EAST SPRING SECONDARY SCHOOL
Towards Excellence and Success

Name: ..... ( )

Class: .....

Preliminary Examination 2020
Secondary 4 Express

CHEMISTRY **6092/01**
Paper 1

15 September 2020 **1 hour**
Tuesday **0800 - 0900**

Additional materials:
OTAS

INSTRUCTIONS TO CANDIDATES

1. Write your name and register number in the spaces above and on the OTAS.

2. This paper consists of 40 multiple choice questions **[40 marks]**

   Answer **ALL** questions. For each question, there are four possible answers, A, B, C and D. Choose the most suitable answers and record your choice using a 2B pencil on the OTAS.

3. Hand in the OTAS and Question paper separately.

4. The use of calculator is allowed.

5. A copy of the Periodic Table is given on page 16.

This question booklet consists of **16** printed pages including the cover page.

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1 A gas, T, has the following properties:

1 has a pungent smell
2 turns damp blue litmus paper red
3 decolourises purple acidified potassium manganate(VII)

What is T?

A ammonia
B carbon dioxide
C chlorine
D sulfur dioxide

2 Both aqueous sodium carbonate and sodium hydroxide solution turn red litmus paper blue.

Which one of the following substances can be used to differentiate the two solutions?

A aqueous potassium sulfate
B aqueous calcium nitrate
C dilute sulfuric acid
D carbon dioxide

3 50 cm^3 of methane, CH_4, diffused through a porous pot in 100 s. 50 cm^3 of gas **Y** took 400 s to diffuse under the same conditions of temperature and pressure.

What could gas **Y** be?

A ammonia
B carbon dioxide
C hydrogen
D sulfur dioxide

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4 The table shows information about ions **Q** and **R**.

	number of proton	number of neutrons	number of electrons
Q	16	18	18
R	17	18	18

What are **Q** and **R**?

A positive ions of the same element

B positive ions of different elements

C negative ions of the same element

D negative ions of different elements

5 Which statement(s) correctly describe(s) the properties of the mixture of iron and sulfur, and the compound iron(II) sulfide, FeS?

1 The ratio of iron to sulfur in mixture is fixed, but varies in the compound iron(II) sulfide.
2 Compound iron(II) sulfide does not have the properties of iron and sulfur but mixture of iron and sulfur has.
3 There is heat and light given out during formation of the mixture of iron and sulfur.

A 1 only

B 2 only

C 2 and 3

D 1 and 3

6 Which row shows the substances in the increasing order of melting point?

	lowest melting point	⟶	highest melting point
A	sodium	diamond	lead(II) bromide
B	sodium	lead(II) bromide	diamond
C	diamond	lead(II) bromide	sodium
D	lead(II) bromide	diamond	sodium

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7 The table below shows the electrical conductivity of four substances **E, F, G** and **H**.

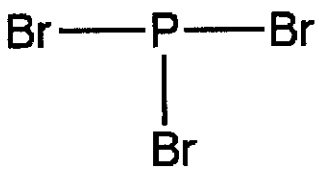
substance	solid state	liquid state	aqueous state
E	X	X	√
F	X	√	√
G	X	X	X
H	√	√	insoluble in water

key:
√ = can conduct electricity
X = cannot conduct electricity

Which of the substance is likely to be hydrogen bromide?

A substance E
B substance F
C substance G
D substance H

8 The diagram shows a molecule of phosphorus tribromide.



How many pairs of electrons in phosphorus atom are not involved in bonding?

A 2
B 4
C 5
D 6

9 The formula of an oxide of element **R** is R_2O.
6.2 g of R_2O contains 4.6 g of **R**.

How many moles of **R** ions does 6.2 g of R_2O contain?

A $\frac{1.6}{16} \div 2$
B $\frac{1.6}{16} \times 2$
C $\frac{6.2}{16 \times 2}$
D $\frac{6.2}{16} \times 2$

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10 68 g of impure hydrogen peroxide, H_2O_2 (M_r = 34) decomposes in the presence of manganese(IV) oxide, to produce 2.4 dm^3 of oxygen gas at room temperature and pressure as shown in the equation.

$$2\,H_2O_2 \rightarrow O_2 + 2\,H_2O$$

What is the purity of the hydrogen peroxide?

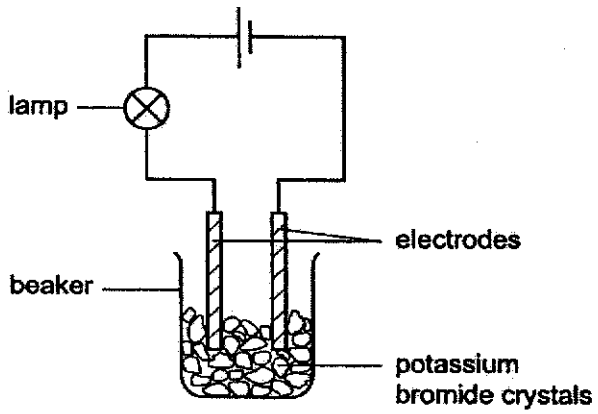
A 2.5 %

B 5.0 %

C 10.0 %

D 15.0 %

11 In the set-up shown, the lamp does not light. Distilled water is then added to the beaker and the lamp lights up.



Which statement explains these results?

A Electrons are free to move in the solution when potassium bromide dissolves.

B Metal ions are free to move when potassium bromide melts.

C Metal ions are free to move when potassium reacts with water.

D Oppositely charged ions are free to move in the solution when potassium bromide dissolves.

12 Which statement describes what happens in a hydrogen-oxygen fuel cell?

A Electricity is generated directly.

B Electricity is used to produce water.

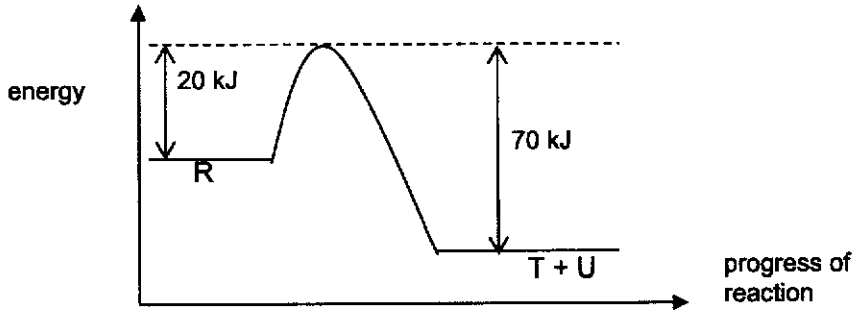
C Hydrogen is burned to produce steam.

D Hydrogen reacts to form fuel.

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13 The diagram below represents the energy profile diagram for the following reaction:

$R \rightarrow T + U$



What is the enthalpy change for this reaction?

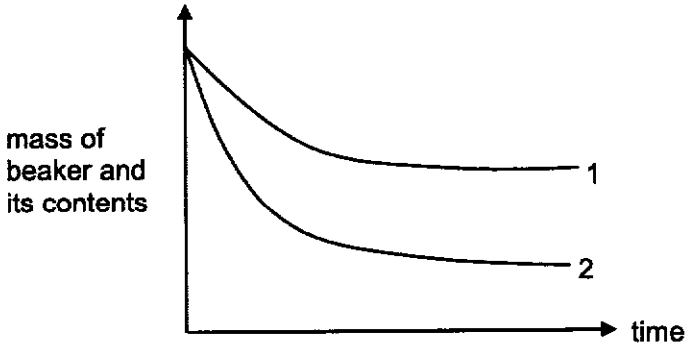
A + 50 kJ

B − 50 kJ

C − 70 kJ

D + 90 kJ

14 Excess zinc was added to a beaker of dilute nitric acid on an electronic balance. A graph of the mass of the beaker and its contents was plotted against time as shown by **Curve 1** below:



What change(s) in the experiment would give **Curve 2**?

I The same mass of zinc but in smaller pieces.

II The same volume of nitric acid but at a higher concentration.

III The same volume of nitric acid but at a higher temperature.

A I only

B II only

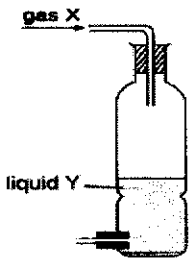
C III only

D I and III only

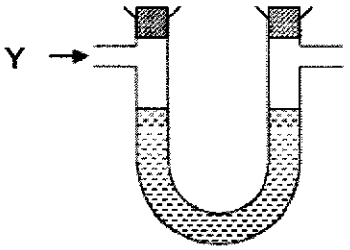
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15 A sample of insoluble gas **Y** contains an impurity that is water soluble. Which of the following is the **most** suitable apparatus to purify gas **Y** using water?

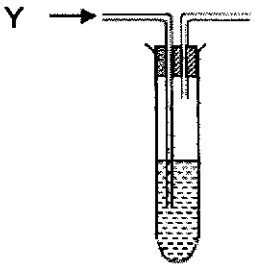
A



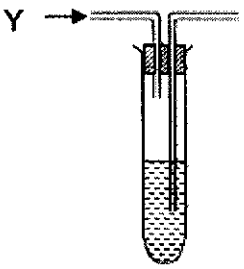
B



C



D



16 The half equation for the action of manganate(VII) as an oxidising agent in an acidic medium is:

$$MnO_4^- + 8H^+ + 5e^- \rightarrow 4Mn^{2+} + 4H_2O$$

What is the change in oxidation state of manganese?

A 2

B 5

C 7

D 8

17 In which reaction is dilute sulfuric acid not behaving as an acid?

A $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

B $H_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2HCl$

C $H_2SO_4 + CuO \rightarrow CuSO_4 + H_2O$

D $H_2SO_4 + Mg \rightarrow MgSO_4 + H_2$

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18 The properties of oxides of elements **X**, **Y** and **Z** are given in the following table.

	properties
oxide of **X**	reacts with both sulfuric acid and aqueous sodium hydroxide
oxide of **Y**	insoluble in water and aqueous sodium hydroxide but soluble in dilute hydrochloric acid.
oxide of **Z**	decolourises acidified potassium manganate(VII) solution

What are **X**, **Y** and **Z**?

	X	Y	Z
A	calcium	sulfur	aluminium
B	aluminium	calcium	sulfur
C	sulfur	aluminium	calcium
D	sulfur	calcium	aluminium

19 The following statements show the properties of a green solid.

I It produced water when it is gently heated alone.
II It gives a green precipitate when dissolved in water and added to aqueous ammonia.
III It gives a white precipitate when dissolved in water and added to acidified silver nitrate solution.

What could the green solid be?

A hydrated iron(II) chloride
B hydrated iron(II) sulfate
C anhydrous copper(II) chloride
D hydrated copper(II) sulfate

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20 The positions of five elements **P, Q, R, S** and **T** are shown in the part of the Periodic Table.

Period	I	II	III	IV	V	VI	VII	0
1st								
2nd				**Q**				**S**
3rd					**T**		**R**	
4th	**P**							

Which statement about the elements shown is **not correct**?

A Element S exists as a monoatomic gas.

B Element P is the most reactive element in Group I.

C Element T has 5 valence electrons in its outermost shell.

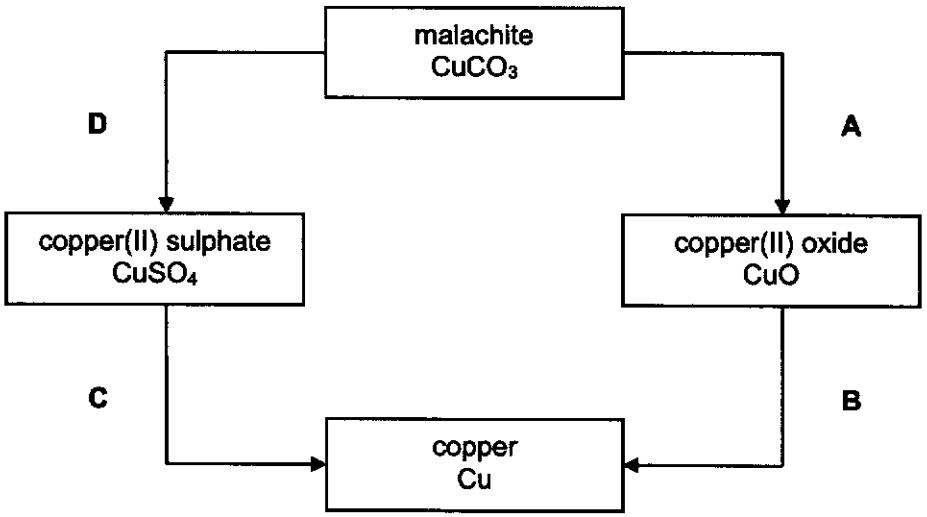
D Elements Q and R form an ionic compound which has the formulae of QR_4.

21 Which element in the table is most likely to be a transition metal?

element	melting point in ^0C	density in g/cm^3	number of chlorides known
A	1083	8.92	2
B	113	2.07	1
C	-7	3.10	2
D	1521	1.12	1

22 The diagram shows some reactions of copper compounds.

Which change is made by adding an acid?



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23 Which statement about a weak acid is correct?

A It has a pH greater than 7.
B It is insoluble in water.
C It does not ionise completely in aqueous solution.
D It turns Universal Indicator blue.

24 Two elements, **R** and **S**, are in the same Period of the Periodic Table. **R** is a metal.

Which of the following must be true for **S**?

A It is a metal.
B It forms an acidic oxide.
C It is a non-metal.
D It has a different proton number.

25 Some facts about three metals are as follows.

metal	fact
rhodium	found naturally as an alloy with other metals
thallium	extracted by electrolysis of its molten chloride
cobalt	extracted by heating its oxide with coke

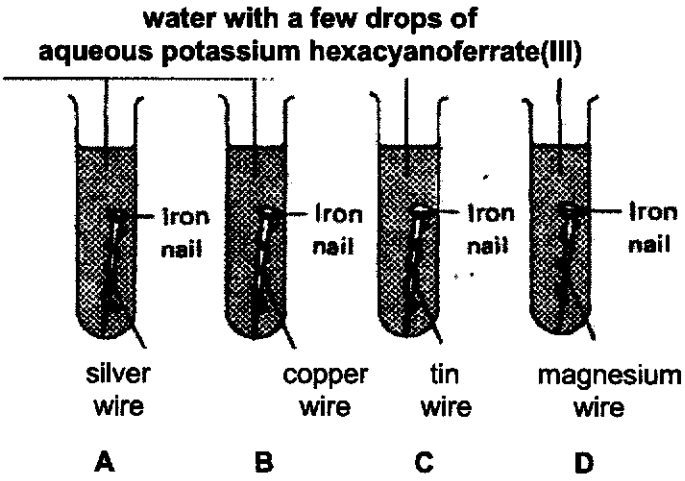
What is the likely order of reactivity of the metals?

	least reactive	⟶	most reactive
A	rhodium	thallium	cobalt
B	thallium	cobalt	rhodium
C	rhodium	cobalt	thallium
D	cobalt	rhodium	thallium

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26 Four test-tubes were set up as shown.

Iron(II) ions will produce a blue colouration in the presence of a few drops of aqueous potassium hexacyanoferrate(III).



In which test-tube would a blue colour not appear around the iron nail after some time?

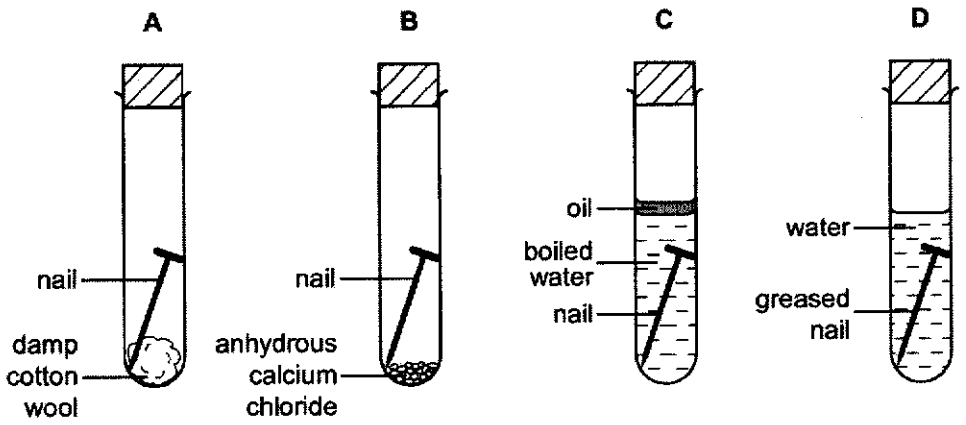
27 Copper(II) carbonate, zinc carbonate and lead(II) carbonate decompose when heated. The temperature of decomposition depends on the reactivity of the metal in the carbonate.

What is the correct order for their decomposition with respect to temperature?

	lowest temperature	⟶	highest temperature
A	copper(II) carbonate	zinc carbonate	lead(II) carbonate
B	copper(II) carbonate	lead(II) carbonate	zinc carbonate
C	lead(II) carbonate	copper(II) carbonate	zinc carbonate
D	lead(II) carbonate	zinc carbonate	copper(II) carbonate

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28 In which test-tube is the iron nail most likely to rust?



29 Magnallium is an alloy of aluminium (85%) and magnesium (15%).

Some properties are listed below.

Which property of magnalium is **not** a reason for its use in the construction of aircraft bodies?

A It conducts electricity.

B It is less dense than aluminium.

C It is stronger than aluminium or magnesium.

D The surface of the alloy is covered by a protective layer of aluminium oxide.

30 Which pair of pollutants cause damage to buildings?

A CFCs and carbon monoxide

B methane and carbon dioxide

C unburnt hydrocarbon and nitrogen monoxide

D nitrogen dioxide and sulfur dioxide

31 Why do farmers and gardeners often treat soil with ammonium sulfate?

A To reduce acidity of soil.

B To kill insects which are harmful to plants.

C To increase the sulfur content of the soil.

D To increase the nitrogen content of the soil.

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32 Which statement is true for all noble gases?

A They have 8 valence electrons.

B They form neutral oxides.

C They are monoatomic.

D They are denser than air

33 Five students each dissolved an indigestion tablet in 100 cm^3 of water. They titrated 25.0 cm^3 of their solutions with dilute hydrochloric acid, using the same indicator. The results are shown in the table.

student	A	B	C	D	E
volume of diluted hydrochloric titrated /cm^3	19.4	19.5	19.4	19.6	21.0

Which statement could explain the result obtained by student E?

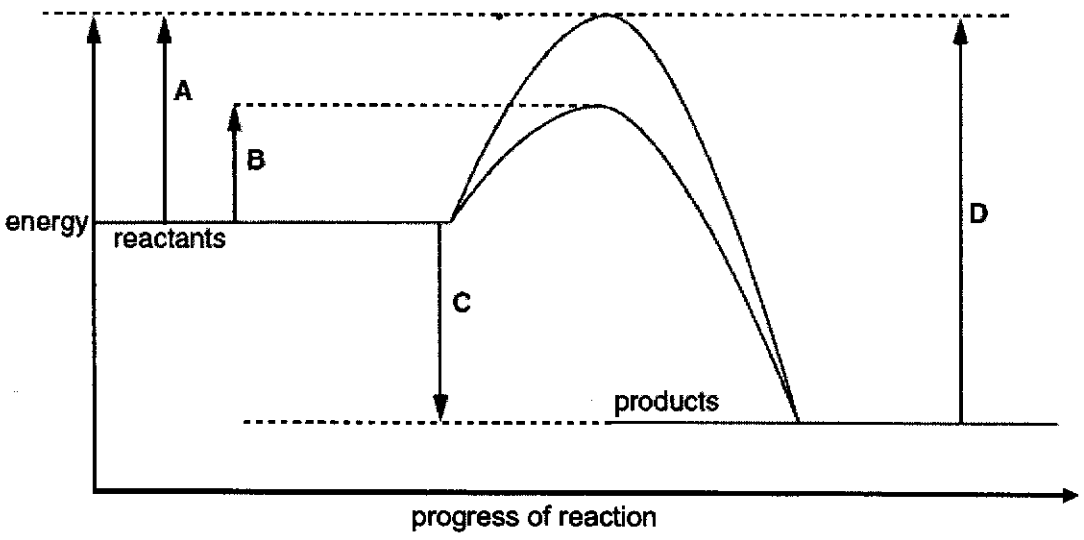
A The pipette was washed out with tablet solution.

B The burette was washed out with hydrochloric acid.

C The titration flask was washed out with the tablet solution.

D The titration flask was washed out with hydrochloric acid.

34 The diagram shows the energy profiles of two similar chemical reactions. A catalyst is present in one of the reactions.

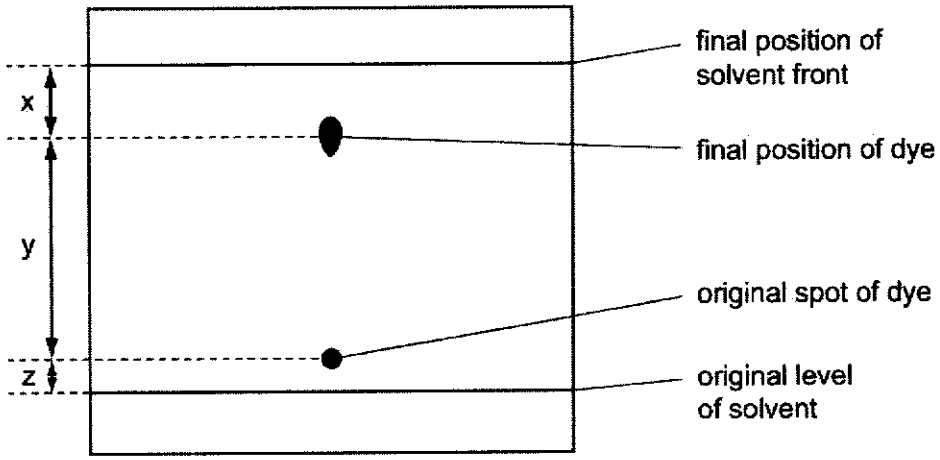


Which letter shows the enthalpy change for the uncatalysed reaction?

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35 The diagram shows the chromatogram obtained by analysis of a single dye.

Three measurements are shown.



How is the R_f value of the dye calculated?

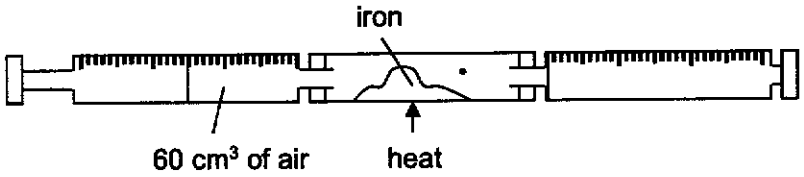
A $\frac{x}{x+y}$

B $\frac{y}{x+y}$

C $\frac{x}{x+y+z}$

D $\frac{y}{x+y+z}$

36 60 cm^3 of a sample of dry air is trapped in syringe. The air is slowly passed over heated iron in a tube until there is no further decrease in volume.



What is the approximate volume of gas that would be used up in this reaction?

A 12 cm^3

B 20 cm^3

C 48 cm^3

D 60 cm^3

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37 Aluminium is used to make saucepans because of its apparent lack of reactivity.

Which property of aluminium explains its unreactivity?

A It has a low density

B It has a surface layer of oxide.

C It has a high electrical conductivity.

D It has shiny surface and reflect heat well.

38 Which of the following statements on the trend of Group I elements is **incorrect**?

A The melting point increases down the group.

B The atomic radius increases down the group.

C The reactivity increases down the group.

D The density increases down the group.

39 Why are catalytic converters fitted to the car exhausts?

A to decrease the amount of carbon dioxide emitted

B to decrease the amount of nitrogen oxides emitted

C to improve energy conservation

D to reduce global warming

40 In an electrolysis experiment, the same quantity of electricity deposited 64 g of copper and 24 g of titanium. What was the charge on the titanium?

A +1

B +2

C +3

D +4

End of Paper 1

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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: 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.)

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Name: ..... ( )

Class: .....

Preliminary Examination 2020
Secondary 4 Express

Chemistry
Paper 2

6092/2

Monday
31 August 2020

1 hour 45 minutes
0800 - 0945

INSTRUCTIONS TO CANDIDATES

1. Write your name, class and register number on the Question paper.
2. This paper consists of 2 sections:

   Section A [50 marks]
   Answer **ALL** questions in the space provided on pages 2 to 9.

   Section B [30 marks]
   Answer all **three** questions, the last question is in the form either/or.
   Answer **all** questions in the spaces provided
3. The use of calculator is allowed.
4. A copy of the Periodic Table is given on page 20.

INFORMATION FOR CANDIDATES

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

Section	Marks
Section A	50
Section B	30
Total	80

This question paper consists of **20** printed pages including the cover page.

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Section A [50 marks]
Answer **all** questions in this section in the space provided.

A1 Selecting from elements with atomic number 1 to 36 only, write down the symbol of an element which

(a) is in Group V , _____ [1]

(b) a noble gas, _____ [1]

(c) is a transition metal, _____ [1]

(d) forms a chloride with a formula of XCl_3, _____ [1]

(e) is a non-metal that forms a solid oxide at room temperature, _____ [1]

(f) exists as allotrope, and _____ [1]

(g) can exist as triatomic molecules. _____ [1]

[Total: 7]

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A2 Fig. 2.1 shows four different set-ups **A**, **B**, **C** and **D** for electrolysis.

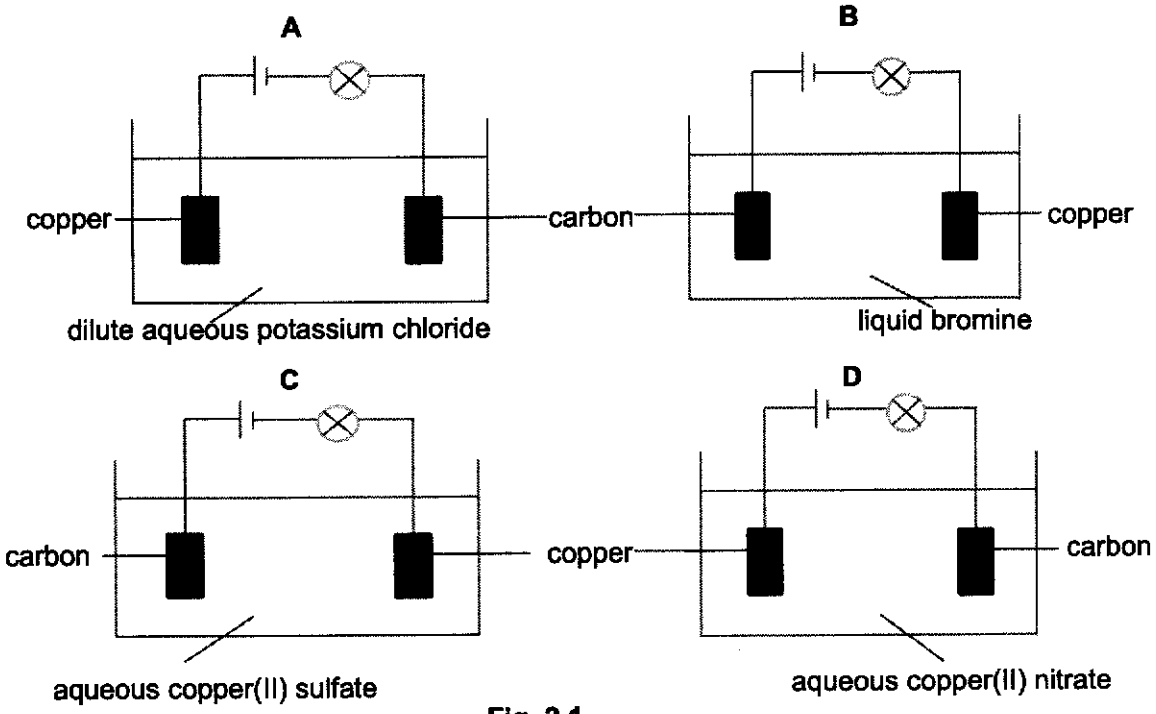


Fig. 2.1

With reference to Fig. 2.1, identify the set-up(s) in which

(a) the light bulb is not lit up, ...[1]

(b) there is effervescence of colourless gas at the anode, ...[1]

(c) there is a solid deposited at the cathode, ...[1]

(d) the colour of the electrolyte changes from blue to colourless. .....[1]

(e) Write the ionic half-equations, for the reactions at both electrodes in set-up **A**.

anode: .....

cathode: .....[2]

[Total: 6]

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A3 Steel is an alloy of iron and carbon.

(a) Describe, with the aid of labelled diagram(s), the benefit of mixing carbon with iron.

.....

.....

.....

.....[3]

(b) The percentage of iron in steel can be determined via reaction with dilute sulfuric acid. The iron in steel reacts with dilute sulfuric acid to produce hydrogen gas as shown in the equation:

$$Fe + 2H^+ \rightarrow Fe^{2+} + H_2$$

A sample of powdered steel weighing 2.4 g was analysed, and 0.142 dm^3 of hydrogen gas was produced at room temperature and pressure.

Calculate the percentage of iron in the sample of steel.

Percentage of iron in the sample of steel = ...[3]

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(c) Describe the chemical changes that take place in a blast furnace when iron is extracted from haematite. Include chemical equations that represent these changes.

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

A4 Table 4.1 shows some data about the composition of the mixtures of exhaust gases emitted from two cars, one with and one without a catalytic converter.

substance in exhaust gases	percentage by volume / %	
	car without catalytic converter	car with catalytic converter
nitrogen	67.60	67.65
carbon dioxide	12.00	12.25
water vapour	11.00	11.10
oxygen	9.00	9.00
carbon monoxide	0.20	0
nitrogen dioxide	0.15	0
unburnt hydrocarbons	0.05	0

Table 4.1

(a) Explain how nitrogen dioxide and carbon monoxide is formed in the engine of cars.

.....

.....

.....[2]

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(b) One of the exhaust gases in Table 4.1 present in large quantities may result in global warming.

(i) Name this gas.

..... [1]

(ii) Describe one environmental problem of global warming.

.....

..... [1]

(c) Using the information in Table 4.1, suggest how a catalytic converter helps to reduce air pollution from cars. Include a suitable chemical equation.

.....

.....

..... [3]

(d) An environmentalist suggests planting more trees along the roadside can improve the air quality by changing the percentage of carbon dioxide and oxygen.

(i) Explain how trees along the roadside changes the percentages of oxygen and carbon dioxide.

.....

..... [2]

(ii) Draw a dot-and cross diagram to show the bonding in carbon dioxide. Show outer shell electrons only. [2]

[Total:11]

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A5 Table 5.1 shows the properties of substance **V**, **W**, **X**, **Y** and **Z**.

properties	V	W	X	Y	Z
solubility in water	no	yes	yes	no	yes
pH	7	10	14	7	2
conduction of electricity in room temperature	no	yes	yes	no	yes
reaction with an acid	carbon dioxide evolved	heat evolved	heat evolved	no reaction	heat evolved
reaction with carbonate	no reaction	carbon dioxide evolved	no reaction	no reaction	carbon dioxide evolved
reaction with acidified potassium manganate (VII)	remained purple	remained purple	remained purple	purple solution decolourised	remained purple

Table 5.1

Use the information in Table 5.1 to answer the following questions.

(a) Acid salt is a class of salt that produces an acidic solution after dissolving in water. Which solution(s) may be an acid salt?

..... [1]

(b) Explain why solutions **W**, **X** and **Z** can conduct electricity.

.....

..... [1]

(c) Which substance is a reducing agent?

.....[1]

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(d) Substance **Y** is zinc sulfite $ZnSO_3$. It can be prepared from sulfurous acid, H_2SO_3.

(i) State the salt preparation method to prepare zinc sulfite.

..... [1]

(ii) Name a chemical that can be reacted with sulfurous acid to prepare zinc sulfite.

.....[1]

(iii) Suggest the experimental steps required to produce a dry sample of zinc sulfite from sulfurous acid and the chemical mentioned in part (i).

.....

.....

.....

.....[2]

[Total: 7]

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A6 Table 6.1 shows some bond energies, measured in kilojoules per mole.

bond	bond energy, in kJ/mol
N ≡ N	945
H – H	436
N – H	391

Table 6.1

The Haber Process is a chemical reaction that produces ammonia gas on a large scale. The equation for the reaction is shown below:

$$3\ H_2\ (g) \quad + \quad N_2\ (g) \rightarrow \quad 2\ NH_3\ (g)$$

(a) Using the bond energies given in Table A6.1, calculate the energy change, ΔH, for this reaction.

energy change, ΔH = ...[2]

(b) Is the reaction an exothermic or endothermic reaction?
Explain your answer in terms of bond-breaking and bond-forming.

.....

.....[3]

(c) Draw an energy profile diagram to represent the reaction above. [3]

(d) The formation of ammonia from its reactants can be sped up by adding iron catalyst. On your energy profile diagram above, draw the profile of energy level for a catalysed reaction of the formation of ammonia and label it "catalysed reaction". [1]

[Total: 9]

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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.

B7 Glass is made up of compounds known as silicates. Pure silicate, SiO_2, has a "glass melting point" of over 2300°C. To reduce manufacturing cost by lowering the processing temperature, soda is added as one of the raw materials in stage 1 of the glass manufacturing process as shown in Fig. 7.1.

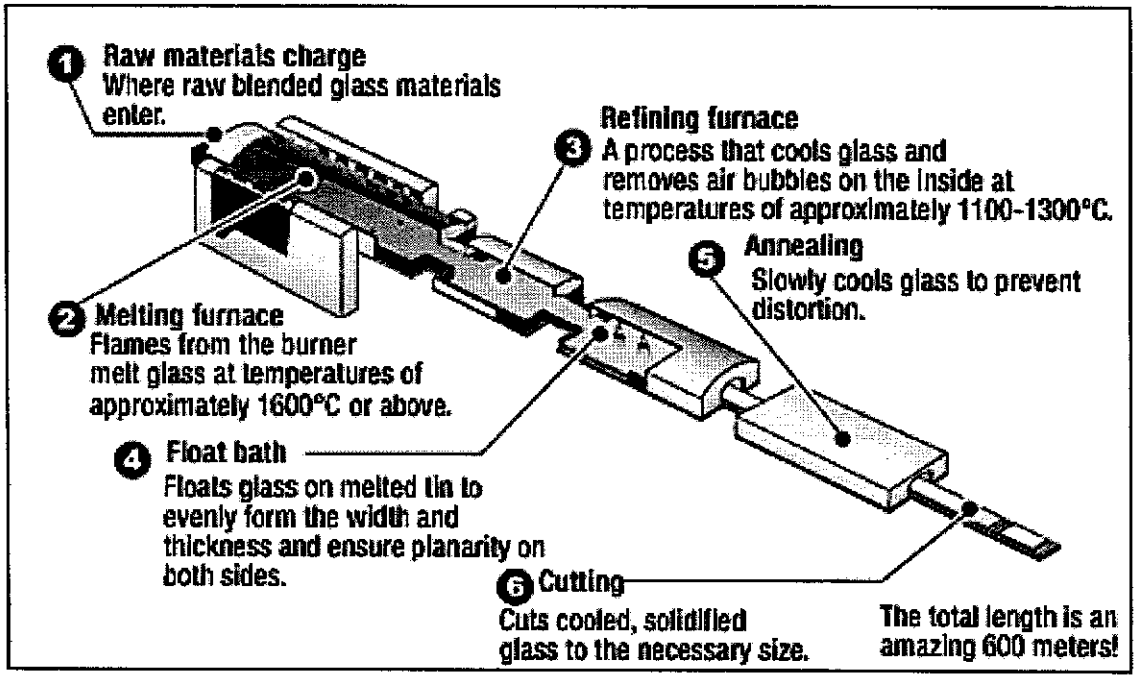
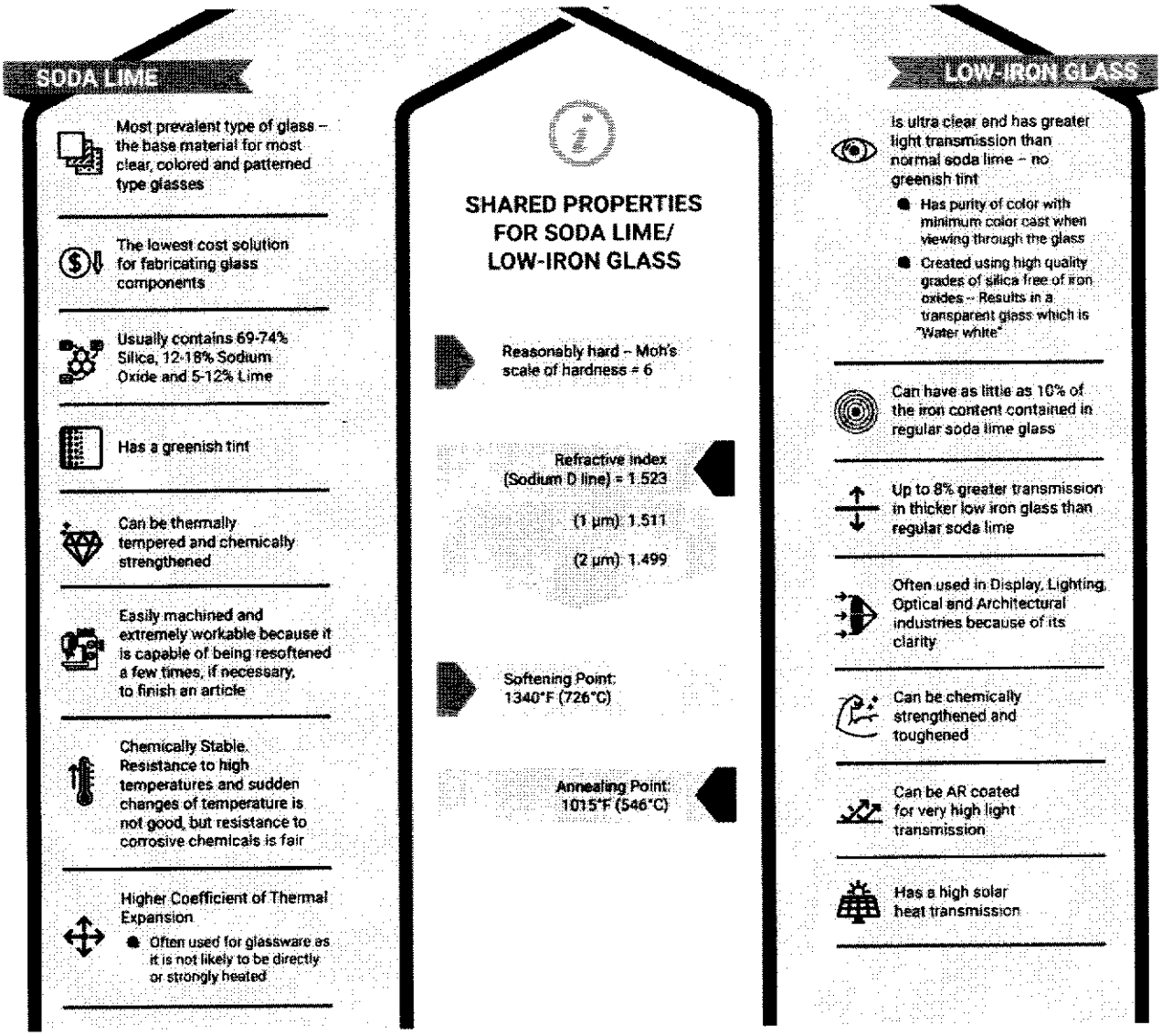


Fig. 7.1

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Soda lime glass typically has an iron oxide content of close to 0.1%. Manufacturers have managed to get iron oxide levels down to just 0.01% in low-iron glass.

Fig. 7.2 shows the comparison of soda lime glass vs low-iron glass.



source: https://www.swiftglass.com/blog/low-iron-glass-vs-standard-clear-glass/

Fig. 7.2

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"Soda" refers to the original source of sodium carbonate in the soda ash obtained from certain plants. However, adding soda makes the glass water soluble, which is usually undesirable, so lime (calcium oxide, CaO, generally obtained from limestone, $CaCO_3$) and sodium oxide are added to provide for a better chemical durability. The resulting glass contains about 69 to 74 percent silicate by weight and is called soda-lime glass.

The simplified structures of a silicate and soda-lime glass are shown in Fig. 7.3.

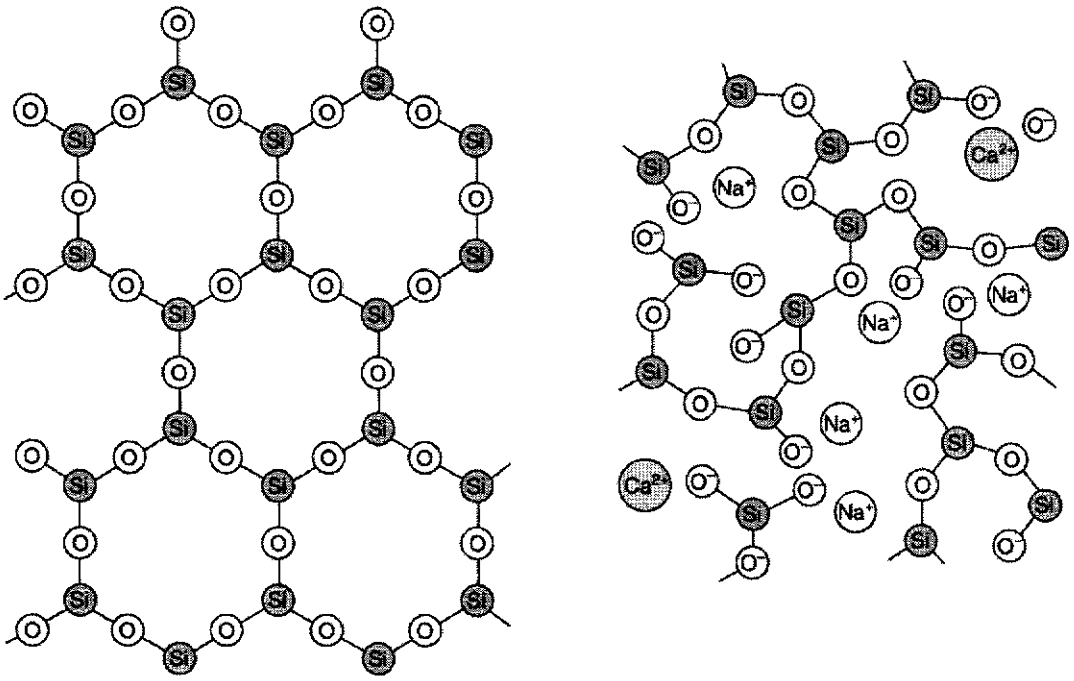


Fig. 7.3

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(a) State the purpose of adding soda to pure silicate when making glass.

.....

.....[1]

(b) With reference to Fig. 7.2, state one common physical property of soda lime glass and low-iron glass.

.....[1]

(c) State the temperature range for removal of air bubbles in the glass in the refining furnace.

.....[1]

(d) Suggest the substance which is responsible for the green tint in the glass.

.....[1]

(e) Write an equation, with state symbols, to show how lime is obtained from the thermal decomposition of limestone.

.....[2]

(f) With reference to Fig. 7.3, explain why the silicate has a higher melting point than soda-lime glass.

.....

.....

.....

.....[2]

(g) Calculate the number of calcium ions in 2 000 g of soda lime glass containing 74 % of silicate and 12 % of sodium oxide by mass.

Number of calcium ions = ...[2]

[Total: 10]

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B8 A student investigated the rate of reaction when dilute acid reacts with excess solid magnesium using the apparatus as shown in Fig. 8.1.

The experiment was carried out at a temperature of 20 °C. He measured the time taken to collect 20 cm^3 of gas at room temperature and pressure. He also measured the total volume of gas collected at the end of the experiment at room temperature and pressure.

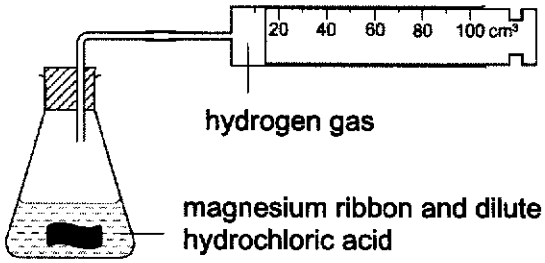


Fig. 8.1

Table 8.2 shows the results obtained in the experiment.

experiment	acid	volume of acid used / cm^3	concentration of acid used in mol/dm^3	time taken to collect 20 cm^3 of gas / s	total volume of gas / cm^3
1	HCl	10	0.25	15	30
2	HCl	10	0.5	7	60
3	HCl	10	1.0	3	100
4	H_2SO_4	10	0.25		

Table 8.2

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(a) Name the salt formed in Fig. 8.1.

.....[1]

(b) Experiment 4 is carried out with sulfuric acid instead. Complete Table 8.2. [2]

(c) There is an error in one of the total volume of gas collected in Table 8.2.

Which experiment is most likely to have the error?

Suggest one modification to the apparatus setup in Fig. 8.1 to correct the error.

.....

.....[2]

(d) Instead of magnesium ribbon, excess calcium solid was reacted with same dilute hydrochloric acid from experiment 1.

Suggest how, if at all, each of the following would change:

(i) the initial rate of production of hydrogen

.....[1]

(ii) the final volume of hydrogen gas produced

.....[1]

(e) Explain, in terms of collision between reacting particles, how using magnesium powder affects the rate of reaction.

.....

.....

.....

.....[3]

[Total:10]

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EITHER

B9 Zinc spar is an ore containing zinc carbonate. It is used to extract zinc in a two-stage process. as shown:

Stage 1 $ZnCO_3 \rightarrow ZnO + CO_2$

Stage 2 $ZnO + C \rightarrow Zn + CO$

(a) Explain why the gas from stage 2 must be removed for the safety of the workers in charge of this extraction process.

.....

.....[1]

(b) Explain why the same two-stage process cannot be used to extract potassium from potassium carbonate.

.....

.....

.....[2]

(c) The world's consumption of zinc falls into five areas. The most important use, approaching 50 percent of the total consumption, is in the corrosion protection of iron and steel.

Describe and explain how zinc protects iron and steel from corrosion.

.....

.....

.....[2]

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(c) In the laboratory, two experiments were set up using zinc metal as shown in Fig. 9.1.

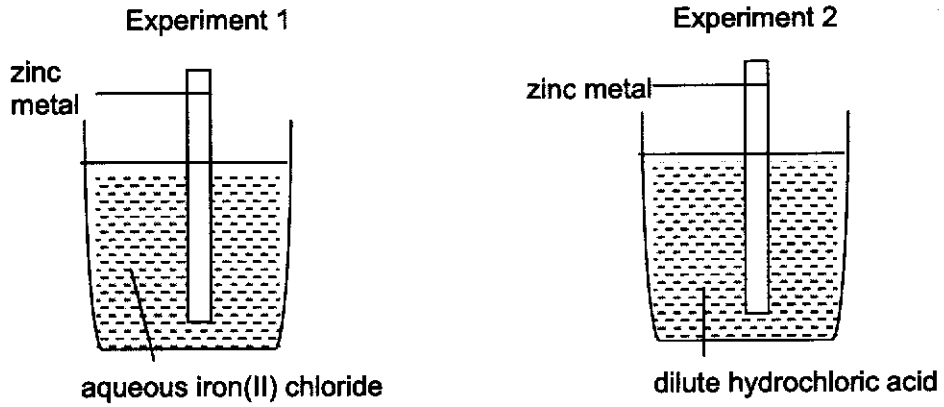


Fig. 9.1

For each experiment, describe what you would observe and how you would test for any gas evolved. Write an equation for the reaction in each beaker. [5]

Experiment 1 .....

.....

.....

.....

.....

Experiment 2 .....

.....

.....

.....

.....

[Total: 10]

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OR

B9 During a practical a student had to identity a gas sample and prepare sodium chloride salt.

(a) The gas is known to be one of the following:

- nitrogen
- oxygen
- ammonia
- a mixture of equal volumes of nitrogen, oxygen and ammonia.

Describe **two** simple tests the student could carry out to decide what the gas is.
Explain your reasoning.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

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(b) Aqueous sodium chloride can be prepared by titrating aqueous sodium hydroxide with dilute hydrochloric acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

(i) Name the two pieces of apparatus used to measure accurately the volumes of the solutions in this titration.

.....[1]

(ii) Given that 25.0 cm^3 of 1.0 mol/dm^3 sodium hydroxide and 25.0 cm^3 of 2.0 mol/dm^3 of hydrochloric acid were used.

Calculate the mass of sodium chloride formed.

mass of sodium chloride = ... g [3]

(iii) Draw a labelled diagram to show how a pure sample of sodium chloride can be obtained by evaporation to dryness. [2]

[Total:10]

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The Periodic Table of Elements

Group																		
I	II										III	IV	V	VI	VII	0
																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

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.)

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East Spring Secondary School
Science Department
Secondary 4E Pure Chemistry Marking Scheme
Preliminary Examination 2020

Paper 1 - Multiple Choice Questions (40 x 1mark)

1	2	3	4	5	6	7	8	9	10
D	C	D	D	B	B	A	D	B	C
11	12	13	14	15	16	17	18	19	20
D	A	B	B	C	B	B	B	A	D
21	22	23	24	25	26	27	28	29	30
A	D	C	D	C	D	B	A	A	D
31	32	33	34	35	36	37	38	39	40
D	C	C	C	B	A	B	A	B	D

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East Spring Secondary School
Science Department
Secondary 4E Pure Chemistry Marking Scheme
Preliminary Examination 2020

A1 Selecting from elements with atomic number 1 to 36 only, write down the symbol of an element which

(a) is in Group V ,	N / P / As	[1]
(b) a noble gas,	He / Ne / Ar / Kr	[1]
(c) is a transition metal,		
(d) forms a chloride with a formula of XCl_3,	Al / Ga / B / N / Fe /P	[1]
(e) is a non-metal that forms a solid oxide at room temperature	Si	[1]
(f) exists as allotrope, and	C / O/ P/ S/ B/Si	[1]
(g) can exist as triatomic molecules.	O	[1]

A2 Use the letters A, B, C and D to answer the following questions. Each letter can be used once, more than once, or not at all.

Identify the set-up(s) in which

(a) the light bulb is **not** lit up,	**B**	[1]
(b) there is effervescence of colourless gas at the anode,	**C**	[1]
(c) there is a brown solid deposited at the cathode,	**C&D**	[1]
(d) the colour of the electrolyte changes from blue to colourless.	**C**	[1]

(e) Write the ionic half-equations, with state symbols, for the reactions at both electrodes in set-up **A**.

anode: $\underline{Cu\ (s) \rightarrow Cu^{2+}\ (aq) + 2e}$

cathode: $\underline{2H^{+}\ (aq) + 2e \rightarrow H_2\ (g)}$ [2]

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9

A3 Steel is an alloy of iron and carbon.

(a) Describe, with the aid of labelled diagram(s), the benefit of mixing carbon with iron. [3]

Mixing of carbon with iron makes steel **harder/stronger** [1]
carbon atom of a **different size disrupt the regular arrangement (can be from diagram) [1]** of pure iron atoms . **Preventing layers of metal atoms from sliding past each other easily [1]** when force is applied.

(b) A 2.4 g sample of powdered steel was analysed by reaction with excess dilute sulfuric acid. The iron reacts as shown in the equation to form 0.142 dm^3 of hydrogen measured at room temperature and pressure.

$$Fe + 2H^+ \rightarrow Fe^{2+} + H_2$$

Calculate the percentage of iron in the sample of steel. [3]

no. of mole of H_2
= 0.142/24
= 0.005916 mol [1]

H_2 : Fe
1 : 1
0.005916:0.005916

mass of 0.0059169mol of Fe.
= 0.331 g[1].

Or no. Of mole of 2.4g
= 2.4/56 = 0.04285 mol

% of Fe
=0.331/2.4 x 100%
=13.8 % [1]

or
= 0.005916 / 0.04285 x 100 %

Percentage of iron in the sample of steel = **13.8 %**

(c) Describe the chemical changes that take place in a blast furnace when iron is extracted from haematite. Write equations that represent these changes. 6c - [4]

Coke burns **in hot air to form carbon dioxide;** 4-5c
$C + O_2 \rightarrow CO_2$ [3]
which rises in the furnace to **react with more coke**, **forming carbon monoxide** 2-3c
$CO_2 + C \rightarrow 2CO$ [2]
The **carbon monoxide reduces iron(II)oxide in haematite** to **molten iron** that flow down the furnace and collected at the bottom. 1c
$Fe_2O_3 + 3CO \rightarrow 2\,Fe + 3CO_2$ [1]

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A4

(a) Explain how nitrogen dioxide and carbon monoxide is formed. [2]
nitrogen dioxide is form when the **oxygen and nitrogen in the air react in the hot engine** [1] carbon monoxide is the product of **incomplete combustion**;[1]

(b) One of the exhaust gases in Table 4.1 present in large quantities may result in global warming. [2]

(i) Name this gas.
carbon dioxide

(ii) Describe one environmental consequence of an increase in global warming.
melting of polar ice caps or increase in sea levels

(c) Using the information from the above table and suitable chemical equation, suggest how a catalytic converter helps to reduce air pollution from cars. [3]
The use of a catalytic converter helps to **convert oxides of nitrogen, carbon monoxide and unburnt hydrocarbons into nitrogen and carbon dioxide. [1]**

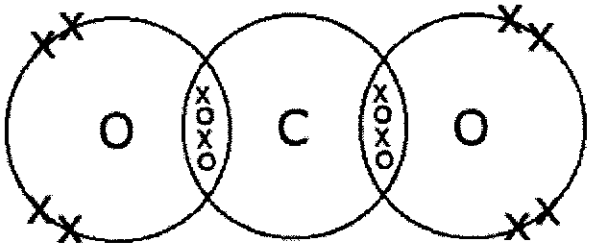
$NO + CO \rightarrow N_2 + CO_2$; [1]

It also converts unburnt hydrocarbons into carbon dioxide and water.[1]

(d) An environmentalist suggests planting more trees along the roadside can improve the air quality by changing the percentage of carbon dioxide and oxygen.

(i) Explain how trees along the roadside changes the percentages of oxygen and carbon dioxide. [2]
Trees will take in carbon dioxide and give out oxygen during the day when it **photosynthesizes**.[1] This **increases the percentage of oxygen and decreases the percentage of CO_2 in the day**.[1]

(ii) Draw dot-and cross diagrams to show covalent bonding in carbon dioxide. Show outer shell electrons only. [2]



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A5 Table 5.1 shows the properties of substance **V**, **W**, **X**, **Y** and **Z**.

properties	V	W	X	Y	Z
solubility in water	no	yes	yes	no	yes
pH	7	10	14	7	2
conduction of electricity in room temperature	no	yes	yes	no	yes
reaction with an acid	carbon dioxide evolved	heat evolved	heat evolved	no reaction	heat evolved
reaction with carbonate	no reaction	carbon dioxide evolved	no reaction	no reaction	carbon dioxide evolved
reaction with acidified potassium manganate (VII)	remained purple	remained purple	remained purple	purple solution decolourised	remained purple

Table 5.1

Use the information in Table 5.1 to answer the following question.

(a) Acid salt is a class of salt that produce acidic solution after dissolving in water. [1]
Which solution(s) may be an acid salt?
Z

(b) Explain why solution **W**, **X** and **Z** can conduct electricity. [1]
There are **free mobile** OH^- **ions** in W and X and H^+ ions in Z

(c) Which substance is a reducing agent? [1]
Y

(d) **Y** is zinc sulfite $ZnSO_3$. It can be prepared from sulfurous acid, H_2SO_3.

(i) Ionic **precipitation** [1]

(ii) Name a chemical that can be reacted with sulfurous acid to prepare zinc sulfite. [1]
Zinc nitrate / zinc chloride/ zinc sulfate

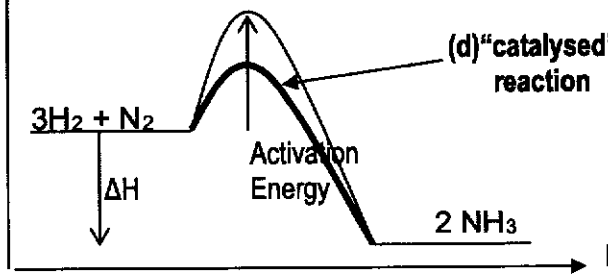
(iii) Suggest the experimental steps required to produce a dry sample of zinc sulfite from sulfurous acid and the chemical mentioned in part (i). [2]
Mix them together
filter to obtain **residue**
wash residue with distilled water
dry between filter paper

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A6 **(a)** Energy absorbed to break bonds = 3(436) + 945 = 2253 kJ
Energy released to form bonds = 6(391) = 2346 kJ [1]
Energy change for reaction = **2253 + (- 2346) = - 93 kJ** [1]

(b) **Exothermic[1]**, since the **energy absorbed** to break old bonds **is lower[1] than the energy given off to form** new **bonds**.[1] [3]

(c) Energy



1 m

1 m (correct profile with reactants & products)

Label activation energy with an arrow pointing upwards from reactants to peak.] 1 m

[Label ΔH with an arrow pointing downwards from reactants to products.] 1 m

B7 **(a)** What is the purpose of adding soda to pure silicate when making glass? [2]

Lower processing temperature

(b) Based on Figure B7.2, state one common physical property of soda lime glass and low-iron glass. [1]

hard / annealing temp = 546 ºC / softening point = 726 ºC / same refractive index / clear

(c) What is the temperature range to remove bubbles in the glass in the refining furnace? [1]
1100-1300 ºC

(d) Suggest which substance is responsible for the green tint in the glass. [1]
Fe^{2+} ions / Iron(II) ion / iron oxide

(e) Write an equation, with state symbols, to show how lime is obtained from the thermal decomposition of limestone. [2]

$CaCO_3$ (s) → CaO (s) + CO_2 (g)
[1]- state symbol, [1] balanced equation + correct formula

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(f) Based on Figure B7.3, explain why the silicate has a higher melting point than soda-lime glass. [2]

silicate pure compound
atoms held in **giant network/ giant covalent/macromolecular structure**
a **lot of energy needed to break covalent bond**[1]
soda-lime a **mixture**, it has **impurities to lower the melting point** [1]

(g) Calculate the number of calcium ions in 2 000g of soda lime glass containing 74% of silicates and 12 % of sodium oxide by mass. [2]

% of CaO
=100 – 74 -12
= 14 %

Mass of CaO
=14% x 2000
=**280 g** [1]

no of CaO
=280 / (40 + 16) x 6 x 10^{23}
= 30 x 10^{23}

in each CaO there are 1 Ca^{2+}

So Ca^{2+} ion = **30 x 10^{23}** [1]

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B8 **(a)** Name the salt formed in Figure B8.1.
Magnesium chloride [1]

(b)

experiment	acid	volume of acid used / cm^3	concentration of acid used in mol/dm^3	time taken to collect 20 cm^3 of gas / s	total volume of gas / cm^3
1	HCl	10	0.25	15	30
2	HCl	10	0.5	7	60
3	HCl	10	1.0	3	100
4	H_2SO_4	10	0.25	**Accept: Value from 6 to 7[1]**	**60[1]**

[2]

(c) **Experiment 3** [1]
Change the gas syringe to a bigger capacity gas syringe [1]
(accept any other reasonable answer)

(d) Instead of magnesium ribbon, calcium solid was reacted with same dilute hydrochloric acid in experiment 1.

Suggest how, if at all, each of the following would change:

[2]

i) the initial rate of production of hydrogen
increase/higher [1] (because calcium is more reactive than magnesium)

ii) the final volume of hydrogen gas produced
remain the same/ no change [1] (because calcium is in excess)

(e) Explain, in terms of collision between reacting particles, how using magnesium powder affects the rate of reaction. [3]

smaller particle size, higher/larger surface area [1] for collision, increase frequency of collisions, **increase frequency/rate of effective collision** [1][so **increase rate of reaction**.[1]

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EITHER

B9 Zinc can be extracted from its ore, zinc spar, $ZnCO_3$, in a two-stage process.

Stage 1 $ZnCO_3 \rightarrow ZnO + CO_2$

Stage 2 $ZnO + C \rightarrow Zn + CO$

(a) Explain why the gas from stage 2 must be removed for the safety of the workers. [1]
stage 2 produce Carbon monoxide which is **a toxic/poisonous gas** that bind with haemoglobin to **prevent red blood cell from transporting oxygen to other part of the body/ causing breathing difficulty**. So it has to be remove for safety of the worker

(b) Explain why the same two-stage process cannot be used to extract potassium from potassium carbonate. [2]

potassium is **higher in the metal reactivity series/ more reactive** [1] or **carbon is less reactive** carbon is **unable to reduce** potassium oxide to potassium. [1]

or
potassium carbonate has **higher thermal stability**[1], it **will not decompose** [1] upon heating.

(c) coating iron or steel with zinc offer **barrier protection/protective barrier**, preventing oxygen and moisture from **contacting the iron** or steel and corrode. [1]
or
Zinc also provide **sacrificial protection** to the iron and steel, it will **corrode in place** of the iron since it is more reactive. [1]

(d) In the laboratory, two experiments were set up using zinc metal.

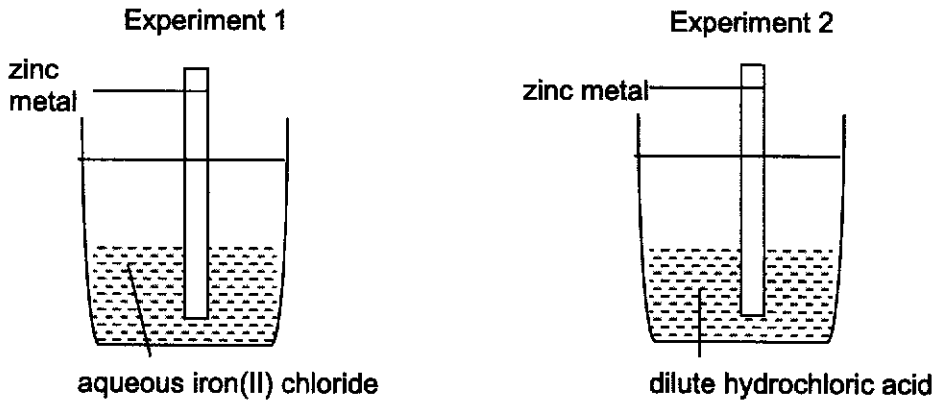


Figure B9.1

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For each experiment, describe what you would observe and how you would test any gas evolved. Write an equation for the reaction in each beaker.

[5]

Experiment 1 : (metal displacement)

green iron(II) chloride will turn **colourless** zinc chloride. (no gas)[1]
black / brown solid deposited on zinc [1]
$Zn + FeCl_2 \rightarrow ZnCl_2 + Fe$ [1]

Experiment 2 : metal with acid

R observed, colourless odourless gas evolved **extinguish lighted splint** with a **'pop' sound.**[1]
$Zn + 2HCl \rightarrow ZnCl_2 + H_2$ [1]

Or B9

(a) **Test 1:** Insert a **glowing splint** into a test-tube containing the gas. If the glowing splint **relights**, it indicates the presence of **oxygen**. [1]

Test 2: Place a **moist red litmus paper** at the mouth of the test-tube containing the gas sample. If the **moist red litmus paper turns blue**, it indicates the presence of **ammonia**. [1]

If both tests are **positive**, indicating the presence of oxygen and ammonia, the gas contains a mixture of **nitrogen, oxygen and ammonia**. [1]

If both tests are **negative**, the gas contains **nitrogen**. [1]

(b)

(i) Burette and pipette [1]

(ii) No. of mole NaOH = $\frac{25}{1000} \times 1 = 0.025$

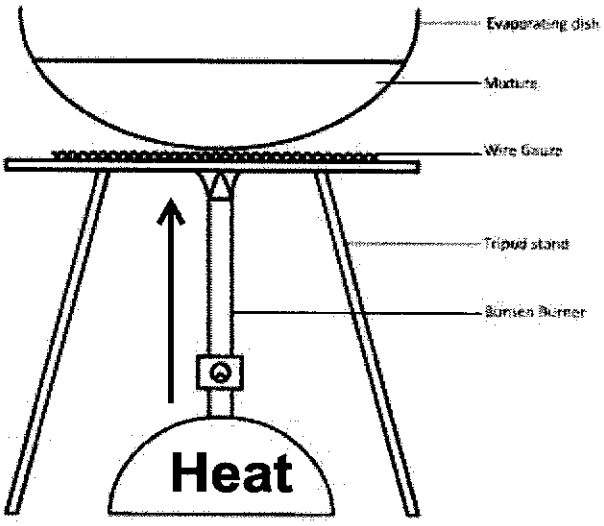
No. of mole HCl = $\frac{25}{1000} \times 2 = 0.05$ [1- calculation of moles of NaOH and HCl]

Mole ratio NaOH : HCl = 1 : 1
No. of mole HCl required = 0.025
NaOH is the limiting reagent. [1]
Mole ratio NaOH : NaCl = 1 : 1

No. of mole NaCl formed = **0.025mol [1]**
Mass of NaCl = 0.025 x (23+35.5) = **1.46g** [1]

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(iii)



Suggested diagram

[1]- suitable diagram
[1] – label

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