| Learning Outcome | Understanding? |
| --- | --- |
| I know that elements are arranged in order of increasing atomic number |  |
| I know that he periodic table allows chemists to make accurate predictions of physical properties and chemical behaviour for any element, based on its position.  |  |
| I know groups of the periodic table are vertical columns which contain elements with similar chemical properties resulting from a common number of electrons in the outer shell . |  |
| I know periods are rows of elements arranged with increasing atomic number, demonstrating an increasing number of outer electrons and a move from metallic to non-metallic characteristics. |  |
| I can categorise the bonding and structure of the first 20 elements:* metallic (Li, Be, Mg, Al, K, Ca)
* covalent molecular (H2, N2, O2, F2, Cl2, P4, S8 and C60
* covalent network (B, C (diamond and graphite) and Si
* Monatomic (noble gases)
 |  |
| I know the definition of covalent radius. |  |
| I can describe and explain the trends in covalent radius down a group and across a period in terms of occupied shells and the nuclear charge. |  |
| I know the definition of first ionisation energy. |  |
| I know the definition of second and subsequent ionisation energies. |  |
| I can describe and explain the trends in ionisation energies down a group and across a period in terms of atomic size, nuclear charge and screening (shielding) effect due to inner shell electrons. |  |
| I know atoms have different attractions for bonding electrons. |  |
| I know the definition of electronegativity. |  |
| I can describe and explain the trends in electronegativity down a group and across a period in terms of covalent radius, nuclear charge and screening (shielding) effect due to inner shell electrons. |  |

**CHEMICAL CHANGES AND STRUCTURE**

1. PERIODICITY
2. STRUCTURE AND BONDING

| Learning Outcome | Understanding? |
| --- | --- |
| 1. ***Types of chemical bond***
 |  |
| I can describe a covalent bond. |  |
| I know when polar covalent bonds are formed. |  |
| I can use notation (δ- and δ+) to indicate partial charges on atoms in a polar covalent bond. |  |
| I know ionic formulae give the simplest ratio of each type of ion in a substance. |  |
| I can describe an ionic bond. |  |
| I can describe an ionic structure. |  |
| I can describe the positions on pure covalent, polar covalent and ionic bonding on a bonding continuum. |  |
| I know the difference in electronegativities between bonded atoms give an indication of the ionic character of a substance. |  |
| I know that compounds formed from metals and non-metals are often, but not always, ionic. |  |
| I can use the physical properties of a substance to deduce type of bonding and structure present. |  |

| Learning Outcome | Understanding? |
| --- | --- |
| 1. ***Intermolecular forces***
 |  |
| I know that some attractive forces must exist between all molecular elements, compounds and monatomic elements. |  |
| I know that there are several types of intermolecular force; collectively known as van der Waal’s forces and these include London dispersion forces and permanent dipole-permanent dipole interactions. |  |
| I know that hydrogen bonding is a type of permanent dipole-permanent dipole interaction. |  |
| I know that London dispersion forces can operate between all atoms and molecules. |  |
| I can explain how London dispersion forces are formed. |  |
| I know that London dispersion forces are much weaker than all other types of bonding. |  |
| I know the strength of London dispersion forces is related to number of electrons within an atom or molecule. |  |
| I know that a molecule is described as polar if it has a permanent dipole. |  |
| I know the spatial arrangement of polar covalent bonds can result in a molecule being polar. |  |
| I know that permanent dipole-permanent dipole interactions are additional electrostatic forces of attraction between polar molecules. |  |
| I can describe the relative strength of London dispersion forces and permanent dipole-permanent dipole interactions between molecules with a similar number of electrons.  |  |
| I can identify compounds where hydrogen bonds are likely to form between molecules. |  |
| I can describe the strength of hydrogen bonding relative to permanent dipole-permanent dipole interactions and covalent bonds. |  |
| I can rationalise melting points, boiling points and viscosity in terms of the nature and strength of intermolecular forces that exist between molecules.  |  |
| I can make qualitative predictions of the strength of intermolecular forces by considering the polarity and number of electrons present in molecules. |  |
| I can compare the melting and boiling points of polar and non-polar substances with a similar number of electrons. |  |
| I know what physical properties are affected by hydrogen bonding. |  |
| I can explain the anomalous boiling points of ammonia, water and hydrogen fluoride in terms of intermolecular forces. |  |
| I know the density of ice is lower than water due to hydrogen bonding. |  |
| I can predict the solubility of ionic, polar and non-polar substances when the polarity of the solvent is known.  |  |
| I know that the spatial arrangement of polar covalent bonds and the presence of O-H or N-H bonds are key features in predicting the solubility of a compound.  |  |

| Learning Outcome | Understanding? |
| --- | --- |
| 1. ***Oxidising and reducing agents***
 |  |
| I can describe oxidation and reduction in terms of electron loss or gain. |  |
| I can define a redox reaction. |  |
| I can describe oxidising and reducing agents in terms of electron acceptors or donors. |  |
| I can identify oxidising and reducing agents in redox reactions. |  |
| I can link the electronegativity of an element with its tendency to act as a reducing or oxidising agent. |  |
| I can locate the strongest oxidising and reducing agents on the periodic table. |  |
| I can name some compounds, group ions and molecules that act as oxidising and reducing agents.  |  |
| I can name some uses of oxidising agents. |  |
| I know the electrochemical series represents a series of reduction reactions. |  |
| I can locate the strongest oxidising and reducing agents on the electrochemical series. |  |
| I can balance ion-electron equations by adding water molecules, hydrogen ions and electrons. |  |
| I can combine ion-electron equations to produce redox equations. |  |

**NATURE’S CHEMISTRY**

1. SYSTEMATIC CARBON CHEMISTRY

| Learning Outcome | Understanding? |
| --- | --- |
| I know the definition of saturated. |  |
| I know the definition of unsaturated |  |
| I can define and recognise an addition reaction. |  |
| I can explain how to idistinguish unsaturated compounds from saturated compounds. |  |
| I can draw full and shortened structural formulae of any molecules. |  |
| I know the definition of isomer. |  |
| I can draw an isomer given the name or structural formula. |  |
| I can draw isomers for a given molecular formula. |  |
| I can predict the boiling point, solubility and volatility of a compound by considering hydrogen bonding, spatial arrangement of polar bonds, molecular size and polarities of solute and solvent. |  |
| I can explain solubility, boiling point and volatility in terms of type and strength of intermolecular forces present. |  |

1. ALCOHOLS

| Learning Outcome | Understanding? |
| --- | --- |
| I can name and identify the functional group present in alcohols. |  |
| I can systematically name straight-chain and branched alcohols with no more than eight carbon atoms in their longest chain. |  |
| I can write a molecular formula or draw a structural formula from the systematic name of straight-chain and branched alcohols with no more than eight carbon atoms in their longest chain. |  |
| I can classify alcohols as primary, secondary or tertiary. |  |
| I know that alcohols with two hydroxyl groups are diols and those containing three are triols. |  |
| I can explain the physical properties of alcohols with reference to hydrogen bonding. |  |

1. CARBOXYLIC ACIDS

| Learning Outcome | Understanding? |
| --- | --- |
| I can name and identify the functional group present in carboxylic acids. |  |
| I can systematically name straight-chain and branched carboxylic acids from structural formulae containing no more than eight carbons in the longest chain. |  |
| I can write molecular formulae and draw structural formulae from the systematic name of straight-chain and branched carboxylic acids containing no more than eight carbons in the longest chain. |  |
| I can write equations and name the salts formed when carboxylic acids react with metal oxides, metal hydroxides and metal carbonates. |  |

1. ESTERS, FATS AND OILS

| Learning Outcome | Understanding? |
| --- | --- |
| I can recognise an ester link. |  |
| I can name esters given the names of the parent alcohol and carboxylic acid. |  |
| I can name esters given the structural formulae of esters formed from straight-chain alcohols and straight-chained carboxylic acids containing no more than eight carbon atoms in their longest chain. |  |
| I can write molecular formulae and draw structural formulae for esters given their systematic names or structural formulae of parent alcohol and carboxylic acid. |  |
| I can name some uses for esters; including their use as solvents for non-polar compounds. |  |
| I know esters are formed by a condensation reaction between an alcohol and a carboxylic acid. |  |
| I know the definition of a condensation reaction. |  |
| I can describe the formation of an ester link. |  |
| I can describe the products of the hydrolysis of an ester. |  |
| I know the definition of a hydrolysis reaction. |  |
| I can predict the products when an ester is hydrolysed. |  |
| I can write a molecular formula or draw a structural formula for the products of hydrolysis of an ester. |  |
| I know edible fats and oils are made from the condensation of glycerol and three carboxylic acids (‘fatty acids’). |  |
| I can describe the structure of a fatty acid molecule. |  |
| I can describe and explain the relative melting points of edible oils and fats in terms of degree of saturation and strength of van der Waal’s forces. |  |
| I can link the degree of unsaturation of an unsaturated compound to the volume of bromine solution decolourised.  |  |
| I know why fats and oils are important in our diet.  |  |

1. SOAPS, DETERGENTS AND EMULSIONS

| Learning Outcome | Understanding? |
| --- | --- |
| I know how soaps are produced from edible fats and oils; and the products of this reaction. |  |
| I can describe the structure of a soap molecule. |  |
| I can describe the cleaning action of soap. |  |
| I can describe hard water. |  |
| I can describe the structure of a detergent molecule. |  |
| I can explain why detergents may be used in preference to soap in hard water areas. |  |
| I can describe what an emulsifier does. |  |
| I can describe an emulsion. |  |
| I can describe the structure of an emulsifier molecule. |  |
| I know that emulsifiers can be made from reacting edible oils with glycerol, and one or two fatty acid groups are linked to each glycerol backbone. |  |

1. PROTEINS

| Learning Outcome | Understanding? |
| --- | --- |
| I know the main roles of proteins as structural materials of animal tissue and the maintenance and regulation of life processes. |  |
| I know enzymes are proteins and they are biological catalysts. |  |
| I can describe the structure of amino acids and know that these are the building blocks of proteins. |  |
| I know how amino acids link to make proteins and that this is a condensation reaction. |  |
| I can recognise a peptide (amide) link. |  |
| I know that proteins which fulfil different roles in the human body are formed by linking different sequences of amino acids. |  |
| I know that amino acids that cannot be made in the body must be acquired from diet (essential amino acids). |  |
| I know that hydrolysis breaks down proteins into amino acids during digestion. |  |
| I can draw the structural formula of amino acids obtained from the hydrolysis of a protein. |  |
| I can draw the structural formula of a section of protein given the structural formulae of amino acids from which it is formed. |  |
| I can describe the structure of some protein shapes and how the chains are held together. |  |
| I can describe and explain the effect of heating on proteins. |  |

1. OXIDATION OF FOOD

| Learning Outcome | Understanding? |
| --- | --- |
| I can describe the oxidation and reduction of carbon compounds in terms of a change in the oxygen to hydrogen ratio. |  |
| I can name reagents that can be used to oxidise primary alcohols to aldehydes then carboxylic acids; and secondary alcohols to ketones and describe the colour changes observed in these reactions. |  |
| I know that tertiary alcohols cannot be oxidised using the oxidising agents above. |  |
| I can identify a carbonyl group and know this is the functional group in aldehydes and ketones.  |  |
| I can systematically name straight-chain and branched aldehydes and ketones containing no more than eight carbon atoms in the longest chain from structural formulae. |  |
| I can write molecular formulae and draw structural formulae from systematic names of straight-chain and branched aldehydes and ketones containing no more than eight carbon atoms in the longest chain. |  |
| I know that aldehydes, but not ketones, can be oxidised to carboxylic acids. |  |
| I know that the oxidising agents Fehling’s solution, Tollens’ reagent and acidified potassium dichromate can be used to distinguish between aldehydes and ketones; and know the colour changes associated with these. |  |
| I know many flavour and aroma molecules are aldehydes. |  |
| I know that oxygen from the air causes the oxidation of food. |  |
| I know oxidation of edible oils gives a rancid flavour. |  |
| I know antioxidants prevent unwanted oxidation reactions occurring. |  |
| I know how antioxidants prevent unwanted oxidation reactions happening.  |  |
| I can identify an antioxidant in a redox reaction. |  |

1. FRAGRANCES

| Learning Outcome | Understanding? |
| --- | --- |
| I can describe essential oils in terms of their provenance, volatility and polarity. |  |
| I know some uses of essential oils. |  |
| I can describe terpenes. |  |
| I can systematically name and draw an isoprene unit.  |  |
| I know terpenes can be oxidised to produce some of the compounds responsible for the distinct aroma of spices. |  |
| I can identify an isoprene unit from the structural formula of a terpene.  |  |
| I can state the number of isoprene units in a terpene molecule from its structural formula. |  |

1. SKIN CARE

| Learning Outcome | Understanding? |
| --- | --- |
| I can describe how UV light in sunlight can cause sunburn and ageing of the skin. |  |
| I know the UV light can break bonds to form free radicals.  |  |
| I know the definition of free radical. |  |
| I know that sunblock prevents UV light reaching the skin. |  |
| I can state the sequence of reactions in free radical chain reactions. |  |
| I can write equations for reactions involving free radicals. |  |
| I can recognise the step in a chain reaction represented by an equation involving free radicals. |  |
| I can describe a free radical scavenger and know why these are added to different products. |  |

**CHEMISTRY IN SOCIETY**

1. GETTNG THE MOST FROM REACTANTS

| Learning Outcome | Understanding? |
| --- | --- |
| I know that industrial processes are designed to maximise profit and minimise the impact on the environment. |  |
| I can name some factors that influence industrial process design. |  |
| I can name some environmental considerations for design of industrial processes. |  |
| I can write and balance chemical equations, using formulae and state symbols, to show mole ratios of reactants and products. |  |
| I know the mass of a mole of any substance, in grams, is equal to the gram formula mass. |  |
| I can calculate the gram formula mass of a substance. |  |
| I can perform calculations using the relationship between the mass and number of moles of a substance. |  |
| For solutions, I can calculate the mass of solute, the number of moles of solute, the volume of solution or concentration of the solution from data provided. |  |
| I can perform calculations using the relationship between the volume of gas, molar volume and the number of moles of a substance.  |  |
| I can perform calculations given a balanced equation using data including: gram formula masses, masses, numbers of moles, concentrations and/or volumes of solutions, molar volumes and volumes for gases.  |  |
| I know that the efficiency with which reactants are converted into desired product is measured in terms of percentage yield and atom economy.  |  |
| I can identify the limiting reactant and excess reactant(s) by calculation and by considering the balanced equation. |  |
| I can explain why an excess of the less expensive reactant may be used. |  |
| I know the definitions of theoretical yield, actual yield and percentage yield. |  |
| I can calculate theoretical yield and use this, along with the actual yield, to calculate the percentage yield of a reaction using this equation:  |  |
| Give the cost of reactants, I can use the percentage yield to calculate the cost of reactants required to produce a given mass of product. |  |
| I know the definition of atom economy. |  |
| I can calculate atom economy using the equation: |  |
| I know reactions with a high percentage yield may have a low atom economy value if large quantities of by-products are formed. |  |

1. CONTROLLING THE RATE

| Learning Outcome | Understanding? |
| --- | --- |
|  ***i) Collision theory*** |  |
| I know why reaction rates must be controlled in industrial processes.  |  |
| I can perform calculations using the relationship between reaction time and relative rate with appropriate units. |  |
| I can use collision theory to explain the effects of the following on reaction rates: concentration, pressure, surface area (particle size), temperature and collision geometry. |  |
|  ***ii) Reaction pathways*** |  |
| I know a potential energy diagram can be used to show the energy pathway for a reaction. |  |
| I know the enthalpy change is the energy difference between reactants and products. |  |
| I know the relative values for enthalpy changes for exothermic and endothermic reactions. |  |
| I know the definition of activation energy and activated complex. |  |
| I can calculate the activation energy from potential energy diagrams.  |  |
| I know a catalyst provides an alternative pathway with a lower activation energy. |  |
| I can show the effect of using a catalyst on a potential activation energy diagram. |  |
|  ***iii) Kinetic energy distribution*** |  |
| I know that temperature is a measure of the average kinetic energy of the particles in a substance. |  |
| I can use energy distribution diagrams (Maxwell-Boltzmann) to explain the effect of changing temperature on kinetic energy of particles and reaction rate. |  |
| I can explain the effects of temperature and adding a catalyst in terms of number of particles with energy greater than the activation energy. |  |

1. CHEMICAL ENERGY

| Learning Outcome | Understanding? |
| --- | --- |
| I know the definition of enthalpy. |  |
| I know the definitions of exothermic and endothermic reactions. |  |
| I know why heat may be removed in industry during exothermic reactions. |  |
| I know that the enthalpy change associated with a reaction can be calculated from the quantity of heat energy released. |  |
| I know the quantity of hear energy released can be determined experimentally and calculated using *Eh= cmΔT*  |  |
| The quantities *Eh, c, m* or *ΔT* can be calculated, in the correct units, given relevant data.  |  |
| I know the definition of enthalpy of combustion. |  |
| I know the definition of Hess’s Law. |  |
| I can calculate the enthalpy change for a reaction using Hess’s Law. |  |
| I know the definitions of molar bond enthalpy and mean bond enthalpy; and can explain the difference between these. |  |
| I can use bond enthalpies to estimate the enthalpy change occurring for a gas phase reaction. |  |

d) EQUILIBRIA

| Learning Outcome | Understanding? |
| --- | --- |
| I can describe the forward and reverse reaction rates; and the concentrations of reactants and products in a reversible reaction at equilibrium in a closed system. |  |
| I can predict the effects of altering temperature or pressure or of adding/removing reactants/products for a given reversible reaction. |  |
| I can describe the effect of adding a catalyst to a reversible reaction. |  |

e) CHEMICAL ANALYSIS

| Learning Outcome | Understanding? |
| --- | --- |
|  ***i) Chromatography*** |  |
| I know chromatography is a technique used to separate the components present within a mixture. |  |
| I know chromatography separates substances by making use of their polarity or molecular size. |  |
| I can identify a component by either distance travelled or retention time, depending on the type of chromatography used. |  |
| I know that the results of a chromatography experiment can sometimes be represented graphically, with retention time and quantity of substance present on the axes.  |  |
|   ***ii) Volumetric analysis*** |  |
| I know the definition of volumetric analysis. |  |
| I can describe how to perform a titration and know what is meant by concordant results. |  |
| I know the definition of a standard solution. |  |
| I can describe how a standard solution is made. |  |
| I know redox titrations are based on redox reactions. |  |
| I can explain why redox titrations using acidified potassium permanganate do not require an indicator. |  |
| Give the balanced equation for a reaction occurring in a titration, I can calculate the concentration of one reactant given the concentration of the other reactant and the volumes of both solutions. |  |
| Give the balanced equation for a reaction occurring in a titration, I can calculate the volume of one reactant given the volume of the other reactant and concentrations of both solutions. |  |

**RESEARCHING CHEMISTRY**

a) COMMON CHEMICAL APPARATUS

| Learning Outcome | Understanding? |
| --- | --- |
| I am familiar with the following apparatus and can draw labelled, sectional diagrams for common chemical apparatus. |  |

b) GENERAL PRACTICAL TECHNIQUES

| Learning Outcome | Understanding? |
| --- | --- |
| I can perform simple filtration using filter paper and a funnel. |  |
| I can use a balance and measure mass by difference. |  |
| I can collect gases by collection over water or by gas syringe and know when each method should be used. |  |
| I can safely heat using a Bunsen burner, water bath or heating mantle. |  |
| I can measure enthalpy changes using *Eh*. |  |
| I know that volume markings on beakers provide only a rough indication of volume. |  |
| I know measuring cylinders generally provide sufficient accuracy for preparative work but for analytical work, burettes, pipettes and volumetric flasks are more appropriate. |  |
| I know titration is used to accurately determine the volumes of solution required to reach the end-point of a chemical reaction. |  |
| I can prepare a standard solution. |  |
| I can perform a simple distillation using a flask, condenser and suitable heat source to separate a mixture of liquids with different boiling points. |  |
| I can suggest and justify an improvement to experimental method given the description of an experimental procedure and/or experimental results.  |  |

1. REPORTING EXPERIMENTAL WORK

| Learning Outcome | Understanding? |
| --- | --- |
| I can process experimental results by tabulating data using appropriate headings and units of measurement. |  |
| I can represent data as a scatter graph with suitable sales and labels. |  |
| I can sketch a line of best fit (straight or curved) to represent the trend observed in data. |  |
| I can calculate average (mean) values. |  |
| I can identify and eliminate rogue points. |  |
| I can comment on the reproducibility of results where measurements have been repeated.  |  |
| I know uncertainty associated with a measurement can be indicated in the form measurement + uncertainty. |  |