**Year 11**

**In year 11** we teach the following modules over the course of the year. Each module draws on prior learning from previous years and builds on understanding from the KS2 programme of study. Each module develops and deepens the Core knowledge that will underpin all areas of the curriculum at KS3 and KS4.

| Topic | Rationale | Knowledge acquisition | Key vocabulary | Skills and enrichment |
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| Atomic structure and the periodic table | The periodic table provides chemists with a structured organisation of the known chemical elements from which they can make sense of their physical and chemical properties | Atoms, elements, compounds, mixtures | Atoms, elements, compounds, mixtures | Separation techniques, Filtration, distillation, Crystallisation.<br>Safe use of a range of equipment to separate chemical mixtures.<br>Numeracy. |
| | | Separating mixtures – distillation – Liebig Condenser, boiling points | Separation techniques, Filtration, distillation, Crystallisation. | |
| | | Separating mixtures – salt and sand – sea water practical – filtration (portion for evaporation) | Evaporation | |
| | | Sea water practical continued, distillation | Distillation, Liebig Condenser | |
| | | History of the atom, structure of the atom, masses and charges of PEN | protons, neutrons and electrons | |
| | | Calculate number of protons, neutrons and electrons in atoms and ions definition and recognition of isotopes | protons, neutrons and electrons isotopes | |
| Atomic structure and the periodic table | The historical development of the periodic table and models of atomic structure provide good examples of how scientific ideas and explanations develop over time as new evidence emerges. | History of the atom, structure of the atom, masses and charges of PEN | | This historical context provides an opportunity for students to show an understanding of why and describe how scientific methods and theories develop over time. |
| | | Calculate number of protons, neutrons and electrons in atoms and ions definition and recognition of isotopes | | |
| | | Electronic structure, drawing electron configurations | Electron configurations, shielding. | |
| | | History of the periodic table timeline of development up to modern periodic table<br>Newlands and Mendeleev | | |
| | | The modern periodic table, groups, periods, metals, non-metals, transition metals, group 0 | | |
| | | Group 7 – the Halogens – electronic structure and reactions | | |
| | | Explaining trends in Group 7 – link to electronic structure | | |
| | | History of the atom, structure of the atom, masses and charges of PEN | | |

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| **Bonding, Structures and Properties** | Chemical bonds are the glue that hold substances together. The attraction of one atom to another determines a substances chemical reactivity and its physical properties. Understanding how these can be determined by considering the atoms involved within the substance can be used to advance our understanding of materials science and where research may go in the immediate future. | 1. Structure of the atom (revision) | Proton, Neutron, Electron, Negligible | • Opportunities for learners to demonstrate their research skills – for an individual polymer. This could be presented as an extended piece of prose (literacy) or 2 minute oral presentation (oracy)<br>• Some opportunities for learners to develop their practical skills, especially those of qualitative observation when comparing the physical properties of ionic, covalent and metallic substances.<br>• Learners could analyse the use and appropriateness of a range of materials for specific purposes.<br>• Further research opportunities exist for learners to demonstrate the new and diverse use of nanoparticles. |
| | | 2. Formation of ions and ionic bonding | Ion, positive, negative, cation, anion, transfer, noble gas, configuration, ionic | |
| | | 3. Ionic compounds and properties of giant ionic lattices | Giant, lattice, 3D, ions, conductivity, brittle, soluble, electrostatic | |
| | | 4. Covalent bonding dot and cross diagrams | Venn diagram, covalent, share | |
| | | 5. Simple covalent molecules and polymers | Polymer, manufactured, covalent, molecule, intermolecular, monomer, polymerisation, thermosetting, thermosoftening | |
| | | 6. Giant covalent structures, to include diamond and graphite | Brilliant, strong, hard, lubricant, delocalised | |
| | | 7. Nanoparticles, to include graphene, fullerenes and nanotubes | Pure, element, lubricant, delocalised, covalent | |
| | | 8. Metallic bonding, and the properties of metals | Delocalised, electrostatic, electron, conduction, sonorous, malleable, ductile, reflective, conductor, compound | |
| | | 9. Giant metallic structures and alloys | Mixtures, properties, malleable, proportion, stainless | |

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| 4.3.1 Quantitative Chemistry | Chemists use quantitative analysis to determine the formulae of compounds and the equations for reactions. Given this information, analysts can then use quantitative methods to determine the purity of chemical samples and to monitor the yield from chemical reactions. Identifying different types of chemical reactions allows chemists to make sense of how different chemicals react together, to establish patterns and to make predictions about the behaviour of other chemicals. | What is the Law of Conservation of Mass? | Balanced, mass, reactants, products | Creativity: Model the law of conservation using molecular model kits.<br><br>Practical: Use magnesium ribbon to produce magnesium oxide. Measure the mass of the ribbon at the start of the experiment, burn the ribbon in a strong Bunsen flame (SAFETY required) and measure the mass of the ribbon at the end of the experiment.<br><br>Use HCl acid in a conical flask with $CaCO_3$. Measure the mass of the reaction on a top pan balance as the reaction proceeds over two minutes.<br><br>Independence: Identify a chemical reaction that has a high atom economy and research the positives to industry of producing a high yield of useful product. |
| | | What is relative atomic and relative formula mass? | Mass number, formula mass, formula, equation, reactants, products | |
| | | Why do we need to know percentage yield and atom economy? | Completion, reversible, yield, reactant, product, theoretical, atom economy | |
| | | What are moles and how do we calculate them? **HT ONLY** | Moles, mol, substance, Avogadro | |
| | | How can we apply moles to work out reacting masses? **HT ONLY** | Balanced, equation, moles, masses, grams | |
| | | How can we apply moles to balance equations? **HT ONLY** | Balancing, equation, converting, reactants, products | |
| | | How can we apply moles to work out limiting factors? **HT ONLY** | Limiting reagents, reactants, quantity | |
| | | How do we calculate the concentration of solutions? | Solutions, concentration, volume, solute | |

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| **Chemical Changes** | Understanding of chemical changes began when people began experimenting with chemical reactions in a systematic way and organising their results logically. Knowing about these different chemical changes meant that scientists could begin to predict exactly what new substances would be formed and use this knowledge to develop a wide range of different materials and processes | How does the pH scale work? | pH, hydrogen ions, concentration, neutralisation reaction, | Practical: (chemistry only) determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration. **REQUIRED PRACTICAL SEPARATES ONLY TITRATION**<br><br>Numeracy: practice order of magnitude calculations<br><br>Research: research the extraction of aluminium and explain why the process is energy intensive<br><br>Practical: investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis. **REQUIRED PRATICAL ELECTROLYSIS** |
| | | How can we accurately calculate the amount of acid needed to neutralise and alkali? (**SEPARATES ONLY)** | Burette, pipette, indicator, endpoint, titrations, concentration | |
| | | What is the difference between a strong and weak acid? | ionisation, strong and weak acids, neutrality, relative acidity, dilute and concentrated | |
| | | What is electrolysis? | Ionic compound, electrolysis, electrolytes, ions, discharge, electrodes, half equations, molten, aqueous. | |
| | | How do we represent the process at each electrode? | Electrode, half equations, oxidation, reduction | |

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| 4.5 Energy changes | Energy changes are an important part of chemical reactions. The interaction of particles often involves transfers of energy due to the breaking and formation of bonds.<br><br>Reactions in which energy is released to the surroundings are exothermic reactions, while those that take in thermal energy are endothermic. These interactions between particles can produce heating or cooling effects that are used in a range of everyday applications.<br>Separate<br><br>Some interactions between ions in an electrolyte result in the production of electricity. Cells and batteries use these chemical reactions to provide electricity. Electricity can also be used to decompose ionic substances and is a useful means of producing elements that are too expensive to extract any other way. | Energy transfer during exothermic and endothermic reactions | Exothermic<br>Endothermic. | Practical skills development - An opportunity to measure temperature changes when substances react or dissolve in water.<br><br>analysis – Draw simple reaction profiles (energy level diagrams) for exothermic and endothermic<br><br>Analysis - Use reaction profiles to identify reactions as exothermic or endothermic.<br>Numeracy skills - Calculate the energy transferred in chemical reactions.<br><br>Extended writing: write instructions to another student how to calculate the energy transferred in a chemical reaction.<br><br>Analysis - Be able to interpret data in terms of the relative reactivity of different metals and to evaluate the use of cells.<br><br>Evaluate - Research and evaluate uses of cells and batteries.<br><br>Practical skills development<br>. |
| | | Using energy transfer reactions | activation energy<br>energy level | |
| | | Reaction profiles for exothermic and endothermic reactions | reaction profiles | |
| | | Bond energy calculations (HT only) | Energy change | |
| | | Cells and batteries | Energy transferred<br>Chemical reaction.<br>Cells and batteries<br>Voltage.<br>Electrode and electrolyte.<br>Alkaline batteries | |
| | | Fuel cells | Fuel cells<br>Oxidation<br>oxidised electrochemically<br>half equations<br>Electrode | |

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| **Rate and extent of chemical change** | Chemical reactions can occur at vastly different rates. Whilst the reactivity of chemicals is a significant factor in how fast chemical reactions proceed, there are many variables that can be manipulated in order to speed them up or slow them down.. | 10. How to determine the rate of a chemical reaction | Product, reactant, rate, mean, tangent, gradient, slope | • Wide range of opportunities for learners to demonstrate their graphing skills. All learners need to practice and demonstrate the ability to draw a suitable tangent on a graph with a curved line of best fit.<br>• Essential opportunities for learners to develop their practical skills, especially those of quantitative observation when measuring data associated with rate of reaction determination.<br>• |
| | | 11. Collision theory and factors affecting the rate of reaction | Collision, particle, energy, activation, rate, concentration, pressure, sufficient, catalyst, temperature, surface area, state | |
| | | 12. Required Practical – Rates of Reaction – The Thiosulfate Cross | Dependent, independent, control, variable, rate, concentration, hydrochloric, thiosulphate. Erlenmeyer , obscure, hypothesis, conclusion | |
| | | 13. Reversible reactions, to include the reaction of anhydrous copper sulfate with water | Reactant, product, forward, backward, reversible, equilibrium, rate, anhydrous, hydrated | |
| | | 14. Equilibria and factors affecting the equilibrium position | Equilibrium, dynamic, pressure, temperature, catalyst, shift, forward, backward | |
| | | 15. The Haber Process; a case study | Le Chatelier (HT), equilibrium, position, shift, rate, pressure, catalyst, temperature, compromise, condition, qualitative(HT) | |
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| 4.7 organic chemistry | The chemistry of carbon compounds is so important that it forms a separate branch of chemistry. A great variety of carbon compounds is possible because carbon atoms can form chains and rings linked by C-C bonds. This branch of chemistry gets its name from the fact that the main sources of organic compounds are living, or once-living materials from plants and animals. These sources include fossil fuels which are a major source of feedstock for the petrochemical industry. Chemists are able to take organic molecules and modify them in many ways to make new and useful materials such as polymers, pharmaceuticals, perfumes and flavourings, dyes and detergents. | Crude oil and hydrocarbons | Hydrocarbons<br>Alkanes, methane, ethane, propane and butane.<br>Saturated. | Numeracy skills - Plot boiling points of alkanes against number of carbons.<br><br>Problem solving - Make predictions of the boiling points of other alkanes.<br><br>Independence - Research uses of the fractions of crude oil.<br><br>Describe the process of fractional distillation.<br><br>Evaluation - Suggest the impact on fuels, feedstock's and petrochemicals of the depleting stocks of crude oil.<br><br>Creativity - Describe a life without oil or oil derived products.<br><br>Evaluation - Look at the cultural and environmental impact of the oil industry around the world.<br><br>Practical skill - Investigate the properties of different hydrocarbons in terms of boiling point, viscosity and flammability with increasing molecular size. |
| | | Fractional distillation of oil | fractional distillation<br>evaporation<br>Condensation. | |
| | | Burning hydrocarbon fuels | • boiling points<br>• viscosity<br>• Flammability. | |
| | | Cracking hydrocarbons | cracking<br>formulae<br>reactants<br>Products. | |

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| **5.8.1 Purity, Formulations and Chromatography**<br><br>**5.8.2 Identification of common gases** | Analysts have developed a range of qualitative tests to detect specific chemicals. The tests are based on reactions that produce a gas with distinctive properties, or a colour change or an insoluble solid that appears as a precipitate. Instrumental methods provide fast, sensitive and accurate means of analysing chemicals, and are particularly useful when the amount of chemical being analysed is small. Forensic scientists and drug control scientists rely on such instrumental methods in their work. | What is the difference between pure and impure substances and how can you distinguish between the two? | Pure, substance, melting point, boiling point, distinguish, impure | Independence: research the melting points and boiling points of common pure substances and compounds. Suggest reasons for different data being available on the internet.<br><br>Independence: research the composition of the following formulations:<br>• Fuel<br>• Cleaning agents<br>• Paints<br>• Medicines<br><br>Practical skills: Investigate how paper chromatography can be used to separate and tell the difference between coloured substances, including the calculation of Rf values **REQUIRED PRACTICAL**<br><br>Analysis: analyse the composition of various tubes of gas by carrying out simple gas tests |
| | | What is a formulation and why are they useful? | Mixture, product, purpose, fertilisers, | |
| | | How do we separate mixtures using simple paper chromatography? | Separation, identification, stationary, mobile, phase, retention factor, soluble, solvent, solute, solution dissolve, chromatograms | |
| | | How do identify common atmospheric gases? | Hydrogen, oxygen, carbon dioxide, chlorine, splint, burning, glowing, lime water, calcium hydroxide, cloudy, precipitate, litmus paper, bleach | |