KS3 Science scheme of work

Years 7, 8 and 9 · 18 units · 180 lessons · 106 practicals and demonstrations

A lesson-by-lesson plan for Key Stage 3 Science, written to the National Curriculum in England: biology, chemistry and physics, with working scientifically built into every unit. Each year has six units, one per half-term, with ten core lessons each, so a school teaching science three times a week has room for assessment, review and extra practicals. Every unit lists its key words, practicals and demonstrations with safety notes, maths skills, common misconceptions and the GCSE topics it leads to.

Overview

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
Year 7	Cells and working scientifically Biology	Particles and their behaviour Chemistry	Forces and motion Physics	Reproduction in animals and plants Biology	Light and sound Physics	Space: Earth, Sun and Moon Physics
Year 8	Mixtures and separating Chemistry	Food, digestion and health Biology	Electricity and magnetism Physics	Chemical reactions; acids and alkalis Chemistry	Breathing, respiration and exercise Biology	Heating and cooling Physics
Year 9	Atoms, elements and the periodic table Chemistry	Inheritance, DNA and evolution Biology	Energy: stores, transfers and costs Physics	The Earth, atmosphere and resources Chemistry	Forces: pressure and moments Physics	Photosynthesis, ecosystems and GCSE skills Biology

Practicals and demonstrations are suggestions: check each one against your school's risk assessments and CLEAPSS guidance. Free to use in your school. © TermStep

Year 7

Starting secondary science: working safely in a lab, the cell and particle models, forces, reproduction, light and sound, and our place in space.

Cells and working scientifically Autumn 1 · Biology

Pupils learn to work safely in a lab, light a Bunsen burner and plan a fair test, then use a microscope to see animal, plant and single-celled organisms and learn how cells build tissues, organs and organisms.

	Lesson and aim	Main task and practical
1	**Working safely in the lab** Spot hazards and follow lab rules.	Find ten hazards in a picture of a lab, match hazard symbols to their meanings and agree five class lab rules.
2	**The Bunsen burner** Light, adjust and use a Bunsen burner safely.	Earn a Bunsen licence: light it, switch between the safety flame and the blue flame, heat water and turn it off. Class practical: Lighting a Bunsen burner and heating water in a boiling tube. *Safety:* Goggles, hair tied back, heatproof mat, safety flame when not heating, tube held with a holder and pointed away from people.
3	**Asking scientific questions** Plan a fair test with independent, dependent and control variables.	Plan and carry out a test of how drop height changes the bounce height of a ball, and record the results in a table. Class practical: Ball-bounce investigation with a metre rule. *Safety:* Clear floor space; stand clear of the drop.
4	**Is it alive?** Use the seven life processes to decide whether something is living.	Sort cards (car, fire, seed, robot, mushroom, crystal) using MRS GREN and justify each decision.
5	**Using a microscope** Set up a light microscope, focus on a specimen and work out the magnification.	Prepare an onion skin slide stained with iodine, focus at low then high power, draw what you see and calculate the total magnification. Class practical: Onion epidermis slide stained with iodine solution. *Safety:* Iodine stains and irritates eyes: goggles. Carry the microscope with two hands. Never point the mirror at the Sun.
6	**Animal and plant cells** Name the parts of animal and plant cells and say what each part does.	Label animal and plant cell diagrams, then compare them in a Venn diagram. Class practical: Prepared slides of animal cells and pondweed leaf cells. *Safety:* Glass slides and cover slips break easily: report breakages.
7	**Specialised cells** Explain how a cell's shape helps it do its job.	Match five specialised cells (red blood, nerve, sperm, root hair, palisade) to their jobs and explain one feature of each.
8	**Diffusion** Describe how substances move into and out of cells by diffusion.	Watch food colouring spread in hot and cold water, then explain how oxygen and carbon dioxide move into and out of cells. Teacher demonstration: Food colouring in beakers of hot and cold water. *Safety:* Hot water no hotter than 60 °C; beakers on a stable bench.

	Lesson and aim	Main task and practical
9	**Single-celled organisms** Describe how amoeba, euglena and yeast are adapted to survive.	Look at pond water under the microscope, then annotate drawings of amoeba and euglena with their adaptations. Class practical: Pond water drops on a slide. *Safety:* Wash hands after handling pond water; cover any cuts.
10	**From cells to organisms** Put cells, tissues, organs, organ systems and organisms in order.	Build an organisation ladder for the digestive and circulatory systems, then answer questions for the unit test.

Key words: hazard, risk, variable, fair test, cell, nucleus, cytoplasm, cell membrane, cell wall, chloroplast, vacuole, mitochondria, specialised cell, diffusion, tissue, organ, magnification

Working scientifically: Hazards and risks, independent, dependent and control variables, results tables, using a microscope.

Maths skills: Total magnification = eyepiece × objective; reading scales; drawing a results table.

Misconceptions: Plant cells have no mitochondria (they do). The cell wall controls what goes in and out (the membrane does). All cells look the same.

Assessment: End-of-unit test (40 minutes) on cells, specialised cells and organisation, with a practical-skills section on variables and magnification.

Leads to: GCSE Biology cell biology and microscopy; the GCSE microscopy required practical; transport by diffusion.

Particles and their behaviour Autumn 2 · Chemistry

Pupils use the particle model to explain the properties of solids, liquids and gases, changes of state, density, diffusion, gas pressure and expansion.

	Lesson and aim	Main task and practical
1	**Solids, liquids and gases** Describe the properties of the three states of matter.	Sort substances into solids, liquids and gases, and test which can be squashed or poured. Teacher demonstration: Squashing sealed syringes of air, water and sand. *Safety:* Syringes sealed with caps; never point at people.
2	**The particle model** Use particle diagrams to explain the properties of each state.	Draw particle diagrams for each state and use them to explain shape, flow and compression.
3	**Density** Calculate density and explain it with particles.	Measure the mass and volume of blocks and an irregular object (by displacement), then calculate their densities. Class practical: Mass and volume of blocks; displacement can for an irregular object. *Safety:* Wipe up spills at once; heavy blocks kept low on the bench.
4	**Changes of state** Name and explain melting, freezing, boiling, evaporating, condensing and subliming.	Complete a change-of-state diagram and explain each change in terms of particles and energy.
5	**Cooling curves** Plot a cooling curve and find a melting point.	Record the temperature of cooling stearic acid every 30 seconds, plot the curve and mark where it freezes. Class practical: Cooling curve of stearic acid in a boiling tube. *Safety:* Hot wax: goggles, tube in a rack, water bath below 80 °C.

	Lesson and aim	Main task and practical
6	**Evaporation and boiling** Explain the difference between evaporation and boiling.	Test how surface area changes how fast water evaporates from paper towels, and explain the results with particles. Class practical: Drying of wet paper towels with different surface areas. *Safety:* Wipe up water spills to prevent slips.
7	**Diffusion** Explain diffusion in liquids and gases.	Time how food colouring spreads in water, then explain a demonstration of two gases meeting in a tube. Teacher demonstration: Ammonia and hydrogen chloride meeting in a long glass tube (teacher only). *Safety:* Done by the teacher in a fume cupboard; both gases are corrosive and irritant.
8	**Gas pressure** Explain gas pressure as particles hitting the walls of a container.	Explain the collapsing can demonstration and predict what happens to a balloon in hot and cold water. Teacher demonstration: Collapsing can: a can with a little boiling water turned into cold water. *Safety:* Teacher only; tongs and goggles; class stands back.
9	**Brownian motion** Describe and explain the random movement of tiny particles.	Watch smoke particles moving under a microscope (or a video) and model the motion with marbles on a tray. Teacher demonstration: Smoke cell under a microscope, or video. *Safety:* Teacher lights the smoke source; no flames near pupils.
10	**Expansion** Explain why solids, liquids and gases expand when heated.	Watch the ball-and-ring demonstration and explain why bridges and railways need expansion gaps. Teacher demonstration: Heated metal ball and ring. *Safety:* Teacher only; the ball stays hot for a long time: heatproof mat.

Key words: solid, liquid, gas, particle, particle model, density, melting point, boiling point, evaporation, condensation, sublimation, diffusion, gas pressure, Brownian motion, expansion

Working scientifically: Making and testing predictions with a model, plotting a line graph, taking temperature readings at set times.

Maths skills: Density = mass ÷ volume; plotting a cooling curve; reading a thermometer.

Misconceptions: Particles themselves melt or expand (they move or spread out). There is air between the particles of a gas (there is nothing). Ice loses mass when it melts.

Assessment: End-of-unit test (40 minutes), including a six-mark explanation: why a balloon shrinks in the freezer.

Leads to: GCSE Chemistry states of matter; GCSE Physics particle model of matter and the density required practical.

Forces and motion Spring 1 · Physics

Pupils measure forces, tell mass from weight, investigate friction and drag, work out resultant forces, and describe motion with speed and distance–time graphs.

	Lesson and aim	Main task and practical
1	**What forces do** Describe forces as pushes or pulls that change speed, direction or shape.	Draw force arrows on pictures and sort the forces into contact and non-contact.
2	**Measuring forces** Measure forces with a newton meter.	Measure the forces needed to lift, drag and open everyday objects and record them in newtons. Class practical: Newton meters on bags, drawers and blocks. *Safety:* Do not stretch a newton meter past its scale.

	Lesson and aim	Main task and practical
3	**Mass and weight** Explain the difference between mass and weight and calculate weight.	Weigh 100 g masses with a newton meter, plot weight against mass and use W = m × g. Class practical: Weighing slotted masses with a newton meter. *Safety:* Keep masses over the bench, not over feet.
4	**Friction** Investigate how the surface changes friction.	Pull a block across four surfaces with a newton meter, repeat three times and find the mean force. Class practical: Friction of a block on carpet, sandpaper, wood and plastic. *Safety:* Sandpaper edges can cut; pull slowly and steadily.
5	**Air and water resistance** Describe how drag depends on shape and speed.	Time paper spinners with different wing sizes falling from 2 m and explain the results using drag. Class practical: Paper spinners dropped from a fixed height. *Safety:* Drop from a stool only with the teacher's permission; no standing on chairs.
6	**Balanced and unbalanced forces** Work out the resultant force and predict the motion.	Calculate resultant forces in tug-of-war and vehicle diagrams and predict whether each object speeds up, slows down or stays the same.
7	**Speed** Calculate speed from distance and time.	Time classmates walking and a toy car rolling 10 m, then calculate each speed in m/s. Class practical: Timing over 10 m with stopwatches. *Safety:* Walk, do not run, in the corridor or hall.
8	**Distance–time graphs** Draw and read distance–time graphs.	Plot a journey from a table, then describe each section of three graphs.
9	**Relative motion** Describe motion relative to different observers.	Solve problems about trains passing, cars overtaking and walking on a moving walkway.
10	**Reaction time and stopping** Measure reaction time and link it to stopping distance.	Do the ruler-drop test five times, find your mean reaction time and explain why it matters for drivers. Class practical: Ruler-drop reaction test. *Safety:* Drop the ruler only, never catch near the face.

Key words: force, newton, newton meter, contact force, non-contact force, mass, weight, gravitational field strength, friction, drag, resultant force, balanced, unbalanced, speed, distance–time graph, relative motion

Working scientifically: Repeat readings and means, choosing equipment, drawing force diagrams, plotting and reading graphs.

Maths skills: Weight = mass × g; speed = distance ÷ time; means of repeat readings; gradients of distance–time graphs.

Misconceptions: A moving object needs a force to keep it moving. Mass and weight are the same thing. Heavier objects always fall faster.

Assessment: End-of-unit test (40 minutes) with speed and weight calculations and a force-diagram question.

Leads to: GCSE Physics forces, weight, resultant forces, speed and distance–time graphs.

Reproduction in animals and plants Spring 2 · Biology

Pupils learn how humans and flowering plants reproduce: reproductive systems, puberty, the menstrual cycle,

fertilisation, pregnancy, flower structure, pollination, seed dispersal and germination.

	Lesson and aim	Main task and practical
1	**Why living things reproduce** Compare sexual and asexual reproduction.	Sort examples (strawberry runners, bacteria, frogs, humans, potatoes) and list one advantage of each type.
2	**Human reproductive systems** Name the parts of the male and female reproductive systems and their jobs.	Label both systems and match each organ to its job. Agree class ground rules first.
3	**Puberty** Describe the changes of puberty and why they happen.	Sort the changes into boys, girls and both, and write a reply to a worried pupil's letter.
4	**The menstrual cycle** Describe the main stages of the 28-day cycle.	Annotate a 28-day cycle diagram with menstruation, the lining building up and ovulation.
5	**Fertilisation and implantation** Describe how sperm and egg meet and how the embryo implants.	Put story cards from ejaculation to implantation in order and explain how the sperm cell is adapted.
6	**Pregnancy and birth** Explain how the placenta keeps the foetus alive and how lifestyle affects it.	Label the foetus in the uterus, then use data on smoking and alcohol to advise a pregnant woman.
7	**Flower structure** Identify the male and female parts of a flower.	Dissect a lily flower, stick each part on a card and label it. Class practical: Lily or alstroemeria dissection. *Safety:* Scalpels cut away from the body on a tile; lily pollen stains clothes; check for pollen allergies.
8	**Pollination** Compare insect and wind pollination and explain why insects matter for food.	Compare insect-pollinated and wind-pollinated flowers in a table, then work out which foods would vanish without bees.
9	**Seeds and dispersal** Describe how seeds form and are spread.	Make paper sycamore seeds and test how wing length changes how far they travel from a fan. Class practical: Paper seed models and a desk fan. *Safety:* Keep fingers and paper away from the fan blades.
10	**Germination** Plan an investigation into the conditions seeds need to germinate.	Set up cress seeds with and without water, warmth and light, and record what happens over a week. Class practical: Cress seeds on cotton wool in labelled dishes. *Safety:* Wash hands after handling seeds and soil.

Key words: gamete, sperm, egg cell, fertilisation, testes, ovary, oviduct, uterus, puberty, menstrual cycle, embryo, foetus, placenta, gestation, stamen, carpel, pollination, seed dispersal, germination

Working scientifically: Dissection skills, planning an investigation over several days, recording observations.

Maths skills: Timelines in days and weeks; percentages of seeds that germinate.

Misconceptions: The baby's and mother's blood mix in the placenta. Flowers are only for decoration. Seeds need light to germinate.

Assessment: End-of-unit test (40 minutes) plus an evaluated germination investigation.

Leads to: GCSE Biology hormones and the menstrual cycle, sexual and asexual reproduction, plant reproduction.

Light and sound Summer 1 · Physics

Pupils learn how waves carry energy, how sound travels and is heard, and how light reflects, refracts, forms images and splits into colours.

	Lesson and aim	Main task and practical
1	**Waves** Describe transverse and longitudinal waves and label their parts.	Make both kinds of wave on a slinky, then label amplitude, wavelength and frequency on a diagram. Class practical: Slinky springs on the floor. *Safety:* Do not let a stretched slinky go: it snaps back.
2	**How sound travels** Explain how sound travels through a medium and why it cannot cross a vacuum.	Watch the bell in a bell jar as the air is pumped out, then compare the speed of sound in air, water and steel. Teacher demonstration: Electric bell in a bell jar with a vacuum pump. *Safety:* Teacher only; the jar is behind a safety screen.
3	**Loudness and pitch** Link loudness to amplitude and pitch to frequency.	Look at sound waves on an oscilloscope app, then sketch waves for loud, quiet, high and low sounds. Teacher demonstration: Signal generator, loudspeaker and oscilloscope (or phone app). *Safety:* Keep volume low; tell the teacher if a sound hurts.
4	**Hearing and ultrasound** Describe how the ear works and how ultrasound is used.	Label the ear, test the class hearing range and read about ultrasound in scans and cleaning.
5	**How light travels** Describe how light travels and how shadows form.	Make shadows with a ray box and explain why light from the Sun reaches us through space.
6	**Reflection** Use the law of reflection.	Shine a ray at a plane mirror at five angles, measure the angles of incidence and reflection and write a conclusion. Class practical: Ray box and plane mirror on paper. *Safety:* Ray boxes get hot: switch off when not in use.
7	**Refraction** Describe and draw refraction at a boundary.	Trace rays through a glass block, draw the normals and describe how the ray bends going in and out. Class practical: Ray box and glass block. *Safety:* Glass blocks are heavy and can chip: keep them on the paper.
8	**Lenses and the eye** Describe how a lens forms an image and how the eye works.	Make a pinhole camera, look at the upside-down image and label the parts of the eye. Class practical: Pinhole camera from a tube and tracing paper. *Safety:* Never look at the Sun through the camera.
9	**Colour** Explain how white light splits and how filters and coloured objects work.	Split light with a prism, then predict and test the colours of objects under red and green light. Class practical: Prism, ray box and coloured filters. *Safety:* Ray boxes get hot; dim lights carefully, keep bags off the floor.
10	**Light and sound compared** Compare light and sound and use their speeds.	Complete a comparison table and work out how far away a storm is from the gap between lightning and thunder.

Key words: vibration, wave, amplitude, wavelength, frequency, hertz, pitch, longitudinal, transverse, medium, vacuum, ultrasound, luminous, reflection, refraction, normal, lens, spectrum, filter

Working scientifically: Measuring angles with a protractor, drawing ray diagrams, using a model (slinky) to explain waves.

Maths skills: Measuring angles; distance = speed × time (thunder and lightning).

Misconceptions: Sound can travel through space. We see because light comes out of our eyes. A coloured filter adds colour to light (it removes colours).

Assessment: End-of-unit test (40 minutes) with a ray diagram and a waves question.

Leads to: GCSE Physics waves, sound, reflection and refraction, the electromagnetic spectrum.

Space: Earth, Sun and Moon Summer 2 · Physics

Pupils explain day and night, the seasons, phases of the Moon and eclipses, compare weight on other planets, and see how our ideas about space changed with evidence.

	Lesson and aim	Main task and practical
1	**The Solar System** Describe the Sun, the planets and their order.	Build a toilet-roll scale model of planet distances along the corridor.
2	**Gravity and weight in space** Calculate weight on other planets.	Use a table of g values to work out your weight on the Moon, Mars and Jupiter.
3	**Day, night and years** Explain day, night and years using the Earth's spin and orbit.	Use a torch and a globe to show day and night, then answer questions on time zones. Class practical: Torch and globe in a dimmed room. *Safety:* Keep walkways clear while the room is dim.
4	**The seasons** Explain the seasons using the tilt of the Earth's axis.	Shine a torch on squared paper at two angles, count the squares lit and explain summer and winter.
5	**Phases of the Moon** Explain why the Moon seems to change shape.	Hold a ball at arm's length round a lamp, sketch each phase and label the cycle. Class practical: Polystyrene ball and a single lamp. *Safety:* The lamp bulb gets hot.
6	**Eclipses** Explain solar and lunar eclipses.	Draw labelled diagrams of both eclipses and explain why never to look at the Sun.
7	**Stars and galaxies** Describe stars, galaxies and the light year.	Order objects from the Moon to the observable universe by size and distance.
8	**Changing ideas about space** Explain how evidence changed the model of the Solar System.	Compare the geocentric and heliocentric models and explain how Galileo's observations supported the Sun-centred model.
9	**Exploring space** Describe how satellites, telescopes and probes help us learn about space.	Research one mission from a fact card and present it in two minutes.
10	**The scale of space** Use light years and the speed of light to compare distances.	Work out how long light takes to reach us from the Sun, the Moon and the nearest star, then revise for the end-of-year test.

Key words: Solar System, planet, orbit, axis, rotation, season, satellite, phases of the Moon, eclipse, star, galaxy, light year, gravity, geocentric, heliocentric

Working scientifically: Using physical models, judging evidence, how scientific ideas change.

Maths skills: Weight = mass × g with other planets' values; scale models; large numbers and light years.

Misconceptions: Summer happens because the Earth is closer to the Sun. The Moon's phases are caused by the Earth's shadow. There is no gravity in space.

Assessment: End-of-year test (50 minutes) covering the Year 7 units.

Leads to: GCSE Physics space physics (separate science) and gravity; GCSE Combined Science forces.

Year 8

Building on Year 7: separating mixtures, food and the digestive system, electricity and magnetism, chemical reactions, breathing and exercise, and heating and cooling.

Mixtures and separating Autumn 1 · Chemistry

Pupils learn what pure means in science, how substances dissolve, and how to separate mixtures by filtration, crystallisation, distillation and chromatography, ending with elements, compounds and mixtures.

	Lesson and aim	Main task and practical
1	**Pure substances and mixtures** Explain what pure means in science.	Sort labels (orange juice, distilled water, air, gold, sea water) and use melting point data to spot an impure sample.
2	**Dissolving** Explain dissolving with particles and show that mass is conserved.	Weigh water and salt before and after dissolving and explain why the mass stays the same. Class practical: Dissolving salt in water on a balance. *Safety:* Wipe spills; balances kept dry.
3	**Solubility** Investigate how temperature changes how much solute dissolves.	Add spatulas of sugar to water at three temperatures until no more dissolves, then plot the results. Class practical: Dissolving sugar at 20, 35 and 50 °C. *Safety:* Water no hotter than 50 °C; kettles used by the teacher.
4	**Filtration** Separate an insoluble solid from a liquid.	Separate sand from salty water and label the filtrate and residue. Class practical: Filtering a sand and salt water mixture. *Safety:* Goggles; glass funnels supported in a clamp or conical flask.
5	**Evaporation and crystallisation** Get a soluble solid back from a solution.	Heat the filtrate in an evaporating basin until crystals start to form, then leave it to crystallise. Class practical: Evaporating salt solution over a Bunsen burner. *Safety:* Goggles; stop heating before dry, as hot salt spits; let the basin cool.
6	**Distillation** Explain how distillation separates a liquid from a solution.	Label the distillation apparatus and explain each step from the demonstration of distilling inky water. Teacher demonstration: Distilling inky water with a Liebig condenser. *Safety:* Teacher only; anti-bumping granules; cold water runs in at the bottom of the condenser.
7	**Chromatography** Use chromatography to separate the dyes in an ink.	Run chromatograms of four felt-tip pens and a mystery ink and identify which pen wrote the note. Class practical: Paper chromatography of felt-tip inks in water. *Safety:* Pencil for the start line; keep the solvent below the line.
8	**The rock salt challenge** Plan and carry out a method to purify rock salt.	Write a step-by-step method, purify rock salt and evaluate how pure the salt is. Class practical: Purifying rock salt by dissolving, filtering and evaporating. *Safety:* Goggles; hot basins on heatproof mats; no tasting.

	Lesson and aim	Main task and practical
9	**Elements, compounds and mixtures** Tell elements, compounds and mixtures apart with particle diagrams.	Sort particle diagrams, then compare iron and sulfur mixed with iron sulfide. Teacher demonstration: Separating an iron and sulfur mixture with a magnet; a sample of iron sulfide to compare. *Safety:* The compound is shown, not made in class: heating sulfur gives off harmful fumes.
10	**Separating in the real world** Choose a separation method for a real problem and justify it.	Match methods to desalination, forensic ink tests, water treatment and crude oil, and justify each choice.

Key words: pure, impure, mixture, solute, solvent, solution, soluble, insoluble, solubility, saturated, filtration, filtrate, residue, crystallisation, distillation, chromatography, element, compound

Working scientifically: Choosing apparatus, writing a method, controlling variables, identifying risks.

Maths skills: Line graphs of solubility against temperature; Rf values (stretch).

Misconceptions: A substance disappears when it dissolves. Pure means natural or clean. Mass is lost when something dissolves.

Assessment: End-of-unit test (40 minutes) plus the rock salt practical write-up.

Leads to: GCSE Chemistry pure substances, formulations, chromatography required practical, water treatment.

Food, digestion and health Autumn 2 · Biology

Pupils learn what a balanced diet contains, test foods for nutrients, follow food through the digestive system, see enzymes at work, and look at how drugs affect the body.

	Lesson and aim	Main task and practical
1	**Nutrients** Name the seven parts of a balanced diet and what each does.	Sort foods into nutrient groups and complete a table of what each nutrient is for.
2	**Food tests** Test foods for starch, sugar and protein.	Test four foods with iodine, Benedict's and biuret solutions, record the colours and decide what each food contains. Class practical: Iodine, Benedict's (in a hot water bath) and biuret tests. *Safety:* Goggles; Benedict's heated in a water bath, never over a flame; no tasting; check for food allergies.
3	**Energy in food** Compare the energy in different foods.	Burn small pieces of dried pasta and crispbread under a boiling tube of water and compare the temperature rises. Class practical: Burning food samples under a boiling tube of water. *Safety:* No nuts (allergies); goggles; hold the food on a mounted needle, heatproof mat.
4	**A balanced diet** Explain the effects of deficiency, obesity and starvation.	Plan a balanced day of meals for a teenager and explain what scurvy and rickets show about vitamins.
5	**The digestive system** Name the organs of the digestive system and their jobs.	Follow a sandwich through a model gut and label each organ on a diagram. Teacher demonstration: Model gut made from tights, a funnel and mashed food. *Safety:* Teacher only; wear gloves and clean up at once.

	Lesson and aim	Main task and practical
6	**Enzymes** Describe how enzymes break down large molecules.	Add amylase to starch, test drops with iodine every minute and time how long the starch takes to disappear. Class practical: Amylase and starch on a spotting tile with iodine. *Safety:* Goggles; amylase can cause allergic reactions: avoid skin contact.
7	**Absorption** Explain how the small intestine absorbs food.	Set up visking tubing with starch and glucose, test the water outside and explain the role of villi. Class practical: Visking tubing model gut. *Safety:* Goggles; Benedict's heated in a water bath only.
8	**Bacteria in the gut** Explain how gut bacteria help digestion and health.	Read about gut bacteria and design a poster on how diet keeps them healthy.
9	**Drugs and health** Describe how medicines and recreational drugs affect the body.	Use case studies on caffeine, nicotine and alcohol to describe effects on behaviour, health and life processes.
10	**Reading food labels** Use food labels to compare foods and make healthy choices.	Compare three breakfast cereals using their labels and recommend one, with reasons and numbers.

Key words: carbohydrate, lipid, protein, vitamin, mineral, fibre, balanced diet, deficiency, kilojoule, digestion, enzyme, amylase, small intestine, villi, absorption, gut bacteria, drug, addiction

Working scientifically: Qualitative tests and recording colour changes, fair testing with enzymes, reading and comparing data.

Maths skills: Energy in food in kJ; percentages of reference intakes on food labels.

Misconceptions: Fat in the diet is always bad. Digestion only happens in the stomach. All bacteria are harmful.

Assessment: End-of-unit test (40 minutes) plus a food-label analysis task.

Leads to: GCSE Biology digestive system, enzymes, the food tests required practical, non-communicable disease.

Electricity and magnetism Spring 1 · Physics

Pupils explain static charge, build and measure series and parallel circuits, calculate resistance, map magnetic fields and make and use electromagnets.

	Lesson and aim	Main task and practical
1	**Static charge and electric fields** Explain static charge and forces between charges.	Rub balloons and rods, test attraction and repulsion, and explain the results with electrons. Class practical: Balloons, polythene and acetate rods, cloths. *Safety:* Avoid static near computers; latex allergy check for balloons.
2	**Circuits and symbols** Draw circuit diagrams with standard symbols and build them.	Build four circuits from diagrams and draw diagrams for four photographed circuits. Class practical: Cells, bulbs, switches and leads. *Safety:* Low-voltage cells only; disconnect if a wire gets hot.
3	**Current** Measure current with an ammeter.	Measure the current at different points in a series circuit and describe the pattern. Class practical: Ammeters in series circuits. *Safety:* Low-voltage cells only; switch off between readings.

	Lesson and aim	Main task and practical
4	**Potential difference** Measure potential difference with a voltmeter.	Measure the potential difference across cells and bulbs and explain where the energy goes. Class practical: Voltmeters connected in parallel. *Safety:* Low-voltage cells only.
5	**Series and parallel circuits** Compare current and brightness in series and parallel circuits.	Build both circuits with two bulbs, measure the currents and explain why homes are wired in parallel. Class practical: Series and parallel bulb circuits with ammeters. *Safety:* Low-voltage cells only.
6	**Resistance** Calculate resistance and investigate how wire length affects it.	Measure current and potential difference for five lengths of wire, calculate resistance and plot a graph. Class practical: Resistance of constantan wire at different lengths. *Safety:* The wire gets hot: low voltage, switch off between readings.
7	**Magnets and magnetic fields** Describe magnetic poles and map a magnetic field.	Plot the field round a bar magnet with a compass and test which materials are magnetic. Class practical: Bar magnets, plotting compasses, sealed iron filings. *Safety:* Iron filings kept in sealed cases; keep magnets away from phones.
8	**The Earth's magnetic field** Explain how a compass uses the Earth's magnetic field.	Make a floating compass from a magnetised needle and use it to find north. Class practical: Magnetised needle on cork in water. *Safety:* Needles are sharp: pass them point-down.
9	**Electromagnets** Investigate what changes the strength of an electromagnet.	Test how the number of coils changes how many paperclips an electromagnet lifts. Class practical: Electromagnets from wire, an iron nail and a low-voltage supply. *Safety:* Coils get hot: low voltage, switch off between tests.
10	**Using electromagnets** Explain how electromagnets are used in motors, relays and cranes.	Watch a simple motor turn, then explain how one device uses an electromagnet in a short write-up. Teacher demonstration: A simple DC motor. *Safety:* Low voltage; keep fingers away from the spinning coil.

Key words: charge, static electricity, electric field, circuit, current, ampere, ammeter, potential difference, volt, voltmeter, series, parallel, resistance, ohm, conductor, insulator, magnetic field, pole, electromagnet, motor

Working scientifically: Building circuits from diagrams, reading meters, tables and line graphs, identifying patterns.

Maths skills: Resistance = potential difference ÷ current; adding currents in parallel circuits.

Misconceptions: Current is used up as it goes round a circuit. All metals are magnetic. A battery stores charge that runs out.

Assessment: End-of-unit test (40 minutes) with circuit diagrams and a resistance calculation.

Leads to: GCSE Physics electricity, circuits, resistance required practical, magnetism and electromagnetism.

Chemical reactions; acids and alkalis

Spring 2 · Chemistry

Pupils tell chemical from physical changes, write word and simple symbol equations, test the conservation of mass, study combustion, decomposition and energy changes, then work with acids, alkalis, neutralisation and

the reactivity of metals.

	Lesson and aim	Main task and practical
1	**Physical and chemical changes** Spot the signs of a chemical reaction.	Visit four small reaction stations, record what you see and decide whether each change is chemical or physical. Class practical: Reaction stations: bicarbonate and vinegar, melting ice, rusty nails, burning a splint. *Safety:* Goggles; teacher checks each station; splints lit only at the Bunsen station.
2	**Word and symbol equations** Write word equations and count atoms in simple formulae.	Turn reaction descriptions into word equations, then count the atoms in formulae such as CO2 and H2O.
3	**Conservation of mass** Show that mass is conserved in a reaction.	React bicarbonate and vinegar in an open flask and in a flask sealed with a balloon, and compare the masses. Class practical: Bicarbonate and vinegar on a balance, open and sealed. *Safety:* Goggles; do not overfill the balloon.
4	**Combustion** Describe combustion and test for its products.	Explain the fire triangle and test the gas from a burning candle with limewater. Class practical: Candle under a beaker; limewater test. *Safety:* Goggles; limewater is an irritant; candles on heatproof mats.
5	**Thermal decomposition** Describe thermal decomposition and test for carbon dioxide.	Heat copper carbonate, record the colour change and bubble the gas through limewater. Class practical: Heating copper(II) carbonate. *Safety:* Goggles; copper carbonate is harmful; remove the delivery tube from the limewater before you stop heating.
6	**Energy changes in reactions** Tell exothermic from endothermic reactions.	Measure the temperature change of two reactions and classify each one. Class practical: Magnesium ribbon in dilute hydrochloric acid; citric acid with sodium hydrogencarbonate. *Safety:* Goggles; acid no stronger than 1 mol/dm^3; no flames near the hydrogen.
7	**Acids and alkalis** Use indicators and the pH scale.	Make red cabbage indicator and test household solutions, then place them on the pH scale. Class practical: Red cabbage indicator and universal indicator. *Safety:* Goggles; household solutions chosen by the teacher; wash spills off skin at once.
8	**Neutralisation** Describe neutralisation and find how much alkali neutralises an acid.	Add alkali drop by drop to acid with indicator and record the volume needed. Class practical: Dilute hydrochloric acid and sodium hydroxide with universal indicator. *Safety:* Goggles; both solutions dilute (0.5 mol/dm^3 or less); sodium hydroxide is an irritant.
9	**Metals and acids** Describe the reaction of metals with acids and test for hydrogen.	React magnesium, zinc and copper with acid, compare the bubbling and test the gas with a lit splint. Class practical: Metals in dilute hydrochloric acid; squeaky pop test. *Safety:* Goggles; small pieces of metal only; dilute acid.
10	**Reactivity and displacement** Use the reactivity series to predict displacement reactions.	Place metals in copper sulfate solution, record which ones change and write the reactivity order. Class practical: Metals in copper(II) sulfate solution on a spotting tile. *Safety:* Goggles; copper sulfate is harmful; wash hands afterwards.

Key words: reactant, product, chemical change, physical change, word equation, formula, conservation of mass, combustion, oxidation, thermal decomposition, exothermic, endothermic, acid, alkali, pH, indicator, neutralisation, salt, reactivity series, displacement

Working scientifically: Safe handling of acids and heating, observing and recording, gas tests, drawing conclusions.

Maths skills: Balancing mass before and after; reading temperature changes; the pH scale.

Misconceptions: Gas made in a reaction weighs nothing. All acids are dangerous and strong. Burning destroys matter.

Assessment: End-of-unit test (40 minutes) with equations to complete and a practical question on neutralisation.

Leads to: GCSE Chemistry chemical changes, energy changes, the neutralisation and temperature-change required practicals, the reactivity series.

Breathing, respiration and exercise Summer 1 · Biology

Pupils learn how the lungs exchange gases, how cells release energy by aerobic and anaerobic respiration, how yeast ferments, and how the skeleton and muscles work together during exercise.

	Lesson and aim	Main task and practical
1	**The gas exchange system** Name the parts of the gas exchange system and their jobs.	Label the lungs from trachea to alveoli and trace the path of an oxygen molecule. Teacher demonstration: Lung dissection (optional) or model lungs. *Safety:* Teacher only; gloves; meat from a butcher; pupils may watch on a screen.
2	**Breathing** Explain how the ribs and diaphragm move air in and out.	Use a bell jar model to explain breathing, then measure your lung volume with a bottle of water. Class practical: Lung volume by water displacement. *Safety:* New mouthpiece for each pupil; do not keep breathing out until dizzy.
3	**Gas exchange in the alveoli** Explain how the alveoli are adapted for gas exchange.	Annotate an alveolus diagram with four adaptations and explain how each one speeds up diffusion.
4	**Smoking and the lungs** Describe how smoking and asthma affect the gas exchange system.	Use data on smoking and lung disease to write a short leaflet for a health clinic.
5	**Aerobic respiration** Describe aerobic respiration and its word equation.	Compare inhaled and exhaled air with limewater and write the word equation for respiration. Class practical: Limewater test on inhaled and exhaled air. *Safety:* Goggles; limewater is an irritant; breathe in only through the right tube.
6	**Anaerobic respiration** Describe anaerobic respiration in muscles.	Count clothes-peg squeezes for ten 20-second periods and explain the fall with lactic acid. Class practical: Clothes-peg squeezing test. *Safety:* Stop if your hand hurts.
7	**Fermentation** Describe fermentation in yeast and its uses.	Set up yeast and sugar in bottles at three temperatures with balloons and compare how much gas forms. Class practical: Yeast and sugar fermentation with balloons. *Safety:* Water no hotter than 40 °C; latex allergy check.
8	**The skeleton** Describe the four jobs of the skeleton.	Label a skeleton diagram and match bones to support, protection, movement and making blood cells.
9	**Muscles and joints** Explain how antagonistic muscles move joints.	Build a card model arm with elastic bands and measure the force of different muscles with a newton meter. Class practical: Model arm; measuring muscle force with a newton meter or bathroom scales. *Safety:* Push or pull steadily; stop if anything hurts.

	Lesson and aim	Main task and practical
10	**Exercise and the body** Investigate how exercise changes pulse and breathing rate.	Measure your pulse and breathing rate at rest and after two minutes of exercise, then explain the changes. Class practical: Pulse and breathing rate before and after step-ups. *Safety:* Pupils with medical conditions may record instead; clear space; stop if dizzy.

Key words: lungs, trachea, bronchus, alveoli, diaphragm, intercostal muscles, gas exchange, aerobic respiration, anaerobic respiration, lactic acid, fermentation, skeleton, joint, ligament, tendon, antagonistic muscles

Working scientifically: Measuring with repeat readings, comparing results, using models and evaluating their limits.

Maths skills: Means and ranges of pulse and breathing rates; bar charts.

Misconceptions: Breathing and respiration are the same thing. We breathe in oxygen and breathe out only carbon dioxide. Muscles can push.

Assessment: End-of-unit test (40 minutes) plus an exercise-data analysis.

Leads to: GCSE Biology gas exchange, aerobic and anaerobic respiration, the response to exercise.

Heating and cooling Summer 2 · Physics

Pupils tell temperature from energy, explain conduction, convection and radiation with particles and waves, test insulators, and use the idea of thermal equilibrium.

	Lesson and aim	Main task and practical
1	**Temperature and energy** Explain the difference between temperature and thermal energy.	Compare heating 100 ml and 200 ml of water by 10 °C and explain why one needs more energy. Class practical: Heating two volumes of water with a Bunsen burner. *Safety:* Goggles; tripod and gauze stay hot; heatproof mat.
2	**Energy and particles** Explain heating and changes of state with particles.	Draw particle diagrams for ice warming, melting and boiling, and explain the flat parts of a heating curve.
3	**Conduction** Explain conduction and compare conductors.	Fix pins with wax to rods of four metals, heat one end and time when each pin drops. Class practical: Conduction rods with wax and pins. *Safety:* Rods stay hot long after heating; goggles; heatproof mat.
4	**Convection** Explain convection currents in liquids and gases.	Draw the convection current from the demonstration and explain sea breezes. Teacher demonstration: A potassium manganate(VII) crystal heated in a beaker of water. *Safety:* Teacher only; the crystal is oxidising and harmful, so it is added with tweezers.
5	**Radiation** Describe infrared radiation and how surfaces affect it.	Measure the radiation from four faces of a Leslie cube and explain why houses in hot countries are painted white. Teacher demonstration: Leslie cube filled with hot water and an infrared thermometer. *Safety:* Hot water: the teacher fills the cube.
6	**Insulation** Investigate which material insulates best.	Wrap beakers of hot water in three materials, record the temperature every two minutes and plot cooling curves. Class practical: Cooling of insulated beakers of hot water. *Safety:* Water no hotter than 60 °C; carry beakers with care.

	Lesson and aim	Main task and practical
7	**Keeping homes warm** Explain how homes lose and keep thermal energy.	Use a thermal image and cost data to rank loft insulation, cavity walls and double glazing.
8	**Thermal equilibrium** Predict the final temperature when hot and cold objects meet.	Mix hot and cold water in different amounts, predict the final temperature and test it. Class practical: Mixing hot and cold water. *Safety:* Water no hotter than 60 °C.
9	**Animals keeping warm** Explain how size, shape and behaviour help animals keep warm.	Compare cooling in one large and several small test tubes of hot water, then link it to penguins huddling. Class practical: Huddling model with test tubes of hot water. *Safety:* Water no hotter than 60 °C; tubes in racks.
10	**Cooling by evaporation** Explain why evaporation cools things down.	Compare a dry thermometer with one wrapped in wet cotton wool and explain why sweating cools us, then revise for the end-of-year test. Class practical: Wet and dry thermometer bulbs. *Safety:* Thermometers roll: keep them in a tray.

Key words: temperature, thermometer, degrees Celsius, thermal energy store, internal energy, conduction, conductor, insulator, convection, convection current, radiation, infrared, thermal equilibrium, evaporation

Working scientifically: Controlling variables over time, plotting cooling curves, evaluating a method.

Maths skills: Temperature differences; plotting and comparing curves; surface area to volume ratio with cubes.

Misconceptions: Heat and temperature are the same thing. Cold flows into things. Metals feel cold because they are colder.

Assessment: End-of-year test (50 minutes) covering the Year 8 units.

Leads to: GCSE Physics energy, thermal insulation required practical, internal energy and specific heat capacity.

Year 9

The GCSE bridge: atoms and the periodic table, genes and evolution, energy and its cost, the Earth and its atmosphere, pressure and moments, and ecosystems, with more independent practical work.

Atoms, elements and the periodic table Autumn 1 · Chemistry

Pupils use the Dalton model and chemical formulae, see how models of the atom changed, and use the periodic table to compare metals and non-metals and the trends in Groups 1, 7 and 0, ending with everyday materials.

	Lesson and aim	Main task and practical
1	**Atoms and elements** Describe Dalton's model of atoms and use chemical symbols.	Use symbol cards to match element names and symbols, then sort elements into everyday uses.
2	**Compounds and formulae** Name simple compounds and count the atoms in a formula.	Build molecules with modelling kits, write their formulae and name them (-ide, -ate).
3	**Changing models of the atom** Describe how models of the atom changed with new evidence.	Put the Dalton, Thomson and Rutherford models on a timeline and explain what evidence changed each one.
4	**The periodic table** Explain how the periodic table is arranged in groups and periods.	Read about Mendeleev, then use the gaps he left to predict the properties of a missing element.
5	**Metals and non-metals** Compare the properties of metals and non-metals.	Test samples for shine, conductivity and how they bend, and place them on the periodic table. Class practical: Testing element samples with a simple circuit. *Safety:* Sulfur and iodine samples stay in sealed tubes; low-voltage cells.
6	**Group 1: the alkali metals** Describe the reactions of Group 1 metals with water and the trend down the group.	Record the demonstration, describe the trend and predict how rubidium would react. Teacher demonstration: Lithium, sodium and potassium in water (teacher only). *Safety:* Rice-grain pieces, safety screen, goggles, class 2 m back; potassium may spit.
7	**Group 7: the halogens** Describe the halogens and the trend in reactivity down the group.	Use data and the displacement results to put chlorine, bromine and iodine in order of reactivity. Teacher demonstration: Halogen displacement reactions (video, or teacher in a fume cupboard). *Safety:* Chlorine and bromine are toxic: video or fume cupboard only.
8	**Group 0: the noble gases** Explain why the noble gases are unreactive and how they are used.	Match noble gases to their uses and explain the link between being unreactive and each use.

	Lesson and aim	Main task and practical
9	**Metal and non-metal oxides** Compare the oxides of metals and non-metals.	Burn magnesium, test its oxide with universal indicator and compare it with the oxide of a non-metal. Class practical: Burning magnesium ribbon in tongs; testing the oxide with indicator. *Safety:* Do not look straight at burning magnesium; goggles; small pieces only.
10	**Polymers, ceramics and composites** Compare the properties of polymers, ceramics and composites.	Test material samples for strength, flexibility and hardness, then choose materials for a bike frame and a mug. Class practical: Bend, scratch and drop tests on material samples. *Safety:* Goggles: ceramics can shatter; drop only from bench height onto a tray.

Key words: atom, element, compound, molecule, formula, chemical symbol, periodic table, group, period, metal, non-metal, alkali metal, halogen, noble gas, oxide, polymer, ceramic, composite

Working scientifically: Using models, spotting trends in data, predicting from patterns.

Maths skills: Counting atoms in formulae; reading trends from tables of melting points.

Misconceptions: Atoms of an element can be different elements. All metals are hard and dense. Molecules are always compounds.

Assessment: End-of-unit test (40 minutes) with a prediction question on an unfamiliar element in Group 1 or 7.

Leads to: GCSE Chemistry atomic structure, the periodic table, Groups 1, 7 and 0, and materials.

Inheritance, DNA and evolution Autumn 2 · Biology

Pupils measure variation, learn how DNA, genes and chromosomes carry inherited information, and explain selective breeding, natural selection, evolution and extinction.

	Lesson and aim	Main task and practical
1	**Variation** Describe continuous and discontinuous variation.	Measure hand span and record tongue rolling across the class, then draw a histogram and a bar chart.
2	**Causes of variation** Explain genetic and environmental causes of variation.	Sort features into genetic, environmental or both, using data on identical twins.
3	**DNA, genes and chromosomes** Describe how DNA, genes and chromosomes are related.	Extract DNA from strawberries and draw a diagram linking cell, nucleus, chromosome, gene and DNA. Class practical: Strawberry DNA extraction with salt, washing-up liquid and cold ethanol. *Safety:* Goggles; ethanol is highly flammable: no flames in the room.
4	**Discovering DNA** Describe how Watson, Crick, Franklin and Wilkins worked out the structure of DNA.	Read the story of Photo 51 and explain how each scientist's evidence helped.
5	**Passing on genes** Explain how genes pass from parents to offspring.	Model inheritance with coloured beads for alleles and, as a stretch, complete a simple cross.
6	**Selective breeding** Explain how humans breed plants and animals for useful features.	Plan a breeding programme for a high-yield wheat or a calm dog and list one risk.

	Lesson and aim	Main task and practical
7	**Natural selection** Explain natural selection step by step.	Play the peppered moth hunt on light and dark backgrounds, then explain the results using natural selection. Class practical: Paper moth hunt on newspaper and dark card. *Safety:* Clear floor space.
8	**Evidence for evolution** Use fossils and antibiotic resistance as evidence for evolution.	Put horse fossils in order and explain how resistant bacteria show evolution happening now.
9	**Extinction** Explain how changes in the environment can lead to extinction.	Use case studies (the dodo, the woolly mammoth, the red squirrel) to explain the causes of extinction.
10	**Protecting biodiversity** Explain how gene banks and conservation protect species.	Read about seed banks and write a short case for saving one endangered species.

Key words: variation, continuous, discontinuous, inherited, environmental, DNA, gene, chromosome, allele, selective breeding, natural selection, adaptation, evolution, fossil, extinction, biodiversity, gene bank

Working scientifically: Collecting class data, choosing the right graph, how scientists work together and use evidence.

Maths skills: Bar charts and histograms; ratios and probabilities in simple crosses (stretch).

Misconceptions: Animals choose to adapt during their lifetime. Evolution is just a theory with no evidence. Humans evolved from chimpanzees.

Assessment: End-of-unit test (40 minutes) with a six-mark natural selection explanation.

Leads to: GCSE Biology inheritance, genetic crosses, variation and evolution, selective breeding, classification.

Energy: stores, transfers and costs Spring 1 · Physics

Pupils describe energy stores and transfers, draw Sankey diagrams, calculate work done, power and the cost of electricity, and compare fossil fuels with renewable energy resources.

	Lesson and aim	Main task and practical
1	**Energy stores** Name the main energy stores and give examples.	Identify the energy stores in eight pictures, from a stretched bow to a cup of tea.
2	**Energy transfers** Describe how energy is transferred and that it is conserved.	Describe the transfers at five stations (a wind-up toy, a falling ball, a kettle) and say where energy is wasted. Class practical: Energy transfer stations. *Safety:* Kettle used by the teacher only.
3	**Sankey diagrams and efficiency** Draw Sankey diagrams and calculate efficiency.	Draw Sankey diagrams for a bulb and an LED and work out which is more efficient.
4	**Work done** Calculate work done as force × distance.	Pull a block up a ramp with a newton meter, measure the force and distance and calculate the work done. Class practical: Pulling a block up a ramp with a newton meter. *Safety:* Keep ramps stable; masses over the bench.
5	**Energy in food and fuels** Compare the energy in foods and fuels in kilojoules.	Use food labels and fuel data to compare energy values and work out minutes of activity for each snack.

	Lesson and aim	Main task and practical
6	**Power** Calculate power and compare the power ratings of appliances.	Time yourself walking and running up stairs, calculate your power and compare it with appliances. Class practical: Measuring personal power on a flight of stairs. *Safety:* Walk or run only with the teacher's say-so; hold the rail.
7	**Paying for electricity** Calculate the cost of using appliances in kilowatt-hours.	Work out a week's electricity bill for a family from appliance power ratings and times.
8	**Fossil fuels** Explain how a power station makes electricity and the problems fossil fuels cause.	Put the steps of a power station in order and list three problems with fossil fuels.
9	**Renewable energy** Describe how renewable resources generate electricity.	Test how the number of blades changes the output of a model wind turbine. Class practical: Model wind turbine with a fan and a voltmeter. *Safety:* Keep fingers away from the blades.
10	**Choosing energy resources** Evaluate energy resources for a town.	Use data on cost, reliability and pollution to choose an energy mix for a town and justify it.

Key words: energy store, kinetic, gravitational potential, elastic, thermal, chemical, energy transfer, conservation of energy, dissipation, Sankey diagram, efficiency, work done, joule, power, watt, kilowatt-hour, fossil fuel, renewable

Working scientifically: Calculations with units, comparing data, evaluating arguments with evidence.

Maths skills: Work done = force × distance; power = energy ÷ time; cost = power (kW) × time (h) × price; efficiency as a fraction or percentage.

Misconceptions: Energy gets used up. Renewable means it has no effect on the environment. A higher-power appliance always costs more to run.

Assessment: End-of-unit test (40 minutes) with an electricity bill calculation and a six-mark evaluation of energy resources.

Leads to: GCSE Physics energy stores, work, power, efficiency, the national grid and energy resources.

The Earth, atmosphere and resources

Spring 2 · Chemistry

Pupils study the structure of the Earth and the rock cycle, the atmosphere and the carbon cycle, how humans are changing the climate, and how we extract and recycle the Earth's resources.

	Lesson and aim	Main task and practical
1	**The structure of the Earth** Describe the crust, mantle and core.	Make a scale model of the Earth's layers and label each with its state and temperature.
2	**Rocks and the rock cycle** Describe how igneous, sedimentary and metamorphic rocks form.	Examine rock samples, sort them into three types and draw the rock cycle. Class practical: Rock samples and hand lenses. *Safety:* Do not drop rocks; wash hands after handling.
3	**Crystal size in igneous rocks** Explain how cooling rate changes crystal size.	Melt salol and let it cool on a warm and a cold slide, then compare the crystals. Class practical: Salol crystals on warm and cold slides. *Safety:* Goggles; salol is an irritant; water bath for melting, no flames.

	Lesson and aim	Main task and practical
4	**Weathering and erosion** Describe physical, chemical and biological weathering.	Drip dilute acid on limestone and granite, record what happens and explain chemical weathering. Class practical: Dilute hydrochloric acid on rock samples. *Safety:* Goggles; dilute acid only; rinse rocks afterwards.
5	**The atmosphere** Describe the gases in the atmosphere and how it has changed.	Draw a pie chart of today's atmosphere and put the changes since the early Earth on a timeline.
6	**The carbon cycle** Describe how carbon moves between living things, the air, oceans and rocks.	Build the carbon cycle from process cards and label photosynthesis, respiration, combustion and decay.
7	**Climate change** Explain how human activity is changing the climate.	Use temperature and carbon dioxide graphs to explain the link and list three effects of climate change.
8	**Earth's resources** Explain why some resources are finite and how we can use them more carefully.	Sort resources into finite and renewable and work out how long some metals will last.
9	**Extracting metals** Explain how carbon is used to extract metals from their ores.	Heat copper oxide with carbon, observe the copper and write the word equation. Class practical: Copper(II) oxide and carbon heated in a crucible (or teacher demo). *Safety:* Goggles; heat strongly in a fume cupboard or well-ventilated room; crucibles stay hot.
10	**Recycling and life cycles** Compare the life cycles of products and the case for recycling.	Compare the life cycle of a glass bottle and a plastic bottle and decide which is better for the planet.

Key words: crust, mantle, core, igneous, sedimentary, metamorphic, rock cycle, weathering, erosion, atmosphere, carbon cycle, greenhouse effect, climate change, finite resource, ore, extraction, reduction, recycling

Working scientifically: Interpreting graphs of real data, judging the quality of evidence, separating fact from opinion.

Maths skills: Pie charts of the atmosphere; reading trends from climate graphs; percentages.

Misconceptions: The greenhouse effect is the same as climate change. The hole in the ozone layer causes global warming. Rocks never change.

Assessment: End-of-unit test (40 minutes) with a climate-data question.

Leads to: GCSE Chemistry the atmosphere, climate change, using resources, life-cycle assessment and metal extraction.

Forces: pressure and moments Summer 1 · Physics

Pupils calculate pressure on solids and in fluids, explain upthrust and floating, test Hooke's law, use the principle of moments and explain how forces change motion.

	Lesson and aim	Main task and practical
1	**Pressure on solids** Calculate pressure as force ÷ area.	Draw round your shoe on squared paper, find its area and work out the pressure you put on the floor. Class practical: Shoe area on squared paper and a bathroom scale. *Safety:* Take turns on the scale; stand still.

	Lesson and aim	Main task and practical
2	**Pressure in liquids** Explain why pressure in a liquid increases with depth.	Explain the water jets from a bottle with holes at three depths and why dams are thicker at the bottom. Teacher demonstration: Water bottle with holes at three heights. *Safety:* Done over a sink or tray; wipe up spills.
3	**Upthrust and floating** Explain floating and sinking using upthrust and weight.	Weigh objects in air and in water, work out the upthrust and predict which will float. Class practical: Newton meter and a tank of water. *Safety:* Wipe spills to prevent slips; keep electrics away.
4	**Atmospheric pressure** Explain why air pressure changes with height.	Explain the upturned glass of water with card and work out why ears pop on a plane. Teacher demonstration: Upturned glass with card over a tray. *Safety:* Over a tray; plastic cup rather than glass.
5	**Hooke's law** Investigate how the extension of a spring depends on the force.	Add masses to a spring, measure the extension each time, plot a graph and find the limit of proportionality. Class practical: Stretching a spring with slotted masses. *Safety:* Goggles in case the spring flies off; G-clamp the stand; masses over a tray.
6	**Moments** Calculate the moment of a force.	Use a spanner and door handle activity, then calculate moments with moment = force × distance.
7	**The principle of moments** Use the principle of moments to balance objects.	Balance masses on a metre rule at different distances and check the principle of moments. Class practical: Balancing a metre rule on a pivot with masses. *Safety:* Masses over the bench; keep the pivot stable.
8	**Levers and gears** Explain how levers and gears make jobs easier.	Sort tools into three types of lever and work out how a bike's gears change the turning force.
9	**Forces and changing motion** Explain how unbalanced forces change speed and direction.	Roll a trolley down a ramp at different angles, time it and describe how the resultant force changed its motion. Class practical: Trolley on a ramp with light gates or stopwatches. *Safety:* Catch the trolley at the bottom; keep the ramp clear.
10	**Engineering with forces** Apply pressure and moments to a design problem.	Design and test a lifting arm from card and syringes, then evaluate it with forces and moments. Class practical: Card and syringe lifting arm. *Safety:* Syringes without needles; do not point at people.

Key words: pressure, pascal, area, upthrust, density, atmospheric pressure, extension, Hooke's law, elastic limit, moment, pivot, principle of moments, lever, gear, acceleration, resultant force

Working scientifically: Planning an investigation, line graphs and lines of best fit, spotting anomalous results.

Maths skills: Pressure = force ÷ area; moment = force × distance; proportional relationships; lines of best fit.

Misconceptions: Heavy objects always sink. Pressure and force are the same thing. A spring stretches by the same amount for ever.

Assessment: End-of-unit test (40 minutes) with pressure and moment calculations and a graph question on Hooke's law.

Leads to: GCSE Physics forces, the force and extension required practical, moments, pressure in fluids and acceleration.

Photosynthesis, ecosystems and GCSE skills Summer 2 · Biology

Pupils explain photosynthesis and plant nutrition, food webs and interdependence, sample a habitat, and practise the planning, analysis and evaluation skills they will need at GCSE.

	Lesson and aim	Main task and practical
1	**Photosynthesis** Describe photosynthesis and test a leaf for starch.	Test a leaf that was kept in the light and one kept in the dark for starch, and write the word equation. Class practical: Testing a leaf for starch with ethanol in a hot water bath and iodine. *Safety:* Ethanol is highly flammable: kettle water only, no flames in the room; goggles.
2	**Leaves** Explain how a leaf is adapted for photosynthesis.	Make a nail-varnish peel of a leaf, count the stomata under the microscope and label a leaf cross-section. Class practical: Nail-varnish stomata peel. *Safety:* Use nail varnish in a ventilated room; carry microscopes with two hands.
3	**The rate of photosynthesis** Investigate how light intensity changes the rate of photosynthesis.	Count the bubbles from pondweed with a lamp at five distances and plot the results. Class practical: Pondweed bubbling at different lamp distances. *Safety:* Lamps get hot; keep water away from mains plugs; LED lamps if possible.
4	**Plant minerals** Describe the minerals plants need and what happens without them.	Match pictures of deficient plants to the missing mineral and explain why farmers use fertilisers.
5	**Food chains and webs** Describe how energy flows through food chains and webs.	Build a food web for a pond from cards and trace three food chains in it.
6	**Interdependence** Predict what happens when one species in a food web changes.	Use predator–prey graphs (lynx and hare) to explain what happens when one population changes.
7	**Toxins in food chains** Explain how toxins build up in food chains.	Model bioaccumulation with counters and explain what happened to birds of prey when DDT was used.
8	**Sampling a habitat** Use quadrats to estimate a population.	Sample daisies on the school field with quadrats, find the mean per quadrat and estimate the total. Class practical: Random quadrat sampling on the school field. *Safety:* Stay in the marked area; wash hands afterwards; check for pollen and bee-sting allergies.
9	**GCSE skills: planning and evaluating** Use accuracy, precision, repeatability and anomalies to evaluate an investigation.	Evaluate a sample method and results from a GCSE-style practical and suggest improvements.
10	**GCSE skills: analysing data** Analyse graphs and draw conclusions like a GCSE scientist.	Draw lines of best fit, find gradients and write conclusions from three data sets, then revise for the end-of-Key Stage 3 test.

Key words: photosynthesis, chlorophyll, chloroplast, stomata, glucose, limiting factor, mineral, producer, consumer, food web, predator, prey, interdependence, bioaccumulation, quadrat, accuracy, precision, anomaly

Working scientifically: Planning, sampling, analysing and evaluating like a GCSE scientist: accuracy, precision, repeatability and anomalies.

Maths skills: Means from quadrat samples; estimating a population; inverse relationships (light and distance); gradients.

Misconceptions: Plants get their food from the soil. Plants respire only at night. Energy is recycled in a food chain.

Assessment: End-of-Key Stage 3 test (60 minutes) across all three years, with a GCSE-style practical question.

Leads to: GCSE Biology photosynthesis and the rate of photosynthesis required practical, ecology and the field investigation required practical, and the working scientifically skills of every GCSE science.