Chemistry
KS3 Curriculum

ASPIRE – ENDEAVOUR - SUCCEED

Purpose and aims

Students:

- develop scientific knowledge and conceptual understanding through the specific disciplines of biology, chemistry and physics
- develop understanding of the nature, processes and methods of science through different types of science enquiries that help them to answer scientific questions about the world around them
- are equipped with the scientific knowledge required to understand the uses and implications of science, today and for the future.

Threshold concepts

Year 7:

- Objects can be classified into groups base on their properties
- Materials can be solids, liquids, or gases
- They can change state when heated/cooled
- Mixtures can be separated
- Some substances dissolve in water
- Substances can change

Year 8:

- Temperature is measured with a thermometer
- Temperature can increase or decrease
- Water can move around (e.g. rain, puddles evaporating)

Year 9:

- There are different types of rocks
- Fossils take a long time to form
- Materials are used because they have suitable properties

Sequence of learning

- **Matter (year 7)** – this is a fundamental concept that underpins all of the chemistry KS3/KS4 curriculum, as well as physics and biology. Students will need to understand particle theory in order to understand the difference between *elements, compounds & mixtures*, to describe what a *chemical reaction* is, compare the *types of chemical reactions*, and will be revisited during parts of the *climate* topic (e.g. carbon cycle) in Y9. It underpins pressure, current and topics in Y7 physics and digestion topics in y7 biology. An understanding of properties of matter is required in order to consider the properties of different *elements, compounds, and mixtures* in the next topic.

- **Elements (year 7)** – this topic requires a prior understanding of *matter* (particle theory and the properties of substances). Students must understand how to use symbols for elements and compounds in order to write symbol equations for chemical reactions, so this will be revisited in periodic table, metals & non-metals, chemical energy, chemical reactions topics in chemistry, as well photosynthesis/respiration in biology. It will also be revisited during the y9 climate topic. (includes separating mixtures)

- **Chemical reactions (year 7)** – this topic will give students an understanding of what a chemical reaction is (in terms of rearrangement of atoms) in order to write equations for these, and explain why they occur in later topics such as metals and non-metals. This must be taught after elements, compounds, and mixtures so that students are able to use the names & formulae of elements and compounds.

- **Periodic table (year 7)** – students will need to understand what an element is, in order is in order to understand how the elements are organised and why they behave differently. This is key to being able to explain the reactions and properties of metals and non-metals. They first practice classifying substances based on their properties in the *matter* topic, return to this in the *periodic table* to consider the differences between metals and non-metals, and will use this skill later in the *earth structure* topic. They will need to be able to write chemical equations to describe the reactions of group 1 and 7 elements (*chemical reactions*).

- **Types of reactions (year 8)** – for students to access this topic they will need an understanding of what a chemical reaction is, how to name chemicals and interpret their formulae, and how to write word/symbol equations (*chemical reactions* topic). This is to allow them to describe the reactions covered in this topic, e.g. displacement.

- **Chemical energy (year 8)** – students need prior knowledge of the main types of *chemical reactions* (e.g. combustion, thermal decomposition) so that we can investigate the energy changes in these reactions (endothermic/exothermic). They need an understanding of how to write symbol equations (*chemical reactions*) in order to draw reaction profile diagrams for these reactions.

- **Earth structure (year 9)** – this will further develop students' understanding of using the properties of substances to classify them (rocks) into categories (covered in *matter*, *periodic table*, and *metals & non-metals*). They will need to understand changes of state (*matter*) in order to understand the formation of igneous and metamorphic rocks.

- **Earth resources (year 9)** – this topic will look at the differences between ceramics, polymers, and metals, so students will need to be able to use their properties to classify them (*matter*). They will need prior knowledge of particle theory (*matter*) in order to understand how polymers are formed. They will use their understanding of the properties of metals (*periodic table, metals and non-metals*). Knowledge of the difference between *elements, compounds and mixtures* will help them to describe the difference between a pure metal, its metal oxide, and the ore it is found in, therefore justifying the necessary separation techniques (*matter*) and use the reactivity series (*metals and non-metals*) in order to explain how metals are extracted using displacement reactions.

- **Climate (year 9)** – students will need an understand of combustion reactions (*types of reactions*), and the word/symbol equations for these (*chemical reactions*), in order to understand how human activities are contributing to increasing atmospheric CO_2 levels. The carbon cycle section of this topic will rely on knowledge of the processes of photosynthesis and respiration, covered prior to this in biology topics, and of combustion reactions, as discussed in the *types of* reactions topic. For each of these processes, students will need to write word and symbol equations (*chemical reactions*) to demonstrate the transfer of carbon through stores in the environment. In order to evaluate the combustion of fossil fuels as a source of energy, students will need an awareness of alternative energy sources (e.g. nuclear, renewables), which will be covered in prior physics topics.

Subject knowledge

Matter

- **Properties**: identify examples of properties, classify substances into groups based on properties, identify methods for investigating properties of substances
- **States of matter**: identify solids, liquids, and gases, describe properties of 3 states, classify substances based on these properties
- **Particle model**: - know that substances are made of particles, describe the arrangement and energy of particles in 3 states
- **Changes of state**: describe changes of state, explain changes of state in terms of gain or loss of energy, draw and explain the shape of cooling/heating curves
- **Density**: define density, calculate density of a substance given its mass and volume
- Gas pressure: define gas pressure, describe factors that affect gas pressure, explain why these affect it
- **Diffusion**: define diffusion, describe factors that affect diffusion, explain why they affect it
- **Atoms**: define what an atom and element are

Elements

- **Elements & their symbols**: identify the symbols of elements using the periodic table
- **Compounds and mixtures**: define compounds and mixtures, identify examples, compare compounds and mixtures
- **Investigating purity**: define a pure substance, identify pure/impure substances using melting and boiling point data
- **Dissolving**: define dissolving, solute, solvent, solution, soluble and insoluble; describe what happens when a substance dissolves, explain how temperature affects dissolving, know that substances have different solubilities in different solvents
- **Separating mixtures**: describe the processes of filtration, evaporation, distillation, and chromatography; identify appropriate separation technique for a given mixture, explain how these processes work in relation to solubility
- **Curriculum careers link: Forensic Science** - consider how forensic scientists use chromatography to obtain evidence for criminal investigations.
- **Naming compounds**: name compounds when given their component elements or chemical formulae
- **Chemical formulae**: identify the elements in a compound, and their proportions, from chemical formulae; write the formula for a compound when given the types and proportions of elements

Chemical Reactions

- **Chemical and physical changes**: identify chemical and physical changes, describe characteristics and observations for chemical and physical reactions
- **Chemical reactions**: define reactants and products, describe properties of chemical reactions
- **Word equations**: write word equations from given reactants and products, predict the sole product of a chemical reaction
- **Conservation of mass**: state the law of conservation of mass, explain why reactions may appear not to obey this law
- **Symbol equations and balancing equations**: write (& balance) symbol equations using given reactant and product formulae, write symbol equations given reactant and product names, recognise and use state symbols in symbol equations, describe how mass would change if symbol equations are given
- **Gas tests**: identify tests for O_2, H_2, Cl_2 and CO_2

Periodic Table

- **Modern periodic table**: describe the structure of the periodic table, describe how elements are organised with reference to properties
- **Mendeleev**: identify key features of Mendeleev's, compare Mendeleev's early periodic table to the modern periodic table
- **Metals & Non-Metals**: identify typical properties of metals and non-metals, classify substances as metals/non-metals based on their properties and location on the periodic table
- **Group 1**: identify group 1 metals, describe their properties, describe trends in properties, describe their reactions with water (qualitatively and using word/ symbol equations)
- **Transition metals**: identify transition metals on the periodic table, describe properties of transition metals, compare properties with group 1
- **Reactivity series**: define the reactivity series, predict reactions of metals using the reactivity series
- **Group 7**: identify group 7 elements, describe their properties, describe trends in properties, describe their reactions with group 1 elements (qualitatively and using word/ symbol equations)
- **Group 0**: identify group 0 elements, describe properties of group 0 elements, compare group 0 elements to group 7

Types of Chemical Reaction

- **pH**: define acids and alkalis, describe properties of acids and alkalis, describe how to measure acidity using the pH scale, describe how indicators are used to measure pH
- **Curriculum careers link: Trading Standards Officer** - investigating the pH of common household products.
- **Neutralisation**: define neutralisation, describe neutralisation reactions in relation to changes in pH, write word and balanced symbol equations for neutralisation reactions
- **Reactions of metals**: describe the reactions of metals with acid, water, and carbonates; write word and balanced symbol equations for these reactions
- **Combustion**: define combustion, identify the reactants and products of combustion reactions, write word and balanced symbol equations for combustion reactions
- **Oxidation**: define oxidation, write word and balanced symbol equations for oxidation reactions
- **Metal & non-metal oxides**: identify metal and non-metal oxides, describe properties of metal and non-metal oxides in relation to pH
- **Thermal decomposition**: define thermal decomposition, write word and balanced symbol equations for thermal decomposition reactions
- **Reactivity & Reactivity Series** – Describe reactivity and how elements can be ordered by their relative reactivity.
- **Metal displacement reactions**: define displacement, describe (qualitatively and using word/symbol equations) metal displacement reactions, explain why displacement reactions occur, predict the outcome of a reaction using the reactivity series
- **Halogen displacement**: describe (qualitatively and using word/symbol equations) halogen displacement reactions, predict the outcome of a reaction

Chemical Energy

- **Exothermic/endothermic**: define exothermic and endothermic, describe uses of exothermic/ endothermic reactions, explain why reactions are exothermic/endothermic with reference to release/absorption of energy
- **Investigating energy changes:** describe how to investigate the energy change of a reaction using calorimetry, evaluate suitability of a given method for investigating energy change.
- **Curriculum careers link: Product Design** - investigating which combination of reactants is the best to make handwarmers, considering scientific data, safety and ease of use.
- **Collision theory**: describe the role of collision in chemical reactions, define activation energy

- **Rate of reaction**: define rate of reaction, describe factors that affect rate of reaction, explain how these factors affect it, calculate rate of reaction
- **Reaction profile diagrams**: identify elements of reaction profile diagrams, interpret reaction profile diagrams, draw labelled reaction profile diagrams for exothermic/endothermic reactions

Earth Structure

- **Layers of earth**: identify the 4 main layers of the earth, describe the properties of each layer, describe how scientists determined the structure of the earth
- **Rock types**: identify the 3 main rock types, describe properties of each type, compare properties of each type
- **Rock cycle**: define processes in the rock cycle, explain how these process form the different rock types
- **Fossil fuels**: define fossil fuels, identify uses of fossil fuels, describe how fossil fuels are formed
- **Water cycle**: define processes in the water cycle, describe how water molecules move through the hydrosphere, explain why these changes occur
- **Atmosphere**: identify gases in the atmosphere, describe composition of the atmosphere

Earth's Resources

- **Finite resources**: define what a finite resource is, identify examples of finite resources, explain why finite resources must be used carefully
- **Crude oil**: describe what crude oil is, describe uses of crude oil, explain problems associated with use of crude oil
- **Polymers**: define what a polymer is, describe their typical properties, justify the use of a particular polymer with reference to its properties, evaluate the effect of the use of polymers in on the environment and human health
- **Ceramics**: define what a ceramic is, identify properties of ceramics, explain why ceramics are used for a given purpose
- **Composites**: define what a composite is, identify examples of composites, explain why composites are used
- **Metals**: identify uses of metals, explain why metals are used for given purposes with reference to their properties
- **Extracting metals**: define what ores and metal oxides are, describe how metals are extracted (carbon and electrolysis), explain why different metals are extracted using different methods
- **Recycling**: describe the processes used to recycle metals, explain why recycling metals is important
- **Potable water**: define potable water, describe the processes used to obtain potable water, explain how each process works
- **Life cycle assessments (LCAs)**: define what a LCA is, explain why LCAs are used, compare LCAs for different products, evaluate the use of products with reference to their LCA.
- **Curriculum careers link: Architectural Engineering** - consider how LCAs are used to consider environmental impact when selecting appropriate materials for a construction project.

Climate

- **Climate/weather**: define climate and weather, describe the difference between climate and weather
- **Greenhouse gases**: identify greenhouse gases, describe the effect of greenhouse gases on the temperature of the earth
- **Carbon cycle**: identify stores of carbon in the environment, define processes that move carbon between stores, explain how the carbon is transferred using word/symbol equations
- **Human impacts on the carbon cycle**: identify human factors that impact on the carbon cycle, explain how they affect it

- **Climate change**: define climate change, describe the (currently accepted) causes and effects of climate change
- **Evidence for climate change**: describe the evidence for climate change, evaluate the evidence for climate change (e.g. peer review)
- **Preventing climate change**: define carbon footprint, suggest solutions to reduce carbon footprint, explain how interventions can prevent climate change, evaluate the suitability of these interventions
- **Pollution**: define pollution, describe how human activities increase atmospheric pollution levels, explain the impact of increased pollution on the environment and human health
- **Acid rain**: describe how acid rain forms, describe the effects of acid rain on the environment and human health

Curriculum Links to Careers

<u>Elements</u> (Y7)

- Students will learn about the practical uses of chromatography, with reference to the work of forensic scientists, who use chromatography to assist with police investigations. Students will conduct an investigation to find out which of a series of suspects committed a theft, based on a sample of the ink used to write a note left at the crime scene and pens that have been seized from suspects. They will conduct paper chromatography of ink samples taken from the suspect's pens, and the sample obtained from the note at the crime scene, to determine which staff member wrote the secret message.

  Students will evaluate this approach and its usefulness for finding out the perpetrator of a crime – if the chromatogram for suspect A's pen matches the sample from the note, does this prove that suspect A wrote the note and is therefore guilty? If not, why not? How useful would this evidence be as part of a prosecution trial?

<u>Types of reactions</u> (Y8)

- This topic will introduce students to the role of Trading Standards Officers in monitoring the safety and quality of products and the claims made by advertisers. We will discuss product testing of cosmetic and household products, with a focus on pH testing. Students will use their understanding of pH and indicators to determine the pH of hygiene products and evaluate the claims made by manufacturers.

<u>Chemical energy</u> (Y8)

- Students will consider how Product Designers use scientific investigations as part of the design process for popular products. They will investigate the energy changes of different reactions in order to determine which would be best for producing a hand warmer. Students will investigate not only which reaction produces the greatest temperature change, but will discuss the importance of evaluating safety, environmental impact, ease of use and overall design in the work of a product designer.

<u>Earth resources</u> (Y9)

- Students have learnt about life cycle assessments and the importance of carrying out LCAs to limit the impact new products have on the environment. They will consider how an Architectural Engineer chooses materials for a given purpose in a construction project by evaluating their properties and life cycle assessment. Students will conduct their own life cycle assessments for a range of products to determine which would be best for a particular use.

Procedural knowledge

The skills required for science is addressed in the "How science works" section of the curriculum. This is embedded across all three science disciplines and the skills associated with it are returned to at regular intervals with increasing levels of difficulty/understanding.

The skills are broken down into 13 individual sections. Each section is focused upon a minimum of twice within topics each year, with the skills involved being applied additionally in other topics.

- Quality of Data - Pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility.
- Evolving ideas - Understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review.
- Evaluating risks - Evaluate risks in methods
- Hypothesis and Prediction - Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience. Make predictions using scientific knowledge and understanding.
- Variables - Identify independent, dependent and control variables.
- Presenting data - Present observations and data using appropriate methods, including tables and graphs.
- Equipment and Practical work - Use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety.
- Developing a method - Select, plan and carry out the most appropriate types of scientific enquiries to test predictions.
- Measurements - Make and record observations and measurements using a range of methods for different investigations including sampling techniques. Understand and use SI units and chemical nomenclature.
- Evaluation - Evaluate the reliability of methods and suggest possible improvements. Evaluate data, showing awareness of potential sources of random and systematic error identify further questions arising from their results.
- Statistical Analysis - Undertake basic data analysis including simple statistical techniques.
- Patterns and Conclusions - Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions. Present reasoned explanations, including explaining data in relation to predictions and hypotheses.
- Calculations - Use and derive simple equations and carry out appropriate calculation. Apply mathematical concepts and calculate results.

See the How Science Works mapping document for a breakdown of where each section is covered within the science curriculum.

Summative Assessment

Assessments occur at the end of each topic of work and include:

- 10-20% of marks on How Science Works skills
- 10-20% of marks on prior knowledge (this may overlap with the how science works marks)
- Higher papers should include questions covering grade 1- grade 4
- Foundation papers should include questions covering grade P1 – grade 2
- Both papers should scale in difficulty throughout the paper.