

Topic 10 AQA Chemistry - Using Resources

- Triple Science Content only in purple
- Triple Science and Higher Content Only in blue

Using the Earth's resources

Why do we use them?

- We use them for **warmth, shelter, food and transport**

We get **natural resources** (from agriculture), providing clothing, food and fuels.

We get **finite resources** (from the earth e.g ocean), processed providing materials and energy.

- **Renewable energy resources:** sources of power that when are replenished, can be used again.
- **Finite resources:** have a supply that is limited, therefore it will end up running out.

Potable Water

Definition:

Potable water is **safe to drink**, but **not pure water** (not just H₂O).

It contains **dissolved minerals and salts** in small amounts that make it safe and pleasant to drink.

To be potable, water must have:

- **Low levels of microbes (bacteria, pathogens)**
- **Low levels of dissolved salts and other contaminants**

Sources of Water in the UK

The source of water depends on **local conditions**:

- **Rainwater** provides freshwater that collects in **lakes, rivers, and reservoirs**.
- In some areas, water is obtained from **groundwater** (from aquifers).
- **Seawater** can be treated to make it potable, but this uses **a lot of energy**.

Making Water Potable

The method depends on the source of the water:

1. Fresh Water (e.g. rivers, lakes)

Treatment steps:

1. **Filtration** – Water is passed through filter beds (sand and gravel) to remove solid particles like leaves, soil, and stones.
2. **Sterilisation** – Chemicals like **chlorine, ozone, or ultraviolet (UV)** light are used to kill harmful microorganisms.

After these steps, the water is potable.

2. Seawater (Desalination)

Used in very dry regions (e.g., the Middle East).

Two main methods:

1. **Distillation** – Boiling seawater and condensing the steam to remove salts.
2. **Reverse Osmosis** – Seawater is forced through a **membrane** that only allows water molecules through, removing salts and impurities.

Both methods require **lots of energy**, making them **expensive** and less sustainable.

Waste Water Treatment

After being used in homes, industry, and agriculture, water becomes **waste water** and must be cleaned before being released back into the environment.

Sources of Waste Water

- **Domestic sewage** (from toilets, sinks, baths, washing)
- **Industrial waste** (from factories and manufacturing)
- **Agricultural waste** (from farms, containing fertilisers or animal waste)

Steps in Waste Water Treatment

1. **Screening:**
Removes large objects (sticks, plastic, leaves) using metal grids.
2. **Sedimentation:**
Water is left to stand so solids sink to the bottom as **sludge**, while lighter waste floats to the top as **effluent** (liquid layer).
3. **Aerobic Digestion (for effluent):**
Air is pumped through the effluent to encourage **aerobic bacteria** to break down organic matter and harmful microbes.
4. **Anaerobic Digestion (for sludge):**
The sludge from the bottom is broken down by **anaerobic bacteria** (without oxygen).
This process produces:
 - **Methane gas** (used as a fuel)
 - **Fertiliser** (from the remaining solid material)
5. **Final Treatment:**
The treated water is released into rivers, lakes, or the sea.
In some cases, it can be further purified for reuse as **drinking water**.

Comparing Water Sources

Source	Advantages	Disadvantages
Fresh water	Low energy use	May need filtration and sterilisation
Seawater (desalination)	Always available	Expensive and energy-intensive
Waste water	Recycled resource	Complex, needs careful treatment

Alternative Methods of Metal Extraction

When **metal ores are low-grade** (contain only small amounts of metal), traditional methods like **mining and smelting** become **expensive and unsustainable**. So, scientists use **biological methods** to extract metals more efficiently.

Bioleaching

Definition:

Uses **bacteria** to extract metals from their ores.

How it works:

- Bacteria feed on the metal compounds in the ore.
- They produce a solution called a **leachate** that contains **metal ions**.
- These metal ions are then extracted using **electrolysis** or **displacement** with a more reactive metal (e.g., scrap iron).

Example:

Copper can be extracted from low-grade copper ores using bacteria.

Advantages:

- Can extract metals from **low-grade ores**.
- **Less energy** and **less pollution** than smelting.

Disadvantages:

- **Slow process**
- **Toxic by-products** may be produced.

Phytomining

Definition:

Uses **plants** to extract metals from the soil.

How it works:

1. Plants are grown on soil that contains metal compounds (e.g., copper).
2. The plants **absorb metal ions** through their roots.
3. The plants are **harvested and burned** to produce **ash** that contains the metal compounds.
4. The metal is then extracted from the ash by **electrolysis** or **displacement**.

Advantages:

- Reduces the need for traditional mining.
- **Environmentally friendly**.
- Can clean contaminated land.

Disadvantages:

- **Slow** and produces **small yields**.
- Burning plants releases **carbon dioxide**.

Why Alternative Methods Are Important

Traditional mining damages the environment (deforestation, pollution).

High-grade ores are **running out**.

Alternative methods allow us to **extract metals sustainably** and reduce waste.

What Is a Life Cycle Assessment?

A **Life Cycle Assessment (LCA)** is used to **assess the environmental impact** of a product throughout its **entire life cycle** — from the extraction of raw materials to disposal.

It helps scientists, companies, and governments decide which products or materials are more **sustainable**.

The Four Main Stages of an LCA

Stage	Description	Environmental Impacts
1. Raw Material Extraction	Obtaining materials from the Earth (e.g., mining metals, drilling for oil, logging for wood).	Uses energy, causes habitat destruction, pollution, and depletion of natural resources.
2. Manufacture and Processing	Converting raw materials into usable products (e.g., refining, forming,	Uses large amounts of energy, produces waste and pollutants.

assembling).

3. Use and Operation	Using the product for its intended purpose.	Energy consumption, emissions (e.g., cars release CO ₂), durability affects lifespan.
4. Disposal	How the product is dealt with at the end of its life (e.g., landfill, recycling, incineration).	Produces waste and pollution; recycling saves materials but uses energy.

Problems With LCAs

- LCAs are **not always completely objective** — they involve **value judgements** about which impacts are most important.
- **Selective LCAs** may ignore certain stages, leading to **biased results** (e.g., companies highlighting only positive aspects of their products).

So, LCAs can be useful for comparison but must be interpreted carefully.

Reducing the Use of Resources

As Earth's population and resource use grow, it's essential to **use resources more sustainably** — so that future generations still have access to them.

Reducing the Use of Natural Resources

Natural resources (like metals, water, and fossil fuels) are **finite** – they will eventually run out.

We can reduce their use through **recycling**, **reusing**, and **sustainable manufacturing**.

Recycling and Reusing Materials

How It's Recycled	Benefits
Metals: (like iron, copper, aluminium) are melted and remoulded into new products.	Reduces need for mining → less pollution and energy use.
Glass: Bottles are reused or melted down and reshaped.	Saves raw materials (sand) and reduces waste.
Paper: Collected and reprocessed into new paper products.	Saves trees, reduces deforestation.
Plastics: Some plastics can be melted and remoulded; others chemically recycled.	Reduces landfill waste and oil use.

Key Idea: Recycling uses **less energy** than producing materials from raw resources, and it helps cut **greenhouse gas emissions**.

What is corrosion?

Corrosion occurs when there are chemical reactions between **a material** and **substances in the environment, causing the destruction of the material.**

Example-

Rusting - requires both **water** and **air** for iron to rust.

How can corrosion be prevented-

By applying a **barrier** separating it from **external substances** that can cause the material to corrode, for example **by painting, or electroplating.**

Aluminium's outer layer is an oxide, which prevents the inner layers from corroding.

What Is Sacrificial protection? - e.g zinc galvanising iron

When the more reactive metal (outer layer metal) donates electrons to the ions of the other metal so it doesn't corrode, therefore protecting it and 'sacrificing' itself.

Alloys

Most everyday metals are alloys

(Metals **mixed** with other metals to make them less soft and more harder/**less malleable**)

E.g Jewellery gold is usually **mixed with silver and zinc and others-** its not pure gold

Bronze is an alloy of **copper and tin - it is used in electrical connectors**

Brass is an alloy of **copper and zinc- used in tools.**

Steel is a mixture of carbon and iron-

Low carbon steels are used for sheeting as they are easily shaped

High carbon steels are used for cutting tools as they are hard.

Stainless steels don't corrode so they are used in cutlery

Ceramics, polymers and composites

How is **Soda Lime glass** made?

- Heated mixture of sand, sodium carbonate, and limestone.

How is **borosilicate glass** made?

- Made from sand and boron trioxide

How are **clay ceramics** made?

- Made from wet clay that is shaped then heated

Polymers-

Low Density Polymers-

Have **weaker** intermolecular forces of attraction, as the chains are further apart from each other.

High Density polymers-

Stronger intermolecular forces of attraction as chains are closer together. Therefore it has a higher melting point.

Thermosoftening polymers-

Made from **tangled** polymer chains.

- Have **weak** intermolecular forces
- Therefore easy to separate
- Therefore less heat/energy needed to break chains

The Haber Process-

Used to manufacture **ammonia**

- Need Nitrogen and Hydrogen
 - Nitrogen is obtained from the air and hydrogen from natural gas
 - The gases are passed over a hot iron catalyst and at a high pressure
 - Hydrogen and nitrogen reacts to form ammonia.
 - The reaction is reversible so ammonia breaks down again into nitrogen and hydrogen.
 - When the ammonia is cooled down, it liquifies
 - The remaining nitrogen and hydrogen are recycled.
- the Haber Process is in dynamic equilibrium- the forward and backward reactions are at the same rate
 - the chemical equation is $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Therefore by increasing pressure, equilibrium shifts to the side with less gas moles (the right side as it only has 2), resulting in more ammonia

The forwards reaction is exothermic, so decreasing the temperature moves equilibrium to the side that is exothermic (to the right), therefore resulting in more ammonia

However it is hard to use these exact conditions, as a low temperature would lead to a very slow rate of reaction, and high pressure to maintain is expensive.

Production and uses of NPK fertilisers

NPK - Nitrogen, Phosphorus, Potassium

NPK fertilisers are mixtures/ formulations of various salts containing specific percentages of the elements

Ammonia can be used to make:
Ammonium Salts
Nitric acid

Potassium chloride, potassium sulphate and phosphate rock can be found by mining.

Phosphate rock is treated with nitric acid or sulfuric acid to produce soluble salts .