Collision Theory	Factors affecting rates	Calculating rates	Collecting gas compulsory practical	Precipitation compulsory practical	Reversible reactions and equilibrium	Factors affecting Equilibrium	Haber process	Check 20	Misconceptions

Key Words

Key Word	Definition
Activation energy	Minimum amount of energy the particles must have to react
Concentration	Number of particles in a given volume
Collisions theory	In order for particles to react they must collide with the activation energy
Catalyst	A substance that speeds up a chemical reaction without being used up
Enzyme	Biological Catalyst
Reversible reaction	A reaction that can go forwards and backwards ⇌
Equilibrium	When the forwards and backwards reaction, happen at the same rate in a closed system

Misconceptions

Volume does not affect the rate of reaction. Temperature, concentration, surface areas and catalysts affect the rate of reaction.

More collisions doesn't mean a faster rate of reaction. More 'frequent' collisions means there are more collisions per unit of time.

During equilibrium the forwards and backwards reaction happen at the same rate in closed system. The reactions happen at the same time, but the key thing is the rate.

Key questions

State the definition for equilibrium

What factors affect the rate of a chemical reaction?

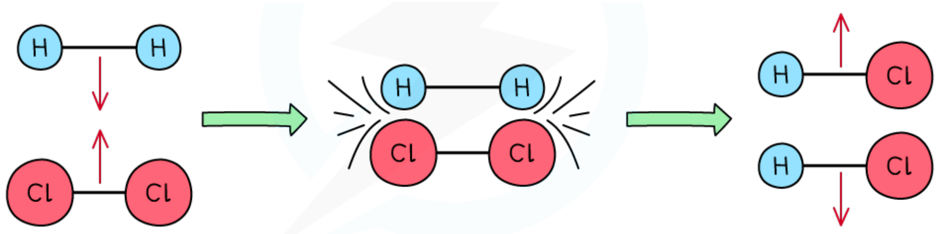
Give an example of a catalyst

Chemistry Topic 6 - Rates of Reaction T Paper 2:KS4

Collision theory

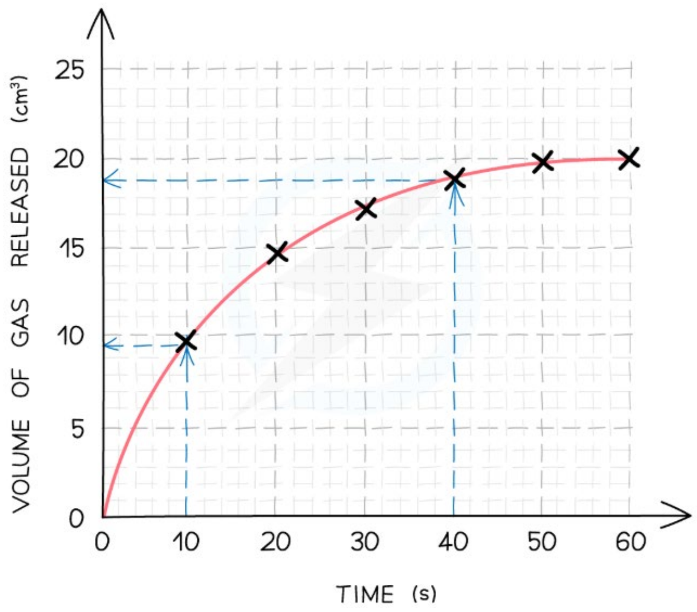
Chemical reactions can occur only when reacting particles collide with sufficient energy.

The amount of energy they need is referred to as activation energy → minimum amount of energy particles must have to react



If particles collide without the activation energy, they do not react

Calculating mean rates from graphs



1. Work out difference in volume
2. Work out difference in time
3. $\frac{\text{Difference in volume}}{\text{difference in time}}$

e.g., $10 \div 30 = 0.33 cm^3/s$

Calculating Rates

To find the rate of a reaction you need to measure the quantity of a reactant used or the quantity of a product formed over time

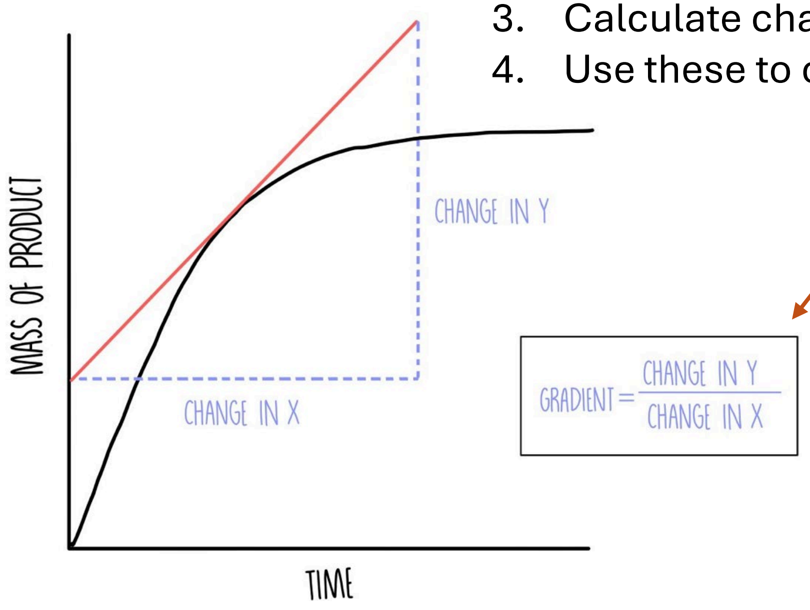
$$\textit{mean rate of reaction} = \frac{\textit{quantity of reactant used}}{\textit{time taken}}$$

$$\textit{mean rate of reaction} = \frac{\textit{quantity of product formed}}{\textit{time taken}}$$

Units for this: g/s or cm^3/s

Calculating rates at specific times from graphs

1. Draw a tangent at the time
2. Calculate change in Y
3. Calculate change in X
4. Use these to calculate gradient



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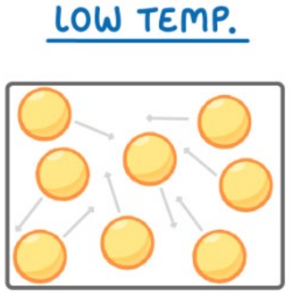
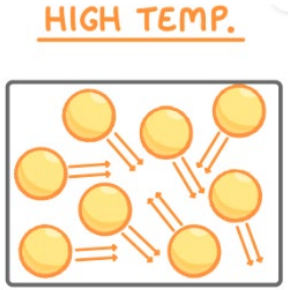
Factors affecting rates

Temperature



Increasing the temperature, increases the rate of reaction

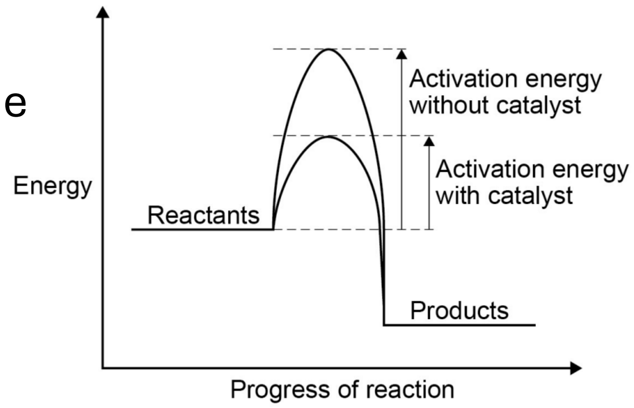
This is because the particles have more energy, so move faster. Resulting in more frequent, successful collisions (more particles have the activation energy)



Catalysts

Using a catalyst, increases the rate of reaction

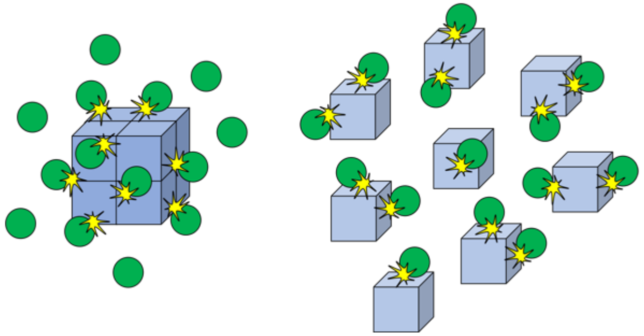
Catalysts provide an alternative route for the reaction to happen, that requires less activation energy



Surface area

Increasing the surface area, increases the rate of reaction

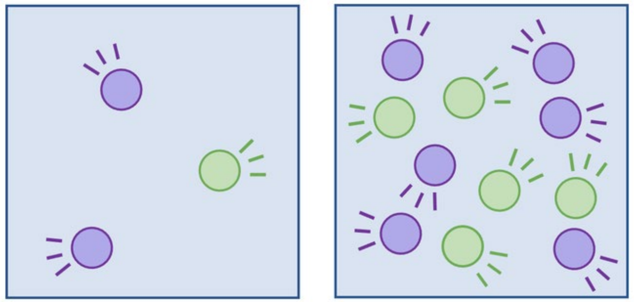
This is because there are more particles available to react so there will be more frequent collisions



Concentration

Increasing the concentration, increases the rate of reaction

This is because there are more particles in the same volume, which means the particles are closer together, resulting in more frequent collisions



Low Concentration High Concentration

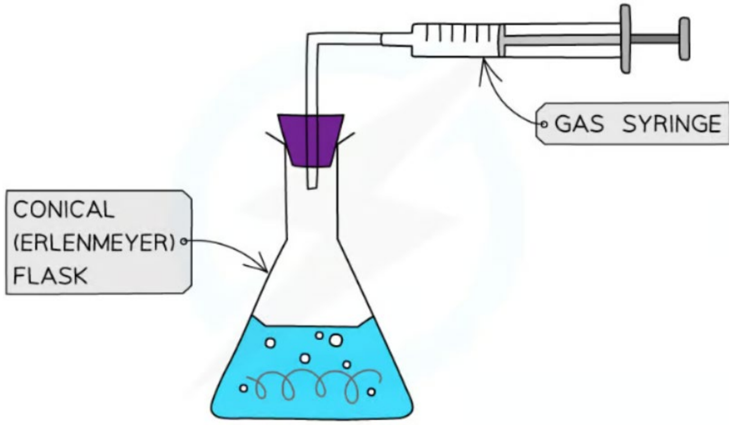
Compulsory practical – Gas collection

This method can be used when one of the products is a gas.

Possible independent variables:
- Surface area of Mg or marble chips
- Concentration / temperature of acid

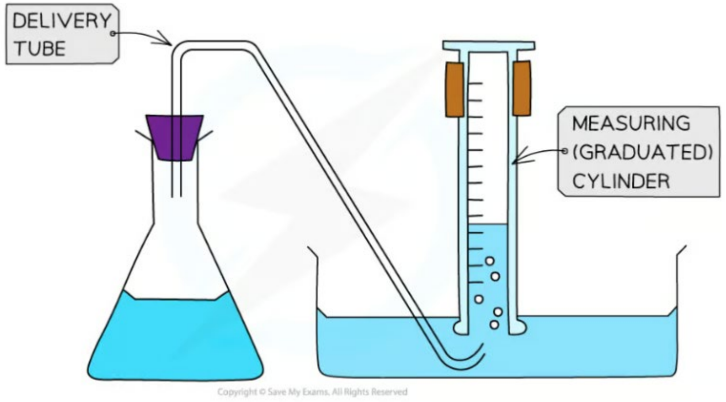
Dependent variable:
- Volume of gas produced every 10seconds or time taken to collect 20cm^3 of gas

Control variables
- Volume of acid
- Mass of Mg/ marble chips



Example – investigate how changing the concentration of acid, affects the rate of reaction

1. Measure out 25cm^3 of hydrochloric acid using a measuring cylinder and add to conical flask
2. Add 1g of magnesium to the flask and connect gas syringe quickly
3. Start stopwatch
4. Time how long it takes to collect 20cm^3 of gas and record
5. Repeat and calculate a mean
6. Repeat with 4 more concentrations of acid



Compulsory practical - precipitation

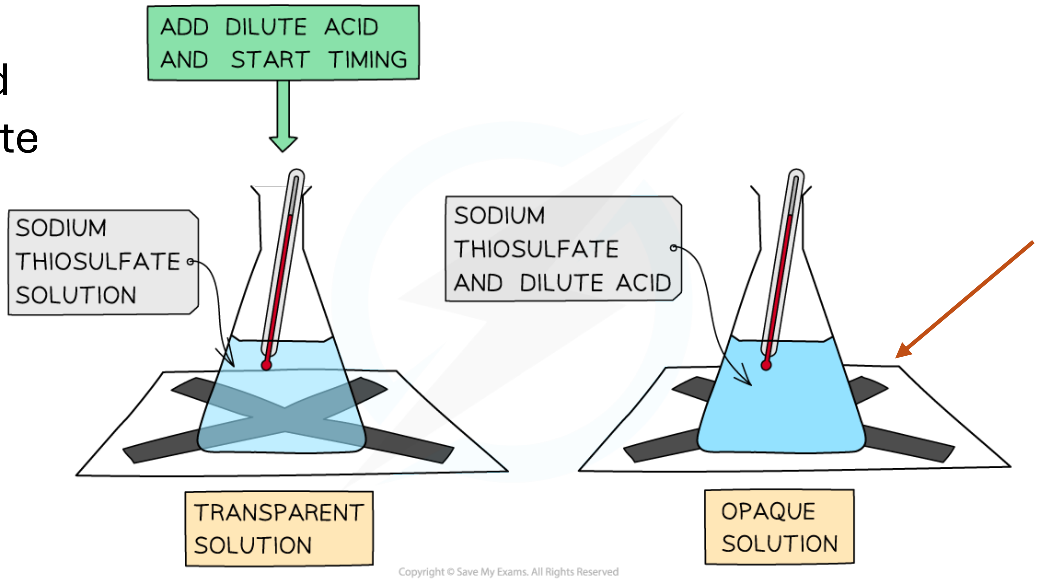
This method can be used when one of the products is a solid

$$Na_2S_2O_3(aq) + 2\ HCl(aq) \rightarrow 2\ NaCl(aq) + H_2O(l) + SO_2(g) + \boxed{S(s)}$$

Possible independent variables:
- Temperature, concentration of hydrochloric acid
- Temperature, concentration of sodium thiosulfate

Dependent variable:
- Time taken for cross to disappear

Control variable
- Volume of hydrochloric acid
- Volume of sodium thiosulfate



Solution goes cloudy because sulfur is made, which is a solid (precipitate)

Example – investigate how changing the concentration of acid, affects the rate of reaction
1. Place a conical flask on top on a black cross
2. Measure out 25cm^3 of hydrochloric acid using a measuring cylinder and add to conical flask
3. With a new measuring cylinder, measure out 5cm^3 of sodium thiosulfate
4. Add the sodium thiosulfate to the flask and start the stopwatch
5. Time how long it takes for the cross to disappear and record
6. Repeat twice more and calculate a mean
7. Repeat with 4 more concentrations of acid

Reversible reactions

Reversible reactions are where the products of a reaction, can react to make the original products again

$$A + B \rightleftharpoons C + D$$

$\rightleftharpoons$ is the symbol for a reversible reaction

The direction of a reaction can be changed by changing the conditions

e.g., $\text{ammonium chloride} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{ammonia} + \text{hydrogen chloride}$

If a reversible reaction is exothermic in one direction, it is endothermic in the opposite direction – the same amount of energy is transferred in each case

Equilibrium

Reversible reactions reach equilibrium when the forwards and backwards reaction, happen at the same rate in a closed system

Le Chatelier's Principal

Any changes made to a reaction at equilibrium, the reaction will counteract that change. E.g., if the temperature is increased the reaction will shift to decrease this.

We can use Le Chatelier's principal to predict what will happen to the position of equilibrium if the conditions are changed.

Effect of temperature on equilibrium

When looking at temperature, equilibrium shifts depending on which direction is exothermic or endothermic

Exothermic – would increase temperature
Endothermic – would decrease temperature

L R

$$N_2(g) + 3H_2(g) \underset{\text{endo}}{\overset{\text{exo}}{\rightleftharpoons}} 2NH_3(g)$$

Describe and explain what happens to the yield of NH_3 if the temperature increased

Change	Reaction	How?	Direction	Yield
↑ temp	↓ temp	endo	left	↓

Yield would decrease, as equilibrium shifts to the left as the backwards reaction is endothermic.

Effect of concentration on equilibrium

When looking at concentration, it completely depends on products and reactants

To increase the concentration of a product – move forwards
To decrease the concentration of a product – move backwards

Some hydrogen (H_2) is removed

Explain what happens to the position of equilibrium

L R

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Change	Reaction	How?	Direction
↓ H_2	↑ H2	More H_2	left

Equilibrium shifts to the left to increase the concentration of H_2

Effect of catalysts on equilibrium

Catalysts have NO effect on equilibrium!

Effect of pressure on equilibrium

When looking at pressure, equilibrium shifts depending on which side has the most/ least gas molecules

Less gas molecules – decreases gas pressure
Most gas molecules – increases gas temperature

L R

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

4 gas molecules 2 gas molecules

Describe and explain what happens to the yield of NH_3 if the pressure increased

Change	Reaction	How?	Direction	Yield
↑ press	↓ press	Less gas	right	↑

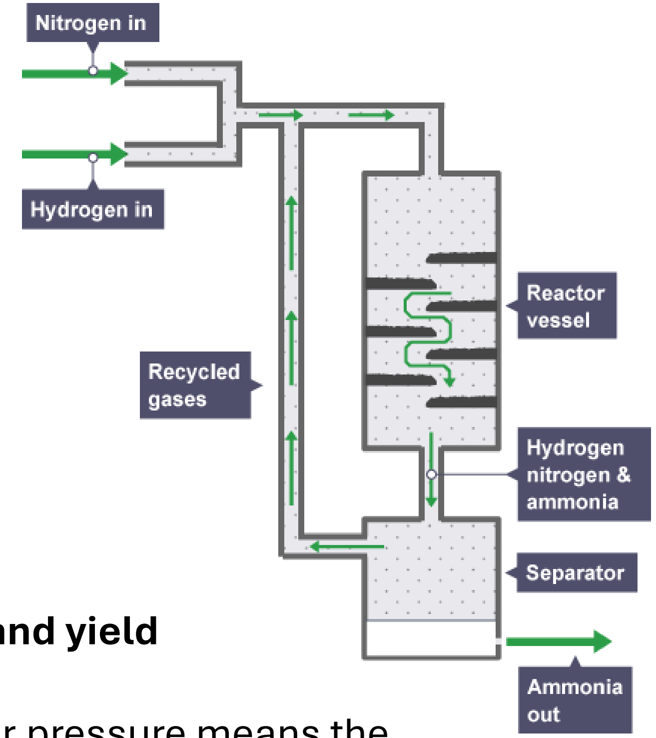
Yield would increase, as equilibrium shifts to the right as it the side with the fewest gas molecules

There are times when pressure has no effect: when there are equal numbers of gas molecules on each side OR when there are no gas molecules present

The Haber Process

Used to make ammonia, which is used to make fertilisers

$$N_2\,(g) + 3H_2\,(g) \underset{\text{endo}}{\overset{\text{exo}}{\rightleftharpoons}} 2NH_3\,(g)$$



Products go into a condenser – here the ammonia liquified and is collected.

Unused N_2 and H_2 are recycled back into the reactor

Source of N_2 = air
Source of H_2 = reacting methane from natural gas with steam

Conditions:

- 450°C
- 200 atm pressure
- Iron catalyst

The conditions for the Haber process are a compromise between rate and yield

- High temperatures = faster rate but lower yield
- High pressure = faster rate and high yield but is not cost effective (higher pressure means the equipment needed to safely do the reaction e.g., thicker reaction vessel, is expensive)
- Catalysts effects the rate of both sides of the reaction

Chemistry Topic 7 - Organic Chemistry Paper 2:KS4

Hydrocarbons and their properties	Crude oil and its uses	Fractional distillation 1	Fractional distillation 2	Cracking	Alkenes	Alcohols	Carboxylic acids	Addition Polymerisation	Condensation Polymerisation	Check 20	Misconceptions lesson

Key Words

Key Word	definition
Hydrocarbon	Compound made of hydrogen and carbon only
Crude oil	Mixture of Hydrocarbons
Saturated	Each carbon makes 4 single covalent bonds
Unsaturated	Each carbon does not make 4 sing covalent bonds
Alkanes	Saturated hydrocarbons
Alkenes	Unsaturated hydrocarbons (contain a double bond)
Viscosity	How gloopy something is
Fraction	Hydrocarbons are hydrocarbons with similar boiling points

Key Questions

How is crude oil formed?

How s cracking done and why is it done?

What small molecule is removed during condensation polymerisation?

What 2 process ae involved on fractional distillation?

How do we test for the presence of alkenes

State the conditions for fermentation

Chemistry Topic 7 - Organic Chemistry Paper 2:KS4

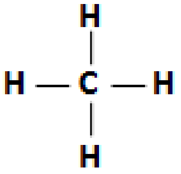
Properties of hydrocarbons

Hydrocarbons are compounds made of hydrogen and carbon only
As the hydrocarbon chain gets smaller hydrocarbons become:

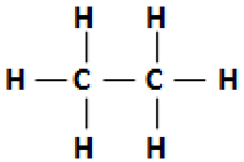
- more flammable
- more runny (less viscous)
- lower boiling point

Alkanes

Alkanes are saturated hydrocarbons (each carbon makes 4 single bonds)

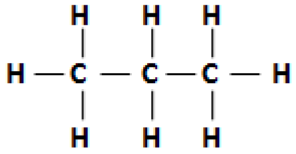


Methane
CH_4

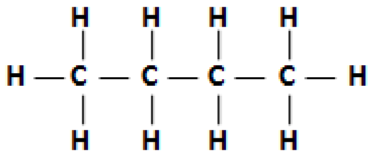


Ethane
C_2H_6

General formula for alkanes
C_nH_{2n+2}



Propane
C_3H_8



Butane
C_4H_{10}

Way to remember (count on fingers)
Martin, **E**ats , **P**eanut , **B**utter

Complete Combustion

fuel + oxygen → carbon dioxide + water

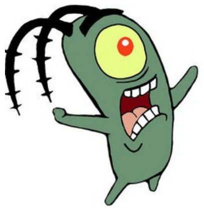
Incomplete Combustion

Happens when there is not enough oxygen
fuel + oxygen → carbon + carbon monoxide+ water

Crude oil

Crude oil is a mixture of hydrocarbons

It is made from plankton, which has been buried under mud for millions of years



Cracking

There is a **high demand** for shorter chain alkanes, but they are in **short supply**. Long chain hydrocarbons are broken down into a shorter alkane and an alkenes.

Conditions

- High temperature to vaporise hydrocarbon
- Mix with steam (steam cracking)

or

- Pass over catalyst (catalytic cracking)

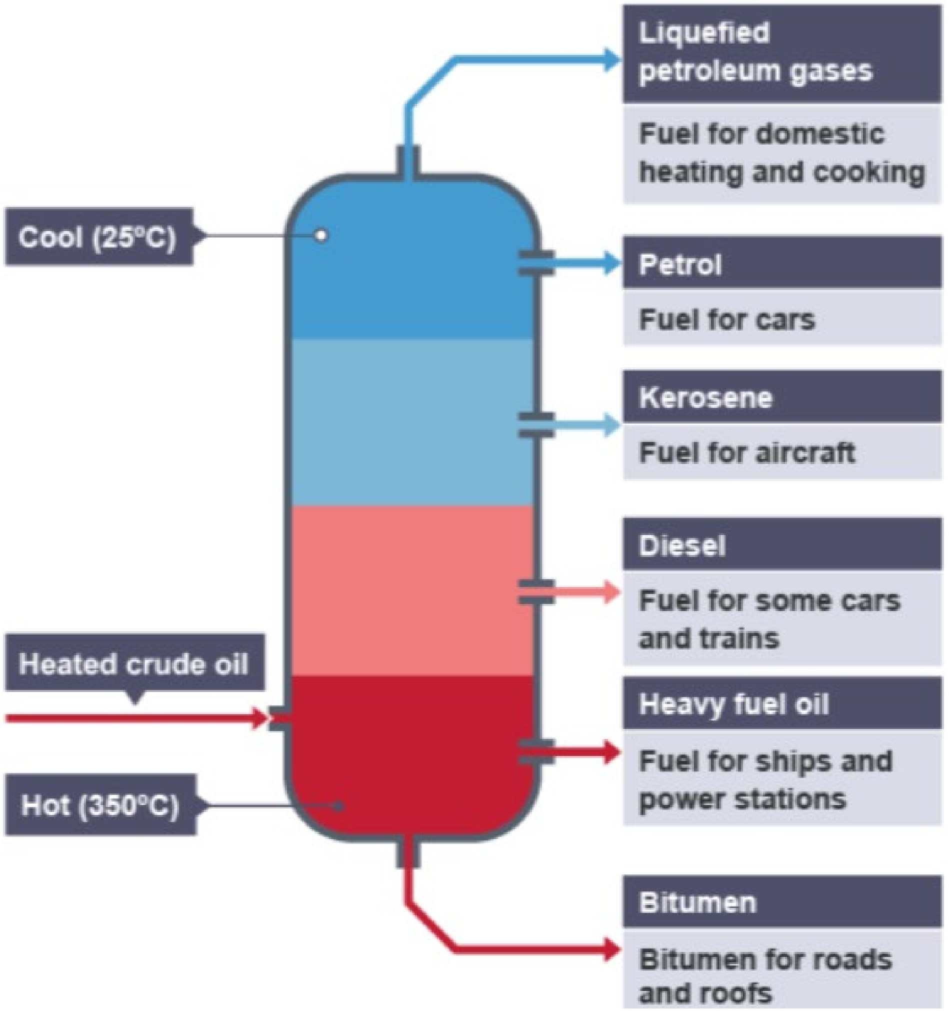
Fractional distillation

Crude oil is heated until it evaporates

Vapours enter the fractionating column which has a temperature gradient (hot at the bottom, cooler at the top)

Different fractions have different boiling points

So, fractions condense at different points along the column depending on their boiling point



Uses of fractions

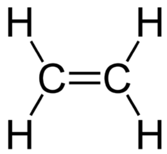
Many fractions are used as fuels:

- Petrol
- Diesel
- Kerosene

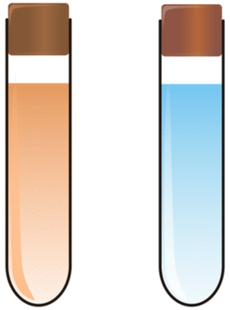
Some fractions become feedstock for the petrochemical industry. Products from the petrochemical industry include:

- Solvents
- Lubricants
- Detergents
- Polymers

Testing for alkenes



Alkenes are unsaturated hydrocarbons (each carbon does not make 4 single bonds)



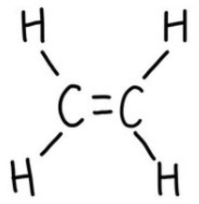
Orange bromine water will turn **colourless** when an alkene is present

It stays orange in when an alkane is present

Chemistry Topic 7 - Organic Chemistry Paper 2:KS4

Alkenes

General formula: C_nH_{2n}
The first 4:
Ethene (C_2H_4)
Propene (C_3H_6)
Butene (C_4H_8)
Pentene (C_5H_{10})



ETHENE

Reactions of Alkenes

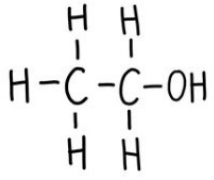
Alkenes undergo combustion, this is most commonly incomplete (producing a smoky flame)

They undergo addition reactions with:

1. Hydrogen (in presence of catalyst) to make alkanes
2. Water (in presence of acid catalyst) to make an alcohol)
3. Halogens to make halogenoalkanes

Alcohols

Have the functional group –OH
The first 4:
Methanol (CH_3OH)
Ethanol (C_2H_5OH)
Propanol (C_3H_7OH)
Butanol (C_4H_9OH)



ETHANOL

Uses:
Solvents
Fuels

Reactions of alcohols with sodium

Reaction forms a salt and hydrogen gas. During the reaction you can see bubbles and a colourless solution formed
e.g.
ethanol + sodium → sodium ethoxide + H_2

Alcohols and water

When alcohols are added to water, they dissolve to form solutions, but solubility decreases as chain length increases

Combustion

They undergo complete combustion

Oxidising agents

Alcohols will react with oxidising agents to form carboxylic acids

Fermentation

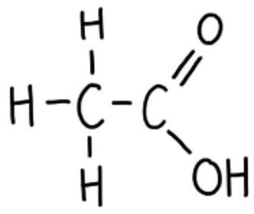
Production of ethanol using yeast for alcoholic drinks

glucose $\xrightarrow{\text{yeast}}$ ethanol + carbon dioxide

Conditions: 37°C, slightly acidic solution and anaerobic conditions

Carboxylic acids

Have the functional group –COOH
The first 4:
Methanoic acid (HCOOH)
Ethanoic acid (CH_3COOH)
Propanoic acid (CH_3CH_2COOH)
Butanoic acid ($CH_3CH_2CH_2COOH$)



ETHANOIC ACID

They are weak acids (partially ionise to release H^+)

They react with carbonates
e.g.
Ethanoic acid + sodium carbonate
→ Sodium ethanoate + water + carbon dioxide

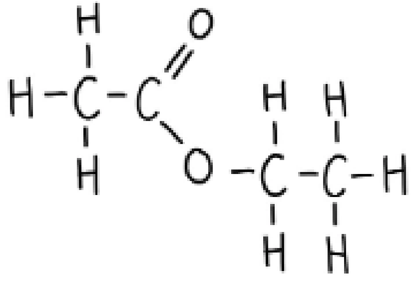
They react with alcohols in the presence of a catalyst to form esters

Chemistry Topic 7 - Organic Chemistry Paper 2:KS4

Esters

Have the functional group –COO

Formed from an alcohol and a carboxylic that react in the presence of an acid catalyst

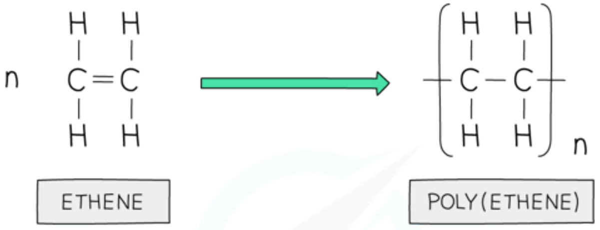


ETHYL ETHANOATE

Ethyl ethanoate is the only ester you need to know. It is made from ethanol and ethanoic acid. Water is also made

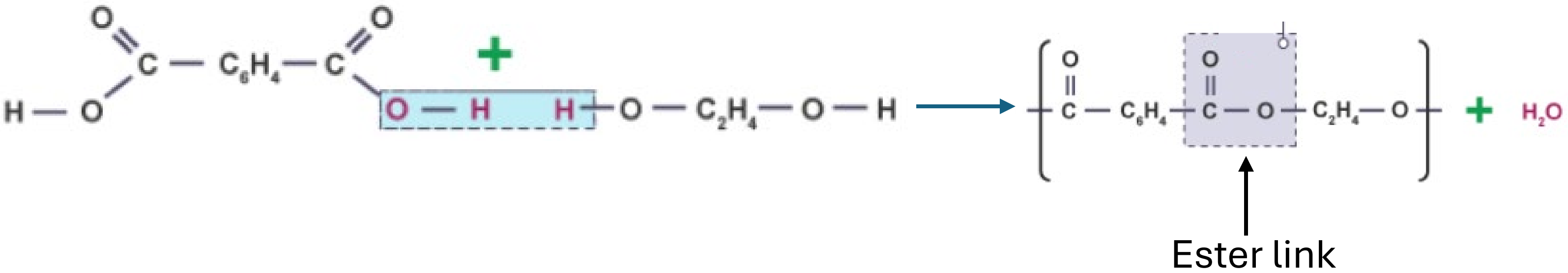
Addition Polymerisation

Monomer: One type (alkene)
Products: 1 - polymer



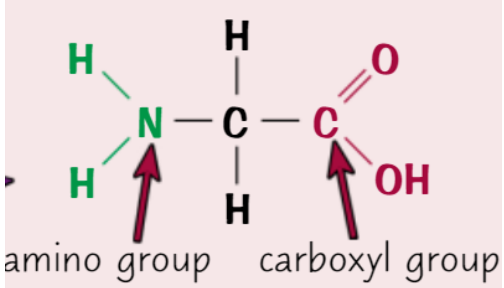
Condensation Polymerisation

Monomer: Either 1 with two different functional groups e.g. amino acid or 2 monomers with 2 of the same functional group e.g. a diol and a di-carboxylic acid
Products: 2 – polymer and water



Naturally Occurring Polymers

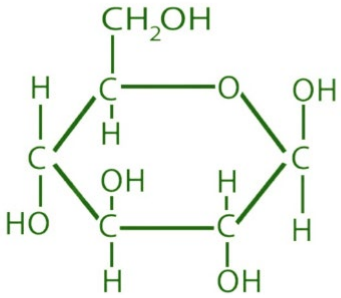
DNA
Made of two polymer chains which comprise of 4 monomers called nucleotides, twisted into a double helix. It encodes genetic instructions



Amino acid (2 functional groups)

Proteins
Made of monomers called amino acids. Have lots of uses in the body e.g. enzymes

Starch
Made from the monomer glucose, used to store energy



Glucose

Cellulose
Made from the monomer glucose, found in plant cells walls

Chemistry Topic 8 - Chemical Analysis Triple Paper 2:KS4

Pure Substances + formulations. Chromatography theory and gas tests	Chromatography compulsory practical	Flame tests and flame emissions spectroscopy	Tests for: hydroxides and anions	Testing for substances compulsory practical	Check 20	Misconceptions lesson

Key Words

Key Word	Definition
Pure substance	Mad of a single element or compound
Formulation	Mixture that has been designed as a useful product
Chromatography	Method used to separate mixtures and give information to help identify substances
Mobile phase (paper chromatography)	Solvent (moves up the paper)
Stationary phase (paper chromatography)	Paper (does not move)

Misconceptions

Pure substances are not things that simply don't have anything added to them. They are made of single elements or compounds

Start line in chromatography must be above the solvent level to stop the substances washing off

When calculating R_f values. Always divide the distance moved by substance by the distance moved by the solvent. Answers are between 0 and 1

In gas tests, the only test that results in a squeaky pop is hydrogen

Key questions

What is a formulation?

What is the equation to calculate R_f values?

What is a pure substance?

What are the two phases in paper chromatography

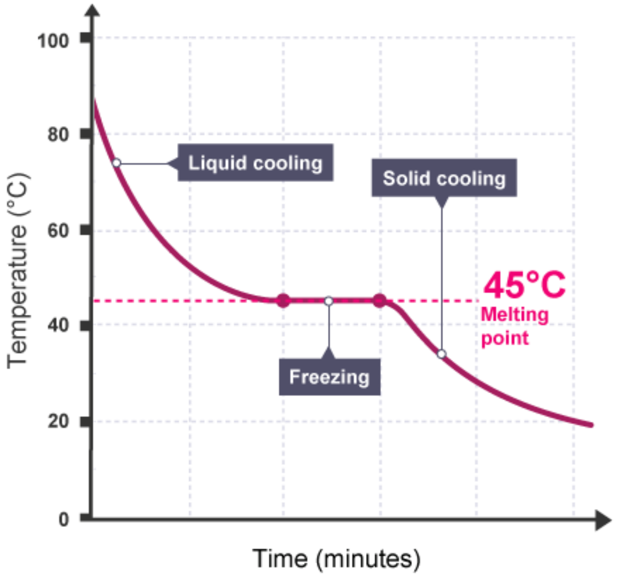
Describe the test and result for hydrogen?

Pure Substances

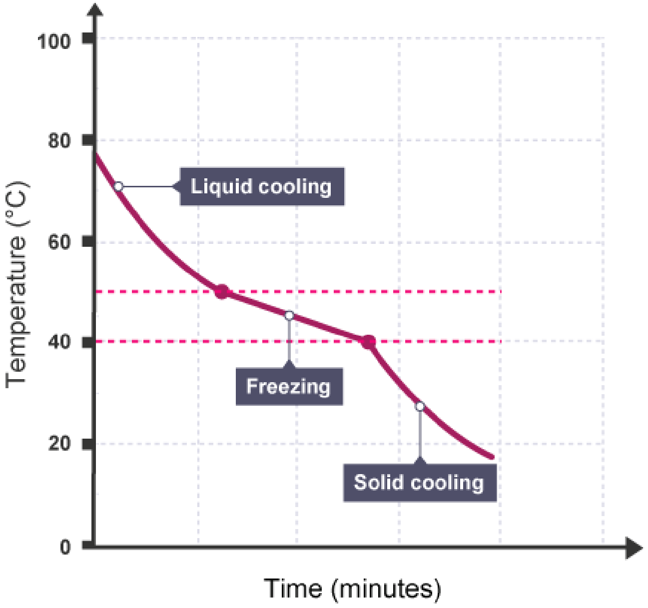
A pure substance is a single element or compound

e.g.,
Carbon = pure
Carbon dioxide = pure
Air = impure (this is because it is a mixture of elements and compounds)

Pure substances melt and boil at specific temperatures
Mixtures melt and boil over a range of temperatures



Pure – freezes at a specific temperature



Impure/ mixture – freezes over a range of temperatures

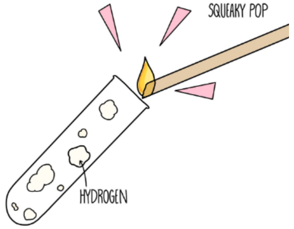
Formulations

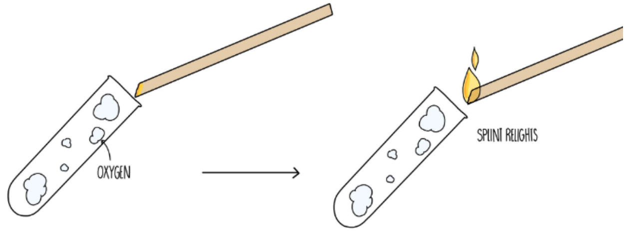
A formulation is a mixture designed as a useful product

e.g., Fuels, fertilisers and medicines

Gas Tests

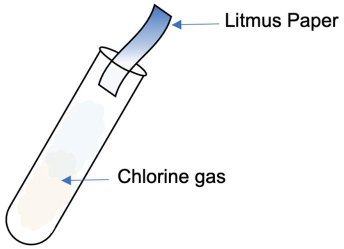
Hydrogen
Test: Lit splint
Result: Squeaky pop

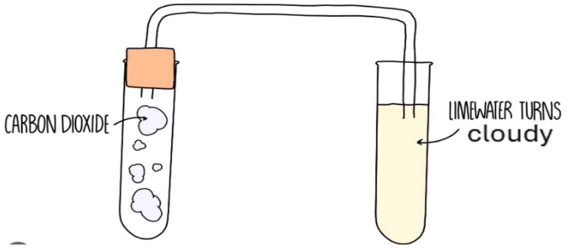




Oxygen
Test: Glowing splint
Result: Relights

Chlorine
Test: Damp blue litmus paper
Result: Bleaches white



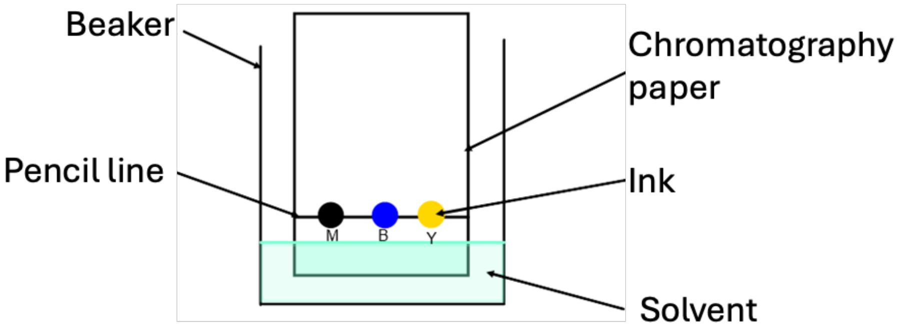


Carbon dioxide
Test: Limewater ($CaOH_{(aq)}$)
Result: Goes cloudy

Chemistry Topic 8 - Chemical Analysis Triple Paper 2:KS4

Chromatography

Method used to separate mixtures and give information to help identify substances



Start line is drawn in pencil as it is insoluble. If it was drawn in pen, it would run.

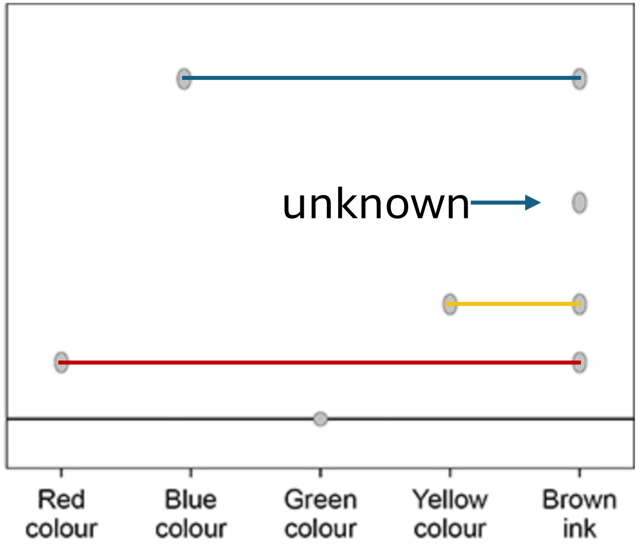
Solvent must be below the start line. This stops the substances washing off into the solvent

Phases of chromatography

Mobile phase – in paper chromatography, this is the <u>solvent</u>. It **moves** and carries the components up the paper

Stationary phase – in paper chromatography, this is the <u>paper</u>. It **doesn't mover** and the components move up it.

Chromatography separates substances based on their solubility. The more soluble, the higher up the paper it travels e.g. blue is most soluble, green is insoluble as it doesn't move off the start line

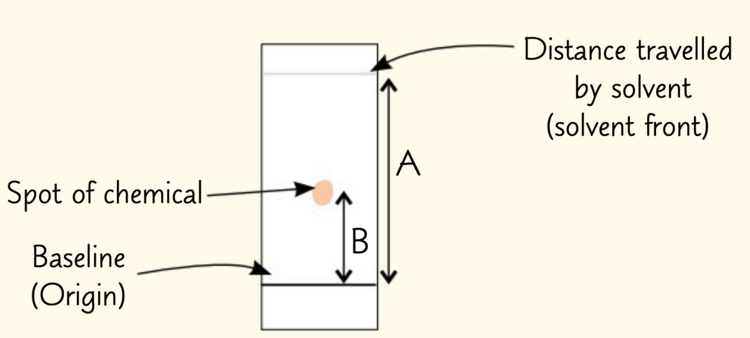


Understanding chromatograms

- **1 spot** in a vertical line means it is a **pure** substance e.g., red, blue, yellow
- **More than 1 spot** in a vertical line means a **mixture** e.g., brown ink
- To work out what is in the mixture, look at spots that match e.g., in brown in there is red, yellow and blue and an unknown

R_f Values

$$R_f \text{ value} = \frac{\text{distance travelled by substance } (B)}{\text{distance travelled by solvent } (A)}$$



Hints:

- Always measure to middle of the spot
- Answers should be between 0 and 1.
- Check the questions for the units to measure in e.g., mm or cm

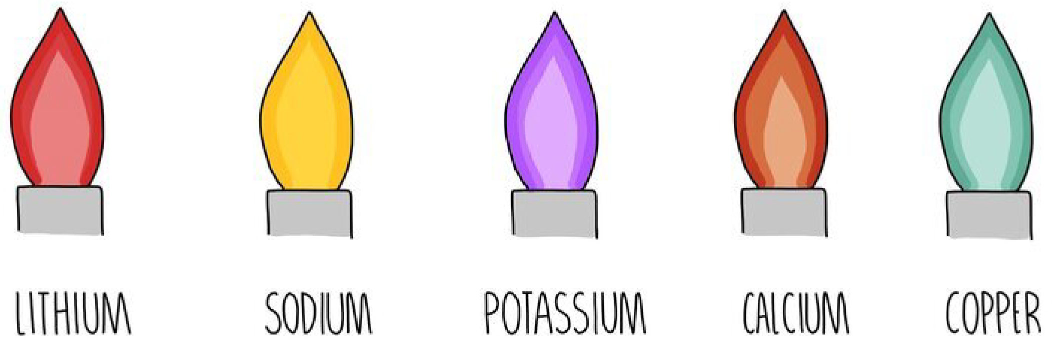
Chemistry Topic 8 - Chemical Analysis Triple Paper 2:KS4

Flame Tests

Flame tests can be used to identify some metals

To carry out a flame test:

1. Dip a platinum wire loop in dilute HCl
2. Heat in a blue flame until it burns with no colour
3. Dip into sample then place into blue flame
4. Observe the colour to identify metal



Lithium	Sodium	Potassium	Calcium	Copper
Crimson	Yellow	Lilac	Orange red	Green

Flame tests can only identify one metal at a time

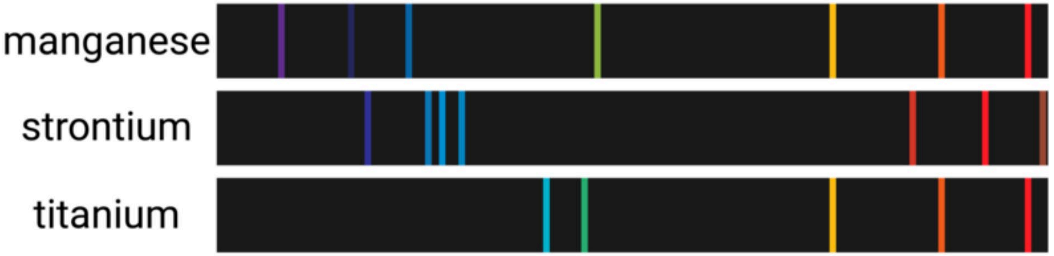
If the loop is not cleaned between tests, **the colours may be masked**, making it impossible to identify the metal

Flame Emissions Spectroscopy

This is an **instrumental method** that can be used to identify **multiple metal ions** in a sample

The sample is put into a flame and the light given out is passed through a spectroscope. The output is a line spectrum that can be analysed to **identify the metal ions** in the solution and **measure their concentrations.**

An unknown sample can be compared against known spectra



The metal in the unknown sample is strontium as the lines match

Instrumental Methods

Elements and compounds can be identified using instrumental methods e.g., flame emissions spectroscopy

Advantages:

- Rapid
- More accurate
- More sensitive

Chemistry Topic 8 - Chemical Analysis Combined Paper 2:KS4

Metal hydroxides

Some metals ion form precipitates when sodium hydroxide solution is added

Metal Ion	Colour of precipitate	Ionic Equation
Calcium	White	$Ca^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Ca(OH)_{2\,(s)}$
Magnesium	White	$Mg^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mg(OH)_{2\,(s)}$
Aluminium*	White redissolves in excess NaOH	$Al^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Al(OH)_{3\,(s)}$
Copper (II)	Blue	$Cu^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Cu(OH)_{2\,(s)}$
Iron (II)	Green	$Fe^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Fe(OH)_{2\,(s)}$
Iron (III)	Brown	$Fe^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow Fe(OH)_{3\,(s)}$

Testing Substances

This is compulsory practical

Hints:

- If the sample is a tablet; describe crushing it with a pestle and mortar, then adding distilled water to make a solution

- There will be a metal to test for (flame test or metal hydroxide) and a non-metal (sulfate, carbonate or halide) so describe the test for metals then the non-metal

Testing for anions (- ions)

Testing for Sulfates SO_4^{2-}

Test:

1. Add dilute HCl
2. Add barium chloride solution

Result:

White precipitate

Testing for Carbonates CO_3^{2-}

Test:

1. Add a dilute acid
2. Bubble gas through limewater

Result:

Limewater goes cloudy

Testing for Halides Cl^-, Br^-, I^-

Test:

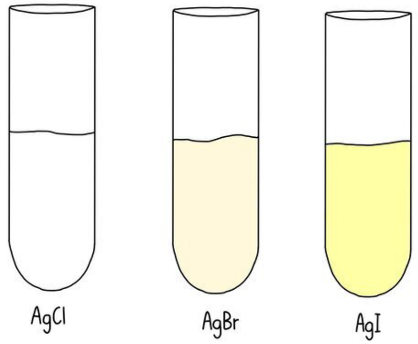
1. Add a dilute nitric acid
2. Add silver nitrate solution

Result:

Cl^- = white precipitate

Br^- = cream precipitate

I^- = yellow precipitate

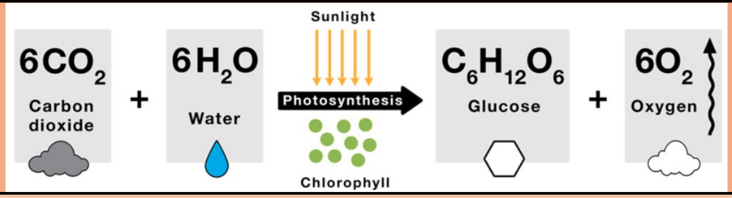


Example reaction: $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

Chemistry Topic 9 - Chemistry of the Atmosphere Paper 2:KS4

Evolution of the Atmosphere	Greenhouse Effect and Climate Change	Carbon Footprints	Air Pollution	Check 20	Misconceptions

Key Words

Key Word	Definition
Photosynthesis	
Greenhouse gas	Gases that help maintain the Earths' temperature. They are water vapour, carbon dioxide and methane
Climate change	Caused by an increase in the average global temperature
Carbon footprint	Total amount of carbon dioxide and other greenhouse gases emitted over a full life cycle
Particulates	Solid particles of carbon
Complete combustion	Products: $CO_2 + H_2O$
Incomplete combustion	Happens when there is not enough oxygen Products: $C + CO + H_2O$

Misconceptions

Air is mostly O_2 and CO_2. This is wrong only 20% is O_2 and 0.04% CO_2. It is mostly N_2 which is 80%

Global warming is a consequence of climate change. Wrong. Global warming is the increase in the Earths average temperature. It causes climate change

Humans causing climate change is completely made up. Wrong the evidence for this has been peer reviewed - checked by lots of scientists who agree it is human caused

Key questions

How did O_2 levels change as the atmosphere evolved?

How is SO_2 made and what problems can it cause?

How did CO_2 levels change as the atmosphere evolved?

Give some potential effects of global climate change

Todays Atmosphere

- Nitrogen (N_2) = 80% or 4/5
- Oxygen (O_2) = 20% or 1/5
- Small proportions of other gases including carbon dioxide, water vapour and noble gases

Evolution of the Atmosphere

Intense volcanic activity released CO_2 which made the Earth's early atmosphere mostly CO_2 with little or no O_2. This is similar to the atmosphere of Mars and Venus today.

↓

Volcanoes also produced N_2 which has built up in the atmosphere, as well as small amounts of CH_4, NH_3.

↓

Water vapour was also released by volcanoes which cooled and condensed to form the oceans.

↓

CO_2 dissolved into the oceans and carbonates were precipitated, producing sediment. Algae and plants evolved about 2.7 billion years ago which carried out photosynthesis absorbing more CO_2 from the atmosphere. **CO_2 levels decreased by the formation of sedimentary rocks and fossil fuels and by being absorbed for photosynthesis.**

↓

O_2 levels increased due to photosynthesis

This is a theory as the timescale of this is 4.6 billion years, so evidence is limited

Greenhouse Gases

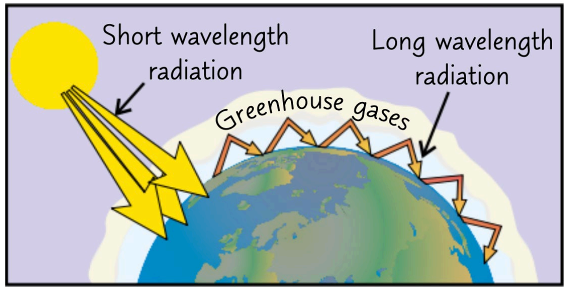
Greenhouse gases in the atmosphere help maintain temperatures on Earth, high enough to support life

3 greenhouse gases

- Carbon dioxide
- Water vapour
- Methane

Greenhouse Effect

The greenhouse effect is the way in which the greenhouse gases, keep the Earth warm enough:



Short wavelength radiation from the sun, enters the atmosphere

It is absorbed by the earth **and** re-emitted as longer wavelength radiation

This absorbed by greenhouse gases in the atmosphere

Increasing the temperature of the Earth (global warming)

Human activities increasing greenhouse gases

Some human activities lead to an increase greenhouse gases in the atmosphere:

- **Agriculture**

→ releases methane
- **Burning fossil fuels**

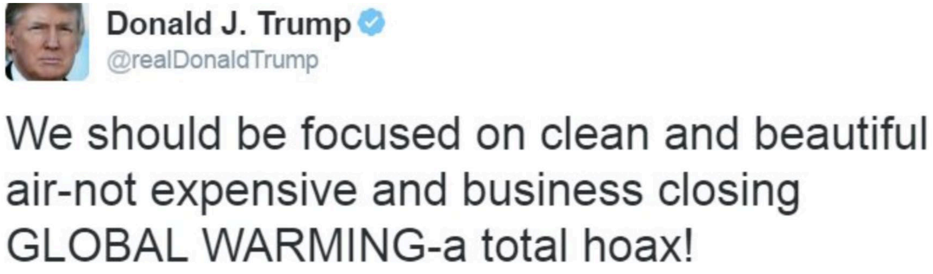
→ releases 'locked up' carbon as CO_2
- **Deforestation**

→ less CO_2 absorbed by photosynthesis
- **Creating waste**

→ releases CO_2 and methane as it decomposes

Based on peer-reviewed evidence, scientists believe these activities will cause the Earth's temperature to increase at the surface and lead to climate change

BUT global climate change is difficult to model as it is complex. This leads to simplified models, speculation and opinions presented in the media what are only based on part of the evidence and can be biased



Climate Change

An increase in the average global temperature is a major cause of climate change

Consequences of climate change:
- Melting Ice caps
- Rising sea levels
- Flooding
- Extremes of weather (e.g., more frequent and severe storms)
- Loss of habitat

Carbon Footprints

Measure of the total amount CO_2 and other greenhouse gases released over a full life-cycle of a produce, service or event

Ways to reduce emissions (reduce CO_2 and CH_4 emissions):
- Use renewable/ nuclear energy rather than fossil fuels
- Use efficient processes to conserve energy and cut waste
- Carbon capture technology (trap CO_2 and bury underground)
- Government cap emissions
- Governments could tax based on emissions (e.g., ULEZ)

Issues with this:
- Still work to be done on alternative technologies with lower emissions.
- Governments worry about effects on economic growth.
- Some people don't want to change and don't get why they should

Pollutants

Particulates (C)

Solid particles of carbon (soot)

Made by:
- Incomplete combustion

Problems:
- Global dimming
- Respiratory Problems

Carbon Monoxide (CO)

Made by:
- Incomplete combustion

Problems:
- Toxic

It it difficult to detect as it is colourless and odourless

Sulfur Dioxide (SO_2)

Made by:
- Sulfur impurities in fuels reacting with oxygen when burnt

Problems:
- Acid rain
- Respiratory problems

You can test for sulfur impurities by burning a sample of the fuel and bubbling the gases release through universal indicator. If it turns red, then SO_2 has been made

Nitrogen Oxides (NO_x)

Made by:
- Nitrogen and oxygen from the air reacting due to high temperatures (e.g., combustion engines)

Problems:
- Acid rain
- Respiratory problems

Acid Rain

Formed when SO_2 and NO_X dissolve in rainwater to make dilute acid

Harms and kills plants and animals, especially in aquatic environments. Damages building and statues

Chemistry Topic 10 - Using Resources T Paper 2:KS4

Finite and Renewable Resources	Recycling and Reusing	Life Cycle Assessments	Potable Water	Waste Water Treatment	Ceramics, composites and Polymers	Properties of Materials	Corrosion	NPK Fertilisers	Check 20	Misconceptions

Key Words

Key Word	Definition
Natural Resource	Minerals that have been made through the formation of the world that can be used for human benefit
Finite Resource	Resource that can only be used once and is in limited supply.
Synthetic	A material made by a chemical process, not naturally occurring.
Renewable Resource	Resources which will not run out in the foreseeable future
Sustainable Development	Development that meets the needs of current generations without compromising the ability of future generations to meet their own needs.
Potable Water	Water that is safe to drink
Desalination	Removing the salt from seawater
Reuse	Using an item again
Recycle	Processing materials so that they can be used to make new products

Misconceptions

Potable water is pure. Wrong, potable water must contain a low level of dissolved salts.

Waste water is treated so that it can be drunk. Wrong, waste water is treated so it can be put back into freshwater sources

We won't run out of metals. Wrong, metals are a finite resource. There is only a limited supply

Key questions

What are the different stages of an LCA?

What are the stages to make potable water?

What are the stages to treat waste water?

How can you find the mass of dissolved salt in a water sample?

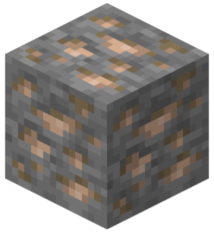
Chemistry Topic 10 - Using Resources T Paper 2:KS4

Resources

Humans use the Earth's resources for:

- Warmth
- Shelter
- Food
- Transport

Natural resources, supplemented by agriculture, provide food, timber, clothing and fuels



Finite resources come from the Earth, oceans and atmosphere which are processed to provide energy and materials e.g., metals and crude oil, which is separated using fractional distillation to provide lots of different fuels

Renewable resources are those that will not run out for the foreseeable future e.g., wood

Chemistry plays an important role in improving agricultural and industrial processes to provide new products. E.g., fertilisers, which are used to increase soil fertility, were traditionally obtained from manure. But humans developed the Haber process to make synthetic fertilisers which allow use to farm intensively and produce enough food for the growing population

Sustainable Development

Development that meets the needs of current generations without compromising the ability of future generations to meet their own needs

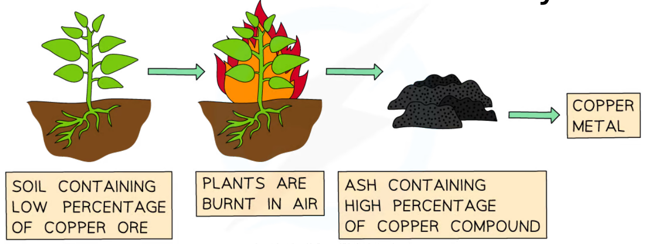
Bioleaching and Phytomining

Metal ores are limited. The way we traditionally extract them is by quarrying and mining which can have environmental impacts such as creating noise pollution and damaging habitats

Some alternative methods have been created to extract metals from low-grade ores:

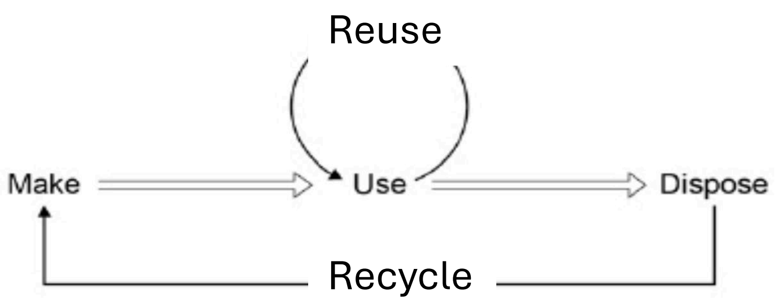
Bioleaching – bacteria produce a leachate solution that contains metal compounds. Metal is then extracted using displacement reactions or electrolysis

Phytomining – plants absorb metal compounds. Plants are harvested and then burnt to produce an ash which contains metal compounds. Metal is then extracted using displacement reactions or electrolysis



Chemistry Topic 10 - Using Resources T Paper 2:KS4

Ways to reduce the use of resources



Reusing and recycling:
- Conserves finite resources
- Reduces use of energy resources
- Reduces waste going to landfill

Glass
- Some can be reused
- Recycled by crushing and melting to make new glass products

Metals
- can be recycled by melting and recasting

To recycle metals, some separation can be required. It depends on how pure you needed the final product. E.g., copper for electrical wire needs to be very pure, so to make it from recycled copper it has be processed

Steel for construction doesn't have to be so pure, so scrap iron can be added easily to a steel furnace which reduces the cost of making steel

Life Cycle Assessments

Life cycle assessments are done to **assess the environmental impact of products** in each of the following stages:
1. Extracting and processing raw materials
2. Manufacturing and packaging
3. Use and operation during its lifetime
4. Disposal at the end of its useful life, including transport and distribution at each stage

Making LCAs

Some things factored into LCA's can be easily quantified e.g., use of water, resources and production of some wastes.

Other things can be more difficult to assign figures to e.g., pollutants and this means is requires value judgments which means LCA's can be subjective

	Plastic bag	Paper bag
Raw materials	Crude oil or natural gas	Wood
Energy used in MJ	1.5	1.7
Mass of solid waste in g	14	50
Mass of CO_2 produced in kg	0.23	0.53
Volume of fresh water used in dm^3	255	4 520

Some LCA's are selective. This means they are used to evaluate a product but can be misused and manipulated to reach pre-determined conclusions, e.g., in support of claims for advertising purposes

Potable Water

Potable water is water that is safe to drink. This is water that has a sufficiently low level of dissolved salts and microbes. It is not pure water as it contains dissolved substances (salts).

The way potable water is produced is dependent on available supplies of water and local conditions:

In the UK, rainwater provides water with low levels of dissolved substances (fresh water) that collects as groundwater.

Potable water is produced by:

1. Choose and appropriate water source (river or lake)
2. **Filter** – pass water through wire mesh then filter beds of sand and gravel to remove solids
3. **Sterilise** – kill harmful microbes using chlorine, ozone or UV

In places where freshwater is limited, desalination may have to be carried out (removing salt from seawater)

Methods of desalination:

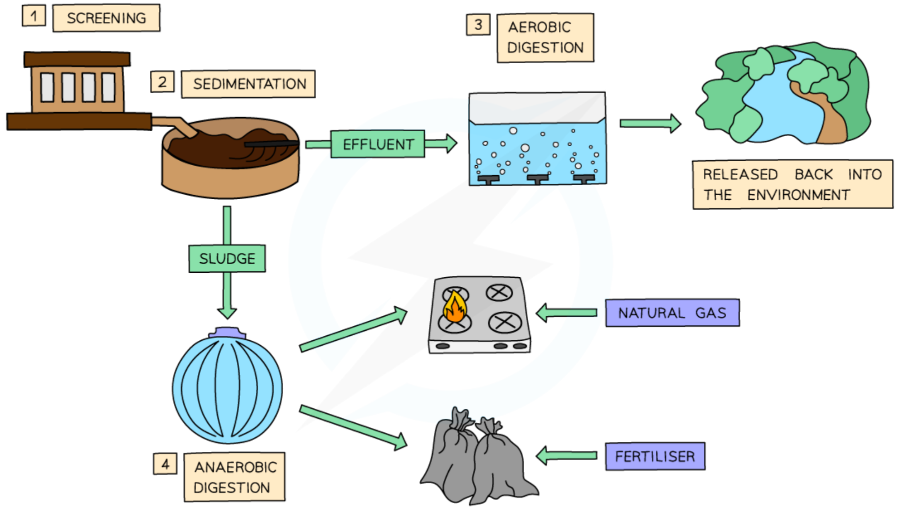
- Distillation
- Reverse osmosis (uses membranes)

Problems with desalination are that it requires large amounts of energy and can only be done on small volumes of water

Waste Water Treatment

Waste water has to be treated before it re-enters fresh water sources.

Sewage and agricultural waste needs organic matter and harmful microbes removing. Industrial waste water may need harmful chemicals removing as well



Stages:

1. **Screening and grit removal**

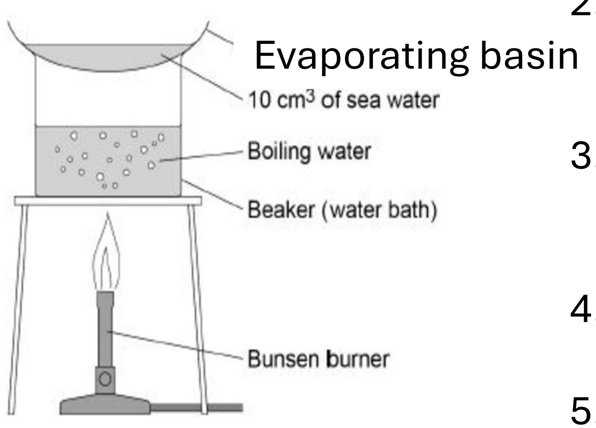
→ Waste is passed twire grid to remove solids and grit

2. **Sedimentation**

→ Waste is allowed to settle in a take forming effluent which floats and sludge which sinks

3. **Aerobic biological digestion of effluent**
4. **Anaerobic digestion of sewage sludge** (this releases methane which can be used as natural gas, and the remaining organic matter can be used as fertiliser)

Compulsory Practical

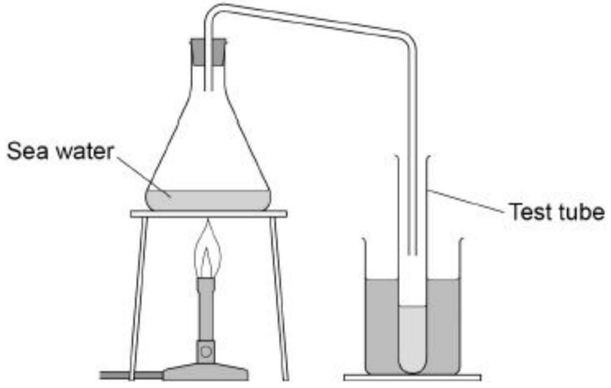


Finding mass of salt in water sample:

1. Measure mass of dry evaporating basin and record
2. Measure out $10cm^3$ of seawater using measuring cylinder and pour into evaporating basin
3. Heat over a water bath until all the water has evaporated (heat until mass is constant)
4. Dry the bottom of the evaporating basin (removes any condensation)
5. Reweigh evaporating basin and record mass
6. Subtract mass of dry evaporating basin to find the mass of dissolved solids

Distillation can be used to make pure water from seawater

Water **evaporates** in the conical flask, the vapour travels down the tube and the cold water in the beaker, makes the vapour **condenses** so that pure water is collected in the test tube



Ceramics

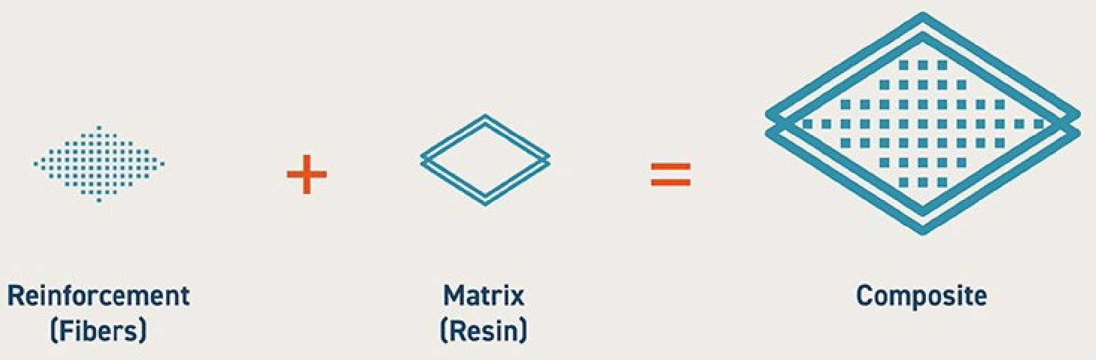
Soda-lime glass - Made by heating sand, sodium carbonate and limestone

Borosilicate glass – made from sand and boron trioxide (has a higher melting point than soda-lime)

Clay Ceramics – made by shaping wet clay and then heating in a furnace e.g. pottery and bricks

Composites

Composites – One material embedded in another; a reinforcement surrounded by a matrix



Examples: fibreglass, chipboard, carbon fibre

Polymers

Properties of polymers depends on the monomer they’re made from and conditions in which they’re made (temperature, pressure and catalyst)

LDPE

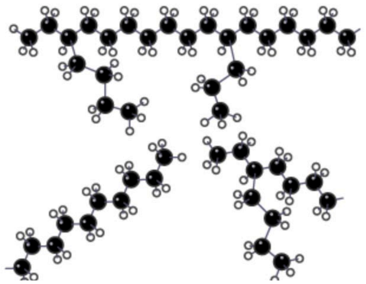
Low density poly(ethene)

Made from: Ethene

Conditions: Moderate temperature and high pressure

Properties: flexible

Uses: carrier bags, bubble wrap



HDPE

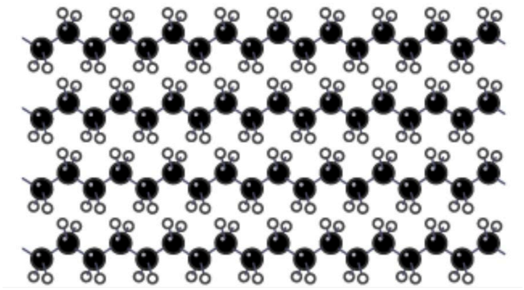
High density poly(ethene)

Made from: Ethene

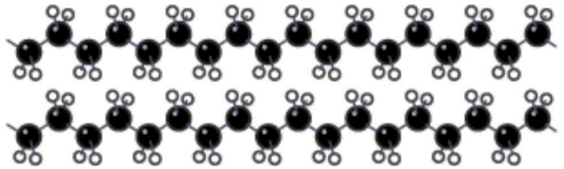
Conditions: lower temperatures, lower pressure and catalyst

Properties: Rigid

Uses: water tanks, drainpipes



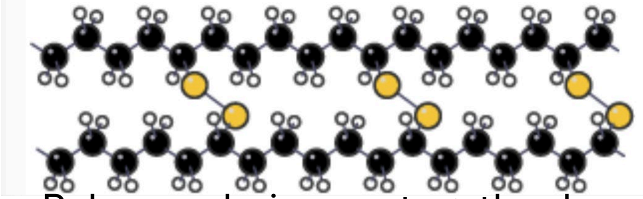
Thermosoftening



Polymer chains are held together by weak forces.

This means these types of polymers can be melted, and made into new products (recycled)

Thermosetting



Polymer chains are together by cross-links (strong covalent bonds)

This means that these polymers, do not melt when heated

Alloys as useful materials

Most metals in everyday use are alloys

Bronze = copper and tin

Brass = copper and zinc

Gold in jewellery is normally an alloys with silver, copper and zinc. Proportion of gold is measured in carats. 24 carat = 100% gold, 18 carat = 75% gold

Steel – alloys of iron containing specific amounts of carbon and other metals. High carbon steel is strong but brittle. Low carbon steel is softer and more easily shaped. Steels with chromium and nickel (stainless) are hard and resistant to corrosion

Aluminium – these alloys are low density

Chemistry Topic 10 - Using Resources T Paper 2:KS4

Corrosion

Corrosion is the destruction of materials by chemical reactions with substances in the environment.

Rusting is an example of corrosion. IT ONLY HAPPENS TO IRON. Air and water are needed for iron to rust. Rust flakes away, wearing away the metal

Haber Process

Used to make ammonia, which is used to make fertilisers

Source of N_2 = air
Source of H_2 = reacting methane from natural gas with steam

$$N_2 (g) + 3H_2 (g) \rightleftharpoons 2NH_3 (g)$$

Conditions:

- 450°C
- 200 atm pressure
- Iron catalyst

Products go into a condenser – here the ammonia liquified and is collected. Unused N_2 and H_2 are recycled back into the reactor

Preventing corrosion

Barriers – applying a coating, such as paint, grease or electroplating stops substances reaching the metal. Some metals produce barriers when they corrode e.g., aluminium will form an oxide coating which prevents further corrosion

Sacrificial – coatings are reactive and contain a more reactive metal to provide protection e.g., zinc is used to galvanise iron. If the coating is scratched, the zinc will react first protecting the iron beneath.

NPK Fertilisers

N, P and K are used in fertilisers to improve agricultural productivity

Sources of N

Ammonia is reacted with nitric acid to make ammonium nitrate (this is good as it contains N from two sources.

Sources of K

Potassium chloride and potassium sulfate can be mined and used straight away as a source of K as the salts are soluble

Sources of P

Phosphate rock is mined, it must be reacted with acids to make soluble salts

Nitric acid → phosphoric acid + calcium nitrate
Sulfuric acid → calcium sulfate + calcium phosphate (single superphosphate)
Phosphoric → calcium phosphate (triple superphosphate)