KS4 Curriculum Map – Chemistry:

Topic	Knowledge *Substantive knowledge*: This is the specific, factual content for the topic, which should be connected into a careful sequence of learning.	Skills *Disciplinary knowledge*: This is the action taken within a particular topic in order to gain substantive knowledge.	Assessment Opportunities What assessments will be used to measure student progress?
Atomic Structure and the Periodic Table	• Atoms formula and equation. • Mixture and separation techniques (filtration, crystallisation, distillation, chromatography). • History of atomic models. • Plum pudding model, Rutherford nuclear model (gold foil experiment) and Bohr model • Size of atoms. • Mass, charge + location of subatomic particles. • Definitions of mass number and atomic number, isotopes. • Electron structure. • Developing the Periodic Table. • Groups and Periods and electronic structure. • Metals and non-metals. • Group 0. • Group 1. • Group 7. • Reactivity trends. • Transition Metals.	• Apply knowledge of physical properties to determine the most appropriate separation method of a mixture. • Describe method of separation of mixtures and apparatus used. • Apply knowledge of experimental work to explain the idea that models change over time. • Compare and contrast key ideas of Plum Pudding and Nuclear model. • Compare relative sizes of nucleus and atom • Use the periodic table to determine the number of different subatomic particles and the position of electrons. • Calculations of RAM. • Research different scientists to enforce the idea that theories change over time and based on experimental observations. • Use Mendeleev's table to make predictions Explain that reactivity is linked to distance, shielding and nuclear charge. • Compare physical and chemical properties of metals and non-metals. • Recall the names of elements of Group 0,1 and 7.	• Collins Connect Quizzes with mid- topic feedback. • Atomic Structure and the Periodic Table topic test linked with ARE.

		• Describe and explain the physical properties reactivity of Group 0 elements. • Describe the physical properties and reactivity of Group 1 metals. • Describe the trend in reactivity of Group 1 elements. • Writing balanced equations for Group 1 metals and water. • Describe and explain the physical properties reactivity of Group 7 elements. • Describe the trend in reactivity of Group 7 elements through displacement reactions. • Predict reactions of Group 7 group using displacement reactions. • Explain the trends in reactivity of Group 1 and 7 elements in terms of number of shells, distance from the nucleus, shielding and attraction of electrons to the nucleus. • Describe the properties of Transition Metals	
Chemical Changes	• Reaction between metals and oxygen to form metal oxides. • The Reactivity Series. • Describing the reactions of metals with water and acid. • Displacement Reactions. • Extraction of metals. • Oxidation and reduction in terms of electrons. • Metals and acids. • Neutralisation and salt production. • Soluble salts. • pH and neutralization. • Strong and weak acids.	• Describing the reactions of metal with oxygen water and acid. • Explain the Reactivity Series in terms of ease of forming ions in reactions • Discuss the link between reactivity and product formed. • Define oxidation and reduction. • Use knowledge of reactivity to determine the most appropriate method of metal extraction. • Writing word and symbol equations. • Write half-equations and ionic equation for displacement and redox reactions. • Evaluate of data to draw conclusions. • Define acid, base, alkali, neutralization. • Describe the outcome of reaction between acid and metal, acid and metal oxide, metal hydroxide and metal carbonate. • Predicting names of salts.	• Collins Connect Quizzes with mid- topic feedback. • Chemical Changes topic test linked with ARE. • Required practical.

		• Describe a method for the production of a pure, dry sample of a salt. • Recognise pH values for strongly acidic, weakly acidic, weakly alkaline and strongly alkaline solutions and their colour with Universal Indicator. • Write equations to show dissociation of strong and weak acids. • Explain that strong and concentrated have different meanings. • Calculate pH given hydrogen ion concentration.	
Energy changes	• Exothermic and endothermic reactions and their uses. • Energy level diagrams and reaction profiles. • Use of calorimeter to measure enthalpy change. • Bond enthalpy. • Chemical cells and batteries. • Fuel cells.	• Define endothermic and exothermic and activation energy. • Draw reaction profiles including activation energy and showing the role of a catalyst. • Calculate enthalpy change using the knowledge that bond breaking and making is endothermic / exothermic. • Explain whether a reaction is exothermic or endothermic overall in terms of bond breaking and bond making. • Interpret voltage data for the relative reactivity of different metals. • Evaluate the use of cells. • Describe how a fuel cells works. • Explain how a fuel cell produces electricity from electrode reactions. • Writing half-equations for electrode processes. • Evaluate the use of a fuel cell compared to rechargeable cells and batteries.	• Collins Connect Quizzes with mid- topic feedback. • Energy Changes topic test linked with ARE. • Required practical
Structure, Bonding and the properties of matter	• Chemical bonds • Ionic bonding • Covalent bonding • Metallic Bonding • The Three States of Matter and the Particle Model.	• Explain chemical bonding in terms of electrostatic forces and the transfer or sharing of electrons. • Draw dot and cross diagrams for ionic compounds formed by metals in Groups 1 and 2 with non-metals in Groups 6 and 7.	• Collins Connect Quizzes with mid- topic feedback • Structure, Bonding and the Properties of Matter topic test linked with ARE.

	• Properties of ionic compounds • Properties of small molecules. • Polymer structures. • Giant covalent structures. • Properties of metals and alloys. • Diamond, graphite, graphene and fullerenes. • Nanoparticles	• Determine the charge on the ions of metals and non-metals from the group number. • Deduce that a compound is ionic from a diagram of its structure in one of the specified forms. • Write formula of named ionic compounds. • Describe the limitations of using dot and cross, ball and stick, two and three-dimensional diagrams to represent a giant ionic structure. • Work out the empirical formula of an ionic compound from a given model or diagram that shows the ions in the structure. • Draw dot and cross diagrams for the simple covalent molecules of hydrogen, chlorine, oxygen, nitrogen, hydrogen chloride, water, ammonia and methane. • Represent the covalent bonds in small molecules, in the repeating units of polymers and in part of giant covalent structures, using a line to represent a single bond. • Describe the limitations of using dot and cross, ball and stick, two and three-dimensional diagrams to represent molecules or giant structures. • Deduce the molecular formula of a substance from a given model or diagram in these forms showing the atoms and bonds in the molecule. • Describe the structure and bonding in metals. • Predict the states of substances at different temperatures given appropriate data. • Explain the different temperatures at which changes of state occur in terms of energy transfers and types of bonding. • Recognise that atoms themselves do not have the bulk properties of materials.	

		• Explain the limitations of the particle theory in relation to changes of state when particles are represented by solid inelastic spheres which have no forces between them. • Use appropriate state symbols in chemical equations for chemical reactions. • Describe and explain the melting points and conductivity of ionic compounds. • Explain why substances that consist of small molecules are usually gases or liquids that have relatively low melting points and boiling points. • Explain why small molecules are insulators. • Describe the structure of polymers and explain their physical properties. • Recognise polymers from diagrams showing their bonding and structure. • Describe and explain the properties of giant covalent structures. • Recognise giant covalent structures from diagrams showing their bonding and structure. • Describe and explain the physical properties of pure metals and alloys. • Compare and explain the electrical and thermal conducting ability of pure metals and alloys. • Students should be able to explain the properties of diamond in terms of its structure and bonding. • Students should be able to explain the properties of graphite in terms of its structure and bonding. • Students should be able to explain the properties of graphene in terms of its structure and bonding.	

		• Recognise graphene and fullerenes from diagrams and descriptions of their bonding and structure. • Give examples of the uses of fullerenes, including carbon nanotubes. • Compare 'nano' dimensions to typical dimensions of atoms and molecules. • Evaluate the use of nanoparticles for a specified purpose • Explain that there are possible risks associated with the use of nanoparticles. • Compounds behave differently to their constituent elements • Calculate surface area: volume ratios	
Chemical Changes (Part 2)	• Extraction of metals. • The process of electrolysis. • Electrolytes. • Electrolysis of molten ionic compounds. • Extraction of aluminium by electrolysis. • Electrolysis (aqueous solutions). • Titrations.	• Use knowledge of reactivity to determine and evaluate the most appropriate method of metal extraction. • Define electrolysis, electrolyte, cathode, anode, cation, anion, discharging • Use of PANIC to help students remember which electrode is which. • Use of OILRIG to remember oxidation and reduction in terms of electrons. • Write half equations for reactions at electrodes. • Discuss and explain the steps in the extraction of aluminium electrolysis. • Discuss the link between reactivity and product formed. • Apply rules for anode and cathode to predict products formed. • Use knowledge of reactivity to determine the most appropriate method of metal extraction • Evaluate of data to draw conclusions • Method of a titration to find reacting volumes of neutralization. • Calculating unknown concentrations	• Collins Connect Quizzes with mid- topic feedback. • Chemical Changes (Part 2) topic test with ARE. • Electrolysis required practical • Titration required practical

Chemical Quantities and calculations	• Conservation of mass and chemical reactions • Relative formula mass. • Mass changes when gases are in reactions • Chemical Measurements and uncertainty. • Moles. • Amount if substances in equations. • Using moles to balance equations. • Concentration of solutions. • Percentage yield. • Atom economy. • Using concentration of solutions. • Amount of substance in volumes of gases.	• Calculate relative formula mass. • Use the law of conservation of mass to balance equations • Use range and mean of results to calculate percentage uncertainty in a result. • Correctly use standard form and significant figures in chemical calculations • Manipulate data in order to draw valid conclusions. • Calculate number of moles in a given mass of a substance. • Calculate the mass of one reactant required to react with a given mass of another reactant. • Determine the limiting reactant in a reaction and explain why it is limiting. • Using moles to write balanced equations. • Calculate product quantities for reactions involving a limiting reagent. • Calculate percentage yield of a product. • Compare the Environmental / economic implications of reactions using atom economy calculations. • Calculate the number of moles of a substance in a solution. • Calculate the concentration of a solution in terms of mass and moles • Calculate gas volumes in reactions.	• Collins Connect Quizzes with mid- topic feedback • Chemical Quantities and calculations topic test linked with ARE.
The rate and extent of chemical change	• Practical methods for studying rate of Reaction. • Calculating rates. • Units of rate. • Factors that can affect rate – concentration, pressure, surface area, temperature and catalyst. • Reversible reactions. • Dynamic equilibrium.	• Define rate of reaction • Calculate mean rate from data tables or graphical analysis. • Calculate the rate of reaction at a specific point in time from the gradient of a tangent. • Draw graphs and use them to draw conclusions. • Apply collision theory to explain the effect	• Collins Connect Quizzes with mid topic feedback. • The rate and extent of chemical change topic test linked with ARE. • Required practical

		of concentration, pressure, temperature, surface area and catalysts on frequency of collisions and rate of reaction. • Draw graphs and use them to draw conclusions • Interpret data to draw accurate conclusions • Apply knowledge of control, dependent and independent variables to design experimental work • Identify anomalies and explain how they are caused. • Use correct terminology when assessing validity of data • Carry out practical work to generate data to support theory work. • Make predictions about the position of equilibrium and yields of products when changes are made to reaction conditions. • Analyse data to assess the most favourable reaction conditions.	
Hydrocarbons	• Crude oil- formation and separation. • Alkanes – properties, combustion and cracking. • Alkenes and their reactions. • Alcohols- properties and reactions. • Methods of alcohol production. • Carboxylic acids and esters. • Addition polymers. • Condensation polymers. • Amino acids. • Starch and cellulose. • DNA.	• Know that crude oil is formed from ancient biomass under high temperature and pressure an in the absence of oxygen. • Know that crude oil is a mixture of hydrocarbons, mainly alkanes. • Define hydrocarbons, homologous series, saturated. • Know that the general formula of an alkane is C_nH_{2n+2} where n = number of carbon atoms in the alkane. • Name and draw the structures of the first four alkanes. • Write molecular formula and draw displayed formula of organic molecules. • Describe how crude oil is separated into fractions by fractional distillation.	• Collins Connect Quizzes with mid- topic feedback • Hydrocarbons topic test linked with ARE.

		• Make links between molecular size of alkanes, and boiling point, viscosity and flammability. • Describe the process of cracking and balance cracking equations. • Evaluate the usefulness of cracking to satisfy demands for low molecular weight alkanes as fuels. • Describe the products of complete and incomplete combustion of hydrocarbons. • Write balanced equations for complete and incomplete combustion. • Describe the test for the production of carbon dioxide and for the presence of water. • Define unsaturated. • Know the names, formula and structures of first four alkenes. • Describe the chemical test for the presence of an alkene and the positive result of the test. • Use knowledge of addition reactions to predict products for reactions of alkene compounds • Draw displayed formulae and structural formulae of first four alcohols and carboxylic acids and ethyl ethanoate. • Describe the properties and reactions of alcohols. • Describe the formation of alcohols through fermentation. • Describe the formation of carboxylic acids through oxidation of alcohols. • Describe the production of an ester by a condensation reaction between a carboxylic acid and an alcohol. • Describe the process of addition and condensation polymerization.	

		• Writing equations to represent addition and condensation polymerization. • Asses the differences between condensation and addition reactions. • Describe the structure of an amino acid in terms of the functional groups present. • Describe that amino acids undergo condensation polymerization to produce polypeptides and then proteins. • Describe how starch and cellulose are both polysaccharides made from condensation reaction of glucose. • Describe the structure of DNA as two polynucleotide chains twisted to form a double helix. • Describe the structure of a nucleotide monomer in terms of a sugar, phosphate group and a base. • Name the four bases in DNA	
Chemical Analysis	• Pure and impure substances. • Mixtures. • Formulations Chromatography. • Tests for gases. • Flame tests to identify cations. • Precipitates of metal hydroxides to identify cations. • Testing for anions. • Instrumental methods. • Flame emission spectroscopy.	• Define pure, impure and mixture • Physical properties of pure and impure substances – melting and boiling points. • Define formulation • Identify role of components in a formulation • Describe how chromatography can be used to separate components in a liquid mixture. • Define mobile phase and stationary phase as used in chromatography. • Analyse chromatograms to asses purity and identify number of components in a mixture. • Calculate the Rf value of a component in a chromatogram. • Identify the identity of components in a chromatogram by comparing with Rf values of reference substances.	• Collins Connect Quizzes with mid- topic feedback • Chemical Analysis topic test linked with ARE. • Required practical

		• Describe the test and positive result for hydrogen, oxygen, carbon dioxide and chlorine. • Describe how flame tests can be used to identify cations. • Explain why flame tests cannot be used to identify different metal ions in a mixture. • Describe how precipitation of metal hydroxides can be used to identify cations. • Write balanced equations of precipitation reactions. • Describe the test and positive result for carbonate, sulfate, chloride, bromide and iodide ions. • Write balanced equations for the tests for anions. • Write balanced equations of precipitation reactions • Describe the advantages of instrumental techniques. • Interpretation of gas-liquid chromatograms. • Describe flame emission spectroscopy. • Analyse spectra from flame spectroscopy • Explain the advantages of flame emission spectroscopy over flame tests.	
The atmosphere	• Proportions of gases in the atmosphere. • The Earth's early atmosphere. • How oxygen levels increased and carbon dioxide levels decreased. • Greenhouse gases and global climate change. • Human activities. • Carbon footprint and it's reduction • Atmospheric pollutants.	• Describe the percentages of gases in the atmosphere today. • Describe ideas about Earth's early atmosphere. • Interpret evidence about Earth's early atmosphere. • Evaluate different theories about the Earth's early atmosphere. • Apply a knowledge of timescales to discuss the limitations of scientific evidence. • Apply knowledge of photosynthesis to explain changes in the atmosphere over time. • Describe the greenhouse effect.	• Collins Connect Quizzes with mid- topic feedback. • The atmosphere topic test linked with ARE

		• Name the three main greenhouse gases. • Explain how human activities increase the levels of greenhouse gases in the atmosphere and lead to climate change and global warming. • Describe the effects of climate change. • Analyse data to draw relevant conclusions (evaluating quality of evidence). • Explore the importance of peer review and communicating results. • Define carbon footprint . • Describe how a personal carbon footprint can be reduced. • Describe how governments can reduce carbon footprints. • Describe and evaluate limitations on carbon footprint reduction. • Describe the origin and the effects of carbon monoxide, oxides of sulfur and nitrogen and particulates.	
Sustainable development	• Using Earths resources and sustainable development. • Potable water. • Waste water treatment. • Alternative methods of metal extraction. • Life Cycle Assessments. • Reduce, reuse and recycle. • Corrosion and it's prevention. • Alloys as useful material. • Ceramics, polymers and composites. • The Haber Process. • NPK fertilisers.	• Define renewable, finite, non-renewable in terms of resources. • Order of magnitude calculations. • Explain how properties are linked to use of a material. • Compare products based on lifecycle assessment using given data. • Compare the ease of obtaining potable water (by type of water available) in different geographical regions. • Describe the steps in waste water management. • Describe the process of phytomining and bioleaching. • Compare products based on lifecycle assessment using data given.	• Collins Connect Quizzes with mid- topic feedback • Sustainable development topic test linked with ARE. • Required practical

		• Describe conditions required for rusting and methods of prevention of rusting. • Describe what is an alloy and name different alloys. • Compare properties of alloys and pure metals. • Explain how properties are linked to use of a material. • Describe what is meant by a ceramic, polymer and composite, and their properties. • Make predictions about the position of equilibrium when changes are made to conditions • Analyse data to assess the most favourable reaction conditions. • Explain the compromise conditions used in the Haber process to get best yield / rate balance. • Identify elements needed for healthy plant growth. • Describe how NPK fertilisers are prepared.	