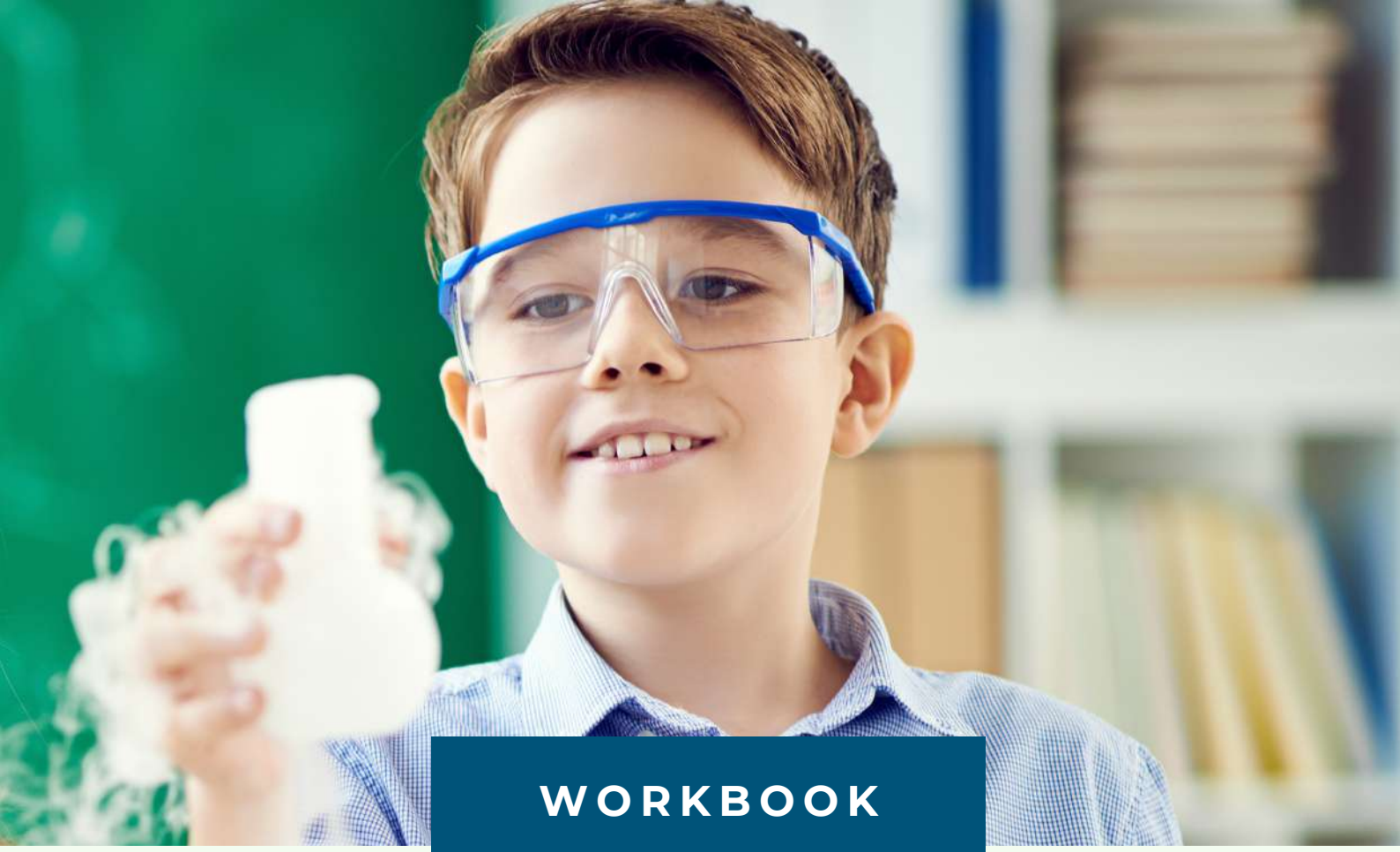


WORKBOOK

Online Chem Tuition

Chemical Changes

TOPIC FOUR

5TH APRIL

HELLO!

Welcome to your AQA GCSE Chemistry revision session. This workbook is designed to be straightforward and directly aligned with what I'll cover in the live lesson, it offers a practical way to apply your knowledge as you learn.

What's in the Workbook:

- **Questions**: These are selected to match the lesson topic, providing you with a chance to practice and solidify your understanding.
- **Symbols Guide**:
  HT - Indicates advanced content aimed at **Higher Tier** students.

  - Signifies material for **GCSE Chemistry** students only.

Using the Workbook During Lesson:

- **Stay Engaged**: Be ready to participate and use the workbook alongside the lesson. You can use the chat to ask questions or get help.
- **Peer Learning**: Take advantage of the group setting. Your classmates' questions can provide additional insights.

Zoom Lesson:

Make sure you have your workbook and a pen ready and join us here.

See you on Zoom!

ALISON GREEN

Online Chem Tuition

REACTIVITY OF METALS

THE REACTIVITY SERIES

Metals can be arranged in order of their reactivity in a reactivity series. The metals potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper can be put in order of their reactivity from their reactions with water and dilute acids.
The reactivity of a metal is related to its tendency to form positive ions.

	Most Reactive	
Makes metal hydroxides and hydrogen with water Makes salts and hydrogen with dilute acids	Potassium Sodium Lithium Calcium Magnesium	Extracted from its ore using electricity - electrolysis
No reaction with water but makes salts and hydrogen with dilute acids	Aluminium **Carbon** Zinc Iron	Extracted from its ore by heating /reduction with carbon
Unreactive with water and dilute acids	**Hydrogen** Copper Silver Gold	Found as elements - native
	Least Reactive	

DISPLACEMENT REACTIONS

A more reactive metal can displace a less reactive metal from a compound.

$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

Ionic Equation: $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

OXIDATION

Metals react with oxygen to produce metal oxides. This is an oxidation reaction as metal **gains oxygen**.

$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

Oxidation is also the **loss of electrons**

HT $Mg \rightarrow Mg^{2+} + 2e^-$

REDUCTION

Metals less reactive than carbon can be extracted from their oxides by reduction with carbon. Reduction involves the **loss of oxygen**.

$CuO(s) + C(s) \rightarrow Cu(s) + CO_2(g)$

Reduction is also the **gain of electrons**

HT $Cu^{2+} + 2e^- \rightarrow Cu$

REACTIVITY OF METALS

Q1. Nickel is extracted from nickel oxide by reduction with carbon.
Explain why carbon can be used to extract nickel from nickel oxide

[2 marks]

AQA June 18 H Q2.4

Q2. A student added copper metal to colourless silver nitrate solution.
The student observed:
• pale grey crystals forming • the solution turning blue.
Explain how these observations show that silver is less reactive than copper.

[3 marks]

AQA June 20 H Q2.2

Q3. A student is given three metals, X, Y and Z to identify. The metals are magnesium, iron and copper. Plan an investigation to identify the three metals by comparing their reactions with dilute hydrochloric acid. Your plan should give valid results.

[3 marks]

AQA June 20 H Q2.3

REACTIVITY OF METALS

Q4.a) In this reaction sodium displaces titanium from titanium chloride: $TiCl_4 + 4\ Na \rightarrow Ti + 4\ NaCl$
Sodium atoms are oxidised to sodium ions in this reaction.
Why is this an oxidation reaction?

HT

[1 mark]

AQA June 18 H Q8.5

Q4.b) Complete the half equation for the oxidation reaction

$$Na \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$

[1 mark]

AQA June 18 H Q8.6

Q5. a) Magnesium displaces zinc from zinc sulfate solution.
Complete the ionic equation for the reaction.
You should include state symbols

HT

$$Mg(s) + Zn^{2+}(aq) \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$

[2 marks]

AQA June 120H Q6.3

Q5. b) Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

[2 marks]

AQA June 20H Q6.3

Q6. The reactivity series sometimes includes non-metals such as carbon, hydrogen and silicon.
Silicon can be extracted by reducing silicon dioxide with different substances.
The equation for one possible reaction is:

$2C(s) + SiO_2(s) \rightarrow Si(s) + 2CO(g)$

Explain what this reaction shows about the position of silicon in the reactivity series

[2 marks]

AQA June 22 H Q7.1

REACTIONS OF ACIDS

REACTIONS OF ACIDS WITH METALS

metal + acid → metal salt + hydrogen

$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

This can be represented as two half equations:

HT

$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$ - this is oxidation as Mg has lost electrons

$2H^+(aq) + 2e^- \rightarrow H_2(g)$ - this is reduction as the H^+ has gained electron

This is a **redox reaction** as **both oxidation and reduction** has occurred.

REACTIONS OF ACIDS WITH METALS

Acids are neutralised by alkalis (eg soluble metal hydroxides) and bases (eg insoluble metal hydroxides and metal oxides) and by metal carbonates.

metal hydroxide + acid → metal salt + water

metal oxide + acid → metal salt + water

metal carbonate + acid → metal salt + water + carbon dioxide

NAMING SALTS

The particular salt produced in any reaction between an acid and a base or alkali depends on:

- the **metal** in the base or alkali - this forms the **first part** of the name.
- the acid used - this forms the **second part** of the name.
    - **hydrochloric acid** (HCl) produces **chlorides**
    - **nitric acid** (HNO_3)produces **nitrates**
    - **sulfuric acid** (H_2SO_4) produces **sulfates**

SOLUBLE SALTS - REQUIRED PRACTICAL 1

Soluble salts can be made from acids by reacting them with solid insoluble substances, such as metals, metal oxides, hydroxides or carbonates. The solid is added to the acid until no more reacts and the excess solid is filtered off to produce a solution of the salt.

1. Measure 50 cm^3 acid in beaker
2. Warm acid
3. Add spatulas of solid base (or metal)
4. Stir
5. Keep adding solid until no more reacts and base is in excess - you can see at bottom of beaker
6. Filter with filter funnel and filter paper
7. Pour solution into evaporating basin
8. Heat using a water bath to evaporate some of the water.
9. Leave to crystallise
10. Dry crystals on filter paper

Why step 2? - speeds up reaction

Why step 5? - all the acid has been neutralised

Why step 6? - excess base/metal removed

Why step 8? - concentrates the solution

Q7. Soluble salts are formed by reacting metal oxides with acids.
Give **one** other type of substance that can react with an acid to form a soluble salt.

[1 mark]

AQA June 18 H Q1.1

Q8. Calcium hydroxide solution reacts with an acid to form calcium chloride. Complete the word equation for the reaction

calcium hydroxide + _____ acid → calcium chloride + _____

[2 marks]

AQA June 19 H Q2.2

Q9. Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

[6 marks]

AQA June 18 H Q1.3

Q10. Soluble salts can be produced by reacting dilute hydrochloric acid with an insoluble solid. Copper, copper carbonate and copper oxide are insoluble solids. Which of these insoluble solids can be used to make a copper salt by reacting the solid with dilute hydrochloric acid?

[1 mark]

AQA June 21 H Q5.3

This question is about zinc and compounds of zinc. A student produces pure crystals of zinc chloride by reacting zinc oxide with hydrochloric acid. The equation for the reaction is:

$$ZnO(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2O(l)$$

Q11.a)The student adds zinc oxide to hydrochloric acid until the zinc oxide is in excess. Give **one** observation that the student could make to show that the zinc oxide is in excess.

[1 mark]

AQA June 22 H Q4.1

Q11.b) Why is excess zinc oxide used rather than excess hydrochloric acid?

[1 mark]

AQA June 22 H Q4.2

Q11.c) Name one other compound that the student could add to hydrochloric acid to produce zinc chloride.

[1 mark]

AQA June 22 H Q4.3

Q11.d) Describe how the student should obtain crystals of zinc chloride from a solution of zinc chloride.

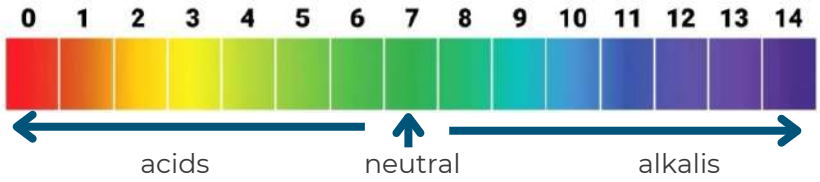
[2 marks]

AQA June 18 H Q4.4

ACIDS AND ALKALIS

PH SCALE AND NEUTRALISATION

The pH scale, from 0 to 14, is a measure of the acidity or alkalinity of a solution, and can be measured using universal indicator or a pH probe.



Produce hydrogen ions (H^+) in aqueous solutions

Aqueous solutions of alkalis contain hydroxide ions (OH^-).

In neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water. This reaction can be represented by the equation:

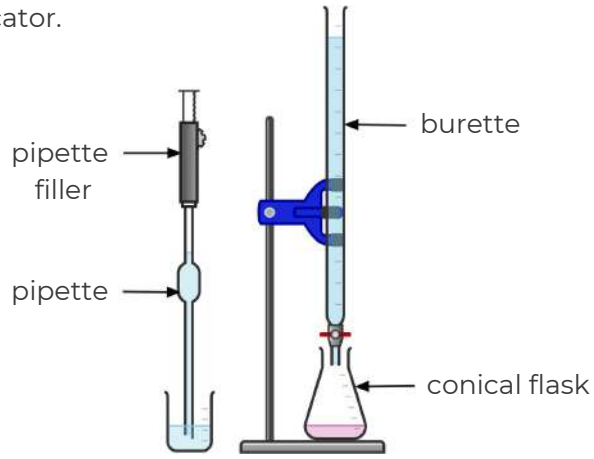
$H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$

HT As the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10.

TITRATION - REQUIRED PRACTICAL 2

The volumes of acid and alkali solutions that react with each other can be measured by titration using a suitable indicator.

- acid in burette
- alkali in conical flask measured out with a 25cm^3 pipette
- add few drops of indicator to flask
- note initial burette reading
- add alkali to acid until colour changes
- swirl conical flask
- add alkali dropwise towards the end
- note final burette reading
- repeat until two readings are within 0.1cm^3



methyl orange

red - acid

yellow - alkali

phenopthalein

colourless - acid

pink - alkali

HT STRONG AND WEAK ACIDS

STRONG

A strong acid is **completely ionised in aqueous solution**. Examples of strong acids are hydrochloric, nitric and sulfuric acids.

$HCl (aq) \rightarrow H^+ (aq) + Cl^- (aq)$

$HNO_3 (aq) \rightarrow H^+ (aq) + NO_3^- (aq)$

$H_2SO_4 (aq) \rightarrow 2H^+ (aq) + SO_4^{2-} (aq)$

WEAK

A weak acid is **only partially ionised in aqueous solution**. Examples of weak acids are ethanoic, citric and carbonic acids.

$CH_3COOH (aq) \rightleftharpoons H^+ + CH_3COO^-$

DILUTE AND CONCENTRATED ACIDS

A concentrated acid will have more moles of acid per unit volume than a dilute acid. A concentrated acid is made into a dilute acid by adding water. Dilute and concentrated does not mean the same as strong and weak

Q12. Which ion do all acids produce in aqueous solution?

[1 mark]
AQA June 19 H Q2.1

Q13. Dilute hydrochloric acid is a strong acid. Explain why an acid can be described as both strong and dilute. HT

[2 mark]
AQA June 18 H Q9.1

Q14. A 1.0×10^{-3} mol/dm^3 solution of hydrochloric acid has a pH of 3.0 What is the pH of a 1.0×10^{-5} mol/dm^3 solution of hydrochloric acid? HT

[1 mark]
AQA June 18 H Q9.2

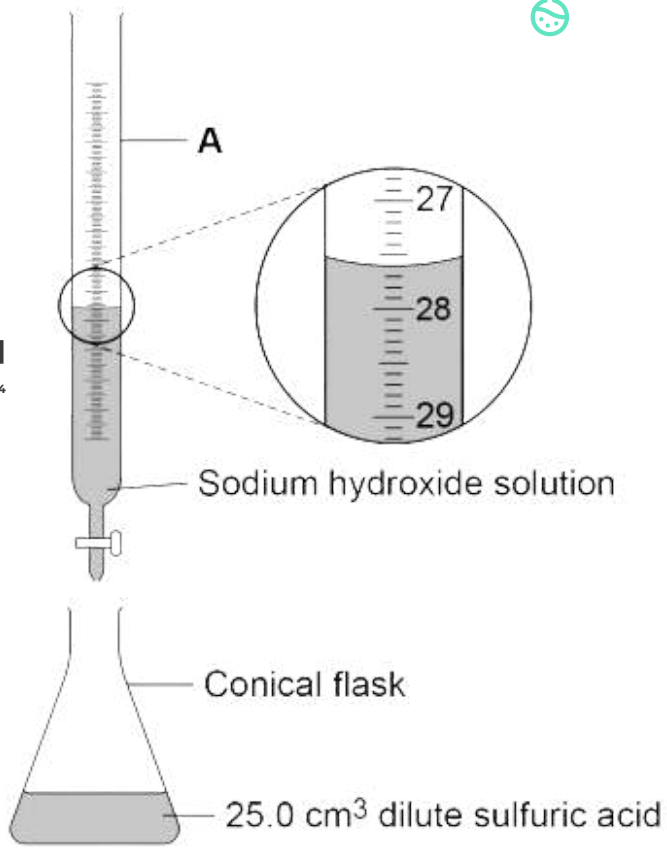
A student investigates the volume of sodium hydroxide solution that reacts with box 25.0 cm^3 of dilute sulfuric acid. The diagram shows the apparatus the student uses.

Q15.a) Name apparatus A.

[1 mark]
AQA June 19 H Q2.3

Q15.b) What is the reading on apparatus A?

[1 mark]
AQA June 19 H Q2.4



Q16. The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid. The student tested two samples of dilute sulfuric acid, P and Q. Describe how the student could use titrations to find which sample, P or Q, is more concentrated.

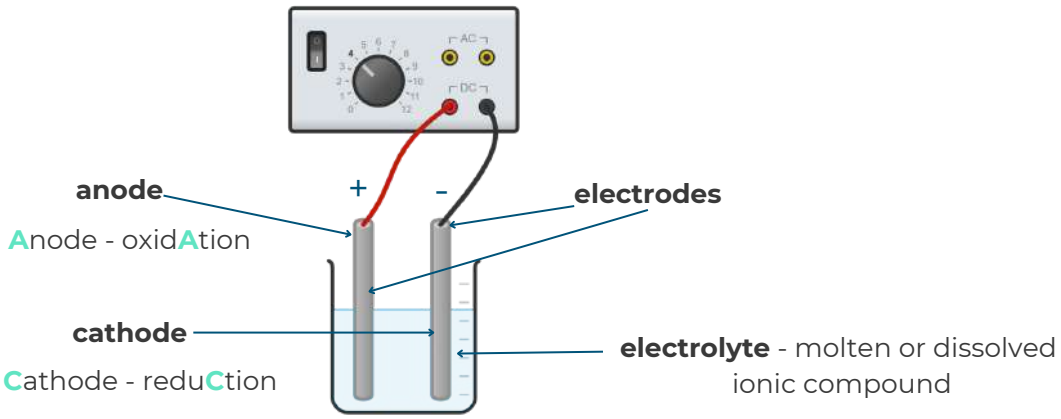
[6 marks]

AQA June 19 H Q2.5

ELECTROLYSIS

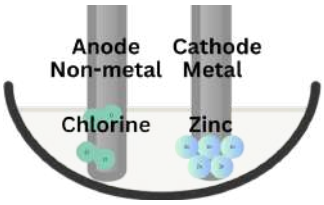
THE PROCESS OF ELECTROLYSIS

When an ionic compound is melted or dissolved in water, the ions are free to move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called electrolytes. Passing an electric current through electrolytes causes the ions to move to the electrodes. Positively charged ions move to the negative electrode (the cathode), and negatively charged ions move to the positive electrode (the anode). Ions are discharged at the electrodes producing elements.



ELECTROLYSIS OF MOLTEN SUBSTANCES

When a simple ionic compound (eg zinc chloride.) is electrolysed in the **molten state** using inert electrodes, the **metal** (zinc) is produced at the **cathode** and the **non-metal** (chlorine) is produced at the **anode.**

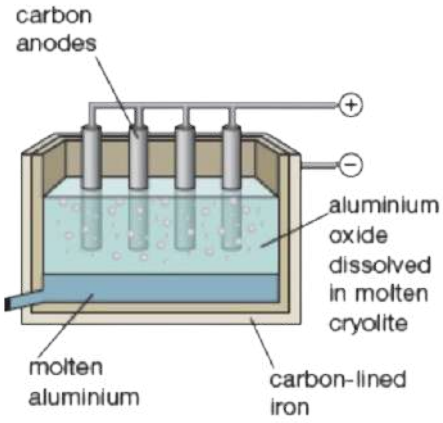


USING ELECTROLYSIS TO EXTRACT METALS

Metals can be extracted from **molten compounds using electrolysis.** Electrolysis is used if the **metal is too reactive** to be extracted by reduction with carbon or if the metal reacts with carbon. **Large amounts of energy are used** in the extraction process to melt the compounds and to produce the electrical current.

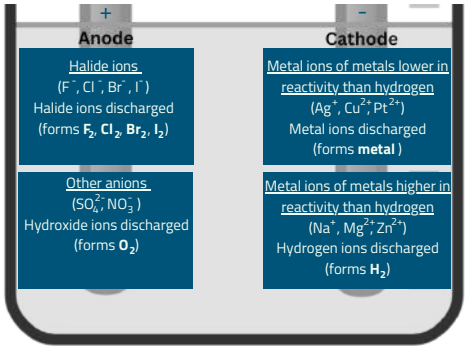
Aluminium is manufactured by the electrolysis of a **molten mixture of aluminium oxide and cryolite** using carbon as the positive electrode (anode). **Cryolite** is used in this process to **lower the melting point of the electrolyte** (mixtures have lower melting points) which therefore **reduces the energy costs.**

The **positive electrode (anode) is made of carbon**, which **reacts with the oxygen** (produced at the anode) to produce carbon dioxide and **so must be continually replaced**

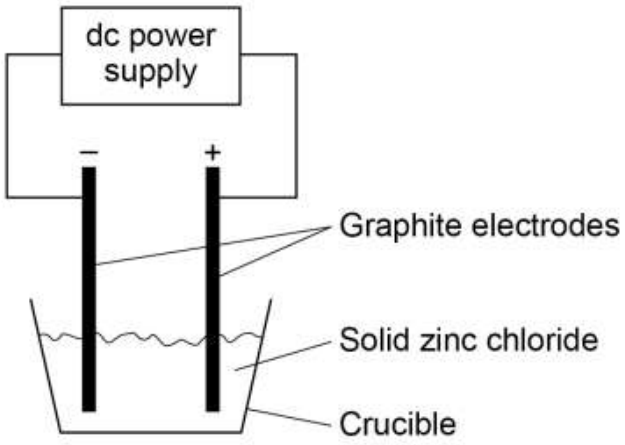


ELECTROLYSIS OF AQUEOUS SOLUTIONS - REQUIRED PRACTICAL 3

The ions discharged when an aqueous solution is electrolysed using inert electrodes depend on the relative reactivity of the elements involved. At the **negative electrode** (cathode), **hydrogen** is produced if the **metal is more reactive than hydrogen**. At the p**ositive electrode** (anode), **oxygen** is produced **unless the solution contains halide ions** when the **halogen** is produced. This happens because in the aqueous solution **water molecules break down** producing **hydrogen ions and hydroxide ions** that are discharged.



A student investigated the electrolysis of different substances. The diagram shows the apparatus.



Q17. Explain why electrolysis would not take place in the apparatus shown above.

[2 marks]

AQA June 18 H Q6.1

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

Q18.a) Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

Q18.b) What happens at the negative electrode during the production of aluminium?

[1 mark]

AQA June 19 H Q7.2

Q18.c) Oxygen is produced at the positive electrode. Complete the balanced half-equation for the process at the positive electrode.

$\rightarrow \quad O_2 \quad +$

[2 marks]

AQA June 19 H Q7.3

Q18.d) Explain why the positive electrode must be continually replaced.

[3 marks]

AQA June 19 H Q7.4

Q19. Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

[2 marks]

AQA June 19 H Q7.6

Q20.a) Two aqueous salt solutions are electrolysed using inert electrodes. Complete table below to show the product at each electrode.

Salt solution	Product at positive electrode	Product at negative electrode
Copper nitrate		copper
Potassium iodide		

[3 marks]

AQA June 21 H Q7.3

Q20.b) Write the half equations for copper nitrate solution

not exam question

ADDITIONAL RESOURCES

Congratulations on completing the workbook!

To further enhance your understanding and support your revision, I've curated a list of additional FREE resources.

VIDEO

ACIDS, ALKALIS & PH

This Facebook Live recording goes through acids, alkali and pH

ACCESS NOW

VIDEO

TITRATION PRACTICAL

This Facebook Live recording goes through titration required practical

ACCESS NOW

WORKSHEET

Here are three videos from my recorded masterclasses.

ELECTROLYSIS MOLTEN SALTS

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EXTRACTING ALUMINIUM

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ELECTROLYSIS OF SOLUTIONS

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