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 material world and impacts society.

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
	Chemistry Students will build on their knowledge separation techniques and **begin to analyse separation techniques** at a KS4 level.	**Chemistry** Students will learn about the **Periodic Table and its development** from the pioneering work made by **Newlands and Mendeleev**. They will compliment this with how the	**Chemistry** Students will learn about **Bonding** (**Ionic, Covalent**). Students will demonstrate their understanding through **diagrams and extended writing**.	**Chemistry** Students will continue Bonding module by learning about **Giant Covalent Structures and Metallic Bonding**. Students will then start the next module on the **Earth's**	**Chemistry** Students will learn the principles of the **Greenhouse Effect** and how this links to **Climate Change**. They will also learn about the **Carbon Footprint** and **evaluate how human**	**Chemistry** Students will learn the principles of the **Greenhouse Effect** and how this links to **Climate Change**. Students will begin learning **Using Resources Part 1.** This includes learning

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	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
Year 9	Students will also build on their 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. *Required Practical - Chromatography, an introduction*.	modern day periodic is arranged (**metals / non-metals**) and **link this to electronic configuration**. Students should also be able to describe **trends in Group 1,7,0**.	Students will be able to **explain trends in 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**. .	**activities** contribute to the Greenhouse Effect → Global Warming → Climate Change. Students will also learn about **pollutants** in the Earth's atmosphere: **how they arise**, **their effects** and how they can be **minimised**.	about **Finite resources** and how to make **potable water**. End of Year Exams.
Year 10	**Chemistry** Students will continue their learning on **Using Resources Part 2**. Here, they will review and build on their knowledge from Year 9. They will cover the required practical, learn about the **LCA** , contextualising this to industry today, and build on the knowledge of **Reduce, Reuse and Recycle** they already have from the material world. *Required Practical: Analysis and purification of water*	**Chemistry** 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**. Students will evaluate energy changes in reactions using **bond energy calculations**. Sets 1 and 2 will also learn about **chemical cells and fuel cells** as part of the triple pathway and **evaluate** their use.	**Chemistry** Students will learn about **Extraction of Metals** via different methods including **Phytomining and Bioleaching**. This will lead them into their learning on **Electrolysis** where they should 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**	**Chemistry** Students will next develop their **acids and bases** knowledge from KS3, by learning about **reactions of acids with metals, bases/alkalis, metal carbonates.** Students will apply their knowledge of the pH scale to describe and explain the **principles of strong and weak acids**. *Required Practical: Preparation of a pure, dry sample of a soluble salt from an insoluble oxide or*	**Chemistry** Students will learn about **Quantitative Chemistry** by first describing the **Law of Conservation of Mass**. Students will then calculate **relative formula masses**. 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 from balanced symbol equations**.	**Chemistry** Students will be reviewing and consolidating what they have learnt so far. End of Year Exams.

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
	samples from different sources, including pH, dissolved solids and distillation.	*Required Practical: Investigate the variables that affect temperature changes in reacting solutions such as, eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals.*	**extracted** from aluminium oxide. *Required Practical - Investigate what happens when aqueous solutions are electrolysed using inert electrodes.*	*carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution.* Students will learn about **Quantitative Chemistry** by first describing the **Law of Conservation of Mass**. Students will then calculate **relative formula masses**. 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 from balanced symbol equations**.	Students will learn how to identify **limiting reagents** through reacting masses calculations. Sets 1 and 2 will apply their learning to calculating **percentage yields and atom economies**. They will then learn how to calculate concentrations from **titration calculations.** *Required Practical: Determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration.* End of Year Revision.	
	Chemistry Students will learn about **collision theory** and the	**Chemistry** Sets 1-4 will then study **Le Chatelier's Principle** and explain how altering reaction	**Chemistry** Students will learn about **testing for gases**.	**Chemistry** Triple students will learn about **Instrumental Analysis** and how this	**Chemistry** Students will prepare for the final exams	**Chemistry** Students will sit their final chemistry exam.

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
Year 11	**factors affecting rate of reaction**. They will also learn about how **catalysts** affect the rate of reaction. *Required Practicals: 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* Students will learn about **reversible reactions and dynamic equilibrium**.	conditions affects the position of the equilibrium. Triple students will then apply their learning to the **Haber Process, its economics and NKP fertilisers**. All students will build on their knowledge of fossils fuels to apply this to **formation, use and extraction of crude oil**. Triple students will then extend their learning to **alcohols, carboxylic acids, polymers, amino acids and DNA**. All students will review and build on their knowledge of **mixtures and pure substances** by applying this to **formulations**. Students will then build on their learning from Year 9 on **chromatography**, by **evaluating solubilities** of	Students will then be reviewing and consolidating what they have learnt so far. *Due to the additional Organic Chemistry module in Autumn 2, Triple students will learn the start of their Chemical Analysis Module in Spring 1.*	used in everyday life. They will then learn how to test for and **identify positive and negative ions.** *Required Practical: Use of chemical tests to identify the ions in unknown single ionic compounds.*		

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		compounds separated using Rf value calculations. *Required Practical: Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.* *Triple students: Flipped learning of remaining Using Materials topics.*				
KS5	**Autumn 1**	**Autumn 2**	**Spring 1**	**Spring 2**	**Summer 1**	**Summer 2**
Year 12	**Teacher 1: Physical and Inorganic Chemistry** Students will build on their KS4 knowledge on **atomic structure** to learn about **orbital theory and electron configuration**. They will also learn about **ionisation energies** and their trends across a period. Finally, students will learn about **Time of**	**Teacher 1: Physical and Inorganic Chemistry** Students will build on their KS4 **quantitative work** on **moles and Avogadro's constant**. They will then learn how to calculate different terms from the **ideal gas equation**. They will then learn about **empirical formula** and how to calculate this from	**Teacher 1: Physical and Inorganic Chemistry** Students will extend their KS4 knowledge on **chemical equilibria** and apply this to **Kc calculations**. They will describe and explain how **different factors affect the position** of the **equilibrium**. Students will also learn about **oxidation and**	**Teacher 1: Physical and Inorganic Chemistry** Students will learn about **periodicity** and the **trends across period 3**. They will then learn about the **trends in group 2**, **reactivity and solubility** of group 2 elements. Finally, they will learn about **group 7 trends** and the **reactions of halide ions**.	**Teacher 1: Physical and Inorganic Chemistry** Students to start A2 learning by focusing on **thermodynamics.** Students will review and extend their understanding on **enthalpy changes**. Students will then apply their learning to **Born Haber Cycles** to calculate different enthalpy changes. This will also be	**Teacher 1: Physical and Inorganic Chemistry** 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. Students will build on their AS knowledge of periodicity, and learn about the **reactions of period 3 elements**.

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
	Flight Mass Spectrometry and perform **Time of Flight calculations**. **Teacher 2: Physical and Organic Chemistry** Students will build on their KS4 knowledge on **bonding** (ionic, covalent: simple molecules, covalent: giant structures, metallic). They will then learn about **electronegativity** and bond polarity. From this, they will learn about the three core **intermolecular forces** and how this influences melting/boiling points. Finally, they will apply their learning on **electron repulsion theory** to predicting **3D shapes** of simple molecules.	both the molecular formula and mass amounts before building on **balancing equations** and **titration calculations**. *Required Practical: Make up a volumetric solution and carry out a simple acid-base titration* They will also build on **atom economies and percentage yield** calculations from KS4. Students will then learn about the key concepts in **energetics** building on **exothermic and endothermic** reaction principles. 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).	**reduction** demonstrating these through half equations. They will state **oxidation states** of elements in different species and apply their learning through **redox equations**. *Required 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-}).* **Teacher 2: Physical and Organic Chemistry** Students will learn about the **structure, nomenclature and reactivity of halogenoalkanes**. The latter be demonstrated through a variety of reaction mechanisms including **nucleophilic substitution, elimination and ozone depletion**.	**Teacher 2: Physical and Organic Chemistry** Students will learn about **alcohol production** and the **oxidation** of alcohols before learning about the **elimination reactions** of alcohols. *Required Practical: Carry out test-tube reactions to distinguish aldehydes from ketones by reaction with Tollens' reagent and Fehling's solution* Students will then learn about Organic Analysis and use **mass spectrometry, infrared spectroscopy** to identify functional groups and assign spectra to a variety of organic compounds. *Required Practical: Identification of functional groups by test-tube reactions*	applied to **enthalpy changes of solution**. **Teacher 2: Physical and Organic Chemistry** Students to start A2 learning by focusing on **Optical Isomerism**. They will learn about **enantiomers and racemic mixtures**. They will then learn about the **oxidation and reactivity** of aldehydes and ketones, focusing on **nucleophilic addition reactions**.	They will then learn about the **trends in period 3 oxides** and **their reactivity** before studying the **acidic / basic nature of period 3 oxides**. **Teacher 2: Physical and Organic Chemistry** Students will then learn about the **structure and acidity of carboxylic acids**. They will finally move onto the **nomenclature of esters, esterification and uses of esters**. *This module will then be finalised in A2.* Students will be reviewing and consolidating what they have learnt. Students will sit their AS chemistry exam.

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
		They will finally extend their learning on **bond calculations** from KS4. *Required Practical: Measurement of an enthalpy change.* **Teacher 2: Physical and Organic Chemistry** Students will build on their KS4 knowledge on **rates** and **collision theory** and apply this to **Maxwell Boltzmann Distribution Curves**. Students will learn the effect of **catalysts** on reaction kinetics and describe everyday examples of **catalysts in industry**. They will also **evaluate the use of CFCs**. *Required Practical: Investigation of how the rate of a reaction changes with temperature.* Students will then move their learning	Students will then study alkenes, their **structure, bonding and reactivity** (**electrophilic addition reactions**). Finally, they will apply their learning to **addition polymers**.			

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		onto **Organic Chemistry** starting with an introduction to **nomenclature, formulae and isomerism.** They will then extend learning on **alkanes** from KS4 looking at **fractional distillation** of crude oil and **cracking** of hydrocarbons. Students will learn about the **combustion** of hydrocarbons and the **chlorination of alkanes** in radical chain reactions.				
Year 13	**Teacher 1: Physical and Inorganic Chemistry** Students to start A2 learning by focusing on **thermodynamics.** Students will review and extend their understanding on **enthalpy changes**. Students will then apply their learning to **Born Haber Cycles** to calculate different enthalpy changes.	**Teacher 1: Physical and Inorganic Chemistry** 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 analyse **pH curves** derived from these to identify appropriate **indicators** to use.	**Teacher 1: Physical and Inorganic Chemistry** Reaction kinetics will then be applied to the **Arrhenius equation and its associated graph work**. Students will then finalise their learning in this module by studying the **Rate Determining Step**.	**Teacher 1: Physical and Inorganic** They will then learn how to perform **redox and titration calculations**. Finally, they will learn about the use of transition metals as **catalysts** with particular reference to the **Contact Process**.	**Teacher 1: Physical and Inorganic Chemistry** Students will build on their AS knowledge of periodicity and learn about the **reactions of period 3 elements**. They will then learn about the **trends in period 3 oxides** and **their reactivity** before studying the **acidic / basic nature of period 3 oxides**.	Students will be reviewing and consolidating what they have learnt. Students will sit their final chemistry exam.

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
	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. 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**. *Required Practical: Measuring the EMF of an electrochemical cell.* **Teacher 2: Physical and Organic Chemistry** Students will start by reviewing their	Students will continue their acids/base work by evaluating how buffer solutions work and performing buffer calculations. *Required Practical: Investigate how pH changes when a weak acid reacts with a strong base and when a strong acid reacts with a weak base.* Students will build on their kinetics learning 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**. **Teacher 2: Physical and Organic Chemistry** Students continue to learn about **electrophilic substation applying**	*Required Practical: Measure the rate of a reaction by an initial rate method, and a continuous monitoring method.* Students will then 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**. **Teacher 2: Physical and Organic Chemistry** Students will start their learning in **biological chemistry** by studying the chemistry in **enzyme action, DNA** and **action of anti-cancer drugs**.	Students will then move onto learning the reaction of **ions in aqueous solutions**. *Required Practical: Carry out simple test-tube reactions to identify transition metal ions in aqueous solution.* **Teacher 2: Physical and Organic Chemistr**y 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**.	Students will then be reviewing and consolidating what they have learnt. **Teacher 2: Physical and Organic** Students will be reviewing and consolidating what they have learnt.	

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
	learning on carboxylic acids from AS. They will then move onto the **nomenclature of esters, their formation / reactions and finally their uses.** Students will also perform **esterification practicals** in the lab. They will then learn about the **nomenclature and reactivity (nucleophilic addition elimination)** of acyl chlorides, amides and acid anhydrides. *Required Practicals: Preparation of - a pure organic solid test of its purity; - a pure organic liquid.* Students will also start their learning on **arenes** – nomenclature, physical properties and reactivity: **electrophilic substation, nitration.**	**this to Friedal-Crafts Acylation**. They will then learn about **amines** – **nomenclature, physical properties and reactivity (nucleophilic reactions).** They will learn about **condensation polymers** and the **biodegradability and disposal** of polymers.	Students will then learn about **^{1}H and ^{13}C NMR** and analyse spectra to identify their corresponding organic compounds. 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**. *Required Practical: Separation of species by thin-layer chromatography.*			