GCSE Separate Biology – Extra Key ideas

1. Atomic structure and the periodic table	
The transition elements are metals with similar properties which are different from those of the elements in Group 1.	Many transition elements have ions with different charges, form coloured compounds and are useful as catalysts.
Compare the properties of Cr, Mn, Fe, Co, Ni, Cu to those of group 1 elements e.g melting points, densities, strength, hardness and reactivity with oxygen / water / halogens.	
2. Bonding, structure and properties of matter	
Nanoscience refers to structures that are 1–100 nm in size, of the order of a few hundred atoms. Nanoparticles, are smaller than fine particles ($PM_{2.5}$), which have diameters between 100 and 2500 nm (1×10^{-7} m and 2.5×10^{-6} m). Coarse particles (PM_{10}) have diameters between 1×10^{-5} m and 2.5×10^{-6} m. Coarse particles are often referred to as dust.	As the side of cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of 10.
Nanoparticles may have properties different from those for the same materials in bulk because of their high surface area to volume ratio. It may also mean that smaller quantities are needed to be effective than for materials with normal particle sizes.	Nanoparticles have many applications in medicine, in electronics, in cosmetics and sun creams, as deodorants, and as catalysts. New applications for nanoparticulate materials are an important area of research.
3. Quantitative Chemistry	
Even though no atoms are gained or lost in a chemical reaction, it is not always possible to obtain the calculated amount of a product because: • the reaction may not go to completion because it is reversible • some of the product may be lost when it is separated from the reaction mixture • some of the reactants may react in ways different to the expected reaction.	The amount of a product obtained is known as the yield. When compared with the maximum theoretical amount as a percentage, it is called the percentage yield. $\% \text{ Yield} = \frac{\text{Mass of product actually made}}{\text{Maximum theoretical mass of product}} \times 100$
The atom economy (atom utilisation) is a measure of the amount of starting materials that end up as useful products. It is important for sustainable development and for economic reasons to use reactions with high atom economy	The percentage atom economy of a reaction is calculated using the balanced equation for the reaction as follows: $\frac{\text{Relative formula mass of desired product from equation}}{\text{Sum of relative formula masses of all reactants from equation}} \times 100$
HT ONLY The concentration of a solution can be measured in mol/dm^3 . The amount in moles of solute or the mass in grams of solute in a given volume of solution can be calculated from its concentration in mol/dm^3	HT ONLY If the volumes of two solutions that react completely are known and the concentration of one solution is known, the concentration of the other solution can be calculated.
HT ONLY Equal amounts in moles of gases occupy the same volume under the same conditions of temperature and pressure. The volume of one mole of any gas at room temperature and pressure (20°C and 1 atmosphere pressure) is 24 dm^3 .	

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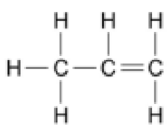
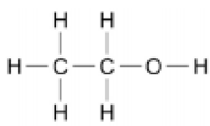
The volumes of gaseous reactants and products can be calculated from the balanced equation for the reaction.	
4. Chemical Changes	
The volumes of acid and alkali solutions that react with each other can be measured by titration using a suitable indicator.	Describe how to carry out titrations using strong acids and strong alkalis only (sulfuric, hydrochloric and nitric acids only) to find the reacting volumes accurately
5. Energy Changes	
Cells contain chemicals which react to produce electricity.	The voltage produced by a cell is dependent upon a number of factors including the type of electrode and electrolyte. A simple cell can be made by connecting two different metals in contact with an electrolyte.
Batteries consist of two or more cells connected together in series to provide a greater voltage.	In non-rechargeable cells and batteries the chemical reactions stop when one of the reactants has been used up. Alkaline batteries are non-rechargeable. Rechargeable cells and batteries can be recharged because the chemical reactions are reversed when an external electrical current is supplied.
Fuel cells are supplied by an external source of fuel (eg hydrogen) and oxygen or air. The fuel is oxidised electrochemically within the fuel cell to produce a potential difference.	The overall reaction in a hydrogen fuel cell involves the oxidation of hydrogen to produce water
Hydrogen fuel cells offer a potential alternative to rechargeable cells and batteries.	
6. The rate and extent of chemical change	
No extra content	
7. Organic Chemistry	
Alkenes are hydrocarbons with a double carbon-carbon bond. The general formula for the homologous series of alkenes is $C_n H_{2n}$	Alkene molecules are unsaturated because they contain two fewer hydrogen atoms than the alkane with the same number of carbon atoms.
The first four members of the homologous series of alkenes are ethene, propene, butene and pentene. Alkenes can be represented using diagrams for example ethene. or 	Alkenes are hydrocarbons with the functional group C=C.
It is the generality of reactions of functional groups that determine the reactions of organic compounds.	Alkenes react with oxygen in combustion reactions in the same way as other hydrocarbons, but they tend to burn in air with smoky flames because of incomplete combustion.
Alkenes react with hydrogen, water and the halogens, by the addition of atoms across the carbon-carbon double bond so that the double bond becomes a single carbon-carbon bond.	Alcohols contain the functional group –OH. Methanol, ethanol, propanol and butanol are the first four members of a homologous series of alcohols. 

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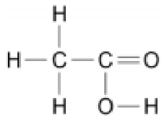
Aqueous solutions of ethanol are produced when sugar solutions are fermented using yeast.

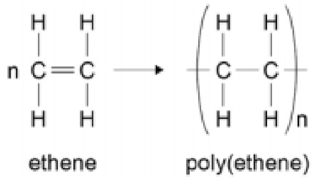
Carboxylic acids have the functional group –COOH. The first four members of a homologous series of carboxylic acids are methanoic acid, ethanoic acid, propanoic acid and butanoic acid.



Alkenes can be used to make polymers such as poly(ethene) and poly(propene) by addition polymerisation.

In addition polymerisation reactions, many small molecules (monomers) join together to form very large molecules (polymers).

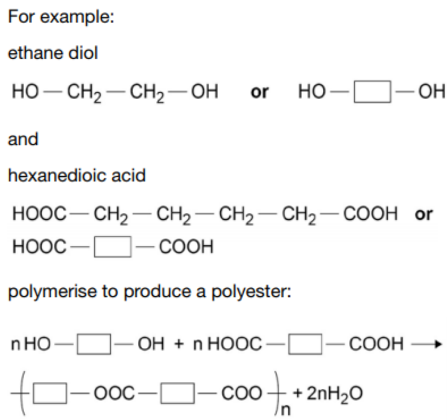
In addition polymers the repeating unit has the same atoms as the monomer because no other molecule is formed in the reaction.



HT ONLY

Condensation polymerisation involves monomers with two functional groups. When these types of monomers react they join together, usually losing small molecules such as water, and so the reactions are called condensation reactions.

The simplest polymers are produced from two different monomers with two of the same functional groups on each monomer.



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Amino acids have two different functional groups in a molecule. Amino acids react by condensation polymerisation to produce polypeptides.

For example: glycine is H_2 NCH_2 COOH and polymerises to produce the polypeptide

(-$HNCH_2$ COO-)$_n$ and n H_2 O

Different amino acids can be combined in the same chain to produce proteins.

DNA (deoxyribonucleic acid) is a large molecule essential for life. DNA encodes genetic instructions for the development and functioning of living organisms and viruses.

Most DNA molecules are two polymer chains, made from four different monomers called nucleotides, in the form of a double helix. Other naturally occurring polymers important for life include proteins, starch and cellulose.

8. Chemical Analysis

Flame tests can be used to identify some metal ions (cations). Lithium, sodium, potassium, calcium and copper compounds produce distinctive colours in flame tests:

- lithium compounds result in a crimson flame
- sodium compounds result in a yellow flame
- potassium compounds result in a lilac flame
- calcium compounds result in an orange-red flame
- copper compounds result in a green flame.

Sodium hydroxide solution can be used to identify some metal ions (cations).

Solutions of aluminium, calcium and magnesium ions form white precipitates when sodium hydroxide solution is added but only the aluminium hydroxide precipitate dissolves in excess sodium hydroxide solution.

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If a sample containing a mixture of ions is used some flame colours can be masked.	Solutions of copper(II), iron(II) and iron(III) ions form coloured precipitates when sodium hydroxide solution is added. Copper(II) forms a blue precipitate, iron(II) a green precipitate and iron(III) a brown precipitate.
Carbonates react with dilute acids to form carbon dioxide gas. Carbon dioxide can be identified with limewater.	Halide ions in solution produce precipitates with silver nitrate solution in the presence of dilute nitric acid. Silver chloride is white, silver bromide is cream and silver iodide is yellow.
Sulfate ions in solution produce a white precipitate with barium chloride solution in the presence of dilute hydrochloric acid.	Elements and compounds can be detected and identified using instrumental methods. Instrumental methods are accurate, sensitive and rapid.
Flame emission spectroscopy is an example of an instrumental method used to analyse metal ions in solutions. The sample is put into a flame and the light given out is passed through a spectroscope. The output is a line spectrum that can be analysed to identify the metal ions in the solution and measure their concentrations.	
9. Chemistry of the atmosphere	
No extra content	
10. Using resources	
Corrosion is the destruction of materials by chemical reactions with substances in the environment. Rusting is an example of corrosion. Both air and water are necessary for iron to rust. Corrosion can be prevented by applying a coating that acts as a barrier, such as greasing, painting or electroplating. Aluminium has an oxide coating that protects the metal from further corrosion. Some coatings are reactive and contain a more reactive metal to provide sacrificial protection, eg zinc is used to galvanise iron.	Most metals in everyday use are alloys. Bronze is an alloy of copper and tin. Brass is an alloy of copper and zinc. Gold used as jewellery is usually an alloy with silver, copper and zinc. The proportion of gold in the alloy is measured in carats. 24 carat being 100% (pure gold), and 18 carat being 75% gold. Steels are alloys of iron that contain specific amounts of carbon and other metals. High carbon steel is strong but brittle. Low carbon steel is softer and more easily shaped. Steels containing chromium and nickel (stainless steels) are hard and resistant to corrosion. Aluminium alloys are low density.
Most of the glass we use is soda-lime glass, made by heating a mixture of sand, sodium carbonate and limestone. Borosilicate glass, made from sand and boron trioxide, melts at higher temperatures than soda-lime glass. Clay ceramics, including pottery and bricks, are made by shaping wet clay and then heating in a furnace.	The properties of polymers depend on what monomers they are made from and the conditions under which they are made. For example, low density (LD) and high density (HD) poly(ethene) are produced from ethene. Thermosoftening polymers melt when they are heated. Thermosetting polymers do not melt when they are heated.
Most composites are made of two materials, a matrix or binder surrounding and binding together fibres or fragments of the other material, which is called the reinforcement.	The Haber process is used to manufacture ammonia, which can be used to produce nitrogen-based fertilisers.

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The raw materials for the Haber process are nitrogen and hydrogen.	The purified gases are passed over a catalyst of iron at a high temperature (about 450°C) and a high pressure (about 200 atmospheres). Some of the hydrogen and nitrogen reacts to form ammonia. The reaction is reversible so some of the ammonia produced breaks down into nitrogen and hydrogen: nitrogen + hydrogen $\rightleftharpoons$ ammonia On cooling, the ammonia liquefies and is removed. The remaining hydrogen and nitrogen are recycled.
Compounds of nitrogen, phosphorus and potassium are used as fertilisers to improve agricultural productivity. NPK fertilisers contain compounds of all three elements. Industrial production of NPK fertilisers can be achieved using a variety of raw materials in several integrated processes. NPK fertilisers are formulations of various salts containing appropriate percentages of the elements.	Ammonia can be used to manufacture ammonium salts and nitric acid.4 Potassium chloride, potassium sulfate and phosphate rock are obtained by mining, but phosphate rock cannot be used directly as a fertiliser. Phosphate rock is treated with nitric acid or sulfuric acid to produce soluble salts that can be used as fertilisers.