnel	evaporation
D	using a separating funnel	crystallisation

23 Salt **R** is heated strongly in a boiling tube and the following observations are observed.

- a gas evolved turns damp red litmus paper blue
- a gas evolved forms white precipitate when bubbled through limewater
- water droplets formed at the top of the boiling tube

What is the identity of salt **R**?

A NH_4Cl **B** $FeCO_3$

C $(NH_4)_2CO_3$ **D** $CuCl_2$

24 An element ***X*** has an electronic configuration 2.2.

The compound formed when ***X*** combines with oxygen is most likely to be

A a compound with a low melting point.

B a gas that dissolves in water to form an electrolyte.

C a good conductor in both solid and molten state.

D an ionic solid.

25 Strontium reacts with element X to form a compound with the chemical formula, Sr**X**.

How many electrons and protons can be present in an ion of element **X**?

	number of electrons	number of protons
A	10	9
B	10	8
C	10	10
D	18	20

26 50 cm^3 of aqueous 0.1 mol / dm^3 hydrochloric acid exactly neutralises 40 cm^3 of aqueous potassium hydroxide solution. The equation for the above reaction is as shown below.

$$HCl + KOH \rightarrow KCl + H_2O$$

What is the concentration of the potassium hydroxide solution?

A 0.625 mol / dm^3 **B** 0.0625 mol / dm^3

C 0.0125 mol / dm^3 **D** 0.125 mol / dm^3

27 12.6 g of sodium hydrogencarbonate undergoes thermal decomposition when heated as shown in the following chemical equation.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

What is the volume of carbon dioxide produced in this reaction?

A 0.075 dm^3 **B** 1.8 dm^3

C 18 dm^3 **D** 36 dm^3

28 Ethane, C_2H_6, burns in oxygen to produce carbon dioxide and water as shown in the equation below.

$$2C_2H_6\,(g) + 7O_2\,(g) \rightarrow 4CO_2\,(g) + 6H_2O\,(l)$$

What is the final volume of gas(es) present at the end of the reaction, when 40 cm^3 of ethane burns in 150 cm^3 of oxygen?

A 10 cm^3

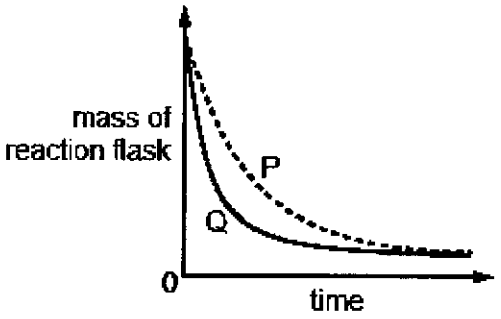
B 40 cm^3

C 80 cm^3

D 90 cm^3

29 In a set of two different experiments, some magnesium ribbons were reacted with excess sulfuric acid and the loss in mass of the reaction flask were measured.

The graph shows the results of two experiments, P and Q.



Which statement best explains the difference between experiment P and Q?

A Larger pieces of magnesium ribbons were used in Q.

B The temperature was lower in Q.

C A larger mass of magnesium ribbon was used in P

D A higher concentration of sulfuric acid is used in Q.

30 Substance R are added to aqueous potassium iodide and acidified aqueous potassium permanganate(VII). The observations are recorded below.

chemical	observations
aqueous potassium iodide	colourless solution turns brown
acidified potassium permanganate(VII)	purple solution turns colourless

From the observations, what can be deduced about substance R?

A It is a reducing agent only.

B It is an oxidising agent only.

C It is both a reducing and oxidising agent.

D It is neither a reducing or oxidising agent.

31 Which of the following is a redox reaction?

A $AgNO_3 + HCl \rightarrow AgCl + HNO_3$

B $N_2 + 3H_2 \rightarrow 2NH_3$

C $LiOH + HNO_3 \rightarrow LiNO_3 + H_2O$

D $NH_4^+ + OH^- \rightarrow NH_4OH$

32 In some coal-burning factories, waste gases are first passed through a wet mixture of powdered calcium carbonate and calcium oxide to remove harmful gases before releasing to the environment.

Which gas will not be removed by this mixture?

A carbon monoxide

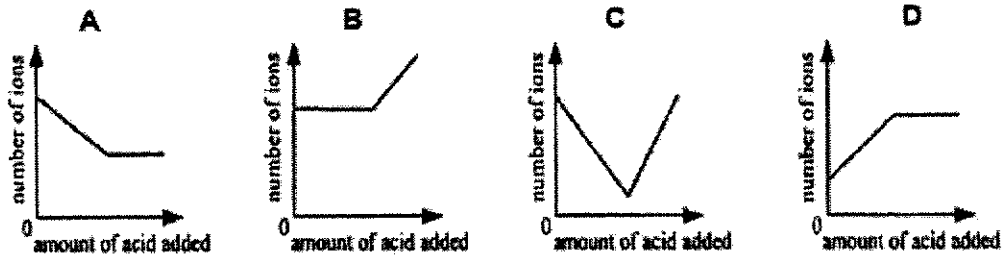
B carbon dioxide

C sulfur dioxide

D nitrogen dioxide

33 Excess dilute sulfuric acid was added to a fixed volume of aqueous barium hydroxide.

Which graph best represents the variation in the total number of mobile ions present in the solution?



34 Lead(II) sulfate is an insoluble salt that is used in production of batteries.

Which of pair of reactants can be best use to produce lead(II) sulfate?

	reactant 1	reactant 2
A	lead	sulfuric acid
B	lead oxide	potassium sulfate
C	lead hydroxide	sulfuric acid
D	lead nitrate	sodium sulfate

[Turn over

35 The positions of unknown elements **J**, **K**, **L**, **M** and **N** are shown in the partial Periodic Table below.

period	group								
	I	II		III	IV	V	VI	VII	0
1								**L**	
2	**J**							**M**	
3	**K**							**N**	

Which of the following statements is correct?

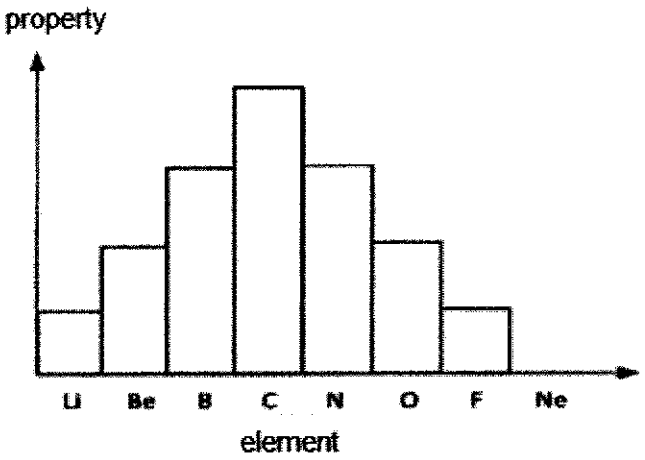
A **J** is less dense than **K**.

B **J** is more reactive than **K**.

C **L** has a darker colour than **M**.

D **M** has a higher boiling point than **N**.

36 The bar chart shows the variation of a specific property of elements in Period 2 from lithium to neon.



Which property of these elements is shown in the chart?

A The number of electrons used in bonding.

B The number of electron shells.

C The boiling and melting points.

D The atomic radius.

[Turn over

37 In a experimental to determine the reactivity of metals **Q**, **R** and **S**, the reactions of the metals with cold water and dilute hydrochloric acid were recorded in the table below. A shaded box indicates that the reaction is not carried out.

metal	reaction with cold water	reaction with dilute hydrochloric acid	displacement reaction
Q		no reaction	
R	no reaction	readily	
S	slow		can displace metal **Q** from its salt solution

What is the order of reactivity for metals Q, R and S starting from the most reactive to least reactive?

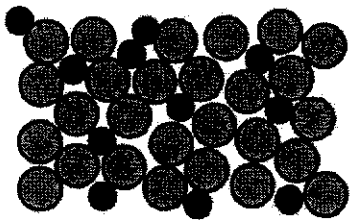
A **S → R → Q**

B **S → Q → R**

C **Q → R → S**

D **R → S → Q**

38 Material **X** is lightweight and strong. The atomic structure of the material **X** is shown below.



Which statement best explains why material **X** is strong enough to be used for building of aircrafts body?

A Material **X** has many free electrons that hold the atoms in place.

B Metal atoms in material **X** cannot slide over each other easily.

C The atoms in material **X** are more compact resulting in greater density.

D The atoms are arranged in a crystal lattice structure with strong ionic bonds existing between the atoms which prevents them from moving.

[Turn over

39 Which reaction describes how pure iron is formed in the blast furnace?

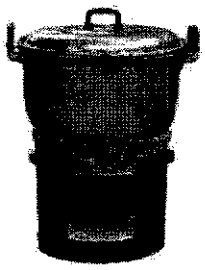
A Iron ore thermally decomposes into iron and oxygen gas at high temperatures in the furnace.

B Calcium carbonate reacts with iron ore to form pure iron and slag.

C Carbon monoxide produced in a reaction reduces the iron ore.

D Coke reacts with iron ore at high temperature.

40 A woman was cooking using a charcoal stove as shown below. She closed the windows to the kitchen as it started to rain heavily. She soon develops a headache and dizziness.



Which of the following air pollutant is responsible for her symptoms?

A carbon monoxide

B carbon dioxide

C sulfur dioxide

D oxides of nitrogen

END OF PAPER

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.).

ZHONGHUA SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2021

SECONDARY 4E/5N

Candidate's Name	Class	Register Number

SCIENCE(CHEMISTRY) 5076 /03

27 August 2021
1 hour 15 minutes

Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen.

You may use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer any **two** questions.

Write your answers in the spaces provided on the question paper.

At the end of the examination, fasten all your work securely together

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	45
Section B	20
Total	65

All essential working must be shown clearly.

A copy of the Data Sheet 'Colours of Some Common Metal Hydroxides' is printed on page 17.

A copy of the Periodic Table is printed on page 18.

Setter: Mr Kelvin Lee
Vetter: Mrs Maybrie Ang and Mr Desmond Chong

This document consists of **18** printed pages, including this cover page.

Section A

Answer **all** the questions in the spaces provided.
Write your answers in the spaces provided on the question paper

1 The names of five oxides are given below.

sulfur dioxide

potassium oxide

dichlorine monoxide

nitrogen monoxide

zinc oxide

(a) Name an oxide that

(i) reacts with both nitric acid and sodium hydroxide.

..... [1]

(ii) turn moist blue litmus paper red.

..... [1]

(b) Draw a 'dot and cross' diagram for dichlorine monoxide. Only the outer shells of electrons need be shown.

[2]
[Total: 4]

A2 The apparatus shown in Fig. 2.1 can be used to separate ethanol from a solution of coloured dyes in ethanol.

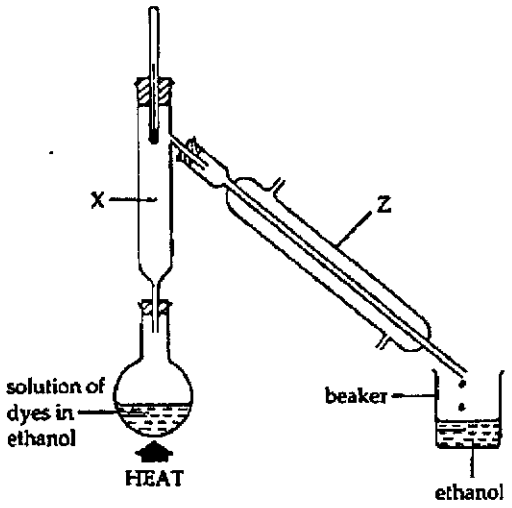


Fig. 2.1

(a) Name the separation technique shown in Fig 2.1.

.....

[1]

(b) During the experiment, explain how you can check that the ethanol obtained is pure.

.....

[1]

(c) Using Kinetic Particle Theory, describe the changes in terms of the arrangement and movement of the particles as it moves from X to Z.

.....

.....

.....

.....

.....

[2]

[Total: 4]

A3 Carbon monoxide and nitrogen monoxide are pollutants from cars that can be removed through a catalytic converter.

The equation for such a reaction is given.

$$2CO\ (g) + 2NO\ (g) \rightarrow N_2\ (g) + 2CO_2\ (g)$$

(a) Explain why carbon monoxide causes breathing problems.

.....

..... [1]

(b) Explain how nitrogen monoxide is formed in a car engine.

.....

..... [1]

(c) Identify the oxidising agent in the reaction above. Explain your answer in terms of the oxidation states.

oxidising agent .....

explanation .....

..... [2]

(d) Explain why this reaction does not remove all the environmental problems caused by exhaust gases.

.....

.....

..... [2]

[Total: 6]

A4 Nitrogen exists as two isotopes, $^{14}_{7}N$ and $^{15}_{7}N$. They can form useful compounds such as sodium nitride and nitrogen trifluoride, which are used in food preservation and manufacture of semi-conductors respectively.

(a) Using nitrogen as an example, explain what is meant by the term *isotopes*.

.....

..... [2]

(b) Complete Table 4.1 below to show the number of subatomic particles in the ion of each isotope.

Table 4.1

ion	number of		
	protons	neutrons	electrons
$^{14}_{7}N^{3-}$			
$^{15}_{7}N^{3-}$			

[2]

(c) Explain, in terms of bonding and structure, why nitrogen trifluoride is a gas at room temperature.

.....

.....

..... [2]

[Total: 6]

A5 Fig 5.1 describes some chemical reactions related to salt **A**.

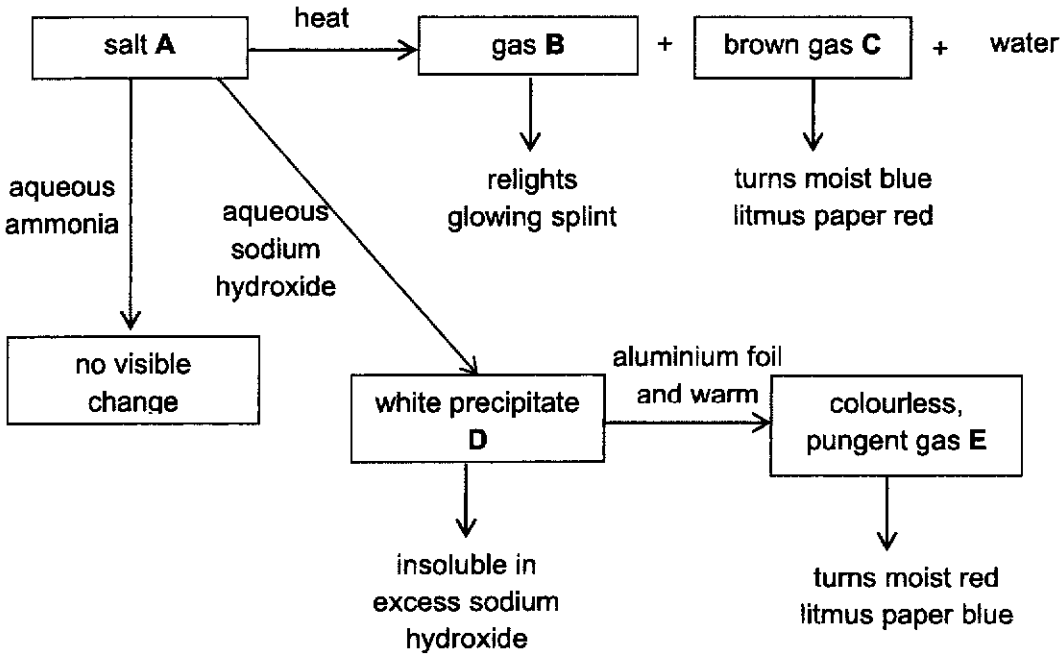


Fig 5.1

(a) Identify the unknowns **A**, **B**, **C**, **D**, and **E**.

A .....

B .....

C .....

D .....

E ..... [5]

(b) Write an ionic equation for the formation of **D**.

..... [1]

[Total: 6]

A6 In separate experiments, powdered samples of metal **X** and metal **Y** reacted with solutions of nickel(II) sulfate and iron(II) sulfate. Table 6.1 shows the change in colours of the solutions.

Table 6.1

	metal **X**	metal **Y**
nickel(II) sulfate	Solution turns from green to colourless	Solution turns from green to colourless
iron(II) sulfate	Solution remains pale green	Solution turns from pale green to colourless

(a) Predict the order of reactivity for the four metals: **X**, **Y**, nickel and iron.

most reactive .....

.....

.....

least reactive ..... [1]

(b) Metal **Y** does not react with cold water but reacts with steam to produce a solid, **Z**.

Suggest the identity of metal **Y**.

..... [1]

(c) In another experiment, powdered sample of metal **Y** was placed in a solution of copper(II) sulfate.

Describe the observations of the experiment.

.....

.....

..... [2]

[Total: 4]

A7 Acid **J** has a relative molecular mass of 36.5. A 200 cm^3 aqueous sample contains 182.5g of **J**.

(a) **(i)** Calculate the concentration of **J** in g/dm^3.

concentration = ... g/dm^3 [2]

(ii) Calculate the concentration of **J** in mol/dm^3.

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

(b) When **J** is mixed with acidified aqueous silver nitrate, a white precipitate **K** forms.

(i) Silver carbonate is white and insoluble in water. Explain why **K** cannot be silver carbonate.

..... [1]

(ii) Suggest the identity of **J**.

..... [1]

[Total: 5]

A8 **(a)** Iron from blast furnaces is usually mixed with other elements to form alloys.

Give a reason why this use of alloy is preferred to that of iron from blast furnaces.

.....

.....

.....

..... [2]

(b) Use chemical equations to explain how impurities are removed from the iron ore in the blast furnace.

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 5]

A9 When calcium carbonate is added to dilute hydrochloric acid, carbon dioxide gas is formed.

A student wants to study the rate of this reaction by measuring the volume of gas formed over time. He added a small mass of powdered calcium carbonate to an excess of 0.1 mol/dm^3 hydrochloric acid. A datalogger was used to plot the graph shown in Fig. 9.1.

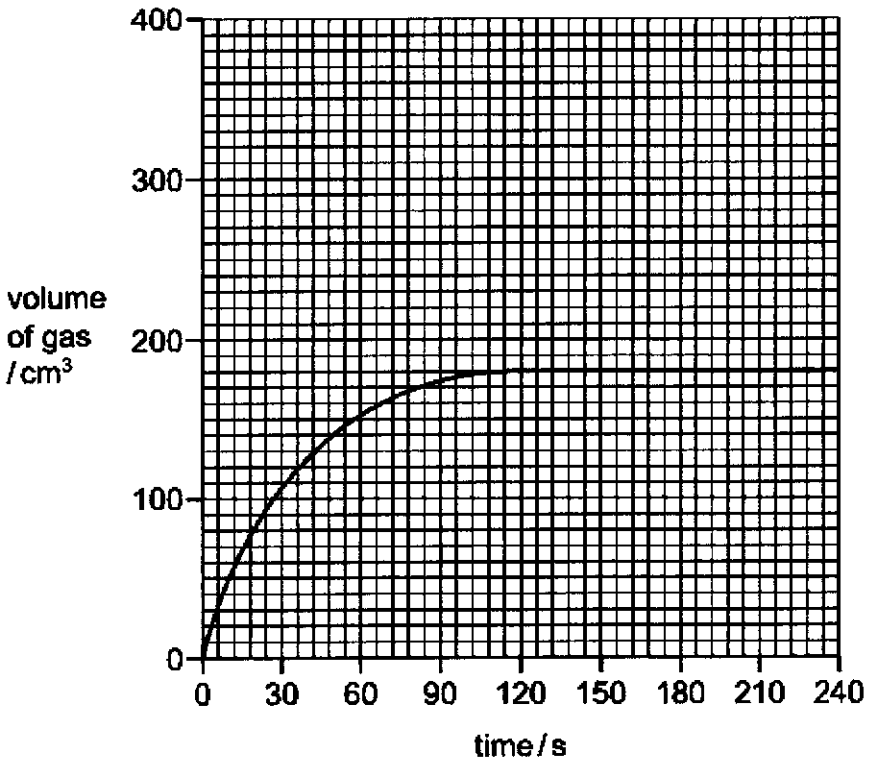


Fig. 9.1

(a) **(i)** State the time the reaction stopped.

..... [1]

(ii) Explain why the reaction stopped.

..... [1]

(b) The experiment was repeated using the same quantity of reactants but large lumps of calcium carbonate was added instead of the powder form.

(i) On Fig 9.1, sketch a curve to represent the graph you would expect. Label the curve, **c**.

[1]

(ii) Explain one similarity and difference between your graph and the original graph.

similarity .....

.....

.....

difference .....

.....

..... [2]

[Total: 5]

Section B

Answer any **two** questions.

Write your answers on spaces provided on the question paper.

B10 In an experiment, acid H_2X solution was added to 10 cm^3 of 0.05 mol/dm^3 aqueous sodium hydroxide in a reacting flask.

(a) Acid H_2X reacts with aqueous sodium hydroxide according to the following equation.

$$H_2X\ (aq) + 2NaOH\ (aq) \rightarrow Na_2X\ (aq) + 2H_2O\ (l)$$

(i) Calculate the number of moles of NaOH that has reacted.

number of moles = ... mol [1]

(ii) 15 cm^3 of acid is required to completely neutralise aqueous sodium hydroxide.

Calculate the concentration of the acid H_2X.

concentration = ... mol/dm^3 [2]

(b) **(i)** State one condition that you would change to increase the rate of reaction without changing the amount of product formed.

..... [1]

(ii) Using collision theory, explain how the condition in **(b)(i)** will increase the rate of reaction.

.....

.....

.....

..... [2]

(c) Describe how you would prepare the Na_2X. Include a suitable indicator in your description.

.....

.....

.....

.....

.....

.....

..... [4]

[Total:10]

B11 The Thermit reaction is used to weld railway rails together.

In Thermit reaction, aluminium powder reacts with iron(III) oxide to make small amounts of molten iron which runs into the gaps between the rails. Solid aluminium oxide is formed at the same time.

(a) Complete the equation for Thermit reaction by filling in the missing state symbols.

2 Al (.....) + Fe_2O_3 (.....) → 2Fe (.....) + Al_2O_3 (.....)

[1]

(b) Table 11.1 shows some information about oxidation state changes during the reaction.

Table 11.1

element	oxidation state at the start	oxidation state at the end	oxidised or reduced?
oxygen	-2	-2	unchanged
aluminium			
iron			

(i) Complete Table 11.1. [2]

(ii) Hence, or otherwise, explain why Thermit reaction is a redox reaction.

.....

.....

..... [1]

(c) **(i)** Predict if the melting point of aluminium oxide is high or low. Explain your answer in terms of structure and bonding.

.....

.....

..... [2]

(ii) Draw a 'dot and cross' diagram to show the arrangement of outer shell electrons in aluminium oxide.

[2]

(d) Is Thermit reaction an endothermic or exothermic reaction? Explain your answer.

.....

.....

.....

..... [2]

[Total:10]

B12 **(a)** This question makes reference to Group I and Group VII of the periodic table. Lithium, sodium and potassium belong to Group I of the Periodic Table.

Table 12.1 shows the observations when these three metals react with water.

Table 12.1

Group I metal	observation
lithium	reacts quickly
sodium	reacts violently
potassium	reacts very violently

(i) Describe and explain the reactivity of Group I metals down the group.

.....

.....

.....

.....

..... [3]

(ii) Rubidium is located below potassium in Group I.

Predict what would happen when rubidium reacts with water.

.....

..... [1]

(iii) Name the gas evolved when Group I metals react with water.

..... [1]

(b) The elements fluorine, chlorine, bromine and iodine have atomic numbers 9, 17, 35 and 53.

All of these non-metallic elements are placed in Group VII of the Periodic Table.

(i) Describe a change in physical property down Group VII.

..... [1]

(ii) Chlorine gas is bubbled into an aqueous solution of potassium iodide.

Describe the changes that would be observed. Explain your answer.

description .....

.....

.....

explanation .....

.....

..... [2]

(iii) Write an ionic equation, with state symbols, for the reaction in **(b)(ii)**.

..... [1]

(c) Write the name and formula of a compound formed when an element from Group I combines with an element from Group VII.

name of compound: ..... chemical formula: ..... [1]

[Total:10]

END OF PAPER

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		Key: proton (atomic) number; atomic symbol; name; relative atomic mass									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 –		

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.).

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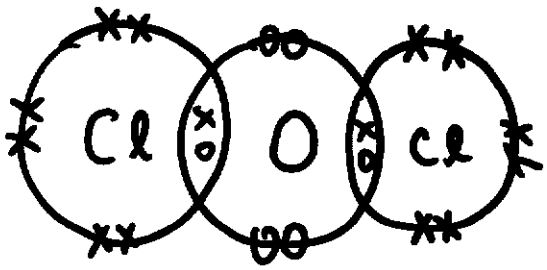
21	22	23	24	25	26	27	28	29	30
C	D	C	D	B	D	B	D	D	C

31	32	33	34	35	36	37	38	39	40
B	A	C	D	A	A	A	B	C	A

Prelim answer key

A1a	(i) zinc oxide (ii) sulfur dioxide / dichlorine monoxide	1 1
A1b		2

A2a	Fractional distillation	1
A2b	The thermometer reads 78°C. / constant boiling point	1
A2c	At X, ethanol is in the gaseous state. The particles are far apart in a disorderly manner and they randomly at high speed in all directions. At Z, ethanol is in the liquid state. The particles are closely packed in a disorderly manner and will be sliding over each other.	1 1

A3a	Carbon monoxide binds with haemoglobin in blood to form carboxyhaemoglobin which prevent blood from transporting oxygen to all parts of body, resulting in suffocation or difficulty breathing.	1
A3b	Nitrogen and oxygen in air react at high temperatures in a car engine to form nitrogen monoxide.	1
A3c	oxidising agent: nitrogen monoxide explanation: Nitrogen monoxide is reduced. The oxidation state of nitrogen in nitrogen monoxide decreased from +2 in NO to 0 in N_2. **OR** Carbon monoxide is oxidized. The oxidation state of carbon increased from +2 in CO to +4 in CO_2.	1 1
A3d	Carbon dioxide is still formed as a product. Excessive carbon dioxide produced can cause global warming / enhance greenhouse effect.	1 1

A4a

Both nitrogen-14 and Nitrogen-15 have 7 protons. 1
Nitrogen-14 has 7 neutrons while nitrogen-15 has 8 neutrons. 1

Isotopes are atoms with the same number of protons but different number of neutrons.

A4b

ion	number of protons	number of neutrons	number of electrons	
$^{14}_{7}N^{3-}$	7	7	10	1
$^{15}_{7}N^{3-}$	7	8	10	1

A4c

Nitrogen trifluoride is a covalent compound with simple molecular structure. 1
The molecules are held together by weak intermolecular forces of attraction. 1
Little energy is required to overcome the forces of attraction. Hence, it has a low boiling point and exists as a gas at room temperature.

A5a

A – calcium nitrate 1
B – oxygen 1
C – nitrogen dioxide 1
D – calcium hydroxide 1
E – ammonia 1

A5b

Ca^{2+} (aq) + $2OH^-$ (aq) → Ca(OH) (s) 1

A6a

Y
iron
X
nickel 1

A6b

zinc 1

A6c

Blue solution turns colourless. 1
Reddish-brown precipitate formed on metal Y. 1

A7a

(i) Concentration = $\frac{\frac{182.5}{200}}{1000}$
= 912.5g/cm^3 1

(ii) Concentration = $\frac{912.5}{36.5}$
= 25 mol/dm^3 1

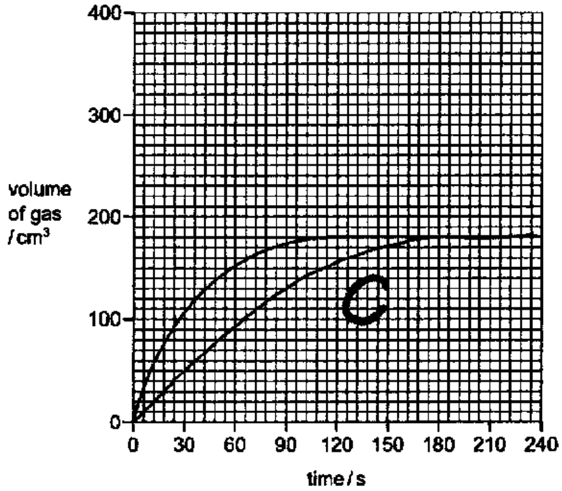
A7b

Silver carbonate will react with acid to form a soluble salt. 1

A7c

Hydrochloric acid 1

A8a	Alloys have atoms of different sizes which disrupt the orderly arrangement. This prevents the layers of atoms from sliding over one another easily when a force is applied. Thus, alloys are harder and stronger, thus preferred to iron.	1 1
A8b	Limestone added decomposes to calcium oxide and carbon dioxide. $CaCO_3 \rightarrow CaO + CO_2$ Calcium oxide neutralizes the acidic impurities, such as silicon dioxide, to form slag. $CaO + SiO_2 \rightarrow CaSiO_3$	1 1 1

A9a	(i) 114 – 120s (ii) Calcium carbonate has completely reacted as hydrochloric acid is in excess.	1 1
A9b	(i)  (ii) Similarity: The volume of gas produced, remains the same as calcium carbonate is a limiting reactant. Since the mass of calcium carbonate remains the same, the volume of gas produced remains unchanged. Difference: Gradient is less steep. The speed of reaction is slower as the large lumps of calcium carbonate have lesser surface area for the reaction to take place. Hence, resulting in a slower reaction.	1 1

Section B

B10a

(i) number of moles = $\frac{10}{1000} \times 0.05$
= 0.0005 — 1

(ii) number of moles of H_2X = 0.0005 ÷ 2
= 0.00025 mol — 1

concentration = $\frac{0.00025}{\frac{15}{1000}}$
= 0.0167 mol/dm^3 — 1

B10b

(i) warm the acid — 1

(ii) An increase in temperature will result in an increase in kinetic energy of particles, hence more particles have energy greater than or equal to activation energy. Hence, this increases the frequency of effective collision between particles, resulting in a higher rate of reaction. — 1 1

B10c

1. Pipette 25.0 cm^3 of NaOH and place it in a conical flask. — 1
2. Add methyl orange into conical flask. Solution turns yellow. — 1
3. Titrate H_2X from the burette into the conical flask until the solution in the conical flask turns orange.
4. Note the volume of H_2X needed at the end-point.
5. Repeat titration mixing the using the same volume of H_2X but without indicator. — 1
6. Heat the solution to dryness. / crystallization — 1

B11a

$2Al\ (s) + Fe_2O_3\ (s) \rightarrow 2Fe\ (l) + Al_2O_3\ (s)$ — 1

B11b

element	oxidation state at the start	oxidation state at the end	oxidised or reduced?
oxygen	-2	-2	unchanged
aluminium	0	+3	oxidised
iron	+3	0	reduced

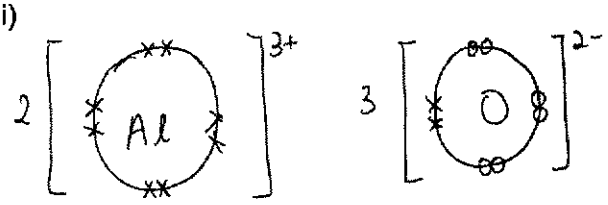
B11b

(ii) In the reaction, aluminium is oxidised and iron in Fe_2O_3 is reduced, so thermit is a redox reaction. — 1

B11c

(i)Aluminium oxide has a high melting point.
Aluminium oxide has a giant crystal lattice structure. — 1
The ions are held together by strong electrostatic forces of attraction. — 1
Hence, a lot of energy is required to overcome the strong forces of attraction and aluminium oxide has a high melting point.

(ii)



2

B11d	Thermit is an <u>exothermic</u> reaction. <u>Heat energy is released in the reaction</u> and the high temperature is sufficient to melt iron.	1 1

B12a (i)	The reactivity of Group I metals increases down the group. Down the group, there are <u>more filled electron shells</u> between the nucleus and the valence electron. Hence, there is a <u>greater tendency to lose the valence electron</u> to attain the noble gas electronic configuration.	1 1 1
B12a (ii)	Rubidium will react <u>explosively</u> with water.	1
B12a (iii)	hydrogen	1
B12b (i)	Melting point/boiling point increases **OR** Colour becomes darker	
B12b (ii)	Colourless solution turns brown. Chlorine is more reactive than iodine and will displace iodine from potassium iodide to form iodine.	1 1
B12b (iii)	Cl_2 (g) + $2I^-$ (aq) → $2Cl^-$ (aq) + I_2 (aq)	1
B12c	Lithium fluoride, LiF Sodium chloride, NaCl Accept any Group I & VII compound.	1