GCSE C10 – Using Resources

science chemistry

1) Sustainable Development

- Any development that meets the needs of current generations without compromising the ability of future generations to meet their own needs.
- To improve sustainability we **reduce** amount of raw materials used, **reuse** products or **recycle** them.

2) Finite and Renewable

- Finite resources are resources used up faster than they can be replaced (coal, oil, gas, nuclear).
- Renewable resources can be replaced at the same rate (or faster) than they are being used up (biofuels).
- Biofuels are fuels derived from renewable sources such as plants (e.g. biodiesel).

Natural Product	Synthetic Replacement
Wood (window frames)	PVC
Cotton (clothes)	Polyester

3) Potable Water

- This is water that is safe to drink for humans. It should have sufficiently low levels of dissolved salts and microbes.

Potable water is not pure water as potable water contains dissolved substances.

In the UK, rain provides most of our fresh water that collects in the ground and in lakes and rivers this is then treated by

- Passing the water through **filter** beds
- **Sterilising** (using chlorine, ozone or ultraviolet light).

If supplies of fresh water are limited, desalination of salt water (sea water) can be done by either:

- Distillation (boiling it to removed dissolved salts)
- Reverse osmosis (using membranes that only allows water molecules through).

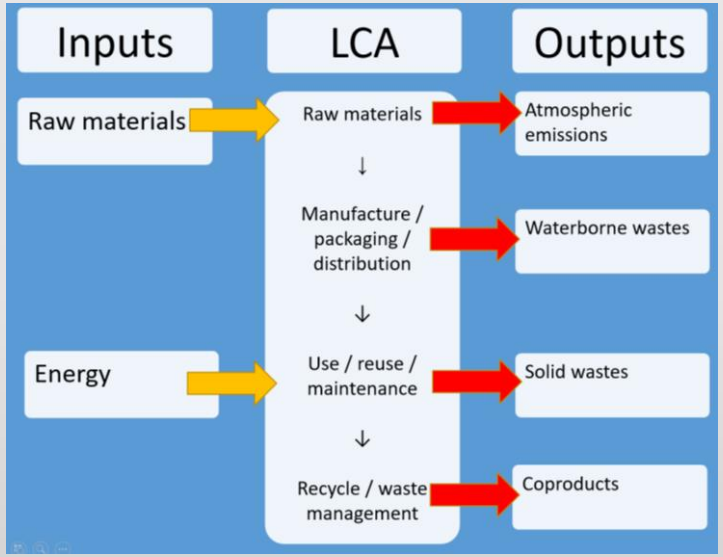
Both these processes require lots of energy.

4) Life cycle assessment and recycling

Life cycle assessments (LCAs) are carried out to assess the environmental impact of a product over it lifetime. We consider each of these stages:

- Extracting and processing raw materials
- Manufacturing and packaging
- Use & maintenance during its lifetime
- Disposal at the end of its useful life.

Use of water, raw materials, energy sources and production of some wastes can be fairly easily quantified. Allocating numerical values to pollutant effects is less straightforward and could be biased by a person's opinion to make their product seem better.



5) Waste water treatment

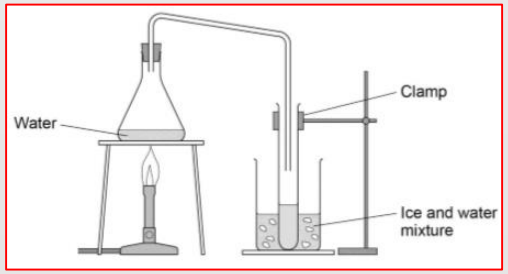
Sewage, agricultural and industrial waste water may require removal of organic matter, harmful microbes and chemicals.

Sewage treatment includes:

- **screening** and grit removal
- **sedimentation** to produce sewage sludge and effluent
- **aerobic biological treatment** of effluent (released back into river)
- **anaerobic digestion** of sewage sludge (used as fuel or fertiliser)

Required Practical – Water purification & analysis

- Measure the mass of the water before & after heating to dryness to determine the mass of dissolved solids.
- Universal indicator can be used to measure the pH.
- Cobalt chloride paper tests for water (changes from blue to pink). It does not tell you if the water is safe to drink.



6) Ways of reducing the use of resources

- The **reduction** in use, **reuse** and **recycling** of materials reduces the use of limited resources, energy sources, waste & environmental impacts.
- Much of the energy for the processes comes from limited resources. Obtaining raw materials from the Earth by quarrying and mining causes environmental impacts.
- Glass bottles can be crushed and melted to make different glass products.
- Metals can be recycled by melting and recasting / reforming into different products (e.g. scrap steel can be added to iron from a blast furnace to reduce the amount of iron ore used.

7) Alternative methods of extracting metals (HT only)

Copper ores are becoming scarce and new ways of extracting copper from low-grade ores are needed

- **Phytomining** uses plants to absorb metal compounds. The plants are harvested and then burned to produce ash that contains metal compounds.
- **Bioleaching** uses bacteria to produce leachate solutions that contain metal compounds.

Copper can be obtained from solutions of these metal compounds by displacement using scrap iron or by electrolysis.

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GCSE C10 – Using Resources (Single Chemistry ONLY)

8) Corrosion and its prevention

- Corrosion is the destruction of materials by chemical reactions with substances in the environment.
- Rusting is an example of iron corrosion. Both air and water are needed.
- Corrosion can be prevented by applying a coating that acts as a barrier, such as greasing, painting or electroplating. Aluminium has an oxide coating that protects the metal from further corrosion.
- Some coatings are reactive & contain a more reactive metal to provide sacrificial protection, e.g. zinc is used to galvanise iron. Zinc is more reactive so will oxidise first so the iron doesn't form iron oxide

9) Alloys

- An alloy is a mixture of 2 or more metals.
- Most metals in everyday use are alloys (e.g. bronze is an alloy of copper & tin whereas brass is an alloy of copper & zinc).
- Gold jewellery is usually an alloy with silver, copper and zinc. The amount of gold in the alloy is measured in carats. 24 carat being 100 % (pure gold), and 18 carat being 75 % gold.
- Aluminium alloys are low density (e.g. used in aircraft).
- Steels are alloys of iron that contain specific amounts of carbon and other metals.

Steel	Properties
High carbon steel	Strong, brittle
Low carbon steel	Softer, easily shaped
Stainless steel (chromium & nickel)	Hard, resistant to corrosion

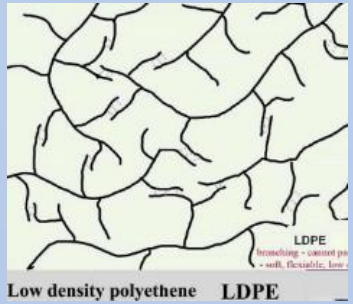
10) Glass & Ceramics

- Most glass is soda-lime glass, made by heating a mixture of sand, sodium carbonate and limestone. Borosilicate glass, made from sand and boron trioxide, melts at higher temperatures than soda-lime glass.
- Clay ceramics, including pottery and bricks, are made by shaping wet clay and then heating in a furnace

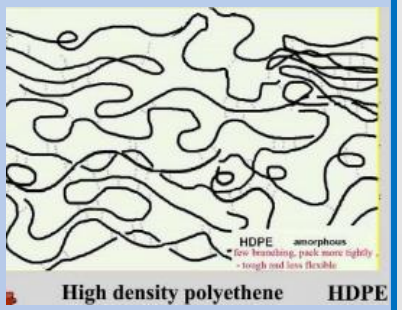
11) Polymers

Properties of polymers depend on what they are made from and the conditions in which they are made.

- Low Density Polyethene (LDPE) is soft and flexible and the polymers are branched so they can't pack tightly together. LDPE made by heating ethene under very high pressure.
- High Density Polyethene (HDPE) is rigid as the polymers pack much more tightly together. HDPE is made by heating ethene at lower temp & pressure with a catalyst.



Low density polyethene LDPE



High density polyethene HDPE

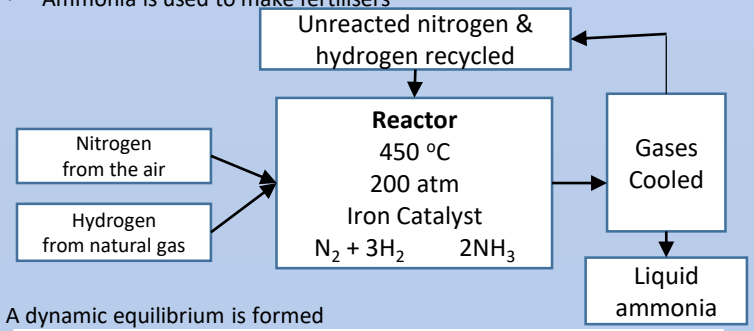
- **Thermosoftening** polymers melt when they are heated. This is because the polymers consist of individual tangled polymer chains with weak forces between the chains.
- **Thermosetting** polymers do not melt when they are heated. This is because the polymers are cross-linked making them harder and less likely to change shape when heated.

12) Composites

- Most composites are made of two materials, a matrix or binder surrounding reinforcement fibres or fragments of the other material.
- Examples include fibreglass, concrete, carbon fibre, wood

13) The Haber Process

- Used to make ammonia (NH_3)
- Ammonia is used to make fertilisers



A dynamic equilibrium is formed

Condition	Rate	Equilibrium shifted	Yield
High temperature	Increases	Left (backwards reaction is endothermic)	Decreases
High Pressure	Increases	Right (less moles)	Increases

- 450^{0}C is a compromise between rate and yield. 200 atmospheres is a high pressure that is still safe and not too expensive.

14) Production and uses of NPK fertilisers

Compounds of nitrogen, phosphorus & potassium are used as fertilisers to improve agricultural productivity. NPK fertilisers are **formulations** used to replace essential elements in the soil.
Plants absorb through their roots so fertilisers must be soluble in water.
To grow well plants need nitrogen, phosphorus and potassium.
e.g. NPK 16-4-10 would mean 16% nitrogen and so on.

Ammonia is an alkaline gas that dissolves in water to produce ammonium hydroxide.
Ammonia can be mixed with nitric acid to make ammonium nitrate to increase the amount of nitrogen in the soil.

Ammonia + nitric acid → ammonium nitrate
$NH_3 + HNO_3 \rightarrow NH_4NO_3$

Potassium chloride, potassium sulfate and phosphate rock are obtained by mining, but phosphate rock cannot be used directly as a fertiliser.
Phosphate rock is treated with nitric acid or sulfuric acid to produce soluble salts that can be used as fertilisers.
e.g. The rock can be treated with nitric acid (HNO_3) to produce phosphoric acid (H_3PO_4) and calcium nitrate ($Ca(NO_3)_2$).
If sulfuric acid was used instead, phosphoric acid and calcium sulfate ($CaSO_4$) would be produced instead.