NORTH HILL HOUSE SCIENCE CURRICULUM OVERVIEW

KEY STAGE AND YEAR	a Animals including humans	b Plants	c Living things in their environment	d Evolution	e Everyday materials	f States of matter	g Rocks	h Earth and space	i Light	j Forces and magnets	k Sound	l Electricity
KS1 YEAR 1	**1a** **Common animals** I can identify and name a variety of common animals including fish, amphibians, reptiles, birds and mammals **What animals eat** I can identify and name a variety of common animals that are carnivores, herbivores and omnivores **Structure of common animals** I can describe and compare the structure of a variety of common animals (fish,	**1b** **Common plants** I can identify and name a variety of common wild and garden plants, including deciduous and evergreen trees **Basic plant structure** I can identify and describe the basic structure of a variety of common flowering plants, including trees			**1e** **Identifying and naming everyday materials** I can distinguish between an object and the material from which it is made I can identify and name a variety of everyday materials, including wood, plastic, glass, metal, water and rock **Identifying properties of everyday materials** I can describe the simple physical properties of a variety of everyday materials			**1h** **Seasonal changes** I can identify changes across the four seasons I can observe and describe weather associated with the seasons and how day length varies				

	amphibians, reptiles, birds and mammals, including pets) **Structure of the human body, and the senses** I can identify, name, draw and label the basic parts of the human body and say which part of the body is associated with each sense											
KS1 YEAR 2	**2a** **Builds on 1a** **Reproduction** I can state that animals, including humans, have offspring which grow into adults **What animals need to survive** I can describe the basic needs of animals, including humans, for survival (water, food and air)	**2b** **Builds on 2a** **Plants from seeds and bulbs** I can observe and describe how seeds and bulbs grow into mature plants **What plants need to grow** I can describe what plants need to grow and stay healthy – water, light and a suitable temperature	**2c** **Builds on 1a, 1b** **Dead or alive?** I can explore and compare the differences between things that are living, dead and things that have never been alive **Habitats** I can identify and name a variety of plants and animals in their habitats, including micro-habitats I can identify that most living things live in habitats to which they are		**2e** **Builds on 1e** **Uses of everyday materials** I can identify and compare the suitability of a variety of everyday materials including wood, plastic, glass, metal, water, rock, paper and cardboard for particular uses **Changing shape** I can find out how the shapes of						

	The importance of food and exercise in humans I can describe the importance for humans of exercise, eating the right amounts of different types of food, and hygiene		suited, and I can describe how different habitats provide for the basic needs of different kinds of animals and plants, and how they depend on each other **How animals obtain food** I can describe how animals obtain their food from plants and other animals, using the idea of a simple food chain **Simple food chains** I can identify and name different sources of food within a food chain		solid objects made from some materials can be changed by squashing. Bending, twisting and stretching							
KS2 YEAR 3	**3a** **Builds on 1a, 2a** **Nutrition** I can identify that animals, including humans, need the right types and amount of nutrition, and that they cannot make their own food: they get nutrition from	**3b** **Builds on 1b** **The basic function of plant parts** I can identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves and flowers					**3g** **Builds on 1a, 1b, 1c** **Grouping rocks** I can compare and group together different kinds of rocks on the basis of their appearance and simple physical properties		**3i** **Builds on 1i** **Light and dark** I recognise that we need light in order to see things and that dark is the absence of light I recognise	**3j** **Builds on 2e** **Forces between objects** I can compare how things move on different surfaces **Magnetic forces** I can compare and group together a		

	what they eat	**The requirements for life** I can explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant **Water transport in plants** I can investigate the way in which water is transported in plants **The life cycle of flowering plants** I can explore the part that flowers play in the life cycle of flowering plants, including pollination, seed formation and seed dispersal					**How fossils form** I can describe in simple terms how fossils are formed when things that have lived are trapped within rock		that light from the Sun can be dangerous and that there are ways to protect my eyes **Shadows** I recognise that shadows are formed when the light from a light source is blocked by a solid object I can work out what makes shadows change size	variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials I understand that magnets attract and repel each other and attract some materials and not others I can describe magnets as having two poles I can predict whether two magnets will attract or repel each other, depending on which poles are facing **Contact and non-contact forces** I recognise that some forces need contact between two objects, but magnetic forces can		

										act at a distance		
KS2 YEAR 4	**4a** **Builds on 1a, 1a, 2a, 3a, 2c** I can describe the simple functions of the basic parts of the digestive system in humans **Human teeth** I can identify the different types of teeth in humans and their simple functions **Food chains** I can construct and interpret a variety of food chains, identifying producers, predators and prey		**4c** **Builds on 1a, 1b, 2a, 2b, 2c** **Grouping living things (classification)** I recognise that living things can be grouped in a variety of ways I can explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment **Dangers posed by environmental change** I recognise that environments can change and that this can sometimes pose dangers to living things		**4e** **Builds on 1e** **The water cycle** I can identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature	**4f** **Builds on 1e, 2e** **Solids, liquids and gases** I can compare and group materials together, according to whether they are solids, liquids or gases **Changes of state** I recognise that some materials change state when they are heated or cooled I can measure or research the temperature at which materials change state happens in degrees Celsius (◦ C)					**4k** **Builds on 1a** **Sound and vibration** I can identify how sounds are made, associating some of them with something vibrating I recognise that vibrations from sounds travel through a medium to the ear **Pitch** I can find patterns between the pitch of a sound and the features of the object that produced it **Volume** I can find patterns between the volume of a sound and the strength of the	**4l** **Builds on 3a, 3b** **Electricity** I can identify common appliances that work on electricity **Simple series circuits** I can construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers I can identify whether or not the lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery I recognise that a switch

											vibrations that produced it I recognise that sounds get fainter as the distance from the sound source increases	opens or closes a circuit, and associate this with whether or not a lamp lights in a simple series circuit **Conductors and insulators** I recognise some common conductors and insulators, and associate metals with being good conductors
KS2 YEAR 5	**5a** **Builds on 1a, 2a, 3a, 4a** **Ageing in humans** I can describe the changes as humans develop to old age		**5c** **Builds on 3a, 3b** **Animal life cycles** I can describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird **Reproduction in plants and animals** I can describe the process of reproduction in some plants and animals		**5e** **Builds on 1e, 2e** **Grouping everyday materials according to their properties** I can compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity and response to magnets			**5h** **Builds on 1h** **The Sun, Moon and Earth** I can describe the Sun, Earth and Moon as approximately spherical objects **Day and night** I can use the idea of Earth's rotation to explain day and night and the apparent movement of the sun across the sky		**5j** **Builds on 3j** **Gravity** I can explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object **Forces between moving objects** I can identify the effects of air resistance,		

					Uses of everyday materials I can give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic			**The heliocentric model** I can describe the movement of the Earth, and other planets, relative to the Sun in the solar system		water resistance and friction, that act between moving surfaces **Levers and pulleys** I recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect		
KS2 YEAR 6	**6a** **Builds on 2a, 3a, 4a** **Human circulation system** I can identify and name the main parts of the human circulatory system, and describe the functions of the heart, blood vessels and blood **Impact of lifestyle on the body** I can recognise the impact of diet, exercise, drugs and lifestyle on the way my		**6c** **Builds on 1a, 1b, 2c, 3b** **Classification** I can describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including microorganisms, plants and animals I can give reasons for classifying plants and animals based on specific characteristics	**6d** **Builds on 2c, 3g, 5c** **Evolution** I recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago **Adaptation** I can recognise that living things produce offspring of the same kind, but normally					**6i** **Builds on 3i** **Light travels in straight lines** I recognise that light appears to travel in straight lines I can use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect			**6l** **Builds on 4l** **Circuit symbols** I can use recognised symbols when representing a simple circuit in a diagram **Cells and voltage** I can associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit I can compare

	body functions **Nutrient and water transport in animals** I can describe the way in which nutrients and water are transported within animals, including humans			offspring vary and are not identical to their parents I can identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution					light into the eye **How we see things** I can explain that we can see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes			and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches

LEADING ONTO AT KS3

KS2 Topic area	**Content to be covered at KS3**
Animals including humans	*Movement* – Levels or organisation, movement- the skeleton, joints and muscles *Cells* – the structure of animal cells and specialised cells, how to use a light microscope to view cells, how substances move into and out of cells *Breathing* – what happens during inhaling and exhaling, the respiratory system and how gases are exchanged in the lungs, the effect of drugs, alcohol and smoking on health *Digestion* – how the digestive system works including the role of bacteria and enzymes, what makes a nutritionally healthy diet and how to carry out food tests *Respiration* – aerobic and anaerobic respiration *Human reproduction* – changes during adolescence, human reproductive systems, fertilisation and implantation in humans, causes of infertility, the development of a foetus, stages of development of a baby, the menstrual cycle and contraception
Plants	*Cells* – the structure of plant cells and specialised cells, how to use a light microscope to view cells, how substances move in and out of cells

	Plant reproduction – the structure and function of flowers, the purpose of pollination, differences between insect-pollinated and wind-pollinated plants, how plants make seeds – fertilisation, how seeds start to grow – germination, how and why seeds are dispersed, photosynthesis, leaf structure, plant minerals
Living things in their environment	*Interdependence* – food chains and webs and, how organisms in an ecosystem are interdependent, bioaccumulation, types of ecosystems and how organisms co-exist within them, what animals compete for, predator-prey relationships, what plants complete for
Evolution	*Evolution* – evolution by natural selection, the work of Charles Darwin, how organisms become extinct, endangered species and ways of preserving biodiversity *Inheritance* – the structure of DNA, the inheritance of DNA *Variation* – what causes variation, studying variation, how organisms adapt to change
States of matter/ Everyday materials	*The particle model* – how the particle model can explain the properties of materials, how the particle model can help explain density, the three states of matter – solids, liquids and gases, changes of state – explaining melting and freezing, boiling, evaporation, condensation and sublimation, using the particle model to explain diffusion, explaining gas pressure, different types of substances – elements and compounds *Separating mixtures* – the properties of a pure substance, using melting temperature to identify substances, solutions and solubility, explaining dissolving, methods for separating mixtures – filtration, evaporation, distillation, chromatography *Acids and alkalis* – what are chemical reactions and why are they useful, acids and alkalis – hazards, properties, explaining and comparing concentration and strength, indicators, the Ph scale, bases, neutralisation reactions and how they can be useful, introducing salts – substances formed in chemical reactions between an acid and a metal or metal compound *Metals and non-metals* – properties of metals and non-metals, comparing physical and chemical properties of elements, how metals react with acids, how metals react with oxygen, how metals react with water and steam, the reactivity series, metal displacement reactions *Matter* – elements, atoms and representing atoms using particle diagrams, compounds and representing compounds using particle diagrams, naming compounds, chemical formulae, polymers – synthetic and natural *The Periodic Table* – an introduction to the layout of the Periodic Table, physical and chemical properties of Group 1, Group 7 and Group 0 elements *Reactions* – how atoms behave in chemical reactions, the law of conservation of mass, using particle diagrams to describe chemical reactions, fuels, combustion reactions, thermal decomposition reactions, writing balanced equations *Endothermic and exothermic reactions* – identifying endothermic and exothermic changes in reactions
Rocks	*Earth's structure* – the structure of the Earth – crust, mantle, core, properties of sedimentary rocks and how they are made, properties of igneous and metamorphic rocks and how they are made, the rock cycle – how rocks change and are recycled, the properties and uses of ceramics
Earth and space	*The Universe* – the structure of the Universe, the model of our Solar System, the planets, explaining night and day, explaining the seasons, the phases of the Moon, comparing the geocentric and heliocentric models of the Universe *Climate* – global warming, the carbon cycle, climate changes *Earth's resources* – the meaning of the term 'ore', methods of extracting metals, advantages and disadvantages of quarrying, finite resources, why recycling of materials is important, advantages and disadvantages of recycling
Light	*Light* – What happens to light as it travels, the speed of light, why we can see solar and lunar eclipses, how reflection from a mirror works, how to construct a ray diagram to where a reflected beam of light will go, how light bends when it enters a different medium, how lenses work, how images form in your eyes, splitting white light with a prism, adding and subtracting colours

Forces and magnets	*Contact forces* – friction and drag, resultant forces and their effect on objects in motion, how to reduce friction, squashing and stretching, turning forces, the law of moments, falling over and the centre of gravity *Pressure* – pressure in gases, fluid pressure, atmospheric pressure, pressure in liquids, pressure and depth, floating and sinking, stress on solids *Magnetism* – how magnets interact, magnetic fields, permanent magnets
Sound	*Sound* – how vibrations cause sound waves, sound needs a medium to travel through, the speed of sound, waves transfer energy, the features of waves – amplitude, frequency, wavelength, loudness and pitch, the ear and hearing
Electricity	*Potential difference (p.d.) and resistance* – how p.d. tells you the amount of energy being transferred from a cell to the charges (and on to the components), modelling circuits, circuit components, how components provide resistance to charges, modelling and measuring resistance, two types of circuit – series and parallel, p.d. in series and parallel circuits, using circuit symbols and circuit diagrams *Current* – current in series and parallel circuits, the properties of charge, where charge comes from – electrons in atoms, lightening

KS3 PROGRAMME OF LEARNING OVER 2 ½ - 3 YEARS

BASED ON THE NATIONAL CURRICULUM AND FOLLOWING THE AQA ACTIVATE SCHEME OF WORK

Overview

EXACT ORDER OF UNITS INDIVIDUALISED TO SUIT COHORT

(specialisms rotated by topic)

YEAR	TERM 1 TOPICS	TERMS 2 TOPICS	TERM 3 TOPICS
7	Movement (B) Particle model (C) Speed (P) Cells (B) Separating mixtures (C)	Gravity (P) Interdependence (B) Metals and non-metals (C) Voltage and resistance (P) Plant reproduction (B)	Acids and alkalis (C) Current (P) Variation (B) Earth structure (C) Energy costs (P)
8	Energy transfer (P) Human reproduction (B) Universe (C) Sound (P) Light (P)	Breathing (B) Periodic table (C) Contact forces (P) Digestion (B) Elements (C)	Pressure (P) Respiration (B) Chemical energy (C) Electromagnets (P) Photosynthesis (B)
9	Types of reaction (C) Magnetism (P) Evolution (B) Climate (C) Work (P)	Inheritance (B) Earth's resources (C) Heating and cooling (P) Wave effects and properties (P)	

SPECIALISM	TOPIC	BIOLOGY CONTENT Highlighted content will not be required at Entry Level	PRIOR LEARNING AT KS2	LEADING ONTO AT KS4
Biology	**Human body**	**Introduction: organisation** The hierarchy of organisation – cell, tissue, organ, organ system, multi-cellular organism Examples of organ systems are the circulatory system, the respiratory system, the reproductive system, the digestive system, the muscular skeletal system and the immune system	1a - Structure of the human body, and the senses 4a - Function of the digestive system 6a – Function of the circulatory system	The digestive system The circulatory system The nervous system Homeostasis
		Key ideas: movement The parts of the human skeleton work as a system for support, protection, movement and the production of new blood cells. Antagonistic pairs of muscles create movement when one contracts and the other relaxes. <u>Outcomes:</u> Explain how a physical property of part of the skeleton relates to its function. Explain why some organs contain muscle tissue. Explain how antagonistic muscles produce movement around a joint. Use a diagram to predict the result of a muscle contraction or relaxation.	1a – human and animals can move 4a- how the skeleton is related to movement and support in humans - what happens to skeleton and muscles as they move	Nervous and reflex responses – role of effectors

		Key ideas: cells Multicellular organisms are composed of cells which are organised into tissues, organs and systems to carry out life processes. There are many types of cell. Each has a different structure or feature so it can do a specific job. Both plant and animal cells have a cell membrane, nucleus, cytoplasm and mitochondria. Plant cells also have a cell wall, chloroplasts and usually a permanent vacuole. <u>Outcomes:</u> Explain why multi-cellular organisms need organ systems to keep their cells alive. Suggest what kind of tissue or organism a cell is part of, based on its features. Explain how to use a microscope to identify and compare different types of cells. Explain how uni-cellular organisms are adapted to carry out functions that in multi-cellular organisms are done by different types of cell. Use a light microscope to observe and draw cells.	Not covered at KS2. A general introduction to the structure of animals and plants Animals and plants grow, move and reproduce	Microscopy Parts of animal and plant cells Eukaryotic and prokaryotic cell structure Specialism in animal and plant cells Transport in cells – diffusion, osmosis, active transport Adaptations of exchange surfaces Cell division The cell cycle Differentiation Stem cells – embryonic and adult Stem cell dilemmas
		Key ideas: breathing In gas exchange, oxygen and carbon dioxide move between alveoli and the blood. Oxygen is transported to cells for aerobic respiration and carbon dioxide, a waste product of respiration, is removed from the body. Breathing occurs through the action of muscles in the ribcage and diaphragm. The amount of oxygen required by body cells determines the rate of breathing. <u>Outcomes:</u> Explain how exercise, smoking and asthma affect the gas exchange system. Explain how the parts of the gas exchange system are adapted to their function. Explain observations about changes to breathing rate and volume. Explain how changes in volume and pressure inside the chest move gases in and out of the lungs.	5a – the many aspects to keeping healthy - the heart and how heartbeat is affected by exercise	Breathing and gas exchange in relation to the circulatory system
		Key ideas: digestion The body needs a balanced diet with carbohydrates, lipids, proteins, vitamins, minerals, dietary fibre and water, for its cells' energy, growth and maintenance. Organs of the digestive system are adapted to break large food molecules into small ones which can travel in the blood to cells and are used for life processes. Iron is a mineral important for red blood cells.	2a – animals need to feed and grow to stay healthy 3a – personal health relating to teeth - relating teeth to diet and the need to care for them	The chemistry of food Catalysts and enzymes The structure of the human digestive system How the human digestive system works The role of bile

		Calcium is a mineral needed for strong teeth and bones. Vitamins and minerals are needed in small amounts to keep the body healthy. <u>Outcomes:</u> Describe possible health effects of unbalanced diets from data provided. Calculate food requirements for a healthy diet, using information provided. Describe how organs and tissues involved in digestion are adapted for their role. Describe the events that take place in order to turn a meal into simple food molecules inside a cell.	5a – the many aspects to keeping healthy	The link between diet, exercise and disease
Biology	**Ecosystems**	**Key ideas: interdependence** Organisms in a food web (decomposers, producers and consumers) depend on each other for nutrients. So, a change in one population leads to changes in others. The population of a species is affected by the number of its predators and prey, disease, pollution and competition between individuals for limited resources such as water and nutrients. Insects are needed to pollinate food crops. <u>Outcomes:</u> Describe how a species' population changes as its predator or prey population changes. Explain effects of environmental changes and toxic materials on a species' population. Combine food chains to form a food web. Explain issues with human food supplies in terms of insect pollinators.	2b – animals and plants in their immediate environment - the range of animals and plants found in different places varies 4b – the concept of a habitat - habitats provide the conditions for life for animals and plants 6a – how plants and animals depend on each other - relating feeding relationships to knowledge of plant nutrition	The importance of communities Organisms in their environment Distribution and abundance of organisms Competition in animals and in plants Adaptation in animals and in plants
		Key ideas: plant reproduction Plants have adaptations to disperse seeds using wind, water or animals. Plants reproduce sexually to produce seeds, which are formed following fertilisation in the ovary. Flowers contain the plant's reproductive organs. Pollen can be carried by the wind, pollinating insects or other animals. <u>Outcomes</u> Describe the main steps that take place when a plant reproduces successfully. Identify parts of the flower and link their structure to their function. Suggest how a plant carried out seed dispersal based on the features of its fruit or seed. Explain why seed dispersal is important to survival of the parent plant and its offspring.	5b – in life cycles there are distinct processes and stages - Plants reproduce as part of their life cycle -reproduction is important to the survival of the species	Plant cell structure Adaptations of leaves for photosynthesis

		Key ideas: respiration Respiration is a series of chemical reactions, in cells, that breaks down glucose to provide energy and form new molecules. Most living things use aerobic respiration but switch to anaerobic respiration, which provides less energy, when oxygen is unavailable. Yeast fermentation is used in brewing and bread making. <u>Outcomes</u> Use word equations to describe aerobic and anaerobic respiration. Explain how specific activities involve aerobic or anaerobic respiration.	New topic at KS3. 4b - the concept of a habitat - habitats provide the conditions for life for animals and plants 5a - the many aspects to keeping healthy - the heart and how heart beat is affected by exercise	The equation for aerobic respiration Aerobic respiration The response to exercise Anaerobic respiration Metabolism and the liver
		Key ideas: photosynthesis Plants and algae do not eat, but use energy from light, together with carbon dioxide and water to make glucose (food) through photosynthesis. They either use the glucose as an energy source, to build new tissue, or store it for later use. Plants have specially-adapted organs that allow them to obtain resources needed for photosynthesis. Iodine is used to test for the presence of starch. <u>Outcomes</u> Describe ways in which plants obtain resources for photosynthesis. Explain why other organisms are dependent on photosynthesis. Sketch a line graph to show how the rate of photosynthesis is affected by changing conditions. Use a word equation to describe photosynthesis in plants and algae.	1b - plants are living things that grow and move - plant similarities and differences 3b - what plants need to grow 4b - the concept of a habitat - habitats provide the conditions for life for animals and plants	The equation for photosynthesis Factors that affect the rate of photosynthesis How plants use glucose Greenhouse economics
Biology	**Variation and natural selection**	**Key ideas: variation** There is variation between individuals of the same species. Some variation is inherited, some is caused by the environment and some is a combination. Variation between individuals is important for the survival of a species, helping it to avoid extinction in an always changing environment. <u>Outcomes:</u> Explain whether characteristics are inherited, environmental or both. Plot bar charts or line graphs to show discontinuous or continuous variation data. Explain how variation helps a particular species in a changing environment. Explain how characteristics of a species are adapted to particular environmental conditions.	2c - the variety of living things in the local environment - animals and plants can be grouped according to their similarities and differences	Variation – genetic and/or environmental The genetics of twins Evolution by natural selection DNA and the genome Inheritance

		Key ideas: human reproduction The menstrual cycle prepares the female for pregnancy and stops if the egg is fertilised by a sperm. The developing foetus relies on the mother to provide it with oxygen and nutrients, to remove waste and protect it against harmful substances. The menstrual cycle lasts approximately 28 days. If an egg is fertilised it settles into the uterus lining. <u>Outcomes:</u> Explain whether substances are passed from the mother to the foetus or not. Use a diagram to show stages in development of a foetus from the production of sex cells to birth. Describe causes of low fertility in male and female reproductive systems. Identify key events on a diagram of the menstrual cycle.	5b – in life cycles there are distinct processes and stages - animals reproduce as part of their life cycle -reproduction is important to the survival of the species	Human reproduction Hormones and the menstrual cycle The artificial control of fertility Infertility treatments Types of reproduction Cell division in sexual reproduction
		Key ideas: evolution Natural selection is a theory that explains how species evolve and why extinction occurs. Biodiversity is vital to maintaining populations. Within a species variation helps against environment changes, avoiding extinction. Within an ecosystem, having many different species ensures resources are available for other populations, like humans. The DNA of every individual is different, except for identical twins. There is more than one version of each gene eg different blood groups. <u>Outcomes:</u> Use evidence to explain why a species has become extinct or adapted to changing conditions. Evaluate whether evidence for a species changing over time supports natural selection. Explain how a lack of biodiversity can affect an ecosystem. Describe how preserving biodiversity can provide useful products and services for humans.	2c - the variety of living things in the local environment - animals and plants can be grouped according to their similarities and differences	Evolution by natural selection Charles Darwin Selective breeding Genetic engineering Ethics of genetic technologies Evidence for evolution Fossils and extinction Antibiotic resistant bacteria Classification
		Key ideas: inheritance Inherited characteristics are the result of genetic information, in the form of sections of DNA called genes, being transferred from parents to offspring during reproduction. Chromosomes are long pieces of DNA which contain many genes. Gametes, carrying half the total number of chromosomes of each parent, combine during fertilisation. <u>Outcomes:</u> Use a diagram to show the relationship between DNA, chromosomes and genes. Use a diagram to show how genes are inherited. Explain how a change in the DNA (mutation) may affect an organism and its future offspring.	New topic at KS3. 2c - the variety of living things in the local environment - animals and plants can be grouped according to their similarities and differences	Types of reproduction Cell division in reproduction DNA and the genome Inheritance in action Sex determination Inherited disorders Screening for genetic disorders Predicting outcomes using Punnett squares and genetic diagrams

		Explain why offspring from the same parents look similar but are not usually identical.		

SPECIALISM	TOPIC	PHYSICS CONTENT Highlighted content will not be required at Entry Level	PRIOR LEARNING AT KS2	LEADING ONTO AT KS4
Physics	**Forces**	**Key ideas: speed** If the overall, resultant force on an object is non-zero, its motion changes and it slows down, speeds up or changes direction. A straight line on a distance-time graph shows constant speed, a curving line shows acceleration. The higher the speed of an object, the shorter the time taken for a journey. <u>Outcomes:</u> Use the formula: speed = distance (m)/time (s) or distance-time graphs, to calculate speed. Illustrate a journey with changing speed on a distance-time graph, and label changes in motion. Describe how the speed of an object varies when measured by observers who are not moving or moving relative to the object.	2e - how pushes and pulls affect the movement of shapes and objects 4e - forces can be measured and compared - friction as a force acting between objects moving across solid surfaces that oppose motion - air resistance and water resistance as forces which oppose the motion of objects through air or water	Speed and distance-time graphs Velocity and acceleration Analysing motion graphs Forces and acceleration Weight and terminal velocity Forces and braking momentum Forces and elasticity
		Key ideas: gravity Mass and weight are different but related. Mass is a property of the object; weight depends upon mass but also on gravitational field strength. Every object exerts a gravitational force on every other object. The force increases with mass and decreases with distance. Gravity holds planets and moons in orbit around larger bodies. G on Earth = 10 N/kg. On the moon it is 1.6 N/kg. <u>Outcomes:</u> Explain unfamiliar observations where weight changes. Draw a force diagram for a problem involving gravity. Deduce how gravity varies for different masses and distances. Compare your weight on Earth with your weight on different planets using the formula. Use the formula: weight (N) = mass (kg) x gravitational field strength (N/kg).	2e – how pushes and pulls affect the movement of shapes and objects 4e – forces can be measured and compared - friction as a force acting between objects moving across solid surfaces that oppose motion - air resistance and water resistance as forces which oppose the motion of objects through air or water	Gravitational potential energy stores Weight and terminal velocity Centre of mass Resultant forces
		Key ideas: contact forces When the resultant force on an object is zero, it is in equilibrium and does not move, or remains at constant speed in a straight line.	2e – how pushes and pulls affect the movement of shapes and objects	Vectors and scalars Forces between objects Resultant forces

		One effect of a force is to change an object's form, causing it to be stretched or compressed. In some materials, the change is proportional to the force applied. <u>Outcomes:</u> Explain whether an object in an unfamiliar situation is in equilibrium. Describe factors which affect the size of frictional and drag forces. Describe how materials behave as they are stretched or squashed. Describe what happens to the length of a spring when the force on it changes. Sketch the forces acting on an object and label their size and direction.	4e – forces can be measured and compared - friction as a force acting between objects moving across solid surfaces that oppose motion - air resistance and water resistance as forces which oppose the motion of objects through air or water	Centre of mass The parallelogram of forces Resolution of forces
		Key ideas: pressure Pressure acts in a fluid in all directions. It increases with depth due to the increased weight of fluid, and results in an upthrust. Objects sink or float depending on whether the weight of the object is bigger or smaller than the upthrust. Different stresses on a solid object can be used to explain observations where objects scratch, sink into or break surfaces. Use the formula: fluid pressure, or stress on a surface = force (N)/area (m2). <u>Outcomes:</u> Use diagrams to explain observations of fluids in terms of unequal pressure. Explain why objects either sink or float depending upon their weight and the upthrust acting on them. Explain observations where the effects of forces are different because of differences in the area over which they apply. Given unfamiliar situations, use the formula to calculate fluid pressure or stress on a surface.	2e – how pushes and pulls affect the movement of shapes and objects 4e – forces can be measured and compared - friction as a force acting between objects moving across solid surfaces that oppose motion - air resistance and water resistance as forces which oppose the motion of objects through air or water	Gas temperature and pressure The effect of pressure on rate of reaction
Physics	**Electromagnets**	**Key ideas: potential difference and resistance** We can model voltage as an electrical push from the battery, or the amount of energy per unit of charge transferred through the electrical pathway. In a series circuit, voltage is shared between each component. In a parallel circuit, voltage is the same across each loop. Components with resistance reduce the current flowing and shift energy to the surroundings. <u>Outcomes:</u> Draw a circuit diagram to show how voltage can be measured in a simple circuit. Use the idea of energy to explain how voltage and resistance affect the way components work. Given a table of voltage against current, use the ratio of voltage to current to determine the resistance.	2f - the concept of electricity - the essential role of electricity - hazards of mains electricity 4f - extending understanding of circuits - dangers of mains electricity - some materials are better conductors than others	Potential difference and resistance Component characteristics

		Use an analogy like water in pipes to explain why part of a circuit has higher resistance. Calculate resistance using the formula: resistance (Ω) = potential difference (V) ÷ current(A).	- the idea of electrical conductors and insulators 6g - how to vary the brightness of bulbs and speed of motors in a circuit - the use and value of conventional symbols for communication	
		Key ideas: current Current is a movement of electrons and is the same everywhere in a series circuit. Current divides between loops in a parallel circuit, combines when loops meet, lights up bulbs and makes components work. Around a charged object, the electric field affects other charged objects, causing them to be attracted or repelled. The field strength decreases with distance. Two similarly charged objects repel, two differently charged objects attract. <u>Outcomes:</u> Describe how current changes in series and parallel circuits when components are changed. Turn circuit diagrams into real series and parallel circuits, and vice versa. Describe what happens when charged objects are placed near to each other or touching. Use a sketch to describe how an object charged positively or negatively became charged up.	2f - the concept of electricity - the essential role of electricity - hazards of mains electricity 4f - extending understanding of circuits - dangers of mains electricity - some materials are better conductors than others - the idea of electrical conductors and insulators 6g - how to vary the brightness of bulbs and speed of motors in a circuit - the use and value of conventional symbols for communication	Current and charge Series circuits Parallel circuits Alternating current Cables and plugs Electrical power and potential difference Electrical currents and energy transfer Appliances and efficiency
		Key ideas: electromagnets If a current flows in a coil of wore (called a solenoid) it produces a magnetic field in which a magnetic material will feel a force You can turn an electromagnet on and off Electromagnets are used in electric bells, loudspeakers and circuit breakers <u>Outcomes:</u> Describe how to make an electromagnet stronger Suggest why electromagnets are useful		
		Key ideas: magnetism Magnetic materials, electromagnets and the Earth create magnetic fields which can be described by drawing field lines to show the strength and direction.	6f – applying knowledge of magnetic attraction, gravitational attraction and friction	Magnetic fields Magnetic fields of electric currents The motor effect

		The stronger the magnet, and the smaller the distance from it, the greater the force a magnetic object in the field experiences. Outcomes: Use the idea of field lines to show how the direction or strength of the field around a magnet varies. Explain observations about navigation using Earth's magnetic field.	- changes in motion when forces act on an object - forces have direction - forces can be measured	
Physics	**Energy**	**Key ideas: energy costs** We pay for our domestic electricity usage based on the amount of energy transferred. Electricity is generated by a combination of resources which each have advantages and disadvantages. Calculate the cost of home energy usage, using the formula: cost = power (kW) x time (hours) x price (per kWh). Food labels list the energy content of food in kilojoules (kJ). Outcomes: Compare the amounts of energy transferred by different foods and activities. Compare the energy usage and cost of running different home devices. Explain the advantages and disadvantages of different energy resources. Represent the energy transfers from a renewable or non-renewable resource to an electrical device in the home.	2f - the concept of electricity - the essential role of electricity - hazards of mains electricity 4f - extending understanding of circuits - dangers of mains electricity - some materials are better conductors than others - the idea of electrical conductors and insulators	Electrical appliances Energy demands Energy from wind and water Power from the Sun and the Earth Energy and the environments Big energy issues
		Key ideas: energy transfer We can describe how jobs get done using an energy model where energy is transferred from one store at the start to another at the end. When energy is transferred, the total is conserved, but some energy is dissipated, reducing the useful energy. Outcomes: Describe how the energy of an object depends on its speed, temperature, height or whether it is stretched or compressed. Show how energy is transferred between energy stores in a range of real-life examples. Calculate the useful energy and the amount dissipated, given values of input and output energy. Explain how energy is dissipated in a range of situations.	New topic at KS3. Possibly introduced indirectly via other topics such as forces, electricity and the need to feed. 2d – how materials can be changed 3c- the properties of materials that we use 4c – temperature as a measure of how hot or how cold objects are - thermal insulators for keeping materials warm or cool	Changes in energy stores Conservation of energy Gravitational and potential energy Kinetic energy and elastic energy stores Energy dissipation Energy and efficiency

		Key ideas: work Work is done and energy transferred when a force moves an object. The bigger the force or distance, the greater the work. Machines make work easier by reducing the force needed. Levers and pulleys do this by increasing the distance moved, and wheels reduce friction. <u>Outcomes:</u> Draw a diagram to explain how a lever makes a job easier. Compare the work needed to move objects different distances.	2e - Forces and magnets *Builds on 1e, 2d - how pushes and pulls affect the movement of shapes and objects 4e - forces can be measured and compared - friction as a force acting between objects moving across solid surfaces that oppose motion	Energy and power
		Key ideas: heating and cooling The thermal energy of an object depends upon its mass, temperature and what it's made of. When there is a temperature difference, energy transfers from the hotter to the cooler object. Thermal energy is transferred through different pathways, by particles in conduction and convection, and by radiation. <u>Outcomes</u> Explain observations about changing temperature in terms of energy transfer. Describe how an object's temperature changes over time when heated or cooled. Explain how a method of thermal insulation works in terms of conduction, convection and radiation. Sketch diagrams to show convection currents in unfamiliar situations.	2d – how heating can cause changes and produce materials which are useful 4c – temperature as a measure of how hot or how cold objects are - thermal insulators for keeping materials warm or cool	Energy transfer by conduction Specific heat capacity Heating and insulating buildings
Physics	**Waves**	**Key ides: sound** Sound travels at 330 m/s which is a million times slower than light Sound cannot travel through a vacuum In longitudinal waves the vibration is parallel to the wave direction The loudness of a sound depends on its amplitude and pitch Frequency is the number of waves past a point per second in Hertz You can use an oscilloscope to measure the amplitude and frequency of a wave <u>Outcomes:</u> Explain why sound cannot travel through a vacuum Explain how the loudness of a sound relates to amplitude Describe how the pitch of a wave relates to frequency Describe how a sound wave gets passed to your brain through the ear		

		Key ides: light Objects are transparent, translucent and opaque Light can travel through a vacuum at 300 000 000 m/s Light can be reflected and refracted Lenses can be used to correct long and short sight Prisms disperse white light into a spectrum of colours Filters and coloured objects subtract colour from wite light <u>Outcomes</u> Construct a ray diagram to model how light reflects and forms images Construct a ray diagram to describe how light enters and leaves transparent materials Describe how lenses may be used to correct vision		
		Key ideas: effects When a wave travels through a substance, particles move to and fro. Energy is transferred in the direction of movement of the wave. Waves of higher amplitude or higher frequency transfer more energy. <u>Outcomes:</u> Explain differences in the damage done to living cells by light and other waves Explain differences in the damage done to living cells by light and other waves, in terms of their frequency. Explain how audio equipment converts sound into a changing pattern of electric current.	1d - the need for light to see things - darkness is absence of light - without sunlight other light sources are seen more easily 3e - the relationship between light, an object and the formation of shadows - movement of the Sun and changes in shadows 6e - mirrors and shiny surfaces alter the direction in which light travels - when you see objects, light enters your eye - contrasting reflection and shadow formation	The nature of waves The electromagnetic spectrum Uses of electromagnetic waves X-rays in medicine
		Key ideas: properties of waves A physical model of a transverse wave demonstrates it moves from place to place, while the material it travels through does not, and describes the properties of speed, wavelength and reflection. <u>Outcomes:</u> Distinguish between longitudinal and transverse waves Describe some properties of waves Describe the properties of different longitudinal and transverse waves. Use the wave model to explain observations of the reflection, absorption and transmission of a wave.	1d - the need for light to see things - darkness is absence of light - without sunlight other light sources are seen more easily 3e - the relationship between light, an object and the formation of shadows - movement of the Sun and changes in shadows	The properties of waves Reflection and refraction

			6e - mirrors and shiny surfaces alter the direction in which light travels - when you see objects, light enters your eye - contrasting reflection and shadow formation	

SPECIALISM	TOPIC	CHEMISTRY CONTENT Highlighted content will not be required at Entry Level	PRIOR LEARNING AT KS2	LEADING ONTO AT KS4
CHEMISTY	**Matter**	**Key ideas: matter – the particle model** Properties of solids, liquids and gases can be described in terms of particles in motion but with differences in the arrangement and movement of these same particles: closely spaced and vibrating (solid), in random motion but in contact (liquid), or in random motion and widely spaced (gas). Observations where substances change temperature or state can be described in terms of particles gaining or losing energy. A substance is a solid below its melting point, a liquid above it, and a gas above its boiling point. Outcomes: Explain unfamiliar observations about gas pressure in terms of particles. Explain the properties of solids, liquids and gases based on the arrangement and movement of their particles. Explain changes in states in terms of changes to the energy of particles. Draw before and after diagrams of particles to explain observations about changes of state, gas pressure and diffusion.	4d - difference between solids and liquids - materials can exist in solid and liquid forms - changes that occur when solids and liquids are mixed - how to separate undissolved solids from liquids - the difference between melting and dissolving 5c - gases can be distinguished from solids and liquids by their properties - uses of important gases - where gases are found 5d - evaporation of water and other liquids - evaporation is when a liquid turns to a gas - condensation (the reverse of evaporation) is when a gas turns to a liquid - melting, freezing, condensing and evaporation are all changes of state that can be reversed	Density States of matter Changes of state Internal energy Specific latent heat Gas temperature and pressure Atoms and radiation The discovery of the nucleus Changes in the nucleus Alpha, beta and gamma radiation Activity and half-life

		Key ideas: separating mixtures A pure substance consists of only one type of element or compound and has a fixed melting and boiling point. Mixtures may be separated due to differences in their physical properties. The method chosen to separate a mixture depends on which physical properties of the individual substances are different. Use techniques to separate mixtures. <u>Outcomes:</u> Explain how substances dissolve using the particle model. Use the solubility curve of a solute to explain observations about solutions. Use evidence from chromatography to identify unknown substances in mixtures. Choose the most suitable technique to separate out a mixture of substances.	2d - distinguishing between an object and the material it is made from - how materials can be changed - how heating can cause changes and produce material which are useful 3c - the properties of materials that we use - what needs to be considered when choosing a material for a particular source 6c - what happens when a variety of solids dissolve - how to make solids dissolve more quickly - filtration	Separating mixtures Fractional distillation Paper chromatography
		Key ideas: the Periodic Table Metals are generally found on the left side of the table, non-metals on the right. Columns are called Groups and rows are called Periods Group 1 contains reactive metals called alkali metals. Group 7 contains non-metals called halogens. Group 0 contains unreactive gases called noble gases. The elements in a group all react in a similar way and sometimes show a pattern in reactivity. As you go down a group and across a period the elements show patterns in physical properties. <u>Outcomes:</u> Use the correct terms for columns and rows. Locate the position of metals and non-metals. State that the Periodic Table groups together elements with similar properties. Use data to describe a trend in physical properties. Describe the reaction of an unfamiliar Group 1 or 7 element. Use data showing a pattern in physical properties to estimate a missing value for an element. Use observations of a pattern in chemical reactions to predict the behaviour of an element in a group.	1c -characteristics and uses of a range of common materials - vocabulary for describing and comparing materials 2d – distinguishing between an object and the material it is made from - how materials can be changed - how heating can cause changes and produce material which are useful 3c – the properties of materials that we use	Development of the periodic table Electronic structure and the periodic table Group 1 elements – the alkali metals Group 7 non-metals – the halogens Explaining trends

		Key ideas: elements Elements are substances that contain only one type of atom. It is not possible to break an element down into other substances. Elements are represented by chemical symbols. Most substances are not pure elements, but compounds or mixtures containing atoms of different elements. They have different properties to the elements they contain. How to use particle diagrams to classify a substance as an element, mixture or compound and as molecules or atoms. How to name simple compounds using rules: change non-metal to –ide; mono, di, tri prefixes; and symbols of hydroxide, nitrate, sulfate and carbonate. <u>Outcomes:</u> State that elements are substances that cannot be broken down. Suggest some uses of a range of elements. Recall the chemical symbols of key elements. Name compounds using their chemical formulae. Given chemical formulae, name the elements present and their relative proportions. Represent atoms, molecules and elements, mixtures and compounds using particle diagrams. Use observations from chemical reactions to decide if an unknown substance is an element or a compound.	1c -characteristics and uses of a range of common materials - vocabulary for describing and comparing materials 2d – distinguishing between an object and the material it is made from - how materials can be changed - how heating can cause changes and produce material which are useful 3c – the properties of materials that we use	Group 1 elements – the alkali metals Group 7 non-metals – the halogens Chemical equations and calculations Separating mixtures Fractional distillation Paper chromatography Particle theory History of the atom Structure of the atom Ions, atoms and isotopes Electronic structure Ionic bonding Covalent bonding Giant covalent structures – diamond and graphite Fullerenes
CHEMISTY	**Reactions**	**Key ideas: metals and non-metals** Metals and non-metals react with oxygen to form oxides which are either bases or acids. Metals can be arranged as a reactivity series in order of how readily they react with other substances. Some metals react with acids to produce salts and hydrogen. Iron, nickel and cobalt are magnetic elements. Mercury is a metal that is liquid at room temperature. Bromine is a non-metal that is liquid at room temperature. <u>Outcomes:</u> Describe an oxidation, displacement, or metal acid reaction with a word equation. Use particle diagrams to represent oxidation, displacement and metal-acid reactions. Identify an unknown element from its physical and chemical properties. Place an unfamiliar metal into the reactivity series based on information about its reactions.	1c - characteristics and uses of a range of common materials - vocabulary for describing and comparing materials 2d – distinguishing between an object and the material it is made from - how materials can be changed - how heating can cause changes and produce material which are useful 3c – the properties of materials that we use	Group 1 – the alkali metals Group 7 – the halogens Trends in reactivity Ionic bonding Giant ionic structures Bonding in metals Giant metallic structures The reactivity series Extracting metals Electrolysis

		Key ideas: acids and alkalis The pH of a solution depends on the strength of the acid: strong acids have lower pH values than weak acids. Mixing an acid and alkali produces a chemical reaction, neutralisation, forming a chemical called a salt and water. Acids have a pH below 7, neutral solutions have a pH of 7, alkalis have a pH above 7. Acids and alkalis can be corrosive or irritant and require safe handling. Hydrochloric, sulfuric and nitric acid are strong acids. Acetic and citric acid are weak acids. **Outcomes:** Identify the best indicator to distinguish between solutions of different pH, using data provided. Use data and observations to determine the pH of a solution and explain what this shows. Explain how neutralisation reactions are used in a range of situations. Describe a method for how to make a neutral solution from an acid and alkali.	2d - distinguishing between an object and the material it is made from - how materials can be changed - how heating can cause changes and produce material which are useful 3c - the properties of materials that we use - what needs to be considered when choosing a material for a particular source 6c - what happens when a variety of solids dissolve - how to make solids dissolve more quickly - filtration	Neutralisation and the pH scale Strong and weak acids
		Key ideas: Chemical energy In some reactions energy is transferred from the surroundings, in others, energy is transferred to the surroundings. This can be explained in terms of the energy required to break bonds and make bonds <u>Outcomes</u>: Suggest whether a reaction is endothermic or exothermic. Use ideas about bond energies to explain energy changes in chemical reactions	1c -characteristics and uses of a range of common materials - vocabulary for describing and comparing materials 2d – distinguishing between an object and the material it is made from - how materials can be changed - how heating can cause changes and produce material which are useful 3c – the properties of materials that we use	Energy changes during reactions Exothermic and endothermic reactions Reaction profiles Bond energy calculations

		Key ideas: types of reaction Combustion is a reaction with oxygen in which energy is transferred to the surroundings as heat and light. Thermal decomposition is a reaction where a single reactant is broken down into simpler products by heating. Chemical changes can be described by a model where atoms and molecules in reactants rearrange to make the products and the total number of atoms is conserved. In some reactions energy is transferred from the surroundings, in others, energy is transferred to the surroundings. <u>Outcomes:</u> Explain why a reaction is an example of combustion or thermal decomposition. Predict the products of the combustion or thermal decomposition of a given reactant and show the reaction as a word equation. Explain observations about mass in a chemical or physical change. Use particle diagrams to show what happens in a reaction. Write word equations from information about chemical reactions. Suggest whether a reaction is endothermic or exothermic.	1c -characteristics and uses of a range of common materials - vocabulary for describing and comparing materials 2d – distinguishing between an object and the material it is made from - how materials can be changed - how heating can cause changes and produce material which are useful 3c – the properties of materials that we use	Rate of reaction Collision theory and surface area Reversible reactions Energy and reversible reactions The effect of catalysts Dynamic equilibrium Pure substances and mixtures Testing for gases
CHEMISTY	**Earth**	**Key ideas: Earth's structure** Sedimentary, igneous and metamorphic rocks can be inter converted over millions of years through weathering and erosion, heat and pressure, and melting and cooling. The three rock layers inside Earth are the crust, the mantle and the core. <u>Outcomes:</u> Explain why a rock has a particular property based on how it was formed. Identify the causes of weathering and erosion and describe how they occur. Construct a labelled diagram to identify the processes of the rock cycle.	3d – rocks underneath the Earth's surface - rock can be broken into pebbles and soil - there are different sorts of soils with different characteristics - pebbles and soils from different rocks have different characteristics	Hydrocarbons Fractional distillation of oil Burning hydrocarbon fuels Cracking hydrocarbons
		Key ideas: Universe The solar system can be modelled as planets rotating on tilted axes while orbiting the Sun, moons orbiting planets and sunlight spreading out and being reflected. This explains day and year length, seasons and the visibility of objects from Earth. Our solar system is a tiny part of a galaxy, one of many billions in the Universe. Light takes minutes to reach Earth from the Sun, four years from our nearest star and billions of years from other galaxies. <u>Outcomes</u> Describe the appearance of planets or moons from diagrams showing their position in relation to the Earth and Sun.	5e – the shapes and relative sizes of the Earth, Sun and Moon - how the Earth, Sun and Moon move relative to each other - how these movements relate to day and night 1d – the need for light to see things - darkness is absence of light - without sunlight other light sources are seen more easily	History of the atmosphere Our evolving atmosphere Greenhouse gases Wave properties Electromagnetic waves

		Explain why places on the Earth experience different daylight hours and amounts of sunlight during the year. Describe how space exploration and observations of stars are affected by the scale of the universe. Explain the choice of particular units for measuring distance.	3e – the relationship between light, an object and the formation of shadows - movement of the Sun and changes in shadows	
		Key ideas: climate Carbon is recycled through natural processes in the atmosphere, ecosystems, oceans and the Earth's crust (such as photosynthesis and respiration) as well as human activities (burning fuels). Greenhouse gases reduce the amount of energy lost from the Earth through radiation and therefore the temperature has been rising as the concentration of those gases has risen. Scientists have evidence that global warming caused by human activity is causing changes in climate. Methane and carbon dioxide are greenhouse gases. Earth's atmosphere contains around 78 % nitrogen, 21 % oxygen, <u>Outcomes:</u> Use a diagram to show how carbon is recycled in the environment and through living things. Describe how human activities affect the carbon cycle. Describe how global warming can impact on climate and local weather patterns.	4b – habitats provide the conditions for life for animals and plants 5e – the shapes and relative sizes of the Earth, Sun and Moon - how the Earth, Sun and Moon move relative to each other - how these movements relate to day and night - seasonal changes in the weather 6a – Plants and animals are suited to their environment	History of the atmosphere Our evolving atmosphere Greenhouse gases Global climate change Atmospheric pollutants
		Key ideas: Earth's resources There is only a certain quantity of any resource on Earth, so the faster it is extracted, the sooner it will run out. Recycling reduces the need to extract resources. Most metals are found combined with other elements, as a compound, in ores. The more reactive a metal, the more difficult it is to separate it from its compound. Carbon displaces less reactive metals, while electrolysis is needed for more reactive metals. <u>Outcomes:</u> Explain why recycling of some materials is particularly important. Describe how Earth's resources are turned into useful materials or recycled. Justify the choice of extraction method for a metal, given data about reactivity. Suggest factors to take into account when deciding whether extraction of a metal is practical.	3d – rocks underneath the Earth's surface - rock can be broken into pebbles and soil - there are different sorts of soils with different characteristics - pebbles and soils from different rocks have different characteristics	The reactivity series Displacement reactions Extracting metals Salts from metals Introduction to electrolysis The extraction of aluminium Finite and renewable resources Making water safe to drink Treating wastewater Extracting metals from ores Reduce, reuse, recycle

PREPARATION FOR GCSE PATHWAY (KS3 COURSE COVERED IN 8 TERMS)	Notes
GCSE B1 Cell structure and transport	
GCSE C1 Atomic structure	
GCSE P1 Conservation and dissipation of energy	

KS4 PROGRAMME OF LEARNING OVER 2 – 2 ½ YEARS – BASED ON THE NATIONAL CURRICULUM

	GCSE TRILOGY PATHWAY Topic and content	CONTENT COVERED AT KS3	ENTRY LEVEL SCIENCE PATHWAY Topic and content
	BIOLOGY		

	Cells and organisation		**C = SOW component number**
	Cell structure and transport Describe how to use a light microscope Compare light and electron microscopes State the difference between magnification and resolution Carry out calculations involving magnification, real size and image size Compare and label the parts of animal and plant cells Use a light microscope to observe, draw and label plant and animal cells Compare the structure of eukaryotic and prokaryotic cells Describe the function of named specialised animal and plant cells Describe how substances move into and out of cells by: - diffusion, - osmosis - active transport Compare and contrast the three processes Name some factors that affect the rate of transport across membranes Describe adaptations of exchange surfaces and the relevance of SA:V ratio	**Key ideas: cells** Multicellular organisms are composed of cells which are organised into tissues, organs and systems to carry out life processes. There are many types of cell. Each has a different structure or feature so it can do a specific job. Both plant and animal cells have a cell membrane, nucleus, cytoplasm and mitochondria. Plant cells also have a cell wall, chloroplasts and usually a permanent vacuole.	**Animal cells 01 C1** Recall the parts of human cells: • Nucleus – controls the activities of the cells and contains the genetic material • Cytoplasm – where most chemical activities take place • Cell membrane – controls the passage of substances in and out of cells Describe how specialised cells are adapted for their function
	Cell division Name the three stages of the cell cycle and what is happening at each stage Describe cell division by mitosis Describe and compare the process of cell differentiation in animals and plants State the function of stem cells in embryos, adult animals and in the meristems in plants Suggest possible uses of stem cells, including therapeutic cloning Suggest how plant clones might be used in horticulture and agriculture Describe some arguments for and against using stem cells	Not covered at KS3 Multicellular organisms are composed of cells which are organised into tissues, organs and systems to carry out life processes. There are many types of cell. Each has a different structure or feature so it can do a specific job. Both plant and animal cells have a cell membrane, nucleus, cytoplasm and mitochondria. Plant cells also have a cell wall, chloroplasts and usually a permanent vacuole.	
	Organisation and the digestive system Explain the hierarchy of cells, tissues and organs and their relative size Describe the order and function of digestive organs Explain the purpose of digestion	**Key ideas: digestion** The body needs a balanced diet with carbohydrates, lipids, proteins, vitamins, minerals, dietary fibre and water, for its cells' energy, growth and maintenance.	**Tissues, organs and systems 02 C1** Recall these definitions: • Tissue – a group of cells with a similar structure and function

	Describe the chemistry of food – the structure and function of simple sugars, starch, lipids and proteins Use reagents to test for food types Describe the role of biological catalysts (enzymes) Explain the lock and key hypothesis and how it relates to digestion Name some factors that affect enzyme action Describe how digestion works in relation to enzyme action and the importance of pH Describe the role of bile in digestion	Organs of the digestive system are adapted to break large food molecules into small ones which can travel in the blood to cells and are used for life processes. Iron is a mineral important for red blood cells. Calcium is a mineral needed for strong teeth and bones. Vitamins and minerals are needed in small amounts to keep the body healthy.	• Organ – groups (aggregations) of tissues performing similar functions • Organ systems – organs which work together Recognise the position of the major organs (brain, heart, liver, lungs, kidneys and reproductive organs) in the human body Describe the functions of the major organs **The human digestive system 03 C1** Recall the parts of the human digestive system and be able to identify them on a diagram Understand the role of enzymes in digestion
	Organising animals and plants <u>A Circulation</u> Recall the main components of blood Describe how red blood cells are adapted to their function Recall the three types of blood vessel, arteries, veins, capillaries, their role and how their structure relates to their function State the function of the heart Recall the main structures of the heart Describe how the double circulatory system works Recall the nature of heart problems and evaluate possible treatments <u>B Breathing and gas exchange</u> Recall the structure and function of the human lungs Describe how human lungs are adapted for gas exchange Describe the process of ventilation and gas exchange <u>C Organisation in plants</u> Identify plant organs and their functions Relate leaf structure to function Describe the transport systems in plants, recalling the structure and function of xylem and phloem	**Key ideas: organisation** The hierarchy of organisation – cell, tissue, organ, organ system, multi-cellular organism Examples of organ systems are the circulatory system, the respiratory system, the reproductive system, the digestive system, the muscular skeletal system and the immune system **Key ideas: breathing** In gas exchange, oxygen and carbon dioxide move between alveoli and the blood. Oxygen is transported to cells for aerobic respiration and carbon dioxide, a waste product of respiration, is removed from the body. Breathing occurs through the action of muscles in the ribcage and diaphragm. The amount of oxygen required by body cells determines the rate of breathing.	**Tissues, organs and systems 02 C1** Recall that the human circulatory system is made up of the heart and the blood Describe how the heart pumps blood round the body in a dual circulatory system Recall that blood transports oxygen, proteins and other chemical substances around the body Recognise the different types of blood cells

	Explain how water moves up the plant – evaporation and transpiration Describe the structure and role of stomata Suggest factors that affect transpiration	**Key ideas: photosynthesis** Plants have specially adapted organs that allow them to obtain resources needed for photosynthesis. Includes the structure and role of leaves, and how plants get water and minerals	
	Disease	New topic at KS4	
	Communicable diseases State the meaning of the word health and factors that cause ill-health Suggest how diseases can interact Describe some differences between communicable and non-communicable disease Interpret health data Define the term pathogen, recall types of pathogen and how they cause disease Suggest how infections spread and how the spread of disease can be reduced or prevented Describe named viral diseases and their treatment and prevention Describe named bacterial diseases and their treatment and prevention Describe named fungal diseases and their treatment and prevention State how the human body defends itself against pathogens – non-specific defences and the immune system Describe the role of white blood cells in defence against pathogens	The consequences of imbalances in the diet The importance of bacteria in the human digestive system The impact of exercise and smoking on the human gas exchange system The effects of recreational drugs on behaviour health and life processes The use of drugs to treat diseases	**Infectious diseases 05 C1** Recall that infectious diseases are caused by microorganisms called pathogens Recall that pathogens include both bacteria and viruses and may produce poisons (toxins) that make us feel ill Recall that viruses damage the cells in which they reproduce
	Preventing and treating disease Explain how vaccination works Define the term herd immunity and explain how it works Describe the roles of, and differences between, antibiotics and painkillers Explain how antibiotics work Suggest how antibiotic resistance develops Describe the process of drug discovery and drug development List steps involved in a drugs trial Suggest the role of double-blind trials and placebos in drug development	The consequences of imbalances in the diet The importance of bacteria in the human digestive system The impact of exercise and smoking on the human gas exchange system The effects of recreational drugs on behaviour health and life processes The use of drugs to treat diseases	T**he role of white blood cells 06 C1** Recognise the two main types of white blood cells: those that ingest bacterial cells and those that produce antibodies Recall that vaccination is used to stimulate the immune response using dead or inactive forms of a pathogen to produce antibodies Describe how vaccination is used in the prevention of disease **Medicinal drugs 07 C1**

			Recall that medical drugs are developed and carefully tested before they can be used to relieve illness Recall that drugs change the chemical processes in the human body Recognise that people can become dependent or addicted to drugs and suffer withdrawal symptoms without them Recall that antibiotics such as penicillin can kill bacterial pathogens Recall that they cannot be used against viral pathogens
	Non-communicable disease Consider the human and financial costs of non-communicable diseases Suggest lifestyle factors that can contribute to non-communicable disease Research links between risk factors and causal mechanisms Define cancer as uncontrolled cell growth and division Describe differences between benign and malignant tumours Suggest some lifestyle risk factors Name some health risk factors associated with smoking Name some health risk factors associated with a poor diet and lack of exercise Name some health risk factors associated with alcohol Describe some possible effects of alcohol on unborn babies	The impact of exercise and smoking on the human gas exchange system The effects of recreational drugs on behaviour health and life processes	**Lifestyle and health 04 C1** Demonstrate an understanding of the effect that lifestyle can have on people's health eg the links between: • diet, exercise and obesity and type 2 diabetes • smoking and cancer • alcohol and liver and brain function Describe the right balance of energy and different food groups required for good health Recognise that people who exercise regularly are usually fitter than people who take little exercise
	Bioenergetics		
	Photosynthesis Write the word equation for photosynthesis – carbon dioxide + water → glucose + oxygen Explain why plants need to carry out photosynthesis and where the reactants come from Describe photosynthesis as an endothermic reaction – one requiring energy from the environment in the form of light Identify adaptations of the leaf for photosynthesis Name factors that affect the rate of photosynthesis (limiting factors)	**Key ideas: photosynthesis** Plants and algae do not eat, but use energy from light, together with carbon dioxide and water to make glucose (food) through photosynthesis. They either use the glucose as an energy source, to build new tissue, or store it for later use. Plants have specially adapted organs that allow them to obtain resources needed for photosynthesis.	**Photosynthesis 01 C2** Recall that the sun is the source of energy for living organisms Describe how green plants and algae trap sunlight energy and use it to make glucose. Recall that this makes them producers Recall the word equation for photosynthesis

	H – Use the inverse square law (light intensity is proportional to 1 over the distance squared from the source) Suggest how plants use glucose H – Discuss greenhouse economics and the maximising of the rate of photosynthesis	Iodine is used to test for the presence of starch.	
	Respiration Write the equation for respiration – glucose + oxygen → carbon dioxide + water Describe respiration as a continuous exothermic reaction in living cells that can be aerobic or anaerobic Compare aerobic and anaerobic respiration Suggest uses of respiration Describe the response to exercise – heart rate, breathing rate, breath volume Describe why muscles get tired during exercise H – Explain why there is oxygen debt following anaerobic exercise and how the body responds to this Describe metabolism as the sum of all reactions, with examples H – state the role of the liver in repaying the oxygen debt	**Key ideas: respiration** Respiration is a series of chemical reactions, in cells, that breaks down glucose to provide energy and form new molecules. Most living things use aerobic respiration but switch to anaerobic respiration, which provides less energy, when oxygen is unavailable. Yeast fermentation is used in brewing and bread making.	**Respiration 04 C1** Recall that respiration is a cellular process that releases energy **Understand that breathing and respiration are not the same process** Recall that glucose comes from the diet and oxygen and carbon dioxide gases are exchanged through the lungs Recall the word equation for respiration: *glucose + oxygen → carbon dioxide + water*
	Biological responses	New topic at KS4	
	The human nervous system Define homeostasis as the regulation of the internal conditions of a cell or organism to maintain optimal conditions for function in response to internal and external changes State what control systems include Describe the pathway of a control system Describe the structure and function of the human nervous system – the pathway from effector to receptor via a coordination centre Define the central nervous system being composed of the brain and spinal cord Describe reflex actions and the reflex arc Explain why reflex actions are important Describe reflex actions as fast and automatic and do not involve the conscious part of the brain State the function of synapses	The basic structure of neurones	**The nervous system 08 C1** Describe the CNS as being composed of the brain and spinal cord Recall that the human body has automatic control systems: the nervous and (endocrine) hormonal system Recall that reflex actions are automatic and rapid. Describe examples of common reflex responses
	Hormonal coordination State the key principles of hormonal control Identify the position of key glands in the human body	The basic structure of neurones **Key ideas: human reproduction**	**Hormonal control 09 C1**

	State that hormones are secreted from the glands Name some similarities and differences between nervous and hormonal action Describe the control of blood glucose levels State some differences in the causes and treatment of Type 1 and Type 2 diabetes H Describe how glucagon interacts with insulin to control blood glucose levels H State the role of negative feedback H State the function of adrenaline and thyroxine Describe the role of hormones in the menstrual cycle Name some hormonal and non-hormonal contraceptives Suggest causes of infertility Describe how IVF works	The menstrual cycle prepares the female for pregnancy and stops if the egg is fertilised by a sperm. The developing foetus relies on the mother to provide it with oxygen and nutrients, to remove waste and protect it against harmful substances. The menstrual cycle lasts approximately 28 days. If an egg is fertilised it settles into the uterus lining.	Recall that hormones are secreted by glands and are transported to target organs by the bloodstream Recall that the menstrual cycle is controlled by several hormones some of which promote egg release Recognise the main features of the menstrual cycle described diagrammatically **Hormonal fertility treatment 010 C1** Recall that hormones can be used to inhibit or stimulate egg production Recall that oral contraceptives contain hormones to inhibit eggs from maturing Recall that fertility drugs stimulate eggs to mature. Evaluate the benefits and drawbacks of hormonal fertility control
	Genetics and reproduction		
	Reproduction Compare types of reproduction – sexual and asexual reproduction Suggest some advantages and disadvantages of sexual and asexual reproduction Describe cell division in sexual reproduction – meiosis State the relationship between DNA, genes and chromosomes Describe the human genome project and the benefits of studying the genome Describe how traits are inherited Describe how sex is determined Complete genetic crosses using Punnett squares Describe the inheritance of polydactyly and cystic fibrosis Describe the screening process for genetic disorders	**Key ideas: human reproduction** The menstrual cycle prepares the female for pregnancy and stops if the egg is fertilised by a sperm. The developing foetus relies on the mother to provide it with oxygen and nutrients, to remove waste and protect it against harmful substances. The menstrual cycle lasts approximately 28 days. If an egg is fertilised it settles into the uterus lining.	**Sexual and asexual reproduction 09 C2** Recall that sexual reproduction involves the joining of male and female sex cells Recall that sexual reproduction involves the mixing of genetic information and so variation in the offspring Recall that asexual reproduction involves only one parent Recall that, in asexual reproduction, there is only one set of genetic information Recall that these identical offspring are called clones **Human genetics 010 C2** Recall that a cell has cytoplasm and a nucleus that controls the actions of the cell. Recall that the genetic material in the nucleus of a cell is DNA Recall that DNA is contained in chromosomes

			Recall that chromosomes carry genes that control the characteristics of the human body Recall that humans have 23 pairs of chromosomes. One pair determines sex, XX for female and XY for male Recall that in genetic engineering, genes can be cut from chromosomes and transferred into the cells of other organisms Recognise that there are risks and benefits in genetic engineering
	Variation and evolution Categorise traits as inherited, environmental or both Describe evolution by natural selection - how mutation can lead to a new phenotype Describe selective breeding – choosing desired characteristics H list the main steps of genetic engineering Name some advantages and disadvantages of genetically modified crops Consider the ethics of genetic technologies	**Key ideas: variation** There is variation between individuals of the same species. Some variation is inherited, some is caused by the environment, and some is a combination. Variation between individuals is important for the survival of a species, helping it to avoid extinction in an always changing environment. **Key ideas: evolution** Natural selection is a theory that explains how species evolve and why extinction occurs. Biodiversity is vital to maintaining populations. Within a species variation helps against environment changes, avoiding extinction. Within an ecosystem, having many different species ensures resources are available for other populations, like humans. The DNA of every individual is different, except for identical twins. There is more than one version of each gene eg different blood groups.	**Evolution, natural and artificial selection 08 C2** Recall Darwin's theory that all living things evolved from simple life forms Describe how the fossil record is evidence for this. Describe how fossils form Recall that in natural selection, individuals with characteristics most suited to their environment are most likely to survive and breed Recall that artificial selection is the process by which humans breed plants and animals for particular traits Describe examples of animals and plants artificially selected for human requirements
	Genetics and evolution Describe the fossil evidence for evolution – how fossils form and why the fossil record is not complete Name some possible causes of the extinction of a species State some possible causes of mass extinctions Describe how antibiotic-resistant bacteria evolve	**Key ideas: genetics** Inherited characteristics are the result of genetic information, in the form of sections of DNA called genes, being transferred from parents to offspring during reproduction. Chromosomes are long pieces of DNA which contain many genes.	

	Describe how the classification systems have changed over time Describe Linnaean classification Describe some new systems of classification Draw conclusions from simple evolutionary trees	Gametes, carrying half the total number of chromosomes of each parent, combine during fertilisation.	
	Ecology		
	Adaptations, interdependence and competition <u>A Interdependence</u> Explain the levels of organisation within an ecosystem Name some biotic and abiotic factors within ecosystems Describe how changes in biotic and abiotic factors can affect communities Describe stable communities Suggest how to investigate the distribution and abundance of species <u>B Competition</u> State what animals and plants compete for Suggest how competition affects the distribution of organisms <u>C Adaptation</u> Describe how animals are adapted to survive in a particular habitat Describe how plants are adapted to survive in a particular habitat	**Key ideas: interdependence** Organisms in a food web (decomposers, producers and consumers) depend on each other for nutrients. So, a change in one population leads to changes in others. The population of a species is affected by the number of its predators and prey, disease, pollution and competition between individuals for limited resources such as water and nutrients. Insects are needed to pollinate food crops.	**Adaptation 02 C2** Explain how different organisms are adapted when shown an image or description **Competition 05 C2** Recall that plants often compete with each other for light, space, water and nutrients Recall that animals often compete with each other for food, mates and territory Consider why the distribution of a particular plant species may vary within a garden or field **Environmental changes 06 C2** Describe how animals and plants are affected by living and non-living factors that alter their environments Recall a living and non-living factor that could alter an environment eg rainfall, average temperature, competitors and predators
	Organising an ecosystem Describe feeding relationships within an ecosystem – food chains, food webs, predator-prey cycles Suggest factors that affect feeding relationships Outline events in the decay cycle Explain why the carbon cycle and why it is vital to life on Earth	**Key ideas: interdependence** Organisms in a food web (decomposers, producers and consumers) depend on each other for nutrients. So, a change in one population leads to changes in others. The population of a species is affected by the number of its predators and prey, disease, pollution and competition between individuals for limited resources such as water and nutrients. Insects are needed to pollinate food crops.	**Food chains and webs 03 C2** Recall the stages of a simple food chain starting with a producer Describe the food chains in a food web and the links between species in the web **Decomposition and recycling 04 C2** Recall that decay is a stage in the food chain/web process Explain that microorganisms are responsible for decay and return carbon

			to the atmosphere to be used by plants in photosynthesis
	Biodiversity and ecosystem Explain the importance of biodiversity in ecosystems Describe some of the effects of the human population explosion on biodiversity Describe how pollution reduces biodiversity Describe how peat destruction and deforestation reduce biodiversity Describe the biological consequences of global warming Describe approaches to reducing the negative impact of human interactions on biodiversity	**Key ideas: interdependence** Organisms in a food web (decomposers, producers and consumers) depend on each other for nutrients. So, a change in one population leads to changes in others. The population of a species is affected by the number of its predators and prey, disease, pollution and competition between individuals for limited resources such as water and nutrients. Insects are needed to pollinate food crops.	**Pollution and the effects of human population growth 07 C2** Describe how rapid human population growth leads to more resource use and more waste Recall that water can be polluted by sewage, fertiliser or toxic chemicals Recall that air can be polluted by smoke and gases such as sulfur dioxide which can cause acid rain Recall that landfill and toxic chemicals such as pesticides and herbicides contribute to land and water pollution

	GCSE TRILOGY PATHWAY **Specialism, topic and content**	**CONTENT COVERED AT KS3**	**ENTRY LEVEL SCIENCE PATHWAY** **Specialism, topic and content**
	CHEMISTRY		
	Atoms, bonding and moles		
	Atomic structure Draw and label the basic structure of an atom State the names and chemical symbols of the first 20 elements of the periodic table Write familiar chemical equations as word equations, or with balanced symbol equations including state symbols Explain how mass may appear to change in a chemical reaction, but that mass is conserved in a reaction Identify methods used to separate mixtures – filtration, crystallisation, simple distillation Suggest how to choose an appropriate separation or purification technique Describe the fractional distillation process	**Key ideas: elements** Elements are substances that contain only one type of atom. It is not possible to break an element down into other substances. Elements are represented by chemical symbols. Outcomes: State that elements are substances that cannot be broken down. Suggest some uses of a range of elements. Recall the chemical symbols of key elements.	**Atoms and elements 01 C3** Recall that all substances are made of atoms Recall that an atom is the smallest part of an element **Atoms and elements 02 C3** Recall that when atoms combine with different atoms a compound is formed. Recall that compounds can be made by metals combining with non-metals or by non-metals combining with other non-metals

	Carry out paper chromatography Describe the history of the atom and experimental work supporting the changing model Compare ions, atoms and isotopes Suggest why ions have a charge Draw the electronic structure of the first 20 elements in the periodic table	**Key ideas: separating mixtures** A pure substance consists of only one type of element or compound and has a fixed melting and boiling point. Mixtures may be separated due to differences in their physical properties. The method chosen to separate a mixture depends on which physical properties of the individual substances are different. Use techniques to separate mixtures. Outcomes: Explain how substances dissolve using the particle model. Use the solubility curve of a solute to explain observations about solutions. Use evidence from chromatography to identify unknown substances in mixtures. Choose the most suitable technique to separate out a mixture of substances.	Recognise simple compounds from their names **Mixtures 05 C3** Recall that a mixture contains two or more substances which are not chemically combined With guidance, carry out or observe the separation of mixtures by filtration, distillation and crystallisation
	The periodic table Describe the development of the periodic table Explain how elements are ordered in the periodic table Describe how the ordering of elements has changed over time Compare metals and non-metals on the basis of physical characteristics and chemical properties Suggest how the reactions of elements relate to the arrangement of electrons in their atoms Explain why the noble gases are unreactive Describe the reactivity and trends of the alkali metals Describe the reactivity and trends of the halogens Investigate halogen displacement reactions	**Key ideas: the Periodic Table** Metals are generally found on the left side of the table, non-metals on the right. Columns are called Groups and rows are called Periods Group 1 contains reactive metals called alkali metals. Group 7 contains non-metals called halogens. Group 0 contains unreactive gases called noble gases. <u>Outcomes:</u> Use the correct terms for columns and rows. Locate the position of metals and non-metals. State that the Periodic Table groups together elements with similar properties.	**Atoms and elements 01 C3** Describe the distribution of elements in the periodic table Describe the vertical columns of the periodic table as groups and the horizontal rows as periods Identify the position of the metals and non-metals on the periodic table Suggest a trend in the reactivity of the Group 1 metals
	Structure and bonding Use particle theory to describe the three states of matter Use the particle model to describe the energy and temperature of a substance when it is at melting point and boiling point Describe how atoms become ions	**Key ideas: atoms, elements and compounds** Most substances are not pure elements, but compounds or mixtures containing atoms of different elements.	**States of matter 03 C3** Recall the three states of matter: solid, liquid and gas Describe the changes between the three states using the terms melting, boiling, condensing and freezing

	Use dot and cross diagrams to represent ionic bonding Describe bonding in ionic compounds Describe bonding in giant ionic structures and explaining properties Describe covalent bonding in simple molecules Use dot and cross diagrams to represent covalent bonding Explain the structure and properties of giant covalent molecules Describe the structure and properties of fullerenes and graphene Describe bonding in metals Suggest some key properties of giant metallic structures	They have different properties to the elements they contain. How to use particle diagrams to classify a substance as an element, mixture or compound and as molecules or atoms. How to name simple compounds using rules: change non-metal to –ide; mono, di, tri prefixes; and symbols of hydroxide, nitrate, sulfate and carbonate. <u>Outcomes:</u> Name compounds using their chemical formulae. Given chemical formulae, name the elements present and their relative proportions. Represent atoms, molecules and elements, mixtures and compounds using particle diagrams. Use observations from chemical reactions to decide if an unknown substance is an element or a compound. **Key ideas: the Periodic Table 2** The elements in a group all react in a similar way and sometimes show a pattern in reactivity. As you go down a group and across a period the elements show patterns in physical properties. <u>Outcomes:</u> Use data to describe a trend in physical properties. Describe the reaction of an unfamiliar Group 1 or 7 element. Use data showing a pattern in physical properties to estimate a missing value for an element. Use observations of a pattern in chemical reactions to predict the behaviour of an element in a group.	Explain the three states of matter using a simple particle model **Different forms of carbon 04 C3** Recall that diamond and graphite are both forms of carbon Recognise the difference in the structure of diamond and graphite Recall that in diamond each carbon atom bonds to four other carbon atoms but that in graphite each carbon atom bonds to only three other carbon atoms Explain that the different properties of diamond and graphite depend on the different structures **Properties of metals 08 C3** Recall that metals have giant structures of atoms with strong bonds between the atoms so most metals have high melting points Recall that metals are: • good conductors of electricity • good conductors of thermal energy. Recognise that the uses of a metal depend on its properties eg copper and aluminium. **Alloys 09 C3** Recall that most metals in everyday use are alloys because the pure metals are too soft for many uses eg iron, gold and aluminium. Recall that an alloy is produced by mixing small amounts of other elements with the metal. Recall that steel is an alloy made by mixing carbon and other metals with iron.

			Polymers 10 C3 Draw or construct polymers from monomers to illustrate understanding of the concept Describe some uses of polymers Consider advantages and disadvantages of modern products made from polymers
	Chemical calculations Explain relative atomic mass Describe how to calculate relative atomic mass and relative formula mass H calculate moles of substance H use balanced symbol equations to work out reacting masses H balance equations H Describe how limiting reactants determine the amount of product formed Calculate concentrations	Reference to concentration Reference to density Some physics calculations – stress, pressure, work done, resultant force, speed, weight, electrical calculations	Word equations Simple calculations
	Chemical reactions and chemical changes		
	Chemical changes Suggest how to deduce an order of reactivity of metals based on experimental results Suggest methods of extracting metals from their ores Describe the reduction and oxidation in terms of loss or gain of oxygen Predict outcomes of displacement reactions Relate reactivity to the tendency to form positive ions H write ionic equations H identify oxidation and reduction in chemical reactions Make salts by reacting metals with an acid Make salts from insoluble bases Predict products from given reactants Carry out neutralisation reactions Describe and explain the pH scale H explain strong and weak acids	**Key ideas: Earth's resources** There is only a certain quantity of any resource on Earth, so the faster it is extracted, the sooner it will run out. Recycling reduces the need to extract resources. Most metals are found combined with other elements, as a compound, in ores. The more reactive a metal, the more difficult it is to separate it from its compound. Carbon displaces less reactive metals, while electrolysis is needed for more reactive metals. <u>Outcomes:</u> Explain why recycling of some materials is particularly important. Describe how Earth's resources are turned into useful materials or recycled. Justify the choice of extraction method for a metal, given data about reactivity. Suggest factors to take into account when deciding whether extraction of a metal is practical.	**Metals and ores 07 C3** Recall that unreactive metals are found in the Earth as metals Recall that most metals are found as compounds that need chemical reactions to extract the metal Recall that metals less reactive than carbon can be extracted by heating the metal ore with carbon Describe an ore as a rock containing enough metal to make it economic to extract Recognise that large amounts of rock have to be quarried or mined to get metal ores Recognise that we can reduce the effects of extracting metals by recycling Describe some of the social, economic and environmental effects of mining and recycling metals **Acids and metal reactions 01 C4**

		Key ideas: acids and alkalis The pH of a solution depends on the strength of the acid: strong acids have lower pH values than weak acids. Mixing an acid and alkali produces a chemical reaction, neutralisation, forming a chemical called a salt and water. Acids have a pH below 7, neutral solutions have a pH of 7, alkalis have a pH above 7. Acids and alkalis can be corrosive or irritant and require safe handling. Hydrochloric, sulfuric and nitric acid are strong acids. Acetic and citric acid are weak acids. **Outcomes:** Identify the best indicator to distinguish between solutions of different pH, using data provided. Use data and observations to determine the pH of a solution and explain what this shows. Explain how neutralisation reactions are used in a range of situations. Describe a method for how to make a neutral solution from an acid and alkali.	Recall that acids react with some metals to produce hydrogen Recall that hydrochloric acid produces chlorides. Recall that sulfuric acid produces sulfates Write word equations for the reactions when given the names of the reactants Describe the test for hydrogen **Neutralisation 02 C4** Recall that an acid is neutralised by an alkali or base to produce a salt and water Recall that an acid is neutralised by a carbonate to produce a salt, water and carbon dioxide Write word equations for the reactions when given the names of the reactants Describe the test for carbon dioxide Describe how to crystallise a salt solution to produce solid salt
	Electrolysis Write word equations to describe the electrolysis of a solution H describe electrolysis in terms of the movement of ions Describe the extraction of aluminium The electrolysis of aqueous solutions H explain the electrolysis of brine using half equations H classify reactions at the electrodes as oxidation or reduction	New topic at KS4 **Key ideas: Earth's resources** There is only a certain quantity of any resource on Earth, so the faster it is extracted, the sooner it will run out. Recycling reduces the need to extract resources. Most metals are found combined with other elements, as a compound, in ores. The more reactive a metal, the more difficult it is to separate it from its compound. Carbon displaces less reactive metals, while electrolysis is needed for more reactive metals. <u>Outcomes:</u> Explain why recycling of some materials is particularly important. Describe how Earth's	

		resources are turned into useful materials or recycled. Justify the choice of extraction method for a metal, given data about reactivity. Suggest factors to take into account when deciding whether extraction of a metal is practical	
	Energy changes Define exothermic and endothermic reactions Draw and interpret reaction profiles H Complete bond energy calculations	**Key ideas: types of reaction** Combustion is a reaction with oxygen in which energy is transferred to the surroundings as heat and light. Thermal decomposition is a reaction where a single reactant is broken down into simpler products by heating. Chemical changes can be described by a model where atoms and molecules in reactants rearrange to make the products and the total number of atoms is conserved. In some reactions energy is transferred from the surroundings, in others, energy is transferred to the surroundings. <u>Outcomes:</u> Explain why a reaction is an example of combustion or thermal decomposition. Predict the products of the combustion or thermal decomposition of a given reactant and show the reaction as a word equation. Explain observations about mass in a chemical or physical change. Use particle diagrams to show what happens in a reaction. Write word equations from information about chemical reactions. Suggest whether a reaction is endothermic or exothermic.	**Energy and rate of reaction 03 C4** Describe reactions that transfer energy to the surroundings so that temperature increases Describe reactions that take in energy from the surroundings so the temperature decreases
	Rates, equilibrium and organic chemistry		
	Rates and equilibrium Calculate the mean rate of reaction Suggest factors that affect the rate of chemical reactions Describe the relationship between collision theory and surface area Describe the effect of temperature on rate of reaction	**Key ideas: types of reaction** Combustion is a reaction with oxygen in which energy is transferred to the surroundings as heat and light. Thermal decomposition is a reaction where a single reactant is broken down into simpler products by heating.	**Increasing the rate of a chemical reaction 04 C4** Describe the increase in the rate of a reaction caused by increasing the: -temperature -concentration of reactants -surface area of reactants

	Describe the effect of concentration or pressure on rate of reaction Use catalysts to change the rate of a reaction Suggest some industrial uses of catalysts Suggest how collision theory explains the effect of catalysts on rate of reaction Describe what happens in a reversible reaction Explain dynamic equilibrium H Explain Le Chatelier's principle – changing reaction conditions can change the amounts of products and reactants in a mixture at equilibrium	Chemical changes can be described by a model where atoms and molecules in reactants rearrange to make the products and the total number of atoms is conserved. In some reactions energy is transferred from the surroundings, in others, energy is transferred to the surroundings. <u>Outcomes:</u> Explain why a reaction is an example of combustion or thermal decomposition. Predict the products of the combustion or thermal decomposition of a given reactant and show the reaction as a word equation. Explain observations about mass in a chemical or physical change. Use particle diagrams to show what happens in a reaction. Write word equations from information about chemical reactions. Suggest whether a reaction is endothermic or exothermic.	-or by adding a catalyst Measure and record the: -time for a reactant to be used up -volume of gas produced -time for a solution to change colour/clarity
	Crude oil and fuels Describe the composition of crude oil Give the names and structure of the first four alkanes Describe the process of the fractional distillation of oil Explain the properties of different fractions Compare complete and incomplete combustion Describe the cracking process and why it is important Describe the structure of alkenes	New topic at KS4. **Key ideas: types of reaction** Combustion is a reaction with oxygen in which energy is transferred to the surroundings as heat and light. Thermal decomposition is a reaction where a single reactant is broken down into simpler products by heating. Chemical changes can be described by a model where atoms and molecules in reactants rearrange to make the products and the total number of atoms is conserved. In some reactions energy is transferred from the surroundings, in others, energy is transferred to the surroundings. <u>Outcomes:</u> Explain why a reaction is an example of combustion or thermal decomposition. Predict the products of the combustion or thermal decomposition of a given reactant and show the reaction as a word equation.	**Crude oil and fuels 07 C4** Recall that crude oil is a mixture of a large number of compounds Describe the location of crude oil Explain how useful fuels, such as petrol and diesel, are produced from crude oil by fractional distillation

		Explain observations about mass in a chemical or physical change. Use particle diagrams to show what happens in a reaction. Write word equations from information about chemical reactions. Suggest whether a reaction is endothermic or exothermic.	
	Analysis and the Earth's resources		
	Chemical analysis Distinguish between pure and impure substances, and formulations Describe how melting and boiling point data can be used to find the purity of a substance Explain how chromatography separates solutes Calculate R_f values Describe how to test for oxygen, hydrogen, carbon dioxide and chlorine	**Key ideas: separating mixtures** A pure substance consists of only one type of element or compound and has a fixed melting and boiling point. Mixtures may be separated due to differences in their physical properties. The method chosen to separate a mixture depends on which physical properties of the individual substances are different. Use techniques to separate mixtures. Outcomes: Explain how substances dissolve using the particle model. Use the solubility curve of a solute to explain observations about solutions. Use evidence from chromatography to identify unknown substances in mixtures. Choose the most suitable technique to separate out a mixture of substances.	**Chromatography 06 C3** Describe how to separate mixtures by chromatography Recognise that in paper chromatography, a solvent moves through the paper carrying different compounds different distances
	The Earth's atmosphere Describe the Earth's early atmosphere Describe a theory for the development of the Earth's current atmosphere Explain the reduction in the proportion of CO_2 in the early atmosphere state composition of dry air Explain the connection between shelly carbonates and carbon Explain the greenhouse effect Link climate change to human activity Suggest possible outcomes of climate change Describe possible methods for reducing greenhouse gas emissions Name some atmospheric pollutants	**Key ideas: climate** Carbon is recycled through natural processes in the atmosphere, ecosystems, oceans and the Earth's crust (such as photosynthesis and respiration) as well as human activities (burning fuels). Greenhouse gases reduce the amount of energy lost from the Earth through radiation and therefore the temperature has been rising as the concentration of those gases has risen. Scientists have evidence that global warming caused by human activity is causing changes in climate. Methane and carbon dioxide are greenhouse gases.	**Burning fuels 08 C4** Explain why burning fossil fuels may harm the environment. Recall that: oxides of sulfur and nitrogen (NO_X) cause acid rain and may harm human health. carbon monoxide can cause death. Solid particles can cause global dimming and harm human health. **Human influences on the environment 09 C4**

	Describe the impact of atmospheric pollutants on health Explain how sulfur dioxide and nitrogen oxides are formed during the combustion of fossil fuels	Earth's atmosphere contains around 78 % nitrogen, 21 % oxygen, <u>Outcomes:</u> Use a diagram to show how carbon is recycled in the environment and through living things. Describe how human activities affect the carbon cycle. Describe how global warming can impact on climate and local weather patterns.	Recall that carbon dioxide is produced by burning fossil fuels Recall that methane is produced from landfills and farming Describe the effects of increased carbon dioxide and methane on the temperature of the atmosphere
	The Earth's resources Name some finite and some renewable resources Describe use of natural, sustainable and finite resources Describe the process of making water safe to drink Describe how wastewater is treated H Discuss alternative ways of extracting metals - phytomining and bioleaching Explain the purpose of Life cycle assessments Explain the importance of reusing and recycling products	**Key ideas: Earth's resources** There is only a certain quantity of any resource on Earth, so the faster it is extracted, the sooner it will run out. Recycling reduces the need to extract resources. Most metals are found combined with other elements, as a compound, in ores. The more reactive a metal, the more difficult it is to separate it from its compound. Carbon displaces less reactive metals, while electrolysis is needed for more reactive metals. <u>Outcomes:</u> Explain why recycling of some materials is particularly important. Describe how Earth's resources are turned into useful materials or recycled. Justify the choice of extraction method for a metal, given data about reactivity. Suggest factors to take into account when deciding whether extraction of a metal is practical.	**Water for drinking 10 C4** Recall that safe drinking water has few dissolved substances and low levels of microbes Describe how safe drinking water is produced by filtration and sterilisation

	GCSE TRILOGY PATHWAY **Specialism, topic and content**	**CONTENT COVERED AT KS3**	**ENTRY LEVEL SCIENCE PATHWAY** **Specialism, topic and content**
	PHYSICS		

	Energy and energy resources		
	Conservation and dissipation of energy List some examples of energy stores Describe a range of energy stores in different contexts State that energy is conserved in any transfer Describe changes in energy stores and account for energy dissipation into the surroundings Calculate the work done by a force Describe the action of frictional forces and the associated heating effect Calculate the gravitational potential energy store of a system using the mass, gravitational field strength and height Calculate the kinetic energy store of an object Calculate the elastic potential energy store of a stretched spring Analyse energy transfer to identify useful and less useful energy transfers Calculate the efficiency of a range of energy transfers H describe design features that can be used to improve the efficiency of an energy transfer Rank electrical devices in terms of their power Rank electrical devices in terms of their efficiency	**Key ideas: energy transfer** We can describe how jobs get done using an energy model where energy is transferred from one store at the start to another at the end. When energy is transferred, the total is conserved, but some energy is dissipated, reducing the useful energy. <u>Outcomes:</u> Describe how the energy of an object depends on its speed, temperature, height or whether it is stretched or compressed. Show how energy is transferred between energy stores in a range of real-life examples. Calculate the useful energy and the amount dissipated, given values of input and output energy. Explain how energy is dissipated in a range of situations.	**Changes in energy stores 01 C5** Describe the change in the way energy is stored in a simple system change such as when a kettle boils. Recognise that not all the changes are useful. Identify the main energy wastages in a range of devices. **Energy transfers and efficiency 02 C5** Recognise that energy cannot be created or destroyed. Explain that in any energy transfer, some energy is stored in less useful ways and is described as 'wasted' energy. Identify ways in which the unwanted energy transfers can be reduced. Explain how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls Recall that the higher the thermal conductivity of a material, the higher the rate of energy transfer by conduction across the material
	Energy transfer by heating Describe ways of reducing unwanted energy transfers Describe materials as good or poor conductors Related the thermal conductivities of a material to the uses of that material Describe the changes in particle behaviour in a material as the temperature of the material increases Describe internal energy as the total kinetic energy and potential energy of the all the particles that make up a system Define the term specific heat capacity Describe the effects of changing the factors involved in the equation Calculate the energy required to change the temperature of an object	**Key ideas: heating and cooling** The thermal energy of an object depends upon its mass, temperature and what it's made of. When there is a temperature difference, energy transfers from the hotter to the cooler object. Thermal energy is transferred through different pathways, by particles in conduction and convection, and by radiation. <u>Outcomes</u> Explain observations about changing temperature in terms of energy transfer.	

	Describe how some design features are used to reduce energy transfers from a home Compare home improvement features in terms of payback time	Describe how an object's temperature changes over time when heated or cooled. Explain how a method of thermal insulation works in terms of conduction, convection and radiation. Sketch diagrams to show convection currents in unfamiliar situations.	
	Energy resources Outline the operation of a fossil fuel burning, and a nuclear power station Suggest why biofuels are considered carbon neutral Describe how a wind farm works Describe the operation of a hydroelectric system Compare the reliability, potential power output and running cost of hydroelectric, wave and tidal systems Compare and contrast the operation and use of solar cells with heating panels Describe how a geothermal power plant works Describe the effects of acid rain Describe the effects of climate change Name some advantages and disadvantages of named energy resources including reliability and start-up times Discuss how to meet future energy needs Consider energy resources in terms of capital outlay and operational costs	Energy resources – Energy resources used to generate electricity Advantages and disadvantages of different energy resources How fossil fuel power stations work How energy is transferred from an energy resource to an electrical device in the home Types of renewable energy resource	**Energy resources 03 C5** Explain what is meant by 'fuel' and 'fossil fuel. Identify energy resources as renewable or non-renewable
	Particles at work		
	Electric circuits Identify circuit components from their symbols Draw and interpret circuit diagrams Describe the operation of a variable resistor and a diode and their effects on current Calculate charge flow ($Q = It$) State that current through a component depends on both the resistance of the component and the potential difference (p.d.) across the component State Ohm's law and describe its conditions Calculate p.d. Calculate the resistance of a component Measure the effect of changing the length of a wire on its resistance in a controlled experiment Identify components from simple I–V graphs	**Key ideas: current** Current is a movement of electrons and is the same everywhere in a series circuit. Current divides between loops in a parallel circuit, combines when loops meet, lights up bulbs and makes components work. Around a charged object, the electric field affects other charged objects, causing them to be attracted or repelled. The field strength decreases with distance. Two similarly charged objects repel, two differently charged objects attract. <u>Outcomes:</u> Describe how current changes in series and parallel circuits when components are changed.	**Current in a circuit 01 C6** Describe a current as a flow of electrical charge. Construct a simple series circuit. Measure current using an ammeter in series. Measure voltage using a voltmeter in parallel across a component. Recognise that current in a component depends on the resistance in the circuit.

	Describe the resistance characteristics of a filament lamp, a thermistor and an LDR Describe the characteristics of a diode and a light-emitting diode Describe the rules for components connected in series Describe the rules for components connected in parallel Explain why adding resistors in series increases the total resistance whilst adding resistors in parallel deceases the total resistance	Turn circuit diagrams into real series and parallel circuits, and vice versa. Describe what happens when charged objects are placed near to each other or touching. Use a sketch to describe how an object charged positively or negatively became charged up. **Key ideas: potential difference and resistance** We can model voltage as an electrical push from the battery, or the amount of energy per unit of charge transferred through the electrical pathway. In a series circuit, voltage is shared between each component. In a parallel circuit, voltage is the same across each loop. Components with resistance reduce the current flowing and shift energy to the surroundings. <u>Outcomes:</u> Draw a circuit diagram to show how voltage can be measured in a simple circuit. Use the idea of energy to explain how voltage and resistance affect the way components work. Given a table of voltage against current. Use the ratio of voltage to current to determine the resistance. Use an analogy like water in pipes to explain why part of a circuit has higher resistance. Calculate resistance using the formula: resistance (Ω) = potential difference (V) ÷ current (A).	
	Electricity in the home State the frequency and voltage of the UK mains supply Measure and compare key characteristics of an a.c. and d.c. source Identify the live, neutral and earth wires in a three-pin plug Identify the key components and their roles of a typical three-pin plug	**Key ideas: energy costs** We pay for our domestic electricity usage based on the amount of energy transferred. Electricity is generated by a combination of resources which each have advantages and disadvantages.	**d.c. and a.c. current 02 C6** Recall that direct current is supplied by cells and batteries. Recall that mains electricity is alternating current. Recall that UK mains electricity has a frequency of 50Hz and is 230V.

	Discuss the choices of materials used in cables and plugs in terms of their physical and electrical properties Describe why a short circuit inside a device presents a hazard Explain the dangers of providing any connection between the live wire and plug State that the power of a device is the amount of energy transferred by it each second Describe the factors that affect the rate of energy transfer by a current in a circuit Explain why different fuses are required for different electrical devices Calculate the power of electrical devices State that the amount of energy an appliance transfers depends on how long the appliance is switched on for and the power of the appliance State that work is done when charge flows Calculate the charge transferred by a current in a given time Calculate energy transfer in kilowatt-hours Suggest reasons for electrical inefficiency	Calculate the cost of home energy usage, using the formula: cost = power (kW) x time (hours) x price (per kWh). Food labels list the energy content of food in kilojoules (kJ). <u>Outcomes:</u> Compare the amounts of energy transferred by different foods and activities. Compare the energy usage and cost of running different home devices. Explain the advantages and disadvantages of different energy resources. Represent the energy transfers from a renewable or non-renewable resource to an electrical device in the home.	**Wiring a plug 03 C6** Recall the colour-coding for three-core flex and the appropriate terminal for each wire. Explain how the earth wire protects the user and how the fuse protects the appliance. Recall that double-insulated appliances do not need an earth wire. **Electrical transfer in electrical appliances 04 C6** Read a domestic electricity meter to measure the amount of energy used. Recall the unit for power (W). Recognise that heating devices have the highest power ratings. Name the units used in a domestic electricity meter to measure energy (kWh). Decide which of a selection of appliances has transferred the most energy for a known period of time.
	Molecules and matter State that the density of a material is the mass per unit volume Calculate the volume of some regular shapes and the density of materials Measure the density of a solid or liquid Calculate the density of an irregular-shaped object Describe the arrangements of particles in a solid, liquid and gas Explain the behaviour of a material in terms of the arrangement of particles within it Describe the changes in behaviour of the particles in a material during changes of state H describe the forces acting between particles in a solid, liquid and gas H describe the changes in the energy of individual particles during changes of state State that melting and boiling points of a pure substance are fixed	**Key ideas: matter – the particle model** Properties of solids, liquids and gases can be described in terms of particles in motion but with differences in the arrangement and movement of these same particles: closely spaced and vibrating (solid), in random motion but in contact (liquid), or in random motion and widely spaced (gas). Observations where substances change temperature or state can be described in terms of particles gaining or losing energy. A substance is a solid below its melting point, a liquid above it, and a gas above its boiling point. <u>Outcomes:</u> Explain unfamiliar observations about gas pressure in terms of particles.	Density is referred to in relation to properties of metals. **States of matter 03 C3** Recall the three states of matter: solid, liquid and gas. Describe the changes between the three states using the terms melting, boiling, condensing and freezing. Explain the three states of matter using a simple particle model.

	State that changes of state are physical changes Use the term latent heat to describe the energy gained during heating for which there is no change in temperature H describe the behaviour of the particles during changes of state State that the internal energy of a system increases as it is heated Identify which changes of state are related to increases in internal energy and which are related to decreases Describe how the behaviour of particles changes as the energy of a system increases H use the concepts of kinetic and potential energy to explain changes in internal energy Measure the latent heat of vaporisation of water Calculate the latent heat of fusion and the latent heat of vaporisation for a substance Define latent heat as the energy change required for 1 kg of a substance to melt Describe pressure as being caused by collision s of gas particles with the walls of its container Describe the behaviour of particles in a gas as the gas is heated Describe Brownian motion Relate the motion of particles in a gas to its temperature and pressure	Explain the properties of solids, liquids and gases based on the arrangement and movement of their particles. Explain changes in states in terms of changes to the energy of particles. Draw before and after diagrams of particles to explain observations about changes of state, gas pressure and diffusion.	
	Radioactivity Name the three types of nuclear radiation Describe how a Geiger counter can be used to detect radiation Describe the decay of an unstable nucleus Identify the locations of protons, neutrons and electrons in the nuclear model Describe the plum pudding model of the atom Compare the plum pudding nuclear model to the atomic model H explain how the evidence from the alpha scattering experiment led to a change in the atomic model Discuss the nature of energy levels using the Bohr model Define the term isotope Describe how to represent alpha and beta decay	New topic at KS4 **Key ideas: elements** Elements are substances that contain only one type of atom. It is not possible to break an element down into other substances. Elements are represented by chemical symbols. <u>Outcomes:</u> State that elements are substances that cannot be broken down. Suggest some uses of a range of elements. Recall the chemical symbols of key elements.	**Radioactivity 10 C5** Name three types of nuclear decay Describe the properties of alpha, beta and gamma particles - penetration into materials - range in air Describe uses of radiation Describe dangers of radiation

	Explain the change in the mass and charge of the nucleus of alpha and beta emission Complete decay equations for alpha and beta decay Rank the three types of nuclear radiation in order of their penetrating power Rank the three types of nuclear radiation in order of their range through air Discuss the damage that can be caused by ionisation and identify some of the precautions that can be taken to reduce exposure Define activity as the rate at which a source of unstable nuclei decays Define half-life as 'the time it takes for half of the material to decay' Find the half-life of a substance from a graph of count rate H Find the ratio of a sample remaining after a given number of half-lives H calculate the net decline, expressed as a ratio, in a radioactive emission after a given number of half-lives		
	Forces in action		
	Forces in balance Describe how scalar have size (magnitude) without direction Describe how vectors have both size and direction Draw a scale diagram to represent a single vector Give examples of contact and non-contact forces Describe the action of pairs of forces in a range of scenarios Investigate the effects of different lubricants on the size of frictional forces Label a diagram showing several forces acting on an object Describe the effect of zero and non-zero resultant forces on the moving of moving and stationary objects H calculate resultant force produced by several forces acting on an object in coplanar directions Identify the approximate centre of mass of a range of simple shapes Use lines of symmetry to identify the location of centre of mass Find the centre of mass of an irregular shape	**Key ideas: contact forces** When the resultant force on an object is zero, it is in equilibrium and does not move, or remains at constant speed in a straight line. One effect of a force is to change an object's form, causing it to be stretched or compressed. In some materials, the change is proportional to the force applied. <u>Outcomes:</u> Explain whether an object in an unfamiliar situation is in equilibrium. Describe factors which affect the size of frictional and drag forces. Describe how materials behave as they are stretched or squashed. Describe what happens to the length of a spring when the force on it changes. Sketch the forces acting on an object and label their size and direction. **Key ideas: gravity**	**Types of forces 04 C5** Describe a force as a push or pull acting on an object due to an interaction with another force. Recall that forces are either contact forces or non-contact forces **Effects of forces 05 C5** Explain that work is done when a force causes an object to move through a distance. (No calculations needed) Explain that when work is done against frictional forces acting on an object, there is a rise in temperature.

	Compare the stability of objects to the position of their centre of mass H use the parallelogram of forces to find the resultant of two forces that do not act along the same line H resolve a single force into two components acting at right angles stating that the two component forces together have the same effect as the single force	Mass and weight are different but related. Mass is a property of the object; weight depends upon mass but also on gravitational field strength. Every object exerts a gravitational force on every other object. The force increases with mass and decreases with distance. Gravity holds planets and moons in orbit around larger bodies. G on Earth = 10 N/kg. On the moon it is 1.6 N/kg. <u>Outcomes:</u> Explain unfamiliar observations where weight changes. Draw a force diagram for a problem involving gravity. Deduce how gravity varies for different masses and distances. Compare your weight on Earth with your weight on different planets using the formula. Use the formula: weight (N) = mass (kg) x gravitational field strength (N/kg). **Key ideas: pressure** Pressure acts in a fluid in all directions. It increases with depth due to the increased weight of fluid, and results in an upthrust. Objects sink or float depending on whether the weight of the object is bigger or smaller than the upthrust. Different stresses on a solid object can be used to explain observations where objects scratch, sink into or break surfaces. Skill Use the formula: fluid pressure, or stress on a surface = force (N)/area (m2). <u>Outcomes:</u> Use diagrams to explain observations of fluids in terms of unequal pressure. Explain why objects either sink or float depending upon their weight and the upthrust acting on them. Explain observations where the effects of forces are different because of differences in the area over which they apply.	

		Given unfamiliar situations, use the formula to calculate fluid pressure or stress on a surface.	
	Motion Describe speed as a scalar quantity Estimate typical speeds for walking, running and cycling Use the gradients of distance-time graphs to compare speeds of objects Describe the difference between speed and velocity Calculate the acceleration of an object using the change in velocity and time Identify the features of a velocity-time graph that represent acceleration and distance travelled Identify a change in speed on a distance-time graph Identify a change in acceleration on a velocity-time graph H use a tangent to determine the speed of an object from a distance-time graph	**Key ideas: speed** If the overall, resultant force on an object is non-zero, its motion changes and it slows down, speeds up or changes direction. A straight line on a distance-time graph shows constant speed, a curving line shows acceleration. The higher the speed of an object, the shorter the time taken for a journey. <u>Outcomes:</u> Use the formula: speed = distance (m)/time (s) or distance-time graphs, to calculate speed. Illustrate a journey with changing speed on a distance-time graph, and label changes in motion. Describe how the speed of an object varies when measured by observers who are not moving or moving relative to the object.	**Speed 06 C5** Recall that speed is measured by the distance travelled in a certain time. Recall the units for speed as metres per second, kilometres per hour and miles per hour. Calculate average speed using the equation: speed = distance/time
	Force and motion State the factors that affect the acceleration of an object H define the inertial mass of an object in terms of forces and acceleration State the difference between the mass of an object and its weight Calculate the weight of objects using their mass and gravitational field strength Explain the motion of an object falling through a fluid Explain terminal velocity List some factors that affect the stopping distance of a car Categorise factors which affect thinking distance, braking distance and both Calculate the braking distance of a car Describe the relationship between speed and both thinking and braking distance H describe momentum as the product of the velocity and mass of an object Define the principle of the conservation of momentum State Hooke's law	**Key ideas: speed** If the overall, resultant force on an object is non-zero, its motion changes and it slows down, speeds up or changes direction. A straight line on a distance-time graph shows constant speed, a curving line shows acceleration. The higher the speed of an object, the shorter the time taken for a journey. <u>Outcomes:</u> Use the formula: speed = distance (m)/time (s) or distance-time graphs, to calculate speed. Illustrate a journey with changing speed on a distance-time graph, and label changes in motion. Describe how the speed of an object varies when measured by observers who are not moving or moving relative to the object.	**Stopping distances 07 C5** Recall that the stopping distance of a vehicle is the sum of the distance the vehicle travels during the driver's reaction time (thinking distance) and the distance it travels under the braking force (braking distance). Explain that, for a given braking force, the greater the speed of the vehicle, the greater the stopping distance. **Reaction times and stopping distances 08 C5** Recognise that the typical reaction time for a person ranges from 0.5s to 0.9s. Measure human reaction times. Describe how a driver's reaction time can be affected by tiredness, drugs and alcohol and distractions.

	Calculate the extension of a material using its length and original length Compare objects in terms of elastic and inelastic behaviour Use the spring constant to calculate the force required to extend a spring		**Weather conditions and braking distances 08 C5** Explain how the braking distance of a vehicle can be affected by adverse road and weather conditions and the poor condition of the vehicle.
	Waves and electromagnetism		
	Describe wave properties State that waves can transfer energy and information without the transfer of matter Identify waves as either transverse or longitudinal Compare transverse and longitudinal waves in terms of direction or vibration and propagation Identify the wavelength and amplitude of a wave Describe the frequency of a wave Measure the speed of a water wave Calculate the period of a wave from its frequency Calculate wave speed from frequency and wavelength H describe refraction at a boundary Describe refraction including the refracted rays Explain refraction in terms of changes in the speed of waves when they move between one medium an another Measure the speed of a wave in water Measure the speed of a wave in a solid (a string)	**Key ideas: properties of waves** A physical model of a transverse wave demonstrates it moves from place to place, while the material it travels through does not, and describes the properties of speed, wavelength and reflection. <u>Outcomes:</u> Describe the properties of different longitudinal and transverse waves. Use the wave model to explain observations of the reflection, absorption and transmission of a wave.	**Longitudinal and transverse waves 08 C6** Recognise that waves transfer energy not physical materials. Distinguish between transverse and longitudinal waves. Know that sound waves need a medium (material) to travel through. **Wave properties 08 C6** Identify wavelength and amplitude on a diagram of a transverse wave. Use the wave equation and recall the correct units for wave speed, frequency and wavelength
	Electromagnetic waves State that electromagnetic (EM) waves transfer energy without transferring matter Identify the position of EM waves in the spectrum in order of wavelength and frequency State that all waves travel at the same speed in a vacuum Describe the relationship between energy transfer and frequency H state that different substances may absorb, transmit, refract or reflect EM waves in ways that vary with wavelength List examples of uses of light, microwave and radio waves Explain why a particular wave is suited to its application State which EM waves are used in communication State that the higher the frequency of a wave, the greater the rate of data transfer possible Compare the rate of information transfer through optical fibres and radio signals	**Key ideas: properties of waves** A physical model of a transverse wave demonstrates it moves from place to place, while the material it travels through does not, and describes the properties of speed, wavelength and reflection. <u>Outcomes:</u> Describe the properties of different longitudinal and transverse waves. Use the wave model to explain observations of the reflection, absorption and transmission of a wave. The EMS is a new topic at KS4	T**he EMS 09 C6** Recall the order of the spectrum (but not the values of wavelength or frequency). Identify the risks associated with ultraviolet waves, X-rays and gamma rays. **Uses of the EMS 10 C6** Recall the seven components of the e-m spectrum. Explain why each type of radiation is suitable for its use.

	Outline the operation of a mobile phone network and the waves used State that high-frequency EM radiation is ionising and describe associated uses and dangers Describe the penetrating power of gamma rays, x-rays and uv rays Describe the formation of an x-ray photograph in terms of absorption and transmission Explain the operation of an x-ray machine Compare the operation of a CT-scanner and that of a simple X-ray device		
	Electromagnetism Describe the interaction of magnetic poles Sketch the shape of a magnetic field around a bar magnet Describe the regions in a magnetic field where magnetic forces are greatest using the idea of field lines State that the magnetic field produced by a current-carrying wire is circular Describe the effect of reversing the direction of the current in the wire Describe the shape of a field produced by a solenoid Describe the factors that affect the strength or direction of the magnetic field around a wire and solenoid H describe how a motor works Apply Fleming's left-hand rule to determine the direction of the force acting on a conductor	**Key ideas: magnetism** Magnetic materials, electromagnets and the Earth create magnetic fields which can be described by drawing field lines to show the strength and direction. The stronger the magnet, and the smaller the distance from it, the greater the force a magnetic object in the field experiences. <u>Outcomes:</u> Use the idea of field lines to show how the direction or strength of the field around a magnet varies. Explain observations about navigation using Earth's magnetic field Electromagnetism is a new topic at KS4.	**Magnets 05 C6** Recall that the poles of a magnet are where the magnetic forces are strongest. Recall that like poles attract and unlike poles repel and recognise these as non-contact forces. Describe the pattern of magnetic fields between two magnets. **Electromagnets and solenoids 06 C6** Recall that a current in a wire produces a magnetic field around the wire. Recall that increasing the current increases the strength of a magnetic field. Construct a simple electromagnet from a solenoid and an iron core. Recall uses of electromagnets in relays and scrapyards.