AQA GCSE **– Chemistry** – Paper 2 Learning Pathway

Learning objectives for paper 2:

C8	Rates and Equilibrium		Revised	Understood
C8.1	Rate of reaction	I can explain how there can be different units for measuring rate of reaction. I can calculate the mean rate of reaction. I can calculate the rate of reaction at a specific time.		
C8.2	Collision theory and surface area	I can describe how changing the surface area changes the rate of reaction. I can describe what the activation energy of a reaction is. I can calculate the surface area to volume ratio.		
C8.3	The effect of temperature	I can use collision theory to explain how changing temperature alters the rate of reaction. I can calculate mean rates of reaction.		
C8.4	The effect of concentration or pressure	I can use collision theory to explain how changing concentration or pressure alters the rate of reaction. I can calculate mean rates of reaction. I can explain how to change gas pressure.		
C8.5	The effect of catalysts	I can use collision theory to explain how adding a catalyst alters the rate of reaction. I can explain, with an example, the industrial use of a catalyst. I can calculate the mean rate of reaction.		
C8.6	Reversible reactions	I can explain, using a familiar reaction, how a reaction can be reversible. I can describe a familiar reversible reaction using a balanced symbol equation. I can predict the observations of a familiar reversible reaction when the conditions are changed.		
C8.7	The effect of concentration or pressure	I can explain why the energy change in a reversible reaction is exothermic in one direction and endothermic in the reverse I can generate balanced symbol equations for reversible reactions from information provided. I can make predictive observations of familiar reversible reactions when information is supplied.		
C8.8	The effect of catalysts	I can describe how to achieve dynamic equilibrium. I can describe how the rate of the forward reaction compares to the rate of the backward reaction in dynamic equilibrium. I can describe Le Chatelier's Principle.		
C8.9	Reversible reactions	I can explain how changing conditions for a system at dynamic equilibrium affects the rate of the forward and reverse I can predict the effect on yield of changing temperature, concentration, or pressure in a given equilibrium system.		
C9	**Crude oil and fuels**			
C9.1	Hydrocarbons	I can describe how to separate crude oil into fractions in a school laboratory. I can classify a hydrocarbon as an alkane. I can state the names and describe the first four alkanes.		
C9.2	Fractional distillation of oil	I can describe how the trend in colour, viscosity, flammability, and boiling point changes as the length of the hydrocarbon chain changes. I can describe how the properties of a fraction of crude oil make it appropriate for its use.		
C9.3	Burning hydrocarbon fuels	I can explain the differences between complete and incomplete combustion. I can write balanced symbol equations for the complete and incomplete combustion of hydrocarbons. I can explain how to test for the products of complete combustion.		
C9.4	Cracking hydrocarbons	I can describe the process of cracking, including conditions. I can generate a balanced symbol equation to describe cracking. I can describe a chemical test to show an alkene is present.		

C10	**Organic reactions- GCSE Chemistry ONLY**			
C10.1	Reactions of the alkenes **GCSE Chemistry ONLY**	I can draw the displayed structural formulae for the first four alkenes. I can draw the displayed structural formulae for the products of the addition reactions between alkenes and hydrogen, water (steam), or a halogen. I can predict the word and balanced symbol equations for the complete combustion of an alkene when the number of carbon atoms is given.		
C10.2	Structures of alcohols, carboxylic acids and esters **GCSE Chemistry ONLY**	I can classify an organic compound as an alcohol a carboxylic acid, or an ester. I can draw the structural and displayed formulae for the first four primary alcohols and the first four carboxylic acids. I can draw the structural and displayed formulae for ethyl ethanoate.		
C10.3	Reactions and uses of alcohols **GCSE Chemistry ONLY**	I can describe fermentation to make aqueous solutions of ethanol, including a word equation. I can describe the reactions of alcohols, including using word equations. I can explain the relationship between ethanol and ethanoic acid.		
C10.4	Carboxylic acids and esters **GCSE Chemistry ONLY**	I can describe why carboxylic acids are acidic. I can use word equations to describe the reactions of carboxylic acids with metal carbonates and with alcohols. I can describe how to make an ester.		
C11	Polymers- **GCSE Chemistry ONLY**			
C11.1	**GCSE Chemistry ONLY** Addition polymerisation	I can describe how monomers become polymers. I can draw the monomer for an addition polymer when the structure of the polymer is given. I can draw an addition polymer structure when the structure of the monomer is given.		
C11.2	**GCSE Chemistry ONLY** Condensation polymerisation	I can describe condensation polymerisation. I can draw a simplified structure of the monomers for a condensation polymer when the structure of the polymer is given. I can draw a simplified structure of a condensation polymer when the structure of the monomers are given.		
C11.3	**GCSE Chemistry ONLY** Natural polymers	I can identify the monomer from the structural formula of a polymer. I can describe the structure of an amino acid. I can explain how amino acids react together in an acid-base reaction.		
C11.4	**GCSE Chemistry ONLY** DNA	I can describe the main structure of DNA. I can describe the importance of DNA for living systems. I can sketch the shape of a DNA strand.		
C12	**Chemical Analysis**			
C12.1	Pure substances and mixtures	I can describe the difference between pure substances, impure substances, and formulations. I can explain how melting point and boiling point data can be used to determine the purity of a substance. I can state uses of formulations.		
C12.2	Analysing chromatograms	I can explain how chromatography separates solutes. I can calculate R_f values from given data. I can use a chromatogram to determine if a sample is pure or impure.		
C12.3	Testing for gases	Hydrogen burns with a "pop" when light Oxygen relights a glowing splint CO_2 turns line water cloudy, Cl_2 turns bleaches damp litmus paper white		
C12.4	Positive ion tests	Flame tests can be used to identify ions NaOH can be used to identify metal ions that form insoluble hydroxides as precipitates		
C12.5	Negative ion tests	Test for carbonates with acid, bubbles of CO_2 form Halides are tested with nitic acid then silver nitrate, know the positive results Sulphates are tested for with HCl then $BaCl_2$ making a white precipitate		
C12.6	Instrumental analysis	Modern instruments give fast accurate and sensitive ways of analysising chemicals Flame emission spectroscopy is an example This tells us which metal ions are present in their spectral lines, also the concentrations in solution		
C13	**The Earth's Atmosphere**			
C13.1	History of atmosphere	Theories about what was in the Earth's early atmosphere and how the atmosphere was formed have changed and developed over time. Evidence for the early atmosphere is limited because of the time scale of 4.6 billion years.		

		One theory suggests that during the first billion years of the Earth's existence there was intense volcanic activity that released gases that formed the early atmosphere and water vapour that condensed to form the oceans. At the start of this period the Earth's atmosphere may have been like the atmospheres of Mars and Venus today, consisting of mainly carbon dioxide with little or no oxygen gas. Volcanoes also produced nitrogen which gradually built up in the atmosphere and there may have been small proportions of methane and ammonia. When the oceans formed carbon dioxide dissolved in the water and carbonates were precipitated producing sediments, reducing the amount of carbon dioxide in the atmosphere.		
C13.2	Early atmosphere	Algae and plants produced the oxygen that is now in the atmosphere by photosynthesis, which can be represented by the equation: $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$ carbon dioxide + water $\xrightarrow{\text{light}}$ glucose + oxygen Algae first produced oxygen about 2.7 billion years ago and soon after this oxygen appeared in the atmosphere. Over the next billion years plants evolved and the percentage of oxygen gradually increased to a level that enabled animals to evolve. Algae and plants decreased the percentage of carbon dioxide in the atmosphere by photosynthesis. Carbon dioxide was also decreased by the formation of sedimentary rocks and fossil fuels that contain carbon. Students should be able to: • describe the main changes in the atmosphere over time and some of the likely causes of these changes • describe and explain the formation of deposits of limestone, coal, crude oil and natural gas.		
C13.3	Greenhouse gases	Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to support life. Water vapour, carbon dioxide and methane are greenhouse gases. Students should be able to describe the greenhouse effect in terms of the interaction of short and long wavelength radiation with matter.		
C13.4		Some human activities increase the amounts of greenhouse gases in the atmosphere. These include: • carbon dioxide • methane. Students should be able to recall two human activities that increase the amounts of each of the greenhouse gases carbon dioxide and methane. Based on peer-reviewed evidence, many scientists believe that human activities will cause the temperature of the Earth's atmosphere to increase at the surface and that this will result in global climate change. However, it is difficult to model such complex systems as global climate change. This leads to simplified models, speculation and opinions presented in the media that may be based on only parts of the evidence and which may be biased.		
C13.5		An increase in average global temperature is a major cause of climate change. There are several potential effects of global climate change. Students should be able to: • describe briefly four potential effects of global climate change • discuss the scale, risk and environmental implications of global climate change. The carbon footprint is the total amount of carbon dioxide and other greenhouse gases emitted over the full life cycle of a product, service or event. The carbon footprint can be reduced by reducing emissions of carbon dioxide and methane. Students should be able to: • describe actions to reduce emissions of carbon dioxide and methane • give reasons why actions may be limited. The combustion of fuels is a major source of atmospheric pollutants.		

		Most fuels, including coal, contain carbon and/or hydrogen and may also contain some sulfur. The gases released into the atmosphere when a fuel is burned may include carbon dioxide, water vapour, carbon monoxide, sulfur dioxide and oxides of nitrogen. Solid particles and unburned hydrocarbons may also be released that form particulates in the atmosphere. Students should be able to: • describe how carbon monoxide, soot (carbon particles), sulfur dioxide and oxides of nitrogen are produced by burning fuels Carbon monoxide is a toxic gas. It is colourless and odourless and so is not easily detected. Sulfur dioxide and oxides of nitrogen cause respiratory problems in humans and cause acid rain. Particulates cause global dimming and health problems for humans.		
C14	The Earth's Resources			
C14.1		Humans use the Earth's resources to provide warmth, shelter, food and transport. Natural resources, supplemented by agriculture, provide food, timber, clothing and fuels. Finite resources from the Earth, oceans and atmosphere are processed to provide energy and materials. Chemistry plays an important role in improving agricultural and industrial processes to provide new products and in sustainable development, which is development that meets the needs of current generations without compromising the ability of future generations to meet their own needs. Students should be able to: • state examples of natural products that are supplemented or replaced by agricultural and synthetic products • distinguish between finite and renewable resources given appropriate information. Students should be able to:		
C14.2		Water of appropriate quality is essential for life. For humans, drinking water should have sufficiently low levels of dissolved salts and microbes. Water that is safe to drink is called potable water. Potable water is not pure water in the chemical sense because it contains dissolved substances. The methods used to produce potable water depend on available supplies of water and local conditions. In the United Kingdom (UK), rain provides water with low levels of dissolved substances (fresh water) that collects in the ground and in lakes and rivers, and most potable water is produced by: • choosing an appropriate source of fresh water • passing the water through filter beds • sterilising. Sterilising agents used for potable water include chlorine, ozone or ultraviolet light. If supplies of fresh water are limited, desalination of salty water or sea water may be required. Desalination can be done by distillation or by processes that use membranes such as reverse osmosis. These processes require large amounts of energy. Students should be able to: • distinguish between potable water and pure water • describe the differences in treatment of ground water and salty water • give reasons for the steps used to produce potable water.		
C14.3		Urban lifestyles and industrial processes produce large amounts of waste water that require treatment before being released into the environment. Sewage and agricultural waste water require removal of organic matter and harmful microbes. Industrial waste water may require removal of organic matter and harmful chemicals. Sewage treatment includes: • screening and grit removal • sedimentation to produce sewage sludge and effluent		

		• anaerobic digestion of sewage sludge • aerobic biological treatment of effluent. Students should be able to comment on the relative ease of obtaining potable water from waste, ground and salt water.		
C14.4		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. The metal compounds can be processed to obtain the metal. For example, copper can be obtained from solutions of copper compounds by displacement using scrap iron or by electrolysis. Students should be able to evaluate alternative biological methods of metal extraction, given appropriate information.		
C14.5		Life cycle assessments (LCAs) are carried out to assess the environmental impact of products in each of these stages: • extracting and processing raw materials • manufacturing and packaging • use and operation during its lifetime • disposal at the end of its useful life, including transport and distribution at each stage. Use of water, resources, energy sources and production of some wastes can be fairly easily quantified. Allocating numerical values to pollutant effects is less straightforward and requires value judgements, so LCA is not a purely objective process. Selective or abbreviated LCAs can be devised to evaluate a product but these can be misused to reach pre-determined conclusions, eg in support of claims for advertising purposes. Students should be able to carry out simple comparative LCAs for shopping bags made from plastic and paper.		
C14.6		he 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. Metals, glass, building materials, clay ceramics and most plastics are produced from limited raw materials. Much of the energy for the processes comes from limited resources. Obtaining raw materials from the Earth by quarrying and mining causes environmental impacts. Some products, such as glass bottles, can be reused. Glass bottles can be crushed and melted to make different glass products. Other products cannot be reused and so are recycled for a different use. Metals can be recycled by melting and recasting or reforming into different products. The amount of separation required for recycling depends on the material and the properties required of the final product. For example, some scrap steel can be added to iron from a blast furnace to reduce the amount of iron that needs to be extracted from iron ore. Students should be able to evaluate ways of reducing the use of limited resources, given appropriate information.		
C15.1		Corrosion is the destruction of materials by chemical reactions with substances in the environment. Rusting is an example of corrosion. Both air and water are necessary for iron to rust. Corrosion can be prevented by applying a coating that acts as a barrier, such as greasing, painting or electroplating. Aluminium has an oxide coating that protects the metal from further corrosion. Some coatings are reactive and contain a more reactive metal to provide sacrificial protection, eg zinc is used to galvanise iron.		
C15.2		Most metals in everyday use are alloys. Bronze is an alloy of copper and tin. Brass is an alloy of copper and zinc.		

		Gold used as jewellery is usually an alloy with silver, copper and zinc. The proportion of gold in the alloy is measured in carats. 24 carat being 100% (pure gold), and 18 carat being 75% gold. Steels are alloys of iron that contain specific amounts of carbon and other metals. High carbon steel is strong but brittle. Low carbon steel is softer and more easily shaped. Steels containing chromium and nickel (stainless steels) are hard and resistant to corrosion. Aluminium alloys are low density.		
C15.3-4		Most of the glass we use is soda-lime glass, made by heating a mixture of sand, sodium carbonate and limestone. Borosilicate glass, made from sand and boron trioxide, melts at higher temperatures than soda-lime glass. Clay ceramics, including pottery and bricks, are made by shaping wet clay and then heating in a furnace. The properties of polymers depend on what monomers they are made from and the conditions under which they are made. For example, low density (LD) and high density (HD) poly(ethene) are produced from ethene. Thermosoftening polymers melt when they are heated. Thermosetting polymers do not melt when they are heated. Students should be able to: • explain how low density and high density poly(ethene) are both produced from ethene • explain the difference between thermosoftening and thermosetting polymers in terms of their structures. Most composites are made of two materials, a matrix or binder surrounding and binding together fibres or fragments of the other material, which is called the reinforcement. Students should be able to recall some examples of composites.		
C15.5-6		The Haber process is used to manufacture ammonia, which can be used to produce nitrogen-based fertilisers. The raw materials for the Haber process are nitrogen and hydrogen. Students should be able to recall a source for the nitrogen and a source for the hydrogen used in the Haber process. The purified gases are passed over a catalyst of iron at a high temperature (about 450°C) and a high pressure (about 200 atmospheres). Some of the hydrogen and nitrogen reacts to form ammonia. The reaction is reversible so some of the ammonia produced breaks down into nitrogen and hydrogen: nitrogen +hydrogen ⇌ammonia On cooling, the ammonia liquefies and is removed. The remaining hydrogen and nitrogen are recycled.		
C15.7		Compounds of nitrogen, phosphorus and potassium are used as fertilisers to improve agricultural productivity. NPK fertilisers contain compounds of all three elements. Industrial production of NPK fertilisers can be achieved using a variety of raw materials in several integrated processes. NPK fertilisers are formulations of various salts containing appropriate percentages of the elements. Ammonia can be used to manufacture ammonium salts and nitric acid. Potassium chloride, potassium sulfate and phosphate rock are obtained by mining, but phosphate rock cannot be used directly as a fertiliser. Phosphate rock is treated with nitric acid or sulfuric acid to produce soluble salts that can be used as fertilisers. Students should be able to: • recall the names of the salts produced when phosphate rock is treated with nitric acid, sulfuric acid and phosphoric acid • compare the industrial production of fertilisers with laboratory preparations of the same compounds, given appropriate information.		