

Extracting Metals by Electrolysis

Answer the questions below.

1. What happens to metal atoms, that causes them to form positive ions?

Metal atoms lose electrons to form positive ions

2. What is another name for positive ions?

Another name for a positive ion is a 'cation'

3. Write the electronic configuration of a sodium atom.

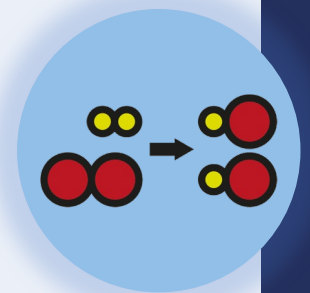
2, 8, 1

4. Write the electronic configuration of a sodium ion.

[2, 8]⁺¹

5. Which electrode will attract positive ions in an electrolysis set-up?

The cathode will attract the positive ions in an electrolysis set-up. (the cations are attracted to the cathode)



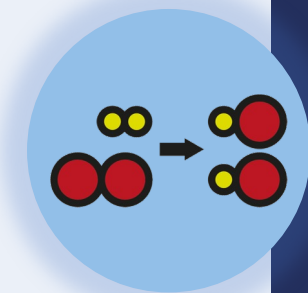
Extracting Metals by Electrolysis

Do Now:

1. What happens to metal atoms, that causes them to form positive ions?
2. What is another name for positive ions?
3. Write the electronic configuration of a sodium atom.
4. Write the electronic configuration of a sodium ion.
5. Which electrode will attract positive ions in an electrolysis set-up?

Drill:

1. Define 'electrolysis'.
2. Explain why electrolysis cannot be carried out with solid ionic substances.

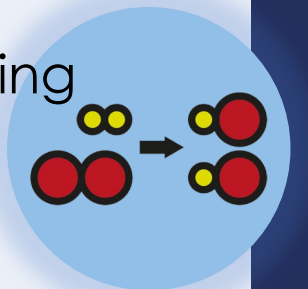


Extracting Metals by Electrolysis

Read Now:

The extraction of minerals, metals and fuels from the Earth has been happening for thousands of years, and humans are doing more and more of it each year. The average person in the UK uses roughly 26 tonnes of raw materials each year. That is the **equivalent** of the weight of four and a half elephants worth! All of these mines are putting pressure on the natural world. **Active** mines all over the world cover an area that is about five times the size of Wales. If we were to suddenly stop mining, there would be an energy crisis for many countries, especially those that depend on coal for electricity. 35% of the world still rely on coal for this purpose. In Europe, we would be affected slightly less as we only depend on coal for 15% of our electricity supply.

1. What mass of raw materials from mines does the average person in the UK use each year?
2. Give one reason why we cannot suddenly stop mining, even though it is putting pressure on the natural world?
3. What percentage of electricity in Europe is generated using coal?
4. Define the words in **bold**.



Extracting Metals by Electrolysis

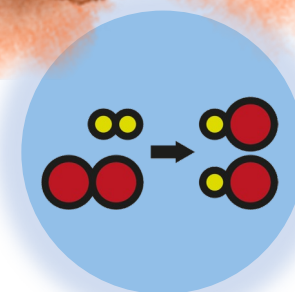
C4.2.8

Science
Mastery



C4.2.1 PKR: Reactions 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

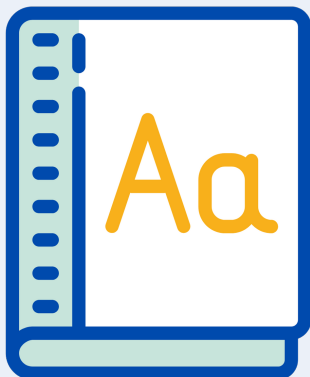
C4.2.7 Introduction to Electrolysis
➤ **C4.2.8 Extracting Metals by Electrolysis**
C4.2.9 Electrolysis of Molten Ionic Compounds
C4.2.10 Electrolysis in Solutions
C4.2.11 RP: Electrolysis of Aqueous Solutions 1
C4.1.12 RP: Electrolysis of Aqueous Solutions 2
C4.1.13 TIF: Corrosion and its Prevention
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:

- Recall that metals can be extracted from molten compounds by electrolysis
- Describe a disadvantage of extraction of metals by electrolysis
- Describe how electrolysis is used to extract aluminium from its ore

Key Words:



molten

extraction

cryolite

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.

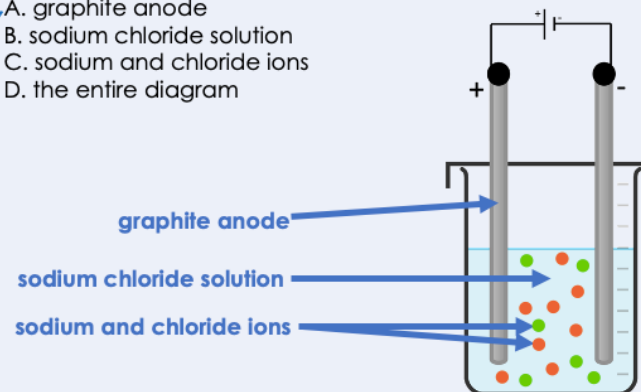
Answer the questions below.

1. Which answer correctly describes the 'anode'?
☐ A. a positive ion
☐ B. a negative ion
☒ C. the positive electrode
☐ D. the negative electrode
2. Which answer correctly explains why electrolysis will not work with solid sodium chloride?
☒ A. Solid sodium chloride doesn't conduct electricity because the ions cannot move in a solid
☐ B. Solid sodium chloride doesn't conduct electricity because the particles cannot move in a solid
☐ C. Solid sodium chloride doesn't conduct electricity because the electrons cannot move in a solid
☐ D. Electrolysis will work with solid sodium chloride

Exit ticket

Answer the question below.

3. Which answer below describes the **electrolyte**?
☐ A. graphite anode
☒ B. sodium chloride solution
☐ C. sodium and chloride ions
☐ D. the entire diagram



Exit ticket

Extraction of metals by electrolysis

Metals can be extracted from their **ores** using electrolysis.

For this to work, the ore needs to be **molten**.

Why do you think the compounds need to be molten?

For electrolysis to work, the ions must be free to move.

Electrolysis is used to extract metals when

- the metal is too reactive to be extracted by reduction with carbon
- the metal is likely to react with carbon

This is an **expensive** process, because it requires a lot of electricity.

The reactivity of a metal determines the method of extraction

The Reactivity Series	Reactivity	Method of extraction
Potassium	<div>Most reactive</div> <div>↑</div> <div>Least reactive</div>	Extracted by electrolysis
Sodium		
Calcium		
Magnesium		
Aluminium		
Carbon		
Zinc		Extracted by displacement reaction with carbon
Iron		
Lead		
Copper		
Silver	Least reactive	No extraction needed
Gold		

Aluminium

Aluminium is the 3rd most abundant element in the Earth's crust, however it wasn't discovered until the 1800's.

Can you guess why?

Aluminium is never found as a pure metal, only in an ore.

Explain which method is used to extract aluminium from its ore.

Electrolysis is used to extract aluminium from its ore. This is because aluminium is more reactive than carbon, so it cannot be extracted by reduction with carbon.

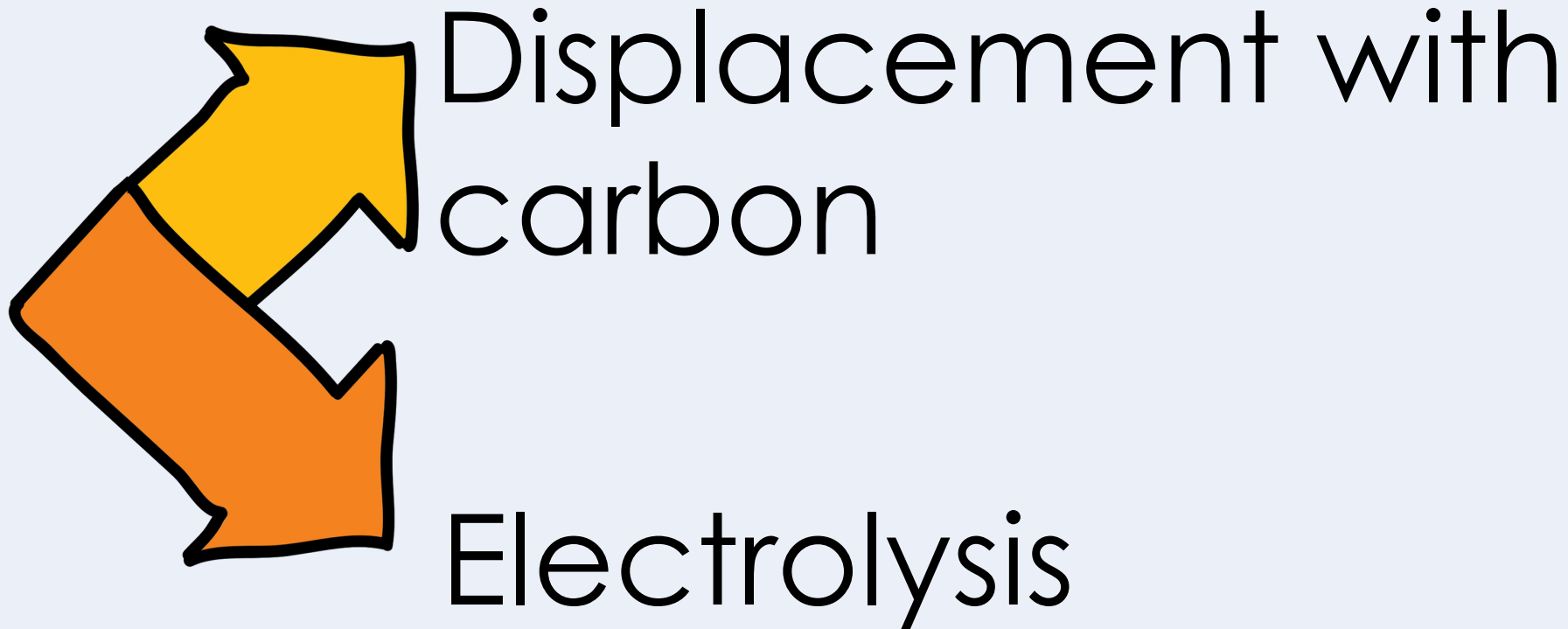
The extraction of aluminium



- Aluminium ore is called **1**
- Bauxite can be purified to produce **2**, Al_2O_3 .
- Aluminium metal can be obtained from aluminium oxide **by** **3**.
- The ions in aluminium oxide need to be **4** for electrolysis.
- It would be **too expensive to melt the ore** for electrolysis, because this would require **5**
- Instead, the aluminium oxide is **6**, so that a solution is made that has a much lower melting point.
- 7** is used as the **positive anode**.

Each of these is a method used to extract metals from their ores.

When is each method used and why?



Drill

1. What is aluminium ore called?
2. State the formula for aluminium oxide.
3. Which process is used to extract aluminium from aluminium oxide?
4. Why does an ore need to be molten for electrolysis to take place?
5. Why isn't aluminium oxide melted for electrolysis to be carried out?
6. What is done for the ions in aluminium oxide to be able to move during electrolysis?
7. Why isn't aluminium extracted from its ore by displacement reaction with carbon?
8. What method is used to extract copper from its ore?
9. What method is used to extract gold from its ore?
10. Why is electrolysis an expensive process?

Drill answers

1. Aluminium ore is called bauxite
2. The formula for aluminium oxide is Al_2O_3
3. Electrolysis is used to extract aluminium from aluminium oxide
4. So that the ions are free to move.
5. Aluminium oxide isn't melted for electrolysis to take place because this requires a lot of energy and so is expensive.
6. The ore is dissolved in cryolite so that the melting point of the mixture is lower, and less heating is needed to melt aluminium oxide.
7. The aluminium isn't extracted by displacement reaction with carbon, because aluminium is more reactive than carbon. Therefore this reaction wouldn't occur.
8. Copper is extracted from its ore by displacement reaction with carbon.
9. Gold does not need to be extracted from an ore because it's so unreactive it is found as a pure metal.
10. Electrolysis is an expensive process because it requires a lot of energy to produce the electricity needed.

I: Explain: *to use scientific understanding to make something clear or state the reason for something happening*

Example question:

Explain why aluminium is extracted using electrolysis.

Model answer:

- Aluminium has to be extracted using electrolysis because it is **more reactive** than **carbon**
- This means that it cannot be extracted by **displacement** with carbon

To 'explain' your answer should:

- Begin with a **scientific statement**.
- Use 'this means that', 'because' or 'so' **to link your statement to the question**.



We: Explain: to use scientific understanding to make something clear or state the reason for something happening

Example question:

Explain why aluminium is not extracted using displacement with carbon.

Model answer:

- Aluminium has to be extracted using electrolysis because it is **more reactive** than **carbon**
- This means that it cannot be extracted by **displacement** with carbon

To 'explain' your answer should:

- Begin with a **scientific statement**.
- Use 'this means that', 'because' or 'so' **to link your statement to the question**.



You: Explain: to use scientific understanding to make something clear or state the reason for something happening

Example question:

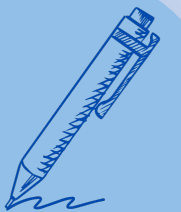
Explain why aluminium oxide is dissolved in cryolite for electrolysis.

Model answer:

- Ions need to be **free** to **move** during electrolysis
- This means that aluminium oxide needs to be **molten** or **in solution**
- It is dissolved in cryolite so that the mixture has a **lower melting point**, so this would require less **energy** to melt and would be less expensive

To 'explain' your answer should:

- Begin with a **scientific statement**.
- Use 'this means that', 'because' or 'so' **to link your statement to the question**.



Answer the questions below.

1. Aluminium is extracted by electrolysis.

Which answer best describes why aluminium cannot be extracted from its ore by heating aluminium oxide with carbon?

- ☐ A. because aluminium is less reactive than hydrogen
- ☒ B. because aluminium is more reactive than carbon
- ☐ C. because aluminium is too reactive

2. Why don't we usually carry out electrolysis on molten aluminium ore?

- ☒ A. It is expensive to heat the ore to a high enough temperature to melt it.
- ☐ B. Electrolysis can be carried out on solid aluminium ore.
- ☐ C. It is too expensive to dissolve the aluminium ore in molten cryolite

Lesson C4.2.8

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!