Topic 1 PHYSICS Particle model	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
The particle model is widely used to predict the behaviour of solids, liquids and gases and this has many applications in everyday life. It helps us to explain a wide range of observations and engineers use these principles when designing vessels to withstand high pressures and temperatures, such as submarines and spacecraft. It also explains why it is difficult to make a good cup of tea high up a mountain!	LINKING <u>KS2</> States of matter Simple physical properties of materials. **Year 7** Particle model Separating Mixtures **Year 8** Elements Periodic Table <u>KS4</> LOOKING **Year 10** Atomic structure – chemistry Particle model – physics **Year 11** Rates – chemistry **Post 16** Kinetic theory	**<u>Lesson 1 – Particle Theory</u>** *…that* properties of solids, liquids and gases in terms of the particles in each state of matter. Particles are moving and have kinetic energy. *…. how to* link arrangement of the particles in each state of matter to their properties and be able to compare them.	Particle solids, liquids, property, gases, forces of attraction, density	**<u>Numeracy</u>** Calculate density Construction of a heating curve Calculate specific latent heat. Calculate specific heat capacity **b) <u>Literacy</u>** Improvement of vocabulary bank – tier 2 -displacement, capacity, property **c) <u>Reading</u>** Reading for understanding, exemplar question contexts. **d) <u>Cultural Capital/Careers</u>** Archimedes ‘Eureka moment.’ **e) <u>Cross curricular knowledge links</u>** Selection of materials for cooking pans – food technology. Heat transfer – DT – materials. **f) <u>Misconceptions</u>** Substances are continuous – no recognition of the particle ideas Particles are within the substance rather than particles being the substance / bulk properties Density is mass per unit volume not how heavy something is.
		<u>Lesson 2 – Density Calculations</u> *…that* density is the mass which is contained in a given volume. A denser material will sink in a less dense material. *…. how to* calculate the density of a given material using: density = mass/volume. How to convert between g and Kg, and ml and l.	Density, mass, volume, formula.	
		<u>Lesson 3 and 4 - Density Practical</u> *…that* displacement can be used to find the volume of an irregular object. *…. how to* practically determine the volume of an irregular shaped object.	Density, displacement, irregular, regular	
		<u>Lesson 5 – Changes of State</u> *…that* If enough energy is added to or removed from an arrangement of particles a change of state can occur. Evaporation occurs when particles near the surface of the liquid have enough energy to escape *…how to* determine what happens to temperature during changes of state.	State, temperature, heat, melt, evaporate, condense, freeze, sublimation.	
		<u>Lesson 6 and 7 –Internal Energy</u> *…that* the total kinetic energy and potential energy of all the particles (atoms and molecules) that make up a system is known as the internal energy. *…how to* construct and interpret a heating/cooling curve.	Internal, kinetic, potential, independent, dependent, control, variables	
		<u>Lesson 8 – Specific Latent Heat</u> *…that* Specific Latent Heat is the energy absorbed by a substance during a change of state *…how to* calculate specific latent heat.	Specific latent heat Latent, heat, internal energy, mass, joules, kilograms,	

	Gas Laws Atomic structure		fusion, vaporisation, vapour	

Topic 2 CHEMISTRY Atomic structure	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
The periodic table provides chemists with a structured organisation of the known chemical elements from which they can make sense of their physical and chemical properties The historical development of the periodic table and models of atomic structure provide good examples of how scientific ideas and explanations develop over time as new evidence emerges.	 KS3 **Year 7** Matter, separating mixtures. **Year 8** Elements, periodic table. KS4  **Year 10** Structure and bonding **Year 11** Atomic structure Structure and bonding **Post 16** Atomic structure Structure and bonding	**Lesson 1 – Compounds and Formulae** *…that* Elements are materials made up of one type of atom. Compounds contain two or more different types of atom, chemically bonded together *…. how to* distinguish between compounds and elements and write simple chemical formulae. Interpret particle diagrams.	Atom, element, compound	**a) Numeracy** Electronic configuration **b) Literacy** Learn significant number of subject specific vocabulary and use in correct context. **c) Reading** Describe how scientific models develop over time. Reading in different formats e.g. timeline. **d) Cultural Capital/Careers** Understand the historical significance and contributions of Dalton and Mendeleev to the development of the periodic Table. **e) Cross curricular knowledge links** DT – materials **f) Misconceptions** Chemicals are not bad for you, everything is made up of chemicals. We can't see atoms and haven't been able to until around 2018, scientists have used other practical techniques to be able to predict what we know about atoms. Theories of atoms have changed over time, a theory is not just an idea, and it has experimental evidence behind it.
		Lesson 2 – Separating Mixtures *…that* a mixture is made up of two or more substances that are not chemically joined together. Mixtures can be separated according to their properties. *…. how to* select the best method for separation of a given mixture, including appropriate apparatus. *…why* a particular method is most appropriate.	Mixture, purity, separation, evaporation, filtration, evaporation, chromatography Solute, solvent, solution.	
		Lesson 3 – Potable Water *…that* potable water, is water which is safe to drink potable water can be obtained by distillation *….how to* explain the process of simple distillation.	Potable, pure, boiling point, melting point	
		Lesson 4 – Structure of the Atom *…that* the atom can be describes in terms of sub atomic particles. Isotopes are atoms of elements with the same number of protons but different numbers of neutrons. *…how to* calculate the numbers of protons, electrons and neutrons in an atom.	Protons, electrons, neutrons, isotopes, sub atomic particle, electronically neutral.	
		Lesson 5 – Developing the Atomic Model *…that* the model of the atom has changed over time, starting with Dalton's idea of atoms being tiny solid	Plum pudding, Bohr, nuclear model, Rutherford.	

		balls to the plum pudding model to the Bohr model of the atom that is used today. ….*how to* compare models of the atom over time.		There is not only one type of atom but 118 known types, these types are called elements.
		Lesson 6 – Electron Configuration *…that* electrons have a specific arrangement in the atom, occupying the lowest energy level first and filling up a shell before moving to the next. ….*how to* arrange the electrons of the first 20 elements.	Electrons, shells, energy levels Electron configuration. occupy	
		Lesson 7 – The Periodic Table *…that* the Periodic table is arranged in columns called groups and rows called periods. The structure of the Periodic table has changed over time. ….*how to* the scientists John Newlands, and Dimitri Mendeleev contributed to the development of the Periodic table.	Period, group	
		Lesson 8 – Group 1 Elements *…that* group 1 are known as the alkali metals and react in a similar way, but the reactivity increases down the group. ….*how to* account for the increase in reactivity down group 1.	Electron configuration, shielding, reactivity.	
		Lesson 9 and 10 – Group 7 Elements *…that* group 7 elements are known as the halogens and undergo displacement reactions. Group 7 elements react in a similar way, but the level of reactivity decreases down the group. *…how to* explain the trend in reactivity down group 7.	Reactivity, electrons, displacement.	
		Lesson 11 – Group 0 and Transition Metals *…that* transition metals are less reactive, denser, harder, and stronger than group 1 metals. Transition metals can be used as catalysts and have coloured compounds.	Transition metal Noble gases Electron configuration	

		…that Group 0 are known as the Noble gases, have full shells of electrons. *…how to* compare the reactivity of group 1 and the transition metals. Explain the unreactivity of group 0.		

Topic 3 BIOLOGY Cell Biology	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
Cells are the basic unit of all forms of life. In this section we explore how structural differences between types of cells enables them to perform specific functions within the organism. These differences in cells are controlled by genes in the nucleus. For an organism to grow, cells must divide by mitosis producing two new identical cells	LINKING KS3 **Year 7** Cells **Year 8** organisms KS4 LOOKING **Year 10** Cells and organisation **Year 11** Cells and organisation **Post 16** Sub cellular organelles, structure and function. Moving substances in and out of cells.	**Lesson 1 – Plant and Animal Cells** *…that* all living things are made of cells A cell is the simplest unit of a living thing. The basic construction of plant and animal cells. *….how to* distinguish between animal and plant cells.	Nucleus, cytoplasm, mitochondria, ribosomes, chloroplast, vacuole, cell membrane, cell wall, organelle.	**a) Numeracy** Using the formula triangles to rearrange magnification equation conversion of units (mm into µm) Expression of answers/numbers in standard form. Calculating surface area: volume ratios. Calculating rates of water uptake/% change. Present observations as tables, graphs, or drawings. Use estimations to judge the relative size or area of sub-cellular structures. **b) Literacy** 'Karyotic' means nucleus 'Pro' means before. 'Eu' means 'true'. Spelling and meanings homework to broaden scientific literacy. **c) Reading** Potential research homework on the cell. Guided reading tasks to support literacy development. **d) Cultural Capital/Careers** The discovery of the cell – Hooke Leeuwenhoek and his contribution to the development of the microscope. Careers in cell biology and microbiology Ethical implications of using stem cells research **e) Cross curricular knowledge links**
		Lesson 2 – Prokaryotic and Eukaryotic Cells *…that* animal and Plant cells are eukaryotic cells. Bacteria are prokaryotic cells. *….how to* distinguish between prokaryotic and eukaryotic cells.	Prokaryotic Eukaryotic	
		Lesson 3 - Cells, Tissues and Organs *…that* a tissue is a group of cells of the same type. An organ is a group of tissues that work together to perform a function. An organ system is a group of organs that work together to do a job.	Tissue, organ, organ system	
		Lesson 4 – Magnification *…that* magnification is making the size of an object appear bigger. *Actual Size = Image Size/ magnification* *….how to* calculate magnification and convert between mm and µm	Magnification, Image Microscope, focus, light, electron, sub- cellular, magnification, standard form	
		Lesson 5 – Comparing Microscopes *…that* some microscopes use light and have low resolution, others use an electron beam and have high resolution. *….how to* compare the advantages and disadvantages of the 2 types of microscope.	Magnification, resolution, light microscope, electron microscope, objective lens, stage, eyepiece focus	
		Lesson 6 – Microscopes Required Practical *…how* to use a light microscope to observe cells, *…how* to observe, draw and label any observable parts of an onion skin cell	Microscope, cover slip, stage, slide, focus, image, eyepiece, magnification	
		Lesson 7 – Stem Cells *…that* stem cells are undifferentiated cells, they are not specialised. Stem cells may be found in embryos and bone marrow of adults.	Stem cell, differentiated, meristem	

		In plants meristems in roots and shoots can develop into any kind of cell. *….how to* compare different types of stem cells.		**f) <u>Misconceptions</u>** Distinguishing between cell membrane and cell wall. On any cell diagram the inner line is the cell membrane. If the diagram has an outer line, it is a cell wall and must be a bacterial, plant or fungal cell. Nucleus, it is not 'the brain of the cell'. Don't write this in exams! The nucleus controls the cells activities as it contains the genetic code (DNA) to make the cells proteins. Mitochondria – release or transfer energy in the cell. Energy cannot be created nor destroyed so do not write about energy being made. Differentiation – is not cell division. Cell division means cells specialising because of different genes being expressed. Cell division means cells splitting in half. Stem cells – they are not the cells found the stems of plants. In plants they are found in meristems and can differentiate into any cell type. Plants have stem cells throughout their entire lives. Distinguishing between the terms osmosis, diffusion and active transport and direction of movement. Specific teaching of this tier 3 vocabulary needed. Diffusion → movement down a concentration gradient passively. Osmosis → diffusion/movement of water from a dilute to more concentrated solution passively via a semi or partially permeable membrane. Active transport → movement against a concentration gradient, it requires ATP.
		<u>Lesson 8 – Specialised Cells</u> *…that* some cells are adapted and specialised in order to carry out a specific function. When a cell develops new organelles it can become specialised to do a specific job. *….how to* link the adaptation of a cell to its function.	specialised cells, differentiation, function	
		<u>Lesson 9 – Chromosomes and DNA</u> *…that* the cell contains all the information required, in the form of DNA to produce new cells. Mitosis is the process by which cells divide for growth and repair purposes (asexual reproduction) *….how to* distinguish between genes & chromosomes DNA	Chromosome, gene, DNA, Mitosis, cell cycle, cell division, interphase, cytokinesis	
		<u>Lesson 10 - Cancer</u> *…that* cancer is a result of uncontrolled cell division. *…that* certain life styles have high risk towards developing a cancer as do some genetics. Tumours may be malignant or benign. *….how to* interpret graphs and data tables on lifestyles, risk factors and cancer.	Uncontrolled, tumour, benign Sunlight (UV), malignant Risk factors, metastasis	
		<u>Lesson 11 - Diffusion</u> *…that* diffusion is movement of particles from an area of high concentration to an area of low concentration. It is a passive process. *….how to* identify and explain the factors that affect the rate of diffusion.	Diffusion, concentration gradient, rate, particles	
		<u>Lesson 12 – Diffusion and Exchange Surfaces</u> *…that* single celled organisms exchange gases via diffusion. For diffusion to occur in complex organisms the exchange surface has certain adaptations. *….how to* describe and explain the adaptations of exchange surfaces.	Gas exchange Adaptation, diffusion, permeable membrane, surface area	
		<u>Lesson 13 – Osmosis</u> *…that* osmosis is the diffusion of water molecules, from a region where the water molecules are in higher concentration, to a region where they are in	diffusion, concentration gradient turgid, plasmolysis, partially, permeable membrane	

		lower concentration, through a partially permeable membrane. Osmosis is a passive process. *….how to* distinguish between diffusion and osmosis. Explain the effect of osmosis in cells. *…why* osmosis is important in plant cells.		
		Lesson 14 – Active Transport *…that* in active transport particles move against a concentration gradient. This process requires energy. …. *how to* explain the process by which nutrients enter root hair cells by active transport.	Active transport, energy.	
		Lesson 15 – Osmosis Practical *…how to* complete a practical to investigate the effects of osmosis on plant tissue	Osmosis, gradient	

Topic 4 PHYSICS Atoms & isotopes	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
New experimental evidence may lead to a scientific model being changed. The discovery of the electron led to the plum pudding model of the atom. The results from the alpha particle scattering experiment led to the development nuclear model.	LINKING KS3 **Year 7** Particle model **Year 8** Elements **Year 9** Chemistry – Atomic Structure KS4 LOOKING **Year 10** Particle model-paper 1 Atomic structure – paper 1 **Year 11** Particle model-paper 1 Atomic structure – paper 1 **Post 16** Nuclear physics.	**Lesson 1 and 2 – Structure of the Atom and Isotopes** *…that* the atom is made up of a central nucleus containing protons and neutrons with electrons orbiting it. Isotopes are different atoms of the same element, with the same number of protons but a different number of neutrons *….how to* describe the sub atomic particles in terms of mass and charge. Calculate the numbers of protons, electrons and neutrons in an atom. Determine the number of sub atomic particles in isotopes.	Proton, electron, neutron, nucleus, isotope.	a) **Numeracy** Calculation of protons, electrons & neutrons in the atom. Radioactive decay equations. b) **Literacy** Use of Greek symbols to represent types of radiation. c) **Reading** Reading for understanding on uses of radiation and irradiation; and exemplars of contamination. d) **Cultural Capital/Careers** What is involved in being a radiographer? e) **Cross curricular knowledge links** Food technology –use of irradiation to sterilise foods. DT – fire alarm and alpha radiation. f) **Misconceptions** Nuclei disappear when they decay – be careful when using the dice demo and removing the dice – they haven't disappeared! Half-life is half the time for the radioactivity to disappear.
		Lesson 3 – Development of the Atomic Model *…that* the theory of atomic structure has changed over time. The plum pudding model is based on a sphere of positive charge. *….how to* explain the results of Rutherford's scattering expt. *...why* the plum pudding model was no longer accepted.	Plum pudding, nuclear, Rutherford Alpha particles.	
		Lesson 4 – Types of Radiation *…that* there are 3 types of nuclear radiation *….how to* describe and explain the properties of each type of radiation.	Nucleus, ionising, penetrating, alpha, beta, gamma.	
		Lesson 5 – Nuclear Decay Equations *…that* Unstable isotopes can become stable by releasing different types of particles.	unstable, alpha, beta, gamma, decay	

		…how to describe and identify the type of radioactive decay which has taken place. Complete nuclear decay equations.		Confusion between the ideas of contamination and irradiation. Absorbing radiation makes things radioactive – you do not become radioactive by absorbing radiation. Beta particles are electrons so much come from the energy shells – this is incorrect – the beta particle is formed when a neutron changes into a proton Radiation was "invented" during World War II – it has actually been around since the Big Bang. Atoms cannot be changed from one element to another – arising from chemistry – they can change during alpha decay and fission and fusion. Once a material is radioactive it remains radioactive forever – it decays over time
		Lesson 6 – Uses of Radiation *…that* radiation has many uses *….how to* describe at least 5 different examples of radiation and explain how to use radiation safely for different purposes.	radiation, isotope, ionising	
		Lesson 7 – Irradiation and Contamination *…that* background radiation is all around us. Contamination is when radioactive atoms get onto objects from touching and handling radioactive substances. Irradiation happens when objects are exposed to radioactive particles, but do not become radioactive. *….how to* use text to extract accurate scientific information.	contamination irradiation mutation cancer	
		Lesson 8 – Half Life *…that* radioactive decay is random and that Half-life is the time it takes for the number of nuclei of a radioactive isotope in a sample to halve. *….how to* determine the half-life of an element from data. Construct graphs to determine half-life of an element.	half-life, nucleus, unstable	

Topic 5 CHEMISTRY Chemical changes	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
Understanding of chemical changes began when people began experimenting with chemical reactions in a systematic way and organising their results logically. Knowing about these different chemical changes meant that scientists could begin to predict exactly what new substances would be formed and use this knowledge to develop a wide range of different materials and processes	LINKING <u>KS3</u> **Year 7** Acids and alkalis Metals and non- metals **Year 8** Types of reaction <u>KS4</u> LOOKING **Year 10** Chemical changes – paper 1 **Year 11** Chemical changes – paper 1 **Post 16** Acid, alkali titrations. Types of acid. Neutralisation reactions.	**<u>Lesson 1 – Metals and Metal Oxides</u>** *…that* metals have distinct properties. *….how to* distinguish between group 1 and transition metals.	Metals, transition metals, groups, oxidation, catalyst	a) **<u>Numeracy</u>** Balancing equations for more able students. b) **<u>Literacy</u>** Etymology of words to describe metallic properties e.g. lustre. c) **<u>Reading</u>** Methods, hazard warnings. d) **<u>Cultural Capital/Careers</u>** e) **<u>Cross curricular knowledge links</u>** Geography –quarrying, social, environmental, economic impacts. f) **<u>Misconceptions</u>** Not all metals are magnetic, actually only three are magnetic Iron, nickel and cobalt. Iron is found in a lot of objects as steel (iron and carbon mixed together) is really strong so is used to make table legs, doors etc. Not all metals are found as pure metal on Earth, most are found in rocks as metal oxides or metal carbonates which are called ores. Strong and weak are not the same meaning as concentrated and dilute when talking about acids and alkalis. Strong means it is more likely to give or take a H+.
		<u>Lesson 2 – Metals in Acid</u> *…that* metals react with acids to produce a salt and hydrogen. *…that* metal reactivity depends upon the position in the reactivity series. *….how to* construct word equations.	Reactivity, metal, acid, product, reactant, salt, hydrogen	
		<u>Lesson 3 and 4 – Reactivity Series and Displacement Reactions</u> *…that* the reactivity series places metals in increasing order of reactivity and can be used to predict reactions. *….how to* use the reactivity series to predict whether or not a displacement reaction will happen.	ionic compounds, reactivity series, displacement	
		<u>Lesson 5 – Extracting Metals</u> *…that* the position of a metal in the reactivity series determines the method of extraction from its ore. *…..how to* evaluate the social, economic and environmental impacts of quarrying.	Reactivity series, metal, ore extraction, displace	
		<u>Lesson 6 – Acids and Alkalis</u> *…that* acids release H^+ ions when added to water. Alkalis are bases that will dissolve in water and release OH^- ions. *…that* there is a difference between strength and concentration. *…the* hazards in using acids and alkalis.	Acid, alkali, neutralisation, base,	

		Lesson 7 – Indicators and pH Scale *…that* indicators are chemicals which change colour to indicate pH of acids and alkalis. *…how to* use the pH scale to indicate the pH of acids and alkalis.	Indicators, litmus, universal indicators, acids, alkalis	Concentrated means there are more particles in a set volume. Dissolved substances can flow through a filter, this is why in a mixture of salt, sand and water a filter will only remove the sand. The salt as it is dissolved in the water will flow through the filter.
		Lesson 8 – Neutralisation and Naming Salts *…that* a salt is formed from an acid and a base. The metal and the acid determine the salt formed. *…how to* construct word equations for neutralisation reactions.	Neutralisation, salts, word equations	
		Lesson 9 and 10 – Making a soluble salt practical *….how to* prepare a pure, dry sample of a soluble salt from an insoluble oxide or carbonate.	evaporation, crystallisation, base, neutralisation, excess	

Topic 6 CHEMISTRY Organic Chemistry	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
The chemistry of carbon compounds is so important that it forms a separate branch of chemistry. A great variety of carbon compounds is possible because carbon atoms can form chains and rings linked by C-C bonds. The main sources of organic compounds are living, or once-living materials from plants and animals. These sources include fossil fuels, a major source of feedstock for the petrochemical industry. Chemists take organic molecules and modify to make	LINKING KS3 **Year 8** Elements, compounds, mixtures **Year 9** Atomic structure, separating mixtures KS4 LOOKING **Year 9** Chemistry of the Atmosphere **Year 10** Organic chemistry Using resources **Post 16** Organic chemistry	**Lesson 1 – Crude Oil** *…that* crude oil is a non-renewable resource made from the remains of microscopic organisms living in the sea. *….how to* interpret data linked to the availability and use of crude oil over time.	Crude oil, heat, pressure, mixture, hydrocarbon	**a) Numeracy** Interpreting charts and graphs on data linking crude oil and its uses. Using general formulae to predict formulae of alkanes and alkenes. **b) Literacy** Systematic naming of molecules in homologous series: meth-, eth-, prop-, etc. Key words in terms of properties of hydrocarbons and the etymology of these words. **c) Reading** Reading for information retrieval. Literacy homework. **d) Cultural Capital/Careers** Organic chemistry can help you get into careers in forensics, pharmaceuticals, making perfumes and flavours (Christmas dinner flavoured crisps!) **e) Cross curricular knowledge links** DT: polymers as design materials. Geography – crude oil as a finite resources **f) Misconceptions** Organic does not mean natural – it chemistry it refers to carbon chemistry. The “hydro” in hydrocarbons does not mean water – it means hydrogen. Saturated means no double bonds present – not a “saturated solution”
		Lesson 2 – Fractional Distillation *…that* crude oil can be separated into hydrocarbons of similar properties, called fractions. *….how to* describe the process of fractional distillation and explain the principles behind it.	crude oil, fractional distillation, fraction, alkane, mixture, separation	
		Lesson 3 – Alkanes and Properties *…that* the properties of alkanes vary according to the length of the carbon chain. *….how to* distinguish between alkanes according to viscosity, flammability, boiling point.	Flammable, viscous, saturated	
		Lesson 4 – Cracking Hydrocarbons …that long chain hydrocarbons can be split into smaller ones by cracking; thermal or catalytic. *…how to* construct cracking equations *…how to* distinguish between saturated and unsaturated compounds using bromine water.	Cracking, thermal, catalytic, saturated, unsaturated	
		Lesson 5 – Alkenes and Polymers *…that* alkenes are carbon compounds containing a C=C bond *…that p*olymers are formed from alkenes	Unsaturated, cracking, thermal, catalytic, monomer, polymer.	

new, useful materials such as polymers, pharmaceuticals, perfumes and flavourings, dyes and detergents.				

Topic 7 CHEMISTRY Chemistry of the atmosphere.	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
The Earth's atmosphere is dynamic and forever changing. The causes of these changes are sometimes man-made and sometimes part of natural cycles. Scientists use software to predict weather and climate change as there are many variables that can influence this. The problems caused by increased levels of air pollutants require scientists and engineers to develop	LINKING KS3 **Year 7** Materials **Year 8** Earth - climate KS4 LOOKING **Year 9** **Year 10** Earth's resources Chemical changes **Year 11** **Post 16**	**Lesson 1 – Composition of the Atmosphere** *… that* the atmosphere is a mixture of gases *…that* theories about what was in the Earth's early atmosphere and how the atmosphere was formed have changed over time. *…how to* interpret graphs and charts which compare atmospheres.	Composition, atmosphere	**a) Numeracy** Construct and interpret tables, graphs and charts on the composition of atmosphere of planets in the solar system. **b) Literacy** Scientific literacy – CO and CO_2 **c) Reading** Reading and summarising accounts on the development of the atmosphere and the effects of climate change. **d) Cultural Capital/Careers** Climate scientist. COP 25. International government agreements on mitigating climate change. George Monbiot – political activist on climate change and the environment. **e) Cross curricular knowledge links** Geography – climate change (f) **Misconceptions** The gas we breath in for respiration isn't the largest part of our atmosphere The proportion of gases has stayed the same for around 200 million years, it has only started to change over the last 200 in a very small way Global warming and cooling are natural and have happened in cycles since Earth
		Lesson 2 – Evolution of the Atmosphere *…that* the Earth's atmosphere evolved from early Earth to modern Earth *…how to* interpret evidence and evaluate different theories about the Earth's early atmosphere.	Evolution, dissolving, sedimentary photosynthesis	
		Lesson 3 – Carbon Dioxide and the Greenhouse Effect *…that* climate change is impacted by the greenhouse effect, *….how to* describe and explain the greenhouse effect and its consequences.	Carbon dioxide, methane, radiation, greenhouse gases, greenhouse effect.	
		Lesson 4 and 5 – Global Warming and Climate Change *…that* climate change is having a significant impact on the way we live, the weather and the habitats in our world. *…..how to* evaluate the impact climate change will have on agriculture, animals, ecosystems, coastal regions and water supplies.	climate change, environment, impact, precipitation, ecosystem	
		Lesson 6 – Products of Combustion *…that* combustion of fuels releases harmful products *…how to* prove the products of complete combustion	Pollutants, emissions, combustion, global dimming, Sulphur dioxide	

solutions that help mitigate human activity.		*….how to* link named emissions with the associated consequence.	Nitrogen oxides, Carbon monoxide	was a ball of molten rock, the argument is that humans have impacted on this cycle. Climate change and global warming are different, climate change is changes to the weather that can have drastic consequences, and global warming is the average warming of the Earth that causes climate change.

Topic 8 CHEMISTRY Analysis	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
Chemists have developed a range of qualitative tests to detect specific chemicals. The tests are based on reactions that produce a gas with distinctive properties, or a colour change or an insoluble solid that appears as a precipitate. Instrumental methods provide fast, sensitive and accurate means of analysing chemicals. Forensic scientists and drug control scientists rely on such instrumental methods in their work.	 KS3 **Year 7** States of matter **Year 8** Reaction types KS4  **Year 10** Analysis – chemistry **Year 11** **Post 16** Analysis using a range of chromatography techniques. Gas tests.	**Lesson 1 – Testing for Common Gases** *…that* carbon dioxide, oxygen, hydrogen and chlorine have specific tests which can be used to identify them *….how to* carry out the tests for carbon dioxide, hydrogen, chlorine and oxygen	Hydrogen, chlorine, carbon dioxide	a) **Numeracy** Calculating Rf values b) **Literacy** Scientific literacy on gas formulae c) **Reading** Reading for learning on case studies. d) **Cultural Capital/Careers** Forensic scientist. Food safety analyst. Food engineer. e) **Cross curricular knowledge links** f) **Misconceptions** A pure substance in chemistry means that it is only one type of particle, pure in general language means it hasn't had anything extra added to it such as pure orange juice. Orange juice isn't pure in chemistry as it contains sugars, water, pulp, and lots of other things. Chromatography results sometimes streak rather than showing specific dots, this is because too much of the mixture is placed on the paper.
		Lesson 2 –Pure Substances and Formulations *…that* a formulation is a specific mixture that has been designed as a useful product. Pure substances have a specific boiling point. Mixtures boil over a range of temperatures. *….how to* distinguish between a pure substance and a mixture.	Formulation, pure substance, mixture	
		Lesson 3 and 4 – Chromatography *…that* chromatography can be used to separate mixtures and can give information to help identify substances. *….how to* calculate Rf values *….how to* set up an investigation to find the content/ solubility of a dye and to calculate the Rf value.	Solvent, solute, chromatography, stationary phase, mobile phase.	

Topic 9 BIOLOGY Bioenergetics	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
Plants harness the Sun's energy in photosynthesis in order to make food. This process liberates oxygen which has built up over millions of years in the Earth's atmosphere. Both animals and plants use this oxygen to oxidise food in a process called aerobic respiration which transfers the energy that the organism needs to perform its functions. Conversely, anaerobic respiration does not require oxygen to transfer energy. During	LINKING KS3 **Year 7** Cells **Year 8** Organisms KS4 LOOKING **Year 9** Link to cells topic **Year 10** Bioenergetics **Year 11** Bioenergetics **Post 16** Photosynthesis – light dependent reaction and the Calvin cycle. Respiration – aerobic, anaerobic and Kreb's cycle.	**Lesson 1 – Aerobic Respiration** *…that* Aerobic respiration involves oxygen and is an exothermic reaction. *….how to* construct the equation for respiration and identify the source of the reactants.	energy, respiration, organisms, oxygen, glucose, proteins, temperature, aerobic, glycogen, mitochondria	**a) Numeracy** Construction of graphs from data tables and for the RP. Interpretation of data on heart rate and exercise. Calculation of breathing and heart rates from given data. b) **Literacy** Etymology of key words **c) Reading** Reading for scientific literacy on exercise and its effects on the body. **d) Cultural Capital/Careers** In 1634, Jan Baptist van Helmont was arrested by agents of the Spanish Inquisition for studying plants and other phenomena. While under house arrest, he started to consider how plants grew. **e) Cross curricular knowledge links** PE- Effect of exercise on heart rate & breathing. **f) Misconceptions** Unlike animals, plants do not eat. Carbon dioxide, minerals and water are not the plant's food. Plants produce food and that's why they're called producers in food chains. Plants obtain water from the soil via their roots, not through their leaves when
		Lesson 2 – Anaerobic Respiration *…that* when respiring cells are respiring too quickly to carry out aerobic respiration. *….how to* explain the phenomenon of oxygen debt and how it is repaid.	Anaerobic respiration, lactic acid, ethanol, oxygen debt.	
		Lesson 3 – The Response to Exercise *…that* Muscle fibres need a lot of energy to contract. *….how to* explain the body's response to demand for energy during exercise in terms of heart rate and breathing rate.	Mitochondria, heart rate, breathing rate.	
		Lesson 4 - Metabolism *…that* Metabolism is all the chemical reactions happening in the body e.g. respiration, breakdown of respiration. *…how to* explain the liver's function in metabolism & repaying oxygen debt.	Metabolism, liver, function, amino acids, lipids.	
		Lesson 5 – Photosynthesis Basics *…that* photosynthesis is an endothermic chemical reaction that uses light energy to make carbohydrates in plants. *….how to* construct the equation for photosynthesis	Photosynthesis, endothermic, chloroplast, chlorophyll.	
		Lesson 6 – Testing a Leaf for Starch *…that* glucose is converted to starch and is stored in plant leaves.	Ethanol, chlorophyll, starch	

vigorous exercise the human body is unable to supply the cells with sufficient oxygen and it switches to anaerobic respiration. This process will supply energy but also causes the build-up of lactic acid in muscles which causes fatigue.		*….how to* carry out a test to show the presence of starch in a photosynthesising leaf.		rain falls on them. In fact, most plant leaves are adapted to allow rain water to fall to the ground. Breathing is not the same as respiration. Breathing is a process of drawing air into and out of the lungs and involves your diaphragm, ribs and intercostal muscles. Respiration is an exothermic chemical reaction. It occurs in all cells and transfers energy from a glucose chemical energy store to an 'energy currency' molecule called ATP. The ATP can be used for all other processes. Plants do not have lungs, so they cannot "breathe". Instead they obtain oxygen from their stomata or from photosynthesis. But plants do respire (as all living organisms do). Plants respire all the time, not just at night when they have finished photosynthesising.
		Lesson 7 – Limiting Factors *…that* a limiting factor is anything in short supply that stops photosynthesis occurring at its maximum speed *….how to* construct & interpret graphs showing limiting factors vs rate of photosynthesis.	Carbon dioxide, light intensity, photosynthesis, temperature.	
		Lesson 8 and 9 – Photosynthesis Practical *…that* the effect of light intensity on photosynthesis can be investigated using pondweed *….how to* carry out an investigation into the effect of light intensity on the rate of photosynthesis using pondweed.	Independent variable, dependent variable, control variable, mean, anomalous, line of best fit.	

Topic 10 BIOLOGY Organisation	**Rationale (Layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
Plants harness the Sun's energy in photosynthesis in order to make food. Palisade cells in plants are adapted to capture sunlight needed for photosynthesis. The plant's transport system is dependent on environmental conditions to ensure that leaf cells are provided with the water and carbon dioxide that they need for photosynthesis	LINKING **KS2** Basic plant structure and function **Year 7** Cells **Year 8** Organisms and photosynthesis **KS4** LOOKING **Year 9** Link to cells topic **Year 10** Organisation **Year 11** Organisation **Post 16**	**Lesson 1 – Leaf Structure** *…that* there are different tissues present in a leaf *…how* the different tissues help make the leaf adapted for photosynthesis	Palisade, mesophyll, stomata, guard cells, waxy cuticle, photosynthesis	**a) Numeracy** Calculating stomatal density. Plotting graphs of transpiration data and analysing the graphs – calculating mean rates of transpiration from graphs. **b) Literacy** Key words etymology. **c) Reading** Reading for information retrieval **d) Cultural Capital/Careers** **e) Cross curricular knowledge links** **f) Misconceptions** Plants obtain water from their leaves this is incorrect. Plants obtain water from their roots via their root hair cells. In fact, most plant leaves are adapted to direct water to the ground e.g., drip tips in rainforest plants. Leaves have stomata to allow exchange of gases. Plants are living! this is a fact. Unlike animals' plants do not eat. Carbon dioxide, water and minerals are not the plants food. Plants produce food during photosynthesis (a chemical reaction) this is why they are called producers.
		Lesson 2 and 3 – Stomata, Xylem and Phloem *…that* there are different tissues present in a plant *…how to* identify and describe the different tissues and their adaptations	Xylem, phloem, lignin, companion cell, transpiration, translocation, root hair cell, stomata, guard cells	
		Lesson 4 and 5 –Transpiration *…that* water is lost from a plants leaves due to evaporation through the stomata *…how to* explain the effect of changes to the environment on the rate of transpiration	transpiration, temperature, humidity, light intensity, root hair cell, xylem vessel, stomata, stomatal density, water uptake, potometer, guard cells.	

Topic 11 PHYSICS Energy	**Rationale (layering, Why this why now?)**	**Knowledge goals: *You need to know….*** *…that (Declarative)* *…. how to (Procedural)* LADDERING	**Key Tier 3 vocabulary**	**Core skills and enrichment opportunities.**
The concept of energy emerged in the 19th century. The idea was used to explain the work output of steam engines. It also became a key tool for understanding chemical reactions and biological systems. Limits to the use of fossil fuels and global warming are critical problems for this century. Physicists & engineers are working hard to identify ways to reduce our energy usage.	LINKING **KS2** Basic concept of heat / thermal energy Year 7 Energy costs and transfers. Year 8 Heating and cooling LOOKING **Year 9** **Year 10 and Year 11** Paper 1 - energy **Post 16** Work done, potential energy, conservation of energy, mechanical energy, power, efficiency	**Lesson 1 – Energy Stores** *…that* energy can be stored and transferred in a variety of ways *….how to* describe how the energy store changes as a system changes and represent this as a flow diagram.	Kinetic Thermal, Chemical, Gravitational potential, Elastic potential, Electrostatic, Magnetic, nuclear, mechanical, radiation, electrical	**a) Numeracy** Use, apply and rearrange energy equations. Convert between magnitudes of units. Interpret pie charts and other data sources on energy. **b) Literacy** Meanings of the terms 'potential' and 'kinetic'. **c) Reading** Reading for scientific literacy – renewable energy sources. **d) Cultural Capital/Careers** Links to engineering related careers and apprenticeships. **e) Cross curricular knowledge links** DT: Knowledge of principles of energy when designing bespoke items e.g. playground items, safety equipment (seatbelts). f) **Misconceptions** Energy and force are interchangeable terms – common mistake – kinetic energy is transferred to friction. An object at rest has no energy- energy of an object commonly
		Lesson 2 – Conservation of Energy *…that* energy can be transferred usefully, stored or dissipated but it cannot be created or destroyed. Energy is dissipated as thermal energy through friction. *….how to* apply the principle of energy conservation & to explain what happens when energy is dissipated.	Conservation, closed system, dissipated, transfer.	
		Lesson 3 – Energy and Work *…that* work done is the energy transferred when a force moves through a given distance. Energy is measured in Joules. Friction opposes motion. Work done to overcome friction is mainly transferred to thermal energy stores by heating. *….how to* apply the equation Work done = force x distance and identify the appropriate units.	Work done, energy, friction, Newton, Joule.	
		Lesson 4 – Gravitational Potential Energy *…that* gravitational potential energy is the energy stored in an object due to its position above the Earth's surface. This is due to the force of gravity acting on the object. When a pendulum swings energy is transferred between the gravitational potential energy store and the kinetic energy store. *….how to* apply the equation $\Delta E = m \times g \times \Delta h$ and convert between magnitude of units.	Gravitational potential energy, gravitational field strength.	
		Lesson 5 - Kinetic Energy *…that* when an object falls, its gravitational potential energy is converted into kinetic energy. The total energy of the system doesn't change	Energy store, kinetic, potential, Joule	

		….*how to* apply the equation $E_k = {}^1/_2\, mv^2$		associated with movement –for example: "I Have no energy left so need to lie down". The only type of potential energy is gravitational – potential chemical and potential elastic are also "potential" as they have energy which is released in a chemical reaction or when the spring is released.
		Lesson 6 – Energy Dissipation *…that* useful energy: is energy transferred to where it is wanted in the way that it is wanted Wasted energy: is the energy that is not usefully transferred. Dissipation is when energy is transferred to heat energy in the surroundings. Friction in a machine causes energy to be wasted & can be reduced by lubrication. ….*how to* explain the impact of friction on moving items and how it can be reduced.	Friction, dissipated, wasted, transfer, thermal energy store.	
		Lesson 7 – Power and Power Calculations *…that* power is the energy transferred by a device in a second & is measured in watts. Electrical appliances have the power rating on a plate on the device. ….*how to* use and apply the equations: Power (W) = work done (J) ÷ time (s) and: Power (W) = energy transferred (J) ÷ time (s). Convert between watts & kW	Power, watts, time, energy transfer,	
		Lesson 8 – Specific Heat Capacity *…that* the amount of energy needed to heat a material is known as Specific Heat Capacity. *…how to* calculate how much energy is needed to heat up different materials. Use and rearrange the equation: Heat = mass x SHC x temp change	Capacity Specific heat capacity	
		Lesson 8 and 9 Specific Heat Capacity Practical *…that* specific heat capacity can be determined by experiment …. *how to* practically determine the specific heat capacity …. *how to* plot specific heat capacity graphs and determine values from the graph	Capacity Specific heat capacity	
		Lesson 10 – Non-Renewable Energy *…that* non-renewable energy sources cannot be replaced. Fossil fuels are running out and alternatives need to be found. Combustion of fossil fuels leads to pollution, global warming & global dimming. Nuclear power is one alternative & does not emit greenhouse gases.	Non-renewable, fossil fuels, nuclear power, global warming, global dimming, emissions.	

		….how to explain the generation of electricity from fossil fuels. Evaluate the use of fossil fuels and nuclear power for electrical generation.		
		<u>Lesson 11 – Renewable Energy</u> *…that* renewable sources are ones where the source is replaced as quickly as it runs out. *….how to* evaluate the advantages & disadvantages of a range of renewable energies using text and data charts.	Solar, hydro-electric, wind, tidal, geothermal, renewable,	