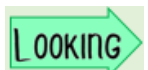


Topic Atomic Structure	Rationale (layering, Why this why now?)	Knowledge goals: <i>You need to know....</i> <i>...that (Declarative)</i> <i>how to (Procedural)</i> L ADDERING	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Ionising radiation is hazardous but can be very useful. Although radioactivity was discovered over a century ago, it took many nuclear physicists several decades to understand the structure of atoms, nuclear forces and stability. Early researchers suffered from their exposure to ionising radiation. Rules for radiological protection were first introduced in the 1930s and subsequently improved. Today radioactive materials are widely used in medicine, industry, agriculture and electrical power generation.	 Linking <u>KS2</u> Filtering, sieving, evaporating, dissolving, solutions. <u>Year 7</u> Matter, separating mixtures. <u>Year 8</u> Elements, periodic table. <u>Year 9</u> KS4  Looking <u>Year 9</u> Year 10 Structure and bonding Year 11 Atomic structure Structure and bonding Post 16 Atomic structure Structure and bonding	<i>...that</i> atoms are very small and consist of electrons, protons and neutrons. (sub-atomic particles) <i>how to</i> represent the sub-atomic particles and the structure of an atom, including the mass number, atomic number and isotopes.	Nucleus, protons, neutrons, electrons, electromagnetic radiation, energy levels	Subject specific skills Use a variety of models to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts. Recognise/draw/interpret diagrams. Translate from data to a representation with a model. Use models in explanations, or match features of a model to the data from experiments or observations that the model describes or explains. Numeracy Use an appropriate number of significant figures, find arithmetic means, construct and interpret frequency tables and diagrams, bar charts and histograms, understand the principles of sampling as applied to scientific data, understand simple probability. Recognise and use expressions in standard form. Use ratios, fractions and percentages. Substitute numerical values into algebraic equations using appropriate units for physical quantities. Solve algebraic equations. Translate information between graphical and numeric form. Literacy and Reading BBC Bitesize – Atomic structure, extended reading articles Parallel histories. Cultural Capital/Careers Careers including Nuclear power reactor operator, energy consultant, Laboratory manager, Research Scientist, Nuclear medicine, Radiation Safety officer, Optical engineer, Astronomer. Cross curricular knowledge links DT- Materials,
		 that the model of the atom has changed over time due to new scientific experimental evidence. how to use evidence to explain why there have been changes in the atomic model.	<i>Electrical charge, elements, mass number, atomic number, isotopes, Scientific model,</i>	
		 that some atomic nuclei are unstable and decay. how to..... apply knowledge to the uses of radiation and evaluate the best sources of radiation to use in a given situation.	alpha, beta, gamma, nuclear model,	
		<i>..... that</i> nuclear equations are used to represent radioactive decay. How to explain the concept of half-life and how it is related to the random nature of radio active decay. (HT ONLY) be able to calculate the net decline, expressed as a ratio, in a radioactive emission after a given number of half-lives.	Radiation, radioactive decay, Becquerel, count rate, Geiger-Muller tube, decays, Balanced equations, atomic numbers, mass numbers. Emission, daughter elements, Radioactive isotopes, count rate, half-life	
		<i>... that radioactive contamination is the unwanted presence of materials containing radioactive atoms on other materials.</i> How to ..compare hazards associated with contamination and irradiation. <i>(Physics only)</i>	Contamination, hazard, irradiation, contamination, precautions,	
			Back ground radiation, cosmic rays, sieverts	

		<i>... that background radiation is around us all of the time and this is affected by occupation and / or location.</i> <i>How to explain why the hazards associated with radioactive material differ according to the half-life involved.</i>		Chemistry - Periodic table and atoms and bonding,
		(Physics only) that nuclear radiations are used in medicine How to evaluate the perceived risks of using nuclear radians in relation to given data and consequences.	Evaluation of perceived risks in relation to data and handling.	Misconceptions – the electrons in an atom orbit the nucleus like planets in our solar system orbit the sun [electron shells represent the specific amounts of energy electrons have, not where electrons are located]; the nucleus of an atom is equivalent to a nucleus in a cell [they are not analogous]. Students’ views about the risk of radiation and radioactivematerials are based more strongly on everyday information than scientific ideas
		(Physics only) that nuclear fission is the splitting of a large and unstable nucleus and that nuclear fusion is the joining of two light nuclei to form heavier nucleus. How to draw and interpret diagrams representing nuclear fission and how a chain reaction may occur.	Uranium, plutonium, fission, fusion, kinetic energy, chain reaction, nuclear reactor.	For example, some students see certain medical applications, such as radiotherapy, as inherently dangerous. Or, they may think that a nuclear power station is as dangerous as a nuclear bomb. Most students follow mass media on a regular basis and the general descriptions of their views show that they are dominated by incoherent bits of information about radioactivity from the media or films. scientific notions play a small or non-existent part.

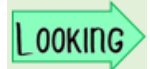
Topic Electricity	Rationale (layering, Why this why now?)	Knowledge goals: <i>You need to know....</i> <i>...that (Declarative)</i> <i>.... how to (Procedural)</i> L ADDERING	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Electric charge is a fundamental property of matter everywhere. Understanding the difference in the microstructure of conductors, semi conductors and insulators makes it possible to design components and build electric circuits. Many circuits are powered with mains electricity but portable electrical devices must use batteries of some kind. Electrical power fills the modern world with artificial light and sound, information and entertainment, remote sensing and control. The fundamentals of	 Linking KS2 States of matter Simple physical properties of materials. Year 7 Particle model Separating Mixtures Year 8 Elements Periodic Table Year 9 KS4  Looking Year 9 Year 10 Atomic structure –chem Particle model - phy Year 11 Rates - chem Post 16	<i>...that</i> circuit symbols act as a language for drawing circuit diagrams. This allows people anywhere in the world to build the same circuit, even if the components look different. <i>.... how to</i> draw circuit symbols	E.g. lamp, battery, diode Current, charge, coulombs, amperes, volts, components	<u>Numeracy</u> Students need to be able to recall and apply equations. Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), 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. <u>Literacy</u> 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. <u>Reading</u> BBC Bitesize, The Illustrated Science Dictionary, World of Science, Horrible Science of Everything, The Science Boo Home Science Experiments
		<i>...that</i> Electric Current is flow of electrical charge and that charge flow, current and time are linked. <i>.... how to</i> use the equation : charge flow = current x time	Potential difference, resistance, ohms	
		<i>...that</i> potential Difference is amount of energy transferred to each coulomb of charge <i>how to place components in the circuit to measure current and potential difference</i> <i>RP3: Use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits.</i>	Circuit diagrams, Proportional Voltage Current Resistance Amps Ohms Volts	
		<i>...that in some resistors the value of R remains constant but that in others it can change as the current changes.</i> <i>.... How to use the equation: potential difference = current x resistance</i> <i>RP4: use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements, including a filament lamp, a diode and a resistor at constant temperature.</i>	Graphs. Linear, non-linear, correlation,	
		<i>...that</i> there are two ways of joining electrical components, in series and in parallel. <i>how to</i> explain qualitatively why adding resistors in series increases the total resistance whilst adding resistors in parallel decreases the total resistance	Series, parallel,	
		<i>...that</i> Mains electricity is an ac supply. In the United Kingdom the domestic electricity supply has a frequency of 50 Hz and is about 230 V. <i>how to</i> explain the difference between direct and alternating potential difference	Alternating current, direct current, Three core cable, insulation, appliance,	

electromagnetism were worked out by scientists of the 19th century. However, power stations, like all machines, have a limited lifetime. If we all continue to demand more electricity this means building new power stations in every generation – but what mix of power stations can promise a sustainable future?		... <i>that</i> the power transfer in any circuit device is related to the potential difference across it and the current through it, and to the energy changes over time. <i>How to</i> describe, with examples, the relationship between the power ratings for domestic electrical appliances and the changes in stored energy when they are in use.	Transfer, work done,	Crisp Packet Fireworks. <u>Cultural Capital/Careers</u> <u>Cross curricular knowledge links</u> Electrician working on repairing some forklift trucks, Electricity plays a huge role in the robotics industry, and it is a fundamental concept. Engineer working in the medical prosthetics field. Working on the national power grid, Whether you are repairing or installing electrical cables, it's imperative that you understand the basics of electricity. Electrical engineers will design the circuit boards that go inside both our everyday items that we'll find in our house, but also highly technical pieces of equipment. <u>Misconceptions</u> Misconception: current is 'used up' as it flows round the circuit Current is not used up: the current is the same all the way round a series circuit. If current is used up, then bulbs near the 'start' of the circuit should be brighter than those near the 'end'. Providing the bulbs are identical, then they will all be the same brightness. Misconception: current starts from one end of a battery and flows through each component of a circuit in turn, until it gets back to the other end of a battery (e.g. battery to wire, then bulb, then wire, then bulb, then wire back to battery) Current flows instantly in all parts of a circuit when there is a complete circuit.
		... <i>that</i> the National Grid is a system of cables and transformers linking power stations to consumers. <i>How to ...</i> explain why the National Grid system is an efficient way to transfer energy.	Cables, transformers (Higher only), consumers, efficiency, step up, step down	
		<i>(Physics only)</i> .. <i>that</i> when certain insulating materials are rubbed against each other they become electrically charged. How toexplain how the transfer of electrons between objects can explain the phenomena of static electricity.	Electrically charge, negative, positive, electrons, repel, attract, non contact force, static,	
		<i>(Physics only)</i> ... <i>that a</i> charged object creates an electric field around itself <i>How to</i> explain how the concept of an electric field helps to explain the non-contact force between charged objects as well as other electrostatic phenomena such as sparking.	electric field pattern, Field, force, isolated charge, electrostatic phenomena, sparking	

Topic Energy	Rationale (layering, Why this why now?)	Knowledge goals: <i>You need to know....</i> <i>...that (Declarative)</i> <i>.... how to (Procedural)</i> L ADDERING	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.	 KS2 Basic concept of heat / thermal energy Year 7 Energy costs and transfers. Year 8 Heating and cooling.	<i>...that</i> energy can be stored and transferred in a variety of ways and there are changes in the way energy is stored when a system changes. <i>....how to</i> describe all the changes involved in the way energy is stored when a system changes, for common situations.	Kinetic, Thermal, Chemical, Gravitational potential, Elastic potential, Electrostatic, Magnetic, nuclear, mechanical, radiation, electrical	<u>Subject specific skills</u> Practical skills – use a range of new equipment to measure the specific heat capacity of different materials. <u>Numeracy</u> Use, apply and rearrange energy equations. Convert between magnitudes of units. Interpret pie charts and other data sources on energy.					
	 Year 9 Energy transfers Types of energy Efficiency Year 10 and Year 11 Paper 1 - energy Post 16 Work done, potential energy, conservation of energy, mechanical energy, power, efficiency	<i>...that</i> the amount of kinetic energy in a moving object, the amount of elastic potential energy stored in a stretched spring and the amount of gravitational potential energy gained by an object raised above ground level can be calculated. <i>....how to</i> calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level. Use and rearrange the associated equations.	Limit of proportionality, spring constant, gravitational field strength, joule, m/s, specific heat capacity	<u>Literacy</u> and <u>Reading</u> Extended reading articles - Just Deserts, Unplugged, Out in the Cold, <u>Cultural Capital/Careers</u> Links to engineering related careers and apprenticeships, oil rig engineer, nutritionists or designers will need a good understanding of energy stores and transfers as well.					
		<i>...that</i> the specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of a substance by one degree Celsius. <i>....how to</i> use & apply the equation: $\Delta E = m c \Delta \theta$ RP1. Investigation to determine the specific heat capacity of one or more materials	Δ -Delta (change in) θ – Theta (Temperature)	<u>Cross curricular knowledge links</u> DT: Knowledge of principles of energy when designing bespoke items eg playground items, safety equipment (seatbelts).					
		<i>...that</i> power is the energy transferred by a device in a second & is measured in watts. Power is defined as the rate at which energy is transferred or the rate at which work is done. <i>....how to</i> 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,	<u>Common Misconceptions</u> <table><tr><th>Misconception</th><th>Comment</th></tr><tr><td>The terms "<u>energy</u>" and "<u>force</u>" are interchangeable.</td><td>The commonest example of this is the thinking of friction as energy - 'kinetic energy is transferred to friction' is a common mistake.</td></tr><tr><td>Work</td><td>From the non-scientific point of view, "work" is synonymous</td></tr></table>	Misconception	Comment	The terms " <u>energy</u> " and " <u>force</u> " are interchangeable.	The commonest example of this is the thinking of friction as energy - 'kinetic energy is transferred to friction' is a common mistake.	Work
Misconception	Comment								
The terms " <u>energy</u> " and " <u>force</u> " are interchangeable.	The commonest example of this is the thinking of friction as energy - 'kinetic energy is transferred to friction' is a common mistake.								
Work	From the non-scientific point of view, "work" is synonymous								

		...<i>that</i> 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. <i>how to</i> apply the equation Work done = force x distance and identify the appropriate units.	Work done, energy ,friction, Newton, Joule.		with "labour". It is hard to convince someone that more work is probably being done dancing for one hour than studying an hour for a test. The fact that you only 'do work' when moving against gravity or another force - so walking on the level or going down a slope is not work is hard for them to grasp.
		...<i>that</i> useful energy: is energy transferred to where it is wanted in the way that it is wanted <i>how to</i> explain the impact of friction on moving items and how it can be reduced. RP2: (Physics only) : Investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties	Friction, dissipated, wasted, transfer, thermal energy store. Thermal conductivity. Lubrication. Insulators & conductors.	An object at rest has no energy.	They commonly associate energy of an object with its movement - they were told they had lots of energy when they ran around as young children - and when tired and still they said things like, 'I have no energy left!'
		...<i>that</i> some energy will be wasted during transfers and the energy efficiency for any energy transfer can be calculated. <i>how to</i> use both equations: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total in put energy transfer}}$	Efficiency	The only type of potential energy is gravitational.	At one time 'potential energy' was GPE! Now we have to ensure they know of all of the types of energy that is potential because it is stored up ready to be released - potential chemical energy in fuels (not released until they are burned), potential elastic energy in a stretched spring (not released until the spring is....
		...<i>that</i> non-renewable energy sources cannot be replaced. Fossil fuels are running out and alternatives need to be found. <i>how to</i> evaluate the advantages & disadvantages of a range of renewable energies using text and data charts.	Non-renewable, fossil fuels, nuclear power, global warming, global dimming, emissions. Solar, hydro-electric, wind, tidal, geothermal, renewable,	Gravitational potential energy depends only on the height of an object and kinetic energy only on the speed.	The mass and gravitational field strength often get overlooked. A circus of objects with the same GPE can be useful - as can a set of caculations of objects of equal KE - to set that up practically would be difficult!

				Doubling the speed of a moving object doubles the kinetic energy.	The squared factor causes many a problem! You need to work through questions on this - at GCSE stopping distances need a good grasp of this - but most want to drive - so it is a topic they actually try hard to understand!
				Energy can be changed completely from one form to another useful (no energy losses as unwanted energy).	Even when electricity is used in a heater there is some 'wasted' energy involved - light, sound Many think that energy is truly lost in many energy transformations because things "use up" energy.

Topic Forces	Rationale (layering, Why this why now?)	Knowledge goals: <i>You need to know....</i> <i>...that (Declarative)</i> <i>how to (Procedural)</i> L ADDERING	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Engineers analyse forces when designing a great variety of machines and instruments, from road bridges and fairground rides to atomic force microscopes. Anything mechanical can be analysed in this way. Recent developments in artificial limbs use the analysis of forces to make movement possible.	 KS2 Moving objects, types of forces KS3 Speed, types of forces,  KS4 – Forces, work, scalars, vectors, atmosphere Post 16 Forces, momentum, moments	<i>...that</i> Scalar quantities have magnitude only. Vector quantities have magnitude and an associated direction. <i>...how to</i> describe the interaction between pairs of objects which produce a force on each object.	Scalar and vector, Contact and non-contact forces, Weight and gravity	Cultural Capital/Careers Mechanic, aerospace engineer, computer game designer. car safety designer Cross curricular knowledge links PE – Sports and motion, Maths – formulas and algebra. Numeracy Recognise and use expressions in standard form. Use ratios, fractions and percentages. Substitute numerical values into algebraic equations using appropriate units for physical quantities. Solve algebraic equations. Translate information between graphical and numeric form. Literacy and Reading Understand scientific methods and theories and how they develop over time. Use a variety of models to make predictions and develop scientific explanations and understanding. Use scientific vocabulary, terminology and definitions. Use prefixes and powers of ten for orders of magnitude.
		<i>...that</i> Weight is the force acting on an object due to gravity. <i>...how to</i> use the equation - weight = mass × gravitational field strength	quantatively and qualitatively.	
		<i>...that</i> a number of forces acting on an object may be replaced by a single force, called the resultant force, that has the same effect as all the original forces acting together. <i>...how to</i> calculate the resultant of two forces that act in a straight line, (HT only) describe examples of the forces acting on an isolated object or system and use free body diagrams to describe qualitatively examples where several forces lead to a resultant force on an object.	Resultant force, Free body diagrams, HT Only	
		<i>...that</i> when a force causes an object to move through a distance work is done on the object. <i>...how to</i> use the calculation work done = force × distance (W = Fs)	work	
		<i>...that</i> to change the shape of an object more than one force has to be applied and that the extension of an elastic object, such as a spring, is directly proportional to the force applied, provided that the limit of proportionality is not exceeded. <i>...how to</i> describe the difference between elastic deformation and	Force, work, newtons, joules, displacement, frictional forces	

		inelastic deformation caused by stretching forces by using the equations $\text{force} = \text{spring constant} \times \text{extension}$. ($F = ke$)		Common Misconceptions <table><tr><td>Measurement is only linear.</td><td>Double the dimensions of an object and they think the curved surface area (csa) and volume also double - they find the fact that csa increases by a factor of 4 and volume (and therefore the mass) by a factor of 8 surprising.</td></tr><tr><td>Any quantity can be measured as accurately as you want.</td><td>.... all you have to do is use a modern 'digital' instrument - they think 'old' instruments are out of date and useless. They find the accuracy of precision instruments being related to construction difficult to understand - it needs to be 'new' and 'electronic' to be any good in their eyes!</td></tr><tr><td>You can measure to any proportion of the smallest unit shown on the measuring device.</td><td>They think they can estimate a third or quarter of a scale division - put them right on this!</td></tr><tr><td>You should start at the end of the measuring device when measuring distance.</td><td>Zero errors due to 'bashed' metre rulers always give a problem - so do ones that are constructed with a 'gap' to allow for wear and tear!</td></tr><tr><td>Some objects cannot be measured because of their size or inaccessibility.</td><td>They think an object must be "touched" to measure it. Use of trig to measure the height of a tree is sometimes suspect!</td></tr><tr><td>Mass is a quantity that you get by weighing an object.</td><td>In general speak they are interchangeable - to a pupil so are their units and numerical values! The doctors and other professions are included in the blame for this!</td></tr></table>	Measurement is only linear.	Double the dimensions of an object and they think the curved surface area (csa) and volume also double - they find the fact that csa increases by a factor of 4 and volume (and therefore the mass) by a factor of 8 surprising.	Any quantity can be measured as accurately as you want.	 all you have to do is use a modern 'digital' instrument - they think 'old' instruments are out of date and useless. They find the accuracy of precision instruments being related to construction difficult to understand - it needs to be 'new' and 'electronic' to be any good in their eyes!	You can measure to any proportion of the smallest unit shown on the measuring device.	They think they can estimate a third or quarter of a scale division - put them right on this!	You should start at the end of the measuring device when measuring distance.	Zero errors due to 'bashed' metre rulers always give a problem - so do ones that are constructed with a 'gap' to allow for wear and tear!	Some objects cannot be measured because of their size or inaccessibility.	They think an object must be "touched" to measure it. Use of trig to measure the height of a tree is sometimes suspect!	Mass is a quantity that you get by weighing an object.	In general speak they are interchangeable - to a pupil so are their units and numerical values! The doctors and other professions are included in the blame for this!
Measurement is only linear.	Double the dimensions of an object and they think the curved surface area (csa) and volume also double - they find the fact that csa increases by a factor of 4 and volume (and therefore the mass) by a factor of 8 surprising.															
Any quantity can be measured as accurately as you want.	 all you have to do is use a modern 'digital' instrument - they think 'old' instruments are out of date and useless. They find the accuracy of precision instruments being related to construction difficult to understand - it needs to be 'new' and 'electronic' to be any good in their eyes!															
You can measure to any proportion of the smallest unit shown on the measuring device.	They think they can estimate a third or quarter of a scale division - put them right on this!															
You should start at the end of the measuring device when measuring distance.	Zero errors due to 'bashed' metre rulers always give a problem - so do ones that are constructed with a 'gap' to allow for wear and tear!															
Some objects cannot be measured because of their size or inaccessibility.	They think an object must be "touched" to measure it. Use of trig to measure the height of a tree is sometimes suspect!															
Mass is a quantity that you get by weighing an object.	In general speak they are interchangeable - to a pupil so are their units and numerical values! The doctors and other professions are included in the blame for this!															
		<i>...that</i> the extension of an elastic object, such as a spring, is directly proportional to the force applied, provided that the limit of proportionality is not exceeded. <i>... how to</i> calculate work done in stretching (or compressing) a spring (up to the limit of proportionality) using the equation: RP6 - Investigate the relationship between force and extension for a spring.	Compressing, elastic deformation, inelastic deformation, directly proportional													
		<i>...that</i> a force or a system of forces may cause an object to rotate. The turning effect of a force is called the moment of the force. <i>....how to</i> use the calculation to work out the size of the moment - moment of a force = force $\times$ distance. ($M = Fd$) (Physics only)	Physics only Turning forces, moments Leavers and gears, perpendicular distance, pivot,													
		<i>...that</i> A fluid can be either a liquid or a gas. The pressure in fluids causes a force normal (at right angles) to any surface. <i>....how to</i> calculate the pressure at the surface of a fluid using the equation: pressure = force normal to a surface area of that surface $p = F/A$.	Pressure in a fluid Pressure in a gas Upthrust, pascals, density, submerged objects,													
		<i>.....that</i> the atmosphere is a thin layer (relative to the size of the Earth) of air round the Earth. The atmosphere gets less dense with increasing altitude. <i>....how to</i> describe a simple model of the Earth's atmosphere, atmospheric pressure and how it varies with height above a surface. How to calculate the pressure due to a column of liquid using the equation - pressure = height of the column $\times$ density of the liquid $\times$ gravitational field strength. [$p = h \rho g$]	Atmospheric pressure													
		<i>...that</i> there is a difference between distance and displacement and a difference between scalar and vector quantities.	HT Distance and displacement Speed and velocity													

		<i>how to</i> use the calculation to work out the distance travelled in a specific time for an object moving at constant speed distance travelled = speed $\times$ time, $s = v t$ (HT only) Students should be able to explain qualitatively, with examples, that motion in a circle involves constant speed but changing velocity	Distance time graphs, Velocity time graphs, gradient,	The five senses are infallible. There is only one way to measure perimeter.	<u>Optical illusions</u> are good on this one! and that is 'all of the way' round - mathematical calculation is suspect!
		...<i>that</i> If an object moves along a straight line, the distance travelled can be represented by a distance–time graph and that the speed of an object can be calculated from the gradient of its distance–time graph. <i>how to</i> draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs, translating information between graphical and numerical form. (HT only) If an object is accelerating, its speed at any particular time can be determined by drawing a tangent and measuring the gradient of the distance–time graph at that time.	HT Estimating magnitudes, uniform acceleration, terminal velocity	Only the area of rectangular shapes can be measured in square units. Surface area can be found only for two-dimensional objects. You cannot measure the volume of some objects because they do not have "regular" lengths, widths, or heights.	The idea of measuring a circle in square units give some children problems Surface area is a concept used only in mathematics classes! Practical making of wrapping for an object helps with this - it is limited to rectangular shapes, but it helps - they have done 'nets' in maths. They need to think of volume as an occupied 'space' rather than a mathematical construct - displacement can experiments are fun!
		 <i>that</i> the average acceleration of an object can be calculated using the equation: acceleration = change in velocity/ time taken $a = \Delta v / t$ <i>how to</i> calculate the acceleration of an object from the gradient of a velocity–time graph. (HT only) The distance travelled by an object (or displacement of an object) can be calculated from the area under a velocity–time graph. (Physics only) Students should be able to: Draw and interpret velocity–time graphs for objects that reach terminal velocity and interpret the changing motion in terms of the forces acting.	HT	The density of two samples of the same substance with different volumes or shapes cannot be the same.	Density is a concept difficult for many... practical hands on experience is vital.
		 <i>that</i> Newton's First Law: states that the resultant force acting on an object is zero and if the object is stationary, the object remains stationary or the object is moving, the object continues to move at the same speed and in the same direction. So the object continues to move at the same velocity.	HT		

		(HT only) The tendency of objects to continue in their state of rest or of uniform motion is called inertia. that Newton's Second Law states that the acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object. As an equation : resultant force = mass × acceleration $F = m a$ <i>RP7: investigate the effect of varying the force on the acceleration of an object of constant mass, and the effect of varying the mass of an object on the acceleration produced by a constant force.</i>		
		... that they can evaluate the effect of various factors on thinking distance based on given data. how to calculate stopping distance (HT only) estimate the forces involved in the deceleration of road vehicles in typical situations on a public road (Physics only) Students should be able to estimate how the distance for a vehicle to make an emergency stop varies over a range of speeds typical for that vehicle. (Physics only) Students will be required to interpret graphs relating speed to stopping distance for a range of vehicles.	Resultant forces, stationary, resistive forces, uniform velocity, inertia. Thinking distance, breaking distance, stopping distance. Reaction times, Energy transfers	
		<i>Momentum (HT only)</i> ... that momentum is a property of moving objects and conservation of momentum states that in a closed system, the total momentum before an event is equal to the total momentum after the event. This is called conservation of momentum. how to use the equation that momentum is defined by – momentum = mass × velocity ($p = m v$). Students should also be able to use the concept of momentum as a model to describe and explain examples of momentum in an event, such as a collision (Physics only) complete calculations involving an event, such	Mass, momentum, velocity, conservation Deceleration, closed system, momentum, safety features,	

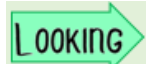
		as the collision of two objects. <i>Changes in momentum (physics only)</i> When a force acts on an object that is moving, or able to move, a change in momentum occurs. The equations $F = m \times a$ and $a = \frac{v - u}{t}$ combine to give the equation $F = \frac{m \Delta v}{\Delta t}$ where $m\Delta v$ = change in momentum ie force equals the rate of change of momentum. Students should be able to apply equations relating force, mass, velocity and acceleration to explain how the changes involved are inter-related.		
--	--	--	--	--

Topic Magnetism and Electromagnetism	Rationale (layering, Why this why now?)	Knowledge goals: <i>You need to know....</i> <i>...that (Declarative)</i> <i>how to (Procedural)</i> L ADDERING	Key Tier 3 vocabulary	Core skills and enrichment opportunities.	
Electromagnetic effects are used in a wide variety of devices. Engineers make use of the fact that a magnet moving in a coil can produce electric current and also that when current flows around a magnet it can produce movement. It means that systems that involve control or communications can take full advantage of this.	Linking KS2 Magnets, KS3 Magnets, magnetic materials, compasses Looking KS4 Magnets, Induced magnets, induced current, motor and generator effect. Post 16 Magnetic Fields, Magnetic Field Strength, The Force on a Moving Charge	<i>...that</i> the poles of a magnet are the places where the magnetic forces are strongest and two magnets are brought close together they exert a force on each other <i>how to</i> describe the attraction and repulsion between unlike and like poles for permanent magnets and the difference between permanent and induced magnets.	Poles, fields, North, South, repel, attract, non-contact force, induced magnet, Iron, Nickel, Cobalt.	<u>Subject specific skills</u> Use a variety of models to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts. Recognise/draw/interpret diagrams. Translate from data to a representation with a model. Use models in explanations, or match features of a model to the data from experiments or observations that the model describes or explains.	
		<i>...that</i> when a current flows through a conducting wire a magnetic field is produced around the wire. <i>.... how to</i> describe how the magnetic effect of a current can be demonstrated by drawing the magnetic field pattern for a straight wire carrying a current and for a solenoid.	Current, solenoid, iron core.	<u>Numeracy</u> Use an appropriate number of significant figures, find arithmetic means, construct and interpret frequency tables and diagrams, bar charts and histograms, understand the principles of sampling as applied to scientific data, understand simple probability	
		<i>...that</i> when a conductor carrying a current is placed in a magnetic field the magnet producing the field and the conductor exert a force on each other. This is called the motor effect. <i>.... how to</i> show that Fleming's left-hand rule represents the relative orientation of the force, the current in the conductor and the magnetic field. Students should be able to recall the equation: force = magnetic f lux density × current × length F = B I l	Fleming’s left-hand rule, magnetic flux density, force.	<u>Literacy and Reading</u> BBC Bitesize – Magnetism, extended reading articles Parallel histories.	
		<i>...that</i> a coil of wire carrying a current in a magnetic field tends to rotate. <i>.....how to</i> explain how a moving-coil loudspeaker and headphones work. (Physics only)	Physics only Rotation, conductor, coil, loudspeakers, headphones, pressure. Rotation, conductor, coil, loudspeakers, headphones, pressure.	<u>Cultural Capital/Careers</u> Careers including Engineers in terms of building all sorts of machines that have electric motors and generators. Sound engineers, transmission of electricity at high voltages in transformers that form the backbone of the National Grid. Fun and sorting materials. <u>Cross curricular knowledge links</u> Geography – Earths magnetic field, <u>Misconceptions</u> <table><tr><td>Misconception</td><td>Discussion of the problem</td><td>Possible Activities</td></tr></table>	Misconception
Misconception	Discussion of the problem	Possible Activities			

		...<i>that</i> If an electrical conductor moves relative to a magnetic field or if there is a change in the magnetic field around a conductor, a potential difference is induced across the ends of the conductor. If the conductor is part of a complete circuit, a current is induced in the conductor. This is called the generator effect. <i>how to</i> recall the factors that affect the size of the induced potential difference/induced current and recall the factors that affect the direction of the induced potential difference/induced current. (Physics only)	Physics only	Potential difference, current, conductor, generator, induced. Potential difference, current, conductor, generator, induced.	<table><tr><td>All metals are attracted to a magnet.</td><td>Only iron, nickel and cobalt and their alloys are attracted to a magnet</td><td>Circus of material to test</td></tr><tr><td>All silver coloured items are attracted to a magnet.</td><td>as above</td><td>as above</td></tr><tr><td>All magnets are made of iron.</td><td>iron is a soft magnetic material - wouldn't work!</td><td>Make magnets - iron and steel - by stroking</td></tr><tr><td>Larger magnets are stronger than smaller magnets.</td><td></td><td>part of a circus - weak big one and strong small one!</td></tr><tr><td>The magnetic and geographic poles of the earth are located at the same place.</td><td></td><td>Web search on navigation of seas and how magnetic pole 'moves'</td></tr><tr><td>The magnetic pole of the earth in the northern hemisphere is a north pole, and the pole in the southern hemisphere is a south pole.</td><td></td><td>Make a model of the earth and put a magnet within it so that search compasses point north</td></tr></table>	All metals are attracted to a magnet.	Only iron, nickel and cobalt and their alloys are attracted to a magnet	Circus of material to test	All silver coloured items are attracted to a magnet.	as above	as above	All magnets are made of iron.	iron is a soft magnetic material - wouldn't work!	Make magnets - iron and steel - by stroking	Larger magnets are stronger than smaller magnets.		part of a circus - weak big one and strong small one!	The magnetic and geographic poles of the earth are located at the same place.		Web search on navigation of seas and how magnetic pole 'moves'	The magnetic pole of the earth in the northern hemisphere is a north pole, and the pole in the southern hemisphere is a south pole.		Make a model of the earth and put a magnet within it so that search compasses point north
		All metals are attracted to a magnet.	Only iron, nickel and cobalt and their alloys are attracted to a magnet	Circus of material to test																			
		All silver coloured items are attracted to a magnet.	as above	as above																			
		All magnets are made of iron.	iron is a soft magnetic material - wouldn't work!	Make magnets - iron and steel - by stroking																			
		Larger magnets are stronger than smaller magnets.		part of a circus - weak big one and strong small one!																			
		The magnetic and geographic poles of the earth are located at the same place.		Web search on navigation of seas and how magnetic pole 'moves'																			
		The magnetic pole of the earth in the northern hemisphere is a north pole, and the pole in the southern hemisphere is a south pole.		Make a model of the earth and put a magnet within it so that search compasses point north																			
		...<i>that</i> the generator effect is used in an alternator to generate ac and in a dynamo to generate dc. <i>how to</i> explain how the generator effect is used in an alternator to generate ac and in a dynamo to generate dc	Potential difference, current, conductor, generator, induced, transformers, coil, efficient, eddy currents.																				
		...<i>that</i> a basic transformer consists of a primary coil and a secondary coil wound on an iron core and that ratio of the potential differences across the primary and secondary coils of a transformer V_p and V_s depends on the ratio of the number of turns on each coil, n_p and n_s. <i>how to</i> use the equations $v_p/v_s = n_p/n_s$ potential difference, V_p and V_s in volts, V. In a step-up transformer $V_s > V_p$ In a step-down transformer $V_s < V_p$ $V_s \times I_s = V_p \times I_p$																					

Topic 1 Particle model	Rationale (layering, Why this why now?)	Knowledge goals: <i>You need to know....</i> <i>...that (Declarative)</i> <i>how to (Procedural)</i> L ADDERING	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</u> States of matter Simple physical properties of materials. <u>Year 7</u> Particle model Separating Mixtures <u>Year 8</u> Elements Periodic Table Year 9 KS4  Looking Year 9 Year 10 Atomic structure –chem Particle model - phy Year 11 Rates - chem Post 16 Kinetic theory Gas Laws Atomic structure	<i>...that</i> properties of solids, liquids and gases in terms of the particles in each state of matter. Particles are moving and have kinetic energy. <i>how to</i> link arrangement of the particles in each state of matter to their properties and be able to compare them.	Particle solids liquids gases forces of attraction density <i>Property</i>	Subject specific skills Use a variety of models to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts. Recognise/draw/interpret diagrams. Translate from data to a representation with a model. Use models in explanations, or match features of a model to the data from experiments or observations that the model describes or explains. <u>Numeracy</u> be able to recall and apply equations to changes where mass is conserved. Use an appropriate number of significant figures, find arithmetic means, construct and interpret frequency tables and diagrams, bar charts and histograms, understand the principles of sampling as applied to scientific data, understand simple probability. Recognise and use expressions in standard form. Use ratios, fractions and percentages. Substitute numerical values into algebraic equations using appropriate units for physical quantities. Solve algebraic equations. Translate information between graphical and numeric form. <u>Literacy and Reading</u> Improvement of vocabulary bank – tier 2 - BBC Bitesize – Particle Model, extended reading articles. Reading for understanding, exemplar question contexts.
		<i>...that</i> density is the mass which is contained in a given volume. A denser material will sink in a less dense material. <i>how to</i> 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.	
		<i>...that</i> displacement can be used to find the volume of an irregular object. <i>how to</i> practically determine the volume of an irregular shaped object. RP 5. use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids. Volume should be determined from the dimensions of regularly shaped objects, and by a displacement technique for irregularly shaped objects. Dimensions to be measured using appropriate apparatus such as a ruler, micrometer or Vernier callipers.	density displacement <i>regular irregular</i>	
		<i>...that</i> 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. <i>how to</i> determine what happens to temperature during changes of state. ..why some substances have higher/lower melting and boiling points than others.	state temperature heat State, melt, evaporate, condense, freeze, sublimation.	
		<i>...that</i> 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. <i>how to</i> construct and interpret a heating/cooling curve.	internal kinetic potential <i>Independent, dependent, control, variables</i>	
		<i>...that</i> Specific Latent Heat is the energy absorbed by a substance during a change of state <i>how to</i> calculate specific latent heat.	specific latent heat Latent, heat, internal energy, mass, joules, kilograms, fusion, vaporisation, vapour	

		<i>...that</i> The amount of energy needed to heat a material is known as Specific Heat Capacity. <i>how to</i> calculate how much energy is needed to heat up different materials. Use and rearrange the equation: $\text{Heat} = \text{mass} \times \text{SHC} \times \text{temp change}$	Capacity Specific heat capacity	<u>Cultural Capital/Careers</u> Archimedes 'Eureka moment.' Architect, Astronomer, Energy Analyst, Food Technology, Games Designer, Geophysicist, Meteorologist, Nuclear Engineer, Radiographer, School teacher,
		 that the temperature of a gas is related to the average kinetic energy of the molecules how to.. explain qualitatively the relation between the temperature of a gas and its pressure at constant volume.		<u>Cross curricular knowledge links</u> Selection of materials for cooking pans – food technology. Heat transfer – DT – materials.
		(Physics only) .. that increasing the volume in which a gas is contained, at constant temperature, can lead to a decrease in pressure. how to... calculate the change in the pressure of a gas or the volume of a gas (a fixed mass held at constant temperature) when either the pressure or volume is increased or decreased.		<u>Misconceptions</u> If a solid or liquid is heated, the particles get bigger. This is not the case. At higher temperatures, they move about more and take up more space, but they do not get bigger. Students tend to overestimate the space between the particles in liquids. They regard a liquid as half-way between a solid and a gas. This is not the case. The particles in a liquid are close together, although they are free to move and change place. Students confuse 'melting' and 'dissolving'. Students find it difficult to accept that most of a gas is empty space.

Topic	Rationale (layering, Why this why now?)	Knowledge goals: <i>You need to know....</i> <i>...that (Declarative)</i> <i>how to (Procedural)</i> L ADDERING	Key Tier 3 vocabulary	Core skills and enrichment opportunities.
Questions about where we are, and where we came from, have been asked for thousands of years. In the past century, astronomers and astrophysicists have made remarkable progress in understanding the scale and structure of the universe, its evolution and ours. New questions have emerged recently. ‘Dark matter’, which bends light and holds galaxies together but does not emit electromagnetic radiation, is everywhere – what is it? And what is causing the universe to expand ever faster?	 Linking KS2 Space, our universe, day and night KS3 Space, our universe, day and night  Looking KS4 Post 16	<i>...that</i> 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. <i>how to explain</i> how, at the start of a star's life cycle, the dust and gas drawn together by gravity causes fusion reactions and that that fusion reactions lead to an equilibrium between the gravitational collapse of a star and the expansion of a star due to fusion energy	Planets, dwarf planets, stars, asteroids, comets, moons, meteoroids, meteors, galaxy, Milky Way, The Universe. Satellites, artificial satellites, natural satellites, orbits, velocity.	<u>Subject specific skills</u> Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts. Recognise/draw/interpret diagrams. Translate from data to a representation with a model. Use models in explanations, or match features of a model to the data from experiments or observations that the model describes or explains. Make predictions or calculate quantities based on the model or show its limitations. Give examples of ways in which a model can be tested by observation or experiment.
		<i>.... that a</i> star goes through a life cycle and the life cycle is determined by the size of the star. <i>How to</i> explain how fusion processes lead to the formation of new elements.	Hydrogen, Helium, attraction, repulsion, energy, pressure, heat.	<u>Numeracy</u> Use scientific vocabulary, terminology and definitions. WS 4.2 Recognise the importance of scientific quantities and understand how they are determined. Use SI units (eg kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate. Use prefixes and powers of ten for orders of magnitude (eg tera, giga, mega, kilo, centi, milli, micro and nano). Interconvert units. Use an appropriate number of significant figures in calculation <u>Literacy and Reading</u> BBC Bitesize –Space Physics, extended reading articles Parallel histories. <u>Cultural Capital/Careers</u> Space systems engineer, Space lawyer, Software engineer, commercial strategist, human spaceflight and microgravity programme manager, Glaciologist, ExoMars delivery manager, Emerging Technology lead, <u>Cross curricular knowledge links</u>
		<i>..... that</i> gravity provides the force that allows planets and satellites (both natural and artificial) to maintain their circular orbits. <i>How to ...</i> describe the similarities and distinctions between the planets, their moons, and artificial satellites	Nebula, protostar, main sequence star, red giant, white dwarf, black dwarf, neutron star, supernovae, black hole, elements, Iron.	
		<i>... that</i> there is an observed increase in the wavelength of light from most distant galaxies. This effect is called red-shift. <i>how to...</i> explain qualitatively the red-shift of light from galaxies that are receding and how red-shift provides evidence for the Big Bang model.	Wavelength, expansion, Doppler effect, Big Bang, dark mass, dark energy, supernovae.	

				Geography – Earths magnetic field, Chemistry – chemical compounds, <u>Misconceptions</u> Astronauts are weightless in orbit Reality: anywhere mass and space exist, gravity exists. The Sun is Yellow Reality: white is the true colour of the Sun. It would be dangerous to fly through an asteroid belt In the Asteroid Belt of the Solar System, which is between the orbits of Mars and Jupiter, the average distance between objects is again a massive 600,000 miles (965,606.4 km). So no, it wouldn't be dangerous to fly through an asteroid belt. You would instantly freeze in space Reality: you wouldn't freeze instantly in the space, despite its average temperature is so low (3K or -270 °C; -454 °F). Because there's no matter in the space, so the heat does not leave the body quickly enough. You only lose heat via thermal radiation. Of course, you would get colder and eventually freeze but very, very slowly.
--	--	--	--	---

Topic Waves	Rationale (layering, Why this why now?)	Knowledge goals: <i>You need to know....</i> <i>...that (Declarative)</i> <i>how to (Procedural)</i> L ADDERING	Key Tier 3 vocabulary	Core skills and enrichment opportunities.				
Wave behaviour is common in both natural and man-made systems. Waves carry energy from one place to another and can also carry information. Designing comfortable and safe structures such as bridges, houses and music performance halls requires an understanding of mechanical waves. Modern technologies such as imaging and communication systems show how we can make the most of electromagnetic waves.	← Linking KS2 Basic concepts of waves and movement KS3 Energy and waves, light waves, sound waves. → Looking KS4 Waves in air, fluids and solids, properties, uses and dangers of waves. Post 16 Diffraction gratings, coherence, path difference, phase difference. industrial application of diffraction gratings, including emission Spectra and identification of	<i>...that</i> waves may be either transverse or longitudinal. <i>how to</i> describe the difference between longitudinal and transverse waves and describe wave motion in terms of their amplitude, wavelength, frequency and period.	Parallel, Perpendicular, Wavelength, Amplitude, Peaks, Troughs, Compressions, Rarefaction, Normal	<u>Subject specific skills</u> 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. <u>Numeracy</u> 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, change the subject of an equation, substitute numerical values into algebraic equations using appropriate units for physical quantities. Practical use of ray boxes and numeracy skills used throughout, such as calculating the speed of a wave. <u>Literacy and Reading</u> Understand scientific methods and theories and how they develop over time. Use a variety of models to make predictions and develop scientific explanations and understanding. Use scientific vocabulary, terminology and definitions. <u>Cultural Capital/Careers</u> Careers include sonographer, seismologist or a seismographer, opticians or ophthalmologists <u>Cross curricular knowledge links</u> Geography, earthquakes and convection currents, coastal erosion <u>Common Misconceptions</u> <table><tr><td>Misconception</td><td>Possible Activities</td></tr><tr><td>Loudness and pitch of sounds are confused with each other.</td><td>Reinforcement of correct scientific vocabulary</td></tr></table>	Misconception	Possible Activities	Loudness and pitch of sounds are confused with each other.	Reinforcement of correct scientific vocabulary
		Misconception	Possible Activities					
		Loudness and pitch of sounds are confused with each other.	Reinforcement of correct scientific vocabulary					
		<i>...that</i> the frequency of a wave is the number of waves passing a point each second and the wave speed is the speed at which the energy is transferred through the medium. <i>how to</i> use the equations to work out period (Physics only) show how, changes in velocity, frequency and wavelength, in transmission of sound waves from one medium to another, are inter-related.	Reflect, refract, Incident Medium, Sound,					
<i>...that</i> there is a method to measure the speed of sound waves in air and to measure the speed of ripples on a watersurface. <i>how to</i> make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements. RP8: make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements.	Ultrasound, S-waves, P-Waves, Seismic waves, Radio Waves, Microwaves, Infrared, Visible light, Ultraviolet, X-Rays, Gamma Rays. Practical applications Velocity, Frequency, wavelength Real, Virtual, inverted Speed, transparent, translucent, Absorption, filters, opaque. Infrared, Energy							
<i>...that waves can be reflected at the boundary between two different materials and waves can be absorbed or transmitted at the boundary between two different materials.</i>		Physics only						

	gases. Concept and applications of stationary wave resonance.	<i>how to</i> construct ray diagrams to illustrate the reflection of a wave at a surface. And how to describe the effects of reflection, transmission and absorption of waves at material interfaces. RP9: Investigate the reflection of light by different types of surface and the refraction of light by different substances		Hitting an object harder changes its pitch.	Practical - getting them to sing the note when hit with different force
				In a telephone, actual sounds are carried through the wire rather than electrical pulses	
				Human voice sounds are produced by a large number of vocal chords.	
				Sound moves faster in air than in solids (air is "thinner" and forms less of a barrier).	
				Sound moves between particles of matter (in empty space) and then 'bumps into' the next matter particle.	
				In wind instruments, the instrument itself vibrates not the internal air column	
				The pitch of whistles or sirens on moving vehicles is changed by the driver as the vehicle passes.	
				The pitch of a tuning fork will change as it "slows down", (i.e. "runs" out of energy)	Practical - getting them to sing the note until it dies
				As sound waves move, the air moves along with them.	
				The pupil of the eye is a black object or a spot on the surface of the eye.	Idea it is the gap in the centre of the iris.
		<i>...that</i> sound waves can travel through solids causing vibrations in the solid. <i>how to</i> describe, with examples, processes which convert wave disturbances between sound waves and vibrations in solids. Examples may include the effect of sound waves on the ear drum and explain why such processes only work over a limited frequency range and the relevance of this to human hearing.	Physics only		Observation of how the pupil changes size in different light intensities (Care they don't blind each other!) Discuss eye exams in an optician -
		<i>...that</i> waves are used for detection and exploration. <i>how to</i> explain in qualitative terms, how the differences in velocity, absorption and reflection between different types of wave in solids and liquids can be used both for detection and exploration of structures which are hidden from direct observation.	Ultrasound waves, Seismic waves, P-waves and S-waves. Echo sounding.		
		<i>...that</i> Electromagnetic waves are transverse waves that transfer energy from the source of the waves to an absorber, they form a continuous spectrum and all types of electromagnetic wave travel at the same velocity through a vacuum (space) or air. <i>...how to</i> give examples that illustrate the transfer of energy by electromagnetic waves. RP10: Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface.	radio, microwave, infrared, visible light (red to violet), ultraviolet, Xrays and gamma rays		
		<i>...that</i> Electromagnetic waves all have many uses and applications due to their individual properties	radio waves – television and radio		

		...<i>how to</i> give brief explanations why each type of electromagnetic wave is suitable for the practical application.	• microwaves – satellite communications, cooking food • infrared – electrical heaters, cooking food, infrared cameras • visible light – fibre optic communications • ultraviolet – energy efficient lamps, sun tanning • X-rays and gamma rays – medical imaging and treatments.			how s/he looks through the pupil
		...<i>that</i> a lens forms an image by refracting light.	Physics only	The eye receives upright images on the retina.	Ray diagrams can be used to show how the image is inverted	Use vid-clips to show full visual system
		...<i>how to</i> construct ray diagrams to illustrate the similarities and differences between convex and concave lenses.		The lens is the only part of the eye responsible for focusing light.	Cornea is primary refractor	Discuss sight correction using lasers - resculpting of the cornea - use a glass ball to refract light.
		...<i>that</i> each colour within the visible light spectrum has its own narrow band of wavelength and frequency.	Physics only	The lens forms an image (picture) on the retina. The brain then "looks" at this image and that is how we see.	Correct terminology for image interpretation needs to be reinforced	Use vid-clips to show full visual system - discuss how blindness can happen to people with perfect eyes
		...<i>how to</i> explain: • how the colour of an object is related to the differential absorption, transmission and reflection of different wavelengths of light by the object • the effect of viewing objects through filters or the effect on light of passing through filters		The eye is the only organ involved in sight; the brain is only for thinking.	Correct terminology for image interpretation needs to be reinforced	Use vid-clips to show full visual system - discuss how blindness can happen to people with perfect eyes
		...<i>that</i> all bodies (objects), no matter what temperature, emit and absorb infrared radiation. A perfect black body is an object that absorbs all of the radiation incident on it.	Physics only	A white light source, such as sunlight, an incandescent or fluorescent bulb, candle flame etc. produces light made up of exactly the same spectrum of colours.	Spectra of sources differ according to the electron transitions involved	Use a series of light sources and compare the spectra or what strips of multicoloured cloth look like under them - discuss how clothing looks different under different light sources. Could look at spectra from stars...
		...<i>how to</i> explain: • that all bodies (objects) emit radiation • that the intensity and wavelength distribution of any emission depends on the temperature of the body		When white light passes through a coloured filter colour is added to the light.	Filters subtract	Use multiple filters

				The rules for mixing color paints and crayons are the same as the rules for mixing coloured lights. So the primary colors for mixing coloured lights are red, blue and yellow.		
				The shades of grey in a black and white newspaper picture are produced by using inks with different shades of gray.		Use a magnifying glass to look at the dots
				The different colors appearing in coloured pictures printed in magazines and newspapers are produced by using different inks with all the corresponding colors.		Use a magnifying glass to look at the dots
				Colour is a property of an object, and is independent of both the illuminating light and the receiver (eye).		Look at coloured objects under different coloured light sources.
				White light is colourless and clear, enabling you to see the "true" color of an object.		

				Explanations of visual phenomena involving color perception usually involve only the properties of the object being observed, and do not include the properties of the eye-brain system. Talk about colour blindness - use colour blindness tests.
--	--	--	--	--