# Science Department Curriculum Overview

# Chemistry: Years 9-13

## Curriculum Overview – Chemistry

Chemistry is an intriguing and exciting subject and our students' learning in Years 9-13 aims to expand on the foundational chemical concepts introduced in Years 7 and 8. In Years 9-11, students will study Atomic Structure and The Periodic Table, Bonding, Quantitative Chemistry, Rates, Energy and Chemical Changes, Chemical Analysis, Organic Chemistry as well as The Earth's Resources and Their Uses. In Years 12-13 cumulatively builds on Bonding, Atomic Structure and Amount of Substance central to chemical work but also introduces a deeper understanding of Kinetics, Periodicity, Equilibria, Reactions of Group 2 and Group 7, Organic Chemistry and Mechanisms and Organic Analysis. The innovative nature of Chemistry means that this field is constantly evolving, and our students are encouraged to complement their learning with wider, up-to-date research in order to expand their contextual appreciation of the subject.

The aims and objectives of the Chemistry curriculum are to enable students to develop:

- essential knowledge and understanding of different aspects of Chemistry;
- chemical practical skills so that they can appreciate the concomitant link between theoretical chemical work and experimental research;
- a confidence in their problem-solving skills towards chemical and quantitative work;
- a passion for the innovative work in Chemistry and the up-to-date research within this field;
- an understanding of how Chemistry shapes and transforms the everyday world and impacts society.

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| **Year 9** | **Chemistry**<br>Students will build on their knowledge separation techniques and **begin to analyse separation techniques** at a KS4 level.<br><br>Students will also build on their | **Chemistry**<br>Students will learn about the **Periodic Table and its development** from the pioneering work made by **Newlands and Mendeleev**.<br><br>They will compliment this with how the | **Chemistry**<br>Students will learn about **Bonding** (**Ionic, Covalent**). Students will demonstrate their understanding through **diagrams and extended writing**.<br><br>Students will be able to **explain trends in** | **Chemistry**<br>Students will continue Bonding module by learning about **Giant Covalent Structures and Metallic Bonding**.<br><br>Students will then start the next module on the **Earth's** | **Chemistry**<br>Students will learn the principles of the **Greenhouse Effect** and how this links to **Climate Change**.<br><br>They will also learn about the **Carbon Footprint** and **evaluate how human** | **Chemistry**<br>Students will learn the principles of the **Greenhouse Effect** and how this links to **Climate Change**.<br><br>Students will learn about **Finite resources** and how to make **potable water**. |

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| | knowledge of **atomic structure** and apply this to **electronic configuration**, **ions and isotopes**. They will also explain the **development of atomic theory** from Dalton to Chadwick.<br><br>*Core Practical - Chromatography* | modern day periodic is arranged (**metals / non-metals**) and **link this to electronic configuration**.<br><br>Students should also be able to describe **trends in Group 1,7,0**. | **reactivity of Group 1 and 7** and **explain the melting point/boiling point trends of Group 7 and 0**. | **Atmosphere** and will **evaluate the composition and the evolution of the Earth's Atmosphere**.<br><br>. | **activities** contribute to the Greenhouse Effect → Global Warming → Climate Change.<br><br>Students will also learn about **pollutants** in the Earth's atmosphere: **how they arise**, **their effects** and how they can be **minimised**. | They will also learn about the **LCA** , contextualising this to industry today, and build on the **Reduce, Reuse and Recycle** principles learnt at KS3.<br><br>*Core Practical: Analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.* |
| **Year 10** | **Chemistry**<br>Students will build on their knowledge of fossils fuels to apply this to **formation, use and extraction** of **crude oil.**<br>**Triple content only:** Students will build on their knowledge from their hydrocarbon learning to apply this to **alcohols, carboxylic acids, polymers, amino acids and DNA.**<br><br>Students will build on their knowledge of the **reactivity series** | **Chemistry**<br>They will also develop their **acids and bases** knowledge by learning about **reactions of acids with: metals, bases/alkalis, metal carbonates.**<br><br>Students will apply their knowledge of the pH scale to describe and explain the **principles of strong and weak acids**.<br>*Core Practical: Preparation of a pure, dry sample of a soluble salt from an* | **Chemistry**<br>Students will learn about **Energy Changes** and will be able to describe both **exothermic and endothermic** reactions and show their differences in **energy profile diagrams**.<br>Students will evaluate energy changes in reactions using **bond energy calculations**.<br>**Triple content only**: Students will then learn about **chemical cells and fuel cells** | **Chemistry**<br>Students will learn about **Quantitative Chemistry** by first describing the **Law of Conservation of Mass**. Students will then calculate **relative formula masses**.<br>Students will calculate **concentration and volume of gases** (non-mole based calculations). They will then learn the **mole equation** and apply this to **calculating masses** | **Chemistry**<br>Students will learn how to identify **limiting reagents** through reacting masses calculations.<br><br>**Triple content only**: Students will apply their learning to calculating **percentage yields and atom economies**. They will then learn how to calculate concentrations from **titration calculations.**<br>*Core Practical: Determination of the reacting volumes of solutions of a strong* | **Chemistry**<br>Students will be reviewing and consolidating what they have learnt so far.<br><br>End of Year Revision. |

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| | to **extraction of metals**. | *insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution.*<br><br>Students will learn about **Electrolysis** and be able to explain **why this method of extraction is used** and **evaluate its disadvantages**. Students will then learn about the extraction of both **molten and aqueous electrolytes**. Students will also learn about how **aluminium is extracted** from aluminium oxide. *Core practical - Investigate what happens when aqueous solutions are electrolysed using inert electrodes.* | and **evaluate** their use. *Core Practical: Investigate the variables that affect temperature changes in reacting solutions such as, eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals.* | **from balanced symbol equations**. | *acid and a strong alkali by titration.*<br><br>End of Year Revision. | |
| | **Chemistry**<br>Students will learn about **collision theory** and the **factors affecting rate of reaction**. | **Chemistry**<br>Students will learn about **reversible reactions and dynamic equilibrium**. Students will study **Le Chatelier's Principle** and explain how | **Chemistry**<br>Students will learn about **testing for gases**.<br>**Triple content only**: Students will learn about Instrumental Analysis and how this | **Chemistry**<br>**Triple content only**: Students will summarise their learning on equilibrium and using Earth's resources in | **Chemistry**<br>**Triple content only**: Students continue their learning by studying **carboxylic acids** and their reactions and **polymers**. | **Chemistry**<br>Students will sit their final chemistry exam. |

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| **Year 11** | They will also learn about how **catalysts** affect the rate of reaction.<br><br>*Core Practical(s): 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* | altering reaction conditions affects the position of the equilibrium.<br><br>Students will then extend their knowledge on mixtures and pure substances by applying this to **formulations**.<br><br>Students will then build on their learning from Year 9 on **chromatography**, by **evaluating solubilities** of compounds separated.<br><br>*Core Practical: Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.* | used in everyday life. They will then learn how to test for and identify positive and negative ions.<br><br>*Core Practical: Use of chemical tests to identify the ions in unknown single ionic compounds.* | the **Haber Process and Fertilizers**.<br>Students will then complete **Quantitative Chemistry Part 2** and apply their quantitative learning to calculating **percentage yields and atom economies**. They will then learn how to calculate concentrations from **titration calculations.** *Core Practical: Determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration.*<br><br>**Triple content only**: Students will then finalise their learning in **organic chemistry** by learning about the **structure, nomenclature and reactivity of alkenes and alcohols.** | **Chemistry**<br>Students will prepare for the final exams | |
| **KS5** | **Autumn 1** | **Autumn 2** | **Spring 1** | **Spring 2** | **Summer 1** | **Summer 2** |
| | **Teacher 1: Physical and Inorganic Chemistry**<br>Students will build on their KS4 knowledge | **Teacher 1: Physical and Inorganic Chemistry**<br>Students will build on their KS4 | **Teacher 1: Physical and Inorganic Chemistry**Students will extend on their KS4 knowledge on | **Teacher 1: Physical and Inorganic Chemistry**<br>Students will learn about **periodicity** and | **Teacher 1: Physical and Inorganic Chemistry**<br>Students to start A2 learning by focusing | **Teacher 1: Physical and Inorganic Chemistry**<br>Students will then learn about **entropy** |

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| **Year 12** | on **atomic structure** to learn about **orbital theory and electron configuration**.<br><br>They will also learn about **ionisation energies** and their trends across a period.<br><br>Finally, students will learn about **Time of Flight Mass Spectrometry** and perform **Time of Flight calculations**.<br><br>**Teacher 2: Physical and Organic Chemistry**<br><br>Students will build on their KS4 knowledge on **bonding** (ionic, covalent: simple molecules, covalent: giant structures, metallic).<br><br>They will then learn about **electronegativity** and bond polarity. From this, they will learn about the three core **intermolecular forces** and how this | **quantitative work** on **moles and Avogadro's constant**. They will then learn how to calculate different terms from the **ideal gas equation**.<br><br>They will then learn about **empirical formula** and how to calculate this from both the molecular formula and mass amounts before building on **balancing equations** and **titration calculations**.<br><br>*Core Practical: Make up a volumetric solution and carry out a simple acid-base titration*<br><br>They will also build on **atom economies and percentage yield** calculations from KS4.<br><br>Students will then learn about the key concepts in **energetics** building on **exothermic and endothermic** reaction principles. | **chemical equilibria** and apply this to **Kc calculations**.<br><br>They will describe and explain how **different factors affect the position** of the **equilibrium**.<br><br>Students will also learn about **oxidation and reduction** demonstrating these through half equations. They will state **oxidation states** of elements in different species and apply their learning through **redox equations**.<br><br>*Core Practical: Carry out simple test-tube reactions in aqueous solution to identify cations (Group 2, $NH_4^+$) and anions (Group 7 (halide), $OH^-$, $CO_3^{2-}$, $SO_4^{2-}$).*<br><br>**Teacher 2: Physical and Organic Chemistry**<br>Students will learn about the **structure,** | the **trends across period 3**.<br><br>They will then learn about the **trends in group 2**, **reactivity and solubility** of group 2 elements.<br><br>Finally, they will learn about **group 7 trends** and the **reactions of halide ions**.<br>**Teacher 2: Physical and Organic Chemistry**<br>Students will learn about **alcohol production** and the **oxidation** of alcohols before learning about the **elimination reactions** of alcohols.<br><br>*Core Practical: Carry out test-tube reactions to distinguish aldehydes from ketones by reaction with Tollens' reagent and Fehling's solution*<br><br>Students will then learn about Organic Analysis and use **mass spectrometry, infrared spectroscopy** to identify functional | on **thermodynamics.** Students will review and extend their understanding on **enthalpy changes**.<br><br>Students will then apply their learning to **Born Haber Cycles** to calculate different enthalpy changes. This will also be applied to **enthalpy changes of solution**.<br><br>**Teacher 2: Physical and Organic Chemistry**<br>Students to start A2 learning by focusing on **Optical Isomerism**. They will learn about **enantiomers and racemic mixtures**.<br><br>They will then learn about the **oxidation and reactivity** of aldehydes and ketones, focusing on **nucleophilic addition reactions**. | and how to calculate entropy changes in reactions. This will then be applied to **Gibb's Free Energy Equations** and associated graph work.<br>Students will build on their AS knowledge of periodicity, and learn about the **reactions of period 3 elements**.<br><br>They will then learn about the **trends in period 3 oxides** and **their reactivity** before studying the **acidic / basic nature of period 3 oxides**.<br><br>**Teacher 2: Physical and Organic Chemistry**<br>Students will then learn about the **structure and acidity of carboxylic acids**.<br><br>They will finally move onto the **nomenclature of esters, esterification and uses of esters**.<br>*This module will then be finalised in A2.* |

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| | influence melting/boiling points.<br><br>Finally, they will apply their learning on **electron repulsion theory** to predicting **3D shapes** of simple molecules. | They will also learn about **enthalpy changes** in a reaction, **calorimetry** before applying this knowledge to **Hess's Law** (both enthalpy of formation and combustion).<br><br>They will finally extend their learning on **bond calculations** from KS4.<br><br>*Core Practical: Measurement of an enthalpy change.*<br><br>**Teacher 2: Physical and Organic Chemistry**<br>Students will build on their KS4 knowledge on **rates** and **collision theory** and apply this to **Maxwell Boltzmann Distribution Curves**.<br><br>Students will learn the affect of **catalysts** on reaction kinetics and describe everyday examples of **catalysts in industry**. | **nomenclature and reactivity of halogenoalkanes**. The latter be demonstrated through a variety of reaction mechanisms including: **nucleophilic substitution, elimination and ozone depletion**.<br><br>Students will then study alkenes their **structure, bonding and reactivity** (**electrophilic addition reactions**). Finally, they will apply their learning to **addition polymers**. | groups and assign spectra to a variety of organic compounds.<br><br>*Core Practical: Identification of functional groups by test-tube reactions* | | |

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| | | They will also **evaluate the use of CFCs**.<br><br>*Core Practical: Investigation of how the rate of a reaction changes with temperature.*<br><br>Students will then move their learning onto **Organic Chemistry** starting with an introduction to **nomenclature, formulae and isomerism.**<br><br>They will then extend learning on **alkanes** from KS4 looking at **fractional distillation** of crude oil and **cracking** of hydrocarbons.<br><br>Students will learn about the **combustion** of hydrocarbons and the **chlorination of alkanes** in radical chain reactions. | | | | |

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| **Year 13** | **Teacher 1: Physical and Inorganic Chemistry**<br>Students to start A2 learning by focusing on **thermodynamics.** Students will review and extend their understanding on **enthalpy changes**.<br><br>Students will then apply their learning to **Born Haber Cycles** to calculate different enthalpy changes. This will also be applied to **enthalpy changes of solution**. Students will then learn about **entropy** and how to calculate entropy changes in reactions. This will then be applied to **Gibb's Free Energy Equations** and associated graph work.<br><br>Students will learn about Acids and Bases extending knowledge of the **pH scale, defining and Kw and calculating Ka**. They will perform **acid / base titration calculations** and | **Teacher 1: Physical and Inorganic Chemistry**<br>Students will continue their acids/base work by evaluating how buffer solution work and performing buffer calculations.<br><br>*Core Practical: Investigate how pH changes when a weak acid reacts with a strong base and when a strong acid reacts with a weak base.*<br><br>Students will then extend their KS4 learning on **chemical cells** and use this to predict the **direction of simple redox reactions**. They will then learn about the **commercial uses of electrochemical cells**.<br><br>*Core Practical: Measuring the EMF of an electrochemical cell.*<br><br>**Teacher 2: Physical and Organic Chemistry**<br>Students will build on their kinetics learning | **Teacher 1: Physical and Inorganic Chemistry**<br>Students will learn about the chemical properties of **transition metals** including **ligand substitution reactions and the chelating effect**. From their prior learning in GCE chemistry, they will apply this to the **shape of transition metal complexes** and their **variable oxidation states**, giving rise to their reactivity and **coloured complexes**.<br><br>They will then learn how to perform **redox and titration calculations**.<br><br>Finally, they will learn about the use of transition metals as **catalysts** with particular reference to the **Contact Process**.<br><br>Students will then move onto learning | **Teacher 1: Physical and Inorganic**<br>Students will build on their AS knowledge of periodicity, and learn about the **reactions of period 3 elements**.<br><br>They will then learn about the **trends in period 3 oxides** and **their reactivity** before studying the **acidic / basic nature of period 3 oxides**.<br><br>Students will then learn their final module from this half of the course where they will study the **equilibrium constant, Kp**. Here they will calculate **partial pressures, mole fractions and Kp calculations**. They will also evaluate how factors such as **temperature and catalysts affect the position of the equilibrium**.<br><br>**Teacher 2: Physical and Organic Chemistry**<br>Students will continue their learning on | **Teacher 1: Physical and Inorganic Chemistry**<br>Students will be reviewing and consolidating what they have learnt so far.<br><br>**Teacher 2: Physical and Organic**<br>Students will be reviewing and consolidating what they have learnt so far with particular emphasis on **Organic Synthesis**. | Students will be reviewing and consolidating what they have learnt so far. |

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| | analyse **pH curves** derived from these to identify appropriate **indicators** to use.<br><br>**Teacher 2: Physical and Organic Chemistry**<br>Students to start A2 learning by focusing on **Optical Isomerism**. They will learn about **enantiomers and racemic mixtures**.<br><br>They will then learn about the **oxidation and reactivity** of aldehydes and ketones, focusing on **nucleophilic addition reactions**.<br><br>Students will then learn about the **structure and acidity of carboxylic acids**.<br><br>They will finally move onto the **nomenclature of esters, their formation / reactions and finally their uses.** | from AS by describing and analysing **rate of reaction using graphs**. They will then learn about the **rate expression** and how this links to the **order of the reaction**. Following this, they will then learn about the **Rate Equation**.<br><br>Reaction kinetics will then be applied to the **Arrhenius equation and its associated graph work**.<br><br>Students will then finalise their learning in this module by studying the **Rate Determining Step**.<br><br>*Core Practical: Measure the rate of a reaction by an initial rate method, and a continuous monitoring method.* | the reaction of ions in aqueous solutions. *Core Practical: Carry out simple test-tube reactions to identify transition metal ions in aqueous solution.*<br><br>**Teacher 2: Physical and Organic Chemistry**<br>Students will learn about **arenes** – nomenclature, physical properties and reactivity: **electrophilic substation, nitration and Friedal-Crafts Acylation**.<br><br>They will then learn about **amines** – **nomenclature, physical properties and reactivity (nucleophilic reactions).**<br><br>They will learn about **condensation polymers** and the **biodegradability and disposal** of polymers.<br><br>Students will then start their next module by learning | **biological chemistry** by studying the chemistry in **enzyme action, DNA** and **action of anti-cancer drugs**.<br><br>Students will then learn about **$^{1}$H and $^{13}$C NMR** and analyse spectra to identify their corresponding organic compounds.<br><br>Students will then learn their final module from this half of the course where they will extend their learning on **chromatography** from KS4 by applying this to **thin layer, gas and column chromatography**.<br><br>*Core Practical: Separation of species by thin-layer chromatography* | | |

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| | Students will also perform **esterification practicals** in the lab.<br><br>They will then learn about the **nomenclature and reactivity (nucleophilic addition elimination)** of acyl chlorides, amides and acid anhydrides.<br><br>*Core practical: Preparation of - a pure organic solid test of its purity; - a pure organic liquid.* | | about the chemistry in **amino acids and proteins**. | | | |