



ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2026
SECONDARY 4 EXPRESS

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Candidate Name

Class

Register Number

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CHEMISTRY

Paper 2

6092 /02

19 August 2026
1 hour 45 minutes

Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number 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 an HB pencil for any diagrams or graphs.

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

Section A

Answer **all** questions.

Write your answers in the spaces provided.

Section B

Answer **one** questions.

Write your answers in the spaces provided.

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

A copy of the Periodic Table is printed on page 24.

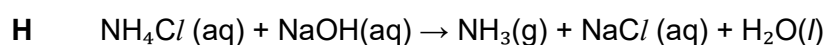
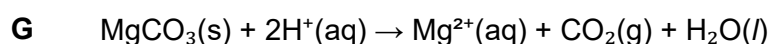
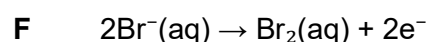
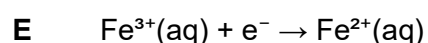
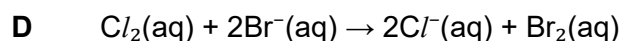
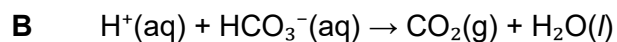
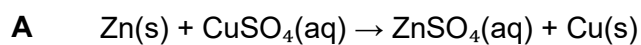
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use	Actual	Maximum Marks
Section A		70
Section B		10
Total		80

Section A

Answer **all** the questions.

1 Choose from the following equations to answer the questions below.



Each equation can be used once, more than once or not at all.

State the letter **A** to **H** for the equation which shows

(a) the production of a gas that turns moist red litmus paper blue,

..... [1]

(b) the formation of a white precipitate,

..... [1]

(c) only an oxidation reaction,

..... [1]

(d) a reaction in which a more reactive metal displaces a less reactive metal from its salt solution,

..... [1]

(e) a halogen displacement reaction.

..... [1]

[Total:5]

- 2 Table 2.1 provides some information on two different forms of carbon allotropes and silicon.

Table 2.1

substance	melting point / °C	electrical conductivity	uses
carbon allotrope A	above 3000	poor	cutting tools, drill bits
carbon allotrope B	above 3000	good	lubricant
silicon	1414	good	semiconductors in electronics

- (a) Explain, in terms of structure and bonding, why carbon allotrope **A** is used as a drill bit while carbon allotrope **B** is used as a lubricant.

.....

.....

.....

.....

.....

[4]

- (b) The structure of silicon is shown in Fig. 2.1

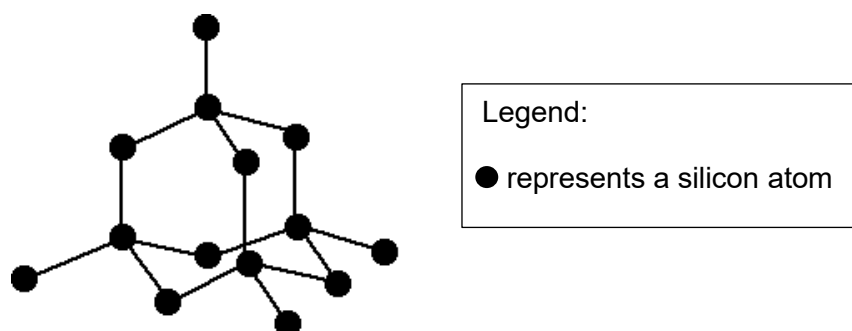


Fig. 2.1

This structure alone is unable to account for one of its physical properties stated in Table 2.1. State this physical property and explain why the structure shown does not fully explain it.

.....

.....

.....

[2]

(c) Methane, is a simple covalent molecule containing carbon.

(i) Draw a 'dot-and-cross' diagram to show the bonding in a methane molecule. Show outer electrons only.

[2]

(ii) Use your diagram in **(c)(i)** to explain how the carbon and hydrogen atoms in methane achieve a stable electronic configuration.

.....

.....

.....

[1]

[Total:9]

- 3 A student conducted two experiments using calcium carbonate and sulfuric acid.



At every minute, the volume of carbon dioxide gas collected was measured and the results were plotted in a graph shown in Fig. 3.1.

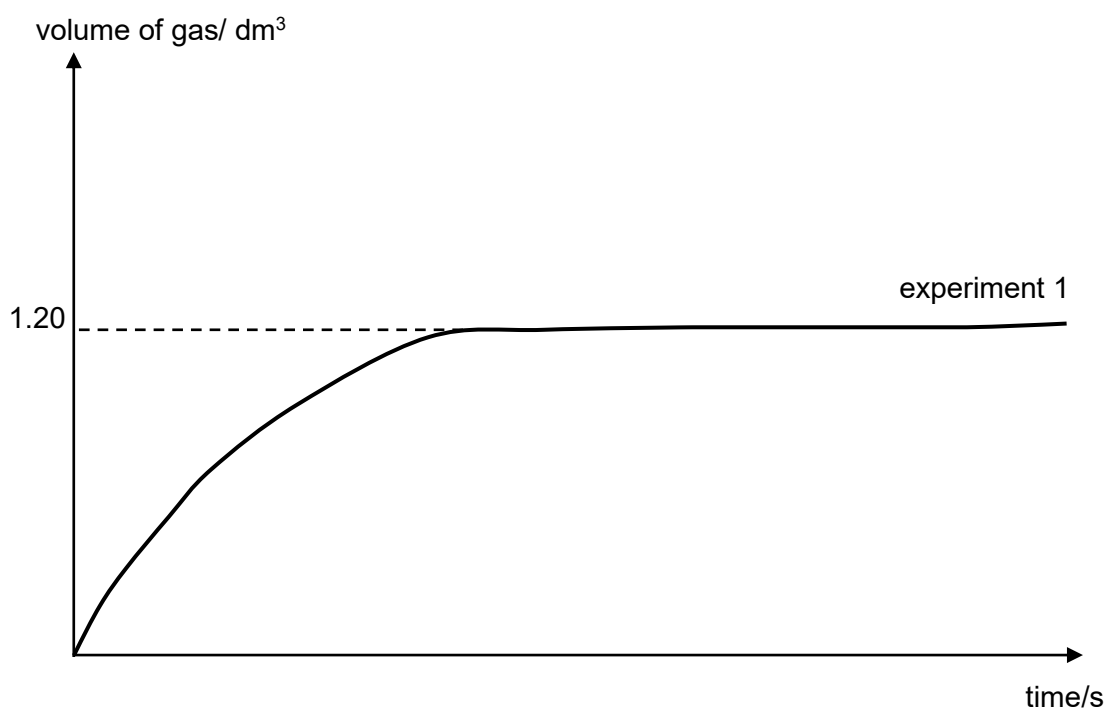


Fig. 3.1

The details of the experiment are shown in Table 3.1.

Table 3.1

experiment	number of moles of calcium carbonate/ mol	number of moles of sulfuric acid/ mol	concentration of sulfuric acid/ mol/dm ³
1	0.06	0.05	2.00
2	0.06	0.02	4.00

- (a) Sketch the graph for experiment 2 in Fig. 3.1 and label it as experiment 2.

[2]

- (b) A third experiment was conducted by the student. 40 cm^3 of 2 mol/dm^3 of phosphoric acid, H_3PO_4 was added to 6 g of calcium carbonate.

Phosphoric acid is a weak acid.

- (i) Construct a balanced chemical equation for the reaction between calcium carbonate and phosphoric acid.

..... [1]

- (ii) Deduce the limiting reactant in this reaction. Show your working.

limiting reactant [2]

- (c) Explain, in terms of Collision Theory, why a weak acid affects the rate of reaction.

.....
.....
.....
..... [3]

[Total: 8]

- 4 A water treatment plant uses metal pipes to transport water. Experiments are carried out on various metals to determine their suitability for use.

In experiment 1, hydrogen gas was passed separately over the heated oxides of the three metals in the combustion tube. The results are given in the Table 4.1.

Table 4.1

metal oxide	chemical formula	appearance before heating	appearance after heating
cobalt oxide	CoO	green powder	grey powder and a colourless liquid on the side of the glass tube
gallium oxide	Ga ₂ O ₃	white powder	white powder and no liquid on glass tube
bismuth oxide	Bi ₂ O ₃	yellow powder	grey powder and a colourless liquid on the side of the glass tube

In experiment 2, pieces of bismuth, gallium and cobalt were added separately to a solution of lead(II) nitrate, Pb(NO₃)₂. The results are given in Table 4.2.

Table 4.2

cobalt	gallium	bismuth
Grey solid formed on cobalt. The solution slowly turned pink.	Grey solid formed on gallium. The solution remained colourless.	No change in bismuth metal or in solution.

- (a) Using the observations from Table 4.1, identify the two metal oxides that were reduced by hydrogen. Explain your answer.

[2]

- (b) Using the observations from Table 4.1 and Table 4.2, arrange the four metals bismuth, cobalt, gallium, and lead in order of decreasing reactivity.

[1]

- (c) Write the ionic equation, including state symbols, for the reaction between cobalt and lead(II) nitrate solution.

[2]

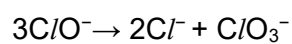
[Turn over

- (d) The metals selected are used in equipment at a water treatment plant. After suspended impurities are removed, chlorine is added to disinfect the water before it is supplied to homes.

Chlorine reacts with cold aqueous sodium hydroxide to produce sodium chlorate(I), the active ingredient in many household bleaches and disinfectants.



The chlorate(I) ion is unstable and decomposes when heated.



- (i) Determine the oxidation number of chlorine in Cl_2 , Cl^- , ClO^- and ClO_3^- .

species	Cl_2	Cl^-	ClO^-	ClO_3^-
oxidation number				

[2]

- (ii) Explain, in terms of oxidation numbers in (d)(i), why chlorine in chlorate(I) ions behaves as both an oxidising agent and a reducing agent.

[2]

[Total: 9]

- 5 Ammonia is formed during the Haber process by reacting hydrogen with nitrogen. Fig. 5.1 shows the percentage yield of ammonia formed under different conditions of temperature and pressure.

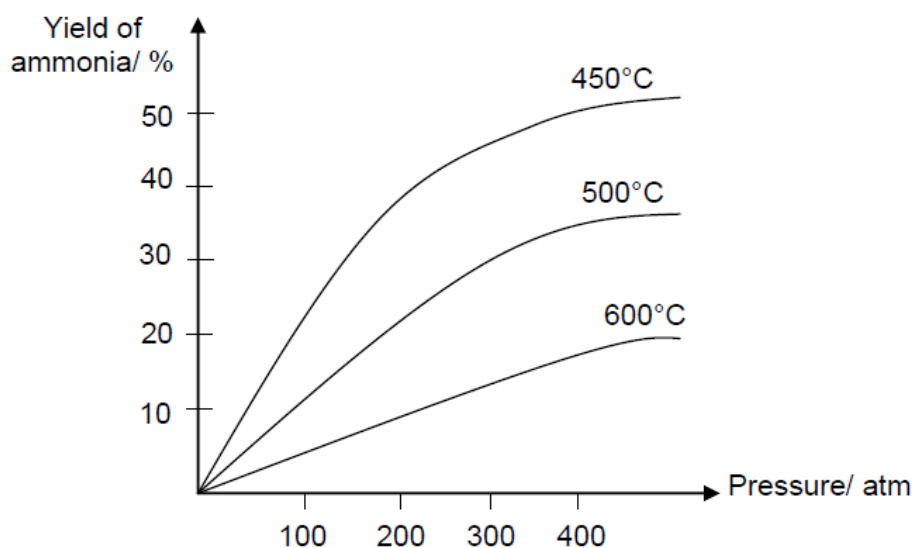


Fig. 5.1

- (a) Explain with the help of an equation, why the nitrogen and hydrogen are mixed in a ratio of 1:3 by volume.

[2]

- (b) Using Fig. 5.1, explain, in terms of Collisions Theory, how a lower pressure affects the rate of reaction in the reactor.

[2]

- (c) Using Fig. 5.1, predict how a lower pressure affects the relative amounts of ammonia, nitrogen and hydrogen that leave the main reactor. Explain your answer.

[3]

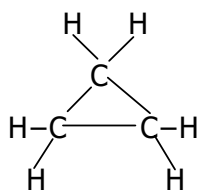
(d) The nitrogen and hydrogen gases leaving the reactor are recycled back into the reactor.

Give two reasons why these gases are recycled.

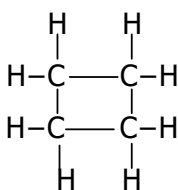
[2]

[Total: 9]

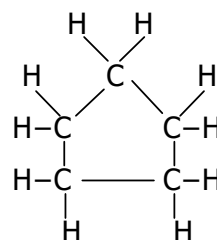
- 6 Cycloalkanes are a homologous series of saturated hydrocarbons. The first three members are shown.



cyclopropane



cyclobutane



cyclopentane

Table 6.1 gives the information about the first three cycloalkanes.

Table 6.1

cycloalkane	mass of 1 mole / g	boiling point / °C
cyclopropane	42	-32.5
cyclobutane	56	10.0
cyclopentane	70	50.0

- (a) Predict the general formula of cycloalkanes containing n carbon atoms.

[1]

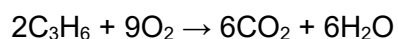
- (b) Cyclohexane is the cycloalkane with six carbon atoms. Draw the full structural formula of cyclohexane.

[1]

- (c) Explain why the boiling point increases down from cyclopropane to cyclopentane.

[2]

- (d) At room temperature, cyclopropane undergoes combustion to form carbon dioxide and water.



$$\Delta H = -2091 \text{ kJ/mol}$$

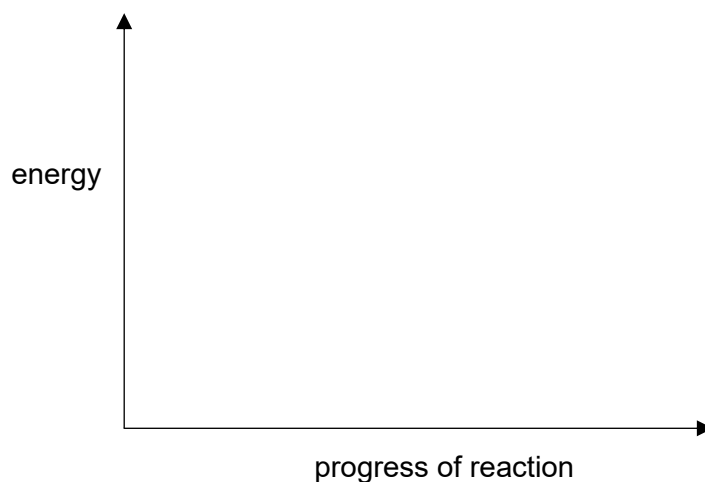
- (i) Explain, in terms of bond breaking and bond formation, why the enthalpy change of the reaction is negative.

[2]

- (ii) Draw an energy profile diagram to show the combustion reaction of cyclopropane.

In your diagram, show and label

- the reactants and products,
- the activation energy for the reaction,
- the enthalpy change for the reaction.



[2]

- (iii) At room temperature and pressure, 24 cm^3 of cyclopropane is completely burned in excess oxygen.

Calculate the volume of carbon dioxide produced.

volume of carbon dioxide = ... cm^3 [2]

[Total: 10]

- 7 Plastics are made of polymers, whose physical properties depend on their monomers and molecular structures.

Types of Polymers

Homopolymer: Made of a single repeating monomer.

Example 1: Poly(ethene) is an addition polymer formed from ethene monomers as shown in Fig. 7.1.

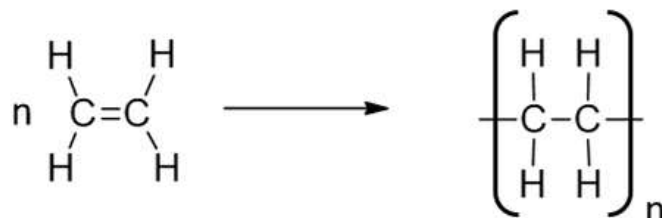
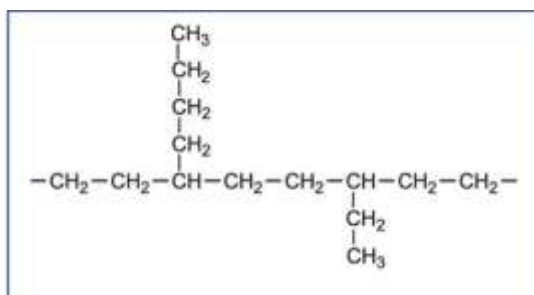


Fig. 7.1

Different processes can be used to manufacture several types of poly(ethene), each with a different structure. Side chains branch from the main polymer chain and prevent polymer chains from packing closely together. The fewer the side chains, the closer the polymer chains can be packed. Fig. 7.2 shows the structures of two types of poly(ethene).

low-density poly(ethene) (LDPE)



Co-polymer high-density poly(ethene) (HDPE)

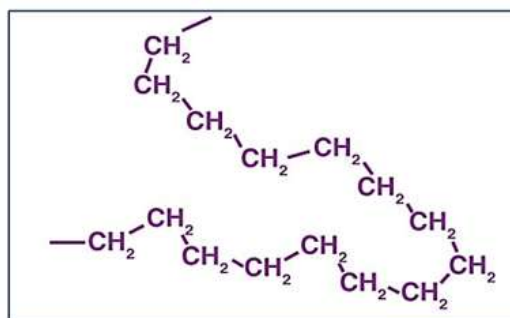


Fig. 7.2

Co-polymer: Formed from two or more different monomer types.

Example: Poly(ethylene terephthalate) (PETE) is a condensation polymer formed from ethylene glycol and terephthalic acid. Fig. 7.3 show the structure of a repeat unit of poly(ethylene terephthalate).

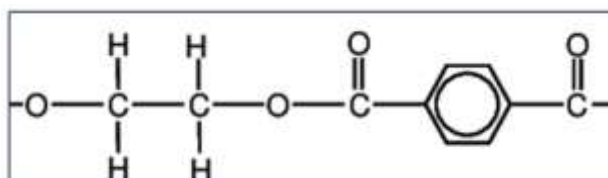
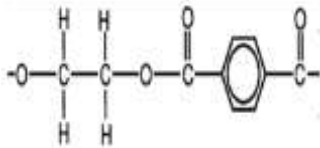
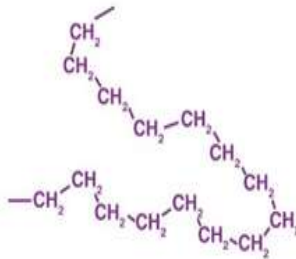
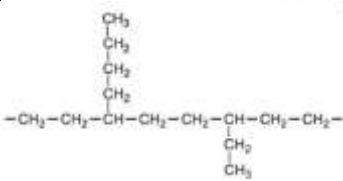
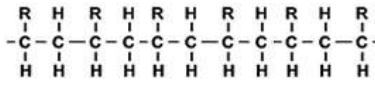
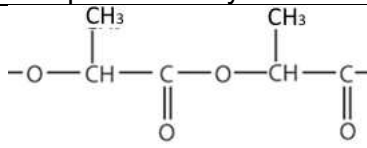


Fig. 7.3

Plastic Recycling and RIC

Plastic recycling processes waste into new products. To ensure quality, different polymer types are labelled using Resin Identification Codes (RIC) for sorting. Plastics typically consist of polymer chains of varying lengths. Table 7.1 shows the names of the polymers that fall under the five different RIC, the general range of molar masses of the different plastics and their percentages of plastic waste generated.

Table 7.1

RIC	polymer name	chemical structure	molar mass / (g/mol)	% of plastic waste generated
	poly(ethylene terephthalate)		8000 – 31 000	18.8
	high density poly(ethene)		100 000 – 250 000	19.8
	low density poly(ethene)		100 000 – 250 000	13.9
	poly(styrene)	 R: represents a hydrocarbon	100 000 – 400 000	5.9
	other plastics, such as polycarbonate, polyamides	 e.g: Poly(lactic acid)	—	17.2

Recycling Methods

Two commonly used methods of plastic recycling are mechanical recycling and chemical depolymerisation.

Mechanical Recycling: A physical method that melts plastics of the same type and forms them into small pellets for reuse. Mostly used for RIC 1, 2, and 4.

Chemical Depolymerisation: A chemical method using heat or reactions to break polymers back down into their original monomers. Mostly used for RIC 1 and 7.

- (a) (i) State one similarity and one difference between the structures of LDPE and HDPE.

.....

.....

..... [2]

- (ii) Explain how and why HDPE has a higher density than LDPE.

.....

.....

..... [2]

- (b) (i) Draw the repeat unit of poly(lactic acid) shown in RIC 7.

[1]

- (ii) Hence classify if poly(lactic acid) is a homopolymer or a co-polymer.

..... [1]

- (c) The shortest chain of poly(styrene) has a molar mass of 100 000 g/mol and consists of 962 repeating units. Elemental analysis shows that poly(styrene) contains 92.3% carbon and 7.7% hydrogen by mass.

- (i) Calculate the relative molecular mass, M_r , of one repeat unit of poly(styrene).

$M_r =$ [1]

- (ii) Show that the empirical formula of poly(styrene) is CH.

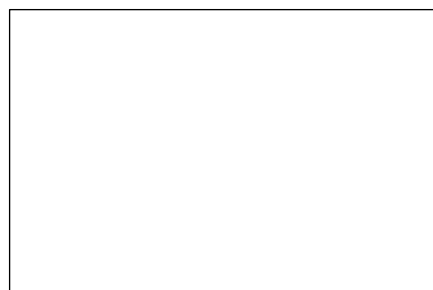
[1]

- (iii) Deduce the molecular formula of one repeat unit of poly(styrene).

molecular formula of a repeat unit = ... [1]

- (iv) Using your answer in (iii) and the structure of poly(styrene) given in Table 7.1, draw the repeat unit of poly(styrene) with the deduced molecular formula of the group **R**.

Repeat unit of poly(styrene)
with the deduced **R** formula:



[1]

- (d) Some people think that “mechanical recycling can only recycle homopolymers while depolymerisation can only recycle co-polymers.” Explain why this information is incorrect.

.....

.....

..... [1]

- (e) Describe one benefit of recycling plastics.

.....

..... [1]

[Total: 12]

- 8 Emission from vehicles is one of the main contributors to the air pollutants, namely carbon monoxide, oxides of nitrogen and unburnt hydrocarbons, into the atmosphere. Catalytic converter is installed in vehicles to help to reduce emission of these air pollutants.

- (a) (i) Describe one harmful effect of carbon monoxide and one harmful effect of oxides of nitrogen.

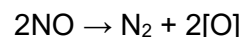
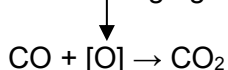
carbon monoxide:

oxides of nitrogen:

[2]

- (ii) The catalytic converter removes carbon monoxide and nitrogen monoxide by oxidation and reduction.

from oxidising agent



Write an overall equation to show how carbon monoxide and nitrogen monoxide react together in the converter.

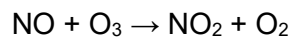
[1]

- (iii) Catalytic converters reduce, but do not eliminate, the emission of environmentally harmful gases from cars. Name one gas that is still emitted in large amounts and state the environmental problem it causes.

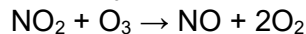
[2]

- (b) Oxides of nitrogen in the upper atmosphere can also cause damage to the ozone layer. Nitrogen monoxide, NO, damages the ozone layer by reacting with ozone in a two step reaction.

step 1



step 2



Explain how the equations show that one nitrogen monoxide molecule can destroy thousands of ozone molecules.

[1]

- (c) Brazil uses biofuel to run their vehicles. Biofuel mainly consists of ethanol obtained from the fermentation of sugarcane juice. Explain how biofuel helps to maintain the level of carbon dioxide in air compared to the use of fossil fuel.

.....

.....

.....

..... [2]

[Total:8]

Section B

Answer **one** question from this section.

- 9 Fig. 9.1 shows three electrolytic cells.

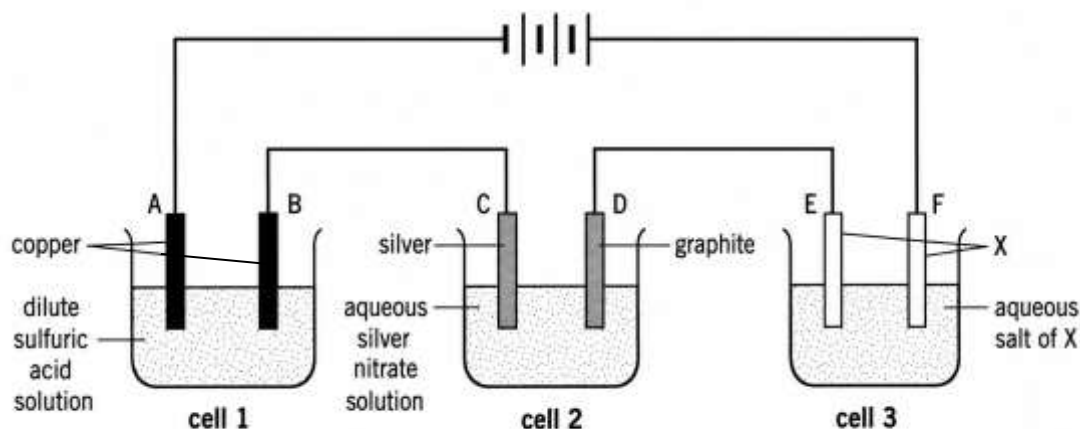


Fig. 9.1

Cell 3 uses chromium as the electrodes and an electrolyte containing chromium ions.

- (a) Identify the electrode(s) where the following observations will be made

- (i) a layer of copper metal deposited,

..... [1]

- (ii) bubbles of gas liberated.

..... [1]

- (b) Write the half equations for the reactions that take place at the following electrodes.

- (i) electrode **B**

..... [1]

- (ii) electrode **C**

..... [1]

- (c) The same quantity of electricity passes through the three electrolytic cells. 2.56 g of copper and 1.04 g of chromium are deposited at their respective electrodes.

(i) Calculate the mass of silver deposited.

mass of silver obtained = ... g [3]

- (ii) Determine the charge of the chromium ions and hence write the half equation for the discharge of chromium ion.

charge of chromium ions = ... [2]

half equation [1]

[Total:10]

- 10 An electrolytic cell and a simple cell are shown in Fig. 10.1.

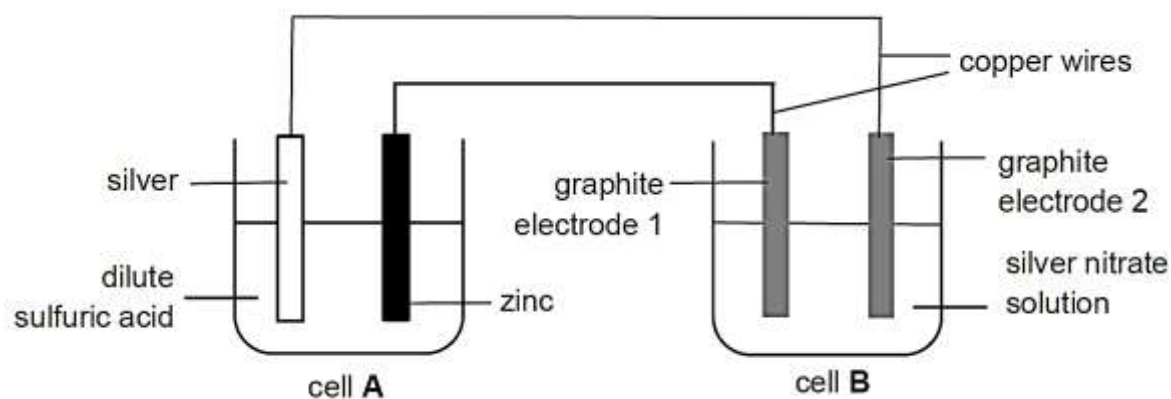


Fig. 10.1

- (a) Both cell **A** and cell **B** use electrodes, electrolytes and copper wires for electrical conduction.

Describe how the electrodes, electrolytes and copper wires conduct electricity.

.....

.....

..... [2]

- (b) With reference to Fig. 10.1, complete Table 10.1.

Table 10.1

cell	electrode	half-equation with state symbols for the electrode reaction
cell A	zinc electrode	
	silver electrode	
cell B	graphite electrode 1	
	graphite electrode 2	

[4]

- (c) Describe and explain the change in pH, if any, of the electrolyte in cell **B** after some time.

.....

.....

..... [2]

- (d) The electrolyte in cell **B** is replaced with molten aluminium oxide.

After a long period of time, one of the graphite electrodes in cell **B** reduces in size and needs to be replaced.

Explain why this graphite electrode needs to be replaced.

.....

.....

..... [2]

[Total:10]

