East Spring Secondary School

Towards Excellence and Success

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

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]

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

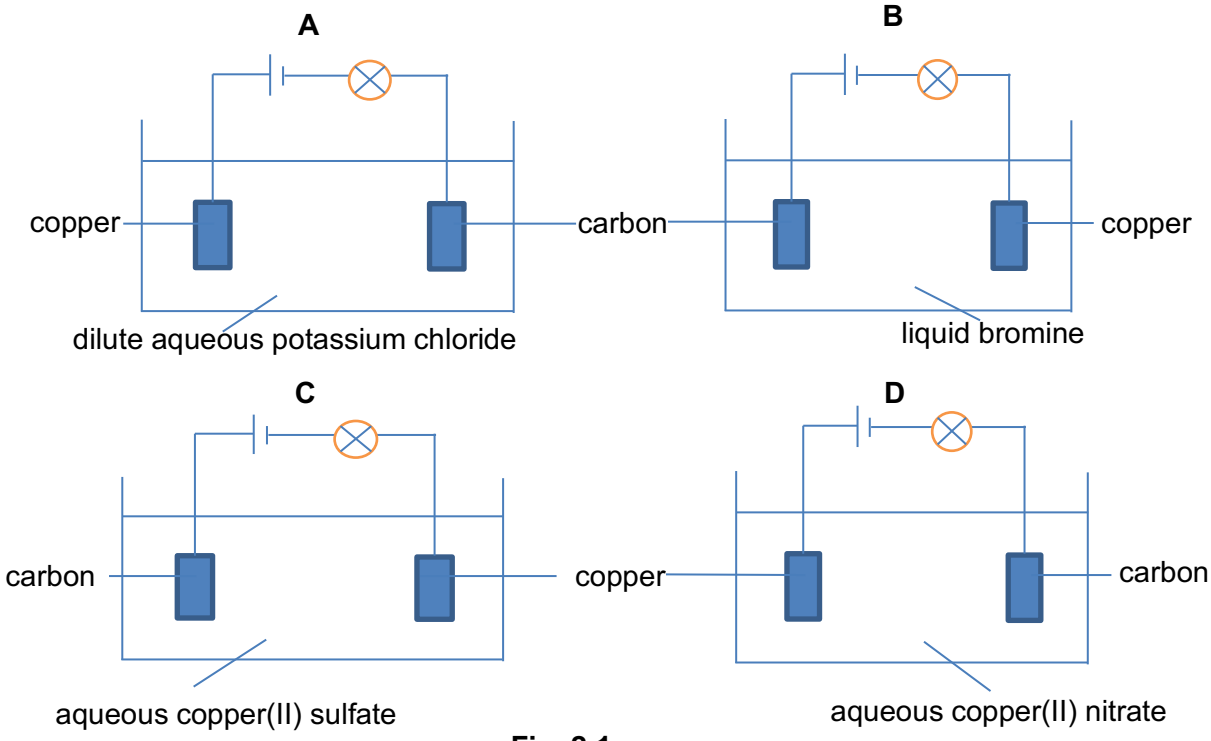


Fig. 2.1

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]

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]

(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]

(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]

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]

(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]

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, ∆H, for this reaction.

energy change, ∆H = ……[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]

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.

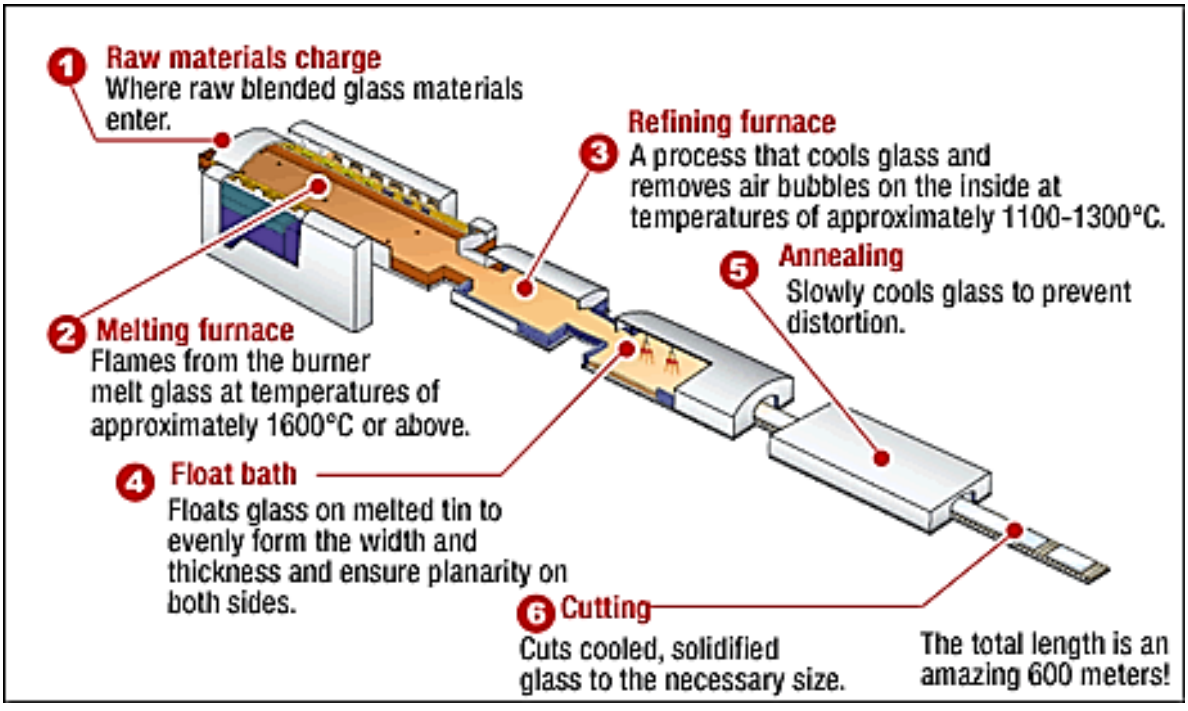
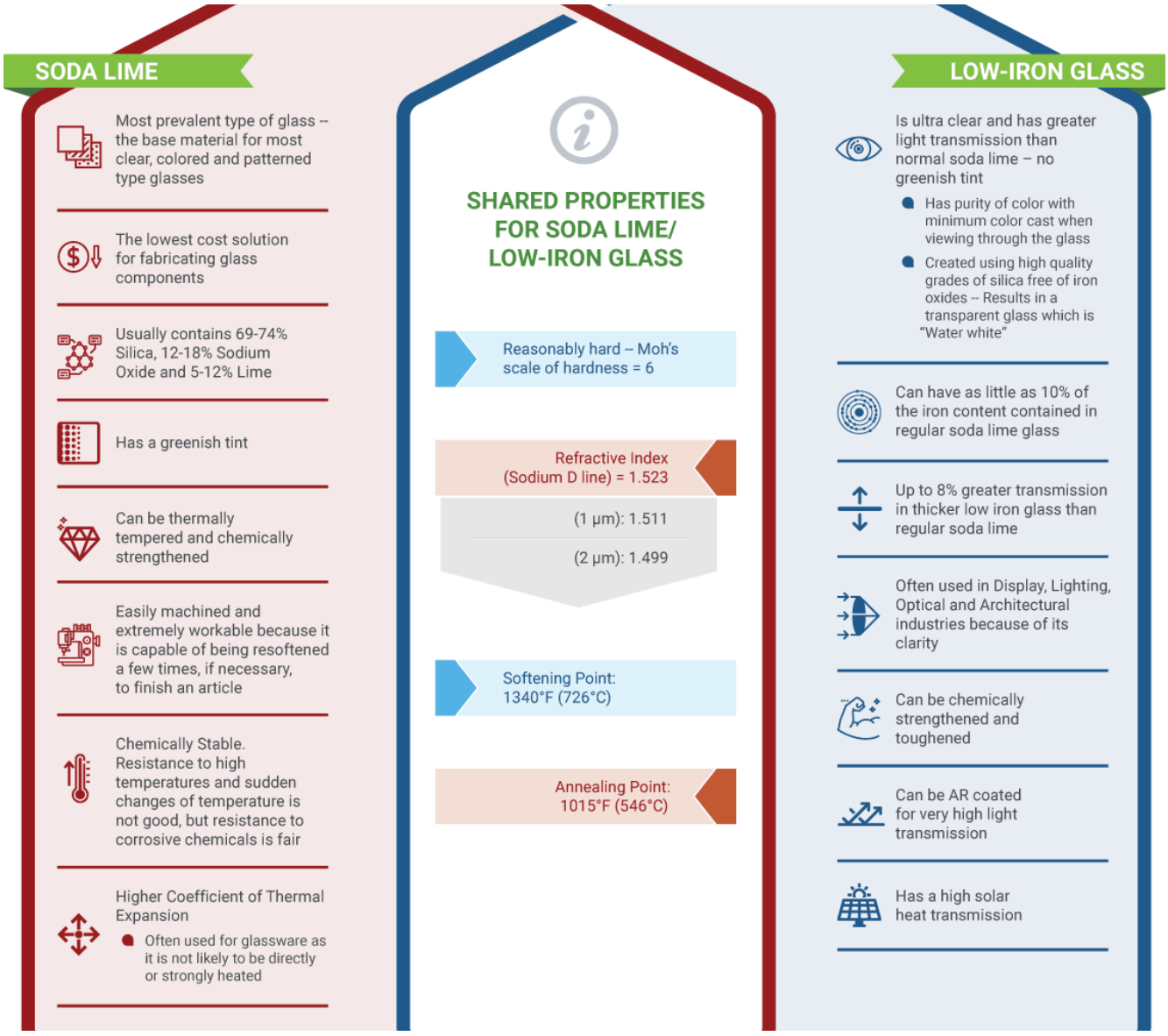


Fig. 7.1

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

“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.

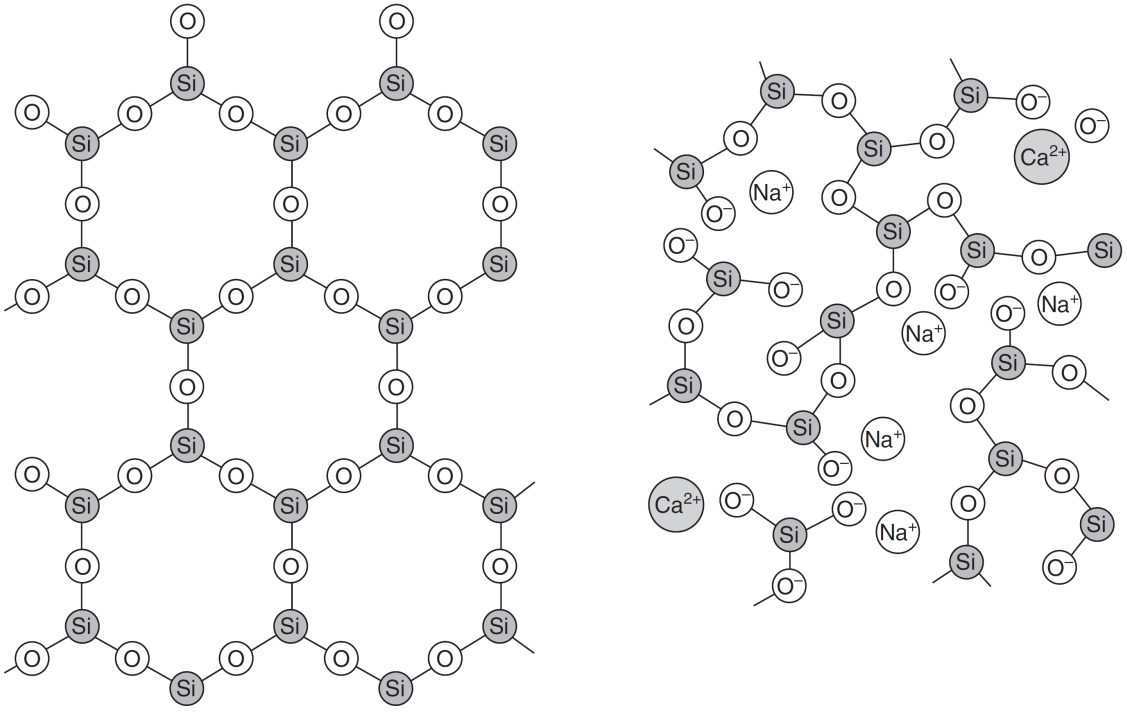


Fig. 7.3

(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]

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.

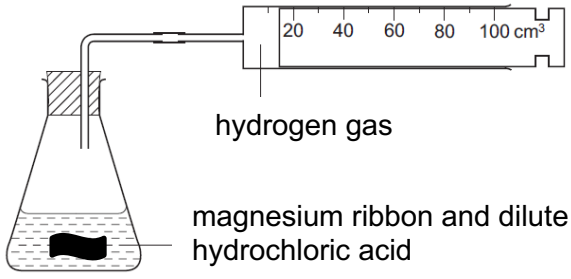


Fig. 8.1

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

(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]

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]

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

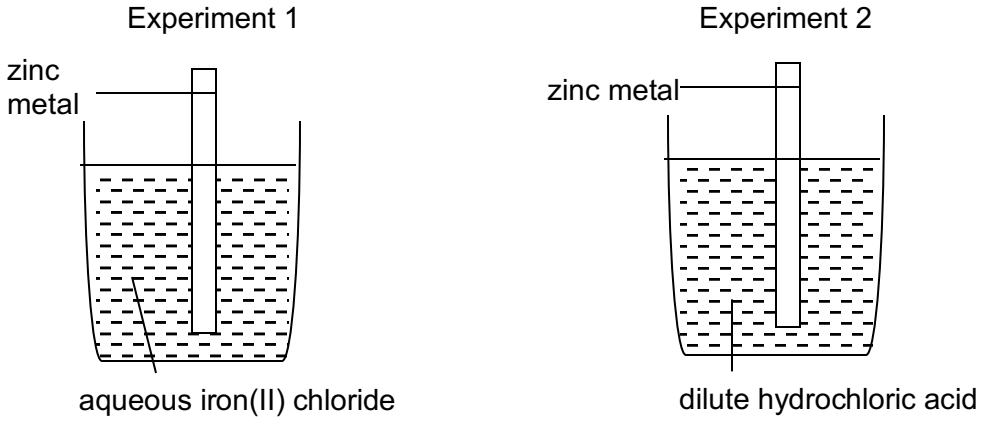


Fig. 9.1

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]

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.

……

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……

……

…… [4]

(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]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	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.)