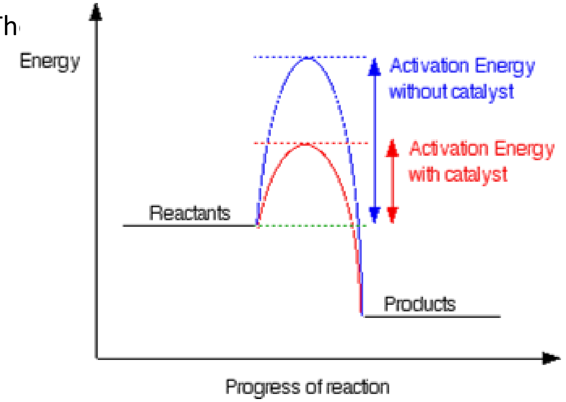
Rates of reaction

Factors affecting the rate of a reaction

Rate of reaction	The rate of a chemical reaction is **how fast** the reactants are changed into products.
Successful collisions	**Collisions** between particles that result in them reacting together.
Activation energy	The **amount of energy** with which particles must collide in order for the **collision to be successful**.
Temperature	**Increased temperature = increased rate of reaction** At a higher temperature there is a larger kinetic energy store so particles **move faster**. This means there are more **frequent successful collisions.**
Concentration	**Increased concentration = increased rate of reaction** In a more concentrated solution there are **more reacting particles** in the same volume. This means there are more **frequent successful collisions.**
Pressure (gases only)	**Increased pressure = increased rate of reaction** Particles are **closer together**. This means there are more **frequent successful collisions.**
Surface Area	**Increased surface area = increased rate of reaction** **Smaller pieces** of material have a larger surface area More reacting particles are **exposed** to collisions. This means there are more **frequent successful collisions**
Catalyst	Catalysts are chemicals added to the reaction which lower **the activation energy**. Th



Measuring rates of reaction

Calculation	Rate of reaction (g/s) = amount of reactant used or product formed (g) / Time taken (s)
Precipitation	Disappearing cross practical - time it takes a clear solution to go **cloudy.**
Change in mass	Use a balance to measure **mass** at start and end of reaction.
Volume of gas	Use a **gas syringe to** collect and measure gas released.

Reversible Reactions

Reversible reaction	A reversible reaction is one where the products of the reaction can themselves react to produce the original reactants. $A + B \rightleftharpoons C + D$
Energy in reversible reactions	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	When the forward and reverse reactions occur at exactly the **same rate.**
Le Chateliers Principle (HT)	If a system is at equilibrium and a **change** is made to any of the conditions, then the system responds to **counteract the change**.
Effect of concentration (HT)	If the concentration of a reactant is **increased,** more products will be formed until equilibrium is reached again. If the concentration of a product **is decreased,** more reactants will react until equilibrium is reached again.
Effect of Increased temperature (HT)	The amount of products at equilibrium **increases for an endothermic** reaction and the amount of products at equilibrium **decreases for an exothermic reaction.**
Effect of decreased temperature (HT)	The amount of products at equilibrium **decreases for an endothermic** reaction and the amount of products at equilibrium **increases for an exothermic reaction.**
Effect of pressure (HT)	An increase in pressure causes the equilibrium position to shift towards the side with the **least molecules** and a decrease in pressure causes the equilibrium position to shift towards the side with the **most molecules**.

Organic chemistry

Crude Oil

Crude oil	**Mixture** of different length **hydrocarbon** chains
Hydrocarbon	A molecule made up of **hydrogen and carbon** only
Fractional distillation	A process used to **separate crude oil** into fractions that contain the same number of carbon atoms. 1. Crude oil is **heated** to 350 degrees 2. Crude oil **evaporates** and vaporises 3. Short chains travel to the top of the column longer chains sink to the bottom 4. Different length chains will condense at their **boiling points**

Fraction	Use	
Gas	Cooking	Short chains
Petrol	Cars	
Naphtha	Chemicals	
Kerosene	Aircraft	
Diesel	Larger vehicles	
Lubricating oil	Oils, waxes and polishes	
Fuel oil	Fuel for ships	Long chains

Long hydrocarbon molecules	Small hydrocarbon molecules
Difficult to ignite	Easy to ignite
Difficult to pour (viscous)	Easy to pour
High melting point	Low melting point
Not as much demand	More in demand (more useful)

Cracking

Cracking	A process used to **break large hydrocarbon** molecules into smaller more **useful** hydrocarbon molecules
Steam Cracking	**Heat** the long chain HC to vaporise it and mix with steam and heat to very high temperatures
Catalytic cracking	Heat the long HC chain to vaporise it and pass over a **catalyst** e.g. aluminium oxide
Products of cracking	Cracking produces a smaller **alkane and an alkene**
Alkane	A hydrocarbon with **single bonds** between the carbon atoms. Crude oil is made up of alkanes
Alkene	Is a hydrocarbon with at least one **double bond** between the carbon atoms

Alkanes	Alkenes
General Formulae CnH2n+2	**General Formulae CnH2n**
Test: Bromine water remains orange when tested with a alkane	**Test: Bromine water goes from orange to colourless when tested with a alkene**
Methane CH_4	-
Ethane C_2H_6	Ethene C_2H_4
Propane C_3H_8	Propene C_3H_6
Butane C_4H_{10}	Butene C_4H_8

Polymers

A polymer is a really long chain that is made from small repeating units joined together called monomers.

Lots of Alkene molecules (monomers) open their double bonds and join together to form a really long chain. Lots of Butene molecules Polybutene

Energy changes

Crude Oil

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Chemical analysis

Purity and Formulations

Pure substance	Only contains **one element or compound**
	Not mixed with anything else
	Tested for using **melting point or boiling point**. A pure substance melts / boils at a specific temperature.
Formulations	A **useful mixture** with a precise **purpose**

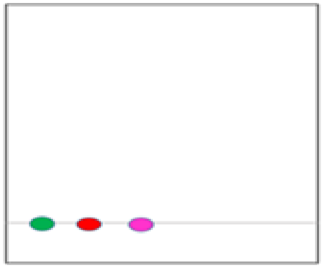
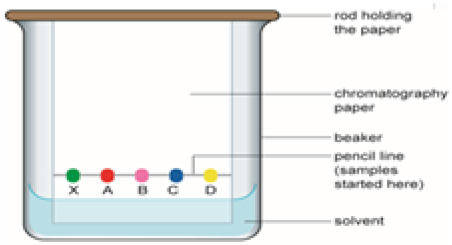
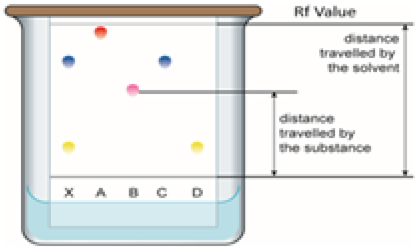
Chromatography

Chromatography	Used to **separate** and identify components of **mixtures** e.g. ink, paints, dyes and food colouring
Rf value	$\frac{\text{Distance travelled by substance}}{\text{Distance travelled by solvent}}$
Mobile phase	Where the molecules can move, e.g. **the solvent**
	The more time spent in the mobile phase the higher the spot moves up the paper
Stationary phase	Where the molecules cannot move, e.g.

Gas Tests

Oxygen, O_2	Relights a **glowing splint**
Chlorine, Cl_2	Bleaches **damp litmus** paper
Hydrogen, H_2	Insert a **lit splint** into the gas
	Makes a "**squeaky pop**" sound
Carbon dioxide, CO_2	Bubble gas through **limewater** (calcium hydroxide in water)
	Turns **cloudy**

Paper Chromatography Method

Step 1	Pencil line drawn 1 cm from the bottom of the chromatography paper (pencil is insoluble so will not travel up the chromatography paper)	
Step 2	Spot of ink on pencil line and allow to dry	
Step 3	Paper placed into beaker containing a solvent, e.g. water A lid prevents solvent evaporation	
Step 4	Solvent rises taking the ink with it More soluble compounds are carried further up the paper, so the compounds spread out	

Atmosphere

1. Early Atmosphere

Early atmosphere	How it changed
Formed by volcanoes	Water vapour condensed as Earth cooled
Large volumes of carbon dioxide and water vapour	Carbon dioxide dissolved in oceans
	Carbon dioxide is locked up in sedimentary rocks
Very little oxygen	Algae and plants photosynthesise increasing oxygen volumes
Small volumes ammonia and methane	Nitrogen released as ammonia reacts with oxygen

2. Atmosphere today

The same for 200 million years

Gas	Percentage (%)
Nitrogen	78
Oxygen	21
Argon	0.9
Carbon dioxide and others	0.04

3. Carbon Footprint

A measure of the amount of carbon dioxide released over the lifetime of the product

Reduce carbon emissions by using renewable energy or taxing those who produce carbon dioxide

4. Greenhouse Effect

Greenhouse gases are **carbon dioxide**, **methane**, and **water vapour.**

Greenhouse gases trap heat so the temperature on Earth is high enough to live on.

1. Sun emits short wave radiation that passes through the atmosphere.
1. Radiation reflected as long wave from the Earth's surface.
1. Long wave radiation absorbed by greenhouse gases and radiated in all directions.
1. Long wave radiation is thermal radiation, so results in warming of the Earth's surface. This is the **greenhouse effect**.

5. Climate Change

Increasing the volumes of greenhouse gases affects the Earth's climate.

Average **temperatures are increasing** as human activity releases greenhouse gases.

Burning fossil fuels	Release carbon dioxide and sulphur dioxide
	Carbon dioxide is a greenhouse gas
Deforestation	Cutting down trees means less carbon dioxide is removed due to photosynthesis
Agriculture	Farm animals and rice fields produce methane

6. Effects of pollution

Polar ice caps melt	Increased sea levels, loss of habitat and coastal erosion
Rainfall levels change	Causes floods and droughts which impact food production Storms are more severe
Temperature change	Affect wild species of animals and plants

Other gases are released when fossil fuels are burnt:

Sulphur dioxide	Causes acid rain, damages plants, buildings, and turns lakes acidic
Carbon monoxide	Toxic odourless gas, binds to haemoglobin
Carbon particulates (soot)	Causes global dimming
Nitrogen oxides	Causes respiratory problems and acid rain