Year 7: Curriculum Intent

The intent of the Year 7 curriculum is to build on knowledge acquired in Key Stage 2 and introduce pupils to the different areas of science at the Kingsway school:

- in Biology - Cells and Systems, Plants and the Environment, and Variation and Inheritance.
- in Chemistry - Particles and Matter, Chemical reactions, and Earth and Atmosphere.
- in Physics - Forces and Motion, Energy, and Waves.
- and across all three sciences - how to Work Scientifically.

Pupils will be taught key knowledge and skills in both theory and practical science. They will learn about the scientific method, how to keep safe and how to draw valid conclusions from data.

Year 7 Chemistry Essential Knowledge Summary

Schemata 1: Particles and Matter 1

Composite Knowledge: Pupils will gain fundamental knowledge about particles and matter. They will be able to apply the particle model to explain or describe properties of different states of matter

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- Name the states of matter.
- Give examples of solids, liquids and gases.
- Know the concept of pure substance.
- Name the different changes of state.
- Draw particle arrangements of solids, liquids and gases

Procedural Knowledge:

- Recognise changes of state from particle diagrams and be able to name changes of state from diagrams
- Label a Bunsen burner
- Describe how to turn a Bunsen burner on safely
- Collect data from practical
- Plot a graph
- Draw before and after diagrams of particles to explain observations about changes of state, gas pressure and diffusion.

Upper Hierarchical Knowledge

- Explain properties of different states of matter using the particle model. e.g why can gases be compressed
- Define Brownian motion and diffusion and explain examples of diffusion using the particle model.
- Explain unfamiliar observations about gas pressure in terms of particles.
- Explain the properties of solids, liquids and gases based on the arrangement and movement of their particles.
- Explain changes in states in terms of changes to the energy of particles.

Working Scientifically

Boiling experiment:

- **WSAT 2** identify hazards and risks and suggest appropriate ways to reduce the risks

Modelling the Particle model

- **WSSK 1** develop a line of enquiry based on observations of the real world, and make predictions based on their prior knowledge and scientific understanding

Schemata 2: Particles and Matter 2

Composite Knowledge: Pupils will gain fundamental knowledge about particles and matter. They will be able to apply the particle model to explain or describe properties of different states of matter

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- Know the concept of pure substance.
- Define filtration
- Define Evaporation
- Know what a mixture is
- Define separation
- Identify chromatography from a diagram

Procedural Knowledge:

- Carry out simple separation techniques such as chromatography
- Carry out filtration
- Carry out evaporation

Upper Hierarchical Knowledge

- Explain the process of distillation
- Plan investigations into separation of:
  Sand and water
  Sand, water and salt
- Explain how and why iron is separated from sulfur
- Use evidence from chromatography to identify unknown substances in mixtures.
- Choose the most suitable technique to separate out a mixture of substances.

Working Scientifically

Separating Mixtures (iron filings and sulfur)

- **WSSK 1** develop a line of enquiry based on observations of the real world, and make predictions based on their prior knowledge and scientific understanding

Separating mixtures (chromatography, filtration and evaporation):

- **WSSK 3** select appropriate apparatus and techniques based on accuracy and precision for an investigation within the laboratory

Schemata 3: Chemical Reactions

Composite Knowledge: Pupils will gain a fundamental understanding of the range of chemical reactions, chemical analysis and apply this to predict the products of a reaction.

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- Hazard symbols and their importance
- defining acids and alkalis in terms of neutralisation reactions
- Identifying household acids and alkalis
- the pH scale for measuring acidity/alkalinity; and indicators
- reactions of acids with alkalis to produce a salt plus water
- displacement reactions
- reactions of acids with metals to produce a salt plus hydrogen
- the properties of metals and non-metals
- the order of metals and carbon in the reactivity series

Procedural Knowledge:

- Identify the hazards from a range of substances
- Test and identify a range of household acids and alkalis
- Use indicators and pH meter to identify substances
- Make an indicator (red cabbage)
- Make a salt
- Use patterns of reactivity to make predictions for chemical reactions
- Predict the formulae for products of reactions between acids and metals, or acids and bases
- Describe in detail what happens to particles in a chemical reaction, compare and contrast physical and chemical reactions

Upper Hierarchical Knowledge

- Offer suitable safety precautions when given a hazard
- Use a variety of indicators to measure acidity and alkalinity
- Categorise substances as strong or weak acids and alkalis using pH values
- Explain what salt formation displaces from the acid
- Predict the formulae for products of reactions between acids and metals, or acids and bases
- Describe combustion, thermal decomposition and oxidation, representing them as symbol equations
- Explain the link between the properties and uses of a metal to its position in the reactivity series
- Describe in detail what happens to particles in a chemical reaction, compare and contrast physical and chemical reactions
- Explain the differences in physical and chemical changes and categorise observations in terms of chemical reactions or physical changes

Working Scientifically

Red cabbage indicator:

House acids and alkalis:

		● **WSAN 1** make and record observations and measurements and present data using appropriate methods including tables with repeat measurements Properties of metals ● **WSSK 3** select appropriate apparatus and techniques based on accuracy and precision for an investigation within the laboratory Reactivity of metals with acid: ● **WSSK 2** identify independent, dependent and control variables and use these to plan and carry out a range of investigations to test a prediction, considering repeatability and reproducibility within their plan Making salts **WSSK 3** select appropriate apparatus and techniques based on accuracy and precision for an investigation within the laboratory
<u>Year 7 (Chemistry) Final Composite Knowledge End Point</u>		
● Name the states of matter and changes of state. ● Apply the particle model to explain or describe properties of different states of matter ● Be able to describe examples of the range of chemical reactions. Carry out various types of chemical analysis. ● Apply this to predict the products of a reaction. ● Collect data from practical ● Categorise substances as strong or weak acids and alkalis using pH values ● Predict the formulae for products of reactions between acids and metals, or acids and bases		

Year 8: Curriculum Intent

The intent of the Year 8 curriculum is to build on knowledge acquired in Year 7 and both broaden and deepen pupil knowledge in the different areas of science at the Kingsway school:

- in Biology - Cells and Systems, Plants and the Environment, and Variation and Inheritance.
- in Chemistry - Particles and Matter, Chemical reactions, and Earth and Atmosphere.
- in Physics - Forces and Motion, Energy, and Waves.
- and across all three sciences - how to Work Scientifically.

Pupils will be taught key knowledge and skills in both theory and practical science. They will learn about the scientific method, how to keep safe and how to draw valid conclusions from data.

Year 8 Chemistry Essential Knowledge Summary

Schemata 1: Earth and Atmosphere 1

Composite Knowledge: Pupils will learn how the earth is structured and how the atmosphere evolved. Pupils will link increasing levels of carbon dioxide to the greenhouse effect and climate change

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- the composition of the Earth
- the composition of the atmosphere
- the rock cycle and the formation of igneous, sedimentary and metamorphic rocks
- the carbon cycle
- the production of carbon dioxide by human activity and the impact on climate.
- properties of ceramics, polymers and composites (qualitative)..

Procedural Knowledge:

- Compare the different layers of the Earth in terms of their properties
- Testing the properties of all three types of rock
- Testing the properties of ceramics, polymers and composites
- Investigating crystal formation of igneous rocks

Upper Hierarchical Knowledge

- Describe the composition of the atmosphere in terms of abundance of components.
- Explain the properties of all types of rocks and how they're linked to their formation
- Explain changes in the levels of carbon dioxide using stages of the carbon cycle
- State the impacts of increasing carbon dioxide levels in the atmosphere.
- Explain the properties of ceramics, polymers and composites

Working Scientifically

Igneous rock crystal formation experiment:

- **WSSK 1** develop a line of enquiry based on observations of the real world, and make predictions based on their prior knowledge and scientific understanding

comparing properties of rocks:

- **WSAN 1** make and record observations and measurements and present data using appropriate methods including tables with repeat measurements

Schemata 2: Particles and Matter

Composite Knowledge: Pupils learn the fundamentals of the periodic table and be able to start to use the periodic table to predict element properties

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- Differences between atoms, elements and compounds
- chemical symbols and formulae for elements and compounds
- the varying physical and chemical properties of different elements
- the Periodic Table: periods and groups; metals and non-metals
- how patterns in reactions can be predicted with reference to the Periodic Table
- the principles underpinning the Mendeleev Periodic Table

Procedural Knowledge:

- Demo of alkali metal reactions
- Investigating properties of elements, mixtures and compounds

Upper Hierarchical Knowledge

- explain why certain elements are used for a given role in terms of its properties and compare the properties and uses of different elements.
- Differentiate elements from compounds when given names and properties.
- Use particle diagrams to explain why a compound has different properties to the elements in it
- explain how the position of an element in the periodic table can be used to predict its properties

Working Scientifically

Demo of alkali metals in water:

- **WSAN 3** relate results to predictions and hypotheses, giving reasoned explanations, and identify further questions from their results

metals and non metals:

- **WSSK 1** develop a line of enquiry based on observations of the real world, and make predictions based on their prior knowledge and scientific understanding

History and development of periodic table:

- **WSAT 1** explain how scientific methods and theories have developed, as new evidence and ideas are taken into account by the scientific community (e.g. the development of the periodic table)

Schemata 3: Earth and Atmosphere 2

Composite Knowledge: Pupils will learn how the earth is structured and how the atmosphere evolved. Pupils will link increasing levels of carbon dioxide to the greenhouse effect and climate change

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:.

- properties of ceramics,
- properties of polymers
- Properties of composites (qualitative).
- Recall the 8 planets in the solar system
- Recall objects and entities found in the solar system
- Recall the seasons on earth
- Name the phases of the moon

Procedural Knowledge:

- Testing the properties of ceramics, polymers and composites
- Explaining how we get summer and winter on earth
- Ordering the size of objects in the universe
- Describing night and day

Upper Hierarchical Knowledge

- Explain the properties of ceramics, polymers and composites
- Explaining why we get phases of the moon
- Describe the appearance of planets or moons from diagrams showing their position in relation to the Earth and Sun.
- Explain why places on the Earth experience different daylight hours and amounts of sunlight during the year.
- Describe how space exploration and observations of stars are affected by the scale of the universe.
- Explain the choice of particular units for measuring distance

Working Scientifically

comparing data of planets:

- **WSAN 1** make and record observations and measurements and present data using appropriate methods including tables with repeat measurements

Year 8 (Chemistry) Final Composite Knowledge End Point

- Define Element, compound and mixtures
- Know symbols for common elements on the periodic table
- Know the difference between a period and group
- Link Mendeleev's ideas to the modern periodic table
- Use knowledge of the periodic table to make predictions about different elements.
- Will have knowledge of displacement reactions
- Know the properties of metals and non metals
- Know what combustion and oxidation reactions are
- Know and describe the layered structure of the earth
- Know what sedimentary, igneous and metamorphic rocks are
- Be able to carry out investigations into properties of different rocks.
- Begin to explain how the earth's atmosphere has developed
- Know what the solar system consists of
- Order objects in size in our universe
- Know how we get night and day on the earth
- Know how we get seasons on earth
- Be able to explain why we see phases of the moon

Year 9: Curriculum Intent

The intent of the Year 9 curriculum is to build on knowledge acquired in both Year 7 and Year 8 and prepare pupils for the final steps before undertaking GCSE science. They will increase the depth and breadth of their knowledge and build strong links in learning to consolidate prior learning and secure the foundations for GCS science. Pupils will continue to study the different areas of science:

- in Biology - Variation and Inheritance.
- in Chemistry - Atomic Structure, the Periodic Table and Chemical reactions.
- in Physics - Forces and Motion and Energy.
- and across all three sciences - how to Work Scientifically.

Pupils will be taught key knowledge and skills in both theory and practical science. They will learn about the scientific method, how to keep safe and how to draw valid conclusions from data.

Year 9 Chemistry Essential Knowledge Summary

Schemata 1: Chemical Reactions

Composite Knowledge: Pupils will learn the differences between exothermic and endothermic reactions in terms of energy changes and then bond energy. They will calculate overall energy change and describe a reaction as endothermic or exothermic. Pupils will also describe the factors that affect the rate of reaction

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- Define exothermic reactions
- Define endothermic reactions
- Define rate of reaction
- Name the factors which affect rate

Procedural Knowledge:

- Draw and label reaction profiles graphs for exothermic and endothermic reactions including overall energy change and activation energy
- Know that bond breaking is endothermic
- Know that bond forming is exothermic
- Write sentences to explain how different factors affect rate of reaction
- Complete and analyse required practical on energy changes

Upper Hierarchical Knowledge

- Explain reactions in terms of bond breaking and bond forming
- Use bond energies to calculate overall energy change
- Draw rate graphs from given data
- Calculate rate from data
- Use collision theory to explain why factors affect rate of reaction

Working Scientifically

- **WSSK 1** develop a line of enquiry based on observations of the real world, and make predictions based on their prior knowledge and scientific understanding
- **WSAN 2** use basic data analysis to calculate means, plot graphs with line of best fit and use this data to draw conclusions

Schemata 2: C1 Atomic Structure & Periodic Table

Composite Knowledge: Pupils will learn fundamentals of atomic structure including the structure of an atom and where subatomic particles are found and how electrons are arranged on shells. Pupils will be able to define materials as elements, compound, mixtures and will be able to describe separation techniques

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- The names and properties of subatomic particle and working out numbers of subatomic particles
- Electron structure and how shells are filled up
- Separation methods and techniques
- Know what a group is.
- Know what a period is.
- Know the separation between metals and nonmetals on the periodic table

Procedural Knowledge:

- Draw diagrams with correctly labelled parts of atom
- Draw diagrams with correctly filled shells for atoms and ions
- Write clear descriptions of how mixtures are separated
- Describe the properties of groups of elements, group 1, 7 and 0
- Demo of alkali metals in water and descriptions of reactions

Upper Hierarchical Knowledge

- Explain why elements are grouped
- Explain why we have isotopes
- Calculate RAM from isotopic abundance
- Explain the properties of group 1 and 7 by linking to electronic structure.
- Explain evolution of atomic models and periodic table

Working Scientifically

Alkali Metals demo

- **WSAN 1** make and record observations and measurements and present data using appropriate methods including tables with repeat measurements

Year 9 (chemistry) Final Composite Knowledge End Point

- Be able to label a diagram of the atom
- Be able to work out the number of protons, neutrons and electrons in a given atom
- Know how to draw and work out the electron structure for the first 20 elements
- Know the properties and reactivity of group 1 and 7 elements.
- Evaluate atomic models
- Evaluate periodic tables suggested in history
- Define exothermic and endothermic reactions
- Draw and label reaction profiles graphs for exothermic and endothermic reactions including overall energy change and activation energy
- Know that bond breaking is endothermic
- Know that bond forming is exothermic
- Define rate of reaction
- Name the factors which affect rate

Year 10: Curriculum Intent

The intent of the Year 10 curriculum is to build on knowledge acquired in Key Stage 3 and prepare pupils for their GCSEs in science. They will continue to increase the depth and breadth of their knowledge and build strong links in learning to consolidate prior learning and secure the knowledge and skills required to excel in GCSE Science.. Pupils will continue to study the different areas of science:

- in Biology - Organisation, Infection & Response and Ecology..
- in Chemistry - Chemical Bonding & Structures, Quantitative Chemistry, Chemical Change and The Rate and extent of Chemical Change.
- in Physics - Particle Model of Matter, Atomic Structure & Radioactivity, Electricity and Forces.
- and across all three sciences - how to Work Scientifically.

Pupils will be taught key knowledge and skills in both theory and practical science. They will learn about the scientific method, how to keep safe and how to draw valid conclusions from data.

Year 10 Chemistry Essential Knowledge Summary

Schemata 1: C2 Bonding, Structure and Properties of matter

Composite Knowledge:
Students will gain a fundamental understanding of the range of different types of chemical bonding and how structure links to properties. Students will build on from knowledge of atomic structure to explain why bonding takes place between atoms.

Component Knowledge:
Foundational Knowledge:
Declarative Knowledge:

- State there are three types of strong chemical bonds:
- Define Ionic bonding
- Define Covalent bonding
- Define Metallic bonding
- Recognise for ionic bonding the particles are oppositely charged ions.
- Recognise for covalent bonding the particles are atoms which share pairs of electrons.
- Recognise in metallic bonding the particles are atoms which share delocalised electrons.
- State that bIonic bonding occurs in compounds formed from metals combined with non-metals.
- State that Covalent bonding occurs in non-metallic elements and in compounds of non-metals.
- State that Metallic bonding occurs in metallic elements and alloys
- Identify chemical bonding in terms of electrostatic forces and the transfer or sharing of electrons.
- Identify when a metal atom reacts with a non-metal atom, electrons in the outer shell of the metal atom are transferred.
- state metal atoms lose electrons to become positively charged ions.
- State Non-metal atoms gain electrons to become negatively charged ions
- Recall the ions produced by metals in Groups 1 and 2
- Recall the ions produced by Groups 6 and 7.
- Draw dot and cross diagrams for ionic compounds formed by metals in Groups 1 and 2 with non-metals in Groups 6 and 7
- State how electrons transfer during the

Schemata 2: C3 Quantitative Chemistry

Composite Knowledge: Students will gain a fundamental understanding of quantitative chemistry and how chemists work with amounts of substances. They will use a variety of different chemical equations to complete a variety of 'amount of substance' questions.
Component Knowledge:
Foundational Knowledge:
Declarative Knowledge:

- Explain the meaning of the law of conservation.
- Write simple word equations.
- Write simple symbol equations.
- Balance symbol equations.
- Describe the equations given in terms of number of moles, reactants and products
- .Review the definition of relative atomic mass.
- Recall how to find the relative atomic mass from the Periodic Table.
- Define the relative molecular mass.
- Be able to calculate the relative formula mass (M_r) of a compound from its formula, given the relative atomic masses
- Explain any observed changes in mass in non-enclosed systems during a chemical reaction.
- Use the balanced symbol equation for a reaction to recognise changes in terms of the particle model
- use measurements of mass before and after an experiment to explain what has happened to the mass during the experiment and why it has happened.
- Know that whenever a measurement is made there is always some uncertainty about the result obtained.
- Represent the distribution of results and make estimations of uncertainty.
- Use the range of a set of measurements about the mean as a measure of uncertainty
- Understand that the measurement of amounts in moles can apply to atoms, molecules, ions, electrons, formulae and equations.
- Know for example that in one mole of carbon (C) the number of atoms is the same as the number of molecules in one mole of carbon dioxide (CO_2).
- Understand that the number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant. The value of the Avogadro constant is 6.02×10^{23} per mole.
- Define one mole in terms of M_r and A_r
- Calculate the number of moles in a substance using the relative formula mass.

Schemata 3: C4 Chemical Changes

Composite Knowledge: Students will gain a fundamental understanding of the range of different types of chemical changes involving metals and non metals. They will use reactivity of metals to explain and develop different ideas including extraction of metals and electrolysis.
Component Knowledge:
Foundational Knowledge:
Declarative Knowledge:

- Explain reduction and oxidation in terms of loss or gain of oxygen
- Define the following terms:
  oxidation
  reduction.
- Write word and balanced symbol equations for the reactions of metals with oxygen to produce metal oxides.
- identify where reduction and oxidation has taken place.
- Recall and describe the reactions, if any, of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water or dilute acids, where appropriate, to place these metals in order of reactivity.
- State why metals such as gold are found in the Earth as the metal itself but most metals are found as compounds that require chemical reactions to extract the metal.
- know why Metals less reactive than carbon can be extracted from their oxides by reduction with carbon.
- Know Reduction involves the loss of oxygen
- Identify the substances which are oxidised or reduced in terms of gain or loss of oxygen
- Know that Oxidation is the loss of electrons and reduction is the gain of electrons.
- Know that acids react with some metals to produce salts and hydrogen.
- Define the term neutralisation.
- Know that acids are neutralised by alkalis.
- Know that acids and bases (metal oxides) produce salts and water
- Know that metal carbonates and acid produce salts, water and carbon dioxide.
- Know that metals reacting with acid produce hydrogen and salts
- Know that the salt produced in any reaction between an acid and a base or alkali depends on:the acid used
- Know that hydrochloric acid produces chlorides
- Know that Nitric acid produces nitrates
- Know that sulfuric acid produces sulfates
- Define the terms:
  soluble
  insoluble.
- Explain what is meant by a soluble salt.
- Explain why reactants are often used in excess.
- Know that salt solutions can be crystallised to produce solid salts.
- Define the following terms:
  acid
  base

Schemata 4: The Rate and extent of Chemical Change

Composite Knowledge: Students will gain a fundamental understanding of how external conditions and factors can affect both rate of reaction and position of equilibrium. Students will analyse graphs to show how rates proceed and will evaluate conditions to maximise rate and equilibrium.

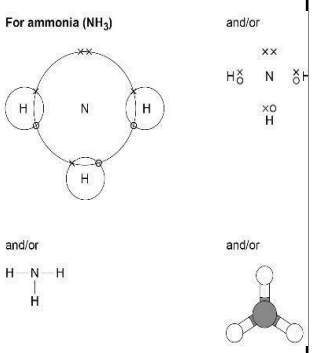
Component Knowledge:
Foundational Knowledge:
Declarative Knowledge:

- Calculate the mean rate of a reaction from given information about the quantity of a reactant used or the quantity of a product formed and the time taken.
- Draw and interpret graphs showing the quantity of product formed or quantity of reactant used up against time.
- Use graphical data to explain each part of the graph ie:
  initially rate is fast
  slows down
  reaction completes.
- Explain what is meant by the units:
  g/s
  cm^3/s
  mol/s.
- Know the Factors which affect the rates of chemical reactions including

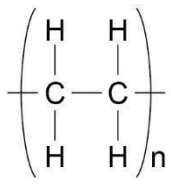
The concentrations of reactants in solution
The pressure of reacting gases,
The surface area of solid reactants
The temperature of reactants
The presence of a catalyst.

- recall how changing these factors affects the rate of chemical reactions.
- Predict and explain using collision theory the effects of changing conditions of concentration, pressure and temperature on the rate of a reaction.
- Predict and explain the effects of changes in the size of pieces of a reacting solid in terms of surface area to volume ratio.
- Use simple ideas about proportionality when using collision theory to explain the effect of a factor on the rate of a reaction.
- Know what Collision theory is
- Know how According to collision theory, chemical reactions can occur.
- Recognise when reacting particles collide with each other and with sufficient energy a reaction is possible.
- Know that the minimum amount of energy that particles must have to react is called the activation energy.
- Recognise that increasing the concentration of reactants in solution, the pressure of reacting gases, and the surface area of solid reactants increases the frequency of collisions and so increases the rate of reaction.
- Know that increasing the temperature increases the frequency of collisions and makes the collisions more energetic, and so increases the rate of reaction.
- identify catalysts in reactions from their effect on the rate of reaction and because they are not included in the chemical equation for the reaction.
- Explain catalytic action in terms of activation energy.
- Define the term activation energy.
- Identify advantages of using catalysts in industrial reactions eg reducing costs.
- Know that enzymes act as catalysts in biological systems.

formation of an ionic compound.
- State how ionic compounds are held together by strong electrostatic forces of attraction between oppositely charged ions.
- Know that forces act in all directions
- Know that an ionic compound is a giant structure in the lattice.
- Know when atoms share pairs of electrons, they form covalent bonds.
- State these bonds between atoms are strong.
- Know that covalently bonded substances may consist of small molecules.
- Know that some covalently bonded substances have very large molecules, such as polymers.
- Know that some covalently bonded substances have giant covalent structures,
- State that diamond, graphite and silicon dioxide are giant structures
- Know that the covalent bonds in molecules and giant structures can be represented in the following forms:



- Know that Polymers can be represented in the form:



poly(ethene)

- State that n is a large number.

- Recognise substances as small molecules, polymers or giant structures from diagrams showing their bonding.
- recognise common substances that consist of small molecules from their chemical formula.
- Draw dot and cross diagrams for the molecules of hydrogen, chlorine, oxygen, nitrogen, hydrogen chloride, water, ammonia and methane
- Represent the covalent bonds in small molecules, in the repeating units of polymers and in part of giant covalent structures, using a line to represent a single bond
- State that metals consist of giant structures of atoms arranged in a regular pattern.

- Define the term limiting reactant.
- Link the limiting reactant to the number of moles.
- Link the limiting reactant to the masses in grams.
- Calculate the mass of solute in a given volume of solution of known concentration in terms of mass per given volume of solution.
- convert cm^3 into dm^3.
- Use the equation
  $C = m / v$
  to calculate the concentration of a solution.

- Calculate the percentage yield of a product from the actual yield of a reaction.
- Describe how atoms are lost or gained in a chemical reaction.
- Explain why atoms can be lost or gained in a chemical reaction.
- Calculate the theoretical yield for simple examples
- Calculate the atom economy for simple examples.
- Explain the meaning of concentration and the unit mol per dm^3.
- Be able to convert cm^3 into dm^3.
- Use the equation
  $C = n / v$
  to calculate the concentration of a solution.
-
- Including reasons for using a burette instead of other measuring equipment.
- Recall the equation:
  $$number\ of\ moles = \frac{mass}{relative\ formula\ mass}$$
- Use the equation:
  volume of gas at rtp = number of moles x molar gas volume (24 dm^3)
  for simple examples.
- Calculate the volume of a gas at room temperature and pressure from its mass and relative formula mass
- Calculate volumes of gaseous reactants and products from a balanced equation and a given volume of a gaseous reactant or product.
-

Procedural Knowledge:

- Use the relative formula mass of a substance to calculate the number of moles in a given mass of that substance and vice versa.
- Calculate the masses of substances shown in a balanced symbol equation.
- Calculate the masses of reactants and products from the balanced symbol equation and the mass of a given reactant or product
- Rearrange the equation
  $C = m / v$
  to make number of moles the subject.
- Know the method on how to carry out a titration.
- Use the masses of substances present in a reaction to write a balanced equation.
- Explain how the mass of a solute and the volume of a solution is related to the concentration of the solution.
- Explain the meaning of concentration and the unit grams per dm^3

alkali
neutral.

- Recall the pH numbers for the following solutions:
  acidic
  alkaline
  neutral.

- Describe the use of universal indicator or a wide range indicator to measure the approximate pH of a solution.
- Use the pH scale to identify acidic or alkaline solutions.
- State that Acids produce hydrogen ions (H^+) in aqueous solutions.
- State aqueous solutions of alkalis contain hydroxide ions (OH^-).
- Know that In neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water.

- Know this reaction can be represented by the equation:

$H^+ (aq) + OH^- (aq) \rightarrow H_2O (l)$

- Use and explain the terms dilute and concentrated (in terms of amount of substance), and
- Use the terms weak and strong (in terms of the degree of ionisation) in relation to acids.
- Explain the meaning of the following terms:
  dilute
  concentrated
  weak
  strong.
- Recall examples of strong and weak acids.
- Describe neutrality in terms on hydrogen ion concentration.
- Describe relative acidity in terms of hydrogen ion concentration.
- Define the term electrolyte.
- Describe how an electric current can pass through an ionic compound.
- Know why solid ionic compounds cannot conduct electricity.
- Know why ionic compounds can conduct electricity when melted or dissolved in water.
- Predict the products of the electrolysis of binary ionic compounds in the molten state
- Recall the reactivity series.
- Give reasons why some metals have to be extracted by electrolysis.
- Know Aluminium is manufactured by the electrolysis of a molten mixture of aluminium oxide and cryolite
- Know that carbon is used for positive electrode (anode).
- Know how aluminium is extracted from its ore.
- Write balanced half equations for the reactions that occur at both electrodes for aluminium extraction
- State why a mixture is used as the electrolyte.
- State why the positive electrode must be continually replaced.
- Define the term aqueous.

- Know how an aqueous solution is electrolysed.

- Predict the products of the electrolysis of aqueous solutions containing a single ionic compound
- Know that at the negative electrode (cathode), hydrogen is produced if the metal is more reactive than hydrogen
- Know that at the positive electrode (anode), oxygen is produced unless the solution contains halide ions when the halogen is produced.
- Know that in the aqueous solution water molecules break down.
- Know that hydrogen ions and hydroxide ions are discharged from this breakdown
- Know that the cathode is the negative electrode

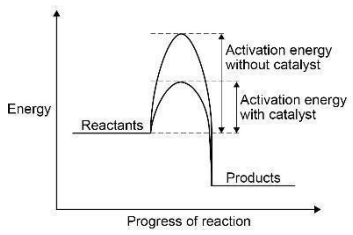
- Know that catalysts increase the rate of reaction by providing a different pathway for the reaction that has lower activation energy.
- Know that In some chemical reactions, the products of the reaction can react to produce the original reactants.
- Know that reversible reactions are represented in the following way:

$$A + B \rightleftharpoons C + D$$

- Know that the direction of reversible reactions can be changed by changing the reaction conditions.
- Know this type of arrow represents reversible reactions $\rightleftharpoons$
- Recall definition of:
  exothermic
  endothermic.
- Know that If a reversible reaction is exothermic in one direction, it is endothermic in the opposite direction.
-

Procedural Knowledge:

- Draw tangents to the curves on graphs and use the slope of the tangent as a measure of the rate of reaction.
- Calculate the gradient of a tangent to the curve on these graphs as a measure of rate of reaction at a specific time.
- Explain the effect on the rate of reaction of the following factors:
  concentration
  pressure
  surface area
  temperature
  catalyst.
- A reaction profile for a catalysed reaction can be drawn in the following form:



- Explain what is meant by a reversible reaction.

- Explain the difference between:

$\rightleftharpoons$ reactions and □ reactions.

- Explain the term equilibrium
- Know how equilibrium is reached when the forward and reverse reactions occur at exactly the same rate
- Describe the effects of temperature on a reversible reaction
- Be able to interpret appropriate given data to predict the effect of a change in concentration of a reactant or product on given reactions at equilibrium.
- Use data to predict the effect of concentration on equilibrium.
- Interpret appropriate given data to predict the effect of a change in temperature on given reactions at equilibrium.
- Use data to predict the effect of temperature on equilibrium
- interpret appropriate given data to predict the effect of pressure changes on given reactions at equilibrium.
- Use data to predict the effect of pressure on equilibrium

Upper Hierarchical Knowledge

- Use graphs of data obtained from concentration reactions to explain what occurs as the reaction proceeds
- Be able to make qualitative predictions about the effect of changes on systems at equilibrium when given appropriate information
- Describe Le Chatelier's principle.
- Explain the effects on equilibrium of changing conditions using suitable examples.
- Explain how the effects of changing conditions on a system at equilibrium can be predicted using Le Chatelier's Principle.
- Explain if the temperature of a system at equilibrium is increased:

- know that the electrons in the outer shell of metal atoms are delocalised and so are free to move through the whole structure.
- Know that the sharing of delocalised electrons gives rise to strong metallic bonds.
- State the three states of matter are solid, liquid and gas.
- Know that Melting and freezing take place at the melting point, boiling
- Know that condensing takes place at the boiling point.
- State that the three states of matter can be represented by a simple model.
- Know in this model, particles are represented by small solid spheres.
- Know that Particle theory can help to explain melting, boiling, freezing and condensing.
- Know that the amount of energy needed to change state from solid to liquid and from liquid to gas depends on the strength of the forces between the particles of the substance.
- Know that the stronger the forces between the particles, the higher the melting point and boiling point of the substance.
- State in chemical equations, the three states of matter are shown as (s) solid
- know that Liquid (l) and (g) gas are state symbols
- Know that Aqueous solutions have the symbol (aq) .
- Know that Ionic compounds have regular structures (giant ionic lattices) in which there are strong electrostatic forces of attraction in all directions between oppositely charged ions.
- State that compounds have high melting points and high boiling points
- Know that Large amounts of energy are needed to break the many strong bonds.
- Know that when melted or dissolved in water, ionic compounds conduct electricity.
- Recognise that ions are free to move and so charge can flow.
- Know that substances that consist of small molecules are usually gases or liquids.
- Recognise that small molecules have low melting points and boiling points.
- Know that these substances have only weak forces between the molecules (intermolecular forces).
- Recognise that intermolecular forces are overcome, not the covalent bonds, when the substance melts or boils.
- Know that intermolecular forces

- Explain how the concentration of a solution in mol/dm^3 is related to the mass of the solute and the volume of the solution.
- Rearrange the equation:
  $C = m / v$
  to make mass the subject.
- explain why indicators eg methyl orange and phenolphthalein are used instead of Universal indicator.
- Change the subject of a mathematical equation.

Upper Hierarchical Knowledge

- Balance complex equations and add state symbols.
- Balance chemical equations and use these to calculate the masses of substances present.
- Be able to balance an equation given the masses of reactants and products.
- Change the subject of a mathematical equation.
- Explain the effect of a limiting quantity of a reactant on the amount of products it is possible to obtain in terms of amounts in moles or masses in grams.
- Calculate the theoretical amount of a product from a given amount of reactant and the balanced equation for the reaction.
- Calculate the atom economy of a reaction to form a desired product from the balanced equation.
- Explain why a particular reaction pathway is chosen to produce a specified product given appropriate data such as atom economy (if not calculated), yield, rate, equilibrium position and usefulness of by-products.
- Use balanced equations and known volume of reactant/product to calculate the volumes of gaseous reactants/ products.

Working Scientifically

Teacher Demo

- Model the law of conservation using molecular model kits. Lego or Duplo bricks can be used to good effect.

- Teacher demonstration.
  The precipitation reaction:

$$lead\ nitrate\ +\ potassium\ iodide$$

- Model compounds with different sized and coloured lego bricks pre-marked with symbol and A_r of different elements. Sum the A_rs marked on the bricks to obtain the M_r
- 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.
- 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.
- Demonstrate combustion of paper in a large beaker to show mass may decrease because products are released to the air as gases.
- Try balancing iron wool on a pair of scales (a makeshift one can be set up using a carefully

- Know that positively charged ions gain electrons at the cathode.
- Know that reduction takes place at the cathode
- Know the anode is the positive electrode
- Know that negatively charged ions lose electrons at the anode.
- Know that oxidation takes place at the anode
- Know that oxidation is loss of electrons
- Know that reduction is gain of electrons.

Procedural Knowledge:

- Draw the atomic structure of metals and the ion formed. Use these to describe how the ion has been formed.
- Make links between the ability to form ions and the reactivity with water and acid.
- Explain the trends in reactivity of Group 1 in terms of atomic structure.
- Describe what occurs in a displacement reaction, using suitable examples.
- Deduce an order of reactivity of metals based on experimental results.
- Write ionic equations for displacement reactions.
- Identify in a given reaction, symbol equation or half equation which species are oxidised and which are reduced.
- Explain in terms of gain or loss of electrons, that these are redox reactions.
- Identify which species are oxidised and which are reduced in given chemical equations.
- Predict products from given reactants.
- Use the formulae of common ions to deduce the formulae of salts.
- Describe how to make pure, dry samples of named soluble salts from information provided.
- Describe how to carry out titrations using strong acids and strong alkalis only (sulfuric, hydrochloric and nitric acids only) to find the reacting volumes accurately.
- Calculate the chemical quantities in titrations involving concentrations in mol/dm^3 and in g/dm^3.
- Explain why strong acids are completely ionised in aqueous solutions but a weak acid is only partially ionised.
- Explain what happens to positive and negative ions during electrolysis and how elements form from their ions.
- Explain why the following atoms could be produced:
  hydrogen
  oxygen.

- Reactions at electrodes can be represented by half equations, for example:

$2H^+ + 2e^- \rightarrow H_2$
and
$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$
or
$4OH^- - 4e^- \rightarrow O_2 + 2H_2O$

Upper Hierarchical Knowledge

- Explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion.
- Explain why displacement occurs.
- Describe how carbon is used to reduce metal oxides. Explain how this takes place in terms of movement of electrons.
- Identify which products have been oxidised in extraction examples. Explain how this takes place in terms of movement of electrons

the relative amount of products at equilibrium increases for an endothermic reaction
the relative amount of products at equilibrium decreases for an exothermic reaction.

- If the temperature of a system at equilibrium is decreased:

  the relative amount of products at equilibrium decreases for an endothermic reaction
  the relative amount of products at equilibrium increases for an exothermic reaction.
- For gaseous reactions at equilibrium:

  Explain how an increase in pressure causes the equilibrium position to shift towards the side with the smaller number of molecules
  Explain how a decrease in pressure causes the equilibrium position to shift towards the side with the larger number of molecules.

Working Scientifically

- React $CaCO_3$ with dilute HCl and measure the volume of CO_2 evolved against time.
- **Required practical 5:**
  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 or turbidity.

- Investigate changing temperature and surface area of reactants and use of catalysts.
- Investigate the catalytic effect of adding different metal salts to a reaction such as the decomposition of hydrogen peroxide.
- Practical: hydrate or dehydrate copper sulfate.
- Heat ammonium chloride in a test tube. Use mineral wool to support a piece of damp pH paper half way up the tube and observe the colour change.
- Investigate the temperature changes for:

$$hydrated\ copper\ sulfate\ (\text{Blue})$$
$$\rightleftharpoons$$
$$anhydrous\ copper\ sulfate\ (White) + water$$

increase with the size of the molecules, ● Identify larger molecules as having higher melting and boiling points. ● Know that these substances do not conduct electricity because the molecules do not have an overall electric charge. ● Identify polymers as very large molecules. ● know that atoms in the polymer molecules are linked to other atoms by strong covalent bonds. ● Know that the intermolecular forces between polymer molecules are relatively strong and so these substances are solids at room temperature. ● Know that substances that consist of giant covalent structures are solids with very high melting points. ● Know that all of the atoms in these structures are linked to other atoms by strong covalent bonds. ● Recognise that these bonds must be overcome to melt or boil these substances. ● Identify that Diamond and graphite (forms of carbon) and silicon dioxide (silica) are examples of giant covalent structures. ● Know that metals have giant structures of atoms. with strong metallic bonding. ● Identify that most metals have high melting and boiling points. ● Know that in pure metals, atoms are arranged in layers. ● Know that metals can be bent and shaped. ● Know that Pure metals are too soft for many uses and so are mixed with other metals to make alloys which are harder. ● State that Metals are good conductors of electricity ● Know that the delocalised electrons in the metal carry electrical charge through the metal. ● State that metals are good conductors of thermal energy because energy is transferred by the delocalised electrons. ● Know that in diamond, each carbon atom forms four covalent bonds with other carbon atoms. ● Know that diamond exists in a giant covalent structure. ● State that diamond is very hard ● State that diamond has a very high melting point. ● State that diamond does not conduct electricity. ● Know that in graphite, each carbon atom forms three covalent bonds with three other carbon atoms, ● Recognize that graphite forms layers of	balanced metre rule). Heat the iron wool strongly to observe the increase in mass of the oxide. • Class thiosulfate 'disappearing cross' experiment at a single fixed concentration using (a) pre-printed computer generated crosses (b) hand drawn crosses using different pens/pencils ● Measure out and compare 1 mole of elements like iron, sulfur, magnesium, copper, aluminium and so on. ● Use a small strip of magnesium ribbon in 20 ml HCl acid. Identify which reactant is the limiting reactant and state the reason for this choice. ● Measure out and compare one mole of common compounds, water, sodium chloride, calcium carbonate and so on. ● To demonstrate the idea of concentration students could make different concentrations of tea, coffee or a dark squash like blackcurrant. ● ● Identify a chemical reaction that has a high atom economy and research the positives to industry of producing a high yield of useful product. ● Identify a chemical reaction that has a low atom economy and research the negatives to industry of producing a low yield of useful product and ways the reactions has been improved to increase the yield of useful product **RP Titration** ● Titrate HCl with NaOH using an indicator of methyl orange. Use the titre results and know volumes of NaOH and concentration, to calculate the concentration of the HCl.	● Write balanced symbol equations/half equations for the displacement of metal oxides. Use these to identify which species has been oxidised or reduced. Give reasons for your answers. ● Write the symbol equation for the neutralisation of an acid and an alkali. ● Describe neutrality and relative acidity in terms of the effect on hydrogen ion concentration and the numerical value of pH ● Write half equations for the reactions occurring at the electrodes during electrolysis. ● Balance supplied half equations. ● Explain thoroughly what happens at the following electrodes using suitable examples and half equations: cathode anode **<u>Working Scientifically</u>** ● Demo, and where appropriate practically investigate, the reactivity of some of the metals with water and acid. ● Carry out displacement reactions ● Reduce iron oxide using carbon: ● Research different methods for extraction metals from their oxides. ● Investigate the reactions of the following metals with sulfuric acid: magnesium zinc iron. ● Investigate the following reactions: acids + soluble metal hydroxide acid + insoluble metal hydroxide acids + metal carbonates. **Required practical 1:** ● Preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution. ● Measure the pH of a variety of the following solutions: acidic alkaline neutral. ● Practical: measure the pH change when a strong acid neutralises a strong alkali. **Required practical 2:** ● Determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration. Determination of the concentration of one of the solutions in mol/dm^3 and g/dm^3 from the reacting volumes and the known concentration of the other solution. ● Use universal indicator or a pH probe to measure the pH of hydrochloric acid, ethanoic acid, sodium hydroxide and ammonium hydroxide ● Measure the pH of different acids at different concentrations. ● Compare the rate of reaction when magnesium is dipped in hydrochloric acid and ethanoic acid of the same concentration. ● Carry out the electrolysis of solutions ● Demo the electrolysis of lead bromide. A safer alternative for practical work is anhydrous zinc chloride. **Required practical 3:** ● Investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis	

hexagonal rings which have no covalent bonds between the layers. ● Know that in graphite, one electron from each carbon atom is delocalised. ● Identify that graphene is a single layer of graphite ● Know that Graphene has properties that make it useful in electronics and composites. ● Know that fullerenes are molecules of carbon atoms with hollow shapes. ● Recognise that the structure of fullerenes is based on hexagonal rings or tubes of carbon atoms ● State that the first fullerene to be discovered was Buckminsterfullerene (C_{60}) which has a spherical shape. ● Know that carbon nanotubes are cylindrical fullerenes ● Recognise the properties that nanotubes useful for nanotechnology, electronics and materials. **<u>Chemistry ONLY</u>** ● State that nanoscience refers to structures that are 1–100 nm in size ● State that Nanoparticles are smaller than fine particles ($PM_{2.5}$), which have diameters between 100 and 2500 nm ● Identify Coarse particles (PM_{10}) as having diameters between 1 x 10^{-5} m and 2.5 x 10^{-6} m. ● State that coarse particles are often referred to as dust. ● ● Know that nanoparticles may have properties different from those for the same materials in bulk. ● Identifying this is because of their high surface area to volume ratio. ● State that smaller quantities of nanoparticles are needed to be effective than for materials with normal particle sizes. ● Know that nanoparticles have many applications in medicine, in electronics, in cosmetics and sun creams, as deodorants, and as catalysts. ● Recognise that new applications for nanoparticulate materials are an important area of research. **Procedural Knowledge:** ● Work out the charge on the ions of metals and non-metals from the group number of the element ● Limited to the metals in Groups 1 and 2, and non-metals in Groups 6 and 7. ● Deduce that a compound is ionic from a diagram of its structure in one of the specified forms			

● Describe the limitations of using dot and cross, ball and stick, two and three dimensional diagrams to represent molecules or giant structures ● Explain intermolecular forces are weak compared with covalent bonds to explain the bulk properties of molecular substances. ● Recognise graphene and fullerenes from diagrams and descriptions of their bonding and structure. ● Explain the properties of graphite in terms of its structure and bonding. ● Know that graphite is similar to metals in that it has delocalised electrons. ● Explain the properties of diamond in terms of its structure and bonding. ● Know that the side of the cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of 10. **<u>Upper Hierarchical Knowledge</u>** ● Be able to translate data between diagrammatic and numeric forms. ● Describe the limitations of using dot and cross, ball and stick, two and three dimensional diagrams to represent a giant ionic structure ● State and describe limitations of the particle model ● Work out the empirical formula of an ionic compound from a given model or diagram that shows the ions in the structure. ● Deduce the molecular formula of a substance from a given model or diagram. ● Explain why alloys are harder than pure metals in terms of distortion of the layers of atoms in the structure of a pure metal. ● Compare 'nano' dimensions to typical dimensions of atoms and molecules. ● Evaluate the use of nanoparticles for a specified purpose. ● **<u>Working Scientifically</u>** ● Demo the formation of sodium chloride in a fume cupboard. ● Use magnesium ribbon to produce magnesium oxide. Draw the dot and cross diagram for this reaction. ● Model the sodium chloride lattice using molecular model kits. ● Demo the formation of hydrogen chloride. Draw the dot and cross diagram for this reaction. ● Model simple covalent substance using molecular model kits. ● Demo giant covalent structures using molecular model kits. ● Use copper wire and silver nitrate solution to grow silver crystals. ● Practically test the conductivity of ionic compounds, eg sodium			

chloride and potassium chloride. ● Practically test the conductivity of simple covalent substances using ethanol and solid wax pieces. ● Model the structure of diamond using model kits ● Model the structure of graphite using model kits.			

Year 10 (Chemistry) Final Composite Knowledge End Point

Schemata 1 – Structure and Bonding

Students will learn about different types of bonding

- **Ionic Bonding:**
  - Transfer of electrons between metals and non-metals.
  - Formation of ions and ionic compounds.
  - Properties of ionic compounds: high melting points, conductivity when molten or dissolved.
- **Covalent Bonding:**
  - Sharing of electrons between non-metals.
  - Formation of molecules.
  - Properties of simple molecular substances: low melting and boiling points, poor conductivity.
- **Metallic Bonding:**
  - Sea of delocalized electrons.
  - Properties of metals: conductivity, malleability, ductility.

Students will learn about structure and properties

- **Giant Ionic Structures:**
  - Lattice structure of ionic compounds.
  - High melting and boiling points.
- **Simple Molecular Structures:**
  - Weak intermolecular forces.
  - Low melting and boiling points.
- **Giant Covalent Structures:**
  - Diamond, graphite, and silicon dioxide.
  - High melting points and unique properties (e.g., hardness of diamond, conductivity of graphite).
- **Metallic Structures:**
  - Layers of atoms and delocalized electrons.
  - Explanation of metal properties in terms of structure and bonding.

Students will about states of matter

- **Particle Model:**
  - Solid, liquid, gas: particle arrangement and movement.
  - Changes of state and energy transfer: melting, boiling, condensation, freezing.

Students will learn about Nanoscience

- **Nanoparticles:**
  - Definition and scale of nanoparticles.
  - Unique properties and applications.
  - Potential risks and benefits of nanotechnology.

Schemata 2 – Quantitative Chemistry

Students will learn about Atomic and Molecular Mass

- **Relative Atomic Mass (Ar):**
  - Definition and calculation based on isotopic abundance.
- **Relative Formula Mass (Mr):**
  - Calculation for compounds using relative atomic masses of constituent elements.

Students will learn about The Mole and Avogadro's Constant

- **The Mole:**
  - Definition of the mole as a unit of amount of substance.
  - Avogadro’s constant: 6.022×10236.022 \times 10^{23}6.022×1023 particles per mole.
  - Use of the mole in converting between mass, particles, and moles.
- **Molar Mass:**
  - Definition and calculation from relative atomic and formula masses.
  - Use in converting between mass and moles.

Students will about Chemical Calculations

- **Balanced Equations:**
  - Interpretation of balanced chemical equations in terms of moles.
  - Use of stoichiometry to calculate reacting masses.
- **Reacting Masses:**
  - Calculations involving masses of reactants and products.
  - Limiting reactants: identification and calculations.

Students will learn about Concentrations of Solutions

- **Concentration:**

- Definition and calculation in terms of mass per unit volume (g/dm³) and moles per unit volume (mol/dm³).

Chemistry Only

Students will learn Volumes of Gases

- **Gas Volumes:**
  - Molar volume of gases at room temperature and pressure (RTP): 24 dm³/mol.
  - Use of molar volume in calculations involving gaseous reactants and products.

Students will learn about Percentage Yield and Atom Economy

- **Percentage Yield:**
  - Calculation from actual yield and theoretical yield.
  - Factors affecting percentage yield in reactions.
- **Atom Economy:**
  - Definition and calculation.
  - Importance of atom economy in sustainable chemistry.

Students will learn about Titrations

- **Acid-Base Titrations:**
  - Procedure and calculations for determining concentrations.
  - Use of indicators and understanding of end-point.
- **Calculations:**
  - Using titration data to calculate unknown concentrations.

Students will learn about Uncertainties and Errors

- **Measurement Uncertainties:**
  - Understanding and calculating uncertainties in measurements.
  - Reporting and reducing uncertainties in experimental results.

Schemata 3 – Chemical Change

Students will learn about Chemical Reactions

- **Chemical Reactions:**
  - Definition and identification of chemical reactions.
  - Evidence of a chemical reaction: color change, gas production, precipitate formation, temperature change.
- **Chemical Equations:**
  - Writing word equations for common reactions.
  - Writing and balancing simple symbol equations.
  - Use of state symbols: (s), (l), (g), (aq).

Students will learn about Acids, Bases, and Neutralization

- **Acids and Bases:**
  - Definition and properties of acids and alkalis (bases).
  - The pH scale: understanding pH values and their significance.
  - Use of indicators (litmus, universal indicator) and pH meters.
- **Neutralization Reactions:**
  - General equation for acid-base neutralization: acid + base → salt + water.
  - Practical applications: everyday examples like antacids and soil treatment.

Students will about Reactions of Acids

- **With Metals:**
  - General reaction: acid + metal → salt + hydrogen gas.
  - Observations and simple tests for hydrogen gas (pop test).
- **With Bases:**
  - General reaction: acid + base → salt + water.
  - Formation and naming of salts based on the acid and base used.
- **With Carbonates:**
  - General reaction: acid + carbonate → salt + water + carbon dioxide.
  - Observations and tests for carbon dioxide gas (limewater test).

Students will learn about Electrolysis

- **Basic Principles:**
  - Definition of electrolysis and its purpose.
  - Key components: electrolyte, anode (positive electrode), cathode (negative electrode).
- **Electrolysis of Molten Compounds:**
  - Simple examples such as the electrolysis of molten lead bromide.
  - Understanding ion movement and products at each electrode.
- **Electrolysis of Aqueous Solutions:**
  - Differences when electrolyzing aqueous solutions.
  - Example: electrolysis of sodium chloride solution producing hydrogen and chlorine.

Students will learn about the Reactivity Series

- **Reactivity Series:**
  - Arrangement of metals in order of reactivity.
  - Comparison of reactivity based on reactions with water, acids, and oxygen.
  - Placement of carbon and hydrogen in the reactivity series for comparison.
- **Displacement Reactions:**
  - Explanation and examples of displacement reactions.
  - Use of displacement reactions to determine the reactivity of metals.

Students will learn about Extraction of Metals

- **Ores and Minerals:**
  - Definition of ores and their economic importance.
  - Common ores of metals like iron, aluminum, and copper.
- **Methods of Extraction:**
  - Extraction of metals below carbon in the reactivity series (e.g., iron) using reduction with carbon.
  - Extraction of metals above carbon (e.g., aluminum) using electrolysis.
- **Reduction with Carbon:**
  - Example: extraction of iron from iron ore in a blast furnace.
  - Chemical equations for the reduction process.

- **Electrolysis:**
  - Extraction of aluminum from bauxite using electrolysis.
  - Chemical equations for the electrolysis process.

Students will learn about Oxidation and Reduction

- **Definitions:**
  - Oxidation: loss of electrons, gain of oxygen.
  - Reduction: gain of electrons, loss of oxygen.
  - Redox reactions: simultaneous oxidation and reduction processes.
- **Examples of Redox Reactions:**
  - Reactions of metals with oxygen (e.g., rusting of iron).
  - Displacement reactions as redox reactions

Schemata 4 - The Rate and Extent of Chemical Change

Students will learn about Rate of Reaction

- **Definition of Rate of Reaction:**
  - The speed at which reactants are converted to products.
  - Calculation of reaction rate: change in quantity of reactant/product over time.
- **Factors Affecting Rate of Reaction:**
  - Concentration: higher concentration increases rate.
  - Temperature: higher temperature increases rate.
  - Surface Area: greater surface area increases rate.
  - Catalysts: substances that increase rate without being consumed.
  - Pressure (for gases): higher pressure increases rate.
- **Collision Theory:**
  - Explanation of how reactions occur when particles collide with sufficient energy.
  - Activation energy: minimum energy needed for a reaction to occur.
- **Measuring Rates of Reaction:**
  - Monitoring changes in mass, volume of gas produced, or color change.
  - Practical methods such as gas syringe or precipitation methods.

Students will learn about Graphical Representation of Reaction Rates

- **Rate Graphs:**
  - Interpreting graphs of concentration vs. time.
  - Determining rate from the gradient of the graph.
  - Understanding different shapes of rate graphs for different reactions.

Students will learn about Catalysts

- **Function of Catalysts:**
  - Definition and role of catalysts in increasing reaction rate.
  - How catalysts lower activation energy.
  - Examples of catalysts in industry (e.g., enzymes in biological processes).

Students will learn about Reversible Reactions and Dynamic Equilibrium

- **Reversible Reactions:**
  - Definition and characteristics of reversible reactions.
  - Examples of reversible reactions (e.g., the Haber process).
- **Dynamic Equilibrium:**
  - Definition and conditions for dynamic equilibrium in a closed system.
  - Characteristics of dynamic equilibrium: rates of forward and reverse reactions are equal.
  - Understanding that concentration of reactants and products remain constant.

Students will learn about Le Chatelier's Principle

- **Le Chatelier's Principle:**
  - Explanation of how changes in concentration, temperature, and pressure affect the position of equilibrium.
  - Predicting the effect of changing conditions on the yield of products.
- **Applications of Le Chatelier’s Principle:**
  - Industrial processes such as the Haber process for ammonia production.
  - Effect of pressure, temperature, and concentration changes on equilibrium position and product yield.

Students will learn about Calculations Involving Reaction Rates

- **Quantitative Aspects:**
  - Calculations involving rate of reaction (e.g., rate = amount of reactant used / time).
  - Interpretation and calculation of data from rate experiments.

Year 11: Curriculum Intent

Year 11 Chemistry Essential Knowledge Summary

Schemata 2: C7 Organic Chemistry

Composite Knowledge: Pct.

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- Be able to recognise substances as alkanes given their formulae in these forms.
- Describe the formation of crude oil.
- Describe the composition of crude oil.
- Define a hydrocarbon.
- Explain what is meant by the formula
- C_nH_{2n+2}
- Make molecular models and work out general formula for the alkanes.
- Draw the covalent bonding in:
  - methane
  - ethane
  - propane
  - butane.
- Define the term saturated
- Describe how fractional distillation works in terms of evaporation and condensation.
- Describe in general terms the conditions used for catalytic cracking and steam cracking.
- Recall the colour change when bromine water reacts with an alkene.
- Recall how boiling point, viscosity and flammability change with increasing molecular size.
- Write balanced equations for the complete combustion of hydrocarbons with a given formula.
- Knowledge of trends in properties of hydrocarbons is limited to:
  - boiling points
  - viscosity
  - flammability.
- Describe the balanced symbol equation including moles present, reactants and products.
- Describe the reaction including moles present, reactants and products.
- Describe what happens when any of the first four alcohols react with sodium, burn in air, are added to water, react with an oxidising agent.
- Recall the main uses of these alcohols.
- Know the conditions used for fermentation of sugar using yeast.
- Be able to recognise alcohols from their names or from given formulae.
- Describe what happens when any of the first four carboxylic acids react with carbonates, dissolve in water, react with alcohols.
- (HT only)
- Recognise carboxylic acids from their names or from given formulae.
- Students do not need to know the names of individual carboxylic acids other than methanoic acid.
- Recognise addition polymers and monomers from diagrams in the forms shown and from the presence of the functional group -C=C- in the monomers.

Schemate 3: C8 Chemical Analysis

Composite Knowledge: Pues.

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- Define the terms:
  - pure substance
  - compound.
- Use data to identify pure and impure substances.
- Identify the contents of mineral waters sold as ‘pure’. Discuss the meaning of ‘pure’.
- Define the terms:
  - mixture
  - formulation.
- Describe a method for paper chromatography.
- Describe what the R_f value is and instructions on how to calculate the R_f value.
- Devise a method for distinguishing between pure and impure substances using chromatography.
- Describe the tests for hydrogen, oxygen, chlorine and carbon dioxide.
- Describe the flame tests for identifying cations to another student.
- Describe how sodium hydroxide can be used to identify some cations to another student.
- Describe how dilute acids can be used to identify carbonates.
- Describe how silver nitrate can be used to identify halides.
- Describe how barium chloride in the presence of dilute hydrochloric acid can be used to identify sulfate ions.
- Describe the process of flame emission spectroscopy.
-
- Discuss the advantages and disadvantages of instrumental analysis versus test tube analysis.
- State advantages of instrumental methods compared with the chemical tests in this specification.

Procedural Knowledge:

- Be able to use melting point data to distinguish pure from impure substances.
- Interpret chromatograms and determine R_f values from chromatograms.
- Provide answers to an appropriate number of significant figures.
- Research how chemical analysis has been used to detect and solve crimes especially in forgery and murder by poisoning.
- Research how robotic spacecraft sent to investigate other planets analyse their atmospheres and surface materials using instrumentation.
- Research instrumental methods for detecting elements and compounds.
- Suggest advantages of the instrumental methods compared with the chemical tests.
-

Upper Hierarchical Knowledge

Explain, in terms of intermolecular forces, the terms:

- melting point
- boiling point.
- Explain what happens to substances during the process of chromatograph.
- Suggest how chromatographic methods can be used for

Schemate 4: C9 Chemistry of the Atmosphere

Composite Knowledge: Pues.

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- Describe the composition of the atmosphere.
- Describe the approximate levels of gases in Earth’s early atmosphere.
- Draw accurate pie charts for the composition of the atmosphere.
- Describe how sedimentary rocks formed and locked up carbon dioxide.
- 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.
- Describe how sedimentary rocks formed and locked up carbon dioxide.
- Describe the greenhouse effect in terms of the interaction of short and long wavelength radiation with matter.
- Recall two human activities that increase the amounts of each of the greenhouse gases carbon dioxide and methane.
- Evaluate the quality of evidence in a report about global climate change given appropriate information.
- Describe uncertainties in the evidence base.
- Describe how greenhouse gases are produced
- Describe briefly four potential effects of global climate change
- Identify the effects of global warming.
- Explain the effects of climate change.
- Describe what a carbon footprint is.
- Describe how emissions can be reduced. Suggest the consequences of the reductions on the Earth, atmosphere and everyday life.
- Describe how carbon monoxide, soot (carbon particles), sulfur dioxide and oxides of nitrogen are produced by burning fuels
- Predict the products of combustion of a fuel given appropriate information about the composition of the fuel and the conditions in which it is used.
- Write word equations for complete and incomplete combustion.
-

Procedural Knowledge:

- Given appropriate information, interpret evidence and evaluate different theories about the Earth’s early atmosphere
- Describe the effect of greenhouse gases on wavelength.
- Compare the Earth’s atmosphere to that of Mars and Venus.
- Discuss the scale, risk and environmental implications of global climate change.
- Use the internet to obtain numerical predictions for the effects of climate change. Using these predictions, suggest the possible effects on the Earth and atmosphere should the predictions become reality.

Schemate 5: C10 Using Resources

Composite Knowledge: Pues.

Component Knowledge:

Foundational Knowledge:

Declarative Knowledge:

- State examples of natural products that are supplemented or replaced by agricultural and synthetic products.
- Distinguish between finite and renewable resources given appropriate information.
- Define the terms:
  - finite
  - renewable.
- 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.
- Define the terms:
  - potable water
  - pure water.
- Describe what a LCA is using a suitable example.
- Discuss the negative issues relating to LCAs and why caution should be used when using them
- Define the following terms using suitable examples:
  - corrosion
  - rusting
  - sacrificial protection.
- Describe how to prevent corrosion using the examples:
  - oxide coating on aluminium
  - zinc on iron
  - magnesium on steel.
- Use suitable examples to explain why corrosion can be prevented using barriers and the role of sacrificial barriers if appropriate to the example used.
- Describe experiments and interpret results to show that both air and water are necessary for rusting.
- Recall a use of each of the alloys specified
- Interpret and evaluate the composition and uses of alloys other than those specified, given appropriate information.
- Define the terms:
  - alloy
  - high carbon steel
  - low carbon steel.
- 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.
- Compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals.
- Recall a source for the nitrogen and a source for the hydrogen used in the Haber process.
- State where the raw materials in the Haber process come from.
- Describe the process for manufacturing ammonia.
- 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

- Draw diagrams to represent the formation of a polymer from a given alkene monomer.
- Relate the repeating unit to the monomer.
- Explain the basic principles of condensation polymerisation by reference to the functional groups in the monomers and the repeating units in the polymers.
- Be able to name the types of monomers from which these naturally occurring polymers are made.
- Describe the structure of DNA in terms of two polymer chains and nucleotides.

Procedural Knowledge:

- Plot boiling points of alkanes against number of carbons.
- Explain how fractional distillation works in terms of evaporation and condensation.
- Balance chemical equations as examples of cracking given the formulae of the reactants and products.
- Research uses of common alkenes.
- Give examples to illustrate the usefulness of cracking.
- Be able to explain how modern life depends on the uses of hydrocarbons.
- Explain what is meant by the formula C_nH_{2n}
- Write balanced symbol equations for the combustion of alkenes in oxygen.
- Write the reaction between an alkene and hydrogen, giving suitable examples.
- Write the reaction between an alkene and water, giving suitable examples.
-

Upper Hierarchical Knowledge

- Make predictions of the boiling points of other alkanes.
- Suggest the impact on fuels, feedstocks and petrochemicals of the depleting stocks of crude oil.
- Explain the properties of hydrocarbons in relation to intermolecular forces.
- Write balanced symbol equations for the combustion of hydrocarbon fuels.
- Describe the balanced symbol equation including moles present, long alkane reactant, specific reaction conditions, and alkene and short alkane products.
- Draw the covalent bonding in:

● ethene
● propene
● butene
● pentene.

- Explain why carboxylic acids are weak acids in terms of ionisation and pH.

Draw the covalent bonding in:

● methanoic acid
● ethanoic acids
● propanoic acid
● butanoic acid.

Describe what happens to one of the first four acids during the reactions:

● dissolving in water to produce acidic solutions
● reacting with carbonates to produce carbon dioxide
● not ionising completely when dissolved in water (they are weak acids)
● reacting with alcohols in the presence of an acid catalyst to distinguishing pure substances from impure substances.

- Be able to write balanced equations for the reactions to produce the insoluble hydroxides.
- Explain what happens to a sample throughout the process of flame emission spectroscopy.
- Interpret instrumental results for flame emission spectroscopy.
- Compare these to chemical tests carried out in this specification.
-

Working Scientifically

- Research the melting and boiling points of common pure substances and compounds.
- Suggest reasons for differences in data available on the internet.
- Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.
- Carry out tests for hydrogen, oxygen. carbon dioxide and chlorine.
- Carry out flame tests on the following cations:

● lithium
● sodium
● potassium
● calcium
● copper.

- Use sodium hydroxide to test for the following cations:

● aluminium
● calcium
● magnesium
● copper(II)
● iron(II)
● iron(III).

- Use dilute acid to test for the following carbonates:

● sodium carbonate
● potassium carbonate.

- Analyse the composition of an egg shell, testing for the presence of various ions using acids and other test tube reactions and flame tests.
- Interpret an instrumental result given appropriate data in chart or tabular form, when accompanied by a reference set in the same form.
- Use of chemical tests to identify the ions in unknown single ionic compounds.

- Suggest the consequences of the reductions on the Earth, atmosphere and everyday life.
- Predict the products of combustion of a fuel given appropriate information about the composition of the fuel and the conditions in which it is used.
- Describe the effect of the following products:

● Carbon monoxide on the human body.
● Sulfur dioxide and oxides of nitrogen on acidity of rain water.
● Sulfur dioxide and oxides of nitrogen on respiratory system.
● Particulates on global dimming.
● Particulates on human health problems.

Upper Hierarchical Knowledge

- Extended writing: describe the theory of the evolution of the Earth's early atmosphere.
- Extended writing: explain why the composition of the atmosphere has changed over billions of years.
- Compare the Earth's atmosphere to that of Mars and Venus.
- Extended writing: explain how algae and plants have caused the concentrations of oxygen in the atmosphere to increase.
- Extended writing: explain how algae and plants have caused the concentrations of carbon dioxide in the atmosphere to decrease.
- Grade 9: explain why the wavelength changes due to greenhouse gases.
- Evaluate the quality of evidence in a report about global climate change given appropriate information.
- Describe how greenhouse gases are produced.
- Evaluate the use of models for predicting climate change.
- Use these equations to describe the reactions in terms of reactants, products made and number of each present.
- Explain why the following can be produced in combustion:

● carbon dioxide
● carbon monoxide
● soot
● water vapour
● sulfur dioxide
● oxides of nitrogen.

Working Scientifically

- Show that aquatic plants (eg Elodea) produce oxygen in daylight.
- Use the internet to obtain data for concentrations of greenhouse gases.
- Evaluate the reliability of the data available on the internet.
- Research the process of peer review in reporting results/data.
- Use data to calculate your own carbon footprint over a period/holiday. Suggest the effects on Earth and atmosphere of the calculated carbon footprint.
- Use shells and acid to show how pollution can cause shells to corrode.

same compounds, given appropriate information.

Procedural Knowledge:

- Extract and interpret information about resources from charts, graphs and tables.
- Use orders of magnitude to evaluate the significance of data.
- Evaluate the impacts and benefits of biological methods of extracting meta
- Research information for the processes of:

● phytomining
● bioleaching.

- Include percentage of metal extracted, concentration of global warming gases released, amount of electricity used etc.

Use this data in an evaluation.

- Use information to interpret the LCA of a given material or product.
- Explain sacrificial protection in terms of relative reactivity.
- Using diagrams, describe the difference between metals and their alloys
- Research the first alloy to include the history of it and its uses.
- Model an alloy using different size marbles. Use this model to discuss the properties of alloys.
- Describe how the following are produced and give uses for each:

● soda-lime glass
● borosilicate glass
● clay ceramics
● low-density poly(ethene)
● high density poly(ethene)
● composites.

- Using diagrams, describe the structure of the following polymers:

● thermosoftening
● thermosetting.

- Use these diagrams and descriptions to explain why the following happens when heated:

● thermosoftening polymers melt
● thermosetting polymers do not melt.

- Extended writing: compare how fertilisers are produced in industry and in the laboratory.
- Investigate what was used as fertilizer before the industrial preparation of fertilisers was invented.
-

Upper Hierarchical Knowledge

- Explain the differences between the two terms using suitable examples.
- Explain the differences between the two terms.
- Extended writing: describe the process of desalination.
- Extended writing: describe the process of distillation
- Extended writing: explain why distillation separates substances.
- Explain what happens to substances during the process of distillation in terms of intermolecular forces of attraction.
- Extended writing: describe the processes of

● phytomining
● bioleaching.

- Evaluate ways of reducing the use of limited resources, given appropriate information.
- Extended writing: describe the environmental impacts of obtaining raw materials from the Earth.
- Describe how to prevent corrosion using the examples:

● oxide coating on aluminium
● zinc on iron

produce esters, for example ethanoic acid reacts with ethanol to produce ethyl ethanoate and water. ● Describe what takes place during condensation polymerisation. ● Identify monomers, polymers and repeating units. ● ● Describe the polymerisation of ethane-1,2-diol and hexanedioic acid. **Working Scientifically** ● Investigate the properties of different hydrocarbons in terms of boiling point, viscosity and flammability with increasing molecular size. ● Identify the products of combustion of alkanes. ● Demo or practical: crack paraffin over porous clay pot. ● Use bromine water to identify alkenes. ● Test for unsaturation in other compounds. ● Research uses of the first four carboxylic acids. ● Research some of the uses of esters and try to work out the alcohols and carboxylic acids used to make them. ● Opportunities within investigation of the reactions of carboxylic acids. ● Use models to represent condensation polymerisation. ● Research common polyesters and their uses. ● Research common amino acids and polypeptides, and polypeptide uses ● Research the history of the discovery of DNA as a polymer chain. ● Research naturally occurring polymers and their uses			● magnesium on steel. ● Use suitable examples to explain why corrosion can be prevented using barriers and the role of sacrificial barriers if appropriate to the example used. ● State properties of examples of alloys. Explain, in relation to the structure, why these alloys have these properties. Research the physical properties of: ● soda-lime glass ● borosilicate glass ● clay ceramics ● low-density poly(ethene) ● high density poly(ethene) ● composites Use these properties to explain how the materials are related to their use. Compare the properties of thermosetting and thermosoftening polymers. ● Using diagrams, describe the structure of the following polymers: ● thermosoftening ● thermosetting. ● Use these diagrams and descriptions to explain why the following happens when heated: ● thermosoftening polymers melt ● thermosetting polymers do not melt. ● (HT only) Interpret graphs of reaction conditions versus rate. ● (HT only) Apply the principles of dynamic equilibrium to the Haber process. ● (HT only) Explain the trade-off between rate of production and position of equilibrium. ● (HT only) Explain how the commercially used conditions for the Haber process are related to the availability and cost of raw materials and energy supplies, control of equilibrium position and rate. ● Write a balanced symbol equation for the manufacture of ammonia. Use this to describe the reaction in terms of reactants, products, conditions and number of moles. ● Recall the following topics: ● dynamic equilibrium ● temperature affecting the rate of a reaction ● pressure. ● Explain how each of these affects the Haber process reaction. ● Discuss the effect of the following conditions on the reaction: ● a high temperature ● a low temperature ● a high pressure ● a low pressure ● use of a catalyst ● no catalyst. ● Discuss the pros and cons of these varying conditions. ● Explain the trade-off between the rate of the reaction and the position of the equilibrium. ● Explain how the conditions used in industry affect the equilibrium position, rate and costs of the reaction. **Working Scientifically** ● Research examples of natural products that are supplemented or replaced by agricultural and synthetic products. ● Analysis and purification of water samples from different sources, including pH, dissolved solids and distillation. ● Research how water is treated.

			● Model phytomining in the laboratory by watering geraniums with dilute copper sulphate for a period of time. The leaves can be burnt and copper can be extracted from the ash by rinsing in dilute hydrochloric acid and electrolysing the solution. ● Use the internet to carry out simple comparative LCAs for shopping bags made from plastic and paper. ● Use the internet to carry out simple comparative LCAs for shopping bags made from plastic and paper. ● Research methods of producing/obtaining metal/glass/building materials/clay ceramics/plastics. Identify in these methods the limited resources that are used to generate the energy. ● Research how glass is recycled. ● Research how metal is recycled and alternatives for use of scrap metals ie in obtaining iron in a blast furnace. ● Investigate the conditions for rusting of iron nails in test tubes. ● Research the physical properties of: ● soda-lime glass ● borosilicate glass ● clay ceramics ● low-density poly(ethene) ● high density poly(ethene) ● composites ● Research the availability and cost of the raw materials and energy supplies in the Haber process. Explain how these relate to the conditions used for the Haber process in industry. ● Research compositions of NPK and their uses. ● Research how fertilisers can be prepared: ● industrially ● in a laboratory.