Year 7 – Science – Knowledge Map

Year 7 Knowledge Concepts:

<table>
<tr><td rowspan="2">Autumn 1 (Yr7)</td><td>Topic(s): Working Scientifically, Particle Model 1</td><td></td><td colspan="3">Key Concepts Explored:
Drawing conclusions, analysing patterns, drawing conclusions, presenting data, the nature of matter, pure and impure substances</td></tr>
<tr><td colspan="2">Explicit Knowledge (Working knowledge to be explicitly taught within the topic)

Working Scientifically:
• To know what a prediction is using scientific knowledge and understanding
• select, plan and carry out the most appropriate types of scientific enquiries to test predictions,
• know what independent, dependent and control variables are
• Know the different apparatus in a lab, what it is used for and how to scientifically draw it.
• Name three sampling techniques.
• What are the three types of graph and when are they used.
• What is the difference between prediction and hypothesis.
• What is random and systematic error.
• Know the SI units: centi, milli, kilo, nano,
• Anomalous result is a data point that does not fit the pattern.
• What are the different types of hazards in a lab?
• How to calculate mean
• What are the different types of error
• What is an anomalous result and what do we do with them.
• What are the headings in a table

Particle Model 1:
• How solids, liquids and gases are arranged</td><td>Remembered Knowledge (knowledge that must be retained and remembered over time)

Working scientifically:
Scientific attitudes-
• pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility
• understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review
• evaluate risks.

Experimental skills and investigations:
• ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience</td><td>None negotiable Grit tasks:</td><td>Ref. NC ks3</td></tr>
</table>

	• Examples of each of the states of matter • The difference between pure and impure substances • Definition of purity • What is a solute, solvent and solution • What does dissolve mean • Definition of a mixture and compound • Know the different separation techniques: filtration, distillation and chromatography • A substance is a solid below its melting point, a liquid above it, and a gas above its boiling point. • Liquids have different boiling points.	• make predictions using scientific knowledge and understanding • select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate • use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety • make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements • apply sampling techniques. Analysis and evaluation: • apply mathematical concepts and calculate results • present observations and data using appropriate methods, including tables and graphs • interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions		

		• present reasoned explanations, including explaining data in relation to predictions and hypotheses • evaluate data, showing awareness of potential sources of random and systematic error • identify further questions arising from their results. Measurement: • understand and use SI units and IUPAC (International Union of Pure and Applied Chemistry) chemical nomenclature • use and derive simple equations and carry out appropriate calculations • undertake basic data analysis including simple statistical techniques. **Particle model:** • the properties of the different states of matter (solid, liquid and gas) in terms of the particle model, including gas pressure • changes of state in terms of the particle model. • the concept of a pure substance • mixtures, including dissolving • diffusion in terms of the particle model		

		• simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography • the identification of pure substances.		

Big Questions

Working Scientifically: ***"Does being curious make you a good scientist?"***
Particle Model 1: ***"What state of matter is sand?"***

Key Vocabulary (that must be explicitly taught to help students to *understand*)
accuracy, precision, repeatability, reproducibility, mean, random and systematic error, particle, particle model, diffusion, gas pressure, density, evaporate, boil, condense, melt, freeze, sublime, solute, solvent, dissolve, solution, insoluble, pure substance, mixture, filtration, distillation, evaporation

Year 8 – Science – Knowledge Map

Year 8 Knowledge Concepts:

<table>
<tr>
<td rowspan="2">Autumn 1 (Yr8)</td>
<td>Topic(s): Organisation, particle model 2</td>
<td></td>
<td colspan="3">Key Concepts Explored: nutrition and digestion, gas exchange, energy and energy changes, physical changes, particle model, energy in matter</td>
</tr>
<tr>
<td colspan="2">Explicit Knowledge (Working knowledge to be explicitly taught within the topic)

Organisation:
• What are the content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water, and why each is needed
• The calculations of energy requirements in a healthy daily diet
• Name the consequences of imbalances in the diet, including obesity, starvation and deficiency diseases
• Name the tissues and organs of the human digestive system, including adaptations to function and how the digestive system digests food (enzymes simply as biological catalysts)
• What is the importance of bacteria in the human digestive system
• plants making carbohydrates in their leaves by photosynthesis and gaining mineral nutrients and water from the soil via their roots
• structure and functions of the gas exchange system in humans
• adaptations to function
• the mechanism of breathing to move air in and out of the lungs
• using a pressure model to explain the movement of gases
• including simple measurements of lung volume
• the impact of exercise, asthma and smoking on the human gas exchange system
• the role of leaf stomata in gas exchange in plants.</td>
<td>Remembered Knowledge (knowledge that must be retained and remembered over time)

Organisation:
• content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water, and why each is needed
• calculations of energy requirements in a healthy daily diet
• the consequences of imbalances in the diet, including obesity, starvation and deficiency diseases
• the tissues and organs of the human digestive system, including adaptations to function and how the digestive system digests food (enzymes simply as biological catalysts)</td>
<td>None negotiable GRIT tasks:

Particle Model (Physics) SQ:

What is density and how can we investigate it?

What processes occur during changes of state?</td>
<td>Ref.

NC KS3</td>
</tr>
</table>

	• aerobic and anaerobic respiration in living organisms • the breakdown of organic molecules to enable all the other chemical processes necessary for life • a word summary for aerobic respiration • the process of anaerobic respiration in humans and micro-organisms • fermentation and a word summary for anaerobic respiration • the differences between aerobic and anaerobic respiration in terms of the reactants, the products formed and the implications for the organism. Particle Model 2 (Physics): • heating and thermal equilibrium: temperature difference between two objects leading to energy transfer from the hotter to the cooler one, through contact (conduction) or radiation; such transfers tending to reduce the temperature difference: use of insulators • Definition of conduction, convection and radiation. • other processes that involve energy transfer: changing motion, dropping an object, completing an electrical circuit, stretching a spring, metabolism of food, burning fuels. • conservation of material and of mass, and reversibility, in melting, freezing, evaporation, sublimation, condensation, dissolving • similarities and differences, including density differences, between solids, liquids and gases • Brownian motion in gases • diffusion in liquids and gases driven by differences in concentration • the difference between chemical and physical changes • the differences in arrangements, in motion and in closeness of particles explaining changes of state, shape and density, the anomaly of ice-water transition • atoms and molecules as particles. • changes with temperature in motion and spacing of particles • internal energy stored in materials.	• the importance of bacteria in the human digestive system • plants making carbohydrates in their leaves by photosynthesis and gaining mineral nutrients and water from the soil via their roots. • the structure and functions of the gas exchange system in humans, including adaptations to function • the mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume • the impact of exercise, asthma and smoking on the human gas exchange system • the role of leaf stomata in gas exchange in plants Particle model 2: • simple machines give bigger force but at the expense of smaller movement (and vice versa): product of force and displacement unchanged • heating and thermal equilibrium: temperature difference between two objects leading to energy transfer from the hotter to the		

		cooler one, through contact (conduction) or radiation; such transfers tending to reduce the temperature difference: use of insulators • other processes that involve energy transfer: changing motion, dropping an object, completing an electrical circuit, stretching a spring, metabolism of food, burning fuels. • energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change • comparing the starting with the final conditions of a system and describing increases and decreases in the amounts of energy associated with movements, temperatures, changes in positions in a field, in elastic distortions and in chemical compositions • using physical processes and mechanisms, rather than energy, to explain the intermediate steps that bring about such changes. • atmospheric pressure, decreases with increase of height as weight of air above decreases with height		

		• pressure in liquids, increasing with depth; upthrust effects, floating and sinking • he differences in arrangements, in motion and in closeness of particles explaining changes of state, shape and density, the anomaly of ice-water transition • atoms and molecules as particles. • pressure measured by ratio of force over area – acting normal to any surface. • conservation of material and of mass, and reversibility, in melting, freezing, evaporation, sublimation, condensation, dissolving • similarities and differences, including density differences, between solids, liquids and gases • Brownian motion in gases • diffusion in liquids and gases driven by differences in concentration • the difference between chemical and physical changes. • changes with temperature in motion and spacing of particles • internal energy stored in materials		
		Big Questions		

		Organisation: **"How do organs in the body work together?"** Particle Model 2 (Physics): **"What happens to particles when they are heated?"**
		Key Vocabulary (that must be explicitly taught to help students to *understand*) Balanced diet, nutrient, carbohydrates, protein, fats, deficient, alveoli, digestive system, enzymes, aerobic, anaerobic, conduction, convection, radiation, melting, freezing, evapouration, sublimation, dissolving, chemical change, physical change,

Year 9 – Science – Knowledge Map – *Biology*

Year 9 Knowledge Concepts:

<table>
<tr><td rowspan="2">Autumn (Yr9)</td><td>Topic(s): Cell Biology</td><td></td><td colspan="3">Key Concepts Explored: Cell Structure / Cell division / Exchange of substances</td></tr>
<tr><td colspan="2">Explicit Knowledge (Working knowledge to be explicitly taught within the topic)
Cell Biology topic:
• Animal and plant cells
• Principles of organisation
• Most animal cells have a nucleus, cytoplasm, membrane, mitochondria and ribosomes.
• Plant and algal cells also have a cell wall and often have chloroplasts and a permanent vacuole.
• Functions of the organelles
• Cell specialisation
• Cell differentiation
• Stem cells are unspecialised cells that can differentiate to form many different types of cells.
• Stem cells from human embryos and adult bone marrow can be cloned and made to differentiate into different cells, eg nerve cells.
• Stem cells may be used to treat paralysis and diabetes in the future.
• Stem cells from meristems in plants are used to produce clones quickly and cheaply.
• Plant and animal cells are eukaryotic cells which have a membrane, cytoplasm and a nucleus.
• Bacterial cells are prokaryotic cells. They are smaller than eukaryotic cells and have a cell wall, membrane and cytoplasm, but do not have a nucleus.
• Microscopy * Required practical 1</td><td>Remembered Knowledge (knowledge that must be retained and remembered over time)
Cell Biology
• Function of organelles in a cell
• Adaptations of specialised cells
• Uses and ethics behind the use of stem cells
• Differences between prokaryotes and eukaryotes – with examples
• Calculating magnification
• Structure of DNA
• Mitosis / meiosis cell division
• Exchange mechanisms with examples in plants and animals – adaptations.</td><td>None negotiable GRIT tasks:</td><td>Ref.

Cell Biology
4.1.1.2
4.1.1.3
4.1.1.4
4.1.2.3
4.1.1.1
4.1.1.5
4.1.2.1
4.1.2.2
4.1.3.1
4.1.3.2</td></tr>
</table>

<table>
<tr>
<td rowspan="3"></td>
<td colspan="2">An electron microscope has a much higher magnification and resolution than a light microscope, so it can be used to study cells in much finer detail and show organelles.
real size=(image size)/magnification
Chromosomes are found in the nucleus. They are made of DNA. Each chromosome carries a large number of genes.
In body cells chromosomes are found in pairs
Mitosis and the cell cycle
Diffusion
Factors affecting the effectiveness of an exchange surface.
Osmosis
Water may move across cell membranes by osmosis.
Required practical 2 – must be carried out.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td colspan="4">Big Questions
Cell Biology:
How are cells arranged?
How are new cells made?
How do substances transport between and inside cells?</td>
</tr>
<tr>
<td></td>
<td colspan="4">Key Vocabulary (that must be explicitly taught to help students to understand)
Cell Biology
Cell, Nucleus, Cell Membrane, Cytoplasm, Mitochondria, Ribosomes, Chloroplast, Vacuole, Cell Wall, Plasmid, Prokaryote, Eukaryote, Specialised, Differentiation, Magnification, Microscopy, Chromosomes, Gene, Mitosis, Undifferentiated, Stem Cell, Meristem, Embryo, Diffusion, Concentration, Excretion, Osmosis, Dilute, Active transport.</td>
</tr>
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Year 10 – Science – Knowledge Map-Chemistry – *Triple content only*

Year 10 Knowledge Concepts:

<table>
<tr>
<td rowspan="2">Autumn (Yr10)</td>
<td colspan="2">Topic(s):
Atomic Structure Review
Chemical Changes
Quantitative Chemistry</td>
<td></td>
<td colspan="3">Key Concepts Explored:
Atomic Structure: structure of the atom, charges, elements, mixtures, compounds
Chemical Changes: extraction of metals, reactivity, electricity, properties and uses of metals
Quantitative Chemistry: relationships between numerical values in equations, factors, multipliers, conversion of units.</td>
</tr>
<tr>
<td colspan="3">Explicit Knowledge (Working knowledge to be explicitly taught within the topic)
Atomic Structure and The Periodic Table (Review Only)
• All substances are made of atoms. An atom is the smallest part of an element that can exist.
• Atoms of each element are represented by a chemical symbol, eg O represents an atom of oxygen, Na represents an atom of sodium.
• There are about 100 different elements. Elements are shown in the periodic table.
• Compounds are formed from elements by chemical reactions. Chemical reactions always involve the formation of one or more new substances, and often involve a detectable energy change. Compounds contain two or more elements chemically combined in fixed proportions and can be represented by formulae using the symbols of the atoms from which they were formed. Compounds can only be separated into elements by chemical reactions.
• Chemical reactions can be represented by word equations or equations using symbols and formulae.
• (HT only) write balanced half equations and ionic equations where appropriate. Factors affecting the effectiveness of an exchange surface.</td>
<td>Remembered Knowledge (knowledge that must be retained and remembered over time)
Atomic Structure and the Periodic Table
• Use the names and symbols of the first 20 elements in the periodic table, the elements in Groups 1 and 7, and other elements in this specification
• Name compounds of these elements from given formulae or symbol equations
• Write word equations for the reactions in this specification
• Write formulae and balanced chemical equations for the reactions in this specification.
• Describe, explain and give examples of the specified processes of separation</td>
<td>None negotiable GRIT tasks:</td>
<td>Ref.
Atomic Structure and the Periodic Table
5.1.1.1
5.1.1.2
5.1.1.3
5.1.1.4
5.1.1.5
5.1.1.6
5.1.1.7
5.8.1.3

5.1.2.1
5.1.2.2
5.1.2.3
5.1.2.4
5.1.2.5
5.1.2.6</td>
</tr>
</table>

	• A mixture consists of two or more elements or compounds not chemically combined together. The chemical properties of each substance in the mixture are unchanged. • Mixtures can be separated by physical processes such as filtration, crystallisation, simple distillation, fractional distillation and chromatography. These physical processes do not involve chemical reactions and no new substances are made. • Chromatography can be used to separate mixtures and can give information to help identify substances. Chromatography involves a stationary phase and a mobile phase. Separation depends on the distribution of substances between the phases. • The ratio of the distance moved by a compound (centre of spot from origin) to the distance moved by the solvent can be expressed as its Rf value: Rf = distance moved by substance distance moved by solvent • Different compounds have different Rf values in different solvents, which can be used to help identify the compounds. The compounds in a mixture may separate into different spots depending on the solvent but a pure compound will produce a single spot in all solvents. • **Required practical activity 12:** investigate how paper chromatography can be used to separate and tell the difference between coloured substances. • New experimental evidence may lead to a scientific model being changed or replaced. • Before the discovery of the electron, atoms were thought to be tiny spheres that could not be divided. • The discovery of the electron led to the plum pudding model of the atom. The plum pudding model suggested that the atom is a ball of positive charge with negative electrons embedded in it. • The results from the alpha particle scattering experiment led to the conclusion that the mass of an atom was concentrated at the	• Suggest suitable separation and purification techniques for mixtures when given appropriate information. • Explain how paper chromatography separates mixtures • Suggest how chromatographic methods can be used for distinguishing pure substances from impure substances • Interpret chromatograms and determine Rf values from chromatograms • Why the new evidence from the scattering experiment led to a change in the atomic model • The difference between the plum pudding model of the atom and the nuclear model of the atom. • Use the nuclear model to describe atoms. • Calculate the numbers of protons, neutrons and electrons in an atom or ion, given its atomic number and mass number. • Relate size and scale of atoms to objects in the physical world. • Calculate the relative atomic mass of an element given the		**Chemical Changes** **4.4.1.1** **4.4.1.2** **4.4.1.3** **4.4.1.4** **4.4.2.1** **4.4.2.2** **4.4.2.3** **4.4.2.4** **4.4.2.5** **4.4.2.6** **Chemical Changes (Electrolysis)** **4.4.3.1** **4.4.3.2** **4.4.3.3** **4.4.3.4** **4.4.3.5**

	centre (nucleus) and that the nucleus was charged. This nuclear model replaced the plum pudding model. • Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances. The theoretical calculations of Bohr agreed with experimental observations. • Later experiments led to the idea that the positive charge of any nucleus could be subdivided into a whole number of smaller particles, each particle having the same amount of positive charge. The name proton was given to these particles. • The experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus. This was about 20 years after the nucleus became an accepted scientific idea. • The relative electrical charges of the particles in atoms are: proton +1; neutron 0; electron -1 • In an atom, the number of electrons is equal to the number of protons in the nucleus. Atoms have no overall electrical charge. • The number of protons in an atom of an element is its atomic number. All atoms of a particular element have the same number of protons. Atoms of different elements have different numbers of protons. • Atoms are very small, having a radius of about 0.1 nm (1 x 10-10 m). The radius of a nucleus is less than 1/10 000 of that of the atom (about 1 x 10-14 m). • Almost all of the mass of an atom is in the nucleus. • The relative masses of protons, neutrons and electrons are: proton 1; neutron 1; electron very small • The sum of the protons and neutrons in an atom is its mass number. • Atoms of the same element can have different numbers of neutrons; these atoms are called isotopes of that element. • Atoms can be represented as shown on periodic table	percentage abundance of its isotopes. • Answer questions in terms of either energy levels or shells • Explain how the position of an element in the periodic table is related to the arrangement of electrons in its atoms and hence to its atomic number • Predict possible reactions and probable reactivity of elements from their positions in the periodic table. • Describe these steps in the development of the periodic table. • Explain the differences between metals and non-metals on the basis of their characteristic physical and chemical properties. This links to Group, Group 1, Group 7, and Bonding, structure and the properties of matter • Explain how the atomic structure of metals and non-metals relates to their position in the periodic table • Explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number.		**Quantitative Chemistry** **4.3.1.1** **4.3.1.2** **4.3.1.3** **4.3.1.4** **4.3.2.1** **4.3.2.2** **4.3.2.3** **4.3.2.4** **4.3.2.5** **4.3.3.1** **4.3.3.2** **4.3.4** **4.3.5**

	• The relative atomic mass of an element is an average value that takes account of the abundance of the isotopes of the element. • The electrons in an atom occupy the lowest available energy levels (innermost available shells). The electronic structure of an atom can be represented by numbers or by a diagram. For example, the electronic structure of sodium is 2,8,1 or showing two electrons in the lowest energy level, eight in the second energy level and one in the third energy level. • The elements in the periodic table are arranged in order of atomic (proton) number and so that elements with similar properties are in columns, known as groups. The table is called a periodic table because similar properties occur at regular intervals. • Elements in the same group in the periodic table have the same number of electrons in their outer shell (outer electrons) and this gives them similar chemical properties. • Before the discovery of protons, neutrons and electrons, scientists attempted to classify the elements by arranging them in order of their atomic weights. • The early periodic tables were incomplete and some elements were placed in inappropriate groups if the strict order of atomic weights was followed. • Mendeleev overcame some of the problems by leaving gaps for elements that he thought had not been discovered and in some places changed the order based on atomic weights. • Elements with properties predicted by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct. • Elements that react to form positive ions are metals. • Elements that do not form positive ions are non-metals. • The majority of elements are metals. Metals are found to the left and towards the bottom of the periodic table. Non-metals are found towards the right and top of the periodic table.	• Explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms • Predict properties from given trends down the group. • Describe the reactions of the first three alkali metals with oxygen, chlorine and water. • Explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms • Predict properties from given trends down the group. • Describe the nature of the compounds formed when chlorine, bromine and iodine react with metals and non-metals. • Explain how properties of the elements in Group 7 depend on the outer shell of electrons of the atoms Predict properties from given trends down the group. **Chemical Changes** • explain reduction and oxidation in terms of loss or gain of oxygen.		

	• The elements in Group 0 of the periodic table are called the noble gases. They are unreactive and do not easily form molecules because their atoms have stable arrangements of electrons. The noble gases have eight electrons in their outer shell, except for helium, which has only two electrons. • The boiling points of the noble gases increase with increasing relative atomic mass (going down the group). • The elements in Group 1 of the periodic table are known as the alkali metals and have characteristic properties because of the single electron in their outer shell. • In Group 1, the reactivity of the elements increases going down the group. • The elements in Group 7 of the periodic table are known as the halogens and have similar reactions because they all have seven electrons in their outer shell. The halogens are non-metals and consist of molecules made of pairs of atoms. • In Group 7, the further down the group an element is the higher its relative molecular mass, melting point and boiling point. • In Group 7, the reactivity of the elements decreases going down the group. A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt. ***Chemical Changes*** **Reactivity of Metals** • Metals react with oxygen to produce metal oxides. The reactions are oxidation reactions because the metals gain oxygen. Students should be able to explain reduction and oxidation in terms of loss or gain of oxygen. • When metals react with other substances the metal atoms form positive ions. The reactivity of a metal is related to its tendency to form positive ions. Metals can be arranged in order of their reactivity in a reactivity series. The metals potassium, sodium,	• recall and describe the reactions, if any, of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water or dilute acids and where appropriate, to place these metals in order of reactivity • explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion • deduce an order of reactivity of metals based on experimental results. • interpret or evaluate specific metal extraction processes when given appropriate information • identify the substances which are oxidised or reduced in terms of gain or loss of oxygen. • 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		

	lithium, calcium, magnesium, zinc, iron and copper can be put in order of their reactivity from their reactions with water and dilute acids. The non-metals hydrogen and carbon are often included in the reactivity series. A more reactive metal can displace a less reactive metal from a compound. • The reactions of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water or dilute acids and where appropriate, to place these metals in order of reactivity • The reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion • Deduce an order of reactivity of metals based on experimental results. • The reactions of metals with water and acids are limited to room temperature and do not include reactions with steam. • Unreactive 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. Metals less reactive than carbon can be extracted from their oxides by reduction with carbon. Reduction involves the loss of oxygen. Knowledge and understanding are limited to the reduction of oxides using carbon. Knowledge of the details of processes used in the extraction of metals is not required. • Interpret or evaluate specific metal extraction processes when given appropriate information • Identify the substances which are oxidised or reduced in terms of gain or loss of oxygen. • (HT ONLY) Oxidation is the loss of electrons and reduction is the gain of electrons • Write ionic equations for displacement reactions • Identify in a given reaction, symbol equation or half equation which species are oxidised and which are reduced. • Acids react with some metals to produce salts and hydrogen.	• 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 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. • 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 • (HT Only) calculate the chemical quantities in titrations involving concentrations in mol/dm3 and in g/dm3 • use and explain the terms dilute and concentrated (in terms of amount of substance), and weak and strong (in terms of the degree of ionisation) in relation to acids		

	• (HT ONLY) Explain in terms of gain or loss of electrons, that these are redox reactions • (HT ONLY) Identify which species are oxidised and which are reduced in given chemical equations. • Knowledge of reactions limited to those of magnesium, zinc and iron with hydrochloric and sulfuric acids. • Acids are neutralised by alkalis (eg soluble metal hydroxides) and bases (eg insoluble metal hydroxides and metal oxides) to produce salts and water, and by metal carbonates to produce salts, water and carbon dioxide. The particular salt produced in any reaction between an acid and a base or alkali depends on: the acid used (hydrochloric acid produces chlorides, nitric acid produces nitrates, sulfuric acid produces sulfates); the positive ions in the base, alkali or carbonate. • Soluble salts can be made from acids by reacting them with solid insoluble substances, such as metals, metal oxides, hydroxides or carbonates. The solid is added to the acid until no more reacts and the excess solid is filtered off to produce a solution of the salt. Salt solutions can be crystallised to produce solid salts • Acids produce hydrogen ions (H^+) in aqueous solutions. Aqueous solutions of alkalis contain hydroxide ions ($OH^–$). The pH scale, from 0 to 14, is a measure of the acidity or alkalinity of a solution, and can be measured using universal indicator or a pH probe. A solution with pH 7 is neutral. Aqueous solutions of acids have pH values of less than 7 and aqueous solutions of alkalis have pH values greater than 7. In neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water. • (TRIPLE ONLY) The volumes of acid and alkali solutions that react with each other can be measured by titration using a suitable indicator. • (HT ONLY) A strong acid is completely ionised in aqueous solution. Examples of strong acids are hydrochloric, nitric and sulfuric acids. A weak acid is only partially ionised in aqueous solution. Examples	• describe neutrality and relative acidity in terms of the effect on hydrogen ion concentration and the numerical value of pH (whole numbers only). **Chemical Changes (Electrolysis)** • predict the products of the electrolysis of binary ionic compounds in the molten state. • explain why a mixture is used as the electrolyte • explain why the positive electrode must be continually replaced. • predict the products of the electrolysis of aqueous solutions containing a single ionic compound. **Quantitative Chemistry** • the use of the multipliers in equations in normal script		

	of weak acids are ethanoic, citric and carbonic acids. For a given concentration of aqueous solutions, the stronger an acid, the lower the pH. As the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10. **Electrolysis** • When an ionic compound is melted or dissolved in water, the ions are free to move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called electrolytes. Passing an electric current through electrolytes causes the ions to move to the electrodes. Positively charged ions move to the negative electrode (the cathode), and negatively charged ions move to the positive electrode (the anode). Ions are discharged at the electrodes producing elements. This process is called electrolysis. • When a simple ionic compound (eg lead bromide) is electrolysed in the molten state using inert electrodes, the metal (lead) is produced at the cathode and the non-metal (bromine) is produced at the anode. • Metals can be extracted from molten compounds using electrolysis. Electrolysis is used if the metal is too reactive to be extracted by reduction with carbon or if the metal reacts with carbon. Large amounts of energy are used in the extraction process to melt the compounds and to produce the electrical current. Aluminium is manufactured by the electrolysis of a molten mixture of aluminium oxide and cryolite using carbon as the positive electrode (anode). • The ions discharged when an aqueous solution is electrolysed using inert electrodes depend on the relative reactivity of the elements involved. At the negative electrode (cathode), hydrogen is produced if the metal is more reactive than hydrogen. At the positive electrode (anode), oxygen is produced unless the solution contains halide ions when the halogen is produced. This happens	before a formula and in subscript within a formula • calculate the percentage by mass in a compound given the relative formula mass and the relative atomic masses. • explain any observed changes in mass in non-enclosed systems during a chemical reaction given the balanced symbol equation for the reaction and explain these changes in terms of the particle model. • 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, 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 (CO2). • calculate the masses of substances shown in a balanced symbol equation		

	because in the aqueous solution water molecules break down producing hydrogen ions and hydroxide ions that are discharged. • **Required practical 3:** investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis. • During electrolysis, at the cathode (negative electrode), positively charged ions gain electrons and so the reactions are reductions. At the anode (positive electrode), negatively charged ions lose electrons and so the reactions are oxidations. Reactions at electrodes can be represented by half equations. **Quantitative Chemistry** • The law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants. This means that chemical reactions can be represented by symbol equations which are balanced in terms of the numbers of atoms of each element involved on both sides of the equation. • The relative formula mass (Mr) of a compound is the sum of the relative atomic masses of the atoms in the numbers shown in the formula. In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown. • Some reactions may appear to involve a change in mass but this can usually be explained because a reactant or product is a gas and its mass has not been taken into account. For example: when a metal reacts with oxygen the mass of the oxide produced is greater than the mass of the metal or in thermal decompositions of metal carbonates carbon dioxide is produced and escapes into the atmosphere leaving the metal oxide as the only solid product. • Whenever a measurement is made there is always some uncertainty about the result obtained.	• calculate the masses of reactants and products from the balanced symbol equation and the mass of a given reactant or product. • 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 mass of solute in a given volume of solution of known concentration in terms of mass per given volume of solution • (HT only) explain how the mass of a solute and the volume of a solution is related to the concentration of the solution. • calculate the percentage yield of a product from the actual yield of a reaction • (HT only) calculate the theoretical mass of a product from a given mass of reactant and the balanced equation for the reaction.		

	• (HT ONLY) Chemical amounts are measured in moles. The symbol for the unit mole is mol. The mass of one mole of a substance in grams is numerically equal to its relative formula mass. One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance. 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 x 1023 per mole. • (HT ONLY) The masses of reactants and products can be calculated from balanced symbol equations. Chemical equations can be interpreted in terms of moles. For example: Mg + 2HCl MgCl2 + H2 shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas. • (HT ONLY) The balancing numbers in a symbol equation can be calculated from the masses of reactants and products by converting the masses in grams to amounts in moles and converting the numbers of moles to simple whole number ratios. • (HT ONLY) In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used. The reactant that is completely used up is called the limiting reactant because it limits the amount of products. • Many chemical reactions take place in solutions. The concentration of a solution can be measured in mass per given volume of solution, eg grams per dm3 (g/dm3). • (TRIPLE ONLY) Even though no atoms are gained or lost in a chemical reaction, it is not always possible to obtain the calculated amount of a product because: the reaction may not go to completion because it is reversible; some of the product may be lost when it is separated from the reaction mixture; some of the reactants may react in ways different to the expected reaction. The amount of a product obtained is known as the yield. When	• calculate the atom economy of a reaction to form a desired product from the balanced equation • (HT only) 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. • explain how the concentration of a solution in mol/dm3 is related to the mass of the solute and the volume of the solution • 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 • change the subject of a mathematical equation.		

compared with the maximum theoretical amount as a percentage, it is called the percentage yield. % Yield = Mass of product actually made Maximum theoretical mass o f product × 100

- (TRIPLE ONLY) The atom economy (atom utilisation) is a measure of the amount of starting materials that end up as useful products. It is important for sustainable development and for economic reasons to use reactions with high atom economy. The percentage atom economy of a reaction is calculated using the balanced equation for the reaction as follows: Relative formula mass of desired product from equation Sum of relative formula masses of all reactants from equation × 100
- (TRIPLE ONLY) The concentration of a solution can be measured in mol/dm3 . The amount in moles of solute or the mass in grams of solute in a given volume of solution can be calculated from its concentration in mol/dm3 . If the volumes of two solutions that react completely are known and the concentration of one solution is known, the concentration of the other solution can be calculated.

(TRIPLE ONLY) Equal amounts in moles of gases occupy the same volume under the same conditions of temperature and pressure. The volume of one mole of any gas at room temperature and pressure (20oC and 1 atmosphere pressure) is 24 dm3 . The volumes of gaseous reactants and products can be calculated from the balanced equation for the reaction.

Big Questions

- What is the role of atoms in the real world?
- What is the importance of the Periodic Table?
- How does the reactivity of a metal affect how it is extracted?

Key Vocabulary (that must be explicitly taught to help students to *understand*)

Atomic Structure and The Periodic Table

Alkali metals, Atom, Atomic nucleus, Atomic number, Chromatography, Compound, Crystallisation, Displacement, Electron, Electron shell, Element, Filtration, Fractional distillation, Group (periodic table), Halogens, Ion, Isotope, Mass number, Metals, Mixture, Neutron, Noble gases, Non-metals, Nuclear model, Periodic table, Plum pudding model, Proton, Relative atomic mass, Simple distillation, Transition metals.

		Chemical Changes Acid, Alkali, Crystallisation, Displacement, Electrolysis, Electrolyte, Extraction, Filtration, Negative electrode (cathode), Neutralisation, Oxidation, pH scale, Positive electrode (anode), Redox reaction, Reduction, Reduction with carbon, Strong acid, The reactivity series, Titration, Universal indicator, Weak acid. **Quantitative Chemistry** Actual yield, Atom economy , Avogadro constant, Avogadro's law, Concentration, Conservation of mass, Limiting reactant, Mole, Percentage by mass, Percentage yield, Relative formula mass, Theoretical yield, Thermal decomposition, Uncertainty.

Year 11 – Science – Knowledge Map-Physics– *Triple content only*

Year 11 Knowledge Concepts:

Autumn (Yr11)	**Topic(s):** **Space physics (physics only)**	**Key Concepts Explored:** **Space physics**: Our solar system, The life cycle of a star, Orbital motion, natural and artificial satellites, Red-shift.		
	Explicit Knowledge (Working knowledge to be explicitly taught within the topic) **Solar system; stability of orbital motions; satellites (physics only)** • Within our solar system there is one star, the Sun, plus the eight planets and the dwarf planets that orbit around the Sun. Natural satellites, the moons that orbit planets, are also part of the solar system. • Our solar system is a small part of the Milky Way galaxy. • The Sun was formed from a cloud of dust and gas (nebula) pulled together by gravitational attraction. • At the start of a star's life cycle, the dust and gas drawn together by gravity causes fusion reactions • Fusion reactions lead to an equilibrium between the gravitational collapse of a star and the expansion of a star due to fusion energy. • A star goes through a life cycle. The life cycle is determined by the size of the star. • Fusion processes in stars produce all of the naturally occurring elements. Elements heavier than iron are produced in a supernova. • The explosion of a massive star (supernova) distributes the elements throughout the universe. • Gravity provides the force that allows planets and satellites (both natural and artificial) to maintain their circular orbits. • For circular orbits, the force of gravity can lead to changing velocity but unchanged speed • For a stable orbit, the radius must change if the speed changes.	**Remembered Knowledge** (knowledge that must be retained and remembered over time) **Space physics** • Fusion reactions lead to an equilibrium between the gravitational collapse of a star and the expansion of a star due to fusion energy. • Gravity provides the force that allows planets and satellites (both natural and artificial) to maintain their circular orbits	**None negotiable GRIT tasks:** Magnetism and Space SQ: How do we observe the properties of a magnetic field? How do we observe the properties of a magnetic field?	Ref. **Space physics** 4.8.1.1 4.8.1.2 4.8.1.3 4.8.2.1

	Red-shift (physics only) • There is an observed increase in the wavelength of light from most distant galaxies. The further away the galaxies, the faster they are moving and the bigger the observed increase in wavelength. This effect is called red-shift. • The observed red-shift provides evidence that space itself (the universe) is expanding and supports the Big Bang theory. • The Big Bang theory suggests that the universe began from a very small region that was extremely hot and dense. • Since 1998 onwards, observations of supernovae suggest that distant galaxies are receding ever faster. • The change of each galaxy's speed with distance is evidence of an expanding universe • There is still much about the universe that is not understood, for example dark mass and dark energy.		TRIPLE: How do we change the potential difference in a system? TRIPLE: What happens as a star comes to the end of its life? TRIPLE: How did the Universe begin?	
		Big Questions **Space physics** • How does the structure of the universe evolve over time?		
		Key Vocabulary (that must be explicitly taught to help students to *understand*) **Space physics** Artificial satellite, Big Bang theory, black dwarf, black hole, circular orbit, dark energy, dark mass, dark matter, dwarf planet equilibrium, expand, fusion energy, fusion reaction, galaxy, gravitational collapse, gravitational field, gravitational force (gravity), main sequence star, Milky Way, moon, natural satellite, nebula, nuclear fusion, neutron star, orbit, planet, protostar, radiation, red giant, red super giant, red-shift, solar system, stable orbit, star, Sun, supernova, universe, wavelength, white dwarf.		

Year 11 – Science – Knowledge Map – Working scientifically

<table>
<tr>
<td rowspan="2">Spring (Yr11)</td>
<td>Topic(s): Working Scientifically</td>
<td></td>
<td colspan="3">Key Concepts Explored: The development of scientific thinking; experimental skills and strategies; analysis and evaluation; vocabulary, units, symbols and nomenclature</td>
</tr>
<tr>
<td colspan="2">Explicit Knowledge (Working knowledge to be explicitly taught within the topic)

1. The development of scientific thinking
• the ways in which scientific methods and theories develop over time
• using a variety of concepts and models to develop scientific explanations and understanding
• appreciating the power and limitations of science and considering ethical issues which may arise
  ○ Explain why data is needed to answer scientific questions, and why it may be uncertain, incomplete or not available.
  ○ Outline a simple ethical argument about the rights and wrongs of a new technology.
• explaining every day and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments
  ○ Describe and explain specified examples of the technological applications of science.
  ○ Describe and evaluate, with the help of data, methods that can be used to tackle problems caused by human impacts on the environment.
• evaluating risks both in practical science and the wider societal context, including perception of risk</td>
<td>Remembered Knowledge (knowledge that must be retained and remembered over time)

• outlining a simple ethical argument
• describing applications of science
• describe and evaluate data and methods
• hazards/risks involved when working with scientific equipment and how to identify these
• Importance of peer review
• Making a hypothesis
• Writing a method
• Identifying independent, dependent and control variables
• Understanding how to use apparatus
• Read measurements off a scale
• Assess whether an experiment is reliable and</td>
<td>None negotiable GRIT tasks:</td>
<td>Ref.
National Curriculum KS4 – pages 5 and 6.

AQA spec –
WS 1.3
WS 1.4
WS 1.5
WS 1.6
WS 2.1
WS 2.2
WS.2.3
WS 2.4
WS 2.5
WS 2.6
WS 2.7
WS 3.1
WS 3.2
WS 3.3
WS 3.4
WS 3.5
WS 3.6</td>
</tr>
</table>

	○ Give examples to show that there are hazards associated with science-based technologies which have to be considered alongside the benefits. ○ Suggest reasons why the perception of risk is often very different from the measured risk (eg voluntary vs imposed risks, familiar vs unfamiliar risks, visible vs invisible hazards). • recognising the importance of peer review of results and of communication of results to a range of audiences. ○ Explain that the process of peer review helps to detect false claims and to establish a consensus about which claims should be regarded as valid. ○ Explain that reports of scientific developments in the popular media are not subject to peer review and may be oversimplified, inaccurate or biased. 2. Experimental Skills and Strategies • using scientific theories and explanations to develop hypotheses ○ Suggest a hypothesis to explain given observations or data. • planning experiments to make observations, test hypotheses or explore phenomena ○ Describe a practical procedure for a specified purpose. ○ Explain why a given practical procedure is well designed for its specified purpose. ○ Explain the need to manipulate and control variables ○ Identify in a given context: ▪ the independent variable as the one that is changed or selected by the investigator ▪ the dependent variable that is measured for each change in the independent variable ▪ control variables and be able to explain why they are kept the same. ○ Apply understanding of apparatus and techniques to suggest a procedure for a specified purpose.	reproducible by evaluating a method • Constructing and interpreting tables, bar graphs and line graphs • Plotting variables from experimental data • Significant figures • Order of magnitude • Change the subject of an equation • Substitute numerical values into algebraic equations • Calculating mean, median, mode		WS 3.7 WS 3.8 WS 4.1 WS 4.2 WS 4.3 WS 4.4 WS 4.5 WS 6.6

	• applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments 　○ Describe/suggest/select the technique, instrument, apparatus or material that should be used for a particular purpose, and explain why. • carrying out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations 　○ Identify the main hazards in specified practical contexts. 　○ Suggest methods of reducing the risk of harm in practical contexts. • recognising when to apply a knowledge of sampling techniques to ensure any samples collected are representative 　○ Suggest and describe an appropriate sampling technique in a given context. • making and recording observations and measurements using a range of apparatus and methods 　○ Read measurements off a scale in a practical context and record appropriately. • evaluating methods and suggesting possible improvements and further investigations. 　○ Assess whether sufficient, precise measurements have been taken in an experiment. 　○ Evaluate methods with a view to determining whether or not they are valid. 3. Analysis and Evaluation • applying the cycle of collecting, presenting and analysing data, including: 　○ presenting observations and other data using appropriate methods			

	▪ Construct and interpret frequency tables and diagrams, bar charts and histograms. ▪ Plot two variables from experimental or other data. ○ translating data from one form to another ▪ Translate data between graphical and numeric form. ○ carrying out and representing mathematical and statistical analysis ▪ use an appropriate number of significant figures ▪ find the arithmetic mean and range of a set of data ▪ construct and interpret frequency tables and diagrams, bar charts and histograms ▪ make order of magnitude calculations ▪ change the subject of an equation ▪ substitute numerical values into algebraic equations using appropriate units for physical quantities ▪ determine the slope and intercept of a linear graph ▪ draw and use the slope of a tangent to a curve as a measure of rate of change ▪ understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate ○ representing distributions of results and making estimations of uncertainty ▪ Apply the idea that whenever a measurement is made, there is always some uncertainty about the result obtained. ▪ Use the range of a set of measurements about the mean as a measure of uncertainty. ○ interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions			

	■ Use data to make predictions. ■ Recognise or describe patterns and trends in data presented in a variety of tabular, graphical and other forms. ■ Draw conclusions from given observations ○ presenting reasoned explanations, including relating data to hypotheses ■ Comment on the extent to which data is consistent with a given hypothesis. ■ Identify which of two or more hypotheses provides a better explanation of data in a given context. ○ being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error ■ Apply the following ideas to evaluate data to suggest improvements to procedures and techniques. ■ An accurate measurement is one that is close to the true value. ■ Measurements are precise if they cluster closely ■ Measurements are repeatable when repetition, under the same conditions by the same investigator, gives similar results. ■ Measurements are reproducible if similar results are obtained by different investigators with different equipment ■ Measurements are affected by random error due to results varying in unpredictable ways; these errors can be reduced by making more measurements and reporting a mean value. ■ Systematic error is due to measurement results differing from the true value by a consistent amount each time.			

	▪ Any anomalous values should be examined to try to identify the cause and, if a product of a poor measurement, ignored. • communicating the scientific rationale for investigations, including the methods used, the findings and reasoned conclusions, using paper-based and electronic reports and presentations. ○ Present coherent and logically structured responses, using the ideas in 2 Experimental skills and strategies and 3 Analysis and evaluation, applied to the required practicals, and other practical investigations given appropriate information. 4. Vocabulary, units, symbols and nomenclature The knowledge and skills in this section apply across the specification, including the required practicals. • developing their use of scientific vocabulary and nomenclature • recognising the importance of scientific quantities and understanding how they are determined • using SI units and IUPAC chemical nomenclature unless inappropriate • using prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano) • interconverting units • using an appropriate number of significant figures in calculations.			

		Big Questions **Working Scientifically** 1. What does thinking scientifically mean? 2. What skills do I need for experiments? 3. How do I analyse and evaluate data?
		Key Vocabulary (that must be explicitly taught to help students to *understand*)

		Accuracy, calibration, data, error, measurement, anomalies, random error, systematic error, zero error, evidence, fair test, hypothesis, interval, precision, range, repeatable, reproducible, resolution, graph, true value, uncertainty, validity, valid conclusion, variables, categoric, continuous, control, dependent, independent, significant figure, mean, median, mode, average, equipment, method, analyse, evaluate, conclude, predictions, calculate