Ceramics:

Non-metals with high bp, insulators, not made from carbon-based compounds
Clay is moulded & fired at high temps = it hardens (good for pottery & bricks)
Glass (soda lime glass) made by melting & cooling, borosilicate glass has higher mp

Composites:
Reinforcement (fibres) surrounded by a matrix (binder) for strength & low density
E.g. Fibre glass (glass fibres encased in plastic) for boats
Carbon fibres have a polymer matrix for sports car manufacture
Concrete made from aggregate & cement for buildings
Wood has cellulose fibres encased in an organic polymer matrix

Properties:

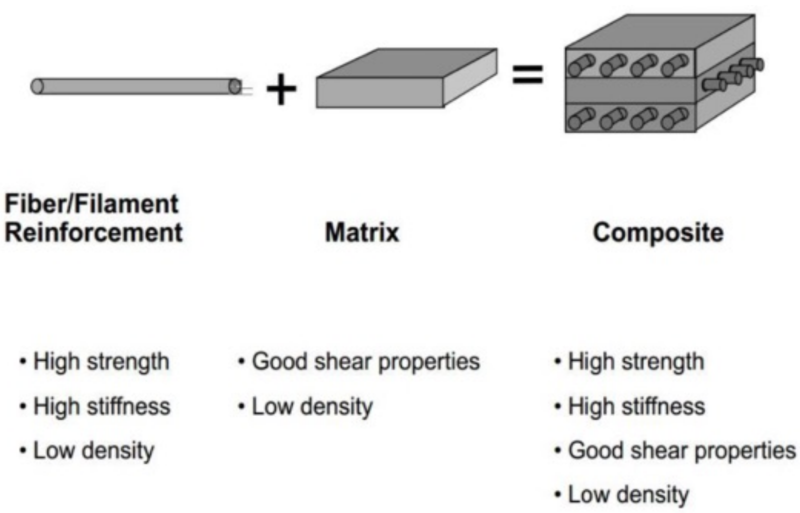
Depend on catalyst & reaction conditions (temp & pressure)
LD polyethene = moderate temp & high pressure (for bottles & bags as flexible)
HD polyethene = lower temp, catalyst (for water tanks as rigid)

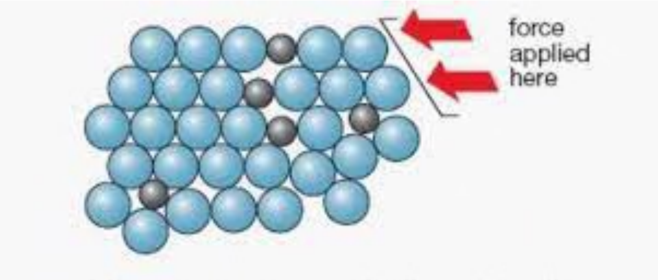
Monomers determine bonds formed, weak bonds incl:

Thermosoftening polymers: chains entwined for melting & remoulding

Thermosetting polymers: solid structures, DONT soften when heated = strong & rigid

Metals:
Malleable, ductile & conductors





Slip cannot occur so easily in an alloy, because the structure has been distorted

Alloys:

Different type/sized atoms distort layers for strength e.g.
Bronze (Copper + tin) for medals
Brass (Copper + zinc) for taps (lower friction required)
Gold (soft so alloys make it durable) e.g 18 carat gold (24 carat= pure gold)
Aluminium (low density & strong) for aircraft

Corrosion:

Iron's surface 'rusts' in contact with water & oxygen in the air

Iron + Oxygen + Water -> Hydrated iron oxide

Iron at surface flakes away so whole metal corrodes

Aluminium oxide doesn't flake off (forms protective layer to prevent further corrosion)

Iron nail in a boiling tube with air AND water = rusts (only with both)

Preventing corrosion:

Coating
Electroplating: electrolysis reduces metal ions onto an iron electrode
Oiling

Sacrificial method: reacting iron with a more reactive metal (which corrodes, protecting the iron)

Galvanising: coat in zinc (protective) but when scratched, acts as a sacrificial metal

Finite & Renewable resources:

Natural e.g. cotton or oil can be replaced by synthetic processes e.g. rubber from tree sap replaced by man made polymers
In agriculture, using fertiliser increases crop yields

Renewable resources reform as we use them e.g. timber
Finite will run out e.g. fossil & nuclear fuels + minerals in ores
Fractional distillation separates fractions of crude oil & reduction in ores produces a pure metal

Risks of extraction:

Economic benefit of jobs & products but mining scars landscape, destroys habitat & reduces biodiversity

Reuse & Recycling:

Sustainable development: provides for current needs whilst not jeopardising reserves for future generations

Extraction is energy intensive (energy from fossil fuels) & wasteful
Catalysts reduce energy requirement for industrial processes, thus conserving energy

High-grade copper ores= finite & in SHORT supply so exact from low-grade ores via:

Bioleaching: bacteria converts copper in ores into soluble compounds = copper is separated from ore.
Leachate has copper ions, extracted via electrolysis/displacement with scrap iron (more reactive.)
Phytomining: grow plants in copper rich soil then burn plants, copper in ash extra extracted via electrolysis.

Recycling:
Less energy intensive than fossil fuel extraction, conserves resources & saves waste going to landfill
Metals: melting & casting used to reshape for recycling
Amount of separation dependent on material e.g. steel + iron added to blast furnace together (reducing amount of iron ore required)

Glass recycling:
Reusing bottles
Glass separated by colour & composition 4 recycling before it's crushed & melted to reshape for a desired function e.g. glass wool for wall insulation

Life cycle assessments:

LCA assesses ENVIRONMENTAL impact, NOT economic

1. Raw materials extraction: mining = pollution & habitats destroyed, processing = energy intensive e.g. fractional distillation

2. Manufacture & packing: energy intensive & pollution from chemicals, disposing waste = landfill or converted into useful chemicals

3. Usage: combustion of fossil fuels = pollution, fertilisers leach into rivers = disrupt ecosystems, long lifespan = less waste in long run

4. Disposal: landfill pollutes water, transport pollutes, incineration = pollution

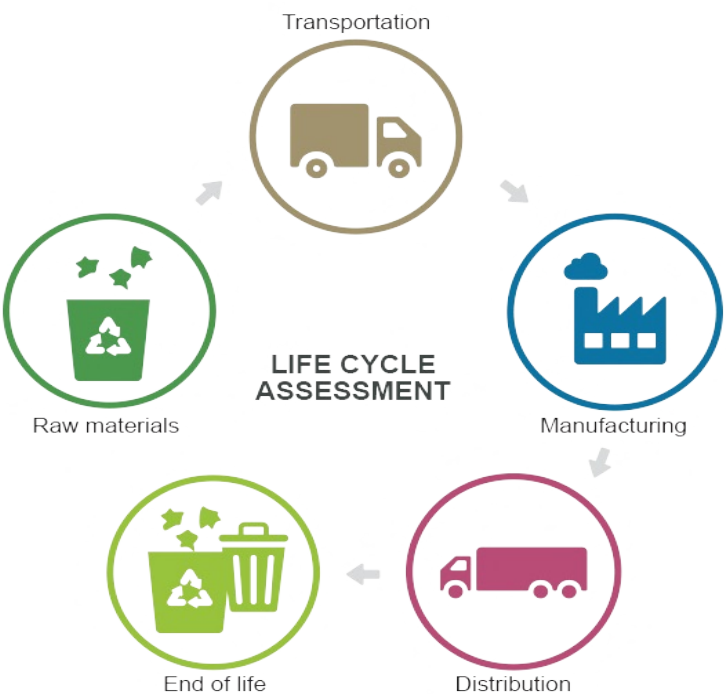
Issues with LCA:

Stages are easily quantified but effect is complex = not OBJECTIVE (biased), selective LCAs done to enhance a business' reputation

Comparison of LCA:

Plastic bag: crude oil-> fractional distillation, cracking & polymerisation but reusable, although cannot biodegrades so pollutes in landfill
Paper bag: timber-> pulping is energy intensive, one-use, biodegradable & recyclable

Does longevity outweigh manufacturing & disposal issues?



Potable water:

Treated so safe for humans, not pure as contains dissolved substances e.g. mineral ions (can't be too high), pH = 7 to kill bacteria

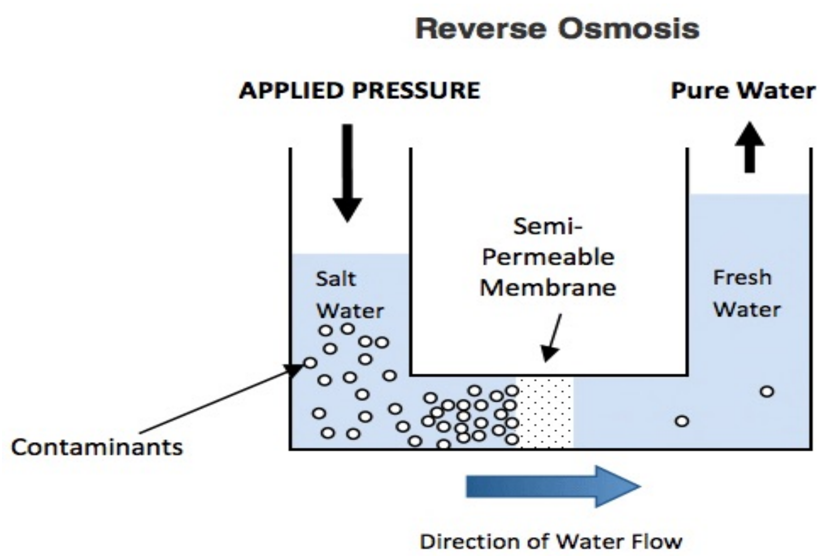
Rainwater collected as surface (lake) or groundwater (aquifers.) UK: In the South, surface water dries up (higher temp) so majority from groundwater

Water treatment:
Filtration- mesh wire screens out twigs & sand beads filter out gravel
Sterilisation- chlorine, UV & ozone to kill microbes

Dry countries desalinate sea water to provide potable water via distillation:

1. Neutralise water via titration (use pH measure not indicator= no contamination)
2. Flame test for sodium (turns yellow) & for chloride with nitric acid (white precipitate forms)
3. Heat in a flask, water evaporates & condenses & dissolved salts remain via distillation
4. Retest pH (has to be neutral) to ensure removal of sodium chloride

Reverse osmosis:
Salty water passed through membranes, ions are trapped & separated
Distillation & Reverse osmosis = ENERGY intensive to expensive
Saudi Arabia imports potable water



Water waste treatment:

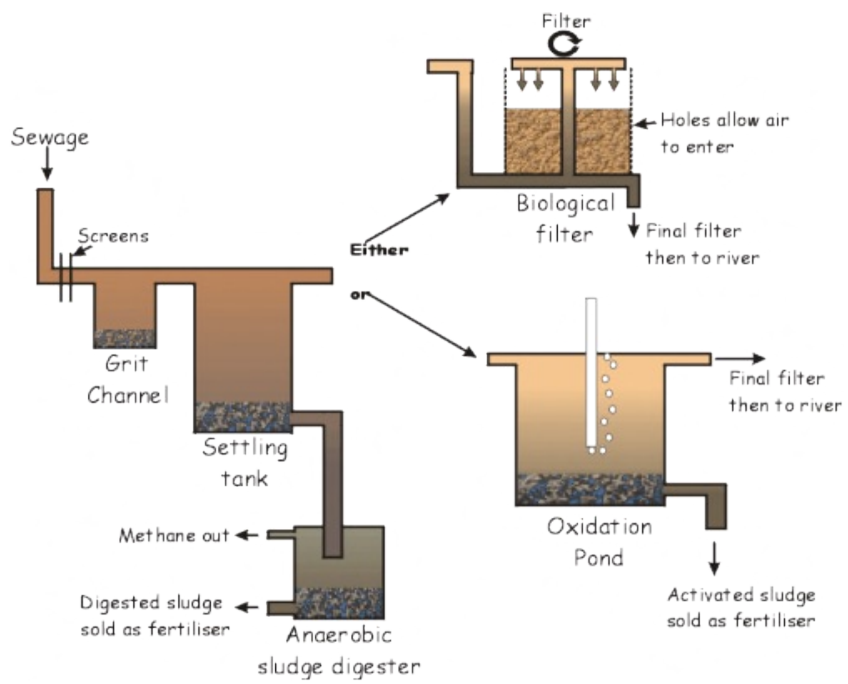
Water sources:

'Used' water (for cooking & bathing) goes to sewage treatment plants
Waste from nutrient run-off & slurry from farms = water produced
Organic matter & microbes are removed, then water is pumped into lakes
Haber process produces waste water (purified as contains chemicals)

Sewage treatment:

1. Screening (removes twigs & grit)
2. Stands in settlement tanks till Sedimentation (sludge sinks, effluent rises)
3. Effluent removed via aerobic digestion
4. Sludge transferred to large tanks & is broken down via anaerobic digestion, releasing CH_4 (used as energy source) & digested waste as a fertiliser
5. Toxic substances removed by chemicals, UV & membranes

Sewage processes are less energy intensive than desalination but more so than freshwater treatment
Singapore treats waste water & recycles it into drinking supplies



Haber Process:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + \Delta H$$

$$\Delta H = -92kJ\ mol^{-1}$$

Industrial scale as reactants are cheaper in bulk:
Nitrogen from air (which is 72% nitrogen)
Hydrogen from reacting methane with steam = forms hydrogen & CO2

Conditions to increase reaction rate:
Iron catalyst
450 degrees cel temp
200 atmospheres = high pressure

Reversible reaction (ammonia converts into hydrogen & nitrogen again) = dynamic equilibrium reached

Ammonia condenses, unused hydrogen & nitrogen are recycled

Used to make NPK Fertiliser

Compromise:

At a low temperature, forward reaction is favoured = higher ammonia yield but slower reaction rate
450 degrees cel = compromise between max yield & speed of reaction

At high pressures, forward reaction is favoured to maximise percentage yield so 200 atmopeheres is used (so isn't too expensive for yield produced)

Iron catalyst increases rate of reaction

NPK fertiliser:

Nitrogen, Phosphorus & Potassium needed for growth so fertilisers replace/increase nutrients 2 increase productivity + crop yield
Formulated fertilisers: cheap & widely available

Ammonia + Oxygen + Water -> nitric acid
Ammonia + acids -> ammonium salts

Ammonia + nitric acid -> ammonium nitrate
= good fertiliser as has nitrogen from 2 sources

$$2N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Nitrogen Hydrogen Ammonia

Industry:
Giant vents at high concentrations= exothermic reaction so heat released evaporates water = concentrated solution

Lab:
Titrations & crystallisation = smaller scale, reactants at low concentrations (safer as less heat), crystallisation = pure ammonium nitrate crystals (very slow)

Phosphate & Potassium are mined:
Phosphate rock = insoluble so plants cannot use as nutrients
Phosphate rock + acid -> soluble phosphates
E.g. nitric acid: phosphoric acid + calcium nitrate
Sulphuric acid: calcium sulphate + calcium phosphate
Phosphoric acid: calcium phosphate