Industrial Manufacture of Chemicals

Question Paper

Level	GCSE
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Single Award (Paper 2C)
Topic	Chemistry in Industry
Sub-Topic	Industrial Manufacture of chemicals
Booklet	Question Paper

Time Allowed: **48 minutes**

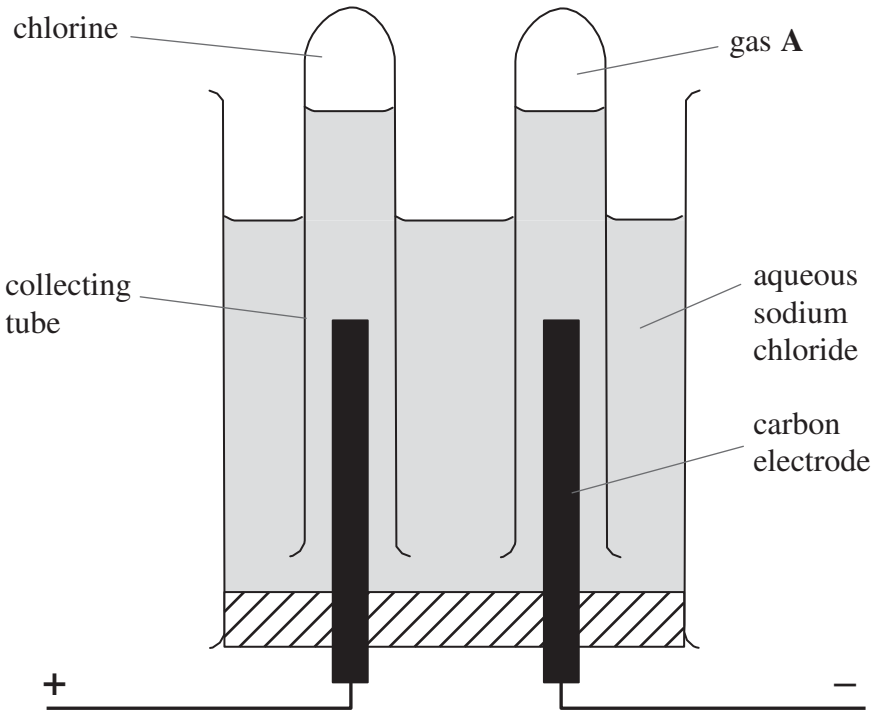
Score: **/40**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

1 The apparatus shown can be used to electrolyse aqueous sodium chloride in the laboratory.



(a) Gases are evolved at both electrodes.

(i) Describe a chemical test to show that the gas evolved at the positive electrode is chlorine.

(2)

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(ii) Identify gas **A**.

(1)

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(b) Some of the solution formed after the electrolysis was tested with the indicator phenolphthalein. The indicator turned pink

Explain this result.

(1)

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(c) The equation for the reaction taking place at the positive electrode is:

$$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$$

Ten faradays (10 F) of electricity were passed through an aqueous solution of sodium chloride.

(i) Calculate the amount, in moles, of chlorine formed.

(1)

(ii) Calculate the volume of chlorine formed.

(One mole of a gas occupies 24 dm^3 at this temperature and pressure)

(2)

(Total for Question 1 = 7 marks)

2 Iron and aluminium are two important metals extracted from their ores on a large scale.

(a) In the extraction of iron, three different raw materials are put into the top of a blast furnace.

Name the main compound present in the following raw materials.

(i) Haematite

(1)

.....

(ii) Limestone

(1)

.....

(b) The following equations represent reactions in the blast furnace.

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $C + CO_2 \rightarrow 2CO$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

E $CaO + SiO_2 \rightarrow CaSiO_3$

Choose from the letters **A**, **B**, **C**, **D** or **E** to answer parts (i) – (iv).

Each letter may be used once, more than once or not at all.

(4)

(i) A reaction that is used to produce heat .....

(ii) A neutralisation reaction .....

(iii) A decomposition reaction .....

(iv) A reaction that forms a reducing agent .....

(c) Molten iron and another molten substance collect at the bottom of the blast furnace.

What is the common name of this other molten substance?

(1)

.....

(d) Aluminium is extracted from its ore by electrolysis. This is a more expensive process than using a blast furnace.

(i) Why is a different method used for aluminium?

(1)

.....

.....

(ii) State the major reason for the high cost of extracting aluminium.

(1)

.....

.....

(e) Coke used in the blast furnace contains carbon. Carbon is also used in the extraction of aluminium, but for a different purpose.

What is this purpose?

(1)

.....

.....

(f)) The extraction of aluminium can be represented by the chemical equation:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Write the two ionic half-equations that can also be used to represent this extraction.

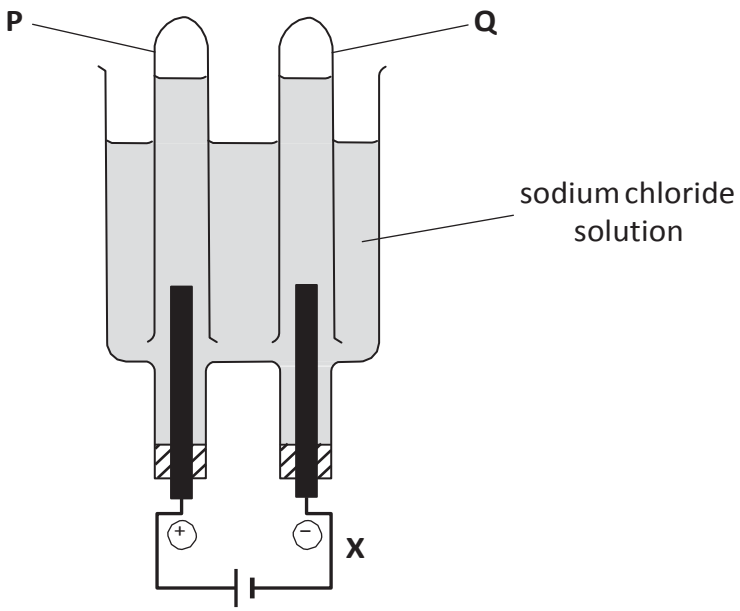
(3)

Half-equation 1 .....

Half-equation 2 .....

(Total for Question 2 = 13 marks)

3 The diagram shows how sodium chloride solution can be electrolysed and the products of electrolysis collected.



(a) (i) Draw an arrow on the diagram to show the direction of electron flow at point **X**.

(1)

(ii) The diagram shows one of the gases being collected in test tube **Q**.

Identify this gas.

(1)

.....

(iii) When the concentration of the sodium chloride solution is low, the gas collected in test tube **P** is mostly oxygen. The formation of this gas can be represented by an ionic half-equation.

Balance the equation.

(1)

..... $OH^- \rightarrow$ ..... H_2O + ... O_2 + ... e^-

(b) When the concentration of sodium chloride solution is high, the gas that collects in test tube **P** is mostly chlorine. The equation for its formation is:

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

In one experiment, the volume of chlorine gas collected was 18 cm^3.

(i) Calculate the amount, in moles, of chlorine gas in 18 cm^3.

(The volume of 1 mol of a gas at room temperature and pressure is 24 000 cm^3)

(2)

Amount = ... mol

(ii) Calculate the quantity of electricity, in coulombs, needed to produce this volume of chlorine gas.

(1 faraday = 96 500 coulombs)

(2)

Quantity = ... C

(c) Chlorine reacts with potassium bromide solution. The equation for this reaction is:

$$Cl_2(g) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$$

This reaction can be described as both a displacement reaction and a redox reaction.

(i) Identify the element that is displaced in this reaction.

(1)

.....

(ii) State the meaning of the term **redox**.

(1)

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.....

(d) Chlorine is used in the manufacture of phosphorus pentachloride, PCl_5

The equation for the reaction is:

$$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g) \qquad \Delta H = -124 \text{ kJ/mol}$$

(i) What does the $\rightleftharpoons$ symbol indicate about this reaction?

(1)

.....

(ii) Predict and explain the effect of increasing the pressure on the equilibrium position of this reaction.

(2)

Prediction .....

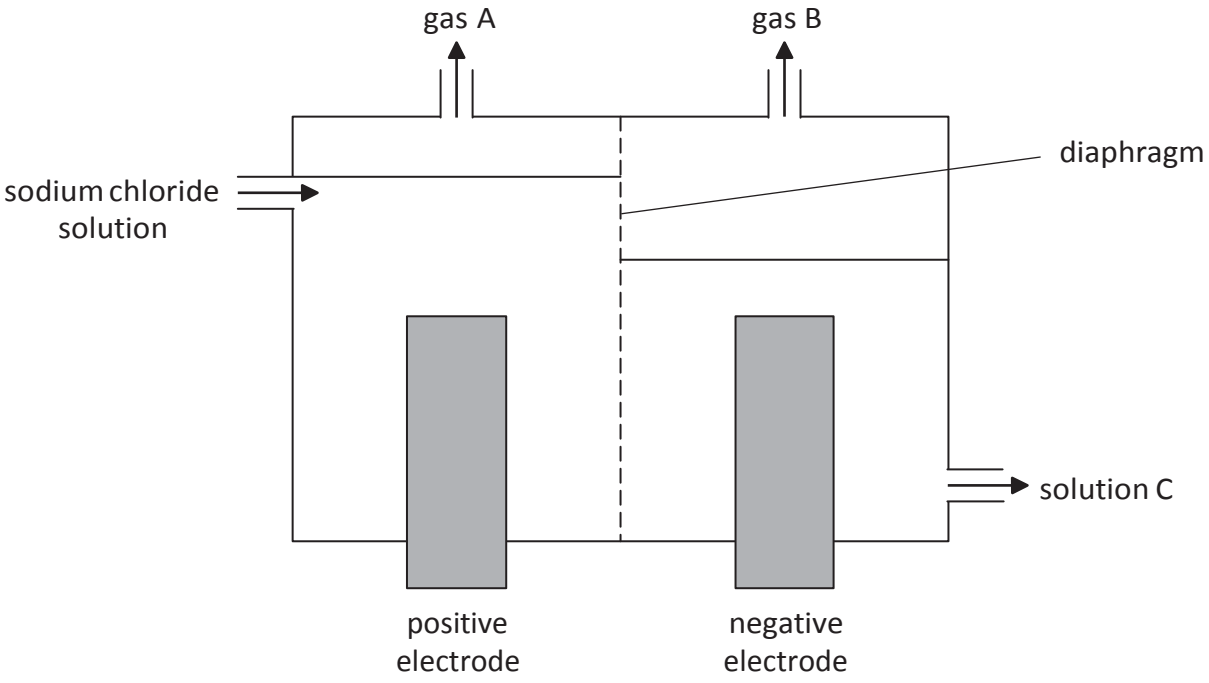
Explanation .....

.....

.....

(Total for Question 3 = 12 marks)

4 The diagram shows the diaphragm cell used in the electrolysis of concentrated sodium chloride solution, NaCl(aq).



(a) Explain what is meant by the term **electrolysis**.

(2)

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(b) Identify gas A, gas B and solution C.

(3)

gas A .....

gas B .....

solution C .....

(c) Sodium is manufactured by the electrolysis of molten sodium chloride, NaCl(l).

Sodium is produced at the negative electrode and chlorine is produced at the positive electrode.

(i) Why does the sodium chloride have to be molten before it will conduct electricity?

(1)

.....

.....

(ii) The ionic half-equation for the formation of sodium is

$$Na^+ + e^- \longrightarrow Na$$

Write the ionic half-equation for the formation of chlorine from chloride ions.

(2)

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(Total for Question 4 = 8 marks)