GCSE (9-1)

Separate Chemistry 2

**Topics for Paper 2**

**Topic 6 – Groups in the periodic table Group 1**

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| **Students should:** | | **Maths skills** |
| 6.1 | Explain why some elements can be classified as:  alkali metals (group 1) – *they have 1 electron in the outside shell*  halogens (group 7) – *they have 7 electrons in the outside shell*  noble gases (group 0) – *they have full outer shells*  based on their position in the periodic table |  |
| 6.2 | Recall that alkali metals: a are soft  b have relatively low melting points |  |
| 6.3 | Describe the reactions of lithium, sodium and potassium with water  2Li + 2H2O 🡪 2LiOH + H2  2Na + 2H2O 🡪 2NaOH + H2  2K+ 2H2O 🡪 2KOH + H2 |  |
| 6.4 | Describe the pattern in reactivity of the alkali metals, lithium, sodium and potassium, with water; and use this pattern to predict the reactivity of other alkali metals   * *Reactivity increases as you go down the group* |  |
| 6.5 | Explain this pattern in reactivity in terms of electronic configurations   * *The more readily a metal loses its outer electron the more reactive it is.* |  |

**Group 7**

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| **Students should:** | | **Maths skills** |
| 6.6 | Recall the colours and physical states of chlorine, bromine and iodine at room temperature   * *Chlorine = green gas* * *Bromine = red-brown liquid that gives off an orange vapour* * *Iodine = dark grey solid that gives off a purple vapour* |  |
| 6.7 | Describe the pattern in the physical properties of the halogens, chlorine, bromine and iodine, and use this pattern to predict the physical properties of other halogens   * *Reactivity decreases as you go down the group.* * *The melting point and boiling point increase as you go down the group.* | 1d 2c |
| 6.8 | Describe the chemical test for chlorine   * *Damp blue litmus paper turns white* |  |
| 6.9 | Describe the reactions of the halogens, chlorine, bromine and iodine, with metals to form metal halides, and use this pattern to predict the reactions of other halogens  *Metal + Halogen 🡪 Metal halide*  For example:  2Na + Cl2 🡪 2NaCl  2Na + Br2 🡪 2NaBr  2Na + I2 🡪 2NaI |  |
| 6.10 | Recall that the halogens, chlorine, bromine and iodine, form hydrogen halides which dissolve in water to form acidic solutions, and use this pattern to predict the reactions of other halogens  *Cl2 + H2 🡪 2HCl* |  |
| 6.11 | Describe the relative reactivity of the halogens chlorine, bromine and iodine, as shown by their displacement reactions with halide ions in aqueous solution, and use this pattern to predict the reactions of astatine   * *A more reactive halogen will displace a less reactive one, for example:*   *Chlorine + Potassium Bromide 🡪 Bromine + Potassium chloride* |  |
| 6.12 | **Explain why these displacement reactions are redox reactions in terms of gain and loss of electrons, identifying which of the substances are oxidised and which are reduced.**   * *The halogens gain electrons.* * *Halide ions lost electrons* * *For example;*   *Cl2 + 2Br- 🡪 Br2 + 2Cl-* |  |

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| **Students should:** | **Maths skills** |
| 6.13 Explain the relative reactivity of the halogens in terms of electronic configurations  *- As you go down the group the element are less reactive because it is harder to attract the extra electron as the atomic radius is bigger.* |  |

**Group 0**

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| **Students should:** | | **Maths skills** |
| 6.14 | Explain why the noble gases are chemically inert, compared with the other elements, in terms of their electronic configurations   * *They have full outer shells so don’t gain or lose electrons* |  |
| 6.15 | Explain how the uses of noble gases depend on their inertness, low density and/or non-flammability   * *Argon is used in filament lamps as it’s non flammable. It stops the filament from burning away.* * *Argon and helium can be used to protect metals that are being welded. It stops them reacting with oxygen.* * *Helium is used in airships and party balloons. Helium has a lower density than air to it will float. It’s also non-flammable which makes it safer than hydrogen.* |  |
| 6.16 | Describe the pattern in the physical properties of some noble gases and use this pattern to predict the physical properties of other noble gases   * *Boiling point, melting point and density all increase as you go down the group.* * *See examples question in your revision guide.* | 1d 2c |

#### Topic 7 – Rates of reaction and energy changes Rates of reaction

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| **Students should:** | | **Maths skills** |
| *7.1* | *Core Practical: Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:*   1. *measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)* 2. *observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)* | 1a, 1c  4a, 4b, 4c, 4d, 4e |
| 7.2 | Suggest practical methods for determining the rate of a given reaction   * *Using a precipitation reaction to time how low long it takes for an X to disappear* * *Measure the change in mass* * *Measure the volume of gas given off* | 4b, 4c, 4d, 4e  Pg 80 Chem  Pg 129-130 Combined Foundation  Pg 131 Combined higher |
| 7.3 | Explain how reactions occur when particles collide and that rates of reaction are increased when the frequency and/or energy of collisions is increased   * *More successful collision occur when the particles are moving faster. Particles need to collide with at least the activation energy to be successful.* | 1c |
| 7.4 | Explain the effects on rates of reaction of changes in:  Temperature – *the hotter it is the faster the rate of reaction. Particles have more energy and speed resulting in more successful collisions.*  Concentration – *The higher the concentration, the faster the rate of reaction. There are more particles in the same volume resulting in increased frequency of collisions*  Surface area to volume ratio of a solid -  *having a large surface are to volume ratio increases the rate of reactions as the particles around it will have more area to work on so the frequency of collisions increase*  Pressure (on reactions involving gases) - *The higher the pressure, the faster the rate of reaction. There are more particles in the same volume resulting in increased frequency of collisions* | 1c, 1d 5c |

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| 7.5 | Interpret graphs of mass, volume or concentration of reactant or product against time  *.- See your revision guide for more info* | 1c  4a, 4d, 4e |
| 7.6 | Describe a catalyst as a substance that speeds up the rate of a reaction without altering the products of the reaction, being itself unchanged chemically and in mass at the end of the reaction |  |
| 7.7 | Explain how the addition of a catalyst increases the rate of a reaction in terms of activation energy   * *Catalysts provide an alternate pathway that has a lower activation energy.* |  |
| 7.8 | Recall that enzymes are biological catalysts and that enzymes are used in the production of alcoholic drinks   * *Enzymes from yeast cells are used in the fermentation process which is used to make alcoholic drinks.* * *They catalyse the reaction that converts sugars into ethanol and carbon dioxide.* |  |

#### Heat energy changes in chemical reactions

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| **Students should:** | **Maths skills** |
| 7.9 Recall that changes in heat energy accompany the following changes:  a salts dissolving in water b neutralisation reactions c displacement reactions d precipitation reactions  *When these reactions take place in solution, temperature changes can be measured to reflect the heat changes* |  |
| 7.10 Describe an exothermic change or reaction as one in which heat energy is given out |  |
| 7.11 Describe an endothermic change or reaction as one in which heat energy is taken in |  |
| 7.12 Recall that the breaking of bonds is endothermic and the making of bonds is exothermic |  |
| * 1. Recall that the overall heat energy change for a reaction is:      1. exothermic if more heat energy is released in forming bonds in the products than is required in breaking bonds in the reactants      2. endothermic if less heat energy is released in forming bonds in the products than is required in breaking bonds in the reactants |  |
| * 1. **Calculate the energy change in a reaction given the energies of bonds (in kJ mol–1)** * *Overall energy change = energy required to break bonds – energy released by forming bonds* | 1a, 1c |
| * 1. Explain the term activation energy * *The minimum energy that particles need to react when the collide* |  |
| * 1. Draw and label reaction profiles for endothermic and exothermic reactions, identifying activation energy | 4a |

#### Topic 8 – Fuels and Earth science Fuels

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| **Students should:** | | **Maths skills** |
| 8.1 | Recall that hydrocarbons are compounds that contain carbon and hydrogen only |  |
| 8.2 | Describe crude oil as:   1. a complex mixture of hydrocarbons 2. containing molecules in which carbon atoms are in chains or rings (names, formulae and structures of specific ring molecules not required) 3. an important source of useful substances (fuels and feedstock for the petrochemical industry) 4. a finite resource *(non-renewable)* |  |
| 8.3 | Describe and explain the separation of crude oil into simpler, more useful mixtures by the process of fractional distillation   * *Oil is heated. It turns into a gas. The vapours rise up the column. The column has a temperature gradient (it’s hot at the bottom and cold at the top). Longer hydrocarbons with a higher boiling point drain off at the bottom as liquids)* |  |
| 8.4 | Recall the names and uses of the following fractions: a gases, used in domestic heating and cooking   1. petrol, used as fuel for cars 2. kerosene, used as fuel for aircraft 3. diesel oil, used as fuel for some cars and trains 4. fuel oil, used as fuel for large ships and in some power stations 5. bitumen, used to surface roads and roofs |  |
| 8.5 | Explain how hydrocarbons in different fractions differ from each other in:   1. the number of carbon and hydrogen atoms their molecules contain – *increases as you go down the group* 2. boiling points – *longer chains have stronger intermolecular forces resulting in a higher boiling point* 3. ease of ignition – *shorter hydrocarbons are easier to ignite as they have a lower boiling point*   d viscosity – *longer chains are highly viscous (thick)*  and are mostly members of the alkane homologous series | 4a, 4c |

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| 8.6 | Explain an homologous series as a series of compounds which: a have the same general formula   1. differ by CH2 in molecular formulae from neighbouring compounds 2. show a gradual variation in physical properties, as exemplified by their boiling points – *the longer the chains, the higher their melting and boiling points* 3. have similar chemical properties | 1c, 1d 4a |

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| **Students should:** | **Maths skills** |
| * 1. Describe the complete combustion of hydrocarbon fuels as a reaction in which:      1. carbon dioxide and water are produced      2. energy is given out |  |
| * 1. Explain why the incomplete combustion of hydrocarbons can produce carbon and carbon monoxide * *There is not enough oxygen* |  |
| * 1. Explain how carbon monoxide behaves as a toxic gas * *Combines with red blood cells instead of oxygen* |  |
| 8.10 Describe the problems caused by incomplete combustion producing carbon monoxide and soot in appliances that use carbon compounds as fuels |  |
| 8.11 Explain how impurities in some hydrocarbon fuels result in the production of sulfur dioxide   * *Fuels contain sulfur impurities. When they are burned they release CO2* |  |
| 8.12 Explain some problems associated with acid rain caused when sulfur dioxide dissolves in rain water   * *Acid rain acidifies lakes, damages buildings, kills trees and corrodes metals.* |  |
| 8.13 Explain why, when fuels are burned in engines, oxygen and nitrogen can react together at high temperatures to produce oxides of nitrogen, which are pollutants |  |
| 8.14 Evaluate the advantages and disadvantages of using hydrogen, rather than petrol, as a fuel in cars  *- Advantages = Clean, only produce water. Renewable.*  *- Disadvantages = Require a special engine which is expensive. Hard to store. Manufactured from fossil fuels.* |  |
| 8.15 Recall that petrol, kerosene and diesel oil are non-renewable fossil fuels obtained from crude oil and methane is a non- renewable fossil fuel found in natural gas |  |
| 8.16 Explain how cracking involves the breaking down of larger, saturated hydrocarbon molecules (alkanes) into smaller, more useful ones, some of which are unsaturated (alkenes)  - *A vapourised hydrocarbon is passed over a powdered aluminium oxide catalyst at 400-700°C and 70atm.* | 1c |
| 8.17 Explain why cracking is necessary  *- There is more of a demand for smaller chains like petrol and diesel.*  *- cracking also produces alkenes that can be used to make polymers* | 2c |

#### Earth and atmospheric science

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| **Students should:** | **Maths skills** |
| 8.18 Recall that the gases produced by volcanic activity formed the Earth’s early atmosphere |  |
| * 1. Describe that the Earth’s early atmosphere was thought to contain:      1. little or no oxygen      2. a large amount of carbon dioxide c water vapour   d small amounts of other gases  and interpret evidence relating to this | 2c 3a 4a |
| 8.20 Explain how condensation of water vapour formed oceans |  |
| 8.21 Explain how the amount of carbon dioxide in the atmosphere was decreased when carbon dioxide dissolved as the oceans formed |  |
| 8.22 Explain how the growth of primitive plants used carbon dioxide and released oxygen by photosynthesis and consequently the amount of oxygen in the atmosphere gradually increased |  |
| 8.23 Describe the chemical test for oxygen  *- Relights a glowing splint* |  |
| 8.24 Describe how various gases in the atmosphere, including carbon dioxide, methane and water vapour, absorb heat radiated from the Earth, subsequently releasing energy which keeps the Earth warm: this is known as the greenhouse effect |  |
| * 1. Evaluate the evidence for human activity causing climate change, considering:      1. the correlation between the change in atmospheric carbon dioxide concentration, the consumption of fossil fuels and temperature change      2. the uncertainties caused by the location where these measurements are taken and historical accuracy * *Historically less data was taken over fewer locations. If you go back far enough there are no records at all.* | 2c, 2h 4a |
| * 1. Describe:   a the composition of today’s atmosphere  b the potential effects on the climate of increased levels of carbon dioxide and methane generated by human activity, including burning fossil fuels and livestock farming  c that these effects may be mitigated: consider scale, risk and environmental implications |  |

#### Topic 9 – Separate chemistry 2 Qualitative analysis: tests for ions

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| **Students should:** | **Maths skills** |
| 9.1C Explain why the test for any ion must be unique |  |
| * 1. C Describe flame tests to identify the following ions in solids: a lithium ion, Li+ (red)      1. sodium ion, Na+ (yellow)      2. potassium ion, K+ (lilac)      3. calcium ion, Ca2+ (orange-red) e copper ion, Cu2+ (blue-green) |  |
| 9.3C Describe tests to identify the following ions in solids or solutions as appropriate:  a aluminium ion, Al3+  b calcium ion, Ca2+  c copper ion, Cu2+ d iron(II) ion, Fe2+ e iron(III) ion, Fe3+  f ammonium ion, NH4+  using sodium hydroxide solution  *Add sodium hydroxide to a solution of your mystery compound then use the colour of the precipitate to tell you which metal ion was in the compound.*  *White then colourless = aluminium ion, Al3+*  *White = calcium ion, Ca2+*  *Blue = copper ion, Cu2+*  *Green = iron(II) ion, Fe2+*  *Brown = iron(III) ion, Fe3+*  *If ammonia gas is given off, it means there are ammonium ions in your mystery substance* |  |
| 9.4C Describe the chemical test for ammonia  *- damp red litmus paper turns blue* |  |

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| * 1. C Describe tests to identify the following ions in solids or solutions as appropriate:      1. carbonate ion, CO32–, using dilute acid and identifying the carbon dioxide evolved. – *add the acid. If* CO32–  *ions are present it will fizz and produce CO2 which turns limewater cloudy.*      2. sulfate ion, SO42–, using dilute hydrochloric acid and barium chloride solution. – *a white precipitate of barium sulfate will form*      3. chloride ion, Cl–, bromide ion, Br–, iodide ion, I–, using dilute nitric acid and silver nitrate solution * *a chloride giveas w white precipitate of silver chloride* * *a bromide gives a cream precipitate of silver bromide* * *an iodide gives a yellow precipitate of silver iodide.* |  |
| 9.6C *Core Practical: Identify the ions in unknown salts, using the tests for the specified cations and anions in 9.2C, 9.3C, 9.4C, 9.5C* |  |
| 9.7C Identify the ions in unknown salts, using results of the tests above |  |
| 9.8C Describe that instrumental methods of analysis are available and that these may improve sensitivity, accuracy and speed of tests |  |

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| **Students should:** | **Maths skills** |
| * 1. C Evaluate data from a flame photometer:      1. to determine the concentration of ions in dilute solution using a calibration curve – *see your revision guide for more info*      2. to identify metal ions by comparing the data with reference data   (no knowledge of the instrument or how it works is required) | 4a |

#### Hydrocarbons

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| **Students should:** | **Maths skills** |
| 9.10C Recall the formulae of molecules of the alkanes, methane CH4, ethane C2H6, propane C3H8 and butane C4H10, and draw the structures of these molecules, showing all covalent bonds  *- See your revision guide for their structures.* | 5b |
| 9.11C Explain why the alkanes are saturated hydrocarbons  *- All the atoms have formed bonds with as many other atoms as they can* |  |
| 9.12C Recall the formulae of molecules of the alkenes, ethane C2H4, propene C3H6, butane C4H8, and draw the structures of these molecules, showing all covalent bonds (but-1-ene and but-2-ene only)  *- See your revision guide for their structures.* | 5b |
| 9.13C Explain why the alkenes are unsaturated hydrocarbons, describing that their molecules contain the functional group C=C  - *they can make more bonds* |  |
| 9.14C Recall the addition reaction of ethene with bromine, showing the structures of reactants and products, and extend this to other alkenes  *- see your revision guide for diagrams* | 5b |
| 9.15C Explain how bromine water is used to distinguish between alkanes and alkenes  - *alkenes can decolourise bromine water. It turns orange to colourless.* |  |
| 9.16C Describe how the complete combustion of alkanes and alkenes involves the oxidation of the hydrocarbons to produce carbon dioxide and water  *- see your revision guide for more info* |  |

#### Polymers

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| **Students should:** | **Maths skills** |
| 9.17C Recall that a polymer is a substance of high average relative molecular mass made up of small repeating units |  |
| * 1. C Describe:      1. how ethene molecules can combine together in a polymerisation reaction *– see your revision guide for more info*      2. that the addition polymer formed is called poly(ethene)   (conditions and mechanisms not required) | 5b |
| 9.19C Describe how other addition polymers can be made by combining together other monomer molecules containing C=C, to include poly(propene), poly(chloroethene) (PVC) and poly(tetrafluoroethene) (PTFE)  (conditions and mechanisms not required) | 5b |
| 9.20C Deduce the structure of a monomer from the structure of an addition polymer and vice versa | 5b |
| 9.21C Explain how the uses of polymers are related to their properties and vice versa: including poly(ethene), poly(propene), poly(chloroethene) (PVC) and poly(tetrafluoroethene) (PTFE)  *- see in your revision guide for more info* |  |
| C Explain:  * + 1. **why polyesters are condensation polymers – *each time an ester link is formed a molecule of water is lost***     2. **how a polyester is formed when a monomer molecule containing two carboxylic acid groups is reacted with a monomer molecule containing two alcohol groups**     3. **how a molecule of water is formed each time an ester link is formed** | 5b |
| * 1. C Describe some problems associated with polymers including the:      1. availability of starting materials      2. persistence in landfill sites, due to non-biodegradability c gases produced during disposal by combustion   d requirement to sort polymers so that they can be melted and reformed into a new product   * *More detail on this on page 101* |  |
| 9.24C Evaluate the advantages and disadvantages of recycling polymers, including economic implications, availability of starting materials and environmental impact |  |
| * 1. C Recall that:      1. DNA is a polymer made from four different monomers called nucleotides (names of nucleotides not required)      2. starch is a polymer based on sugars      3. proteins are polymers based on amino acids | 5b |

#### Alcohols and carboxylic acids

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| **Students should: Maths skills** | |
| 9.26C Recall the formulae of molecules of the alcohols, methanol, ethanol, propanol (propan-1-ol only) and butanol (butan-1-ol only), and draw the structures of these molecules, showing all covalent bonds  *- See your revision guide for more info* | 5b |
| 9.27C Recall that the functional group in alcohols is –OH and that alcohols can be dehydrated to form alkenes |  |
| 9.28C *Core Practical: Investigate the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol* | 1a, 1c 2c |
| 9.29C Recall the formulae of molecules of the carboxylic acids, methanoic, ethanoic, propanoic and butanoic acids, and draw the structures of these molecules, showing all covalent bonds  *- see your revision guide for more info* | 5b |
| 9.30C Recall that the functional group in carboxylic acids is –COOH and that solutions of carboxylic acids have typical acidic properties  *- see page 103* |  |
| 9.31C Recall that ethanol can be oxidised to produce ethanoic acid and extend this to other alcohols (reagents not required) |  |
| 9.32C Recall members of a given homologous series have similar reactions because their molecules contain the same functional group and use this to predict the products of other members of these series |  |
| 9.33C Describe the production of ethanol by fermentation of carbohydrates in aqueous solution, using yeast to provide enzymes |  |
| 9.34C Explain how to obtain a concentrated solution of ethanol by fractional distillation of the fermentation mixture  *Heat ethanol and water. Ethanol evaporates first and rises up column. A Liebig condenser is used to condense the ethanol vapour. Ethanol is collected in a flask.* |  |

#### Bulk and surface properties of matter including nanoparticles

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| **Students should: Maths skills** | |
| 9.35C Compare the size of nanoparticles with the sizes of atoms and molecules  *- 1-100nmacross. Nano particles contain roughly a few atoms so they’re bigger than atoms.* | 1b, 1d  2h |
| 9.36C Describe how the properties of nanoparticulate materials are related to their uses including surface area to volume ratio of the particles they contain, including sunscreens  - *small particles provide better protection from the Sun but don’t leave white marks on the skin.*  *- surface are to volume ratio = surface area / volume* | 1c 5c |
| 9.37C Explain the possible risks associated with some nanoparticulate materials  *- See your revision guide for more info* |  |
| 9.38C Compare, using data, the physical properties of glass and clay ceramics, polymers, composites and metals  *- See your revision guide for more info* | 2c |

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| **Students should: Maths skills** | |
| 9.39C Explain why the properties of a material make it suitable for a given use and use data to select materials appropriate for specific uses  *- See your revision guide for more info* | 2c |