Triple Science Chemistry

C1, C2 and C3

Core Questions and Keywords and Definitions

C1 Core Questions

Question	Answer
List the gases released by volcanoes that are thought to have formed the early atmosphere?	Carbon dioxide, water vapour, nitrogen, and small amounts of methane and ammonia.
What are thought to be the relative proportions of the gases that formed the early atmosphere?	Little or no oxygen, large amounts of carbon dioxide, large amounts of water vapour and small amounts of other gases.
Why can't we be certain about how the earth's atmosphere formed?	There is only limited evidence (from rocks) about the earth's early atmosphere.
How were the earth's oceans formed?	Water vapour, released by volcanoes, **condensed** to form the oceans.
Describe the processes, other than photosynthesis, that reduced the amount of carbon dioxide in the atmosphere.	a) Carbon dioxide dissolved into the oceans. b) Dissolved carbon dioxide was incorporated into the shells of marine organisms. c) When marine organisms die their shells can eventually form carbonate rocks.
Describe what caused the amount of oxygen in the atmosphere to gradually increase.	The evolution of plants which use carbon dioxide for photosynthesis, and release oxygen, caused the levels of atmospheric oxygen to gradually increase to its present level.
Describe an experiment that can be carried out in the lab, which would allow us to work out how much oxygen there is in the air.	Set up two gas syringes joined by a silica tube. Inside the silica tube is a small amount of copper turnings. The two syringes and silica tube should contain exactly 100cm^3 of air. Heat the copper turnings strongly, using a Bunsen burner, whilst passing the air in the syringes gently backwards and forwards over the heated copper. The copper reacts with the oxygen in the air, removing it, and forming copper oxide (which is a black). The removal of the oxygen reduces the volume of air contained in the syringes. The final volume (about 79cm^3) allows us to work out the percentage of the air that was oxygen.
List the percentages of the gases in our modern atmosphere.	Nitrogen 78%, oxygen 21%, argon 0.9%, carbon dioxide 0.04%.
How are small changes in our atmosphere caused by a) Volcanic activity b) Burning fossil fuels c) Farming d) Deforestation	a) Volcanoes release sulphur dioxide b) Burning fossil fuels releases carbon dioxide, carbon monoxide and sulphur dioxide. Vehicle engines can also release nitrogen oxides. c) Cattle and rice fields can release methane. d) Deforestation means that there are fewer trees to remove carbon dioxide from the atmosphere.
How are igneous rocks, such as granite, formed, and what determines the size of the crystals within the rock?	Igneous rocks are formed from solidified magma or lava. Magma that cools quickly contains small crystals, and magma that cools slowly contains large crystals.
What type of rock are chalk and limestone examples of?	Sedimentary rock.

Describe how sedimentary rocks are formed.	Layers of sediment build up on the sea bed. Over time these layers are compacted by the weight of the layers above, water is squeezed out, and rock is formed.
What are the characteristics of sedimentary rocks?	a) Sedimentary rocks may contain fossils b) Sedimentary rocks are easily eroded.
What type of rock is marble an example of?	Metamorphic rock.
How are metamorphic rocks formed? Give an example.	They are formed by the action of heat and/or pressure. Marble is formed by the action of heat and pressure on chalk or limestone.
Name the mineral present in chalk, limestone and marble.	Calcium carbonate ($CaCO_3$)
Name one advantage and one disadvantage of quarrying limestone.	Advantage: Employment/raw materials for the construction industry. Disadvantage: Pollution (noise or traffic fumes)/damage to the local environment.
Calcium carbonate is quarried on a large scale to produce three modern materials which are mostly used in the construction industry. Name those three materials.	Glass, cement and concrete.
What substances are contained in a) cement b) concrete?	a) limestone and powdered clay b) cement, sand, gravel and water
What is “thermal decomposition”, and what are the products of the thermal decomposition of calcium carbonate?	Thermal decomposition means “breaking down using heat”, and calcium carbonate thermally decomposes to produce calcium oxide and carbon dioxide.
Below are two carbonates and the temperature at which they decompose. Put them in order of ease of decomposition, starting with the one that is the most easy to decompose. (Can you see a link between ease of decomposition and reactivity of the metal in the carbonate?) Copper carbonate 200°C Sodium carbonate 1000°C	Copper carbonate, sodium carbonate. (The carbonate that contains the more reactive metal (sodium) is the most difficult to decompose.)
What is an “atom”.	An atom is the smallest particle of an element that can take part in a chemical reaction.
What is meant by the “conserving mass” in chemical reactions?	The total mass before and after a reaction are the same. (Total mass of the reactants = total mass of the products.)
What is the phrase that chemists use to describe the principle of the conservation of mass?	“Atoms are not created or destroyed in a chemical reaction, they are only rearranged to make new products with different properties from the reactants.” (NB This is why chemical reactions are best expressed in the form of a balanced symbol equation.)

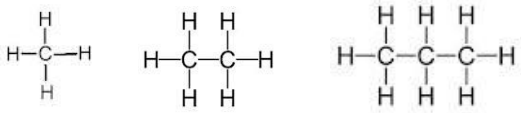
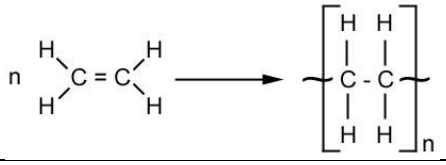
What happens when a small amount of water is added to calcium oxide?	A lot of heat is released and solid calcium hydroxide ($Ca(OH)_2$) is formed.
What is formed if more water is then added?	The calcium hydroxide dissolves in water to form the solution that we call “limewater”.
Explain how calcium oxide, calcium hydroxide and calcium carbonate can be used in farming.	Farmers can spray these chemicals over their fields to reduce soil acidity.
How can acidic gases be removed from coal-fired power station chimneys?	Wet powdered calcium carbonate is reacted with the acidic gases and neutralises them.
What are the two functions of hydrochloric acid in the stomach?	a) Help digestion b) Kill bacteria
Why do indigestion remedies work?	They contain substances that neutralise excess stomach acid.
Name the three types of metal compounds that can neutralise acids.	Metal oxides, metal hydroxides and metal carbonates.
What are the products of the reaction between an acid and a metal oxide?	A salt and water.
What are the products of the reaction between a metal hydroxide and an acid?	A salt and water.
What are the products of the reaction between a metal carbonate and an acid?	A salt, carbon dioxide and water.
What type of salts are produced by hydrochloric acid?	Chloride salts
What type of salts are produced by sulphuric acid?	Sulphate salts
What type of salts are produced by nitric acid?	Nitrate salts
What is electrolysis?	Electrolysis is the process by which some compounds can be split apart, using electricity (d.c.), to give simpler substances.
Name the products of the electrolysis of dilute hydrochloric acid.	Hydrogen and chlorine
Describe the chemical test for hydrogen.	Squeaky pop test (a lighted splint makes a high pitched squeaky pop when in contact with hydrogen gas)
Describe the chemical test for chlorine.	Chlorine turns damp red litmus paper pink and then bleaches it.
What are the three products of the electrolysis of brine (salt water)?	Chlorine, hydrogen and sodium hydroxide solution.

Which hazard symbol would be found on a container of chlorine gas?	Toxic 
Give three uses for chlorine.	1. Used to manufacture bleach 2. Used to kill bacteria 3. Used to make the polymer PVC (poly(chloroethene)
Describe the chemical test for oxygen	A glowing splint relights when placed in contact with oxygen gas.
How do we obtain a supply of unreactive elements, like gold and platinum to make jewellery?	They are found uncombined in the earth, and can simply be dug out.
Where do we find more reactive metals like iron or copper?	They are found combined, in ores, in the earth's crust.
What is an "ore"?	An ore is a rock that contains enough of a metal to make it profitable to extract the metal.
Describe how iron is extracted from its ore.	Iron ore (iron oxide) is heated with carbon (the iron is reduced – loses its oxygen to the carbon).
Describe how aluminium is extracted from its ore.	Aluminium is extracted by electrolysis.
Explain why aluminium is extracted in this way, and not by simply heating it with carbon.	Aluminium is a reactive metal. Reactive metals bond strongly to the other elements in their ores. It requires a lot of energy to separate a reactive metal from those other elements. Electrolysis can provide large amounts of electrical energy to separate the metal from the other elements in the ore. All reactive metals have to be extracted by electrolysis. The disadvantage is that this method is expensive.
What is meant by "oxidation"?	The gain of oxygen. E.g. magnesium is "oxidized" when it combines with oxygen to form magnesium oxide.
What is meant by "reduction"?	The loss of oxygen. E.g. copper oxide is "reduced" when it is heated with carbon and the oxygen is transferred to the carbon to form carbon dioxide and copper metal.
Name the ONLY metal that "rusts", and what compound is formed?	Iron. Iron oxide is formed.
What is "corrosion"?	Corrosion is the oxidation of metals. (Only the corrosion of iron is called rusting.)
Give two advantages of recycling metals.	1. Recycling preserves the metal as a resource for future generations.. 2. Recycling is less damaging to the environment.

Why is aluminium used to make aircraft bodies?	Aluminium does not corrode and is relatively low density.
Why is copper used to make saucepans, water pipes and for electrical wiring?	Because copper is a good conductor of heat and electricity, and it does not corrode easily.
Why is gold used for jewellery and coinage?	Because gold does not corrode, and it is relatively malleable.
Why is steel used to make car bodies and bridges?	Steel is strong and corrosion resistant.
What is an “alloy”?	An alloy is a mixture of metals.
Why does converting a pure metal into an alloy often increase its strength?	In a pure metal all the atoms are the same size. This means that the atoms can roll over each other if a force is applied to the metal, so it is malleable and ductile. In an alloy the atoms are not all the same size (because they are not all the same element). This means they cannot roll over each other so easily, and the alloy is stronger than the pure metal if a force is applied.
What are the two advantages of alloy steels over pure iron?	1. Alloy steels have a greater resistance to corrosion. 2. Alloy steels are stronger.
What is “nitinol”, and what is it used for?	Nitinol is a smart (or shape memory) alloy of nickel and titanium. It is a “smart” alloy, because it responds to its environment by going back to its original shape when heated. It is used to make spectacle frames and stents for damaged arteries.
In gold, what are “carats” and “fineness”?	We sometimes use gold alloys to make jewellery. Carats indicate the proportion of pure gold in the alloy. 24 carat gold contains 100% gold, and 9 carat gold contains 37.5% gold. Fineness indicates the number of parts per thousand of gold atoms.
What is a hydrocarbon?	A hydrocarbon is a compound that contains hydrogen and carbon ONLY.
What is the chemical formula of crude oil?	There isn’t one! Crude oil is a complex mixture of hydrocarbons.
With respect to crude oil, what is a “fraction”?	A fraction is a simpler, more useful mixture of hydrocarbons with a similar boiling point, e.g. petrol or bitumen.
What is the name of the process used to separate crude oil into its fractions?	Fractional distillation.
The fractions come off of the fractionating column in the following order (starting from the top of the column). Name the uses of each fraction: a) Refinery gases b) Petrol c) Kerosene d) Diesel oil e) Fuel oil f) Bitumen	a) domestic heating and cooking b) fuel for cars c) fuel for aircraft d) fuel for some cars and trains e) fuel for large ships and in some power stations f) used to surface roads and roofs

Hydrocarbons in different fractions differ from each other in: Number of carbon atoms in their molecules, boiling points, ease of ignition (flammability) and viscosity (stickiness). a) which fraction has the most carbon atoms in its molecules (the longest carbon chain)? b) which fraction has the lowest boiling point? c) which fraction is the hardest to ignite (least flammable)? d) which fraction has the lowest viscosity?	a) bitumen b) refinery gases c) bitumen d) refinery gases
What are the reactants and products of the complete combustion of hydrocarbons?	Reactants – hydrocarbon and oxygen. Products - carbon dioxide and water ONLY. (Energy is released, but it is not a product, because it is not a chemical substance.)
Describe the chemical test for carbon dioxide.	Carbon dioxide turns limewater “milky”.
What are the products of the incomplete combustion of hydrocarbons? Why are they different from the products of complete combustion?	Products – carbon monoxide and/or carbon and water. (Sometimes carbon dioxide is also produced. Incomplete combustion produces a mixture of carbon compounds.) Carbon monoxide (CO) and/or carbon (C) are produced because there is not enough oxygen available to form carbon dioxide (CO_2).
Why are we concerned about incomplete combustion?	Incomplete combustion can cause the release of carbon monoxide, which is toxic, and damage appliances by producing a build-up off soot (carbon).
What effect does carbon monoxide have on the body?	Carbon monoxide is toxic. It reduces the amount of oxygen that can be transported around the body by the blood.
What is “acid rain”, and how does it arise?	Acid rain is rain that is more acidic than normal. (Rainwater is naturally slightly acidic because of dissolved carbon dioxide, but acid rain is even more acidic and has a pH lower than 5.2.) All fossil fuels (coal, gas and crude oil) contain impurities, particularly sulphur. When the fuel is burnt the sulphur combines with oxygen to produce sulphur dioxide gas. When water vapour in the atmosphere condenses the sulphur dioxide gas dissolves in it to form an acidic solution. This can then fall as rain and because it is more acidic than normal rainwater it is called “acid rain”.
What are the problems associated with acid rain, and what can we do about it?	Acid rain makes rivers, lakes and soils acidic, harming the organisms living there. Acid rain damages the leaves and roots of plants and trees. Acid rain can speed up the weathering of limestone (rocks or buildings) and marble. To reduce the production of acid rain we can; 1. reduce the amount of sulphur in fuels 2. remove acidic gases from power station emissions (by reacting them with wet powdered calcium carbonate). 3.

What is the “greenhouse effect”?	The greenhouse effect is the natural action of gases in the atmosphere (carbon dioxide, methane and water vapour – so these are called “greenhouse gases”) which trap heat energy from the sun and keep the earth warm. **(N.B.** It is NOT the same as “global warming” (climate change) – but can lead to it. And it is NOT caused by the hole in the ozone layer. Confusion about this is common, and arises because some of the gases (called CFCs) that react with ozone and damage the ozone layer, can also act as greenhouse gases, but their effect is small compared to carbon dioxide, methane and water vapour.)
What is “climate change” (global warming) and what is thought to cause it?	Climate change refers to an average rise in the mean temperature of the atmosphere (measured as a 30 year rolling average). Significant increases are likely to change global weather patterns. The majority of scientists agree that climate change is the caused by an increase in the amount of carbon dioxide in the atmosphere. (N.B. Not all scientists agree that human actions are the cause of climate change.)
How can we reduce the amount of carbon dioxide in the atmosphere?	a) use alternative fuels b) plant more trees c) iron seeding of oceans d) chemically convert carbon dioxide into hydrocarbons
Explain what biofuels are?	A biofuel is any fuel obtained from living or recently dead organisms. Biofuels are RENEWABLE fuels. Biofuels still release carbon dioxide when they are burnt, but they only release the amount of carbon dioxide taken in by the plants grown to produce them. They can be considered carbon neutral (but in fact they may not be when production and distribution are taken into account).
Name a biofuel produced from sugar cane or sugar beet. How is it made, and how is it used?	Ethanol (sometimes called bioethanol). It is produced by the fermentation of the sugars in sugar cane or beet. It is used as a fuel for cars, mixed with petrol. It reduces the amount of petrol needed.
What is the main disadvantage of the use of bioethanol and other biofuels?	Growing the crops used to make biofuels requires land and may affect the availability of land for growing food crops.
Describe four characteristics of a good fuel.	1. ignites/burns easily 2. produces little smoke and leaves no residue (ash or other residue) 3. produces a large amount of heat 4. easy to store and transport.
What is the cause of a sooty flame.	Incomplete combustion. (Not enough oxygen present to convert all the carbon in the hydrocarbon fuel to carbon dioxide, so carbon particles are one of the products of the reaction.)
What reaction takes place in a hydrogen fuel cell.	Hydrogen and oxygen are combined to produce water. Energy is released during this reaction and can be used to power vehicles.

Give an advantage and a disadvantage of combining hydrogen and oxygen in a fuel cell, rather than petrol, as a fuel for cars.	Advantage – hydrogen is a clean fuel. The only product of the combination of hydrogen and oxygen is water. Disadvantage – hydrogen can be explosive/hydrogen is not readily available in filling stations at present/cars would need modification/the process needed to produce the hydrogen fuel results in the production of carbon dioxide.
Are alkanes saturated or unsaturated?	Saturated. (They have no carbon-carbon double bonds that can open up to bond with any more hydrogen atoms – they are saturated with hydrogen.)
What is the formula for a) methane b) ethane c) propane Draw the structures of these molecules	a) CH_4 b) C_2H_6 c) C_3H_8 
What is the formula for the alkenes a) ethene b) propene Draw the structures of these molecules. What is the chemical test for an alkene?	a) C_2H_4 b) C_3H_6 Test – Alkenes turn bromine water from orange to colourless.
a) Explain what “cracking” is, and what products are made. b) Why do oil companies bother to carry out this reaction?	a) Cracking is the splitting (using heat) of a long chain saturated hydrocarbon (an alkane) to form a shorter chained alkane and an alkene. b) Shorter chained hydrocarbons make better fuels. Crude oil contains too many of the longer chained molecules, so oil companies crack them to i) **make more of the useful fuels**, and ii) **make alkenes** (which can be used to make polymers).
Why can ethene molecules react with each other, and what is formed? Write an equation for this reaction.	Ethene molecules have a carbon-carbon double bond that can open up and join the ethene molecules (the monomers) together to make a long chain molecule (the polymer) called poly(ethene). 
Name the polymer that is made from the following monomers; 1. propene 2. chloroethene 3. tetrafluoroethene.	1. Poly(propene) 2. Poly(chloroethene) 3. Poly(tetrafluoroethene) (PTFE)
Poly(ethene) is flexible, cheap and a good insulator. So what uses does it have?	Plastic bags, plastic bottles, cling film and insulation for electrical wires.
Why is poly(propene) used to make buckets and bowls?	It is flexible, shatterproof and has a high softening point (won’t melt if hot water is put into it.)

Poly(chloroethene) (PVC) is tough, cheap and long-lasting and a good insulator. So what uses does it have?	It is used for window frames, gutters, pipes and insulation for electrical wires.
Why is PTFE ("Teflon") used as a non-stick coating for pans?	It is tough, slippery and resistant to corrosion.
What are the two main problems associated with the widespread use of polymers?	1. Most polymers are not biodegradeable and persist in landfill sites. 2. Many polymers produce toxic products when they are burnt.
Name two ways in which we can overcome the problems associated with the disposal of polymers.	1. By recycling them. 2. By developing biodegradeable polymers.

C1 Keywords and Definitions

Keywords	Definitions
Atmosphere	The layer of gases that surrounds the Earth.
Atoms	The smallest part of an element, consisting of protons, neutrons and electrons.
Balanced Equations	An equation which is equal on both sides of the equals sign.
Chalk	A white powdery sedimentary rock.
Chemical formula	The way we write substance with symbols to show what they are made up of.
Compound	A substance formed from two or more elements bonded together.
Concrete	Cement mixed with sand and gravel.
Crystals	The name given to minerals with a special structure. They can sometimes be sort after and look nice.
Deforestation	The removal of trees from an area.
Element	The most basic substances formed of one type of atom and found in the Periodic Table.
Fossil	The mineral imprint, usually of the hard parts of prehistoric plants and animals etc.
Granite	A common type of igneous rock formed when magma cools slowly.
Igneous rocks	The group of rocks created directly by cooling magma from inside the Earth.
Lava	The name for magma which has come to the surface of the Earth.
Limestone	A type of rock that is made up of calcium carbonate and is used for cement.
Magma	Molten rock.
Marble	A metamorphic rock formed from limestone (or chalk).
Metamorphic rocks	The group of rocks created from sedimentary rocks which have been put under great heat and pressure.
Noble gases	A group of unreactive element gases found on the right hand side of the Periodic Table.
Photosynthesise	To produce food using sunlight, water and carbon dioxide in a plant.
Products	The result of a reaction.
Quarry	A large hole dug into the ground or a hillside to remove rocks.
Rate	How fast something happens.
Reactant	Something that is reacted with something else.
Sediment	The small grains from weathered igneous rocks.
Sedimentary rock	The group of rocks produced by grains of rock being cemented and compacted together.
Solidifies	Becomes hard (solid).

State symbols	A symbol shown in brackets to show what state a substance is in when writing formulae.
Thermal decomposition	The breakdown of something due to heating.
Trace	A very small amount.
Word Equations	Equations that are written using full words and not symbols.
	The layer of gases that surrounds the Earth.
Alkali	A base dissolved in water - the opposite of an acid.
Antacids	Medicines that neutralise stomach acid.
Aqueous solutions	Substances dissolved in water.
Bases	Substances that can react with acids (they are called alkalis when they can be and are dissolved in water).
Decomposed	When a substance is broken up.
Digested	Broken down into smaller molecules, particularly in the stomach.
Hazard symbols	A way of showing how dangerous something is using pictures.
Hazardous	Something that is dangerous is not stored and used correctly.
Indicator	Something used to show information about something else (e.g. how acidic something is).
Insoluble	Cannot be dissolved.
Limewater	Another name for calcium hydroxide solution, used to test for carbon dioxide and make concrete.
Litmus paper	Coloured paper used to test whether something is acid or alkali.
Neutralisation reaction	A reaction where an acid and alkali neutralise each other.
pH Scale	The number scale used to measure how acidic or alkaline something is.
Precipitate	An insoluble product from the reaction of soluble substances.
Precipitation reactions	When soluble substances react together to form an insoluble substance.
Ratio	A mathematical word for a proportion.
Salt	An (ionic) compound formed from a neutralisation reaction.
Soluble	Can be dissolved.
Universal indicator	A solution that changes colour depending on the pH of the substance it is mixed with.
Alloy	A metal mixed with small amount of other metals.
Alloy steels	Iron mixed with different amounts of other metals.
Carats	The measure of how pure gold is other than fineness.
Conduct	Transfer (heat or electricity).
Corrosion	When a metal changes by reacting with oxygen.
Density	How much mass something has for its size.
Ductile	Can be stretched into wires.
Electrolysis	The way in which we can use electricity to break down (decompose) molecules.
Electrolytes	Compounds that can be decomposed (broken down) by electrolysis.
Extraction	The process of getting a metal from out of a rock/ore.
Fineness	The measure of how pure gold is other than carats.
Malleable	Can be hammered into a shape.
Ores	Metal compounds found in rocks.
Oxidation	The addition of oxygen to a substance.
Reactivity series	The order of how reactive substances are.
Recycled	Reusing something rather than throwing it away.
Reduction	When a metal from its oxide by heating with carbon.
Rusting	The corrosion of iron in the presence of oxygen and water.
Shape memory alloy	An alloy that returns to its original shape if it is deformed.

Smart material	A material that has a property that changes with a change in conditions.
Boiling points	The temperatures at which things boil.
Crude oil	Oil in its unrefined state from the ground.
Fossil fuels	Coal, oil and gas.
Fractional distillation	The way in which we separate the fractions of crude oil by heating and using a special piece of equipment.
Fractions	The name for the simpler mixtures removed from a fractionating column.
Hydrocarbon molecules	Molecules consisting of hydrogen and carbon, such as in oil.
Ignite	To set alight.
Mixture	Two or more things combined but not chemically joined.
Non-renewable resource	A resource which cannot be replace once it is used up.
Viscosity	How thick something is.
Acid rain	Rain that is slightly acidic due to mixing with sulphur dioxide, carbon dioxide and/or nitrous oxides.
Alkanes	Hydrocarbon molecules with single bonds that follow the CnH2n+2 rule.
Alkenes	Hydrocarbon molecules with single and double bonds that follow the CnH2n rule.
Biodegradable	Can be broken down in nature.
Biodiesel	A biofuel made from vegetable oils.
Biofuels	Fuels made from plants.
Bonds	The name for the join between atoms that make up molecules.
Bromine test	The test used to check if a hydrocarbon is saturated or unsaturated.
Bromine water	The name for bromine dissolved in water.
Carbon monoxide	The result of incomplete combustion. A poisonous gas.
Carbon neutral	Overall it does not add carbon dioxide to the atmosphere.
Combustion	Burning - reacting something with oxygen (in air usually).
Complete combustion	When a hydrocarbon is completely reacted and only carbon dioxide and water remain as products.
Cracking	Using electricity to break up carbon chains into smaller ones.
Double bond	Where atoms in a molecule have more than one bond with each other.
Ethanol	A biofuel made from wheat, sugar cane or sugar beet (an alcohol).
Fuel cell	A device which can produce electrical energy without burning/combusting.
Incinerated	Burnt until destroyed.
Incomplete combustion	When a hydrocarbon is burnt without enough oxygen and carbon monoxide is a product.
Monomer	Substances whose molecules react together to form polymers.
Plastics	Manufactured polymers.
Poly(chloroethene) (PVC)	The full name of PVC, a common plastic.
Poly(ethene)	A polymer of ethene.
Poly(propene)	The polymer of propene.
Poly(tetrafluoroethene) (PTFE or Teflon)	The chemical name for Teflon.
Polymer	Substances made up of thousands of simple repeating units.
Polymerisation	The process of forming polymers from monomers (long chains from molecules).
Renewable	Something that can be replaced once it has been used up.
Saturated	When all the bonds are single bonds in a molecule.
Soot	Solid carbon particles that result from combustion (burning).
Unsaturated	When there are double bonds in a molecule.

C2 Core Questions

Question	Answer
How did Mendeleev arrange the elements known at the time into a periodic table?	By using the mass number and other properties of the elements and the properties of their compounds.
How did Mendeleev use his table?	To predict the existence and properties of some elements that were still to be discovered.
Where are the non-metals found in the periodic table?	At the top on the right hand side.
Name 3 sub-atomic particles.	Protons, neutrons and electrons.
Describe the structure of an atom.	A nucleus containing protons and neutrons, surrounded by electrons in shells.
How does the size of the nucleus compare to the overall size of the atom.	The nucleus is very small. (if an atom were the diameter of the London Eye, the nucleus would be the size of a pea at the centre!)
What are the relative charges and masses of protons, neutrons and electrons.	Protons: mass 1, charge +1 Neutrons: mass 1, charge 0 Electrons: mass almost zero, charge -1.
Which particle gives the atom its identity?	The number of protons present.
If an atom contains 12 protons, how many electrons will it have?	12.
What is the atomic number of an element?	The number of protons.
What is the mass number of an element?	The total number of protons and neutrons.
What is the relative atomic mass, (A_r)?	The relative mass of an atom compared to the mass of an atom of carbon-12.
In what order are elements arranged in the periodic table?	In order of increasing atomic number.
What do we call the rows and columns of the periodic table.	Rows are periods and groups are columns
What do all elements in the same row of the periodic table have in common?	They have the same number of shells of electrons.
What do all elements in the same column of the periodic table have in common?	They have the same number of electrons in their outer shell (and therefore have similar chemical properties).
Lithium has a mass number of 7 and an atomic number of 3; work out the number of protons, neutrons and electrons present.	3 protons, 3 electrons and 4 neutrons.
What is an isotope?	Two or more atoms of the same element (the same number of protons) but with a different number of neutrons.
What are the maximum numbers of electrons that can be present in the first three electron shells of an atom?	1st shell = 2 2nd shell = 8 3rd shell = 8
What is the electronic configuration of silicon (atomic number 14)?	2,8,4
What is the electron configuration of calcium (atomic number 20)?	2,8,8,2

Why are some atomic masses not whole numbers?	Some naturally occurring elements are made up of 2 or more isotopes so their relative atomic mass is an average of these isotopes.
What is the formula for calculating relative atomic mass of an element from the relative mass and abundance of its isotopes?	$\frac{(\%\text{ abundance} \times \text{atomic mass}) + (\%\text{ abundance} \times \text{atomic mass})}{100} = \text{relative atomic mass}$
Why do atoms join together to form compounds?	To get a full outer shell of electrons.
Describe an ionic bond.	A metal loses electron(s) to a non-metal. This results in the metal becoming a positively charged ion and the non-metal a negatively charged ion. These oppositely charged ions then attract.
How is sodium chloride formed?	The sodium atom transfers its outer electron to the chlorine atom, producing a pair of oppositely charged ions that stick together by electrostatic attraction.
Name 3 types of bonding?	Ionic, covalent and metallic.
What is an ion?	A charged atom or group of atoms.
What charge do metal ions (cations) carry?	Positive charge
How does a Sodium atom form the Na^+ ion?	The sodium atom loses its one outer electron.
What is the formula of the compound formed from Mg^{2+} and Cl^- ions, and from Na^+ and O^{2-}?	$MgCl_2$ Na_2O
What are the names of: 1) MgS $MgSO_4$	1) Magnesium sulphide Magnesium sulphate
What do the compound endings: 1) ide 2) ate mean?	1) ide – a compound of only the named substances ate – a compound of the named substances and oxygen
2) Describe how to prepare a pure dry sample of an insoluble salt.	2) Mix together the soluble salts that will produce an insoluble salt as a precipitate. Filter, wash and dry the precipitate.
Describe the structure of ionic substances.	2) Ionic substances are a regular arrangement of oppositely charged ions held together in a lattice structure by strong electrostatic forces.
List and explain two physical properties of ionic compounds.	1. They have high melting because there are strong electrostatic forces holding the oppositely charged ions in place, therefore a lot of energy to separate them. They can conduct electricity when molten or in aqueous solution (dissolved in water) because the ions are free to move and carry their charge.
List the general rules that describe the solubility of common types of substances in water.	All common sodium, potassium and ammonium salts are soluble. All nitrates are soluble. Common chlorides are soluble, except silver and lead. Common sulfates are soluble, except lead, barium and calcium. Common carbonates and hydroxides are insoluble, except sodium, potassium and ammonium.
What is a precipitate?	A solid that is formed from two reacting solutions.
What is the name of the insoluble precipitate formed when lead nitrate reacts with potassium chloride?	2. Lead chloride
What is the insoluble salt barium sulphate used for?	Barium sulphate is opaque to X-rays. It is given to patients as a "barium meal" in order to take X-ray images of the gut. (It is toxic, but because it is insoluble it does not enter the blood stream, and therefore not harmful.)

Describe the flame colours seen for sodium, potassium, calcium, and copper.	Sodium - Yellow, potassium - lilac, calcium - red and copper blue/green.
What is a test for the carbonate ion $(CO_3)^{2-}$ ion?	Add an acid and the carbon dioxide is given off turns limewater milky.
What is a test for the sulphate ion $(SO_4)^{2-}$ ion?	Add a few drops of hydrochloric acid and then some barium chloride solution. A white precipitate forming is a positive result.
What is a test for a Cl^- ion?	Add a few drops of nitric acid then silver nitrate solution. A white precipitate forming is a positive result.
How were rubidium and caesium discovered?	Spectroscopy
Describe what happens in covalent bonding?	Two non-metals overlap their outer electron shells and share at least one pair of electrons.
What does covalent bonding result in the formation of?	molecules
Do simple molecular covalent compounds conduct electricity?	No, because they don't have free electrons or ions to carry the charge.
Explain why simple molecular substances have low melting points?	There are only weak forces of attraction between the molecules (even though the covalent bonds within the molecule are strong).
Why is diamond used in cutting tools?	Diamond is very hard because all the carbon atoms are joined by 4 strong covalent bonds.
Why does diamond have such a high melting point?	In diamond each carbon atom is held in place by 4 strong covalent bonds and it takes a lot of energy to break these bonds.
Why does graphite conduct electricity?	In graphite each carbon forms 3 bonds, this leaves one electron left over from each carbon atom which sits between the graphite layers and is free to move and carry a charge.
Why can graphite act as a lubricant?	The layers of carbon atoms in graphite are only very weakly joined and are therefore free to slide past each other.
Describe the bonding in metals?	All metals form positive ions and their outer electrons are lost and sit between the metal ions (forming a 'sea of electrons').
Why do metals conduct electricity?	There are free electrons in the metallic structure that can move.
Why are metals malleable?	They bend because the ions can slide over one another.
What is an exothermic reaction and give an example?	A reaction that gives out heat energy. For example combustion.
What is an endothermic reaction and give an example?	A reaction that takes in heat energy. For example photosynthesis.
Is the breaking of bonds exothermic or endothermic?	Endothermic.
Is the making of bonds exothermic or endothermic?	Exothermic.
Why is a reaction exothermic?	In an exothermic reaction less energy is needed to break bonds than is given out when new bonds are made.
If a reaction is to occur what 2 things need to happen between reacting particles?	The particles must collide and the collision must have enough energy.
How does increasing the temperature speed up a reaction?	It gives the particles more energy so they collide more often and the collisions have more energy.
How does increasing the concentration of a solution speed up a reaction?	It means there are more particles present so it will increase the number of collisions.
Explain how breaking up a solid reactant increases the rate of reaction.	It increases the surface area of the solid meaning that more collisions can occur because there are more particles exposed to the other reactant in the smaller pieces. This increases the likelihood of a successful collision.
Explain how adding a catalyst speeds up the reaction.	It speeds up the reaction because the catalyst provides an alternative route for the reaction that requires less energy.

What does a catalytic converter do, and how is the rate of reaction maximized?	They react carbon monoxide and unburned fuel (from exhausts) with oxygen to give carbon dioxide and water. The rate of reaction is maximized by having a high surface area and operating at high temperature.
How can two immiscible liquids be separated?	By the use of a separating funnel.
How can liquid air be separated to produce nitrogen and oxygen?	By fractional distillation.
Complete the following gaps: _____ gas leaves at the top of the fractionating column because it has a _____ boiling point.	**Nitrogen** gas leaves at the top of the fractionating column because it has a **lower** boiling point.
In chromatography, define the R_f value.	R_f = distance moved by the component / distance moved by the solvent
What is chromatography used for?	Separation and identification of components in mixtures in a variety of contexts, such as the food industry and forensic science.
What do we call group 1, group 7 and group 0 in the periodic table?	The Alkali metals, the Halogens and the Noble gases.
Explain why metals are malleable.	The ions are all the same size so they slide over each other if a force is applied to the metal.
Explain why metals can conduct electricity.	They have free (delocalized) electrons that can move and carry the charge.
What are the two typical properties of the transition metals?	1. High melting points They form coloured compounds(e.g. copper sulphate)
How are the Alkali metals different from transition metals?	1. They are soft (can be cut with a knife). They have comparatively low melting points.
Describe the reaction of sodium with water.	1) The metal reacts and moves around the surface of the water. 2) The reaction gives of a gas. The product of the reaction is soluble in the water.
What two products are formed when alkali metals are added to water?	A hydroxide and hydrogen gas.
State the order of reactivity in group one and explain it.	Reactivity increases as you go down the group. This is because the outer electron is further away from the nucleus and is therefore more easily lost.
Describe the physical properties of the halogens at room temperature.	2. Fluorine is a pale yellow gas. Chlorine is a yellow/green gas. Bromine is a brown liquid. Iodine is a grey solid.
What is formed when halogens react with hydrogen?	2. Hydrogen halides. These can dissolve in water to from acids e.g. HCl, hydrogen chloride dissolves in water to form hydrochloric acid.
What is formed when halogens react with metals?	3) Metal halides. E.g. $2Fe + 3Cl_2 = 2FeCl_3$ (iron(III)chloride)
State the order of reactivity of the halogens and explain it.	Reactivity decreases as you go down the group.
If chlorine is added to sodium bromide solution what happens?	A displacement reaction takes place forming sodium chloride solution and bromine. This is because the chlorine is more reactive than the bromine.
Why are the noble gases unreactive?	They already have a full outer shell of electrons.
What are the properties of the noble gases?	1. Inertness (so used in welding and filament lamps) 2. Low density (used in balloons) non-flammability.
How were the noble gases discovered?	Scientists realised the density of nitrogen made in a reaction was different to the density of nitrogen obtained from air. This made them predict other more dense gases were present which they then found by performing experiments.
What is an empirical formula?	The simplest ratio of the elements in a compound.

Why do reactions never give the full theoretical yield of products?	1. incomplete reactions 2. small loses during the preparation competing, unwanted reactions.
Define the percentage yield of a reaction.	% yield = (actual yield/theoretical yield) x 100%
What factors do chemists in industry look for when designing a process to produce a commercial product?	1. High percentage yield 2. All the products of the reaction are commercially useful. 3. The reaction occurs at a suitable speed.

C2 Keywords and Definitions

keyword	Definition
Atomic number	The number of protons in an element.
Atoms	The smallest part of an element that can take part in nuclear reactions.
Electronic configuration	The pattern of the electrons in their shells.
Electrons	The sub-atomic particles with a negative charge that orbit the nucleus.
Energy levels	Another name for shells or orbitals, relating to the energy electrons have.
Groups	The columns on the Periodic table.
Isotopes	An atom with a different number of neutrons from the mean.
Mass number	The number showing how much mass an element has.
Mean	A form of average where we add the numbers up and divide by how many there are.
Metals	A compound that is a good conductor of heat and electricity (found on the left of the Periodic table).
Neutrons	The particles in the nucleus with no charge.
Non-metals	An element that is not a metal and is found to the right of the Periodic table.
Nucleus	The centre of the atom consisting of protons and neutrons.
Periodic table	The table in which all elements are found in an organised way.
Periods	The rows on the Periodic table.
Protons	The positively charged sub-atomic particles found in the nucleus.
Relative abundance	This means "in comparison there are a lot more of these"
Relative atomic mass	The mass of a compound, for example.
Relative Charge	The charge of a particle relative to other particles.
Relative mass	The mass of a particle relative to other particles.
Shells	Another name for orbitals - the pathways of the electrons around the nucleus.
Anions	An ion with a negative charge.
Aqueous solution	When something is dissolved in water.
Barium meal	A drink containing barium sulphate.
Boiling point	The temperature at which something boils.
Bonds	The name for the attraction between particles in a compound.
Cations	An ion with a positive charge.
Compound ions	Ions that contain one or more elements.
Dissolves	When a solute splits up and mixes with a solvent.
Electrolysis	A process of splitting up compounds using electrical current.
Filtration	Separating larger molecules from smaller ones using a partially permeable membrane.
Flame tests	A test to detect the ions in a substance by observing their colour in a Bunsen flame.
Formula	A way of writing down a substance with symbols where it is made of two or more atoms.
Insoluble	Not able to be dissolved.
Ion	An atom that has gained or lost electrons to give it an overall charge.
Ionic bonds	The type of bond that is caused by opposite charges.

Ionic compounds	A compound bonded due to ions of opposite charge.
Lattice structure	The name of the structure that is caused by ionic bonding.
Melting point	The temperature at which something melts.
Molten	Melted to form a liquid.
Precipitate	An insoluble solid formed when two solutions are mixed together during precipitation.
Precipitation reaction	A reaction between two solutions to form an insoluble solid.
Salt	A compound formed by the neutralisation of an acid and an alkali.
Soluble	Able to be dissolved.
Spectroscopy	Analysis of the light from a particular source.
State symbols	The letters after an element in an equation, showing whether it is a solid, liquid, gas or in solution etc.
Toxic	Poisonous.
Chromatogram	The result of a chromatography test.
Chromatography	A process of separating mixtures to identify them (sometimes using paper and a solvent).
Covalent bonds	A bond formed by non-metal atoms held together by sharing electrons.
Diamond	A very hard substance made from carbon atoms.
Dissolve	What happens to a solute when placed in a solvent.
Dot and cross diagram	A diagram used to model covalent bonding.
Double bond	The type of bond where two pairs of electrons are shared.
Fraction	A certain part of crude oil that comes out of a fractionating column at the same point.
Fractional distillation	The process of separating fractions using a column and heat to separate by boiling point.
Fractionating column	A column used to separate fractions based upon their boiling points.
Giant molecular covalent substances	Lots of non-metals atoms held together in lattices to form bigger structures.
Graphite	A substance made from carbon that is arranged in layers.
Immiscible	Where liquids will not mix together completely.
Liquefied	Turned to liquid.
Lubricant	Something that reduces friction between two objects.
Miscible	If liquids can be mixed together to form another substance.
Molecule	More than one atom bonded together by covalent bonds.
Rf value	A comparison value for points on a chromatogram
Separating funnel	A piece of glassware used to separate two immiscible liquids.
Simple molecular covalent substances	A few atoms held together by very strong covalent bonds.
Solubilities	How soluble something is.
Solution	The result of a solute being dissolved in a solvent.
Solvent	Something which dissolves a solute.
Alkali metals	The metals found in group 1 of the Periodic table.
Delocalised electrons	Electrons that can move away from the original nucleus.
Displacement reaction	A reaction where one reactant takes the place of another element in the compound it is reacted with.
Elements	The most basic materials found in the Periodic table.
Halides	A compound of which one part is a halogen.
Halogens	Group VII of the Periodic table.
Inert	Non-reactive.
Malleable	Can be hammered into another shape without breaking.
Metallic bonds	The bonds formed between metal atoms.

Noble gases	The gases found in
Reactivity	How readily something takes part in a chemical reaction.
Transition metals	Metals in the centre of the Periodic table.
Concentration	How much of a substance is present in a dilution.
Endothermic	Takes in heat during a reaction.
Exothermic	Gives out heat during a reaction.
Rate of a chemical reaction	How quickly a reaction happens.
Surface area	The total area of an object or chemical.
Actual yield	The amount of product we make when the reaction is carried out (not the theoretical amount).
By-products	The products of a reaction that are not desired or intended.
Percentage	How much of something as a fraction out of one hundred.
Percentage by mass	The amount of an element as an amount of the total mass (as a percentage).
Percentage yield	The percentage of how much desirable product we obtain from a reaction.
Relative atomic mass	The total mass of a compound.
Theoretical yield	The amount of product we should have based on the equation for the reaction.
Waste products	Undesirable products from a reaction that are not needed.
Yield	The amount of product from a reaction.

C3 Core Questions

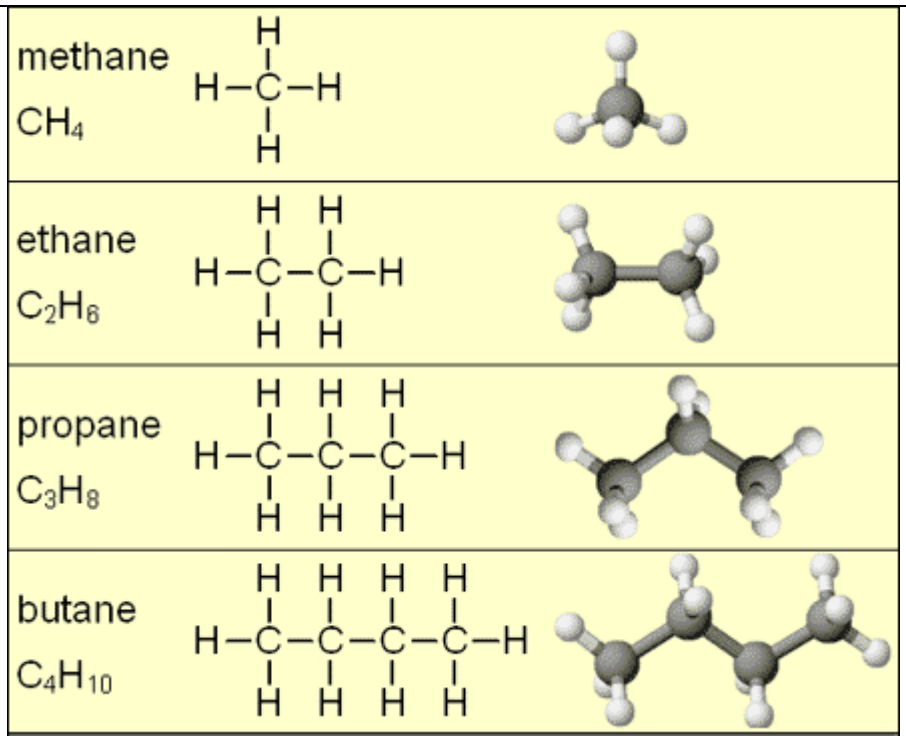
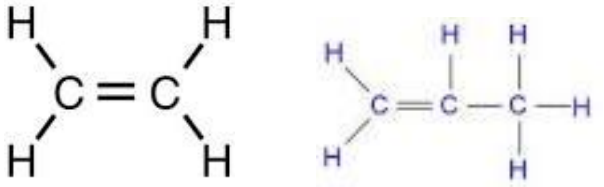
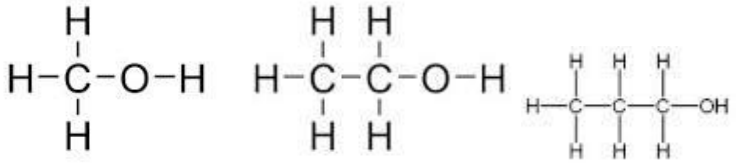
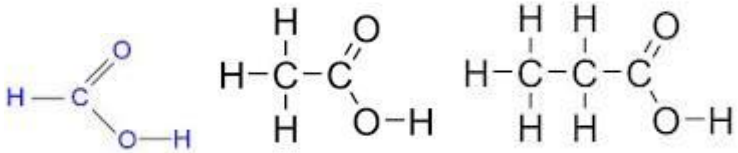
Question	Answer
What term do we use to describe analysis that investigates the kind of substance present?	Qualitative
What term do we use to describe analysis that investigates the amount of substance present?	Quantitative
What substance do we use to test for a) Al^{3+}, b) Ca^{2+}, c)Cu^{2+}, d)Fe^{2+} and e)Fe^{3+}, and what would you see?	Sodium hydroxide solution a) white precipitate b) white precipitate c) pale blue precipitate d) green precipitate e) brown (rust) precipitate
How do we test for the ammonium ion NH_4^+?	By using sodium hydroxide solution. Warming and testing for the ammonia gas produced.
How do we test for the ions Cl^-, Br^- and I^- and what would we see?	Test for the ions using silver nitrate solution acidified with nitric acid. Chloride ions give a white precipitate. Bromide ions give a cream precipitate. Iodide ions give a yellow precipitate.
How do we identify Na^+, K^+, Ca^{2+}, Cu^{2+} using flame tests.	Na^+ yellow/orange flame K^+ pale lilac flame Ca^{2+} brick red flame Cu^{2+} blue/green flame
How do we identify the carbonate ion CO_3^{2-}.	Add dilute acid and identifying the carbon dioxide formed using limewater.
How do we identify the sulphate ion SO_4^{2-}	Add dilute hydrochloric acid and barium chloride Solution. A white precipitate forms.
Give two examples of the use of ion tests.	1. To check the purity of drinking water 2. To check for the presence of substances in the blood.
What causes hard water?	The presence of dissolved calcium or magnesium ions.

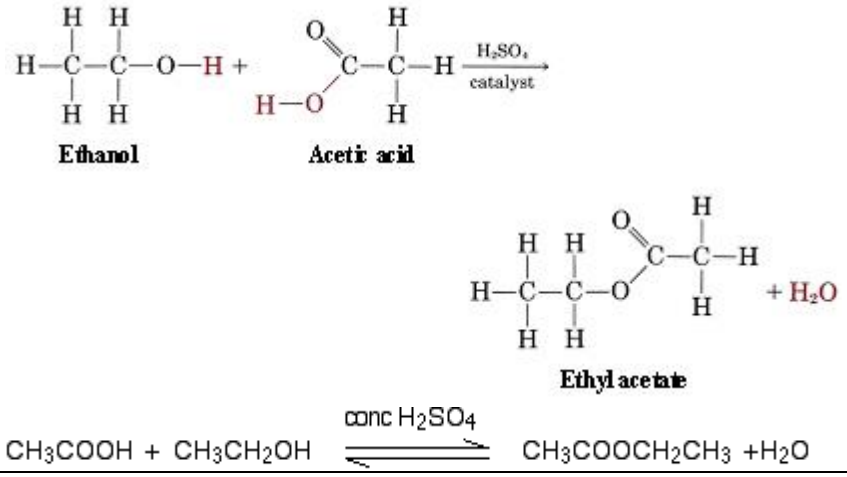
What are the problems caused by hard water?	1. Soap does not easily form a lather. 2. The formation of "scum" causes soap to be wasted.
How can we get rid of temporary hardness in water?	By boiling.
How can we soften permanently hard water?	By removing the calcium/magnesium ions that cause it, using an ion exchange resin.
What is a mole?	A mole of a substance is the atomic or molecular mass of that substance in grams AND it is the Avogadro number of particles (6.022×10^{23}).
Describe how to make a soluble salt from an acid and an insoluble base.	Excess of the insoluble base is added to ensure that all the acid is used up. The left over insoluble base can then be removed by filtration. The filtrate is the soluble salt and water. The water can be removed by evaporation.
Describe how to make a soluble salt from an acid and an alkali (a soluble base).	Titration, with an indicator, must first be used to determine the exact amount of the alkali that reacts with the acid. The experiment is repeated three times and the average volume of acid required to neutralise the base is found. The correct amount of acid and alkali can then be combined, leaving out the indicator. The solution remaining after the reaction is only the salt and water. The water can then be removed by evaporation.
What ions are involved in an acid-base titration?	The hydrogen ions (H^+) from the acid react with the hydroxide ions (OH^-) from the base.
What type of reaction takes place during an acid-base titration?	A neutralisation reaction.
What is an indicator?	An indicator is a dye that changes colour according to its pH. Indicators can be used to determine when a solution is neutral.
What colour is the indicator methyl orange in acid and in alkaline solutions.	Methyl orange is red in acid solutions and yellow in alkaline solutions.
What colour is the indicator phenolphthalein in an alkali, and what colour change is observed at the end point of the titration?	Phenolpthalein is pink in an alkaline solution. It becomes colourless when the solution is neutral or acidic.
Write a balanced symbol equation (including state symbols) for the formation of copper sulfate from an acid and an insoluble base.	$CuO\ (s) + H_2SO_4(aq) \rightarrow CuSO_4\ (aq) + H_2O(l)$
Potassium nitrate (KNO_3) is a soluble salt. Suggest an acid and a soluble base that could be used to make potassium nitrate.	Nitric acid and potassium hydroxide.
What is the formula to calculate the concentration of a solution in mol dm^{-3}?	Concentration = moles of solute (mol) / volume (dm^3)
What is the formula to calculate the number of moles of an element or compound?	Number of moles = mass in grams / relative atomic mass (g) (or the relative formula mass if it is a compound)
Describe how an ion exchange column softens water.	The calcium and magnesium ions that cause hard water are passed through the ion exchange column. Inside the column are small resin beads. The beads have sodium ions weakly attached to their surface. The calcium and magnesium ions displace the sodium ions. The calcium and magnesium ions stay in the column and the sodium ions flow out of the column in the water. Sodium salts are soluble so they do not cause the problems associated with hard water. The column must be periodically recharged with sodium chloride to flush out the calcium and magnesium ions.
What is an electrolyte?	An ionic substance dissolved in water.

Where do positively charged ions (cations) move to during electrolysis?	Towards the negative cathode
Where do negatively charged ions (anions) move during electrolysis?	Towards the positive anode
Describe oxidation and reduction in terms of electron gain/loss	Oxidation is loss of electrons and reduction is gain of electrons.
At which electrodes do oxidation and reduction take place?	Oxidation takes place at the anode and reduction takes place at the cathode.
Write a half-equation for the reduction of copper ions at the cathode.	$Cu^{2+} + 2e^- \rightarrow Cu$
Write a half-equation for the oxidation of copper at the anode.	$Cu \rightarrow Cu^{2+} + 2e^-$
How is sodium metal produced?	By the electrolysis of molten sodium chloride.
Name two uses for sodium.	1. Used in street lamps. 2. Used as a coolant in some nuclear reactors.
What are the products of the electrolysis of sodium chloride solution?	Anode: Chlorine gas Cathode: Hydrogen gas Sodium hydroxide solution is formed in the cell.
What two ions are present in water?	Hydrogen ions (H^+) and hydroxide ions (OH^-).
During the electrolysis of a salt solution will the metal or the hydrogen ions discharge at the cathode?	It depends on their relative positions on the reactivity series. The ion that is lowest on the reactivity series will discharge at the cathode.
During the electrolysis of a salt solution will the non-metal or the hydroxide ions discharge at the anode?	Oxygen from the hydroxide ion is discharged at the anode **unless** there is a halide (F^-, Cl^-, Br^-, I^-) present, in which case the halide will discharge as the corresponding halogen gas.
What are the products of the electrolysis of copper chloride solution?	Copper (cathode) and chlorine gas (anode).
What are the products of the electrolysis of copper sulphate solution?	Copper (cathode) and oxygen gas (anode)
What are the products of the electrolysis of sodium sulphate solution?	Hydrogen gas (cathode) and oxygen gas (anode).
What are the products of the electrolysis of molten lead bromide?	Bromine gas (anode) and lead (cathode).
Describe how copper is purified by electrolysis.	Using a pure copper cathode, an impure copper anode and copper sulphate solution as the electrolyte. Impure copper on the anode is oxidised to form Cu^{2+}, which passes into solution and travels to the cathode. Any impurities fall to the bottom of the cell. At the cathode the copper ions are reduced to copper metal and deposited on the cathode as pure copper.

How do the masses of the electrodes change during the purification of copper?	The mass of the anode decreases and the mass of the cathode increases.
What is electroplating used for?	Used to improve the appearance and/or the resistance to corrosion of metal objects.
What are the conditions of room temperature and pressure (RTP)?	25°C and 1 atm
What volume does one mole of any gas occupy?	24 dm^3
How many dm^3 are 1. 100 cm^3? 2. 500 cm^3? 3. 1000 cm^3?	1. 0.1 dm^3 2. 0.5 dm^3 3. 1 dm^3
What volume does 16g of oxygen gas occupy at RTP?	**12 dm^3** (16g/32 = 0.5 mol, 0.5 x 24 dm^3 = 12 dm^3)
What volume of oxygen gas (at RTP) is required to convert 16g of methane to carbon dioxide and water?	**48 dm3**. (16g if methane = 1 mole. Balanced equation shows that 2 moles of oxygen is needed to convert each mole of methane. Therefore, 2 x 24 dm^3 = 48 dm^3 of oxygen is required.)
How are nitrogenous fertilizers produced from ammonia?	Ammonia is reacted with nitric acid to produce ammonium nitrate.
Give the balanced symbol equation for making nitrogenous fertilizers.	$HNO_3 + NH_3 \rightarrow NH_4NO_3$
Give one advantage and one disadvantage of the use of nitrogenous fertilizers.	Advantage: Promotes plant growth, thereby enabling more people to be fed. Disadvantage: Eutrophication.
Describe the process of eutrophication and its effects.	Excess fertilizers are washed into rivers and lakes. Algae and plants grow quickly. When these plants die they are decomposed by fungi and bacteria which use up the oxygen in the water. Other organisms may die as a result of lack of oxygen.
Write a balanced symbol equation for the Haber process.	$N_2 + 3H_2 \leftrightarrow 2NH_3$
Where do the reactants for the Haber process come from?	Nitrogen is extracted from the air and hydrogen is obtained from natural gas.
What is a reversible reaction?	A reaction which can take place in both the forward and backward direction. (The reaction never goes to completion.)
What is a dynamic equilibrium?	The forward and the backward reaction both take place at the **same time**, and at the **same rate**.
How is the position of a dynamic equilibrium affected by changes in temperature and pressure?	The position of the equilibrium shifts in order to cancel out the effect of the change.
The forward reaction of the Haber process is exothermic. What is the effect on yield of ammonia of increasing the temperature?	Yield of ammonia decreases.
What is the effect on the yield of ammonia of increasing the pressure?	Yield of ammonia increases.
What compromise conditions of temperature and pressure are used in the Haber process?	450°C and 200 atm.

What catalyst is used in the Haber process?	Iron
What effect does the catalyst have on yield, and how quickly equilibrium is reached?	Catalyst has no effect on yield, but it does reduce the time taken for equilibrium to be reached.
What reactants or conditions are needed for fermentation?	Reactant: Carbohydrate (usually sugar) Conditions: Warmth, an enzyme in yeast must be present.
What are the products of the fermentation of glucose?	Ethanol and carbon dioxide gas.
Write a balanced symbol equation for the fermentation of glucose.	$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$
How can we obtain a concentrated ethanol solution from a fermentation mixture?	Fractional distillation.
Place wine, beer and spirits in order of the percentage of alcohol they contain (greatest first).	Spirits, wine, beer.
List three negative effects of alcohol	Slower reaction times/violent or aggressive behaviour/loss of balance and coordination/vomiting and fainting/dehydration/increased risk of heart disease or stroke/cirrhosis of the liver
What social issues can arise from alcohol abuse?	Cost of treating alcohol-related medical conditions/public order problems in city centres.
How can ethanol be produced from ethane?	By reacting it with steam.
What is a “homologous series”?	A family of carbon compounds that have a similar chemical formula. They have the same chemical properties, but show a trend in their physical properties.
How does soap remove dirt and grease?	Part of the soap anion is hydrophobic and dissolves in dirt or grease. The other part is hydrophilic and dissolves in water.
How is soap made?	By boiling with concentrated alkali solution (soaps are sodium or potassium salts of long carbon chain carboxylic acids).
What type of fabric can be made by recycling polyester?	Fleece.
How are liquid oils converted to solid fats?	By reacting with hydrogen (hydrogenation).

Name and draw the alkanes up to 4 carbons.	
Name and draw the alkenes up to 3 carbons.	Ethene (C_2H_4), propene (C_3H_6). 
Name and draw the alcohols up to 3 carbons.	Methanol, ethanol, propanol. 
Name and draw the carboxylic acids up to 3 carbons.	Methanoic acid, ethanoic acid, propanoic acid. 
What is formed when ethanol is oxidised and how does this relate to the spoiling of wine?	Ethanoic acid is produced. This is what happens to the alcohol in wine when it is exposed to the air – ethanol is oxidised to ethanoic acid (wine oxidises to vinegar).
What are the uses of vinegar?	As a flavouring and as a preservative.
Describe how ethanoic acid behaves like a typical acid with Indicators, Metals, Carbonates	a) universal indicator turns red b) a salt (an ethanoate) and hydrogen gas are produced c) a salt (an ethanoate) and carbon dioxide and water are produced.

Give the reaction between ethanol and ethanoic acid to give ethyl ethanoate and water (in symbol and molecular form).	

C3 Keywords and Definitions

alcohol carbon compound which contains one or more hydroxyl (-OH) groups
alkali a solution which contains excess OH- ions and has a pH greater than 7
alkane a hydrocarbon in which all the bonds between the carbons are single
alkene a hydrocarbon in which there are one or more double bonds between carbon atoms
analysis investigation into the kinds and or amounts of substances present in a sample
anion Negatively charged ion, formed by gaining electrons (usually non-metal)
Base a substance that will react with an acid to form only salt and water
burette apparatus used to accurately measure the volume of a solution that has been added during a titration
carboxyl group a group of 2 oxygen atoms, one carbon atom and one hydrogen atom, usually written as -COOH or CO2H
carboxylic acid an acid that contains a carboxyl group
catalyst a substance that speeds up the rate of a reaction without being used up in the reaction
catalytic hydrogenation a reaction in which hydrogen is added to a compound using a catalyst to speed up the reaction, such as the addition of hydrogen to saturated oils with alkene C=C double bonds to produce a compound with only single bonds.
cathode negative electrode
cation positively charged ion, formed by losing electrons (usually a metal ion)
concentration a measure of how much solute is dissolved in a solvent. The units are g dm-3 or mol dm-3
corrosion chemical changes to metals converting them to compounds, as in rusting of iron
cracking a type of chemical reaction in which large alkane molecules are decomposed into 2 or more smaller molecules to form smaller alkanes and alkenes
crystallise to make something from crystals
dehydration removing water
discharged conversion of ions to elements by electron transfer at the electrodes during electrolysis
dynamic equilibrium when the forwards and backwards reactions are occurring at the same rate
Electrode a rod made of metal or carbon which carries the current in the electrolyte.
Electrolysis the process in which electrical energy from a d.c. supply decomposes some compounds. A chemical change.
Electrolyte ionic liquid where moving ions carry the current during electrolysis.
Electroplating covering one metal with a thin
Ester carbon compound made from the reaction of an acid (often a carboxylic acid) with an alcohol.
Ethanoic acid. The carboxylic acid which contains two carbon atoms, and which is the active ingredient in vinegar.
Ethanol the chemical name of the alcohol in alcoholic drinks.
Evacuated tube a tube from which the air has been removed so that there is a vacuum.
Excess reactants that are not used up when the reaction is finished.
Exothermic a type of reaction that releases heat energy, e.g. combustion.

Filtrate the product of filtration; a fluid that has passed through a filter.
Filtration separating large molecules from smaller ones using a partially permeable membrane, as in the bowman's capsule of a nephron.
Filtration the separation of undissolved solids from a liquid by filtering.
Flame test an analytical test to find out which metal ion is present in a substance. Different metals produce different colours in a bunsen burner flame.
Fractional distillation a method of separating amixture of liquids with different boiling points into individual components (fractions).
Fractions the different mixtures produced by fractional distillation.
General formula formula showing the proportions of different atoms in a molecule for a series of compounds (a homologous series) that have similar properties. For example, alkenes have the general formula c*n*h2*n* (where '*n*' is a constant).
Haber process the industrial process in which ammonia is made from the reaction between hydrogen and nitrogen.
Half-equation ionic equation showing electron transfers in reduction or oxidation.
Hard water water which contains dissolved calcium or magnesium ions and does not easily form a lather with soap.
Hydration adding water.
Hydrocarbon a compound of hydrogen and carbon only.
Hydrogen ions, h+(aq) positively charged hydrogen ion. The more hydrogen ions in solution the greater the acidity.
Hydrogenated a substance such as a vegetable oil which has had hydrogen added to it; converting an unsaturated c=c double bond to a single bond.
Hydrophilic 'water-loving' substances which are attracted to water and mix with it.
Hydrophobic 'water-hating' substances which are repelled by water and do not mix (e.g. oil).
Hydroxide ions, oh−(aq) one hydrogen and one oxygen atom carrying a negative charge, acts as a base
Hydroxyl an oxygen atom joined by covalent bonds to a hydrogen atom (an −oh group).
Impure not pure, a mixture.
Indicator substance which can change colour depending on the ph of a solution.
Inert unreactive material, unlikely to take part in chemical reactions.
Insoluble substance which does not dissolve in a given solvent.
Ion exchange column device used to soften hard water. Contains a resin with an excess of na+ ions. When hard water passes through the column, the ca2+ ions in the water are exchanged for na+ ions.
Ionic compound substance containing ions from two or more elements.
Ionic equation equation which only shows the ions changed by a reaction, with the other ions omitted.
Ionising radiation radiation that can cause charged particles to be formed by knocking outer electrons out of the atom, or giving them enough energy to break free from the atom. Causes tissue damage and may cause mutations.
Litmus a natural acid/alkali indicator, obtained from lichen. Turns red in acidic solutions and blue in alkaline solutions.
Molar volume the volume of one mole of any gas at room temperature and pressure (24 dm3).
Mole the quantity of a substance which is equivalent to its relative formula mass in grams.
Molecular formula the formula that shows the actual number of atoms of each element that combine to make a molecule of a compound.
Neutralisation reaction reaction in which a base or alkali reacts with an acid.
Nitrogenous fertiliser fertiliser that contains nitrogen compounds such as nitrates.
Oxidation a reaction in which oxygen is added to a chemical; loss of an electron by a negative ion. Pacemaker a device which helps the heart to beat properly by detecting the action potentials and applying electrical signals to regulate the heart action.
Permanent hardness property of hard water that cannot be removed by boiling the water.
Phenolphthalein an indicator. Turns colourless in acidic solutions and pink in basic solutions.
Pipette apparatus used to accurately measure a set volume of a solution, which can be used in a titration.
Polyester a type of plastic made from long chains of esters, which can be used to make drinks bottles and fi bres for clothing.
Precipitate insoluble solid formed when two solutions are mixed together and a precipitation reaction occurs.

Precipitation reaction a reaction in which an insoluble product is formed from soluble reactants.
Preservative a substance that is added to food to keep it edible for longer.
Purity measure of the amount of the main substance present in a sample related to the amount of impurity present.
Qualitative analysis investigation into the kind of substances present in an unknown sample.
Quantitative analysis investigation into the amount of each substance present in an unknown sample.
Reduction gain of an electron by a positive ion.
Refine increase the purity of a material, such as a metal.
Relative atomic mass the mean mass of an atom relative to the mass of an atom of carbon-12, which is assigned a mass of 12.
Relative formula mass the sum of the relative atomic masses of all the atoms in a formula.
Reversible reaction a chemical reaction that can work in both directions.
Salt a compound formed by neutralisation of an acid by a base. The fi rst part of the name comes from the metal in the metal oxide, hydroxide or carbonate. The second part of the name comes from the acid.
Saturated a molecule which contains only single bonds between the carbon atoms and has the maximum possible number of atoms attached to the carbon chain.
Scum insoluble precipitate formed when the dissolved calcium and magnesium ions in hard water bind with soap.
Soft water water which forms a good lather with soap.
Soluble substance which dissolves in a given solvent.
Solute the solid or liquid that dissolves in a given
Solvent to form a solution.
Solution the clear mixture that forms when a solute dissolves in a given solvent. Solvent the liquid that dissolves the solute. (solute + solvent solution)
Structural formula a formula that shows the way that all the atoms are arranged and joined together in a molecule.
Temporary hardness property of hard water that can be removed by boiling the water.
Titration technique in volumetric analysis, used to find the exact volumes of solutions which react with each other.
Titre the volume of solution delivered by the burette at the ‘end point’ when the indicator changes colour.
Unsaturated a molecule which contains one or more double bonds between the carbon atoms, allowing extra atoms to be added on to the carbon
Yield the amount of product formed in a reaction.