# C2

**Rates of reaction:** Can be measured by reactant decrease/time or product increase/time (g/s or $cm^3$/s)

| | |
|---|---|
| **Temperature** | Increased Kinetic energy = more frequent and energetic collisions |
| **Pressure and concentration** | More particle in given volume = more frequent collisions |
| **Surface area** | More exposed particles = more frequent collisions |
| **Catalysts** | Lower activation energy (provide a different reaction pathway)<br>Do not get used up<br>Enzymes are biological catalysts |

**Reversible reactions**: A+ B ⇌ C+D e.g. ammonia chloride ⇌ ammonia + hydrogen chloride
Endothermic in one direction and Exothermic in the other
Equilibrium = forward and backward reaction occur at same rate if gases can not escape

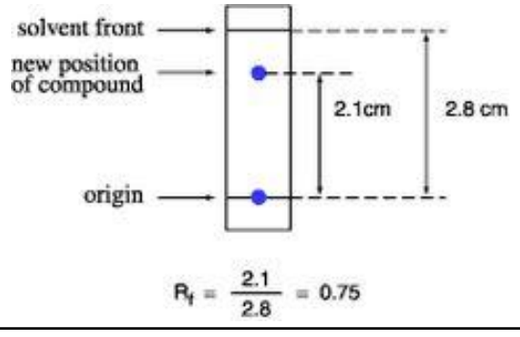
hydrated copper sulfate ⇌ (endothermic / exothermic) anhydrous copper sulfate + water

**Dynamic Equilibrium** (HT)

| | | |
|---|---|---|
| **Reactant Concentration** | Concentration increase | **Products** increase |
| | Concentration decrease | **Reactants** increase |
| **Temperature** | Temperature increase | **Endothermic** direction product increase |
| | Temperature decrease | **Exothermic** direction product increase |
| **Pressure** | Pressure increase | Side with **smaller** number of molecules increases |
| | Pressure decrease | Side with **larger** number of molecules increase |

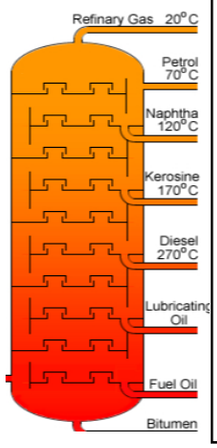
**Pure substance:** single element or compound – specific melting and boiling points
**Formulation**: a mixture that has been designed as a useful product – fuel, paint, medicine, alloy, food

**Chromatography**
Used to separate mixtures. Different compounds have different Rf values
Stationary phase → mobile phase
**Rf = Distance moved by substance / distance moved by solvent**

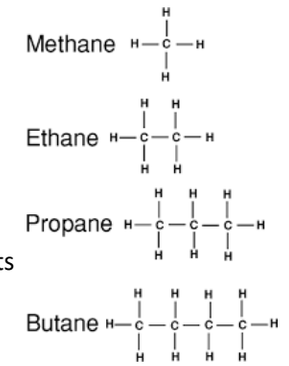



| Substance | Test | Positive Result |
|---|---|---|
| **Hydrogen** | Burning splint | Squeaky pop |
| **Oxygen** | Glowing splint | Splint relights |
| **Carbon dioxide** | Limewater | Turns cloudy |
| **Chlorine** | Damp Litmus paper | Turns white |

**Instrumental methods** provide fast, sensitive and accurate analysis




**Crude Oil**
Finite resource found in rocks. Crude oil is made of ancient biomass (mainly plankton) that was buried in mud
Mixture of hydrocarbons (compound of hydrogen and carbon)




**Fractional distillation** used to separate the fractions
- Heat crude oil and fractions evaporate
- Fractions cool and condense
- Different fractions boil at different boiling points

Fractions include petrol, diesel oil, kerosene and feedstock for the petrochemical industry such as solvents, polymers, lubricants and detergents

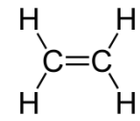
Crude oil mostly **Alkanes:** As the molecular size increases;
- **Boiling point increases**
- **Viscosity increases**
- **Flammability decreases**

$C_nH_{2n+2}$

Hydrocarbon + oxygen → Water + Carbon dioxide

**Cracking:** Splitting up a long hydrocarbon to make **small hydrocarbons for fuel and alkenes to make plastics**
**Catalytic cracking** – pass over a hot catalyst, **steam cracking** – mix with steam and heat

**Alkenes** have C=C double bond. They are more reactive and flammable than alkanes
Bromine water will turn colourless with an alkene
Alkenes can make **polymers e.g.** Many Ethene make poly(ethene)



$C_nH_{2n}$

**Atmosphere changes**
For the last **200 million** years: 78% N, 21% $O_2$, 1% other: water vapour, noble gases and $CO_2$

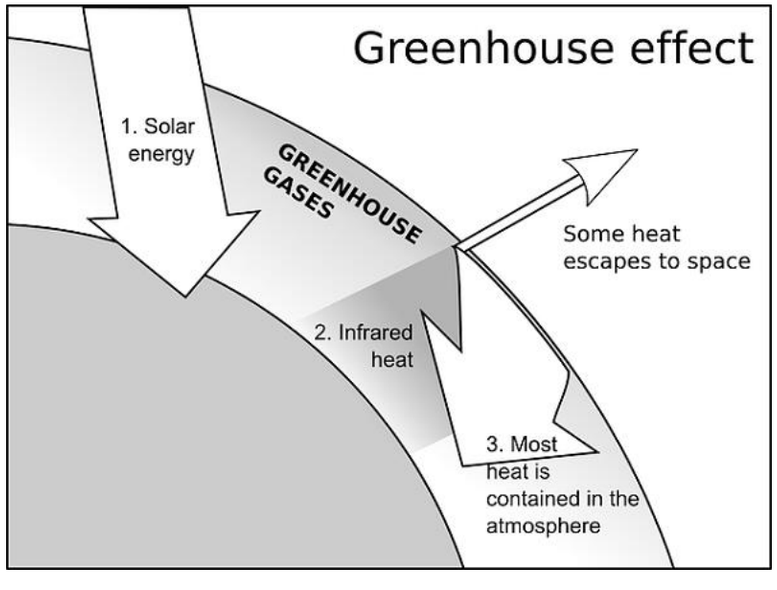
**4.6 Billion years ago:**
1. Volcanoes gave out **methane, nitrogen, ammonia, $CO_2$ and steam** for 1 billion years
2. Water condensed to form oceans
3. Carbon dioxide dissolved in the oceans
4. Sedimentary rocks of carbonate (limestone) and fossil fuels produced - $CO_2$ in atmosphere went down

**2.7 Billion years ago:**
5. Plants grew and photosynthesised- $CO_2$ went down and $O_2$ went up
6. Animals could now evolve

Now $CO_2$ is increasing again – Global warming, oceans becoming acidic

**Greenhouse Effect**
Greenhouse gases include water vapour, carbon dioxide and methane – keep temperature warm enough on Earth for life

Earth absorbs electromagnetic radiation with **short wavelength**
Heat is radiated with a **longer wavelength** and so can not escape




**Global Warming**
**Cause:** Human activities increase carbon dioxide levels – deforestation, burning or fossil fuels
**Consequence:** Polar ice caps melt, sea level rises, flood, droughts. Changing habitats can lead to changing migration patterns and famine
**Solution:** reduce our **carbon footprint** (total amount of carbon dioxide emitted over the full life cycle of a product, service or event)
Use renewable energy, walk rather than drive, insulate homes (difficult to convince public to do this due to cost or desire to maintain a certain quality of life)

Evidence has been **peer reviewed** – however difficult to model complex systems. **Speculation and opinion** in media can be **biased**

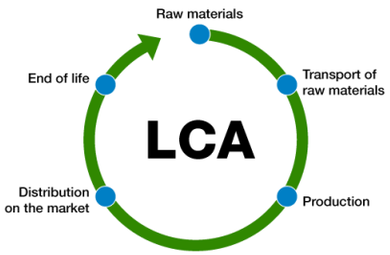
**Other pollutants**
**Complete combustion:** Fuel + oxygen → water + carbon dioxide
**Incomplete combustion:** Fuel + oxygen → water + **carbon monoxide or carbon particulates (soot)**

**Carbon monoxide –** toxic gas that stops oxygen getting to cells, colourless and odourless – difficult to detect
**Particulates – global dimming** – health problems for human, blocks the suns light
**Sulfur dioxide – acid rain** - kills plants and aquatic animals. Damages limestone buildings
**Oxides of Nitrogen –** breathing problems

**Sustainable development**
Development that meets the needs of the current generation without damaging future generations
**Finite** resources will run out
Natural products can be replaced with agricultural or **synthetic** products
e.g. natural manure → synthetic fertiliser made by chemists or cotton →nylon

**Life Cycle Assessment**
Assess the environmental impact of products (including **transport**)
1. **Extracting** and processing raw material
2. **Use** of product
3. **Disposal** of product

Give numerical values to each stage to allow comparison




Problems:
-allocating numbers is **not objective** (we will all have different opinions)
-If LCAs are selective in the information they give or abbreviated (short versions) they can be misused or **biased**

**LCA Example**
**Plastic Bag**
1. Raw material is crude oil, fractional distillation and cracking and transport use lots of energy (9)
2. Can be reused, do not release carbon dioxide (2)
3. Do not biodegrade but can be recycled (6)

Total = 17/30

**Paper Bag**
1. Raw material is trees that are renewable (3)
2. Can be not be reused many times (4)
3. Biodegradable, recyclable (2)

Total = 9/30

**Reduce, Reuse, Recycle**


1. + Limits quarrying
2. + Limits mining
3. + Less use of crude oil
4. + Less carbon dioxide emissions
5. + Less landfill

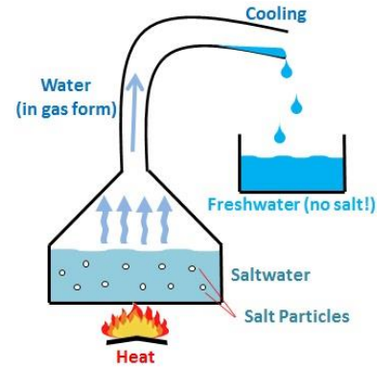
- Recycling requires collection, transport, sorting
- Difficult to get the public to recycle
- Reuse can be limited if the product is damaged or rusty

**Other Resources**
Glass, Clay ceramics and most plastics made from limited resources. To process them requires energy (electricity) which also comes from finite resources

**Metals** can be **recycled** by **melting and recasting and reforming**
**Glass** can be **recycled** by **crushing, melting and reforming**

**Water**
**Potable Water –** Safe to drink. Not pure water. It has low levels of dissolved salts and microbes.

Making Potable water from lake ground water:
1. **Fresh ground water** collects in lakes in rivers
2. Water passed through **filter beds**
3. **Sterilize with chlorine, ozone or UV light**




**Desalination** (Making potable water from sea water)
1. Boil, evaporate and condense the water (**Distillation**)
2. Or "**Reverse osmosis**" – to separate the salt from water

Both methods require a lot of energy – costly and releases carbon dioxide emissions when electricity used

Making potable water from **Sewage:**
1. **Screening** removes grit
2. **Sedimentation** separates sewage sludge (solid waste) and effluent (Liquid waste)
3. **Anaerobic digestion of sewage sludge** – biogas or dried sludge can then be used as a renewable energy
4. **Aerobic biological treatment of effluent** (Bacteria and oxygen added so that matter can be decomposed)

**Alternative Metal extraction methods**
**Phytomining**
1. Plants absorb copper from low grade ores (where there is very little copper in them)
2. Plants harvested and burnt
3. Ash contains metal compounds

+ Avoids mining of metal, decontaminates polluted land, carbon neutral
- May require fertiliser, slow, metal compounds still need to be purified

**Alternative Metal extraction methods**
**Bioleaching**

1. Bacteria used on low grade ores
2. Leachate (waste) produced that contain metal compound

+ Avoids mining of metal, no carbon dioxide or sulphur dioxide produced
- Metal compounds still need to be purified, can produce toxic substances

**Alternative Metal extraction methods**
**Displacement**
A more reactive metal is added to purify
Copper oxide + iron → iron oxide + copper

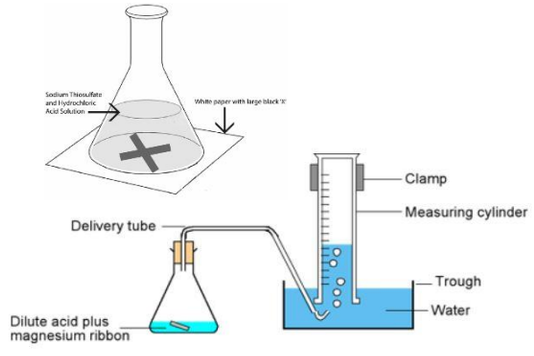
**Electrolysis:**
Liquid ionic compound (melted or dissolved) split using electricity e.g. Aluminium oxide

+ Can be the only method of metal extraction for reactive metals
-Requires lots of energy
- costly and releases carbon dioxide emissions when electricity used

**RP2: Chromatography**: See calculation on **Rf value** on previous page
Use pencil to draw line as it will not dissolve in the solvent
Pigment you are testing must be above the solvent line so that they are not washed away.
Lid is used to avoid evaporation
Small particles move the smallest amount of distance

**RP1a: Rates of Reaction:** The effect of **concentration** on the rate of reaction
Sodium thiosulfate + hydrochloric acid = product turns the liquid cloudy and the cross disappears
IV: Concentration of acid, DV: Time taken for the reaction to happen CV: Volume, Temperature
Repeat, remove anomalies, calculate mean. Compare to others to prove if they are **reproducible**
Problems: Subjective – some see the cross for longer

**RP1b Rates of reaction:** The effect of **temperature** on the rate of the reaction
Magnesium + hydrochloric acid → magnesium chloride + hydrogen
IV: Temperature, DV: Volume of gas collected, CV: Concentrations, volume and mass, time
Repeat, remove anomalies, calculate mean. Compare to others to prove if they are **reproducible**
Problems: Gas could escape and not be measured. Syringe would have a higher resolution than Measuring cylinder




**RP3a: Water Purification – measuring the amount of dissolved solids**
1. Check the pH of the water samples
2. Weight the mass of each water sample
3. Heat each sample until the water has evaporated
4. Weigh the dissolved solid crystals left behind

**RP3b: Water Purification by distillation**
1. Boil and evaporate the water
2. Cools and condense the water vapour
3. Collect the distilled water