

# Unit 1: GCSE Applied Science

## 1.3.2 Our Planet

### Obtaining raw materials

Raw material	Method
Metal oxides	Surface or subsurface mining
Shale gas	Fracking
Crude oil or natural gas	Drilling
Salt	Solution mining or deep-shaft mining
Oxygen or nitrogen	Fractional distillation of air

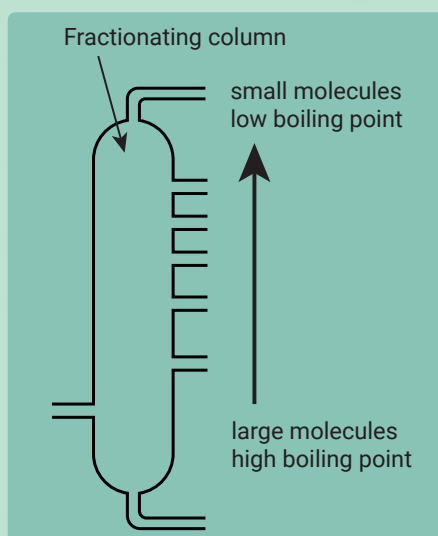
### Processing raw materials

Raw materials often need to be processed. Physical processes (e.g. separation) and chemical processes may be needed to transform the raw material into something useful.

#### Crude oil

Crude oil is a complex mixture of hydrocarbons which need separating to produce useful products.

- Fractional distillation** is used to separate the different fractions by making use of differences in the boiling temperatures.
- The longer the hydrocarbon chain, the higher boiling points and 'thicker' the liquid (more viscous).
- Most fractions are used as fuels.



#### Cracking

Some of the large molecule hydrocarbons that were separated in fractional distillation of crude oil are not useful. These large molecules can be converted into smaller and more useful molecules by a process known as **cracking**.

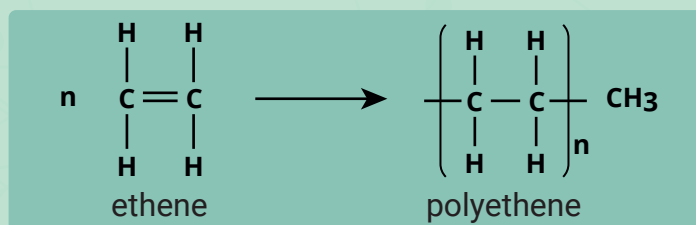
Cracking produces small reactive molecules **called monomers** which can be used to make plastics.

### Polymerisation

Polymer molecules are very long chained molecules.

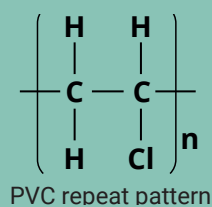
Polymers are made by joining together a **very** large number of small reactive molecules (monomers) to make a long chain.

An example of a polymerisation reaction is shown below:



The monomer is ethene (C<sub>2</sub>H<sub>4</sub>). The carbon atoms in the monomer are joined by a **double** bond.

Polyethene is the polymer. Many ethene units have joined. There is only a **single** bond between the carbon atoms. **The repeat pattern** is shown above.



Other polymers will have different repeat patterns.

#### Bioplastics

Produced from renewable sources such as vegetable oil or corn starch.

Advantages and disadvantages of bioplastics:

Advantages	Disadvantages
Obtained from a renewable source unlike oil-based plastics which come from non-renewable crude oil.	The land that is used for growing crops to produce oil for bioplastics is no longer available to grow food.
Less carbon dioxide (greenhouse gas) is released producing bioplastics than oil-based plastics.	Crops require the use of fertilisers and pesticides.
They are compostable: they decay into natural materials.	

#### Metal ores

Ores are rocks that contain metals or compounds of metals.

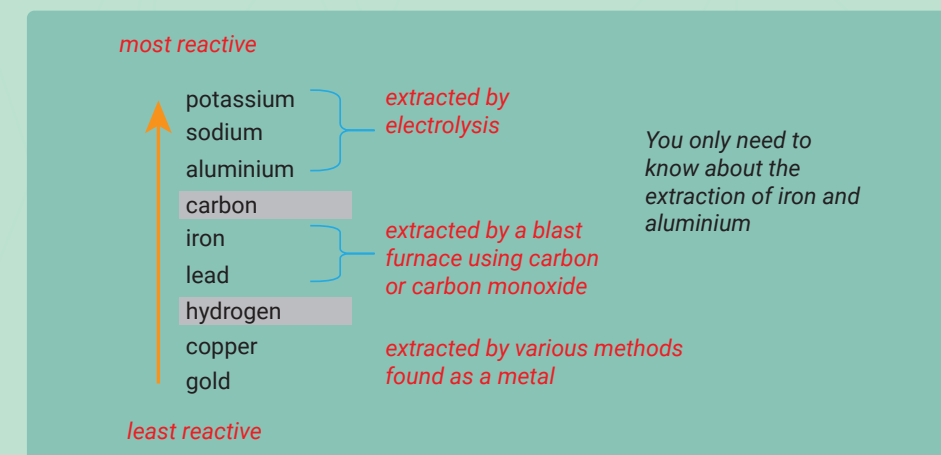
**Metal ores need to be reduced to obtain metal**

**Reduction** - oxygen is removed or electrons added.

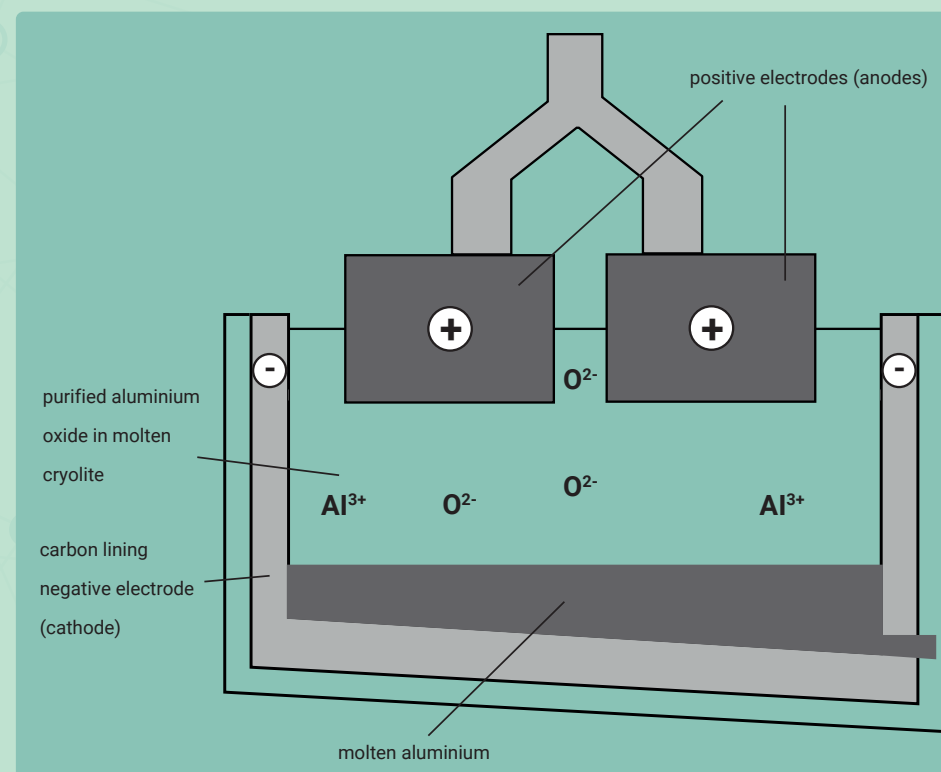
**Oxidation** - oxygen added or electrons are lost.

There is more than one way to reduce a metal ore. The method we use depends upon the reactivity of the metal. The more reactive the metal, the harder it is to reduce. Very reactive metals are extracted using electricity, while less reactive metals are extracted by reduction with carbon.

A simplified reactivity series is shown below.



#### Aluminium extraction



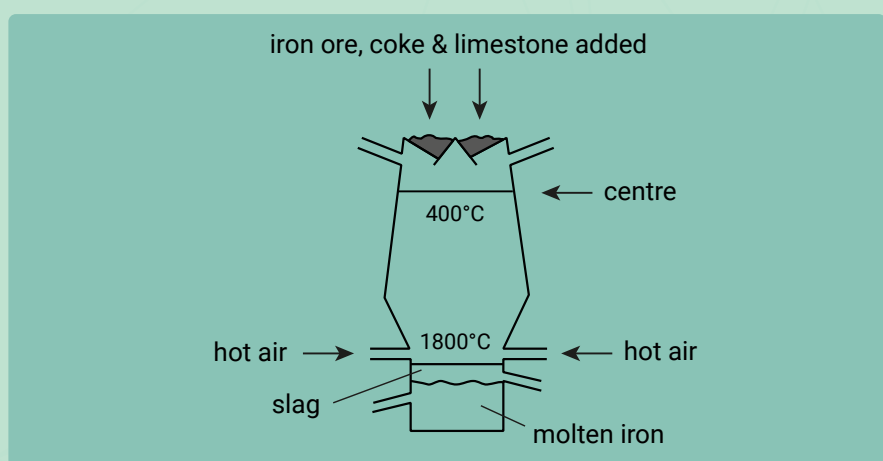
Ore = bauxite

Negative electrode:  $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$  Reduction

Positive electrode:  $2\text{O}^{2-} + 4\text{e}^- \rightarrow \text{O}_2$  oxidation

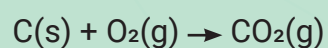
### Iron Extraction

Raw materials needed: haematite; coke; limestone; air



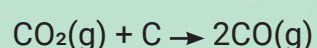
#### Reactions:

carbon + oxygen  $\rightarrow$  carbon dioxide

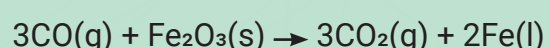


from coke

carbon dioxide + carbon  $\rightarrow$  carbon monoxide



carbon monoxide + iron(III) oxide  $\rightarrow$  carbon dioxide + iron



Iron is formed as a liquid and flows to the bottom of the blast furnace.

Limestone reacts with impurities in the iron to form slag which floats on top of the molten iron.

#### Costs of metal extraction:

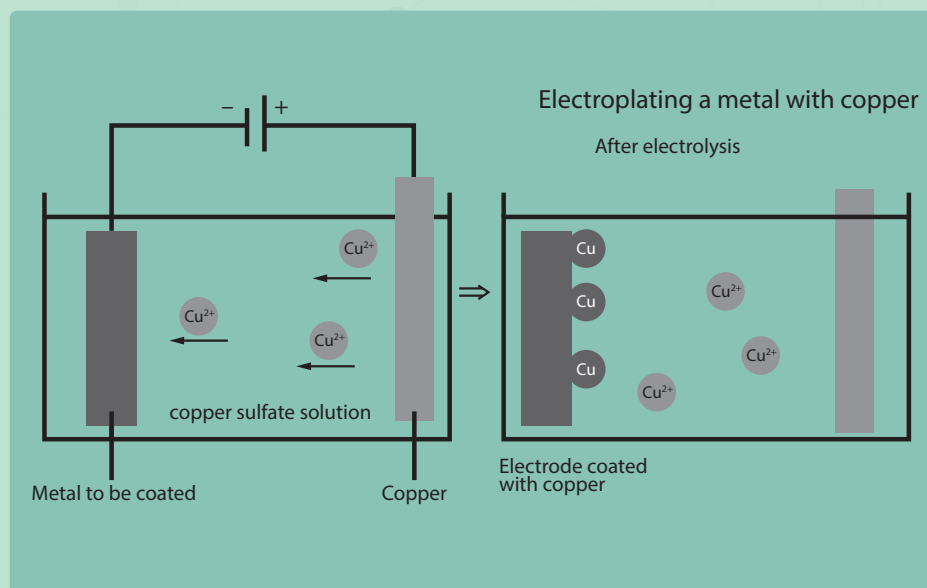
- Labour to obtain and process ore and obtain other raw materials.
- Transportation costs.
- Energy costs.

#### Electroplating

Electroplating is used to coat a cheap metal with a more expensive one, such as copper or silver.

The article to be electroplated is made the cathode and immersed in a solution containing ions of the required metal.

The **anode** is usually a **bar of the metal** used for plating. During electrolysis metal is deposited on the article as metal from the anode goes into solution. Suitable objects that are electroplated include jewellery, cutlery and cookery utensils.



Electroplating is done for:

- Improve the look (decoration)
- Provide resistance to corrosion
- Reduce abrasive wear

#### Fate of products

Most **plastics** made from fossil fuels remain in the environment for a very long time. The environmental impacts of plastics include:

- litter problem - waste plastics are a visible and ugly
- danger to wildlife - some animals mistake plastic for food. The animals may choke to death on plastics
- plastic waste in the oceans - the amount of floating plastics in the world's oceans is growing dramatically.

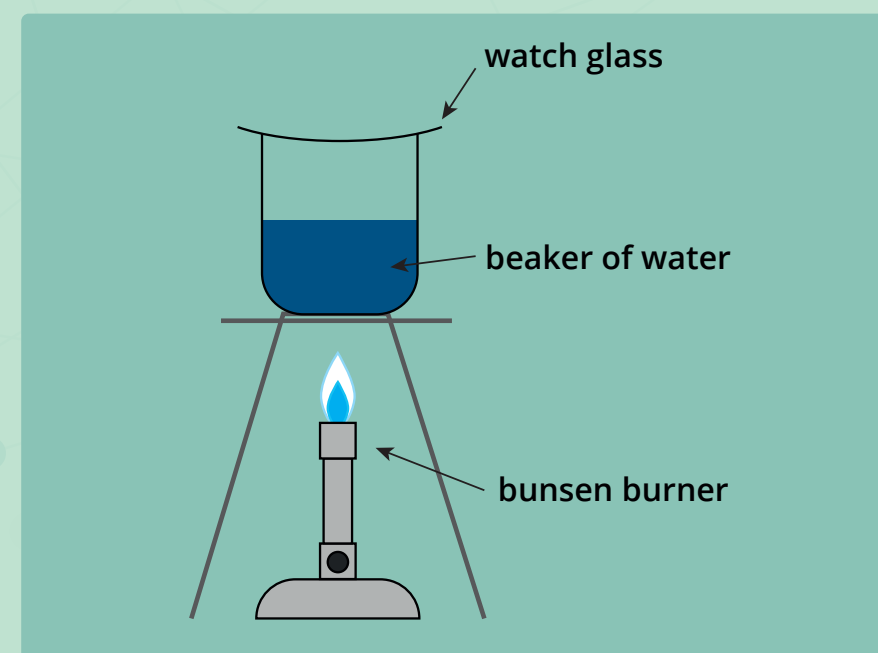
**Biodegradable** plastics can be made which break down due to the action of microbes.

Many **metals corrode** when exposed to air and water e.g. iron. This process is the reverse reaction of the extraction of the metal.

#### Impacts of extracting materials

- mining – spoil heaps
- drilling – oil spills
- fracking – earth tremors, possible contamination of ground water
- bioplastics crops – less ground for producing food

#### Lab preparation of bioplastic (plastic from potato starch)



- Put 20 cm<sup>3</sup> of water into the beaker and add 4 g of potato starch, 3 cm<sup>3</sup> of hydrochloric acid and 2 cm<sup>3</sup> of propane-1,2,3-triol.
- Put the watch glass on top of the beaker boil it gently for 15 minutes.
- Add sodium hydroxide solution dropwise to neutralise the mixture. Test with indicator paper after each drop is added.
- Add a drop of food colouring and mix.
- Pour the mixture onto a petri dish and push it around so that there is an even covering.
- Repeat steps 1-6 without the propane-1,2,3-triol.
- Label the mixtures and leave them to dry out for about 1 day.

**In this experiment** propane-1,2,3-triol. Is a plasticiser. It makes the plastic more flexible.