GCSE Chemistry to GCE Chemistry – Specification mapping

The purpose of this document is to demonstrate the overlap between GCSE and GCE. For an effective progression through to A level, it will be useful if centres establish a baseline point from which to build on. The mapping document should enable teachers to streamline the teaching and get to the A level content within the first two weeks of term. This will serve two purposes:

a) Students will actually feel they are learning something new and maintain their interest in the subject.

b) Students will be able to discover very early on in the course whether Chemistry A level is really a suitable subject choice for them.

The following are some suggestions for how to use this resource:

1) post GCSE exams – if your school brings back the Year 11s after their exams

2) induction weeks at the start of 6th Form

3) setting summer homework in preparation for 6th Form

4) levelling the baseline of all students from their range of GCSE qualifications.

GCE Chemistry Topic 1 – Atomic structure and the Periodic Table	GCSE Chemistry
1. know the structure of an atom in terms of electrons, protons and neutrons	**Topic 1: Atomic Structure** 1.2 Describe the structure of an atom as a nucleus containing protons and neutrons, surrounded by electrons in shells 1.5 Describe the nucleus of an atom as very small compared to the overall size of the atom
2. know the relative mass and relative charge of protons, neutrons and electrons	**Topic 1: Atomic Structure** 1.3 Recall the relative charge and relative mass of a proton, a neutron and an electron: 1.6 Recall that most of the mass of an atom is concentrated in the nucleus
3. know what is meant by the terms 'atomic (proton) number' and 'mass number'	**Topic 1: Atomic Structure** 1.7 Recall the meaning of the term mass number of an atom 1.8 Describe atoms of a given element as having the same number of protons in the nucleus and that this number is unique to that element 1.16 Explain the meaning of atomic number of an element in terms of position in the periodic table and number of protons in the nucleus

GCE Chemistry Topic 1 – Atomic structure and the Periodic Table		GCSE Chemistry
4.	be able to determine the number of each type of sub-atomic particle in an atom, molecule or ion from the atomic (proton) number and mass number	**Topic 1: Atomic Structure** 1.4 Explain why atoms contain equal numbers of protons and electrons 1.10 Calculate the numbers of protons, neutrons and electrons in atoms given the atomic number and mass number **Topic 1: Ionic Bonding** 1.23 Calculate the numbers of protons, neutrons and electrons in simple ions given the atomic number and mass number
5.	understand the term 'isotopes'	**Topic 1: Atomic Structure** 1.9 Describe isotopes as different atoms of the same element containing the same number of protons but different numbers of neutrons in their nuclei
6.	be able to define the terms 'relative isotopic mass' and 'relative atomic mass', based on the ^{12}C scale	**Topic 1: Atomic Structure** 1.11 Explain how the existence of isotopes results in relative atomic masses of some elements not being whole numbers

GCE Chemistry Topic 1 – Atomic structure and the Periodic Table	GCSE Chemistry
7. understand the terms 'relative molecular mass' and 'relative formula mass', including calculating these values from relative atomic masses. *Definitions of these terms will not be expected* *The term 'relative formula mass' should be used for compounds with giant structures.*	**Topic 1: Calculations involving masses** 1.43 Calculate relative formula mass given relative atomic masses
8. be able to analyse and interpret data from mass spectrometry to calculate relative atomic mass from relative abundance of isotopes and vice versa	**Topic 1: Atomic Structure** **1.12 Calculate the relative atomic mass of an element from the relative masses and abundances of its isotopes**
16. know the number of electrons that can fill the first four quantum shells	**Topic 1: The Periodic Table** 1.19 Predict the electronic configurations of the first 20 elements in the periodic table as diagrams and in the form, for example 2.8.1

GCE Chemistry Topic 1 – Atomic structure and the Periodic Table	GCSE Chemistry
21. be able to predict the electronic configurations, using 1s notation and electrons-in-boxes notation, of: i. atoms, given the atomic number, *Z*, up to *Z* = 36 ii. ions, given the atomic number, *Z*, and the ionic charge, for *s*- and *p*-block ions only, up to *Z* = 36	**Topic 1: The Periodic Table** 1.19 Predict the electronic configurations of the first 20 elements in the periodic table as diagrams and in the form, for example 2.8.1
22. know that elements can be classified as *s*-, *p*- and *d*-block elements	**Topic 1: The Periodic Table** 1.20 Explain how the electronic configuration of an element is related to its position in the periodic table
24. understand periodicity in terms of a repeating pattern across different periods	**Topic 1: The Periodic Table** 1.17 Describe that in the periodic table a. elements are arranged in order of increasing atomic number, in rows called periods b. elements with similar properties are placed in the same vertical columns called groups

GCE Chemistry - Topic 2 – Bonding and structure	GCSE Chemistry
1. know that ionic bonding is the strong electrostatic attraction between oppositely charged ions	**Topic 1: Ionic Bonding** 1.27 Explain the structure of an ionic compound as a lattice structure held together by strong electrostatic forces (ionic bonds) between oppositely-charged ions
3. understand the formation of ions in terms of electron loss or gain 4. be able to draw electronic configuration diagrams of cations and anions using dot-and-cross diagrams	**Topic 1: Ionic Bonding** 1.22 Recall that an ion is an atom or group of atoms with a positive or negative charge 1.24 Explain the formation of ions in ionic compounds from their atoms, limited to compounds of elements in groups 1, 2, 6 & 7

GCE Chemistry - Topic 2 – Bonding and structure	GCSE Chemistry
6. understand that the physical properties of ionic compounds and the migration of ions provide evidence for the existence of ions	**Topic 1: Types of Substance** 1.33 Explain the properties of ionic compounds limited to: a. high melting points and boiling points, in terms of forces between ions b. whether or not they conduct electricity as solids, when molten and in aqueous solution **Topic 3: Electrolytic process** 3.22 Recall that electrolytes are ionic compounds in the molten state or dissolved in water 3.24 Explain the movement of ions during electrolysis, in which: a. positively charged cations migrate to the negatively charged cathode b. negatively charged anions migrate to the positively charged anode
7. know that a covalent bond is the strong electrostatic attraction between two nuclei and the shared pair of electrons between them	**Topic 1: Ionic bonding** 1.28 Explain how a covalent bond is formed when a pair of electrons is shared between two atoms **Topic 1: Covalent bonding** 1.29 Recall that covalent bonding results in the formation of molecules

GCE Chemistry - Topic 2 – Bonding and structure	GCSE Chemistry
8. be able to draw dot-and-cross diagrams to show electrons in simple covalent molecules, including those with multiple bonds and dative covalent (coordinate) bonds	**Topic 1: Covalent bonding** 1.31 Explain the formation of simple molecular, covalent substances using dot-and-cross diagrams, including: a. hydrogen b. hydrogen chloride c. water d. methane e. oxygen f. carbon dioxide
20. understand, in terms of intermolecular forces, physical properties shown by materials, including: a. the trends in boiling temperatures of alkanes with increasing chain length b. the effect of branching in the carbon chain on the boiling temperatures of alkanes c. the relatively low volatility (higher boiling temperatures) of alcohols compared to alkanes with a similar number of electrons d. the trends in boiling temperatures of the hydrogen halides, HF to HI	**Topic 1: Types of substance** 1.34 Explain the properties of typical covalent, simple molecular compounds limited to: a. low melting points and boiling points, in terms of forces between molecules (intermolecular forces) b. poor conduction of electricity

GCE Chemistry - Topic 2 – Bonding and structure	GCSE Chemistry
22. know that metallic bonding is the strong electrostatic attraction between metal ions and the sea of delocalised electrons	**Topic 1: Types of substance** 1.42 Describe most metals as shiny solids which have high melting points, high density and are good conductors of electricity whereas most non-metals have low boiling points and are poor conductors of electricity
23. know that giant lattices are present in: i. ionic solids (giant ionic lattices) ii. covalently bonded solids, such as diamond, graphite and silicon(IV) oxide (giant covalent lattices) iii. solid metals (giant metallic lattices)	**Topic 1: Types of substance** 1.32 Explain why elements and compounds can be classified as: a ionic b simple molecular (covalent) c giant covalent d metallic and how the structure and bonding of these types of substances results in different physical properties, including relative melting point and boiling point, relative solubility in water and ability to conduct electricity (as solids and in solution)

GCE Chemistry - Topic 2 – Bonding and structure	GCSE Chemistry
25. know the different structures formed by carbon atoms, including graphite, diamond and graphene	**Topic 1: Types of substance** 1.35 Recall that graphite and diamond are different forms of carbon and that they are examples of giant covalent substances 1.36 Describe the structures of graphite and diamond 1.37 Explain, in terms of structure and bonding, why graphite is used to make electrodes and as a lubricant, whereas diamond is used in cutting tools 1.38 Explain the properties of fullerenes including C60 and graphene in terms of their structures and bonding
26. be able to predict the type of structure and bonding present in a substance from numerical data and/or other information	**Topic 1: Types of substance** 1.32 Explain why elements and compounds can be classified as: ionic a. simple molecular (covalent) b. giant covalent c. metallic and how the structure and bonding of these types of substances results in different physical properties, including relative melting point and boiling point, relative solubility in water and ability to conduct electricity (as solids and in solution)

GCE Chemistry Topic 2 – Bonding and structure	GCSE Chemistry
27. be able to predict the physical properties of a substance, including melting and boiling temperature, electrical conductivity and solubility in water, in terms of: i. the types of particle present (atoms, molecules, ions, electrons) ii. the structure of the substance iii. the type of bonding and the presence of intermolecular forces, where relevant	**Topic 1: Types of substance** 1.33 Explain the properties of ionic compounds limited to: a high melting points and boiling points, in terms of forces between ions b whether or not they conduct electricity as solids, when molten and in aqueous solution 1.34 Explain the properties of typical covalent, simple molecular compounds limited to: a low melting points and boiling points, in terms of forces between molecules (intermolecular forces) b poor conduction of electricity 1.40 Explain the properties of metals, including malleability and the ability to conduct electricity

GCE Chemistry - Topic 3 – Redox 1	GCSE Chemistry
4. understand oxidation and reduction in terms of electron loss or electron gain	**Topic 3: Electrolytic processes** **3.28 Explain oxidation and reduction in terms of loss or gain of electrons**
11. understand that metals, in general, form positive ions by loss of electrons with an increase in oxidation number 12. understand that non-metals, in general, form negative ions by gain of electrons with a decrease in oxidation number 13. be able to write ionic half-equations and use them to construct full ionic equations	**Topic 1: The Periodic Table** 1.18 Identify elements as metals or non-metals according to their position in the periodic table, explaining this division in terms of the atomic structures of the elements **0.4 Write balanced ionic equations**

GCE Chemistry Topic 4 – Inorganic Chemistry and the Periodic Table	GCSE Chemistry
2. understand reasons for the trend in reactivity of the Group 2 elements down the group 4. know the reactions of the oxides of Group 2 elements with water and dilute acid, and their hydroxides with dilute acid	**Topic 6: Group 1 of the periodic table** 6.5 Explain this pattern in reactivity in terms of electronic configurations **Topic 3: Acids** 3.11 Explain the general reactions of aqueous solutions of acids with metal oxides and metal hydroxides
7. understand the formation of characteristic flame colours by Group 1 and 2 compounds in terms of electron transitions *Students will be expected to know the flame colours for Groups 1 and 2 compounds.*	**Topic 9: Qualitative analysis – tests for ions** 9.2C Describe flame tests to identify the following ions in solids: a. lithium ion, Li^+ (red) b. sodium ion, Na^+ (yellow) c. potassium ion, K^+ (lilac) d. calcium ion, Ca^{2+} (orange-red) e. copper ion, Cu^{2+} (blue-green)

GCE Chemistry Topic 4 – Inorganic Chemistry and the Periodic Table	GCSE Chemistry
9. understand reasons for the trends in melting and boiling temperatures, physical state at room temperature, and electronegativity for Group 7 elements	**Topic 6: Group 7 of the periodic table** 6.6 Recall the colours and physical states of chlorine, bromine and iodine at room temperature 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
10. understand reasons for the trend in reactivity of Group 7 elements down the group	**Topic 6: Group 7 of the periodic table** 6.13 Explain the relative reactivity of the halogens in terms of electronic configurations
11. understand the trend in reactivity of Group 7 elements in terms of the redox reactions of Cl2, Br2 and I2 with halide ions in aqueous solution, followed by the addition of an organic solvent	**Topic 6: Group 7 of the periodic table** 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 **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**

GCE Chemistry Topic 4 – Inorganic Chemistry and the Periodic Table	GCSE Chemistry
12. understand, in terms of changes in oxidation number, the following reactions of the halogens: i. oxidation reactions with Group 1 and 2 metals ii. the disproportionation reaction of chlorine with water and the use of chlorine in water treatment iii. the disproportionation reaction of chlorine with cold, dilute aqueous sodium hydroxide to form bleach iv. the disproportionation reaction of chlorine with hot alkali v. reactions analogous to those specified above	**Topic 6: Group 7 of the periodic table** 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
13. understand the following reactions: i. solid Group 1 halides with concentrated sulfuric acid, to illustrate the trend in reducing ability of the hydrogen halides ii. precipitation reactions of the aqueous anions Cl^-, Br^- and I^- with aqueous silver nitrate solution, followed by aqueous ammonia solution iii. hydrogen halides with ammonia and with water (to produce acids)	**Topic 6: Group 7 of the periodic table** 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

GCE Chemistry Topic 4 – Inorganic Chemistry and the Periodic Table	GCSE Chemistry
15. know reactions, including ionic equations where appropriate, for identifying: i. carbonate ions, CO_3^{2-}, and hydrogencarbonate ions, HCO_3^-, using an aqueous acid to form carbon dioxide ii. sulfate ions, SO_4^{2-}, using acidified barium chloride solution iii. ammonium ions, NH_4^+, using sodium hydroxide solution and warming to form ammonia *Tests for halide ions and for the ions of Group 1 and 2 metals are also required, but are covered elsewhere in this topic.*	**Topic 3: Acids** 3.11 Explain the general reactions of aqueous solutions of acids with metal carbonates **Topic 9: Qualitative analysis – tests for ions** 9.3C Describe tests to identify the following ions in solids or solutions as appropriate: ammonium ion, NH_4^+using sodium hydroxide solution 9.5C Describe tests to identify the following ions in solids or solutions as appropriate: a. carbonate ion, CO_3^{2-}, using dilute acid and identifying the carbon dioxide evolved b. sulfate ion, SO_4^{2-}, using dilute hydrochloric acid and barium chloride solution

GCE Chemistry - Topic 5 – Formulae, equations and amounts of substance	GCSE Chemistry
2. be able to use the Avogadro constant, *L*, (6.02×10^{23} mol^{-1}), in calculations	**Topic 1: Calculations involving masses** **1.50 Recall that one mole of particles of a substance is defined as:** **a. the Avogadro constant number of particles (6.02×10^{23} atoms, molecules, formulae or ions) of that substance**
3. know that the molar mass of a substance is the mass per mole of the substance in g mol^{-1}	**Topic 1: Calculations involving masses** **1.50 Recall that one mole of particles of a substance is defined as:** **b. a mass of 'relative particle mass' g**
4. know what is meant by the terms 'empirical formula' and 'molecular formula'	**Topic 1: Calculations involving masses** 1.45 Deduce: a. the empirical formula of a compound from the formula of its molecule b. the molecular formula of a compound from its empirical formula and its relative molecular mass

GCE Chemistry - Topic 5 – Formulae, equations and amounts of substance	GCSE Chemistry
5. be able to calculate empirical and molecular formulae from experimental data *Calculations of empirical formula may involve composition by mass or percentage composition by mass data.*	**Topic 1: Calculations involving masses** 1.44 Calculate the formulae of simple compounds from reacting masses or percentage composition and understand that these are empirical formulae **1.46 Describe an experiment to determine the empirical formula of a simple compound such as magnesium oxide**
6. be able to write balanced full and ionic equations, including state symbols, for chemical reactions	0.1 Recall the formulae of elements, simple compounds and ions 0.2 Write word equations 0.3 Write balanced chemical equations including the use of state symbols (s), (l), (g) and (aq) **0.4 Write balanced ionic equations**

GCE Chemistry - Topic 5 – Formulae, equations and amounts of substance	GCSE Chemistry
7. be able to calculate amounts of substances (in mol) in reactions involving mass, volume of gas, volume of solution and concentration *These calculations may involve reactants and/or products.*	**Topic 1: Calculations involving masses** 1.47 Explain the law of conservation of mass applied to: a. a closed system including a precipitation reaction in a closed flask b. a non-enclosed system including a reaction in an open flask that takes in or gives out a gas 1.51 **Calculate the number of:** **a. moles of particles of a substance in a given mass of that substance and vice versa** **b. particles of a substance in a given number of moles of that substance and vice versa** **c. particles of a substance in a given mass of that substance and vice versa** **Topic 5: Quantitative Analysis** 5.16C **Describe the molar volume, of any gas at room temperature and pressure, as the volume occupied by one mole of molecules of any gas at room temperature and pressure (The molar volume will be provided as 24 dm^3 or 24000 cm^3 in calculations where it is required)**

GCE Chemistry - Topic 5 – Formulae, equations and amounts of substance	GCSE Chemistry
8. be able to calculate reacting masses from chemical equations, and vice versa, using the concepts of amount of substance and molar mass	**Topic 1: Calculations involving masses** 1.48 Calculate masses of reactants and products from balanced equations, given the mass of one substance 1.52 **Explain why, in a reaction, the mass of product formed is controlled by the mass of the reactant which is not in excess** 1.53 **Deduce the stoichiometry of a reaction from the masses of the reactants and products**
9. be able to calculate reacting volumes of gases from chemical equations, and vice versa, using the concepts of amount of substance	**Topic 5: Quantitative Analysis** 5.17C **Use the molar volume and balanced equations in calculations involving the masses of solids and volumes of gases**
10. be able to calculate reacting volumes of gases from chemical equations, and vice versa, using the concepts of molar volume of gases ***CORE PRACTICAL 1: Measure the molar volume of a gas***	**Topic 5: Quantitative Analysis** 5.17C **Use the molar volume and balanced equations in calculations involving the masses of solids and volumes of gases** 5.18C **Use Avogadro's law to calculate volumes of gases involved in a gaseous reaction, given the relevant equation**

GCE Chemistry - Topic 5 – Formulae, equations and amounts of substance	GCSE Chemistry
11. be able to calculate solution concentrations, in mol dm^{-3} and g dm^{-3}, for simple acid–base titrations using a range of acids, alkalis and indicators *The use of both phenolphthalein and methyl orange as indicators will be expected* ***CORE PRACTICAL 2: Prepare a standard solution from a solid acid and use it to find the concentration of a solution of sodium hydroxide*** ***CORE PRACTICAL 3: Find the concentration of a solution of hydrochloric acid***	**Topic 1: Calculations involving masses** 1.49 Calculate the concentration of solutions in g dm^{-3} **Topic 3: Acids** 3.3 Recall the effect of acids and alkalis on indicators, including litmus, methyl orange and phenolphthalein 3.18 Describe how to carry out an acid-alkali titration, using burette, pipette and a suitable indicator, to prepare a pure, dry salt **Topic 5: Quantitative Analysis** 5.8C **Calculate the concentration of solutions in mol dm^{-3} and convert concentration in g dm^{-3} into mol dm^{-3} and vice versa** 5.9C *Core Practical: Carry out an accurate acid-alkali titration, using burette, pipette and a suitable indicator* **5.10C Carry out simple calculations using the results of titrations to calculate an unknown concentration of a solution or an unknown volume of solution required**

GCE Chemistry Topic 5 – Formulae, equations and amounts of substance	GCSE Chemistry
14. be able to calculate percentage yields and percentage atom economies using chemical equations and experimental results Atom economy of a reaction = (molar mass of the desired product) (sum of the molar masses of all products) × 100%	**Topic 5: Quantitative Analysis** 5.11C Calculate the percentage yield of a reaction from the actual yield and the theoretical yield 5.12C Describe that the actual yield of a reaction is usually less than the theoretical yield and that the causes of this include: a. incomplete reactions b. practical losses during the experiment c. competing, unwanted reactions (side reactions) 5.13C Recall the atom economy of a reaction forming a desired product 5.14C Calculate the atom economy of a reaction forming a desired product
15. be able to relate ionic and full equations, with state symbols, to observations from simple test tube reactions, to include: i. displacement reactions ii. reactions of acids iii. precipitation reactions	**Topic 3: Acids** 3.11 Explain the general reactions of aqueous solutions of acids with: a. metals b. metal oxides c. metal hydroxides d. metal carbonates to produce salts

GCE Chemistry - Topic 5 – Formulae, equations and amounts of substance	GCSE Chemistry
15. be able to relate ionic and full equations, with state symbols, to observations from simple test tube reactions, to include: i. displacement reactions ii. reactions of acids iii. precipitation reactions	**Topic 3: Acids** 3.19 Recall the general rules which describe the solubility of common types of substances in water: a. all common sodium, potassium and ammonium salts are soluble b. all nitrates are soluble c. common chlorides are soluble except those of silver and lead d. common sulfates are soluble except those of lead, barium and calcium e. common carbonates and hydroxides are insoluble except those of sodium, potassium and ammonium 3.20 Predict, using solubility rules, whether or not a precipitate will be formed when named solutions are mixed together, naming the precipitate if any **Topic 4: Obtaining and using metals** 4.1 Deduce the relative reactivity of some metals, by their reactions with water, acids and salt solutions

GCE Chemistry - Topic 5 – Formulae, equations and amounts of substance	GCSE Chemistry
15. be able to relate ionic and full equations, with state symbols, to observations from simple test tube reactions, to include: i. displacement reactions ii. reactions of acids iii. precipitation reactions	**Topic 4: Obtaining and using metals** 4.2 **Explain displacement reactions as redox reactions, in terms of gain or loss of electrons** 4.3 Explain the reactivity series of metals (potassium, sodium, calcium, magnesium, aluminium, (carbon), zinc, iron, (hydrogen), copper, silver, gold) in terms of the reactivity of the metals with water and dilute acids and that these reactions show the relative tendency of metal atoms to form cations
16. understand risks and hazards in practical procedures and suggest appropriate precautions where necessary.	0.5 Describe the use of hazard symbols on containers: a. to indicate the dangers associated with the contents b. to inform people about safe-working precautions with these substances in the laboratory 0.6 Evaluate the risks in a practical procedure and suggest suitable precautions for a range of practicals including those mentioned in the specification

GCE Chemistry Topic 6 – Organic Chemistry I	GCSE Chemistry
1. know that a hydrocarbon is a compound of hydrogen and carbon only	**Topic 8 - Fuels** 8.1 Recall that hydrocarbons are compounds that contain carbon and hydrogen only
3. know what is meant by the terms 'homologous series' and 'functional group'	**Topic 8 - Fuels** 8.6 Explain an homologous series as a series of compounds which: a. have the same general formula b. differ by CH2 in molecular formulae from neighbouring compounds c. show a gradual variation in physical properties, as exemplified by their boiling points d. have similar chemical properties **Topic 9 – Alcohol and carboxylic acids** 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

GCE Chemistry - Topic 6 – Organic Chemistry I	GCSE Chemistry
4. be able to name compounds relevant to this specification using the rules of Union of Pure and Applied Chemistry (IUPAC) nomenclature *Students will be expected to know prefixes for compounds up to C10*	**Topic 9 – Hydrocarbons** 9.10C Recall the formulae of molecules of the alkanes, methane, ethane, propane and butane, and draw the structures of these molecules, showing all covalent bonds 9.12C Recall the formulae of molecules of the alkenes, ethene, propene, butene, and draw the structures of these molecules, showing all covalent bonds (but-1-ene and but-2-ene only) 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 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
8. know the general formula for alkanes	**Topic 8 – Fuels** 8.6 Explain an homologous series as a series of compounds which have the same general formula
9. know that alkanes and cycloalkanes are saturated hydrocarbons	**Topic 9 – Hydrocarbons** 9.11C Explain why the alkanes are saturated hydrocarbons

GCE Chemistry - Topic 6 – Organic Chemistry I	GCSE Chemistry
10. understand that alkane fuels are obtained from the fractional distillation, cracking and reforming of crude oil *Reforming is described as the processing of straight-chain hydrocarbons into branched-chain alkanes and cyclic hydrocarbons for efficient combustion.*	**Topic 8 – Fuels** 8.2 Describe crude oil as: a. a complex mixture of hydrocarbons b. containing molecules in which carbon atoms are in chains or rings (names, formulae and structures of specific ring molecules not required) c. an important source of useful substances (fuels and feedstock for the petrochemical industry) d. a finite resource 8.3 Describe and explain the separation of crude oil into simpler, more useful mixtures by the process of fractional distillation 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) 8.17 Explain why cracking is necessary **Topic 2– methods of separating and purifying substances** 2.7 Explain the types of mixtures that can be separated by using fractional distillation
GCE Chemistry - Topic 6 – Organic Chemistry I	**GCSE Chemistry**

11. know that pollutants, including carbon monoxide, oxides of nitrogen and sulfur, carbon particulates and unburned hydrocarbons, are formed during the combustion of alkane fuels	**Topic 8 – Fuels** 8.8 Explain why the incomplete combustion of hydrocarbons can produce carbon and carbon monoxide 8.11 Explain how impurities in some hydrocarbon fuels result in the production of sulfur dioxide 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
12. understand the problems arising from pollutants from the combustion of fuels, limited to the toxicity of carbon monoxide and the acidity of oxides of nitrogen and sulfur	**Topic 8 – Fuels** 8.9 Explain how carbon monoxide behaves as a toxic gas 8.10 Describe the problems caused by incomplete combustion producing carbon monoxide and soot in appliances that use carbon compounds as fuels 8.12 Explain some problems associated with acid rain caused when sulfur dioxide dissolves in rain water

GCE Chemistry Topic 6 – Organic Chemistry I	GCSE Chemistry
16. understand the reactions of alkanes with: i. oxygen in air (combustion) ii. halogens, in terms of the mechanism of radical substitution through initiation, propagation and termination steps *The use of curly half-arrows is not expected in this mechanism*.	**Topic 9 - Hydrocarbons** 9.16C Describe how the complete combustion of alkanes and alkenes involves the oxidation of the hydrocarbons to produce carbon dioxide and water
18. know the general formula for alkenes	**Topic 8 – Fuels** 8.6 Explain an homologous series as a series of compounds which: have the same general formula
19. know that alkenes and cycloalkenes are unsaturated hydrocarbons	**Topic 9 - Hydrocarbons** 9.13C Explain why the alkenes are unsaturated hydrocarbons, describing that their molecules contain the functional group C=C

GCE Chemistry Topic 6 – Organic Chemistry I	GCSE Chemistry
22. understand the addition reactions of alkenes with: i hydrogen, in the presence of a nickel catalyst, to form an alkane *Knowledge of the application of this reaction to the manufacture of margarine by catalytic hydrogenation of unsaturated vegetable oils is expected*. ii halogens to produce dihalogenoalkanes iii hydrogen halides to produce halogenoalkanes iv steam, in the presence of an acid catalyst, to produce alcohols v potassium manganate(VII), in acid conditions, to oxidise the double bond and produce a diol	**Topic 9 - Hydrocarbons** 9.14C Recall the addition reaction of ethene with bromine, showing the structures of reactants and products, and extend this to other alkenes
25. know the qualitative test for a C=C double bond using bromine or bromine water	**Topic 9 - Hydrocarbons** 9.15C Explain how bromine water is used to distinguish between alkanes and alkenes

GCE Chemistry Topic 6 – Organic Chemistry I	GCSE Chemistry
26. know that alkenes form polymers through addition polymerisation *Be able to identify the repeat unit of an addition polymer given the monomer, and vice versa.*	**Topic 1: Types of substance** 1.39 Describe, using poly(ethene) as the example, that simple polymers consist of large molecules containing chains of carbon atoms **Topic 9 - Hydrocarbons** 9.17C Recall that a polymer is a substance of high average relative molecular mass made up of small repeating units 9.18C Describe how ethene molecules can combine together in a polymerisation reaction and that the addition polymer formed is called poly(ethene) (conditions and mechanisms not required) 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) 9.20C Deduce the structure of a monomer from the structure of an addition polymer and vice versa

GCE Chemistry - Topic 6 – Organic Chemistry I	GCSE Chemistry
27. know that waste polymers can be separated into specific types of polymer for: i. recycling ii. incineration to release energy iii. use as a feedstock for cracking	**Topic 9 - Hydrocarbons** 9.23C Describe some problems associated with polymers including the: a. availability of starting materials b. 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 9.24C Evaluate the advantages and disadvantages of recycling polymers, including economic implications, availability of starting materials and environmental impact
28. understand, in terms of the use of energy and resources over the life cycle of polymer products, that chemists can contribute to the more sustainable use of materials	**Topic 4 – Maintaining and using metals** 4.11 Describe that a life-cycle assessment for a product involves consideration of the effect on the environment of obtaining the raw materials, manufacturing the product, using the product and disposing of the product when it is no longer useful 4.12 Evaluate data from a life cycle assessment of a product

GCE Chemistry - Topic 6 – Organic Chemistry I	GCSE Chemistry
32. understand the reactions of halogenoalkanes with: i. aqueous potassium hydroxide to produce alcohols (where the hydroxide ion acts as a nucleophile) ii. aqueous silver nitrate in ethanol (where water acts as a nucleophile) iii. potassium cyanide to produce nitriles (where the cyanide ion acts as a nucleophile) Students should know this as an example of increasing the length of the carbon chain. iv. ammonia to produce primary amines (where the ammonia molecule acts as a nucleophile) v. ethanolic potassium hydroxide to produce alkenes (where the hydroxide ion acts as a base) 33. understand that experimental observations and data can be used to compare the relative rates of hydrolysis of: i. primary, secondary and tertiary halogenoalkanes ii. chloro-, bromo-, and iodoalkanes using aqueous silver nitrate in ethanol **CORE PRACTICAL 4: Investigation of the rates of hydrolysis of some halogenoalkanes**	**Topic 9 – Tests for Ions** 9.5C Describe tests to identify the following ions in solids or solutions as appropriate: chloride ion, Cl^-, bromide ion, Br^-, iodide ion, I^-, using dilute nitric acid and silver nitrate solution

GCE Chemistry - Topic 6 – Organic Chemistry I	GCSE Chemistry
38. understand the reactions of alcohols with: i. oxygen in air (combustion) ii. halogenating agents: • PCl_5 to produce chloroalkanes • 50% concentrated sulfuric acid and potassium bromide to produce bromoalkanes • red phosphorus and iodine to produce iodoalkanes iii. potassium dichromate(VI) in dilute sulfuric acid to oxidise primary alcohols to aldehydes (including a test for the aldehyde using Benedict's/Fehling's solution) and carboxylic acids, and secondary alcohols to ketones. In equations, the oxidising agent can be represented as [O]. iv. concentrated phosphoric acid to form alkenes by elimination Descriptions of the mechanisms of these reactions are not expected.	**Topic 9 – Alcohols and carboxylic acids** 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* 9.31C Recall that ethanol can be oxidised to produce ethanoic acid and extend this to other alcohols (reagents not required)

GCE Chemistry - Topic 6 – Organic Chemistry I	GCSE Chemistry
39. understand the following techniques used in the preparation and purification of a liquid organic compound: i. heating under reflux ii. extraction with a solvent in a separating funnel iii. distillation iv. drying with an anhydrous salt v. boiling temperature determination **CORE PRACTICAL 5: The oxidation of ethanol** **CORE PRACTICAL 6: Chlorination of 2-methylpropan-2-ol using concentrated hydrochloric acid**	**Topic 2– Methods of separating and purifying substances** 2.7 Explain the types of mixtures that can be separated by using fractional distillation

GCE Chemistry - Topic 8 – Energetics I	GCSE Chemistry
3. be able to construct and interpret enthalpy level diagrams showing an enthalpy change, including appropriate signs for exothermic and endothermic reactions *Activation energy is not shown in enthalpy level diagrams but it is shown in reaction profile diagrams.*	**Topic 7– Heat energy changes in chemical reactions** 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 7.16 Draw and label reaction profiles for endothermic and exothermic reactions, identifying activation energy
5. understand experiments to measure enthalpy changes in terms of: i. processing results using the expression: energy transferred = mass x specific heat capacity × temperature change ($Q=mc\Delta T$) ii. evaluating sources of error and assumptions made in the experiments. Students will need to consider experiments where: • substances are mixed in an insulated container and the temperature change is measured • enthalpy of combustion is measured, such as using a series of alcohols in a spirit burner • the enthalpy change cannot be measured directly.	**Topic 7– Heat energy changes in chemical reactions** 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 and that, when these reactions take place in solution, temperature changes can be measured to reflect the heat changes

GCE Chemistry - Topic 8 – Energetics I	GCSE Chemistry
9 know what is meant by the terms ‘bond enthalpy’ and ‘mean bond enthalpy’	**Topic 7– Heat energy changes in chemical reactions** 7.12 Recall that the breaking of bonds is endothermic and the making of bonds is exothermic
10. be able to calculate an enthalpy change of reaction using mean bond enthalpies and explain the limitations of this method of calculation	**Topic 7– Heat energy changes in chemical reactions** 7.13 Recall that the overall heat energy change for a reaction is: a. exothermic if more heat energy is released in forming bonds in the products than is required in breaking bonds in the reactants b. endothermic if less heat energy is released in forming bonds in the products than is required in breaking bonds in the reactants **7.14 Calculate the energy change in a reaction given the energies of bonds (in kJ mol^{-1})**

GCE Chemistry - Topic 9 – Kinetics I	GCSE Chemistry
1. understand, in terms of collision theory, the effect of a change in concentration, temperature, pressure and surface area on the rate of a chemical reaction.	**Topic 7– Rates of Reaction** 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
2. understand that reactions only take place when collisions take place with sufficient energy, known as activation energy	**Topic 7– Rates of Reaction** 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 7.4 Explain the effects on rates of reaction of changes in temperature, concentration, surface area to volume ratio of a solid and pressure (on reactions involving gases) in terms of frequency and/or energy of collisions between particles **Topic 7– Heat energy changes in chemical reactions** 7.15 Explain the term activation energy
3 be able to calculate the rate of a reaction from: i. data showing the time taken for reaction ii. the gradient of a suitable graph, by drawing a tangent, either for initial rate, or at a time, t	**Topic 7– Rates of Reaction** 7.5 Interpret graphs of mass, volume or concentration of reactant or product against time

GCE Chemistry - Topic 9 – Kinetics I	GCSE Chemistry
5. understand the role of catalysts in providing alternative reaction routes of lower activation energy	**Topic 7– Rates of Reaction** 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
9. understand the economic benefits of the use of catalysts in industrial reactions	**Topic 5– Dynamic Equilibria** **5.21C Explain how, in industrial reactions, including the Haber process, conditions used are related to:** **a. the availability and cost of raw materials and energy supplies** **b. the control of temperature, pressure and catalyst used produce an acceptable yield in an acceptable time**

GCE Chemistry - Topic 10 – Equilibrium I	GCSE Chemistry
1. know that many reactions are readily reversible and that they can reach a state of dynamic equilibrium in which: i. the rate of the forward reaction is equal to the rate of the backward reaction ii. the concentrations of reactants and products remain constant	**Topic 4 – Reversible reactions and equilibria** 4.13 Recall that chemical reactions are reversible, the use of the symbol ⇌ in equations and that the direction of some reversible reactions can be altered by changing the reaction conditions 4.14 Explain what is meant by dynamic equilibrium
2 be able to predict and justify the qualitative effect of a change in temperature, concentration or pressure on a homogeneous system in equilibrium	**Topic 4 – Reversible reactions and equilibria** 4.13 Recall that chemical reactions are reversible, the use of the symbol ⇌ in equations and that the direction of some reversible reactions can be altered by changing the reaction conditions 4.17 **Predict how the position of a dynamic equilibrium is affected by changes in: temperature, pressure and concentration** **Topic 5 – Dynamic Equilibria** 5.20C **Predict how the rate of attainment of equilibrium is affected by: changes in temperature, changes in pressure, changes in concentration and use of a catalyst**

GCE Chemistry - Topic 10 – Equilibrium I	GCSE Chemistry

3. evaluate data to explain the necessity, for many industrial processes, to reach a compromise between the yield and the rate of reaction	**Topic 5 – Dynamic Equilibria** 5.21C **Explain how, in industrial reactions, including the Haber process, conditions used are related to:** **a. the availability and cost of raw materials and energy supplies** **b. the control of temperature, pressure and catalyst used produce an acceptable yield in an acceptable time**

GCE Chemistry Topic 10 – Equilibrium I	GCSE Chemistry
2. be able to predict and justify the qualitative effect of a change in temperature, concentration or pressure on a homogeneous system in equilibrium	**Topic 3 – Electroytic processes** **3.22C know the effect of changing either temperature or pressure on the position of equilibrium in a reversible reaction:** • **an increase (or decrease) in temperature shifts the position of equilibrium in the direction of the endothermic (or exothermic) reaction** • **an increase (or decrease) in pressure shifts the position of equilibrium in the direction that produces fewer (or more) moles of gas** ***References to Le Chatelier's principle are not required***