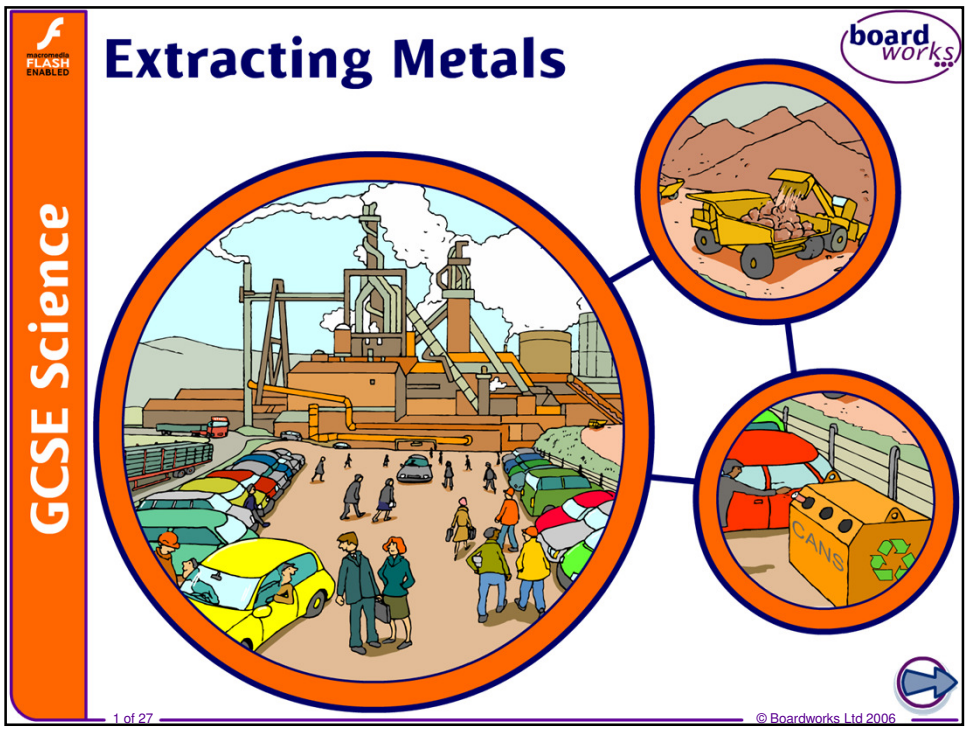
Extracting Metals
GCSE Science
CANS
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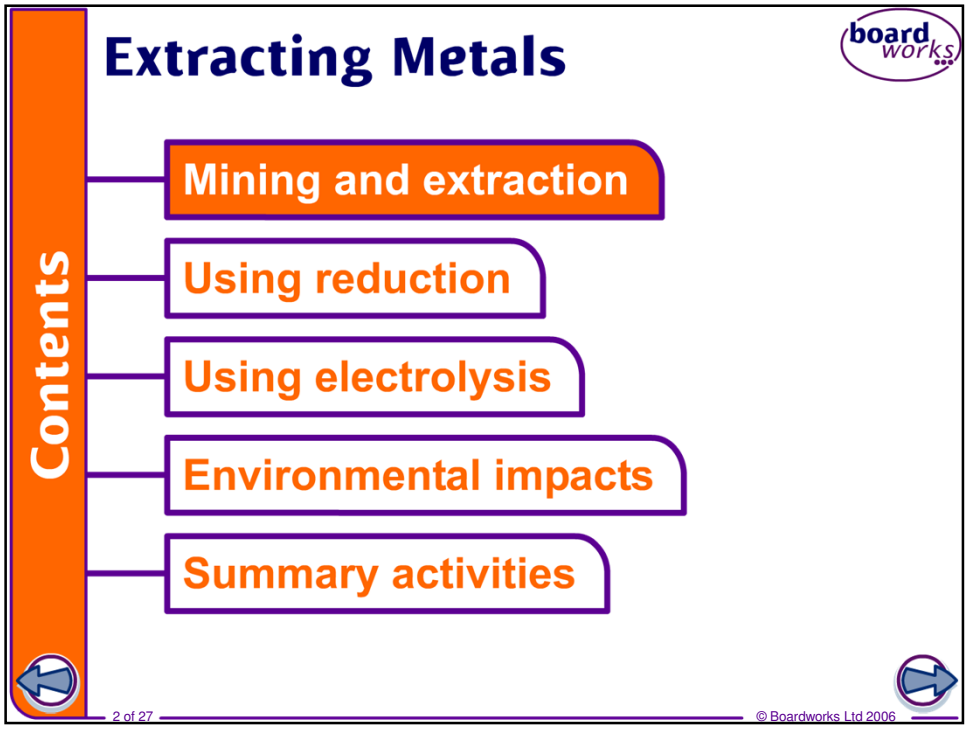
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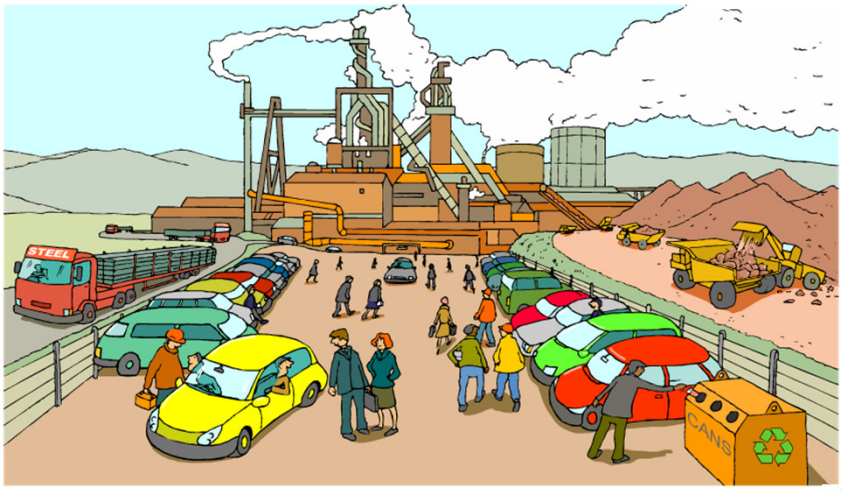
How are metals extracted?

Metal extraction is a large and important industry.
What positive and negative impacts does it have?



Why are metals extracted?

Most metals are found in the Earth's crust combined with other elements in rocks known as **ores**.

For example, iron is found combined with oxygen in ores called **haematite** and **magnetite**.

Metals need to be extracted from ores before they can be turned into useful products, such as cars or cutlery.

The extraction of metals and minerals is the fifth-largest industry in the world. The South African mining industry alone employs 800,000 people.

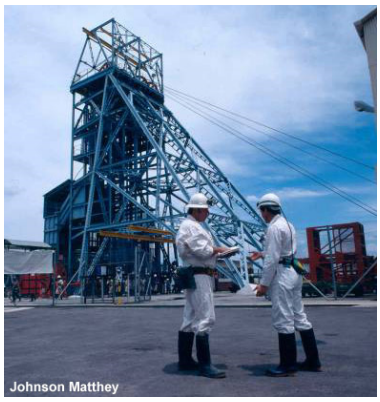
How is chemistry important to this industry?

Why are some areas mined and not others?

Mining for ores is expensive and so is only carried out where minerals are abundant enough for this to be profitable.

In industry, an ore is a rock that contains enough metal to make mining and extraction economical.

However, the value of ores changes over time due to society and technology.



For example, rocks containing only 5% copper would have been considered unprofitable in the 19th century. Today, most copper comes from ores containing 0.4 to 1% copper.

What methods are used to extract metals?

Extraction methods vary for different metals.

Gold and other unreactive metals occur **native**. Metals that are found in the ground as uncombined elements do not require further extraction.

Most metals are found combined with other elements, as compounds in ores. These metals need to be separated from the other elements that they are combined with using **chemical reactions**.

There are two main ways of extracting metals from their ores:

- **burning ores with carbon (reduction)**
- **electrolysis**

How do mining companies decide which method to use?

How does reactivity affect extraction?

The reactivity of a metal determines how it is extracted.

increasing reactivity

potassium
sodium
calcium
magnesium
aluminium
(carbon)
zinc
iron
lead
(hydrogen)
copper
silver
gold
platinum

Metals above carbon in the reactivity series must be extracted using **electrolysis**. Electrolysis can also be used to purify copper.

Metals less reactive than carbon can be extracted from their ores by **reduction** using carbon, coke or charcoal.

Platinum, gold, silver and copper can occur **native** and do not need to be extracted.

Extracting Metals

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What is reduction?

Metals are often found combined with oxygen as **oxides**.
To obtain the metal, the oxygen must be removed.

The removal of oxygen from a substance is called **reduction**.

metal oxide (in ore) —(reduction)→ **metal**

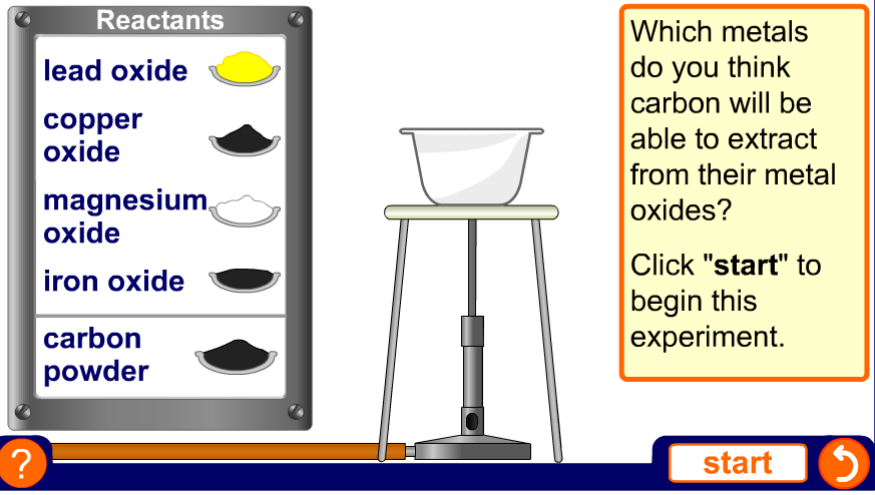
Carbon can be used to extract metals by reduction.

lead oxide	+	carbon	→	lead	+	carbon monoxide
PbO	+	C	→	Pb	+	CO

In this reaction, the carbon removes oxygen from lead oxide.
This occurs because carbon is more reactive than lead.
The addition of oxygen to a substance is called **oxidation**.

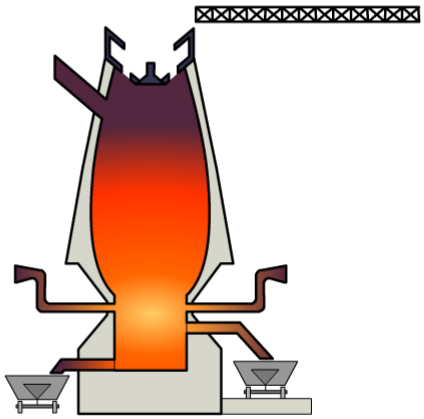
Reactions of metal oxides and carbon

What metals can be extracted using carbon?



Extracting iron in industry

How does a blast furnace work?



Iron is extracted from iron ore by burning it with carbon in a blast furnace at very high temperatures.

Click "**play**" to find out how the blast furnace works.

Which metals does carbon reduce?

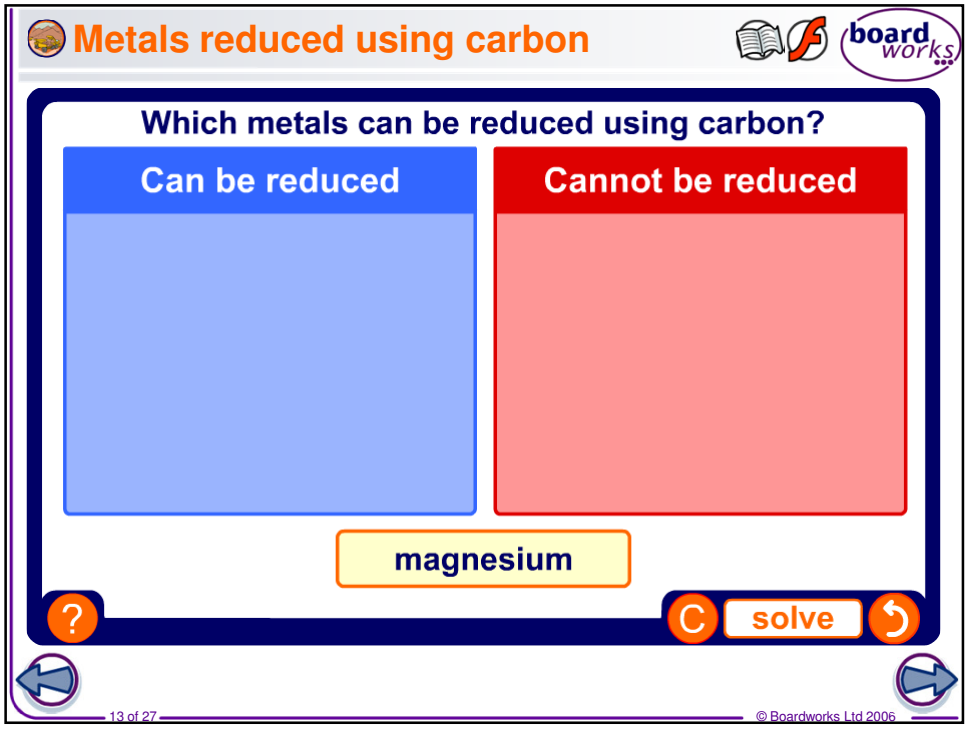
potassium
sodium
calcium
magnesium
aluminium
(carbon)
zinc
iron
lead
(hydrogen)
copper
silver
gold
platinum

A metal can be reduced by carbon if it is less reactive than carbon and so appears below carbon in the reactivity series.

Certain metals, such as iron, can be only be reduced using carbon if they are heated to very high temperatures.

If a metal is more reactive than carbon, other chemical reactions and processes must be used in its extraction.

Using the reactivity series, can you name a metal that **cannot** be extracted from its ore using carbon?


Metals reduced using carbon
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Which metals can be reduced using carbon?
Can be reduced
Cannot be reduced
magnesium
?
C
solve
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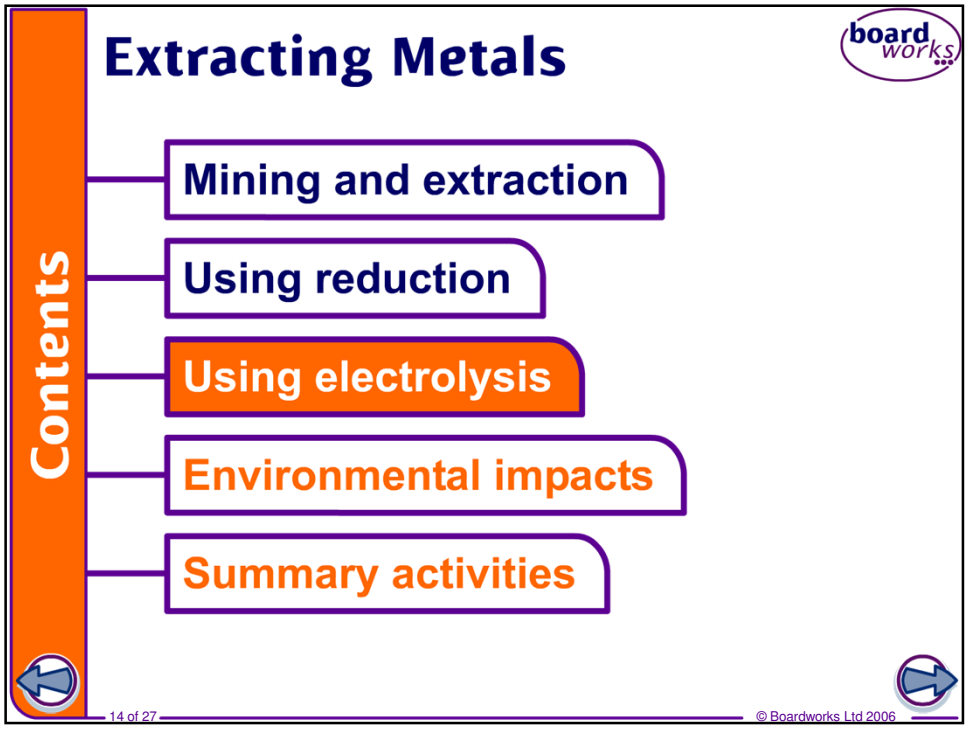
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What is electrolysis?

Electrolysis is a process that uses electricity to separate the elements in a compound. The word electrolysis means 'splitting with electricity'.

Electrolysis is expensive and so it is only used to extract reactive metals that cannot be extracted in other ways.

Aluminium is a reactive metal that is found in the ore **bauxite**. It is combined with oxygen as aluminium oxide. Electrolysis is used to remove the oxygen and extract aluminium, which means that reduction takes place.

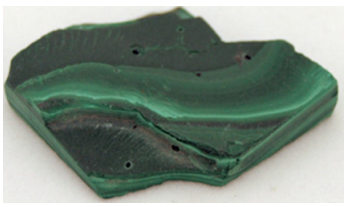
What is the word equation for the extraction of aluminium?

aluminium oxide → aluminium + oxygen

How is copper purified?

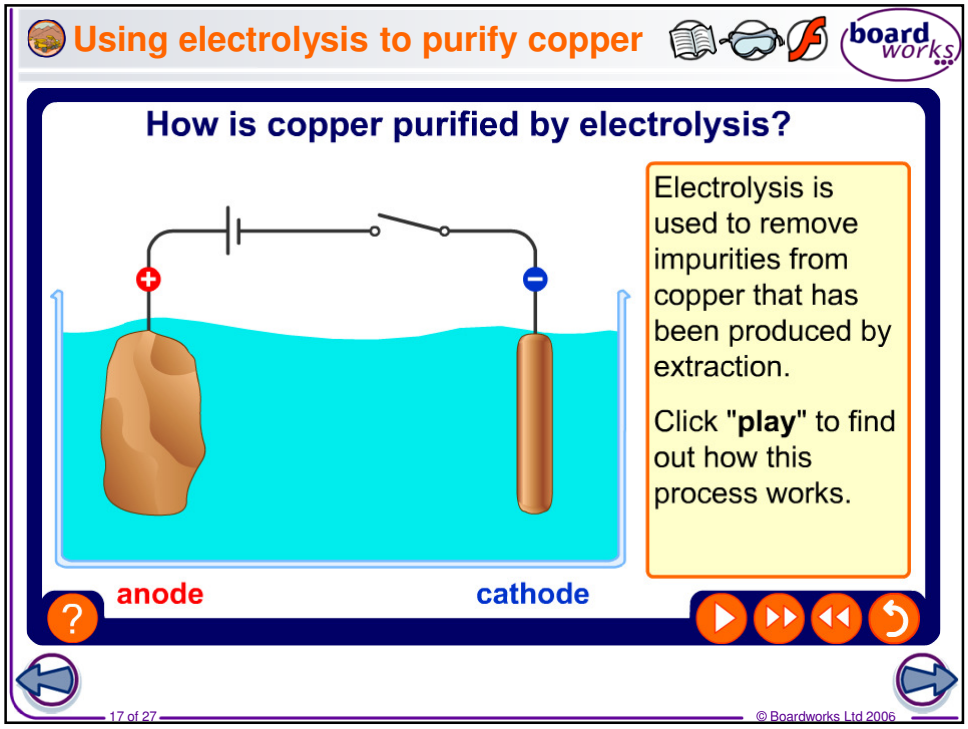
Copper is an excellent conductor and does not corrode quickly. These properties make it a good material for wiring and plumbing.

Only pure copper can be used for electric wires. Even a very low level of impurities will reduce copper's conductivity.



Copper is not very reactive and can occur native but it is rare to find pure copper. Usually, it is found combined with other elements, such as in the ore **malachite**.

The copper extracted from compounds by reduction with carbon is impure. **Electrolysis** can actually be used at this stage to remove the impurities and obtain pure copper.


Using electrolysis to purify copper
board works
How is copper purified by electrolysis?
Electrolysis is used to remove impurities from copper that has been produced by extraction.
Click "play" to find out how this process works.
anode
cathode
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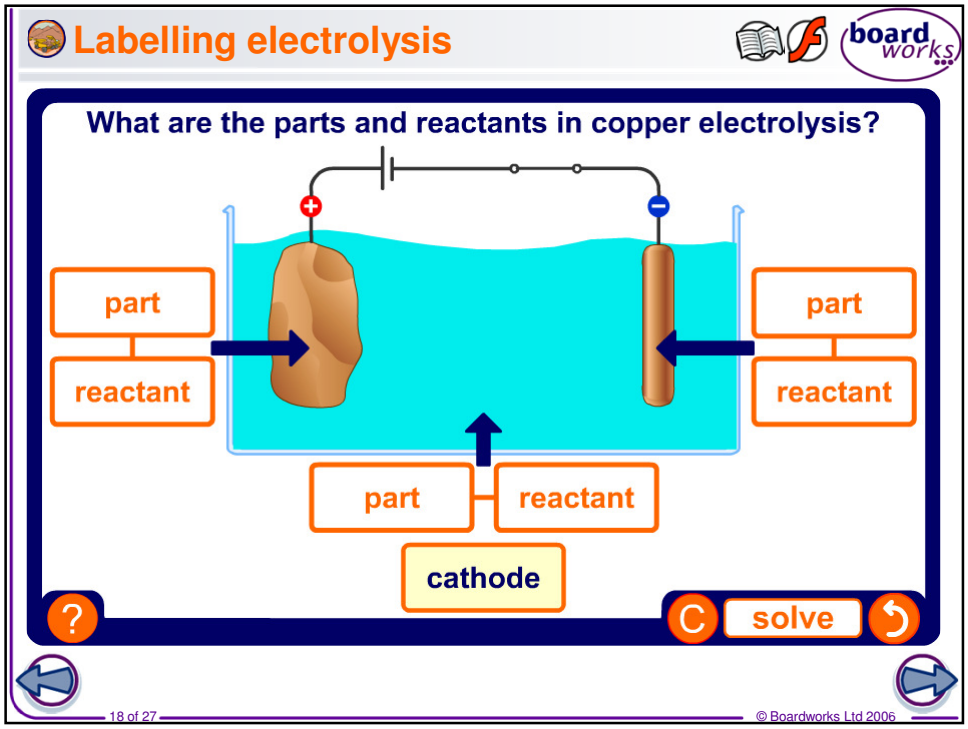
Labelling electrolysis
board works
What are the parts and reactants in copper electrolysis?
part
reactant
part
reactant
part
reactant
cathode
solve
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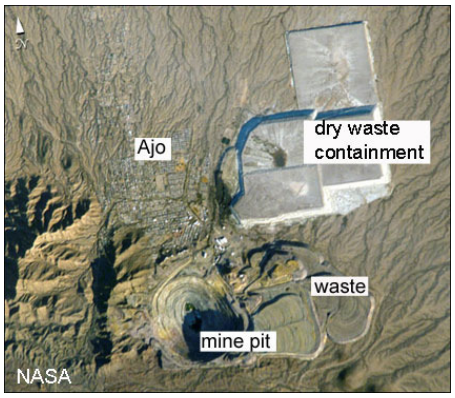
Extracting Metals

How does extraction affect the environment?

Open-cast mining removes ores using explosives. It produces dust and can scar the landscape. This disused copper mine in Ajo, Arizona, measures one mile wide.



Extracting metals causes huge amounts of waste. Copper production discards 99.5% of the extracted ore.

Harmful waste gases, including sulfur dioxide, carbon dioxide and carbon monoxide, are produced by extraction.

Extraction, especially electrolysis, also uses lots of electricity.

How can the impacts of extraction be reduced?

New mining techniques can decrease the effects of metal extraction on the environment.

- **Leaching** uses less electricity than traditional mining and does not produce waste gases. Copper ores are treated with and dissolved in dilute sulfuric acid, producing copper sulfate. Electrolysis is then used to extract the copper. Certain bacteria can also be used to dissolve ores and form copper sulfate.

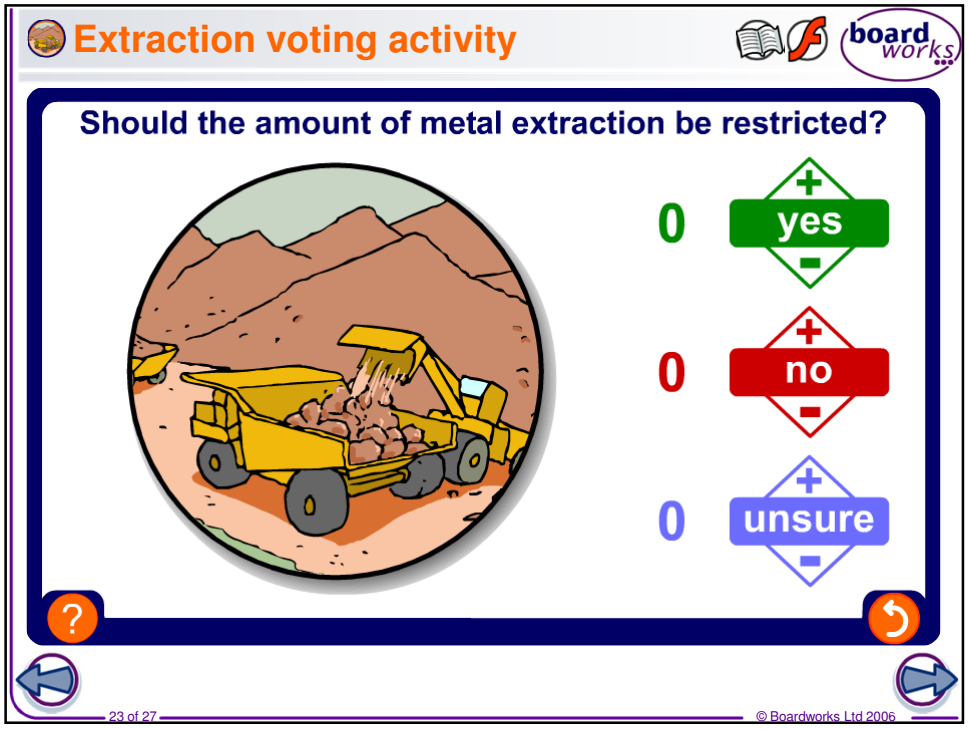
- **Phytomining** uses plants to absorb metals from the soil. The process can be used to clean contaminated land. Treating the plants with certain chemicals increases their ability to accumulate minerals in their cells.

How can recycling help?

Metals are easier to recycle than plastic and they retain their original properties, such as conductivity and hardness.

- Recycling uses up to 95% less electricity than producing metals from ores.
- Recycling costs less than extracting metals and can be profitable.
- Recycling creates less waste and reduces the number of sites that have to be mined.

One problem is that metallic materials in recycled objects are often mixtures of different metals. This can mean that obtaining pure metals from recycling is more expensive, as it may use more electricity than extracting metals from ores.


Extraction voting activity
boardworks
Should the amount of metal extraction be restricted?
0
yes
0
no
0
unsure
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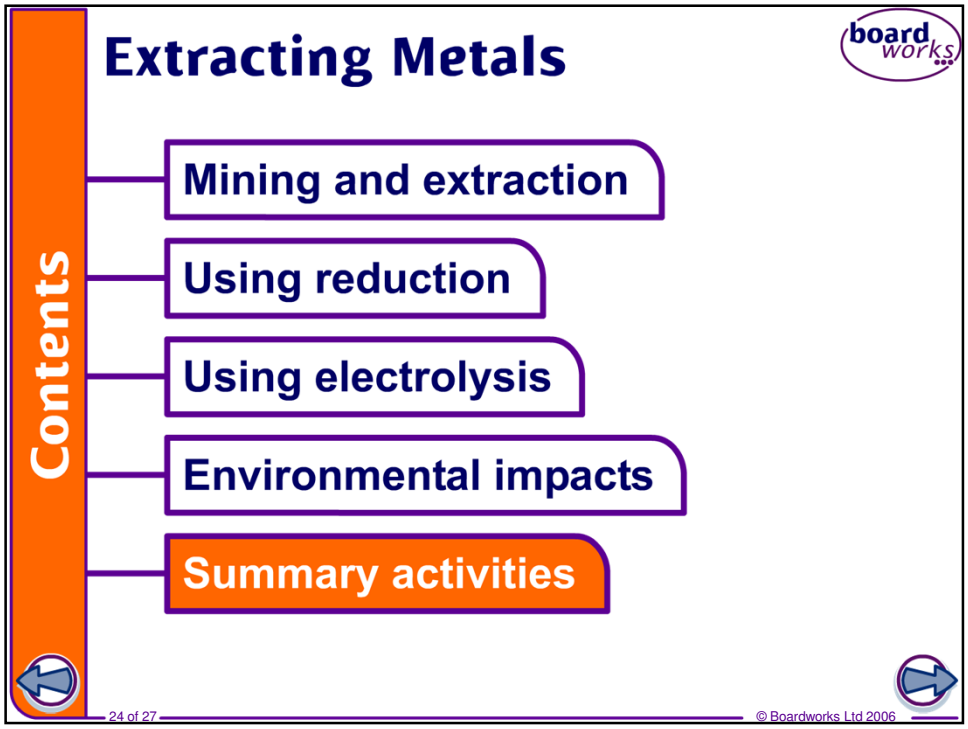
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Glossary

- **anode** – The positive electrode used in electrolysis.
- **blast furnace** – A tall oven used to extract iron from iron ore by burning it with carbon at high temperatures.
- **cathode** – The negative electrode used in electrolysis.
- **electrolysis** – The use of an electric current to separate out the elements in a compound.
- **electrolyte** – An ionic compound that conducts electricity when in a liquid state.
- **native** – The natural occurrence of a metal as an element in the environment.
- **ore** – A rock that contains a metal combined with other elements in concentrations that make it profitable to mine.
- **oxidation** – The addition of oxygen to a substance.
- **reduction** – The removal of oxygen from a substance.

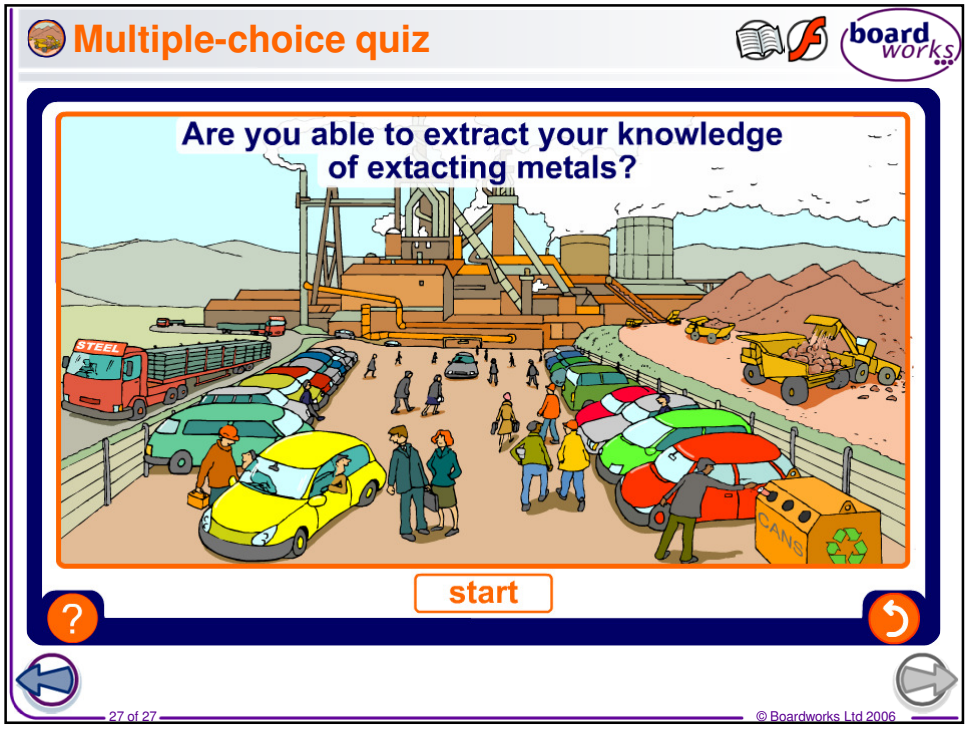
Anagrams

How quickly can you unscramble anagrams of words about

e x t r a c t i n g

m e t a l s ?

start


Multiple-choice quiz
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Are you able to extract your knowledge of extacting metals?
STEEL
CANS
start
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