Raedwald Trust KS4 Chemistry Programme of Study

The three pathways below increase in difficulty and content from left to right. Baseline assessments are given to each student within the first science lessons at a site and the appropriate pathway is selected. This Programme of Study lists the Chemistry element of Entry Level Science and the foundation and higher AQA GCSE Chemistry content for comparison. Please see the Raedwald Trust KS4 Biology and Physics Programmes of Study for those parts of the full content. The full AQA Chemistry GCSE content taught at The Raedwald Trust, is listed below.

Working Scientifically

All of the below skills are taught throughout this Programme of Study, within the separate units. The lists below are for reference only and should only be taught explicitly if a significant difficulty with certain aspects are identified, to help a student to close any gaps in learning.

Entry Level	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
AO1: Show knowledge and understanding of science, and how it works, and apply it where appropriate. Students should be able to: • recall scientific facts • apply scientific ideas. AO2: Demonstrate the ability to design an investigation, take measurements, present data and identify patterns and relationships. Students should be able to: • plan a simple investigation, identifying the techniques or equipment needed and the method to be followed • make a simple prediction about the outcome of the investigation • use equipment and materials safely to take simple measurements or	**1 Development of Scientific Thinking** WS 1.3 Appreciate the power and limitations of science and consider any ethical issues which may arise. WS 1.4 Explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments. WS 1.5 Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences. WS 1.6 Recognise the importance of peer review of results and of communicating results to a range of audiences. **2 Experimental Skills and Strategies** WS 2.1 Use scientific theories and explanations to develop hypotheses. WS 2.2 Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena. WS 2.3 Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment. WS 2.4 Carry out experiments appropriately having due regard for the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations. WS 2.5 Recognise when to apply a knowledge of sampling	All aspects of working scientifically are in both the Foundation and Higher Assessments.

observations that are meaningful and valid • record the results in an appropriate way • display the data using an appropriate method • state what has been found out during the investigation (drawing a conclusion) and describe simple relationships in the data • simply evaluate the investigation for its success in justifying the initial prediction.	techniques to ensure any samples collected are representative. WS 2.6 Make and record observations and measurements using a range of apparatus and methods. WS 2.7 Evaluate methods and suggest possible improvements and further investigations. **3 Analysis and Evaluation** WS 3.1 Presenting observations and other data using appropriate methods. WS 3.2 Translating data from one form to another. WS 3.3 Carrying out and represent mathematical and statistical analysis. WS 3.4 Representing distributions of results and make estimations of uncertainty. WS 3.5 Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions. WS 3.6 Presenting reasoned explanations including relating data to hypotheses. WS 3.7 Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error. WS 3.8 Communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms. **4 Scientific Vocabulary, quantities, units, symbols and nomenclature.** WS 4.1 Use scientific vocabulary, terminology and definitions. WS 4.2 Recognise the importance of scientific quantities and understand how they are determined. WS 4.3 Use SI units (eg kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate. WS 4.4 Use prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano).	

	WS 4.5 Interconvert units. WS 4.6 Use an appropriate number of significant figures in calculation.	

4.1 Atomic structure and the periodic table

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
Students should have knowledge and understanding of the following content: **3.3 Component 3 – Elements, mixtures and compounds.** 3.3.1 Atoms, elements and compounds Outcome 1 ● what atoms are, atom symbols, all elements are on the periodic table ●where metals and non-metals are on the periodic table. Knowledge of Group 1 as reactive metals and Group 7 as reactive non-metals. Outcome 2 ● that compounds are formed from elements by chemical reactions and chemical reactions can be represented by word equations. 3.3.2 How structure affects properties	**4.1.1 A simple model of the atom, symbols, relative atomic mass, electronic charge and isotopes** 4.1.1.1 Atoms, elements and compounds Know: ● what atoms are, atom symbols, all elements are on the periodic table ● Compounds are formed from elements by chemical reactions Students will be able to: • name and know the symbols of the first 20 elements in the periodic table, name compounds from given formulae or symbol equations • write word equations, formulae and balanced chemical equations. 4.1.1.2 Mixtures Know: ● what a mixture is and how they can be separated Students should be able to: • describe, explain and give examples of the specified processes of separation 4.1.1.3 The development of the model of the atom Know:	Students will be able to: ●write balanced half equations and ionic equations where appropriate.

Outcome 3 ●The three states of matter. **Suggested activity for TDA Compare the melting points of a range different substances, eg candle wax, beeswax polish, butter, margarine, cooking fat.** Outcome 4 ●the structures and properties of diamond and graphite. 3.3.3 Separating mixtures Outcome 5 ●know what a mixture is and how mixtures can be **Suggested activity for TDA Compare the time needed to filter mixtures of water and calcium carbonate that has different particle sizes.** Outcome 6 ●how paper chromatography can be used to separate mixtures and can give information to help identify substances. **Suggested activity for TDA Investigate the different colours in inks or food colours using paper chromatography.** 3.3.4 Metals and alloys Outcome 7 ●how unreactive and reactive metals are obtained and the social, economic and environmental impacts of mining ores and recycling metals. Outcome 8	●experimental evidence may lead to a scientific model being changed or replaced. ● The plum pudding model, Alpha particle scattering experiment and the Niels Bohr model and the experimental work of James Chadwick. Students should be able to: ●know how scientific methods and theories develop over time. 4.1.1.4 Relative electrical charges of subatomic particles Know: ●The relative electrical charges of the particles in atoms ● Atoms have no overall electrical charge. The number of protons in an atom of an element is its atomic number. Students should be able to: ●Use the nuclear model to describe atoms. 4.1.1.5 Size and mass of atoms Know: ●Atoms are very small, having a radius of about 0.1 nm (1 x 10-10 m). The radius of a nucleus is less than 1/10 000 of that of the atom (about 1 x 10-14 m). The relative masses of protons, neutrons and electrons. ●what mass number describes and describe isotopes. Students should be able to: ● Make calculations involving protons, neutrons and electrons. 4.1.1.6 Relative atomic mass Know: ●The relative atomic mass of an element is an average value that takes account of the abundance of the isotopes of the element. Students should be able to: ● Calculate the relative atomic mass of an element given the percentage abundance of its isotopes. 4.1.1.7 Electronic structure	

●the structure of metals and their properties. **Suggested activity for TDA Compare the properties, such as conductivity or density, of some metals.** Outcome 9 ●why most metals in everyday use are alloys. **Suggested activity for TDA Investigate the hardness of different alloys or steels.** 3.3.5 Polymers Outcome 10 ● how polymers are formed and how this relates to their properties. ●that polymers are not biodegradable which can lead to problems with waste disposal. **Suggested activity for TDA Compare the biodegradability of different polymers and other materials.** **3.4 Component 4 – Chemistry: Chemistry in our world** 3.4.1 Reactions of acids Outcome 1 ●the reaction of acids with some metals and the word equations for these reactions. ●The test for hydrogen. **Suggested activity for TDA Investigate the amount of hydrogen produced when acids react with different metals.**	Know: ●electrons in an atom occupy the lowest available energy levels, the electronic structure of an atom can be represented by numbers or by a diagram. Students should be able to: ● represent the electronic structures of the first twenty elements of the periodic table in both forms. **4.1.2 The periodic table** 4.1.2.1 The periodic table Know: ●how elements in the periodic table are arranged. Students should be able to: • predict possible reactions and probable reactivity of elements from their positions in the periodic table. 4.1.2.2 Development of the periodic table Know: ●how the periodic table was developed over time. Students should be able to: ●Describe these steps in the development of the periodic table. ●Explain how testing a prediction can support or refute a new scientific idea. 4.1.2.3 Metals and non-metals Know: ●Elements that react to form positive ions are metals. Elements that do not form positive ions are non-metals. Students should be able to: • explain the differences between metals and non-metals. • explain how the reactions of elements are related to the arrangement of electrons in their atoms. 4.1.2.4 Group 0 Know: ●elements in Group 0 are called the noble gases.	

Outcome 2 ●that acids can be neutralised by alkalis and carbonates and the word equations for these. ●Household chemicals may be used to illustrate these reactions. ●Carbon dioxide turns limewater milky. **Suggested activity for TDA Investigate the reactions of acids with different carbonates.** 3.4.2 Energy and rate of reaction Outcome 3 ●Some reactions transfer energy to the surroundings so the temperature increases other reactions take in energy from the surroundings, so the temperature decreases. **Suggested activity for TDA Compare the temperature changes caused by some reactions.** Outcome 4 ●how the rate of a chemical reaction may be increased. **Suggested activity for TDA Investigate how to make a chemical reaction go faster.** 3.4.3 Earth's atmosphere Outcome 5 ●the evolution of the Earth's atmosphere and the factors the caused it. **Suggested activity for TDA Investigate**	Students should be able to: • explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms • predict properties from given trends down the group. 4.1.2.5 Group 1 Know: ●elements in Group 1 are known as the alkali metals. Students should be able to: ● describe the reactions of the first three alkali metals with oxygen, chlorine and water. • explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms 4.1.2.6 Group 7 Know: ●The elements in Group 7 of the periodic table are known as the halogens. Students should be able to: ● describe the nature of the compounds formed when chlorine, bromine and iodine react with metals and non-metals. ●A more reactive halogen can displace a less reactive halogen. • predict properties from given trends down the group. **4.1.3 Properties of transition metals** 4.1.3.1 Comparison with Group 1 elements Know: ●what transition elements metals are and their properties. Students should be able to: ● describe the difference in properties compared with Group 1. 4.1.3.2 Typical properties Know: ●Many transition elements have ions with different charges, form coloured compounds and are useful as catalysts. Students should be able to:	

the production of oxygen by aquatic plants in different conditions by counting bubbles. Outcome 6 ●how carbon dioxide was removed from the early atmosphere and the current Earths atmosphere. **Suggested activity for TDA Compare the amount of carbon dioxide in fresh air and exhaled ai**r. 3.4.4 Fuels and human impacts on the atmosphere Outcome 7 ●what crude oil is and how it may be separated into fractions by fractional distillation. Outcome 8 ●the effect of burning fuels on the Earth's atmosphere and on human health. **Suggested activity for TDA Compare the amount of soot produced when burning different fuels.** Outcome 9 ●how human activities have changed the atmosphere and our environment. 3.4.5 Water for drinking Outcome 10 ●the content of water that is safe to drink and how this water is obtained. **Suggested activity for TDA Investigate the amount of dissolved solids in water**	● exemplify these general properties by reference to compounds of Cr, Mn, Fe, Co, Ni, Cu.	

from different locations by evaporating samples and weighing residues.		

4.2 Bonding, structure and the properties of matter

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.2.1 Chemical bonds, ionic, covalent and metallic 4.2.1.1 Chemical bonds Know: ●There are three types of strong chemical bonds: ionic, covalent and metallic. Students should be able to: ● explain chemical bonding in terms of electrostatic forces and the transfer or sharing of electrons. 4.2.1.2 Ionic bonding Know: ●how ionic bonds are formed. Students should be able to: ● draw dot and cross diagrams. 4.2.1.3 Ionic compounds Know: ●how ionic compounds are formed. Students should be able to: • deduce that a compound is ionic from a diagram, describe the limitations of using models and work out the empirical formula of an ionic compound.	

	4.2.1.4 Covalent bonding Know: ●how covalent bonds are formed. Students should be able to: ●recognise common small molecules from their chemical formula and that covalently bonded substances have very large molecules, such as polymers. • draw dot and cross diagrams and describe the limitations of different models, deduce the molecular formula of a substance from a given model or diagram. 4.2.1.5 Metallic bonding Know: ●the electron arrangement of metals and how the bonding in metals may be represented in diagram form. Students should be able to: ●Recognise substances as metallic giant structures from diagrams showing their bonding. **4.2.2 How bonding and structure are related to the properties of substances** 4.2.2.1 The three states of matter Know: ●The three states of matter and how they can be represented. ●The energy needed to change states. Students should be able to: • predict the states of substances at different temperatures given appropriate data 4.2.2.2 State symbols Know: ●the state symbols (s), (l) and (g), with (aq) for aqueous solutions. Students should be able to: ●use state symbols in chemical equations.	4.2.2.1 The three states of matter Know: ●the limitations of the simple particle model. Students should be able to: ●explain the limitations of the particle theory in relation to changes of state.

	4.2.2.3 Properties of ionic compounds Know: ● the structure of ionic compounds and relate this to their properties 4.2.2.4 Properties of small molecules Know: ●small molecules are usually gases or liquids and relate this to their properties. Students should be able to: ● use the idea that intermolecular forces are weak compared with covalent bonds to explain the bulk properties of molecular substances. 4.2.2.5 Polymers Know: ●Polymers have very large molecules. The atoms in the polymer molecules are linked to other atoms by strong covalent bonds. Students should be able to: ● recognise polymers from diagrams showing their bonding and structure. 4.2.2.6 Giant covalent structures Know: Substances that consist of giant covalent structures are solids with very high melting points. All of the atoms in these structures are linked to other atoms by strong covalent bonds. Students should be able to: ● recognise giant covalent structures from diagrams showing their bonding and structure. 4.2.2.7 Properties of metals and alloys Know: ●Metals have giant structures of atoms with strong metallic bonding and how this affects their properties. Students should be able to:	

	● explain why alloys are harder than pure metals. 4.2.2.8 Metals as conductors Know: ●why metals are good conductors of electricity and thermal energy. **4.2.3 Structure and bonding of carbon** 4.2.3.1 Diamond Know: ●the structure and properties of diamond. Students should be able to: ● explain the properties of diamond in terms of its structure and bonding. 4.2.3.2 Graphite Know: ●the structure and properties of graphite. Students should be able to: ● explain the properties of graphite in terms of its structure and bonding. 4.2.3.3 Graphene and fullerenes Know: ●the structure and properties of graphene. Students should be able to: • recognise graphene and fullerenes from diagrams and descriptions of their bonding and structure • give examples of the uses of fullerenes, including carbon nanotubes. **4.2.4 Bulk and surface properties of matter including nanoparticles** 4.2.4.1 Sizes of particles and their properties	

	Know: ●the size of nanoparticles, fine particles and coarse particles. Students should be able to: ● compare 'nano' dimensions to typical dimensions of atoms and molecules. 4.2.4.2 Uses of nanoparticles Know: ●the applications of nanoparticles. Students should be able to: • evaluate the use of nanoparticles for a specified purpose and the associated risks.	

4.3 Quantitative chemistry

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.3.1 Chemical measurements, conservation of mass and the quantitative interpretation of chemical equations 4.3.1.1 Conservation of mass and balanced chemical equations Know: ●The law of conservation of mass and the use of the multipliers in equations in normal script before a formula and in subscript	4.3.2.1 Moles Know: ●that chemical amounts are measured in moles, know how to make calculations involving moles and involving Avogadro's constant. Students should be able to: ● use the relative formula mass of a substance to calculate

	within a formula. 4.3.1.2 Relative formula mass Know: ●what the relative formula mass (Mr) of a compound tells us. Students should be able to: ● calculate the percentage by mass in a compound. 4.3.1.3 Mass changes when a reactant or product is a gas Know: ●Some reactions may appear to involve a change in mass due to a reactant or product being a gas and its mass has not been taken into account. Students should be able to: ● explain any observed changes in mass in non-enclosed systems during a chemical reaction. 4.3.1.4 Chemical measurements Know: ●Whenever a measurement is made there is always some uncertainty about the result obtained. Students should be able to: • represent the distribution of results and make estimations of uncertainty. **4.3.2 Use of amount of substance in relation to masses of pure substances** 4.3.2.5 Concentration of solutions Know: ●chemical reactions take place in solutions and how concentration of a solution can be measured. Students should be able to: • calculate the mass of solute.	the number of moles. 4.3.2.2 Amounts of substances in equations Know: ●how the masses of reactants and products can be calculated and how chemical equations can be interpreted in terms of moles. Students should be able to: • calculate the masses of substances shown in a balanced symbol equation 4.3.2.3 Using moles to balance equations Know: ●how to balance numbers in a symbol when using mass and moles and by converting the numbers of moles to simple whole number ratios. Students should be able to: ● balance equations given the masses of reactants and products 4.3.2.4 Limiting reactants Know: ●a chemical reaction involving two reactants often uses an excess of one of the reactants. Students should be able to: ● explain the effect of a limiting quantity of a reactant on the amount of products produced. 4.3.2.5 Concentration of solutions Students should be able to: • explain how the mass of a solute and the volume of a solution is related to the concentration of the solution.

	4.3.3 Yield and atom economy of chemical reactions 4.3.3.1 Percentage yield Know: ●atoms are not gained or lost in a chemical reaction, but know why is not always possible to obtain the calculated amount of a product. ●how to calculate percentage yield. Students should be able to: • calculate the percentage yield of a product from the actual yield of a reaction 4.3.3.2 Atom economy Know: ●The atom economy (atom utilisation) of useful products and how the percentage atom economy of a reaction is calculated. Students should be able to: • calculate the atom economy of a reaction to form a desired product from the balanced equation	4.3.3.1 Percentage yield Students should be able to: • calculate the theoretical mass of a product. 4.3.3.2 Atom economy Students should be able to: • explain why a particular reaction pathway is chosen to produce a specified product. **4.3.4 Using concentrations of solutions in mol/dm3** Know: ●The concentration of a solution can be measured in mol/dm3 and how to carry out calculations involving this. Students should be able to: ● explain how the concentration of a solution in mol/dm3 is related to the mass of the solute and the volume of the solution. **4.3.5 Use of amount of substance in relation to volumes of gases** Know: ●Equal amounts in moles of gases occupy the same volume under the same conditions of temperature and pressure, the volumes can be calculated from the balanced equations. Students should be able to: • calculate the volume of a gas at room temperature and the volumes of gaseous reactants and products from a balanced equation.

4.4 Chemical changes

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.4.1 Reactivity of metals 4.4.1.1 Metal oxides Know: ●Metals react with oxygen to produce metal oxides. Students should be able to: ● explain reduction and oxidation. 4.4.1.2 The reactivity series Know: ●metals react with other substances to form positive ions and can be arranged in a reactivity series. The non-metals hydrogen and carbon are often included in this. Students should be able to: • recall and describe the reactions, if any, of metals with water or dilute acids and place these in order of reactivity 4.4.1.3 Extraction of metals and reduction Know: ●Unreactive metals such as gold are found in the Earth, most metals are found as compounds. Students should be able to: • interpret or evaluate specific metal extraction processes and identify the substances which are oxidised or reduced. **4.4.2 Reactions of acids** 4.4.2.1 Reactions of acids with metals Know: ●Acids react with some metals to produce salts and hydrogen.	4.4.1.4 Oxidation and reduction in terms of electrons Know: ●oxidation is the loss of electrons and reduction is the gain of electrons. Student should be able to: • write ionic equations for displacement 4.4.2.1 Reactions of acids with metals Students should be able to: • explain redox reactions and identify which species are oxidised and which are reduced.

	4.4.2.2 Neutralisation of acids and salt production Know: ●Acids are neutralised by alkalis, bases and metal carbonates. Students should be able to: • predict products from given reactants and use the formulae of common ions to deduce salt formulae. 4.4.2.3 Soluble salts Know: ●Soluble salts can be made from acids. Students should be able to: ● describe how to make pure, dry samples of named soluble salts. **Required practical 1: preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution.** 4.4.2.4 The pH scale and neutralisation Know: ●the hydrogen ions produced during neutralisation reactions. Students should be able to: • describe the use of different methods of measuring pH. • use the pH scale to identify acidic or alkaline solutions. 4.4.2.5 Titrations Know: ●The volumes of acid and alkali solutions that react can be measured by titration using a suitable indicator. Students should be able to: • describe how to carry out titrations to find the reacting volumes accurately. **Required practical 2: determination of the reacting volumes of**	4.4.2.6 Strong and weak acids Know: ●how acids are ionised in aqueous solutions. Students should be able to: • use and explain the terms dilute, concentrated, weak and strong in relation to acids • describe neutrality and relative acidity.

	solutions of a strong acid and a strong alkali by titration. **4.4.3 Electrolysis** 4.4.3.1 The process of electrolysis Know: ●When an ionic compound is melted or dissolved in water, the ions are free to move about within the liquid or solution and the effect his has on electrical conductivity. 4.4.3.2 Electrolysis of molten ionic compounds Know: ●where metal and non-metal is produced when a simple ionic compound is electrolysed. Students should be able to: ● predict the products of the electrolysis of binary ionic compounds. 4.4.3.3 Using electrolysis to extract metals Know: ●metals are extracted from molten compounds by electrolysis. Students should be able to: • explain why a mixture is used as the electrolyte and why the positive electrode must be continually replaced. 4.4.3.4 Electrolysis of aqueous solutions Know: ● ions discharged when an aqueous solution is electrolysed depends on the relative reactivity of the elements involved. Students should be able to: ● predict the products of the electrolysis of aqueous solutions containing a single ionic compound. **Required practical 3: investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis.**	4.4.3.5 Representation of reactions at electrodes as half equations Know: ●where oxidation and reduction reactions occur during electrolysis. Students should be able to: ●represented electrolysis half equations.

4.5 Energy changes

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.5.1 Exothermic and endothermic reactions 4.5.1.1 Energy transfer during exothermic and endothermic reactions Know: ●Energy is conserved in chemical reactions. Students should be able to: • distinguish between exothermic and endothermic reactions and evaluate the applications of these reactions given appropriate information. **Required practical 4: investigate the variables that affect temperature changes in reacting solutions such as, eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals.** 4.5.1.2 Reaction profiles Know: ●Chemical reactions can occur only when reacting particles collide with each other and with sufficient energy. Students should be able to: • draw simple reaction profiles showing the relative energies of reactants and products, the activation energy and the overall energy change. • use reaction profiles to identify reactions as exothermic or endothermic . **4.5.2 Chemical cells and fuel cells**	4.5.1.3 The energy change of reactions Know: ●the energy changes that occur during chemical reaction.. Students should be able to: ● calculate the energy transferred in chemical reactions using bond energies supplied.

	4.5.2.1 Cells and batteries Know: ●Cells contain chemicals which react to produce electricity. Students should be able to: ● interpret data for relative reactivity of different metals and evaluate the use of cells. 4.5.2.2 Fuel cells Know: ●Fuel cells are supplied by an external source of fuel (eg hydrogen) and oxygen or air. Students should be able to: • evaluate the use of hydrogen fuel cells in comparison with rechargeable cells and batteries.	4.5.2.2 Fuel cells Students should be able to: • write half equations for the electrode reactions in the hydrogen fuel cell.

4.6 The rate and extent of chemical change

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.6.1 Rate of reaction 4.6.1.1 Calculating rates of reactions Know: ●The rate of a chemical reaction can be found by measuring the quantity of a reactant used or the quantity of product formed	4.6.1.1 Calculating rates of reactions Students should be able to: ●use quantity of reactants in terms of moles and units for rate of reaction in mol/s.

	over time. Students should be able to: • calculate the mean rate of a reaction from given information. • draw and interpret graphs showing the quantity of product formed or quantity of reactant used up against time and draw tangents to the curves on these graphs. 4.6.1.2 Factors which affect the rates of chemical reactions Know: ●the factors which affect the rates of chemical reactions. Students should be able to: ● recall how changing this factor affects the rate of chemical reactions. **Required practical 5: investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced and a method involving a change in colour or turbidity. This should be an investigation involving developing a hypothesis.** 4.6.1.3 Collision theory and activation energy Know: ●Collision theory explains how various factors affect rates of reactions. Students should be able to : • use collision theory to predict and explain the effects of changing conditions. 4.6.1.4 Catalysts Know: ●the affect catalysts have on chemical reactions and how a reaction profile for a catalysed reaction can be drawn. Students should be able to: ● identify catalysts in reactions from their effect on the rate of reaction and explain catalytic action in terms of activation energy.	• calculate the gradient of a tangent to the curve on these graphs as a measure of rate of reaction at a specific time 4.6.2.4 The effect of changing conditions on equilibrium Know: ●The conditions that effect the relative amounts of reactants and products at equilibrium and know that this can be predicted using Le Chatelier's Principle. Students should be able to: ● make qualitative predictions about the effect of changes on systems at equilibrium. 4.6.2.5 The effect of changing concentration Know:

	4.6.2 Reversible reactions and dynamic equilibrium 4.6.2.1 Reversible reactions Know: ●In some chemical reactions, the products of the reaction can react to produce the original reactants. 4.6.2.2 Energy changes and reversible reactions Know: ●If a reversible reaction is exothermic in one direction, it is endothermic in the opposite direction. 4.6.2.3 Equilibrium Know: ●When and why equilibrium is reached in a reversible reaction.	●If the concentration of one of the reactants or products is changed, the system is no longer at equilibrium. Students should be able to: ●interpret appropriate data to predict the effect of changes in concentration. 4.6.2.6 The effect of temperature changes on equilibrium Know: ●how temperature changes at equilibrium affects the amount of produce produced. Students should be able to: ● interpret data to predict the effect temperature changes have on reactions at equilibrium. 4.6.2.7 The effect of pressure changes on equilibrium Know: ●the effect that changes of gaseous pressure have on reactions at equilibrium and relate this to the symbol equation for that reaction. Students should be able to: ● interpret appropriate given data to predict the effect of pressure changes at equilibrium.

4.7 Organic chemistry

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.7.1 Carbon compounds as fuels and feedstock 4.7.1.1 Crude oil, hydrocarbons and Know; ●how crude oil formed, that it is a mixture of hydrocarbons and it is a finite resource found in rocks. Students should be able to: ● recognise substances as alkanes given their formulae. 4.7.1.2 Fractional distillation and petrochemicals Know: ●hydrocarbons in crude oil may be separated into fractions which can be processed to produce fuels and feedstock for the petrochemical industry. Many useful materials on which modern life depends are produced by the petrochemical industry. Students should be able to: ● explain how fractional distillation works. 4.7.1.3 Properties of hydrocarbons Know: ●Some properties of hydrocarbons depend on the size of their molecules. Students should be able to: ● recall how boiling point, viscosity and flammability change with increasing molecular size. ●write balanced equations for the complete combustion of hydrocarbons with a given formula.	

	4.7.1.4 Cracking and alkenes Know: ●Hydrocarbons can be broken down (cracked) to produce smaller, more useful molecules. Students should be able to: ●describe the conditions used for catalytic cracking and steam cracking and the products produced. ●the colour change when bromine water reacts with an alkene. ●balance chemical equations involving cracking. **4.7.2 Reactions of alkenes and alcohols** 4.7.2.1 Structure and formulae of alkenes Know: ●the structure of alkenes, the general formula for the homologous series of alkenes and the first four members of the homologous series of alkenes. 4.7.2.2 Reactions of alkenes Know: ●the products of reactions with alkenes and the bonds formed. Students should be able to: • describe the reactions and conditions for the addition of hydrogen, water and halogens to alkenes • draw fully displayed structural formulae for given reactions. 4.7.2.3 Alcohols Know: ●the functional group found in alcohols and the first four members of the homologous series. Students should be able to: • describe reactions for the first four alcohols in the series. •recall the main uses of these alcohols and recognise alcohols from their names or from given formulae.	

	4.7.2.4 Carboxylic acids Know: ●the functional group for carboxylic acids and the first four members of the homologous series. Students should be able to: • describe reactions involving the first four carboxylic acids. **4.7.3 Synthetic and naturally occurring polymers** 4.7.3.1 Addition polymerisation Know: ●Alkenes can be used to make polymers. Students should be able to: • recognise addition polymers and monomers from diagrams and be able to draw diagrams to represent the formation of a polymer. 4.7.3.4 DNA (deoxyribonucleic acid) and other naturally occurring polymers Know: ●the structure of DNA and other naturally occurring polymers important for life. Students should be able to: ● name the monomers from which these naturally occurring polymers are made.	4.7.2.4 Carboxylic acids Students should be able to: • explain why carboxylic acids are weak acids and recognise carboxylic acids from their names or formulae. 4.7.3.2 Condensation polymerisation Know: ●Condensation polymerisation involves the reaction of monomers. Students should be able to: ● explain the basic principles of condensation polymerisation. 4.7.3.3 Amino acids Know: ●Amino acids have two different functional groups in a molecule and react by condensation polymerisation to produce polypeptides.

4.8 Chemical analysis

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.8.1 Purity, formulations and chromatography 4.8.1.1 Pure substances Know: ●a pure substance is a single element or compound. Students should be able to: ● use melting point and boiling point data to distinguish pure from impure substances. 4.8.1.2 Formulations Know: ●A formulation is a mixture that has been designed as a useful product.. Students should be able to: ● identify formulations given appropriate information. 4.8.1.3 Chromatography Know: ●Chromatography can be used to separate mixtures and can give information to help identify substances. Students should be able to: • explain how paper chromatography separates mixtures • suggest how chromatographic methods can be used for distinguishing pure substances from impure substances • interpret chromatograms and determine Rf values from chromatograms **Required practical 6: investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.**	

	4.8.2 Identification of common gases 4.8.2.1 Test for hydrogen Know: ●The test for hydrogen. 4.8.2.2 Test for oxygen Know: ●The test for oxygen. 4.8.2.3 Test for carbon dioxide Know: ●The test for carbon dioxide. 4.8.2.4 Test for chlorine Know: ●The test for chlorine. **4.8.3 Identification of ions by chemical and spectroscopic means** 4.8.3.1 Flame tests Know: ●Flame tests can be used to identify some metal ions. Students should be able to: ● identify species from the results of flame tests. 4.8.3.2 Metal hydroxides Know: ●Sodium hydroxide solution can be used to identify some metal ions. Students should be able to: ● write balanced equations for the reactions to produce insoluble hydroxides.	

	4.8.3.3 Carbonates Know: ●Carbonates react with dilute acids to form carbon dioxide gas. 4.8.3.4 Halides Know: ●Halide ions in solution produce precipitates with silver nitrate solution in the presence of dilute nitric acid. 4.8.3.5 Sulfates Know: ●Sulfate ions in solution produce a white precipitate with barium chloride solution in the presence of dilute hydrochloric acid. **Required practical 7: use of chemical tests to identify the ions in unknown single ionic compounds.** 4.8.3.6 Instrumental methods Know: ●Elements and compounds can be detected and identified using instrumental methods. Students should be able to: ● state advantages of instrumental methods compared with the chemical tests. 4.8.3.7 Flame emission spectroscopy Know: ●Flame emission spectroscopy is an example of an instrumental method used to analyse metal ions in solutions. Students should be able to: ● interpret an instrumental result given appropriate data in chart or tabular form.	

4.9 Chemistry of the atmosphere

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.9.1 The composition and evolution of the Earth's atmosphere 4.9.1.1 The proportions of different gases in the atmosphere Know: ●the changes in proportions of atmospheric gases.. 4.9.1.2 The Earth's early atmosphere Know: ● how the Earth's atmosphere was formed and has changed and developed over time. Students should be able to: ● evaluate different theories about the Earth's early atmosphere. 4.9.1.3 How oxygen increased Know: ●Algae and plants produced the oxygen that is now in the atmosphere. 4.9.1.4 How carbon dioxide decreased Know: ●Algae, plants and other factors decreased the percentage of carbon dioxide in the atmosphere. Students should be able to: • describe the main changes in the atmosphere over time and some of the likely causes of these changes	

	4.9.2 Carbon dioxide and methane as greenhouse gases 4.9.2.1 Greenhouse gases Know: ●Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to support life. Students should be able to: ● describe the greenhouse effect. 4.9.2.2 Human activities which contribute to an increase in greenhouse gases in the atmosphere Know: ●human activities increase the amounts of greenhouse gases. Students should be able to: ● recall two human activities that increase the amounts greenhouse gases. • evaluate the quality of evidence about global climate change given appropriate information and describe uncertainties in the evidence base and recognise the importance of peer review. 4.9.2.3 Global climate change Know: ●An increase in average global temperature is a major cause of climate change. Students should be able to: • describe four potential effects of global climate change; discuss the scale, risk and implications. 4.9.2.4 The carbon footprint and its reduction Know: ●how to describe the carbon footprint of a is greenhouse gas. Students should be able to: • describe actions to reduce emissions of carbon dioxide and methane and give reasons why actions may be limited.	

	4.9.3 Common atmospheric pollutants and their sources 4.9.3.1 Atmospheric pollutants from fuels Know: ●The combustion of fuels is a major source of atmospheric pollutants. Students should be able to: • describe how atmospheric pollutants are produced by burning fuels and predict the products of combustion of a fuel. 4.9.3.2 Properties and effects of atmospheric pollutants Know: ●the effect atmospheric pollutants have on global dimming and human health. Students should be able to: ● describe and explain the problems caused by increased amounts of pollutants in the air.	

4.10 Using resources

AQA Entry Level Certificate Science	Foundation AQA Chemistry GCSE	Higher AQA Chemistry GCSE
	4.10.1 Using the Earth's resources and obtaining potable water 4.10.1.1 Using the Earth's resources and sustainable development Know: ●Humans use the Earth's resources to provide warmth, shelter, food and transport. Students should be able to: • state examples of natural products that are supplemented or replaced by agricultural and synthetic products and distinguish between finite and renewable resources • extract and interpret information about resources from charts, graphs and tables and use orders of magnitude to evaluate data. 4.10.1.2 Potable water Know: ●Water of appropriate quality is essential for life. ●Sterilising agents used for potable water. ●the process of desalination. Students should be able to: • distinguish between potable water and pure water and give reasons for the steps used to produce potable water. • describe the differences in treatment of ground water and salty water **Required practical 8: analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.**	

	4.10.1.3 Waste water treatment Know: ●Urban lifestyles and industrial processes produce large amounts of waste water that requires treatment. Students should be able to: ● comment on the relative ease of obtaining potable water. **4.10.2 Life cycle assessment and recycling** 4.10.2.1 Life cycle assessment Know: ●why life cycle assessments (LCAs) are carried out. Students should be able to: ● carry out simple comparative LCAs for shopping bags. 4.10.2.2 Ways of reducing the use of resources Know: ●The reduction in use, reuse and recycling of materials by end users reduces the use of limited resources, use of energy sources, waste and environmental impacts. Students should be able to: ● evaluate ways of reducing the use of limited resources. **4.10.3 Using materials** 4.10.3.1 Corrosion and its prevention Know: ●Corrosion is the destruction of materials by chemical reactions with substances in the environment. Students should be able to: • describe experiments and interpret results to show that both air and water are necessary for rusting • explain sacrificial protection in terms of relative reactivity. 4.10.3.2 Alloys as useful materials Know: ●Most metals in everyday use are alloys.	4.10.1.4 Alternative methods of extracting metals Know: ●The Earth's resources of metal ores are limited. Copper ores are becoming scarce and new ways of extracting copper from low-grade ores include phytomining, and bioleaching. These methods avoid traditional mining methods of digging, moving and disposing of large amounts of rock. Phytomining uses plants to absorb metal compounds. The plants are harvested and then burned to produce ash that contains metal compounds. Bioleaching uses bacteria to produce leachate solutions that contain metal compounds. Students should be able to: ● evaluate alternative biological methods of metal extraction, given appropriate information.

	Students should be able to: • recall a use of each of the alloys specified and interpret and evaluate the composition and uses of alloys. 4.10.3.3 Ceramics, polymers and composites Know: ●the production methods and properties of named materials. Students should be able to: • explain how low density and high density poly(ethene) are produced and the structures of thermosoftening and thermosetting polymers. ●compare quantitatively the physical properties of materials and how these properties are related to their uses. **4.10.4 The Haber process and the use of NPK fertilisers** 4.10.4.1 The Haber process Know: ●The Haber process is used to manufacture ammonia. Students should be able to: ● recall a source for the nitrogen and hydrogen used in the Haber process and explain the process. 4.10.4.2 Production and uses of NPK fertilisers Know: ●compounds used as fertilisers improve agricultural productivity. Students should be able to: • recall the reactions that produce fertilisers. • compare the industrial production of fertilisers with laboratory preparations given appropriate information.	4.10.4.1 The Haber process Students should be able to: • interpret graphs of reaction conditions versus rate and apply the principles of dynamic equilibrium to the Haber process • explain how commercially used conditions for the Haber process are related to the availability and cost of raw materials, energy supplies and control of equilibrium position and rate.

- AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures
- AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:
    - in a theoretical context
    - in a practical context
    - when handling qualitative data
    - when handling quantitative data
- AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:
    - make judgements and reach conclusions
    - develop and refine practical design and procedures.

The assessment objectives proposed by Ofqual are broadly similar to those for the current GCSEs but the inclusion of working scientifically will have a significant impact on teaching and learning.

AO1 Demonstrate knowledge and understanding of:

• scientific ideas

• scientific techniques and procedures.

40% (current 37.5%)

AO2 Apply knowledge and understanding of:

• scientific ideas

• scientific enquiry, techniques and procedures.

40% (current 35%)

AO3 Analyse information and ideas to:

• interpret and evaluate

• make judgements and draw conclusions

• develop and improve experimental procedures.

Assessment objectives for writing iGCSE:

AO5- Communicate clearly, effectively and imaginatively, selecting and adapting tone, style and register for different forms, purposes and audiences. Organise information and ideas, using structural and grammatical features to support coherence and cohesion of texts

AO6 – we will use a range of vocabulary and sentence structures for clarity, purpose and effect, with accurate spelling and punctuation. (This requirement = 20% of the marks).

AO7- Demonstrate presentation skills in a formal setting (written or spoken).

Assessment objectives for speaking and listening iGCSE: (these thread through all units).

AO7- Demonstrate presentation skills in a formal setting (written or spoken).

AO8: Listen and respond appropriately to spoken language, including to questions and feedback on presentations

AO9: Use spoken Standard English effectively in speeches and presentations.