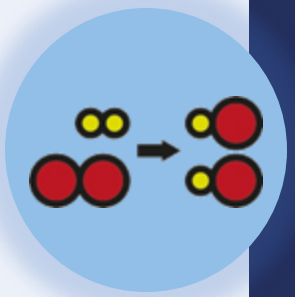
Required Practical: Electrolysis of Aqueous Solutions

Answer the questions below.

1. What is used to measure current in a circuit?
   An ammeter is used to measure current.
2. State the ions that water produces in a solution.
   Water produces hydrogen (H^+) and hydroxide (OH^-) ions
3. Describe the test for hydrogen gas.
   If a lit splint in placed in hydrogen gas, a squeaky pop is heard.
4. Sodium chloride solution contains two types of positive ions, hydrogen ions (H+) and sodium ions (Na+). Why is hydrogen produced at the negative electrode and not sodium?
   Sodium is more reactive than hydrogen, so therefore hydrogen is produced at the cathode.
5. Balance the half equation $H^+ + e^- \rightarrow H_2$
   $2H^+ + 2e^- \rightarrow H_2$

Do Now



Required Practical: Electrolysis of Aqueous Solutions

Do Now:

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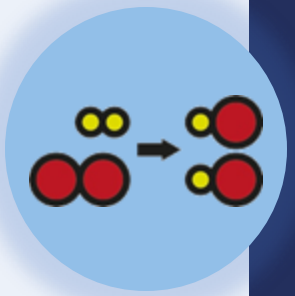
Drill:

1. State the ions in molten sodium chloride
2. State the ions in sodium chloride solution.
3. Deduce which ions would be discharged at each electrode in the electrolysis of sodium chloride solution.



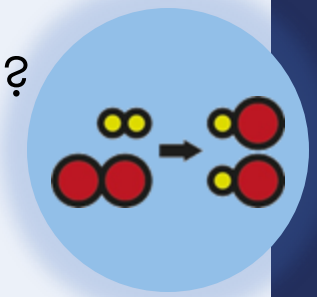
Do Now

Required Practical: Electrolysis of Aqueous Solutions

Read Now:

If you can quench your thirst by walking to the kitchen for a glass of water, then you are one of the lucky ones. Almost 2 billion people worldwide do not have easy access to drinking water, according to the World Health Organisation (WHO). Half of the world's population could be living in areas that are facing water **scarcity** by 2025, according to UNICEF. Scientists are busy thinking of solutions. One option is to take salty water from the ocean and make it drinkable using a process called desalination. Desalination requires a lot of energy, but it may be possible to power the process using solar energy. Other solutions include capturing water from the air or from the sea, and there are even technologies that can produce **potable water** from human faeces!

1. How many people worldwide do not have easy access to drinking water?
2. What proportion of the world's population are facing water scarcity by 2025?
3. Define the words in **bold**.
4. Describe one possible solution to bring clean drinking water to more people worldwide.



Do Now

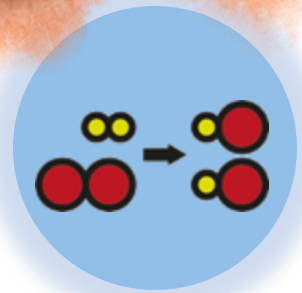
03/02/2025

Required Practical: Electrolysis of Aqueous Solutions

C4.2.11 C4.2.12

Science Mastery

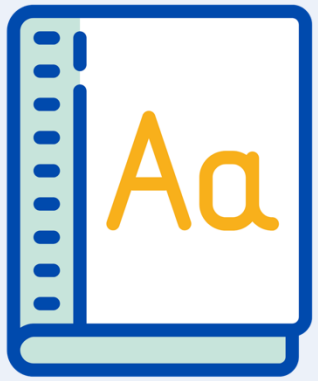
C4.2.1 PKR: Reactivity of Metals
C4.2.2 Extracting Less Reactive Metals
C4.2.3 PKR: Ions, Ionic Bonding and Deducing Ionic Formulae
C4.2.4 (HT) Ionic Equations and Displacement Reactions
C4.2.5 (HT) Writing Half Equations
C4.2.6 (HT) Ionic Equations for the Reactions of Acids and Metals
C4.2.7 Introduction to Electrolysis
C4.2.8 Extracting Metals by Electrolysis
C4.2.9 Electrolysis of Molten Ionic Compounds
C4.2.10 Electrolysis in Solutions
➢ **C4.2.11 RP: Electrolysis of Aqueous Solutions 1**
C4.1.12 RP: Electrolysis of Aqueous Solutions 2
C4.1.13 TIF: Corrosion and its Prevention
C4.2.14 (HT) Obtaining Raw Materials
C4.2.15 Recycling Metals
C4.2.16 Feedback Lesson



Following this lesson, students will be able to:

- Describe the apparatus used for electrolysis
- Safely carry out the electrolysis of a salt solution
- Predict the products of electrolysis of a salt solution
- Test for gases produced in electrolysis

Key Words:



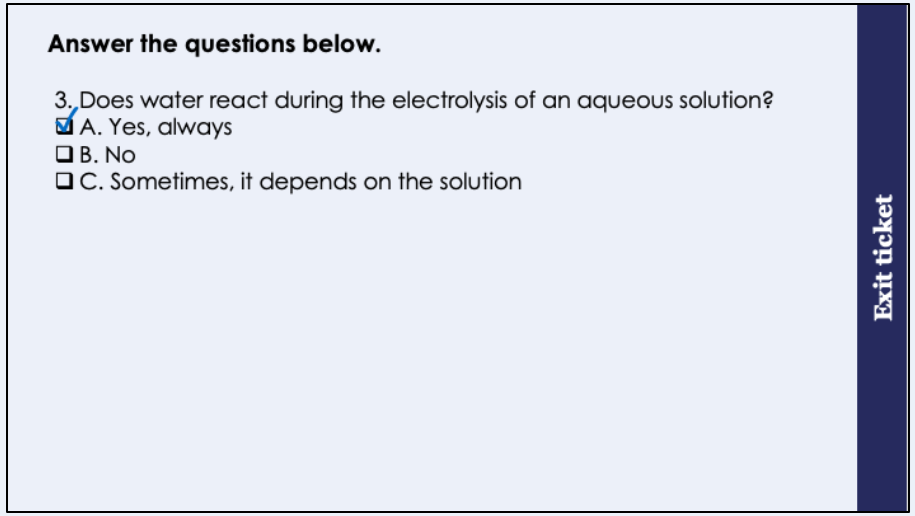
electrolysis | **salt solution** | **short circuit** | **inert**

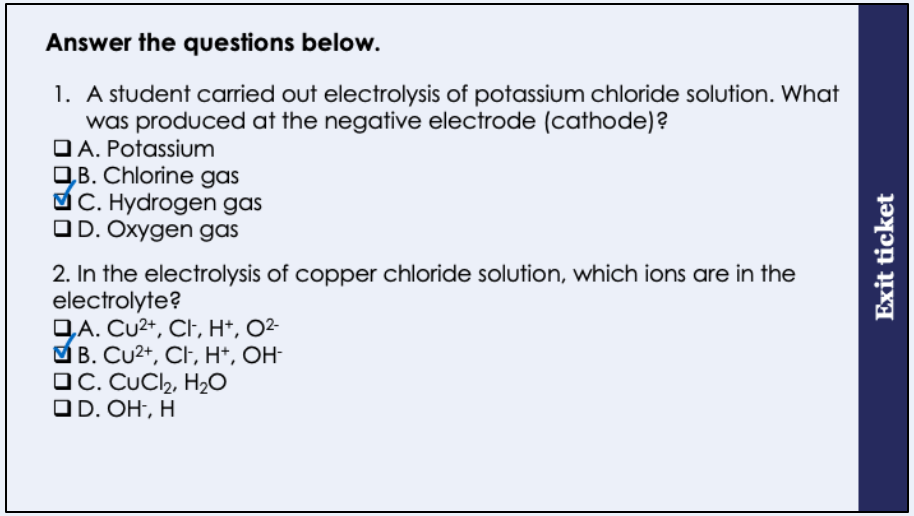
Lesson Objectives

This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the previous lesson's exit ticket.

- The teacher should customise this slide as needed, to facilitate
  - **reteach**, **explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving** previous work.

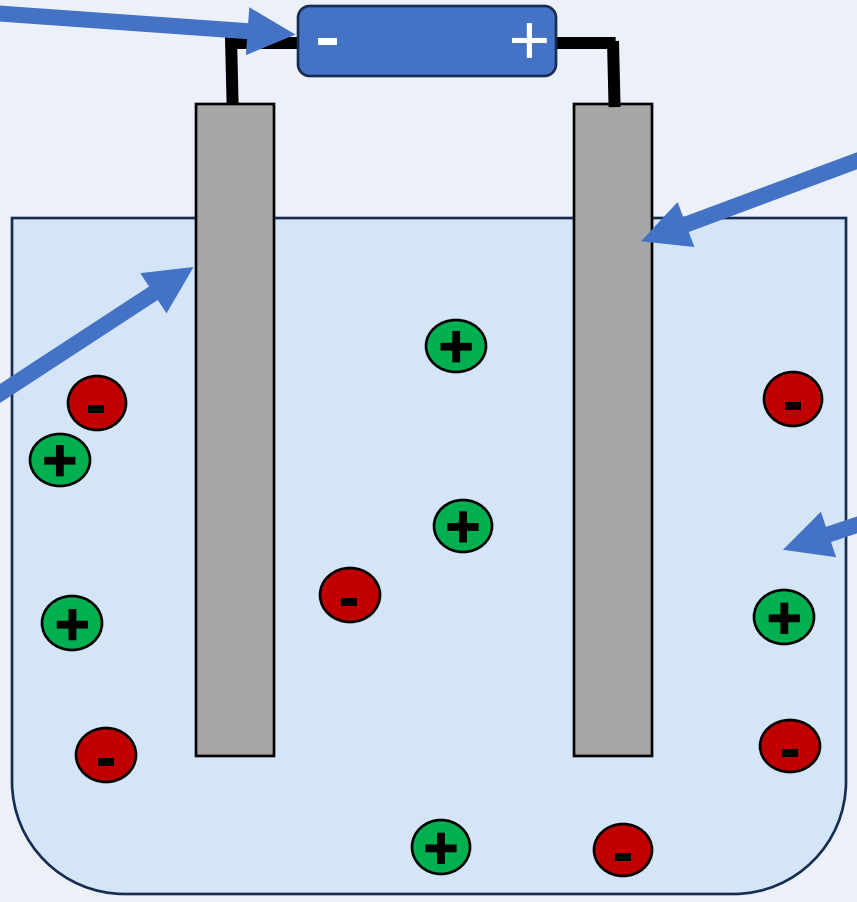




Fix-it

What happens in electrolysis?

Battery or power source
Generates a current to flow through the electrolyte



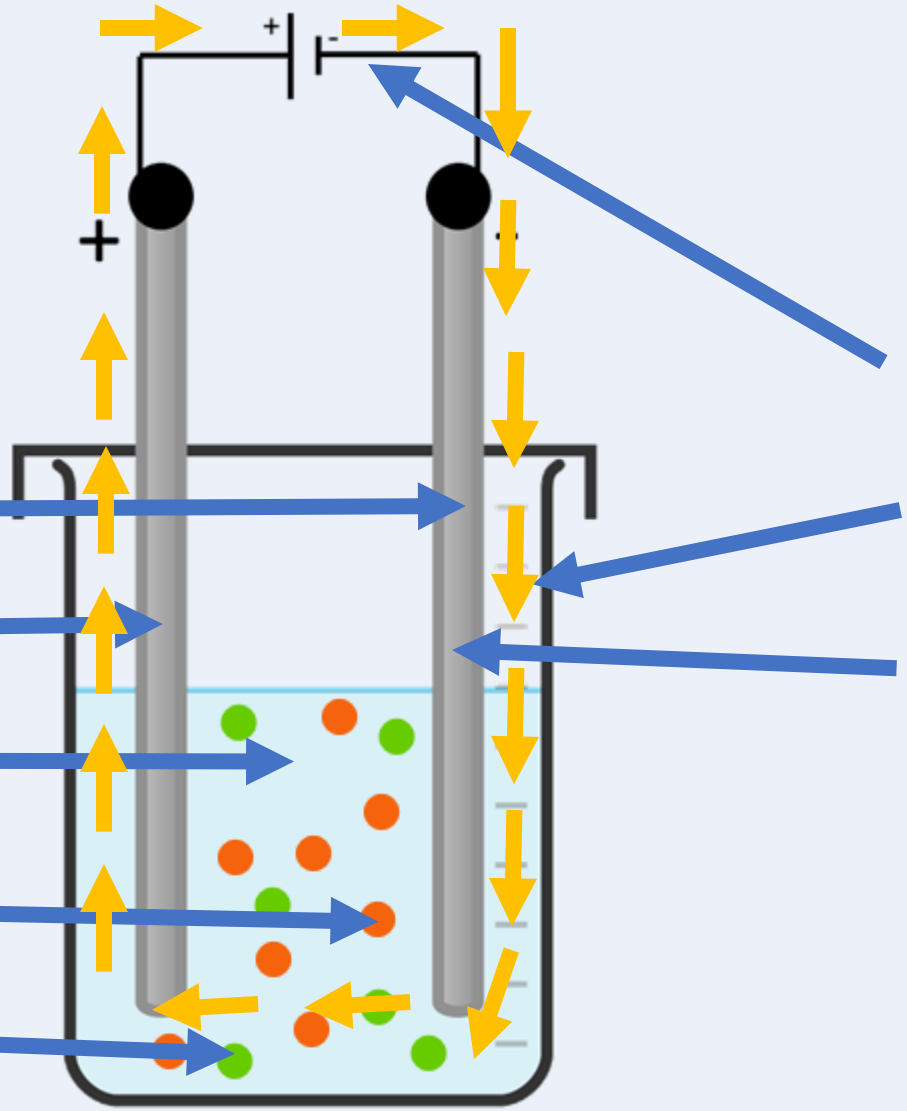
Cathode
Negatively charged electrode

Anode
Positively charged electrode

Electrolyte
The liquid that contains the ions (current is passed through)

Can you correctly label the electrolysis diagram?

- = positively charged ions
- = negatively charged ions



cell/battery

cathode

beaker

anode

an inert material

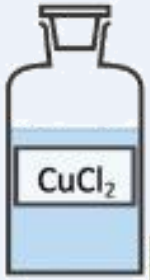
electrolyte

cation

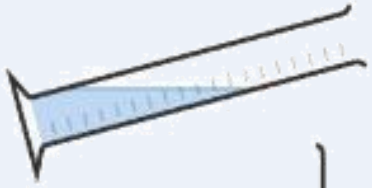
Stretch: the flow of electrons when the circuit is switched on

anion

Aim: Investigate what happens when two different aqueous solutions are electrolysed using inert electrodes.



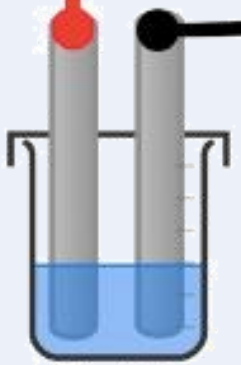
1. Pour 50 ml of copper (II) chloride solution into the 100 ml beaker.



2. Place the petri dish lid on top of the beaker and insert the graphite rods ensuring they do not touch one another.

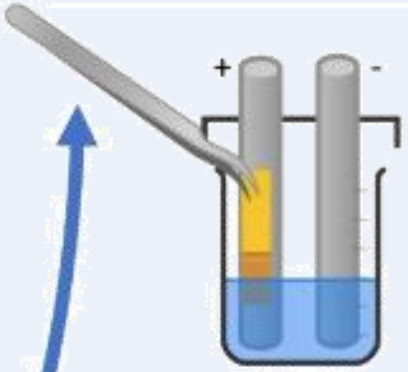
3. Connect the two graphite rods to the power supply using the crocodile clips and 4mm leads.

4. Set the power supply to 4V and switch it on.



5. Monitor the activity at the two electrodes and record any observations in your table.

6. Hold a small piece of blue litmus paper in the forceps and position this in the solution next to the positive electrode (anode). Use any change in its appearance to identify the element formed and record this in your table.



7. Empty the electrolysis cell and rinse. Use new electrodes to repeat the experiment with sodium chloride solution.

Introduction

Analysing the products of electrolysis

We can use gas tests to identify the gases produced in electrolysis

Gas to test	Method	Positive result
Oxygen	Place a glowing splint into the gas	The splint will relight
Hydrogen	Place a lit splint into the gas	It will make a squeaky pop sound
Chlorine	Place damp blue litmus paper in a test tube of the gas	The litmus paper is bleached

A student makes a hypothesis:

"When different salt solutions are electrolysed with inert electrodes, the product at the negative electrode is always a metal."

Talk Task

Discuss with your partner how you would test this hypothesis in the laboratory. You should:

- think about how you would set up the apparatus
- give the independent variable
- describe what you would see at the negative electrode if the hypothesis is true.
- Suggest one safety precaution that should be taken during this investigation.

Drill

1. Define electrolysis.
2. What is an electrolyte?
3. What is the positive electrode called?
4. What is the negative electrode called?
5. Why does an electrolyte have to be a liquid?
6. What electrode does a cation move towards?
7. What electrode does an anion move towards?
8. At which electrode does oxidation take place?
9. At which electrode does reduction take place?
10. *(HT only) Write a half equation to show what happens when chloride ions are discharged at the anode.*

Check for understanding

Drill answers

1. Electrolysis is the process of passing an electric current through a substance, to break it down into its ions.
2. An electrolyte is a liquid that contains ions.
3. The positive electrode is called the anode
4. The negative electrode is called the cathode
5. An electrolyte has to be a liquid so that the ions are free to move.
6. A cation (+) moves towards the cathode (-)
7. An anion (-) moves towards the anode (+)
8. Oxidation takes place at the anode
9. Reduction takes places at the cathode
10. $2Cl^- \rightarrow Cl_2 + 2e^-$

Check for understanding

I: Testing a hypothesis with electrolysis

A student had a hypothesis '*The electrolysis of a salt solution produces a metal at the negative electrode and a gas at the positive electrode*'

(a) What observation would a student make if a gas is produced at the positive electrode? **Bubbles/fizzing/effervescence at the positive electrode**

(b) What observation would a student make if a metal is produced at the negative electrode? **A solid produced at the negative electrode**

(c) The table below shows the students results. Which salt solution in the table above does not match the student's hypothesis?

Salt solution	**Product at the negative electrode**	**Product at the positive electrode**
Copper chloride	copper	chlorine
Sodium fluoride	hydrogen	fluorine
Potassium nitrate	Hydrogen	oxygen

Salt solution: **Potassium nitrate or sodium fluoride**

Reason: **Hydrogen is not a metal**

Apply

We: Testing a hypothesis with electrolysis

A student had a hypothesis '*The electrolysis of sodium chloride solution produces a sodium metal at the negative electrode and chlorine gas at the positive electrode*'

(a) What observation would a student make if chlorine gas was produced at the positive electrode? **Bubbles/fizzing/effervescence**

(b) What observation would a student make if sodium was produced at the negative electrode?

A solid produced at the negative electrode

(c) When the student carried out the electrolysis experiment, she observed bubbles at both electrodes. Explain this observation.

Chlorine gas was observed forming at the positive electrode (as the hypothesis predicted). However, at the negative electrode hydrogen gas was produced, not sodium. This is because hydrogen is less reactive than sodium, and so hydrogen ions are discharged instead of sodium ions.

Apply

You: Testing a hypothesis with electrolysis

A scientist had a hypothesis '*The electrolysis of magnesium chloride produces magnesium at the negative electrode and chlorine at the positive electrode*'

(a) What observation would a scientist make if chlorine is produced at the positive electrode?

Bubbles/fizzing/effervescence at the positive electrode

(b) What observation would a scientist make if magnesium is produced at the negative electrode? **A solid produced at the negative electrode**

(c) Complete the table to suggest whether the hypothesis is correct or incorrect.

Hypothesis about what will happen at the anode	Correct or Incorrect?	**Correct**
Hypothesis about what will happen at the cathode	Correct or Incorrect?	**Correct**

Apply

Answer the questions below.

1. Which answer is not a reason that graphite is used for electrodes?

❑ A. Graphite is an inert material
☑ B. Graphite is a simple covalent substance
❑ C. Graphite is a good conductor of electricity

2. What will a student observe at the negative electrode when carrying out the electrolysis of sodium chloride?

❑ A. A solid will form (sodium metal)
❑ B. A gas will form (chlorine gas)
☑ C. A gas will form (hydrogen gas)

3. A gas is collected at the negative electrode. When a lit splint is placed in the gas, a squeaky pop sound is heard. What is the gas?

☑ A. Hydrogen
❑ B. Oxygen
❑ C. Chlorine

Exit ticket

Feedback

Lesson C4.2.11 C4.2.12	
What was good about this lesson?	What can we do to improve this lesson?

Send us your feedback by clicking this link
or by emailing sciencemastery@arkonline.org
Thank you!