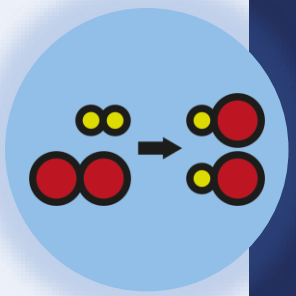
Electrolysis of Molten Ionic Compounds

Answer the questions below.

1. State the name of the two electrodes in an electrolysis set-up.
   Anode, cathode
2. State the charge on these electrodes.
   An anode has a positive charge, and a cathode has a negative charge.
3. Give one industrial use of electrolysis.
   Electrolysis is used to produce oxygen for diving tanks.
4. Aluminium oxide, Al_2O_3, is an ore of aluminium. Calculate the relative formula mass of aluminium oxide.
   102
5. State the formula for an aluminium ion.
   Al^{3+}

Do Now



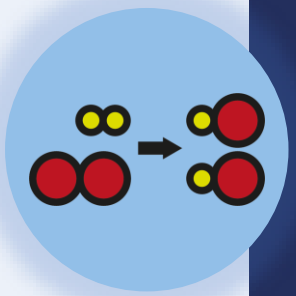
Electrolysis of Molten Ionic Compounds

Do Now:

1. State the name of the two electrodes in an electrolysis set-up.
2. State the charge on these electrodes.
3. Give one industrial use of electrolysis.
4. Aluminium oxide, Al_2O_3, is an ore of aluminium. Calculate the relative formula mass of aluminium oxide.
5. State the formula for an aluminium ion.

Drill:

1. State the formula for an oxide ion.
2. Which electrode would an oxide ion be attracted to?
3. State the formula for a hydrogen ion.
4. What type of substance always contains hydrogen ions?



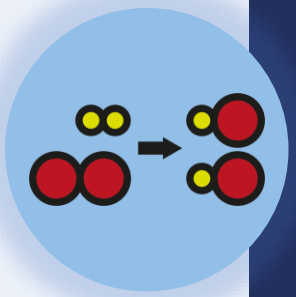
Do Now

Electrolysis of Molten Ionic Compounds

Read Now:

Many companies are busy coming up with new ideas to help us move to a more sustainable future. One way of doing this would be by using electric cars and motorcycles instead of transport fuelled by fossil fuels. In Argentina, a student called Santiago Hernandez had an idea when he was studying the topic of electrolysis. He wondered if it could be used to propel a vehicle. Now, he has invented an electric motor which runs on salt water, with no other fuel needed. The design will need more modifications before it will produce enough electricity for full-size vehicles.

1. State one change that we could make to our lifestyles towards a more sustainable future.
2. Where is Santiago Hernandez from?
3. What did Santiago think that electrolysis could be used for?
4. What does Santiago's motor need to work?
5. Why isn't Santiago's motor ready to use in cars now?

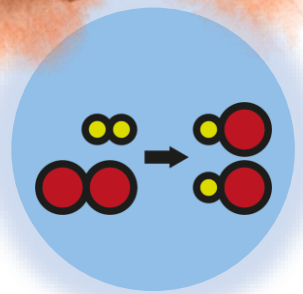


Do Now

Electrolysis of Molten Ionic Compounds

C4.2.9

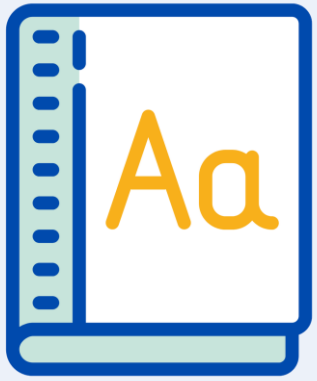
Science Mastery



Following this lesson, students will be able to:

- Recall that during electrolysis, ions are discharged at the electrodes forming elements
- Predict the ions discharged at each electrode
- (HT) Write half equations to describe the discharge of ions at each electrode

Key Words:



discharged | **anode** | **cathode**

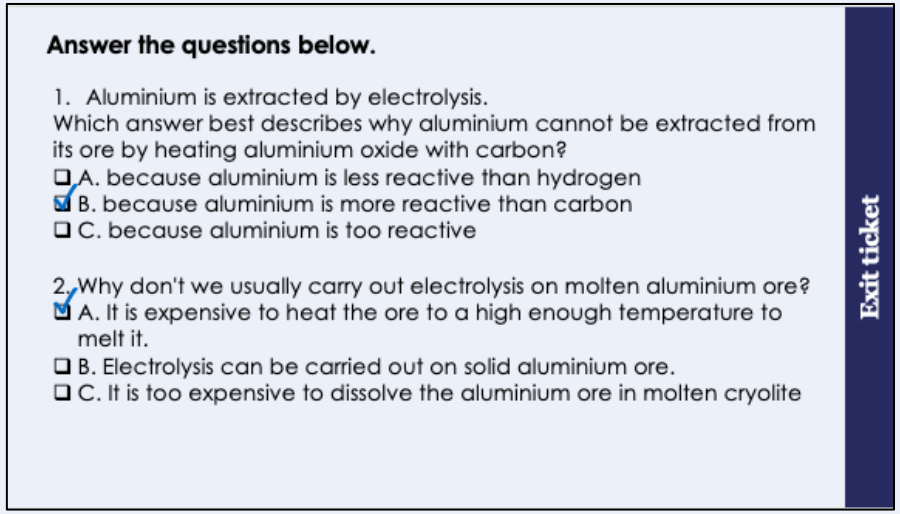
electrolysis | **electrolyte**

Lesson Objectives

This is the fix-it portion of the lesson

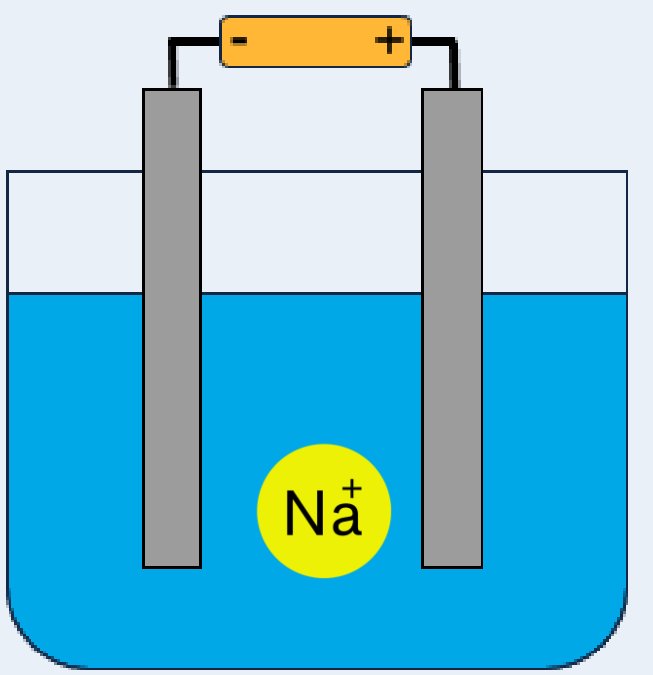
The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the previous lesson's exit ticket.

- 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 to a positive ion in the electrolyte?



Let's take the example of **molten sodium chloride.**

Sodium chloride contains one positive ion (cation): **Na^+**.

1. When the current Is switched on, **the positive ion moves towards the negative electrode** (cathode)

2. At the cathode, the cation is **discharged** (turns from an ion to an element)
3. The metal is **observed** to form at the cathode

Higher Tier only

This can be summarised with a half equation:

$$Na^+_{(l)} + e^- \rightarrow Na_{(s)}$$

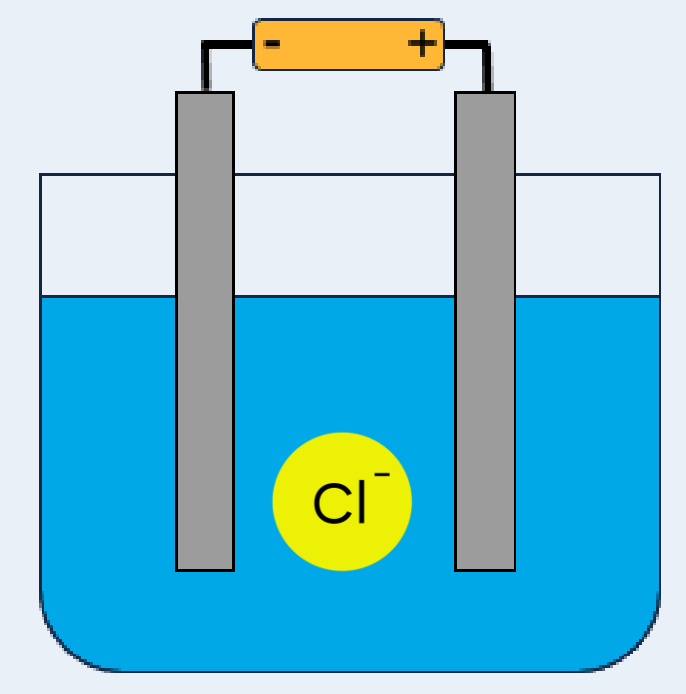
Complete the table.

Electrolyte name	Ions in the electrolyte	Ion discharged at the cathode	What would be observed at the cathode?	(HT only) Half equation at the cathode
Molten lithium fluoride	Li^+ F^-	Li^+	Lithium metal would form	$Na^+ + e^- \rightarrow Na$
Molten potassium chloride	K^+ Cl^-	K^+	Potassium metal would form	$K^+ + e^- \rightarrow K$

PANIC

Positive **A**node **N**egative **I**s **C**athode

What happens to a negative ion in the electrolyte?



Let's take the example of **molten sodium chloride.**

Sodium chloride contains one negative ion (anion): **Cl^-**.

1. When the current Is switched on, **the negative ion moves towards the positive electrode** (anode)

2. At the anode, the anion is **discharged** (turns from an ion to an element)
3. The non-metal is **observed** to form at the cathode

Higher Tier only

This can be summarised with a half equation:

$$2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$$

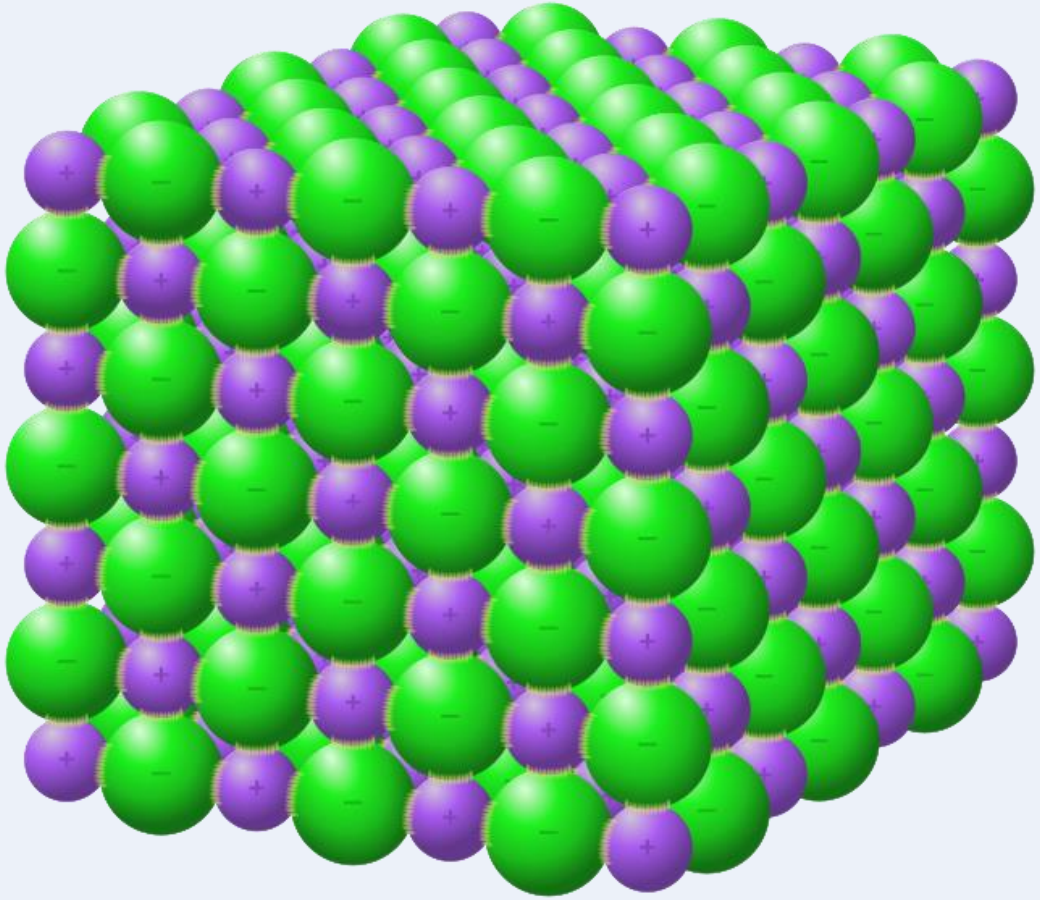
Complete the table.

Electrolyte name	Ions in the electrolyte	Ion discharged at the anode	What would be observed at the anode?	(HT only) Half equation at the cathode
Molten lithium fluoride	Li^+ F^-	F^-	Bubbles of fluorine gas would form.	$2F^- \rightarrow F_2 + 2e^-$
Molten potassium chloride	K^+ Cl^-	Cl^-	Bubbles of chlorine gas would form	$2Cl^- \rightarrow Cl_2 + 2e^-$

PANIC

Positive **A**node **N**egative **I**s **C**athode

This is an ionic compound.



Discuss why electrolysis will not work on this substance.

What could a scientist do to so that electrolysis could be carried out with this substance?

Talk Task

Drill

1. What is a cation?
2. What is an anion?
3. Name the positive ion present in molten lithium chloride.
4. Name the negative ion present in molten beryllium oxide.
5. What is produced when a positive ion is discharged at an electrode?
6. What is produced when a negative ion is discharged at an electrode?
7. What is observed when a chloride ion is discharged?
8. At which electrode will a positive ion be discharged?
9. At which electrode will a negative ion be discharged?
10. *(HT only)* Write a half equation to represent the discharge of a sodium ion (Na^+)

Check for understanding

Drill answers

1. A cation is a positively charged ion
2. An anion is a negatively charged ion
3. The positive ion in molten lithium chloride is Li^+
4. The negative ion in molten beryllium oxide is O^{2-}
5. When a positive ion is discharged at an electrode, a metal is produced
6. When a negative ion is discharged at an electrode, a non-metal is produced
7. When a chloride ion is discharged, chlorine gas is produced
8. A positive ion will be discharged at the the negative electrode (cathode)
9. A negative ion will be discharged at the positive electrode (anode)
10. $Na^+ + e^- \rightarrow Na$

Check for understanding

I: Describing what happens at each electrode

A scientist carried out the electrolysis of molten lithium fluoride.

(a) Describe what will occur at each electrode.
(b) HT only – Write half equations to describe the discharge of ions at each electrode

(a) At the anode (positive electrode)

- Fluoride ions (F^-) will move towards the anode
- Here, the ions will be discharged
- They will lose electrons. This is called oxidation.
- To form fluorine gas
- Bubbles of fluorine gas will be observed.

At the cathode (negative electrode)

- Lithium ions (Li^+) will move towards the cathode
- Here, the ions will be discharged
- They will gain electrons. This is called reduction.
- To form lithium metal
- Lithium metal will be observed forming

(b) $2F^- \rightarrow F_2 + 2e^-$

$Li^+ + e^- \rightarrow Li$

Apply

We: Describing what happens at each electrode

A scientist carried out the electrolysis of molten sodium chloride.

(a) Describe what will occur at each electrode.
(b) HT only – Write half equations to describe the discharge of ions at each electrode

(a) At the anode (positive electrode)

- Chloride ions (Cl^-) will move towards the anode
- Here, the ions will be discharged
- They will lose electrons. This is called oxidation.
- To form chlorine gas
- Bubbles of chlorine gas will be observed.

At the cathode (negative electrode)

- Sodium ions (Na^+) will move towards the cathode
- Here, the ions will be discharged
- They will gain electrons. This is called reduction.
- To form sodium metal
- Sodium metal will be observed forming

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

$Na^+ + e^- \rightarrow Na$

Apply

You: Describing what happens at each electrode

A scientist carried out the electrolysis of molten potassium bromide.

(a) Describe what will occur at each electrode.
(b) HT only – Write half equations to describe the discharge of ions at each electrode

(a) <u>At the anode (positive electrode)</u>

- Bromide ions (Br^-) will move towards the anode
- Here, the ions will be discharged
- They will lose electrons. This is called oxidation.
- To form bromine
- Bromine will be observed (a brown red liquid).

<u>At the cathode (negative electrode)</u>

- Potassium ions (K^+) will move towards the cathode
- Here, the ions will be discharged
- They will gain electrons. This is called reduction.
- To form potassium metal
- Potassium metal will be observed forming

(b) $2Br^- \rightarrow Br_2 + 2e^-$

$K^+ + e^- \rightarrow K$

Apply

Answer the questions below.

1. Sodium ions move to the negative electrode. Choose the best explanation for this.

- ❑ A. Sodium electrons are negative so they are attracted to the negative electrode
- ☑ B. Sodium ions are positive so they are attracted to the negative electrode
- ❑ C. Sodium ions are negative and are attracted to the negative electrode

2. Molten lead bromide was electrolysed using inert electrodes. Choose what was produced at the positive electrode (anode).

- ☑ A. Bromine
- ❑ B. Bromide ions
- ❑ C. Lead
- ❑ D. Lead ions

Exit ticket

Answer the question below.

3. Choose the correct statement.

- ☐ A. Negative ions gain electrons from the positively charged cathode
- ☑ B. Positive ions gain electrons from the negatively charged cathode
- ☐ C. Negative ions lose electrons at the negatively charged cathode

Exit ticket

Feedback

Lesson C4.2.9	
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!