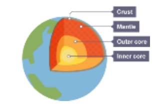
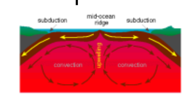
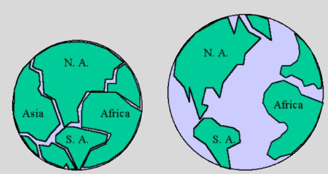
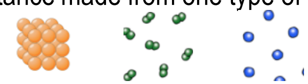
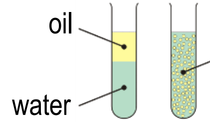
C1 Atmosphere and Earth Chemistry Knowledge Organiser

Which gases were released into the atmosphere by volcanoes?	Carbon dioxide, ammonia, methane and steam 	Give a use for argon, oxygen, nitrogen.	Nitrogen: store sperm and food; oxygen in hospitals for breathing; argon in light bulbs.
How did the oceans form?	Steam condensed when the Earth's atmosphere cooled. 	What is the composition of today's atmosphere?	79% nitrogen, 21% oxygen, 0.03% carbon dioxide, 1% argon
Where did oxygen come from?	Plants absorbed carbon dioxide during photosynthesis and released oxygen. 	What is the structure of the Earth?	Inner core = solid iron and nickel; outer core = molten iron and nickel, mantle: hot, molten rock; thin crust made of rock. 
Where did nitrogen come from?	Oxygen reacted with ammonia to produce water and nitrogen.	What causes earthquakes?	Radioactive processes inside the core release energy that drive convection currents inside the mantle which causes the plates of the crust to move suddenly. 
What happened to carbon dioxide that was in the atmosphere?	It dissolved in the oceans. It reacted with other chemicals to make limestone rocks and sea shells.		
Why does no-one know how life on the Earth began?	There was no life at the beginning. (diagram: Pangaea = supercontinent) 	How do islands form?	Plates move apart and lava rises to fill the gap.
Give two theories that describe how life on Earth began.	Murchison meteor brought life to Earth. Life started near volcanic vents on the seabed.	Why are not all earthquakes reported?	To avoid mass panic; not all cause enough damage to be significant
Describe the Miller Urey experiment.	They mixed water, ammonia, methane and hydrogen and produced a high voltage spark to simulate lightening. Left the mixture for several weeks. The resulting mixture contained 11 amino acids. Amino acids contain N, H, C, O.	Why are scientists unable to predict earthquakes and why don't they always evacuate?	Evacuations are expensive. Scientists cannot see what goes on below the crust. They cannot measure the forces that build up and know when these forces have reached their limit.
Describe fractional distillation of air.	Air is compressed and cooled to -200°C. Carbon dioxiode and water are removed as they would otherwise block the pipes. At -200°C nitrogen, argon and oxygen are liquid. The air is slowly warmed back up. Nitrogen boils off first and is collected. Next it is argon, and oxygen is left behind.	Describe the work of Alfred Wegener 	He suggested that all continents were once joined in a super continent (Pangaea) and moved apart a few cm every year for millions of years. His evidence: continents fit together like jig-saw pieces, similar rocks and fossils are found on continents that are far apart. His ideas were only accepted when ocean floors were mapped in the 20th century. Other scientists thought continents had been linked by land bridge that were flooded.

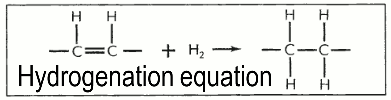
C1 Ethanol, Fundamental ideas

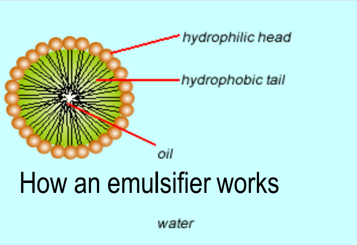
Mass number	Number of protons + neutrons	Ethanol formula	C_2H_5OH
Why are chemical equations balanced?	Because of the law of conservation of mass. Atoms cannot be created or destroyed which means you need to have the same number of each type of atom on both sides of the equation.	Describe fermentation to produce ethanol	Dissolve sugar in warm water. Add yeast. Seal the container with cotton wool to ensure no oxygen enters but the carbon dioxide can escape. The enzyme in yeast converts the sugar to carbon dioxide and ethanol during anaerobic respiration.
Atomic number	Number of protons	Equation for fermentation	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
Compound	Two or more different types of atoms chemically bonded. 	Uses of ethanol from fermentation	Alcoholic beverages (the ethanol produced is impure which adds taste to the alcohol); bioethanol fuel
Element	Substance made from one type of atom only. 	Describe hydration to produce ethanol	First, crack long alkanes to produce ethene. Then mix ethene with steam and pass over a hot phosphoric acid catalyst.
Mass of protons, electrons, neutrons	Protons = 1; Neutrons = 1; Electrons = 0	Equation for hydration	$C_2H_4 + H_2O \rightarrow C_2H_5OH$
Describe an atom	Positive nucleus that contains protons and neutrons surrounded by electrons that are found on shells.	Uses of ethanol from hydration	Ethanol produced via hydration is pure. For this reason it is used as a solvent for varnishes and perfumes; used as a fuel.
Electron configuration	Shows where the electrons are found. 2 electrons fit onto the first shell, 8 electrons fit onto the other shells. E.g. K = 2,8,8,1 and O = 2,6	Advantages of fermentation	Simple process; cheap process; bioethanol is a carbon neutral fuel; bioethanol is a renewable fuel as the raw material is plants. This means crude oil is preserved. Harvest time creates jobs.
Describe the purpose of the Periodic Table	Arrangement of atoms in order of atomic number. Atoms in the same group have the same number of electrons in the outer shell. Atoms in the same period have the same number of shells.	Disadvantages of fermentation	Batch process; slow process; yeast is destroyed and has to be replaced; land is used to grow crops for bioethanol instead of crops being a food source; habitats are destroyed to create farm land.
Why are all atoms neutral?	Because the number of protons = the number of electrons in an atom.	Advantages of hydration	Fast; continuous (24/7) process; no waste product formed; ethanol is 100% pure and can be used in industry.
How are compounds formed?	Atoms either lose/gain electrons to make ions ore atoms share electrons to make covalent bonds.	Disadvantages of hydration	Needs crude oil to create ethene; crude oil is non-renewable so reserves are depleted; crude oil can be spilled during transport and harm wild life; cracking requires large amounts of energy

C1 Fats, Oils, Emulsions

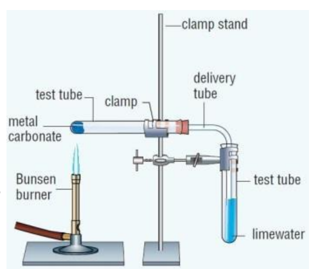
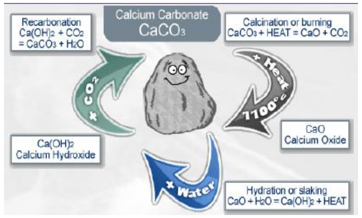
Why are fats added to food?	Fats are energy stores.	Define immiscible	Not mixable
Why do we cook with food?	Cooking with fat is faster than with water; it adds texture, flavour and colour to the food; it adds vitamins to the food.	What is an emulsion?	A mixture of two immiscible substances. (E.g. when oil and water are mixed and shaken, an emulsion forms. 
What is a saturated fat?	A fat that contains only carbon-carbon single bonds	Properties of an emulsion	Emulsions are opaque and thicker.
What is an unsaturated fat?	A fat that contains carbon-carbon single bonds as well as carbon=carbon double bonds	Describe an emulsifier	A chemical that is added to an emulsion to prevent the two immiscible liquids from separating.
Which fats are healthier, saturated or unsaturated?	unsaturated	Explain how an emulsifier works	The hydrophilic head bonds to the water and the hydrophobic tail bonds to the oil droplet.

Disadvantages of cooking with oil?	Food absorbs fat which increases the energy content of the food.
How are oils extracted from seeds?	Crush the seeds; press the seeds to extract the oil; Add a solvent to absorb impurities; evaporate the solvent so the pure oil is left behind.
How are oils extracted from plant material, such as flowers?	Steam distillation: steam is passed through flowers. Steam and oil vapour rise up and are cooled and condensed. The oil now floats on top of the water. The water is run off and the oil is left behind.
How do you turn an unsaturated fat into a saturated fat?	Hydrogenation (adding hydrogen)
What are saturated fats used for?	Spreads; baking & cooking
Describe hydrogenation	The oil is heated to 60ºC and mixed with a nickel catalyst. Hydrogen is bubbled through the mixture. The hydrogen is added to the double bond. A saturated hydrocarbon/fat is formed.





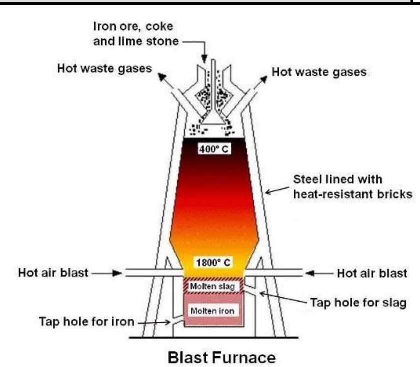
C1 Limestone

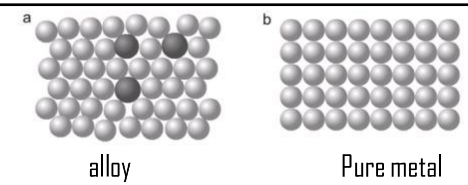
Limestone uses	Bricks, statues, cement, mortar, concrete, bread, toothpaste	How calcium oxide is produced in the limestone cycle	Thermal decomposition of the limestone
Reasons for mining limestone	Creates jobs, workers spend money in local area = boost to local economy, better transport links are created to access mine	Calcium hydroxide paste common name	Slaked lime
Reasons against mining limestone	Loss of habitat, noise pollution from blasting, dust pollution, air pollution from increased traffic	Calcium hydroxide solution common name	Limewater
Chemical name of limestone	Calcium carbonate	Calcium hydroxide formula	$Ca(OH)_2$
Chemical formula of limestone	$CaCO_3$	How calcium hydroxide paste is produced in the limestone cycle	A small amount of water is added to quicklime ($CaO + H_2O \rightarrow Ca(OH)_2$)
Thermal decomposition definition	Breaking down a chemical using heat	How calcium hydroxide solution is produced in the limestone cycle	A lot of water is added to quicklime or slaked lime
Thermal decomposition of limestone	$CaCO_3 \rightarrow CaO + CO_2$	How calcium carbonate is produced in the limestone cycle	Carbon dioxide is bubbled through limewater.
Thermal decomposition of copper carbonate	$CuCO_3 \rightarrow CuO + CO_2$ (colour change from green solid to black solid)	Slaked lime uses	Plaster
How to investigate the thermal decomposition of a metal carbonate	Heat metal carbonate in a test tube. Start the stop clock when you start heating. Stop timing when the limewater turns cloudy. NOTE: a few bubbles formed at the start are just air. 	Why lime mortar (calcium hydroxide paste) hardens over time	The calcium hydroxide reacts with the carbon dioxide in the air to form solid calcium carbonate. Any water evaporates into the air over time. 
Calcium oxide formula	CaO	What is chemical weathering?	Metal carbonates reacting with acid
Calcium oxide common name	Quicklime	How to make cement	Heat powdered limestone with powdered clay
How to make concrete	Mix cement, sand, water, aggregate	How to make mortar	Mix sand, cement, water
Advantages of concrete	Can be poured into different shapes, can be reinforced to make it stronger, can be painted	Disadvantages of concrete	Ugly

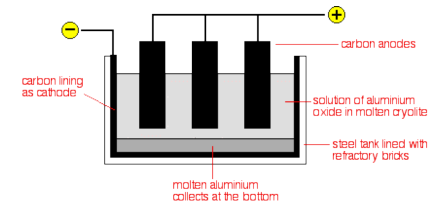
C1 Metals I

Native	Unreactive metals that are found by themselves in the ground. E.g. gold, silver, copper.
Ore	Mineral or rock with enough metal or metal compound to make it economically worthwhile extracting
Alloy definition	Mixture of metal with another metal or non-metal
Why pure metals are soft	Atoms are arranged in neat layers which can slide
Why alloys are harder than pure metals	Layers are distorted as atoms are of different size. The layers do not slide
Reduction	Using carbon to remove oxygen from a metal oxide
Blast Furnace procedure	Coke, iron ore and limestone enter the blast furnace from the top. Hot air is blown into the furnace. Coke reacts with oxygen from the air to form carbon dioxide. Carbon dioxide reacts with more coke to make carbon monoxide. Carbon monoxide reacts with the iron oxide ore to form molten iron and carbon dioxide. Limestone reacts with impurities to form slag. The slag floats on top of the molten iron.
Stainless Steel	Alloy of iron, nickel and chromium. Corrosion resistant and used to make cutlery and sinks.
How steel is made	Iron from the blast furnace (called pig iron) is too brittle as it contains too much left over carbon from the coke. Oxygen is bubbled through the pig iron. Oxygen reacts with some of the carbon to make carbon dioxide. The carbon content is reduced to below 4%.
High carbon steel properties and uses	Because it is hard and strong but still quite brittle, it is used to make tools.

Low carbon steel properties and uses	This steel is softer and more easily shaped. It is used to make car bodies, machinery or ships.
Why metals need to be recycled	Metals are non-renewable resources and unless we recycle metal objects, we will run out of metals. Recycling also saves 95% energy.
Which metals are extracted by electrolysis	Metals that are above carbon in the reactivity series.
Definition of electrolysis	Using electricity to break down a metal compound.
Which metals are extracted by reduction	Metals that are below carbon in the reactivity series (apart from the native metals)
Why titanium and aluminium are expensive	They require electrolysis to be extracted. Electrolysis requires large amount of energy. The process is also long and expensive raw materials such as argon and magnesium are needed in the extraction process.
Advantages of titanium and aluminium alloys	Both alloys are corrosion resistant, very strong and have a low density.
Titanium alloy uses	Titanium is used for hip replacements, racing bikes and space vehicles.



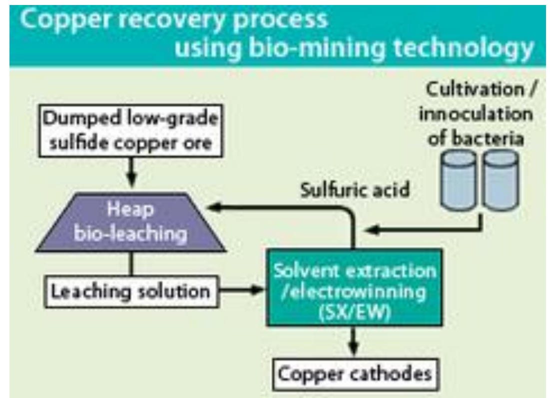


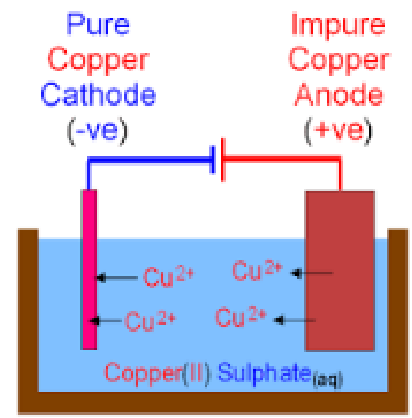


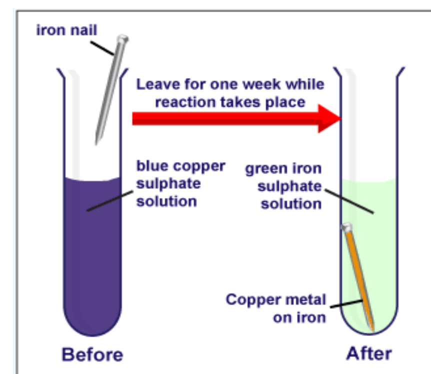
C1 Metals II

High grade ore	Copper rich ore
Low grade ore	Ore low in copper
Smelting	Ore is heated in a furnace
Copper properties	Good conductor of heat and electricity; shiny, ductile, malleable, golden in colour; unreactive
Copper uses	Pipes, wires, cooking pots
Brass	Copper and zinc alloy (used to make instruments)
Bronze	Copper and tin alloy (used to make statues)
Why we need to extract copper via phytomining and bioleaching	Mines are running out of high grade copper ores. Low grade ores need new extraction methods. Mines are environmentally unfriendly and the new extraction methods avoid the loss of habitats.
Phytomining process	Plants are planted on soil that contains copper compounds. The copper compounds are absorbed through the roots. The plants are burned and the ash that is left behind contains the desired copper compounds. The ash is dissolved in acid to form a copper solution (e.g. ash + sulfuric acid = copper sulfate solution). Electrolysis is used to extract the copper from the copper sulfate.
Bioleaching process	Bacteria are sprayed over low grade copper ore. The bacteria produce a waste product called leachate. The leachate solution contains dissolved copper ions. Electrolysis is used to extract the copper from the leachate.
How scrap iron is used in the copper extraction	Iron is more reactive than copper. Scrap iron is added to the leachate or copper sulfate solution from bioleaching and phytomining. The iron replaces the copper to form pure copper and an iron solution. Scrap iron is cheap and easily available from scrap yards.

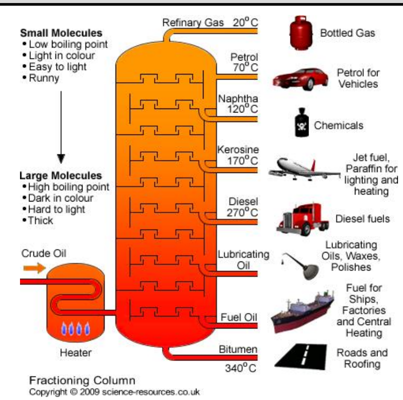
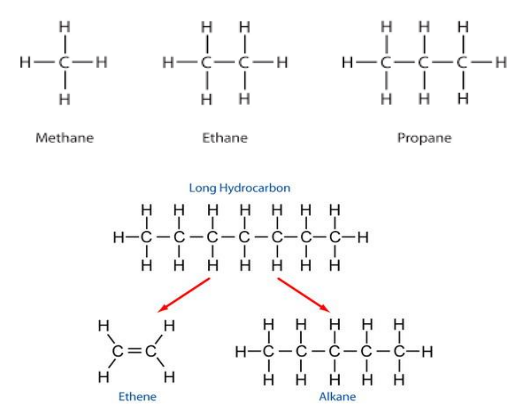
How copper is purified via electrolysis	A copper anode and copper cathode are placed into the leachate or copper sulfate solution. The copper sulfate solutions contains copper ions. The positive copper ions move to the negative cathode where they accept 2 electrons each and form copper atoms. Copper atoms from the anode dissolve into solution. The process finishes, when the anode has fully dissolved into solution.



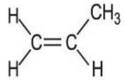
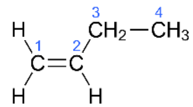
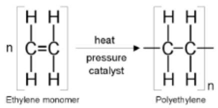
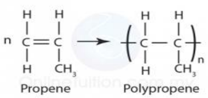




C1 Crude Oil, Cracking, Polymers I

What is crude oil?	A mixture of different hydrocarbons	What is produced when fuels combust incompletely?	Carbon monoxide
What is a hydrocarbon?	A compound made of hydrogen and carbon ONLY	Problems caused by carbon dioxide and carbon monoxide	Carbon dioxide: global warming Carbon monoxide: toxic
Alkane definition	Saturated hydrocarbons with the general formula C_nH_{2n+2};	Other pollutant gases produced by burning fuels & the impact of the gases on health and the environment	Sulfur dioxide: acid rain; SO_2 is removed from chimney gases by reacting it with $CaO/Ca(OH)_2$ Nitrogen oxides: asthma, acid rain; nitrogen oxides are formed when nitrogen and oxygen from the air react in the engine due to the spark produced in the engine to ignite the fuel Particulates (soot): global dimming
Saturated	Hydrocarbon with only C-C single bonds	Define cracking	Breaking large alkanes into small alkanes and alkenes
What makes a good fuel	Ignites easily, burns slowly, releases large amounts of energy, not toxic, easy to store, little waste product left behind	Define polymerisation, monomer and polymer	Monomer: alkene used to make a polymer Polymer: many monomers joined together Polymerisation: many monomers link together by opening up their double bond to form carbon-carbon single bonds to link the monomers
Trends in properties of alkanes	Short alkanes have low melting and boiling points as there are only weak intermolecular forces between the molecules which are easily overcome. The longer the alkane, the darker the colour, the more viscous and the less volatile the substance.	Define fraction	The collection of hydrocarbons with similar boiling points is called a fraction.
		Define fractional distillation of crude oil	Separation of a mixture of hydrocarbons based on the difference in their boiling points.
Describe the process of fractional distillation	Crude oil is heated and vaporised. The vapour enters the fractional distillation column at the bottom. The column is hotter at the bottom and gets colder towards the top. The crude oil vapours rise. When the hydrocarbon vapours reach their boiling point (which is also their condensing point), they condense. Small hydrocarbons have a low boiling point and condense near the top (some vapours never condense, these vapours come out at the top). Some hydrocarbons never vaporise; they stay at the bottom of the column.		

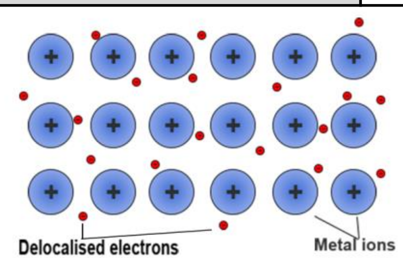
C1 Crude Oil, Cracking, Polymers II

Alkene definition	Unsaturated hydrocarbon with formula C_nH_{2n}	Reasons for cracking	Large alkanes are in high supply but low demand; small alkanes are in low supply but high demand
Unsaturated	Hydrocarbon that also contains C=C double bonds	Catalytic cracking	Large hydrocarbons are heated and vaporised and passed over a hot catalyst (e.g. broken porcelain)
Name and formula of first 5 alkanes	Methane CH_4, Ethane C_2H_6, Propane, C_3H_8, Butane C_4H_{10}, Pentane C_5H_{12}	Steam cracking	Large hydrocarbons are mixed with steam and heated to very high temperatures to crack
Name and formula of first 4 alkenes	Ethene C_2H_4, Propene C_3H_6, Butene C_4H_8, Pentene C_5H_{10}  	How to distinguish between alkanes and alkenes	Add orange bromine water and shake. If the bromine water decolourises, an alkene was present. No colour change indicates that an alkane was present.
What is produced when fuels combust completely?	Carbon dioxide and water e.g. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$	How to draw a polymer from a monomer and how to name the polymer	 
Problems caused by non-biodegradable polymers	They use up landfill space which we are running out of. They can blow easily into habitats where they might suffocate or poison animals.  	What are smart polymers?	Polymers that change their properties due to a change in the environment. E.g. hydrogels swell when in contact with water. They are used in nappies and wound dressings. Shape memory alloys change shape when exposed to heat. They are used to stitch wounds. As they warm up, they tighten and close the wound.
Define biodegradable plastics	Plastics that can be broken down by micro-organisms.	Disadvantages and advantages of biodegradable polymers	As these plastics can be broken down by micro-organisms, they do not use up landfill space or kill wildlife. Crops are needed to make these polymers- this causes food shortages and a rise in food prices. Habitats are destroyed to create more farm land.
Recycling advantages and disadvantages	Adv: saves energy, less carbon dioxide is released, crude oil reserves preserved Disadv: plastics need to be transported from recycling station to recycling factory where they need to be sorted and cleaned.	How to dispose of plastics	Landfill Recycling Burning to create energy to heat homes (burning can however produce toxic by-products such as HCl
Homologous series	Compounds with the same general formula that differ by a CH_2 group from one molecule to the next	Polymers and their uses	Teflon- non stick so used to coat frying pans Polypropene – hard,stiff so used to make crates Polyethene – can be shaped: shopping bags

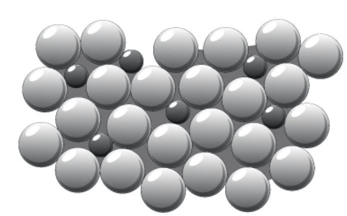
C2 New materials, Metals, Alloys Knowledge Organiser

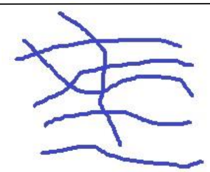
Nanoparticle	Particle the size of 1-100nm	Why metals conduct heat	The delocalised electrons can travel through the metal structure and pass on energy.
Nanoparticle vs atom	Atoms are smaller than nanoparticles.	Why metals conduct electricity	The delocalised electrons can travel through the metal structure and carry charge through the metal.
Nanoparticle vs bulk material	Nano particles are much smaller than bulk materials. E.g. gold nanoparticles are smaller than gold items such as gold bars.	Polymer	Long chain of atoms made when many monomers join. The double bond in the monomers opens to allow the monomers to link to make a polymer.
Nanoparticles properties	They have a larger surface area than bulk materials	Thermoplastic polymers	Plastics that are made of long polymer chains that have weak intermolecular forces between the chains.
Nanoparticle uses	Catalysts (only a little material is needed as the surface area is so large)/ Added to sun creams as the nanoparticles can get deeper into the skin and don't leave a white film/ good lubricants as they can get better into small gaps	Thermoplastic polymer properties	Low melting points as little energy is needed to break the weak intermolecular forces between the chains. This allows the chains to slide over each other.
Nanoparticle dangers	Are so small they might enter the blood stream and cause damage inside the body. Might be inhaled and cause lung damage.	Thermosetting polymers	Plastics that are made of long polymer chains that have cross links (covalent bonds) between the chains.
Alloy	Mixture of a metal and other metals or non metals	Thermosetting polymers properties	High melting points & strong as the cross links are strong. A lot of energy is needed to break cross links.
Alloys properties	The atoms in alloys are different sizes. This distorts the layers. The layers can no longer slide past each other hence alloys are stronger than pure metals.		
Smart alloys	These are alloys that can be bent into different shapes. When heated they return to their original shape by themselves. Useful in dentistry		
Metallic bond	Electrostatic attraction between positive metal ions and sea of delocalised electrons.		
Why metals are malleable & ductile	The atoms are arranged in layers that can slide past each other.		

Metal structure

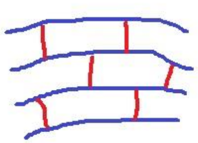


Alloy structure



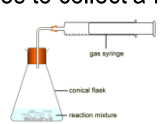


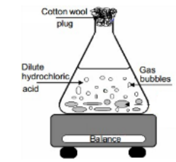
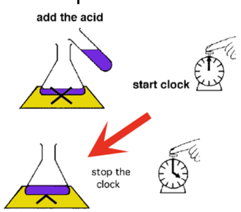
Thermosoftening

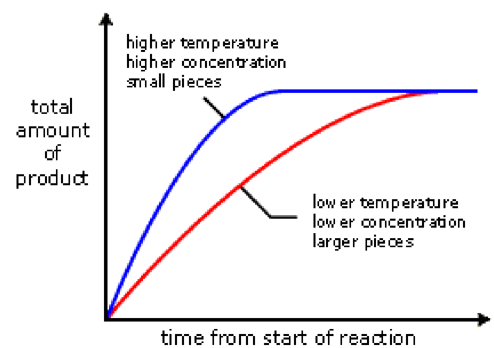


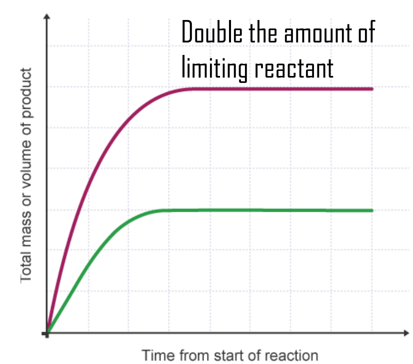
Thermosetting

C2 Rate of Reaction

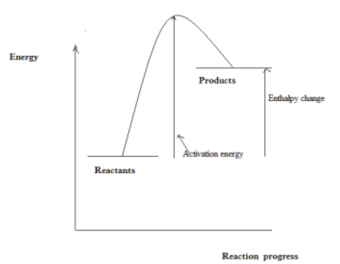
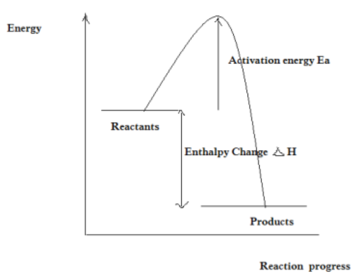
Collision theory	For a reaction to take place, particles must collide with the correct orientation and with enough energy to start the reaction
Activation energy	The minimum amount of energy needed to start the reaction
Rate	Change in concentration or volume / change in time
Concentration change and rate	The higher the concentration, the faster the rate because there will be more particles present and therefore more frequent successful collisions.
Temperature change and rate	The higher the temperature, the faster the rate. The particles will have more energy and move faster. More particles will have the required activation energy. As a result there will be more frequent successful collisions.
Surface area change and rate	Going from large lumps to small powder increases the surface area. More particles are exposed and as a result there will be more frequent successful collisions. This increases the rate.
What is a catalyst	A substance that speeds up the rate of reaction without being used up itself
How does a catalyst work	It provides an alternative reaction pathway. This new pathway has a lower activation energy. As a result more particles now have the activation energy and there will be more frequent successful collisions.
How to measure rate when a gas is produced	Use a conical flask connected to a gas syringe. Time how long it takes to collect a fixed volume of gas. 

Observations for the acid and magnesium experiment	Fizzing (hydrogen gas is produced); the magnesium piece disappears
How to measure the rate of reaction for the acid-magnesium experiment using a balance	Place a conical flask with acid onto a balance. Place the magnesium next to the flask. Record the mass. Add the magnesium to the acid and add a cotton plug to avoid splashing. Time how long it takes to lose a fixed mass of gas. 
Describe the black cross experiment	In a conical flask mix hydrochloric acid and sodium thiosulfate. Place the flask on a black cross and time how long it takes until you can no longer see the black cross. Repeat, but either change the concentration or temperature of sodium thiosulfate. 
Observations for the black cross experiment	A yellow precipitate of solid sulfur is formed (the solution goes cloudy as a result).

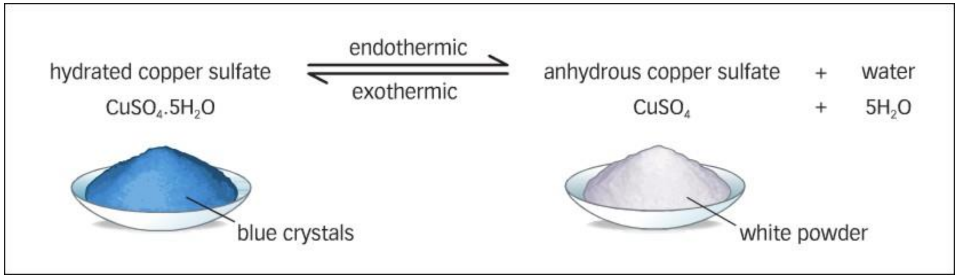




C2 Energy changes and reversible reactions

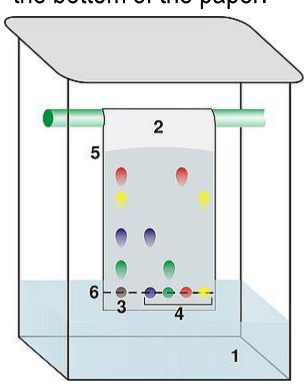
Endothermic definition	Energy is transferred from the surroundings to the reacting chemicals
Exothermic definition	Energy is transferred from the reacting chemicals to the surroundings
How to recognise an endothermic reaction	The temperature/thermometer reading goes down, the reaction vessel feels cold; there are endothermic reactions that differ: some reactions need to be heated constantly (thermal decomposition)
How to recognise an exothermic reaction	The temperature/thermometer reading goes up, the reaction vessel feels hot; sometimes light is produced
Exothermic reaction examples	Combustion, neutralisation, respiration
Endothermic reaction examples	Thermal decomposition, photosynthesis, dissolving sherbet
Endothermic energy profile diagram	
Exothermic energy profile diagram	

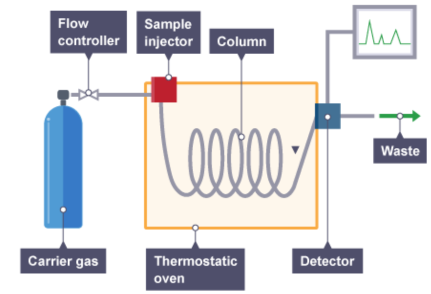
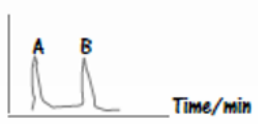
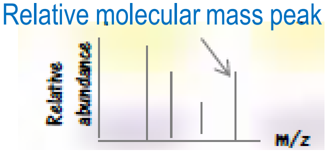
Colour of hydrated copper sulfate	Blue
Colour of anhydrous copper sulfate	White
How to change hydrated copper sulfate into anhydrous copper sulfate	Heat the blue copper sulfate in a test tube until it is white. You will see steam as the water is driven off the blue copper sulfate. This reaction is an endothermic process.
How to change anhydrous copper sulfate into hydrated copper sulfate with observations	Add water to the white copper sulfate. You will hear a hiss as the reaction is exothermic and the heat released evaporates some of the water you add.



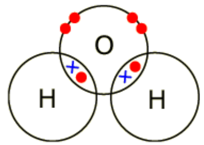
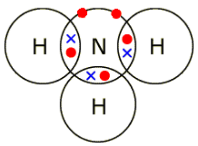
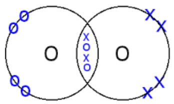
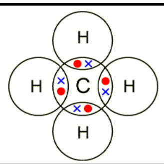
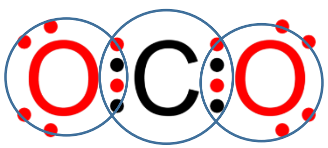
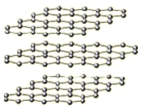
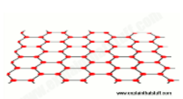
In an exothermic reaction, energy is released into the surroundings as heat. As a result, the temperature of the surroundings increases.

In an endothermic reaction, energy is absorbed from the surroundings. As a result, the temperature of the surroundings drops.

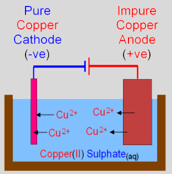
Advantages of instrumental methods	Faster than experimental methods; you only need a small sample; results are more accurate.
Disadvantages of instrumental methods	Instrumental methods require specialist training (expensive) and you need a known data base to compare results to.
How to interpret a paper chromatogram	The number of dots/spots tells you how many dyes a colour is made of. The level of each dot/spot tells you which dye is contained.
What is chromatography	Method to separate a mixture of soluble substances.
What is a food additive	Substance added to food to improve colour, taste, appearance and shelf life (preservatives are added).
How to carry out paper chromatography	Draw a pencil line 1cm from the bottom of the paper (pencil will not smudge). Transfer the colour investigated onto the pencil line. Place the paper into the solvent so that only the tip of the paper touches the solvent (if the pencil line is submerged in water, the colour will wash off instead of rising up the paper). Place a lid over the beaker (to prevent evaporation of the solvent). Wait until the solvent has risen up the paper. The dye that dissolves best in the solvent rises furthest. The dye that dissolves least stays near the bottom of the paper.  1 Solvent 2 paper 3 known colour 4 unknown colours 5 solvent line 6 pencil line

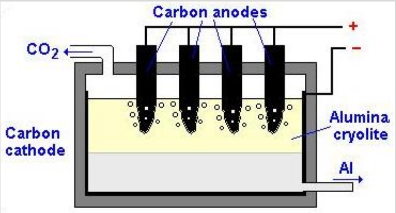
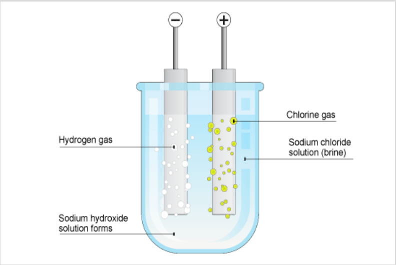
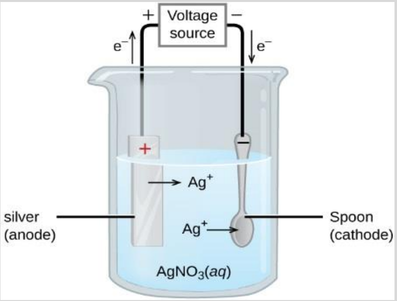
Describe gas chromatography	A mixture of volatile compounds is injected and vaporised. An inert (unreactive) carrier gas carries the vapours through a column inside an oven. Inside the column the mixture separates. As each component of the mixture leaves the column, it is detected by a machine. The machine prints out a chromatogram. 
How to interpret a gas chromatogram	Height of the peak = amount of the component in the mixture Time = retention time = how long the component took to travel through the column. The retention time can be looked up in a data book to identify the component. Number of peaks = how many components were in the mixture 
What is a mass spectrum	Two components could have the same retention time. To distinguish between the components, a mass spectrum is run to identify the relative molecular mass of the component. The relative molecular mass is the peak furthest to the right: Relative molecular mass peak 

C2 Covalent bonding

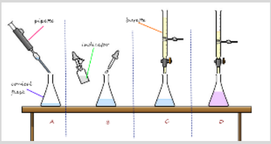
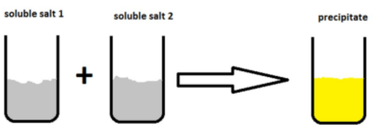
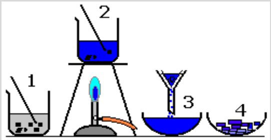
Define simple molecule	A small group of atoms bonded together by strong covalent bonds.	Why graphite conducts electricity	Each carbon atom forms three covalent bonds with other carbon atoms. This leaves one electron per atom free to move between the layers and through the structure.
Dot and cross diagram for water		Why graphite is a solid and has a high melting point	It forms a giant lattice with many strong covalent bonds that need to be broken to melt graphite.
Dot and cross diagram for NH_3 ammonia		Why graphite is soft and slippery	Graphite is made of layers which are held together by weak intermolecular forces. These intermolecular forces are easily overcome which allows the layers to slide under pressure.
Dot and cross diagram for oxygen O_2		Why diamond does not conduct electricity	Each carbon atom is bonded to four other carbon atoms leaving no electron free to move through the structure.
Dot and cross diagram for methane CH_4		Why diamond is hard	It forms a giant lattice with many strong covalent bonds.
Dot and cross diagram for carbon dioxide CO_2		Why diamond has a higher melting point than graphite	Each carbon atom in diamond is bonded to four other carbon atoms. In graphite, each carbon atom is only bonded to three other carbon atoms. It takes more energy to break 4 bonds per carbon atom in diamond than 3 bonds per carbon atom in graphite.
Covalent bond definition	Shared pair of electrons	Why simple covalent molecules do not conduct electricity	They don't have free electrons.
Why boiling and melting points of simple molecules are low	There are only weak intermolecular forces between the molecules. It takes little energy to overcome these forces and separate the molecules (note, the covalent bonds are not broken)	Which type of elements combine to form covalent structures?	Non-metals
Draw diamond and graphite and graphene	  	Define giant covalent structure	Huge number of atoms held together by a network of strong covalent bonds. (e.g. graphite, diamond, silica [sand], graphene)

C2 Ionic compounds & Electrolysis

Which elements combine to form ionic compounds?	Metal and non-metal
What is an ionic bond?	Electrostatic attraction between oppositely charged ions
How is an ionic compound such as $MgCl_2$ formed?	Each magnesium atom loses two electrons to form a Mg^{2+} ion. Each chlorine atom gains one electron forming $2Cl^-$ ions. The ions attract.
Explain why melting and boiling points of ionic compounds are high	Ionic compounds form a giant ionic lattice with strong electrostatic attractions between the oppositely charge ions. A lot of energy is needed to separate the ions and break the strong bonds.
Explain why solid ionic compounds cannot conduct electricity	The ions are fixed in place and cannot move.
Explain why molten or dissolved ionic compounds can conduct electricity	The ions are now free to move and carry charge to the oppositely charged electrode.
Define oxidation and reduction	Loss of electrons = oxidation Gain of electrons = reduction
Define electrolysis	Splitting an ionic compound using electricity
Charge of the anode Charge of the cathode	Positive (anions are negative & move to anode) Negative (cations are positive & move to cathode)
Describe how copper is purified 	Use impure copper as the anode. Use pure copper as the cathode. Fill the beaker with copper sulfate solution. Copper from the anode will form copper ions and go into the solution: $Cu \rightarrow Cu^{2+} + 2e-$. Copper ions will travel to the cathode, gain two electrons and form solid copper: $Cu^{2+} + 2e- \rightarrow Cu$

Which reaction happens at the anode	Negative anions lose electrons at the anode = oxidation: $2Cl^- \rightarrow Cl_2 + 2e-$; $2O^{2-} \rightarrow O_2 + 4e-$
Which reaction happens at the cathode	Positive cations gain electrons at the cathode = reduction: $Mg^{2+} + 2e- \rightarrow Mg$; $2H^+ + 2e- \rightarrow H_2$
Describe the electrolysis of aluminium oxide (bauxite) 	Bauxite (Al_2O_3) is mixed with cryolite to lower the melting point and reduce energy requirement to save fossil fuels and reduce CO_2 emissions. Aluminium ions move to the cathode where they gain 3 electrons to make Al (reduction): $Al^{3+} + 3e- \rightarrow Al$. Oxide ions move to the anode where they lose 2 electrons each, form oxygen atoms and pair up to form oxygen gas: $2O^{2-} \rightarrow O_2 + 4e-$ (oxidation). The oxygen gas reacts with the carbon anode to form carbon dioxide. The anode is used up and has to be replaced regularly.
Describe the electrolysis of brine 	Brine is salt water (dissolved NaCl). The ions present in brine are H^+ and Na^+ as well as Cl^- and OH^-. The H^+ and OH^- come from water. At the cathode, H^+ ions are discharged to form H atoms which pair up to make H_2 gas. Na^+ is not discharged as sodium is more reactive than hydrogen. At the anode, Cl^- ions lose an electron each, form Cl atoms which pair up to make Cl_2 gas. The Na^+ and OH^- ions left behind form NaOH solution. H_2 gas is a rocket fuel, Cl_2 is used to disinfect water, NaOH is used to make bleach.
Describe silver plating 	Use silver as the anode. Use the object to be plated as the cathode. Fill the beaker with silver nitrate solution. Silver from the anode will form silver ions and go into the solution: $Ag \rightarrow Ag^+ + e-$. Silver ions will travel to the cathode, gain an electron and form solid silver on the surface of the object: $Ag^+ + e- \rightarrow Ag$

C2 Acids, Bases & Salts

What is an acid?	A proton donor	What is a base?	Proton acceptor
Neutralisation ionic equation	$H^+ + OH^- \rightarrow H_2O$	Give examples of bases	Metal oxide, metal carbonate, metal hydroxide, ammonia
Hydrochloric acid + base	Chloride salts e.g. sodium chloride	Sulfuric acid + base	Sulfate salts e.g. magnesium sulfate
Nitric acid + base	Nitrate salts e.g. ammonium nitrate	Acid + metal oxide	Salt + water
Acid + metal hydroxide	Salt + water	Acid + metal carbonate	Salt + water + carbon dioxide
Acid + ammonia	Ammonium salt	Acid + metal	Salt + hydrogen
Define alkali	Soluble base	Examples of alkalis	Metal hydroxides (NaOH, $Ca(OH)_2$), ammonia NH_3
Salt uses	Added to fireworks to give colour; added to soil as a fertiliser; medicine; flavour foods	Uses of acids	HCl = stomach acid; sulfuric acid H_2SO_4 = battery acid; CH_3COOH ethanoic acid = vinegar
Uses of bases	MgO = milk of magnesia; $CaCO_3$ = indigestion tablets, chalk; NH_3 = window cleaner; NaOH = oven cleaner	Insoluble salts examples	Lead sulfate, lead chloride, silver chloride, silver bromide, silver iodide, metal carbonates (apart from group 1 carbonates and ammonium carbonate)
How to make a salt from an acid and an alkali 	Use a pipette to measure out the alkali. Place alkali into a conical flask. Fill the burette with the acid. Add indicator to the alkali. Slowly add the acid to the alkali. Stop when the indicator changes colour. Note down the volume of acid used. Repeat the experiment without indicator, using the same volumes of acid and alkali. Transfer the solution into an evaporating basin. Heat to evaporate the water until a saturated solution is formed. Leave and wait for the salt crystals to form. Wash and dry.	How to make an insoluble salt from two solutions that contain the components of the salt	Select two solutions that contain the ions needed to make the salt. Mix the two solution. The salt (a precipitate) will form. Filter off the precipitate. Wash the precipitate with water. Dry the precipitate.  
How to make a salt from an acid and a solid base 	Measure out the acid into a beaker. Warm the acid to speed up the rate of reaction. Add the solid base until no more dissolves (the base is in excess). Filter off the excess base. Transfer the solution into an evaporating basin. Heat to evaporate the water until a saturated solution is formed. Leave and wait for the salt crystals to form. Wash and dry.	Soluble salts examples	Group 1 salts, ammonium salts, all nitrates, most chlorides (exceptions lead chloride, silver chloride)

C2 Moles

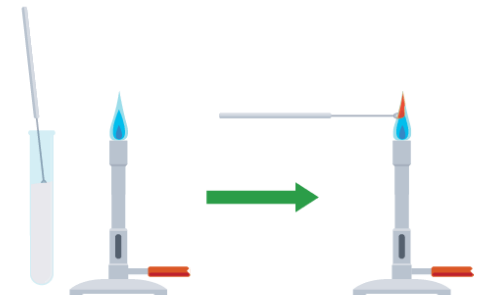
<table>
<tr><td>How to calculate the percentage by mass of an element in a compound</td><td>Mass of the element in the compound divided by the relative formula mass</td><td>E.g. percentage by mass of aluminium in Al_2O_3
Al = 27; O = 16
2Al = 54; Al_2O_3 =54 + (3x16) = 102; % by mass of aluminium = 54/102 x 100 = 52.9%</td></tr>
<tr><td>How to calculate the relative formula mass of a compound</td><td>Add all relative atomic masses together</td><td>E.g. Al_2O_3 =(27x2) + (3x16) = 102</td></tr>
<tr><td>What is the mass of one mole of an element?</td><td>The relative atomic mass</td><td>E.g. 1 mole of Al = 27g
1 mole of O_2 = 32g</td></tr>
<tr><td>What is the mass of one mole of a compound?</td><td>The relative formula mass</td><td>E.g. 1 mole of Al_2O_3 = 102g</td></tr>
<tr><td>Define isotope</td><td>Atoms with the same number of protons but different number of neutrons.</td><td>E.g. O-16 and O-18 are isotopes. Both have 8 protons, but O-16 has 8 neutrons whereas O-18 has 10 neutrons</td></tr>
<tr><td>How to calculate the empirical formula of a compound from percentage or mass of each element in the compound.</td><td>Step 1: write down the element symbols
Step 2: copy the % or mass from the question and write it under each symbol
Step 3: write the relative atomic mass of each element underneath the % or mass form the question
Step 4: divide the % or mass from the question by the relative atomic mass
Step 5: Divide each answer from step 4 by the smallest answer from step 4
Step 6: write the formula of the compound
[Step 5b: if the answers are not close to the nearest whole number, scale up the answers until they are close to the nearest whole number]</td><td>
<table>
<tr><th colspan="2">Example 1 with step 5b</th></tr>
<tr><td>Al</td><td>O</td></tr>
<tr><td>52.9%</td><td>47.1%</td></tr>
<tr><td>27</td><td>16</td></tr>
<tr><td>52.9/27 = 1.96</td><td>47.1/16 = 2.94</td></tr>
<tr><td>1.96/1.96 = 1</td><td>2.94/1.96 = 1.5</td></tr>
<tr><td>1 x 2 = 2</td><td>1.5 x 2 = 3</td></tr>
<tr><td colspan="2">Al_2O_3</td></tr>
</table>
<table>
<tr><th colspan="3">Example 2 without step 5b</th></tr>
<tr><td>C</td><td>H</td><td>O</td></tr>
<tr><td>40g</td><td>6.67g</td><td>53.33g</td></tr>
<tr><td>12</td><td>1</td><td>16</td></tr>
<tr><td>40/12 = 3.33</td><td>6.67/1 = 6.67</td><td>53.33/16 = 3.33</td></tr>
<tr><td>3.33/3.33 =1</td><td>6.67/3.33 =2</td><td>3.33/3.33=1</td></tr>
<tr><td colspan="3">CH_2O</td></tr>
</table>
</td></tr>
<tr><td>Define empirical formula</td><td>Simplest ratio of atoms of each element in the compound</td><td>E.g. molecular formula = C_6H_6; empirical formula = CH
E.g. molecular formula = empirical formula = C_3H_8</td></tr>
<tr><td>Percentage yield</td><td>Actual amount/expected amount x 100</td><td>E.g. 98t made, 112t expected. % yield = 98/112 x 100 = 87.5%; some product was lost in transferring chemicals; some product might have escaped as a gas or reacted back.</td></tr>
<tr><td>Calculating theoretical yield</td><td>Use the balanced equation to work out the starting masses. Then use information from the question to scale up or down.</td><td>How much water can be made from 2g of hydrogen? $2H_2 + O_2 \rightarrow 2H_2O$. $2H_2$ = 4g $2H_2O$ = 36g. So from 2g of hydrogen you can make 18g of water.</td></tr>
</table>

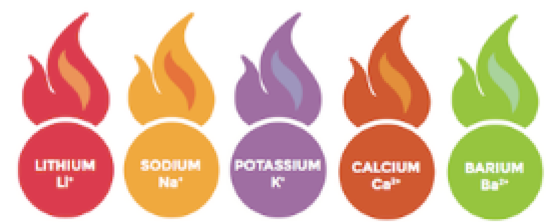
C3 Identifying unknown compounds Knowledge Organiser

Lithium flame colour	Crimson
Sodium flame colour	Yellow
Potassium flame colour	Lilac
Barium flame colour	Green
Calcium flame colour	Brick red
Iron (II)/Fe^{2+} + NaOH	Green precipitate of $Fe(OH)_2$ forms
Iron(III)/Fe^{3+} + NaOH	Orange-brown precipitate of $Fe(OH)_3$ forms
Ca^{2+} + NaOH	White precipitate of $Ca(OH)_2$ forms which does not dissolve if excess NaOH is added
Al^{3+} + NaOH	White precipitate of $Al(OH)_3$ forms which does dissolve if excess NaOH is added
Copper (II)/Cu^{2+} + NaOH	Blue precipitate of $Cu(OH)_2$ forms
Mg^{2+} + NaOH	White precipitate of $Mg(OH)_2$ forms which does not dissolve if excess NaOH is added
Test for sulfate ions SO_4^{2-} and observations	Add HCl to remove any carbonate impurities. Add barium chloride. A white precipitate of barium sulfate $BaSO_4$ forms.
Test for carbonate ions CO_3^{2-} and observations	Add any acid. Bubbles of CO_2 will form.
Test for chloride ions Cl^- and observations	Add nitric acid to remove any carbonate impurities. Add silver nitrate. A white precipitate of AgCl forms.
Test for bromide ions Br^- and observations	Add nitric acid to remove any carbonate impurities. Add silver nitrate. A cream precipitate of AgBr forms.
Test for iodide ions I^- and observations	Add nitric acid to remove any carbonate impurities. Add silver nitrate. A yellow precipitate of AgI forms.

How to carry out the flame test

Dip nichrome wire loop into concentrated HCl.
Heat the wire.
This will get of any impurities on the wire loop.
Put a small amount of compound to be tested onto wire loop and hold the loop in the roaring blue flame.
Use the colour to identify the ion present.



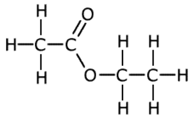


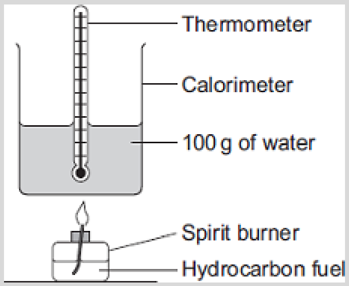
Ionic equation to show how the precipitates form

$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$	Iron(II) hydroxide
$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$	Iron(III) hydroxide
$Ca^{2+} + 2OH^- \rightarrow Ca(OH)_2$	Calcium hydroxide
$Cu^{2+} + 2OH^- \rightarrow Cu(OH)_2$	Copper(II) hydroxide
$Al^{3+} + 3OH^- \rightarrow Al(OH)_3$	Aluminium hydroxide
$Mg^{2+} + 2OH^- \rightarrow Mg(OH)_2$	Magnesium hydroxide
$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$	Barium sulfate
$Ag^+ + Cl^- \rightarrow AgCl$	Silver chloride
$Ag^+ + Br^- \rightarrow AgBr$	Silver bromide
$Ag^+ + I^- \rightarrow AgI$	Silver iodide

C3 Organic Chemistry Knowledge Organiser

1 Functional group	A group of atoms or bonds that determine how a compound reacts
2 Alcohol	Compounds that contain a –OH group General formula: $C_nH_{2n+1}OH$
3 Methanol, Ethanol, Propanol, Butanol	CH_3OH, CH_3CH_2OH, $CH_3CH_2CH_2OH$, $CH_3CH_2CH_2CH_2OH$
4 Alcohol uses	Solvents, fuels, disinfectants, alcoholic beverages
5 Alcohol properties	pH = 7 (neutral); volatile (evaporate easily)
6 Alcohol + sodium	→ hydrogen bubbles + sodium ethoxide
7 Alcohol + oxygen	→ carbon dioxide + water (combustion reaction) $CH_3OH + 1.5O_2 \rightarrow CO_2 + 2H_2O$ $CH_3CH_2OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
8 Alcohol + carboxylic acid (with a sulfuric acid catalyst)	→ ester+ water $CH_3CH_2OH + CH_3COOH \rightarrow CH_3COOCH_2CH_3 + H_2O$
9 Alcohol + acidified potassium dichromate	→ carboxylic acid (oxidation reaction) Observation: orange potassium dichromate turns green
10 Carboxylic acid	Compounds that end on –COOH; general formula $C_nH_{2n+1}COOH$
11 Methanoic, Ethanoic, Propanoic acid	$HCOOH$, CH_3COOH, CH_3CH_2COOH
12 Carboxylic acid properties	Weak acids with a pH of 4-6 which is higher than the pH of strong acids; carboxylic acids are weak acids because they only partially dissociate when dissolved in water
13 Carboxylic acid uses	Food flavourings (e.g. ethanoic acid is added to vinegar to give flavour)
14 Carboxylic acid test 1	Add universal indicator: if a carboxylic acid is present, the indicator turns orange-red

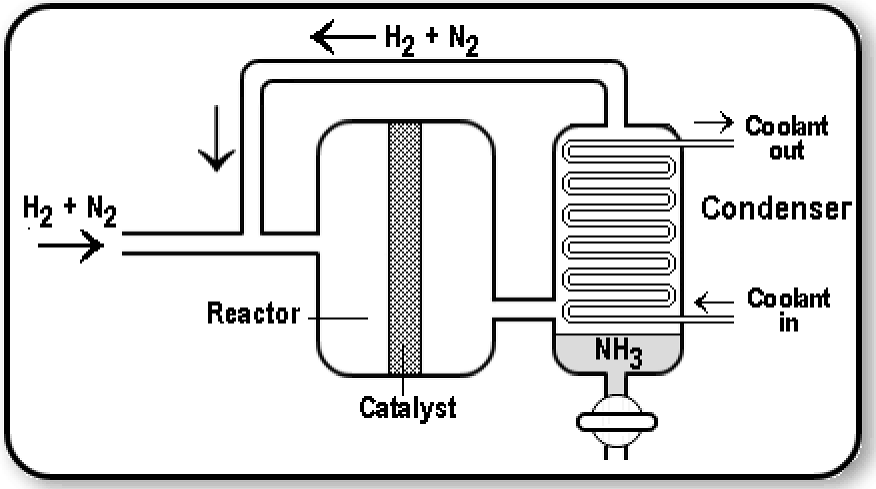
15 Carboxylic acid test 2	Add a metal carbonate (e.g. sodium carbonate). Bubbles of CO_2 gas will be released.
16 Carboxylic acid + alkali (ethanoic acid + sodium hydroxide)	→ salt+ water (sodium ethanoate + water)
17 Carboxylic acid + metal oxide (ethanoic acid + sodium oxide)	→ salt+ water (sodium ethanoate + water)
18 Carboxylic acid + metal carbonate (ethanoic acid + calcium carbonate)	→ salt+ water + carbon dioxide (calcium ethanoate + water + carbon dioxide)
19 Ester	Compounds that contain –COO- bridge
20 Ester uses	Perfumes, food flavourings, solvent
21 Ethyl ethanoate	
22 Ester properties	Fruity, sweet smelling
23 Molecular formula	Gives the type of element and the number of each element in the compound, e.g. C_2H_6O
24 Displayed formula	Shows all the bonds in the compound (example: see ethyl ethanoate)
25 Burning fuels experiment	Use measuring cylinder to fill calorimeter with 100ml of water. Measure temperature of water. Add a lid to prevent heat loss. At draught excluders to prevent heat loss. Measure mass of spirit burner. Light fuel. Extinguish flame after a fixed amount of time (e.g. 2 minutes). Record temperature rise. Reweigh spirit burner. Find out how much fuel was burned. Calculate the temperature rise per gram of fuel burned. To prevent heat loss by evaporation, use a larger volume of water. If the fuel does not burn completely, but incompletely, the energy released is lower than expected.



C3 Equilibria Chemistry Knowledge Organiser

Ammonia formula	NH_3
Haber process equation	$N_2 + 3H_2 \rightleftharpoons 2NH_3$
Where raw materials for come from	Nitrogen: from fractional distillation of air Hydrogen: from reaction of methane with steam
Ammonia uses	To make fertilisers, explosives and dyes
Reactants needed to make ammonium nitrate	Ammonia and nitric acid
Reactants needed to make ammonium sulfate	Ammonia and sulfuric acid
Why fertilisers are soluble	So that they can be absorbed through the roots.
What happens to unreacted H_2 and N_2?	They are recycled
Temperature, pressure, catalyst used	450°C, 200atm, iron catalyst
How can fertilisers end up in people's bodies?	Fertilisers are washed into rivers and get into drinking water.
Closed system	Sealed reaction vessel. Nothing can enter and nothing can leave the vessel.
Equilibrium definition	Forward and backward reaction take place at the same time and rate and the overall quantities of reactants and products remain the same.
Haber process exo/endo?	exothermic

What is ideal pressure to maximise ammonia yield?	Pressure should be high. There are 4 gas molecules on the left hand side and 2 gas molecules on the right hand side. At high pressure the equilibrium favours the forward reaction and the equilibrium shifts to the right.
Why is a lower pressure used?	High pressure is expensive as the reaction vessel needs to have reinforced walls. This costs a lot of money. A lower pressure is used despite the loss of yield as a compromise.
What is the ideal temperature to have a high ammonia yield?	Ideal temperature is low. The forward reaction is exothermic. At low temperature, the forward reaction is favoured and the equilibrium shifts right.
Why is a higher temperature used?	A low temperature results in a slow rate. A slightly higher temperature and a catalyst are used to increase the rate of reaction.
What happens to the ammonia produced and why?	The ammonia gas is cooled and condensed and removed to prevent it from reacting backwards.
Why do plants need nitrogen?	To build amino acids which are needed to build proteins.



C3 Periodic Table Chemistry Knowledge Organiser

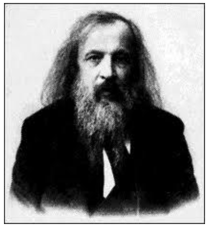
How many groups in Newland's table?	7
How was the Newland's table arranged?	By atomic mass and every 8th element was meant to have similar properties but the pattern broke down after the third row.
For which elements did Newland's pattern work?	F, Cl, Br, I Li, Na, K Mg, Ca B, Al C, Si N, P O, S
Why was Newland criticised?	Metals and non-metals were not separated; the pattern broke down after the third row; some boxes contained two elements; no gaps left for undiscovered elements
How many groups are there in Mendeleev's table?	8
How did Mendeleev arrange the elements?	First in atomic mass order but then he changed some elements around to ensure that all elements in one group share the same chemical properties. He left gaps for undiscovered elements. He divided metals and non-metals.
Why was Mendeleev criticised?	He did not explain his ideas well. But his table/ideas were accepted when the missing elements were discovered and matched his predictions.
How are the elements arranged in today's Periodic Table?	In atomic number (proton number) order
How many groups are there in today's PT?	8
Elements in the same group have the same…	Outer electron configuration and therefore the same chemical properties.
What is today's PT used for?	The electron structure is used to predict how elements react.

Why was it easy to add the noble gases to Mendeleev's PT?	Because they could just be added to the end of the table.
Why can we be certain that there are no more new elements that fit between two elements?	The elements are arranged in atomic number/proton number order. To fit an element between two elements would involve splitting a proton.
In which group do you find the noble gases?	Group 0/8
The noble gases are inert. What does this mean?	They are unreactive
Why are the noble gases inert?	They all have a full outer shell and do not need to lose or gain any electrons.
What are the noble gases helium, neon, argon, krypton used for?	Helium: in airships Neon: In light bulbs/advertising signs Argon: In light bulbs/lasers/sealed food packages to prevent food from decomposing Krypton:

Newlands' Octaves (his 'Periodic Table' of 1866)

H	Li	Ga	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co, Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zr	Di, Mo	Ro, Ru
Pd	Ag	Cd	U	Sn	Sb	Te
I	Cs	Ba, V	Ta	W	Nb	Au
Pt, Ir	Tl	Pb	Th	Hg	Bi	Th

I	II	III	IV	V	VI	VII	VIII		
H 1.01									
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5			
K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9	Co 58.9	Ni 58.7
Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9			
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101	Rh 103	Pd 106
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127			
Ce 133	Ba 137	La 139		Ta 181	W 184		Os 194	Ir 192	Pt 195
Au 197	Hg 201	Ti 204	Pb 207	Bi 209					
			Th 232		U 238				



C3 Periodic Table II Chemistry Knowledge Organiser

What is Group 1 called?	Alkali metals
What is Group 7 called?	Halogens
Where are the transition metals found?	In the middle of the Periodic table
What is the density of Group 1 metals compared to Transition metals?	Less dense
When Group 1 metals react, what happens in terms of electrons?	They lose their outer electron and form 1+ ions
When Group 7 atoms react, what happens in terms of electrons?	They gain an electron to make a full outer shell and form 1- ions
Alkali metal + water =	Hydrogen + metal hydroxide solution
Lithium + water =	Lithium hydroxide + hydrogen; lithium skids across the surface of the water
Sodium + water =	Sodium hydroxide + hydrogen; sodium melts into a ball that skids across the surface of water
Potassium + water =	Potassium hydroxide + hydrogen; so much heat is produced, the hydrogen gas ignites and burns with a lilac flame. $2K + 2H_2O \rightarrow 2KOH + H_2$
Why are Group 1 metals called the alkali metals?	Because when they react with water they make an alkaline solution of metal hydroxide
Describe and explain the trend in reactivity down group 1	Reactivity increases as the outer electron is further from the pull of the nucleus and therefore lost more easily as it is more shielded.
What is the trend in melting points down group 1?	Alkali metals become softer down the group, so the melting point decreases.

Colour of the halogens	Fluorine = yellow, chlorine = green, bromine = brown, iodine = purple-black
States of the halogens	Fluorine and chlorine = gas, bromine = liquid, iodine = solid
Trend in reactivity down group 7 with a reason	Reactivity decreases as the atoms get bigger so the outer shell is more shielded from the nuclear charge and it is harder to attract an 8th electron to the outer shell.
Halogen displacement reactions	A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.

	KCl	KBr	KI
Cl		Yellow/brown [y]	Purple [y]
Br	Orange/brown [n]		Purple [y]
I	Purple [n]	Purple [n]	

Key
[n] = no reaction
[y] = a reaction

When a halogen is part of a solution with Potassium it can be used to make a displacement reaction where possible. The results are known by the colours that it produces. A more reactive halogen will displace a less reactive halogen from one of its compounds.

- $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$
- $Cl_2 + 2KI \rightarrow 2KCl + I_2$
- $Br_2 + 2KCl \rightarrow$ X
- $Br_2 + 2KI \rightarrow 2KBr + I_2$
- $I_2 + 2KCl \rightarrow$ X
- $I_2 + 2KBr \rightarrow$ X

Transition metals properties	They are harder than group 1 and 2 metals They form coloured compounds They have a higher melting point than group and 2 metals They are good catalysts They form different ions with different charges, e.g. Iron (II) and Iron (III)

C3 Water & Water treatment Chemistry Knowledge Organiser

What is clean water?	Water that contains low levels of dissolved substances and micro-organisms.	What is hard water?	Water that contains dissolved magnesium and calcium ions
What is pure water?	Only H_2O contained. Produced by distillation of water which is expensive as it requires a lot of energy.	How does water become hard?	Acidic rain water runs over rocks dissolving calcium and magnesium based rocks: $CaCO_3 + H_2CO_3 \rightarrow Ca^{2+} + 2HCO_3^-$
Describe screening	Water passes through a screen to catch large objects (leaves, twigs,…)	What is temporary hardness?	Water that contains calcium ions or magnesium ions and HCO_3^- ions.
Describe settlement	Water is left to stand so sand and soil settle to the bottom of the tank	What is permanent hardness?	Water that contains calcium ions or magnesium ions but no HCO_3^- ions.
Describe flocculation	Aluminium sulfate is added to the water. Metal ions clump together and sink to the bottom. The sludge is collected and dumped.	How do you show water is hard?	Add water sample into test tube. Add 1 drop of soap solution. Seal the test tube with a bung. Shake. Scum forms rather than a lather.
Describe filtration	Water is passed through fine sand to filter it.	How do you show water sample 1 is twice as hard as water sample 2?	Add water samples into test tube. Add 1 drop of soap solution to each sample. Seal the test tubes with a bung and shake. Keep adding 1 drop of soap solution at a time until a stable lather forms. Sample 1 will require twice as much soap solution.
Describe chlorination	Chlorine is bubbled through the water to kill bacteria.	How do you remove temporary hardness?	By boiling the water. Limescale ($CaCO_3$) is formed. $Ca^{2+} + 2HCO_3^- \rightarrow CaCO_3 + H_2CO_3$
Describe fluoridation	Fluoride is added to protect teeth from decay. Bacteria responsible for tooth decay can lead to heart damage.	How do you remove permanent hardness?	Use a washing soda which contains sodium carbonate. The sodium ions in the washing soda replace the calcium ions in the hard water. Limescale is formed quickly where it can be easily removed. Run the water through an ion exchange resin. The resin is packed with sodium ions or hydrogen ions which replace the calcium ions in the hard water. To recharge the resin, it is flushed with salt water.
Potential dangers of fluoride consumption	Excess fluoride might lead to fluorosis (teeth and bones become brittle); brain damage might also occur.		
Describe neutralisation	Adding chlorine to water makes it acidic. The pH of water needs to be returned to 7 before it goes to the consumer.		
What is contained in water filters at home	Carbon: to absorb toxic chlorine and improve the taste Ion exchange resin: to replace calcium ions with sodium ions (increases salts level in water) Nano-silver: discourage growth of bacteria.	What are the advantages and disadvantages of hard water?	Adv: calcium is needed for bone and teeth development. It adds taste and reduces risk of heart diseases. Disadv: Wastes soap. Scum is formed which uses up soap. Limescale insulates heating elements/blocks pipes.

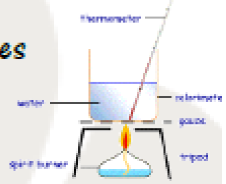
C3 Energetics Chemistry Knowledge Organiser

Define endothermic	Energy is transferred from the surroundings to the chemical system. Thermometer reading goes down
Define exothermic	Energy is transferred from the chemical system to the surrounding. Thermometer reading goes up
Bond breaking- endo or exo?	Endothermic
Bond making – endo or exo?	Exothermic
Energy of reactants above energy of products=	Exothermic
Energy of reactants below energy of products =	Endothermic
Activation energy =	Energy required to start the reaction. This is the energy needed to break the bonds.
Energy change =	Bond breaking – bond making
Energy (J) =	Mass of liquid that changes temperature x c x change in temperature
ΔH =	Energy (kJ) / moles of solid used
When burning a fuel, why is not all of the energy transferred to the water that is being heated?	The fuel burns incompletely rather than completely. Heat is lost to the surroundings and does not reach the container the water is heated in.
How do you prevent heat loss/gain in an experiment?	Use a lid or add draught excluders so no heat can enter or escape.

0.2g of ethanol is used to raise the temperature of 50ml of water by 25°C. What is the energy change ΔH?

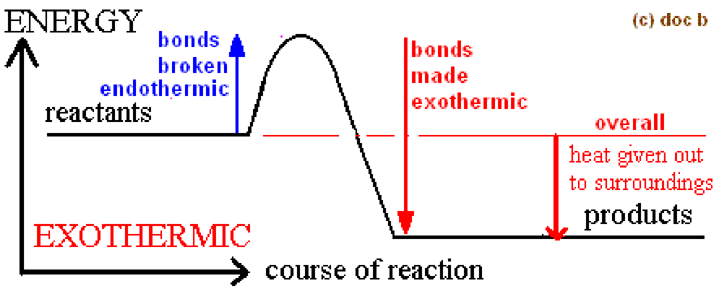
$Q = 50g \times 4.2JK^{-1}g^{-1} \times 25K = 5250J = 5.25kJ$

0.2g ethanol ($M_r = 46$) = 0.0043moles ($mass/M_r$)



$\Delta H = 5.25/0.0043 = 1220kJmol^{-1}$

The experimental result is often lower than the theoretical value due to heat loss or incomplete combustion of the fuel.



Calculating the amount of energy released during a chemical reaction:

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

Average bond energies for breaking bonds:

C-H: +413 kJ mol^{-1}, O=O: +497 kJ mol^{-1}, C=O: +805 kJ mol^{-1}, O-H: +463 kJ mol^{-1}

Bonds broken = 4(C-H) + 2(O=O)

Bonds made = 2(C=O) + 4(O-H)

Energy change: (bond energies of bonds broken) - (bond energies of bonds made)

$\therefore \Delta H = [(4 \times 413) + (2 \times 497)] - [(2 \times 805) + (4 \times 463)]$

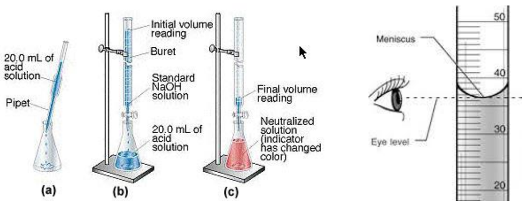
$\therefore \Delta H = 2646 - 3642$

$\therefore \Delta H = -816$ kJ mol^{-1}

The negative sign indicates that the reaction is overall exothermic.

A bond energy represents the energy needed to break 1 mole of a particular bond.

C3 Titrations Chemistry Knowledge Organiser

How to calculate moles from concentration and volume	Moles = concentration x volume in $cm^3/1000$
Concentration unit	$moldm^{-3}$
How to convert concentration from $moldm^{-3}$ to gdm^{-3}	Multiply the concentration in $moldm^{-3}$ by the relative formula mass of the compound
How to work out moles from mass in g	Moles = mass/relative formula mass
How to perform a titration	Use a pipette to measure out a fixed volume of alkali of unknown concentration. Transfer the alkali into a conical flask. Place the conical flask onto a white tile. Add 2-3 drops of indicator. Fill a burette with acid of known concentration. Read off the start volume from the bottom of the meniscus at eye level. Add the acid to the alkali drop by drop and swirl. Stop adding the acid when the indicator changes colour. Read off the end volume of acid from the bottom of the meniscus at eye level. Calculate the titre (the volume of acid used). Repeat the experiment until you have 2 concordant titre results. [Concordant = $0.1cm^3$ apart] Calculate the average volume of acid used (remember to ignore any anomalous results) 

How to carry out a titration calculation:

What is the concentration of an NaOH solution if 25.0 cm^3 is neutralized by 23.4 cm^3 0.998 $mol\,dm^{-3}$ HCl solution?

1. Calculate no. moles HCl: **moles = (conc. × volume) / 1000 = (0.998 × 23.4) / 1000 = 0.0234**
2. Determine ratio of NaOH to HCl: **$NaOH + HCl \rightarrow NaCl + H_2O$ ratio NaOH:NaCl = 1:1**
3. Calculate no. moles of NaOH: **0.0234 moles HCl = 0.0234 moles NaOH**
4. Calculate conc. of NaOH: **conc. = (moles × 1000) / volume (0.0234 × 1000) / 25.0 = 0.936 $mol\,dm^{-3}$**

Concentration of NaOH in gdm^{-3} :
Relative formula mass of NaOH = 23 + 16 + 1 = 40
40 x 0.936 = $37.44gdm^{-3}$

A standard solution was prepared by dissolving 2.6061g sodium carbonate in distilled water and making up to $250cm^3$. A $25.0cm^3$ portion of this solution was titrated against hydrochloric acid. $18.7cm^3$ of the acid were required for neutralisation. What is the concentration of the acid? (RMM [Na_2CO_3]= 106 $gmol^{-1}$)