| **Lesson** | **Lesson title** | **Lesson objectives** |
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| TOPIC 1 - ENERGY |
| 1.1 | Potential energy | * Consider what happens when a spring is stretched.
* Describe what is meant by gravitational potential energy.
* Calculate the energy stored by an object raised above ground level.
 |
| 1.2 | Investigating kinetic energy | * Describe how the kinetic energy store of an object changes as its speed changes.
* Calculate kinetic energy.
* Consider how energy is transferred.
 |
| 1.3 | Work done and energy transfer | * Understand what is meant by work done.
* Explain the relationship between work done and force applied.
* Identify the transfers between energy stores when work is done against friction.
 |
| 1.4 | Understanding power | * Define power.
* Compare the rate of energy transfer by various machines and electrical appliances.
* Calculate power.
 |
| 1.5 | Specific heat capacity | * Understand how things heat up.
* Find out about heating water.
* Find out about specific heat capacity.
 |
| 1.6  | Required practical: Investigating specific heat capacity | * Use theories to develop a hypothesis.
* Evaluate a method and suggest improvements.
* Perform calculations to support conclusions.
 |
| 1.7 | Dissipation of energy | * Explain ways of reducing unwanted energy transfer.
* Describe what affects the rate of cooling of a building.
* Understand that energy is dissipated.
 |
| 1.8 | Energy efficiency | * Explain what is meant by energy efficiency.
* Calculate the efficiency of energy transfers.
* Find out about conservation of energy.
 |
| 1.9 | Required practical: Investigating ways of reducing the unwanted energy transfers in a system | * Use scientific ideas to make predictions
* Analyse data to identify trends.
* Evaluate an experimental procedure.
 |
| 1.10 | Using energy resources | * Describe the main energy resources available for use on Earth.
* Distinguish between renewable and non-renewable resources.
* Explain the ways in which the energy resources are used.
 |
| 1.11 | Global energy supplies | * Analyse global trends in energy use.
* Understand what the issues are when using energy resources.
 |
| 1.12  | Key concept: Energy transfer | * To be able to recognize objects with energy.
* To be able to recognize the different types of energy.
* To be able to describe energy transfers.
* To be able to use and describe the law of conservation of energy.
 |
| 1.13 | Maths skills: Calculations using significant figures | * Substitute numerical values into equations and use appropriate units.
* Change the subject of an equation.
* Give an answer using an appropriate number of significant figures.
 |
| 1.14 | Maths skills: Handling data | * Recognise the difference between mean, mode and median.
* Explain the use of tables and frequency tables.
* Explain when to use scatter diagrams, bar charts and histograms.
 |
| TOPIC 2 - ELECTRICITY |
| 2.1 | Static electricity | * Describe how insulating materials can become charged.
* Know that there are two kinds of electric charge.
* Explain these observations in terms of electron transfer.
 |
| 2.2 | Electric fields | * Explain what an electric field is.
* Draw an electric field pattern for a charged sphere.
* Use the idea of an electric field to explain electrostatic attraction and sparking.
 |
| 2.3 | Electric current | * Know circuit symbols.
* Recall that current is a rate of flow of electric charge.
* Recall that current (*I*) depends on resistance (*R*) and potential difference (*V*)
* Explain how an electric current passes round a circuit.
 |
| 2.4 | Series and parallel circuits | * Recognise series and parallel circuits.
* Describe the changes in the current in series and parallel circuits.
* Describe the changes in the potential difference in series and parallel circuits.
 |
| 2.5 | Investigating circuits | * Classify materials as either conducting or insulating.
* Use series circuits to test components and make measurements.
* Carry out calculations on series circuits.
 |
| 2.6 | Circuit components | * Set up a circuit to investigate resistance.
* Investigate the changing resistance of a filament lamp.
* Compare the properties of a resistor and a filament lamp.
 |
| 2.7 | Required practical: Investigate, usingcircuit diagrams to construct circuits,the *I–V* characteristics of a filament lamp, a diode and a resistor at constant temperature | * Understand how an experiment can be designed to test an idea.
* Evaluate how an experimental procedure can yield more accurate data.
* Interpret and explain graphs using scientific ideas.
 |
| 2.8  | Required practical: Use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits, including the length of a wire at a constant temperature and combinations of resistors in series and parallel | * Use a circuit to determine resistance.
* Gather valid data for use in calculations.
* Apply the circuit to determine the resistance of combinations of components.
 |
| 2.9 | Control circuits | * Use a thermistor and a light-dependent resistor (LDR).
* Investigate the properties of thermistors, LDRs and diodes.
 |
| 2.10 | Electricity in the home | * Recall that the domestic supply in the UK is 230 V ac and 50 Hz.
* Describe the main features of live, neutral and earth wires.
 |
| 2.11 | Transmitting electricity | * Describe how electricity is transmitted using the National Grid.
* Explain why electrical power is transmitted at high potential differences.
* Understand the role of transformers.
 |
| 2.12 | Power and energy transfers | * Describe the energy transfers in different domestic appliances.
* Describe power as a rate of energy transfer.
* Calculate the energy transferred.
 |
| 2.13 | Calculating power | * Calculate power.
* Use power equations to solve problems.
* Consider power ratings and changes in stored energy.
 |
| 2.14  | Key concept: What’s the difference between potential difference and current? | * Understand the concepts of current and potential difference.
* Apply the concepts of current and potential difference.
* Use these concepts to explain various situations.
 |
| 2.15 | Maths skills: Using formulae and understanding graphs | * Recognise how algebraic equations define the relationships between variables.
* Solve simple algebraic equations by substituting numerical values.
* Describe relationships expressed in graphical form.
 |
| TOPIC 3 – PARTICLE MODEL OF MATTER |
| 3.1 | Density | * Use the particle model to explain the different states of matter.
* Describe differences in density for different states of matter.
* Calculate density for the different states of matter.
 |
| 3.2  | Required practical: To investigate the densities of regular and irregular solid objects and liquids | * Interpret observations and data.
* Use spatial models to solve problems.
* Plan experiments and devise procedures.
* Use an appropriate number of significant figures in measurements and calculations.
 |
| 3.3 | Changes of state | * Describe how, when substances change state, mass is conserved.
* Describe energy transfer in changes of state.
* Explain changes of state in terms of particles.
 |
| 3.4 | Internal energy | * Describe the particle model of matter.
* Understand what is meant by the internal energy of a system.
* Describe the effect of heating on the energy stored within a system.
 |
| 3.5 | Specific heat capacity  | * Describe the effect of increasing the temperature of a system in terms of particles.
* State the factors that are affected by an increase in temperature of a substance.
* Explain specific heat capacity.
 |
| 3.6 | Latent heat | * Explain what is meant by latent heat.
* Describe that when a change of state occurs it changes the energy stored but not the temperature.
* Perform calculations involving specific latent heat.
 |
| 3.7 | Particle motion in gases | * Relate the temperature of a gas to the average kinetic energy of the particle.
* Explain how gas has a pressure.
* Explain that changing the temperature of a gas held at constant volume changes its pressure.
 |
| 3.8 | Increasing the pressure of a gas | * Describe the relationship between the pressure and volume of a gas at constant temperature.
* Calculate the change in the pressure or volume of a gas held at constant temperature when either the pressure or volume is increased or decreased.
* Explain how doing work on a gas can increase its temperature.
 |
| 3.9  | Key concept: Particle model and changes of state | * Use the particle model to explain states of matter.
* Use ideas about energy and bonds to explain changes of state.
* Explain the relationship between temperature and energy.
 |
| 3.10 | Maths skills: Drawing and interpreting graphs | * Plot a graph of temperature against time, choosing a suitable scale.
* Draw a line of best fit (which may be a curve).
* Interpret a graph of temperature against time.
 |
| TOPIC 4 – ATOMIC STRUCTURE |
| 4.1 | Atomic structure | * Describe the structure of the atom.
* Use symbols to represent particles.
* Describe ionisation.
 |
| 4.2 | Radioactive decay | * Describe radioactive decay.
* Describe the types of nuclear radiation.
* Understand the processes of alpha decay and beta decay.
 |
| 4.3 | Background radiation | * Recall sources of background radiation.
* Describe how different types of radiation have differing ionising power.
* Justify the selection of sources for particular applications.
 |
| 4.4 | Nuclear equations | * Understand nuclear equations.
* Write balanced nuclear equations for alpha decay.
* Write balanced nuclear equations for beta decay.
 |
| 4.5 | Radioactive half-life | * Explain what is meant by radioactive half-life.
* Calculate half-life.
* Choose the best radioisotope for a task.
 |
| 4.6 | Hazards and uses of radiation | * Describe radioactive contamination.
* Give examples of how radioactive tracers can be used.
* Explain how contaminated waste is disposed of.
 |
| 4.7 | Irradiation | * Explain what is meant by irradiation.
* Understand the distinction between contamination and irradiation.
* Appreciate the importance of communication between scientists.
 |
| 4.8 | Uses of radiation in medicine | * Compare gamma rays and X-rays.
* Describe some uses of radiation for medical diagnosis and therapy.
 |
| 4.9 | Using nuclear radiation | * Explore the risks and benefits of using nuclear radiation.
* Describe how internal organs can be explored.
* Understand how nuclear radiation can control or destroy unwanted tissue.
 |
| 4.10 | Nuclear fission | * Describe nuclear fission.
* Explain how a chain reaction occurs.
* Explain how fission is used.
 |
| 4.11 | Nuclear fusion | * Explain nuclear fusion.
* Describe the conditions needed for fusion.
* Describe how nuclear fusion might be an attractive energy source.
 |
| 4.12  | Key concept: Developing ideas for the structure of the atom | * Understand how ideas about the structure of the atom have changed.
* How evidence is used to test and improve models.
 |
| 4.13 | Maths skills: Using ratios and proportional reasoning | * Calculate radioactive half-life from a curve of best fit.
* Calculate the net decline in radioactivity.
 |
| TOPIC 5 - FORCES |
| 5.1 | Forces | * Describe a force.
* Recognise the difference between contact and non-contact forces.
* State examples of scalar and vector quantities.
 |
| 5.2 | Speed | * Calculate speed using distance travelled divided by time taken.
* Calculate speed from a distance–time graph.
* Measure the gradient of a distance–time graph at any point.
 |
| 5.3 | Acceleration | * Describe acceleration.
* Calculate acceleration.
* [Higher tier] Explain motion in a circle.
 |
| 5.4 | Velocity–time graphs | * Draw velocity–time graphs.
* Calculate acceleration using a velocity–time graph.
* [Higher tier] Calculate displacement using a velocity–time graph.
 |
| 5.5 | Calculations of motion | * Describe uniform motion.
* Use an equation for uniform motion.
* Apply this equation to vertical motion.
 |
| 5.6 | Heavy or massive? | * Identify the correct units for mass and weight.
* Explain the difference between mass and weight.
* Understand how weight is an effect of gravitational fields.
 |
| 5.7 | Forces and motion | * Understand what a force does.
* Explain what happens to an object if all the forces acting on it cancel each other out.
* Analyse how this applies to everyday situations.
 |
| 5.8 | Resultant forces | * Calculate the resultant from opposing forces.
* Draw free-body diagrams to find resultant forces.
* [Higher tier] Understand that a force can be resolved into two components acting at right angles to each other.
 |
| 5.9 | Forces and acceleration | * Explain what happens to the motion of an object when the resultant force is not zero.
* Analyse situations in which a non-zero resultant force is acting.
* Explain what inertia is.
 |
| 5.10  | Required practical: Investigating the acceleration of an object | * Plan an investigation to explore an idea.
* Analyse results to identify patterns and draw conclusions.
* Compare results with scientific theory.
 |
| 5.11 | Newton’s third law | * Identify force pairs.
* Understand and be able to apply Newton’s third law.
 |
| 5.12 | Momentum [higher tier] | * Explain what is meant by momentum.
* Apply ideas about the rate of change of momentum to safety features in cars.
* Use momentum calculations to predict what happens in a collision.
 |
| 5.13 | Keeping safe on the road | * Explain the factors that affect stopping distance.
* Explain the dangers caused by large deceleration.
* Estimate the forces involved in the deceleration of a road vehicle (higher tier).
* Apply the idea of rate of change of momentum to explain safety features (higher tier).
 |
| 5.14 | Moments | * Describe the turning effect of a force about a pivot.
* Explain and use the principle of moments.
* Explain what is meant by the centre of mass of an object.
 |
| 5.15 | Levers and gears | * Describe how levers and gears can be used to transmit the rotational effect of a force.
* Explain how levers and gears transmit forces.
 |
| 5.16 | Pressure in a fluid | * Explain how pressure acts in a fluid.
* Calculate pressure at different depths in a liquid (higher tier).
* Explain what causes upthrust (higher tier).
 |
| 5.17 | Atmospheric pressure | * Show that the atmosphere exerts a high pressure.
* Explain variations in atmospheric pressure with height.
* Describe a simple model of the Earth’s atmosphere and atmospheric pressure.
 |
| 5.18 | Forces and energy in springs | * Explain why you need two forces to stretch a spring.
* Describe the difference between elastic and inelastic deformation.
* Calculate extension, compression and elastic potential energy.
 |
| 5.19  | Required practical: Investigate the relationship between force and the extension of a spring | * Interpret readings to show patterns and trends.
* Interpret graphs to form conclusions.
* Apply the equation for a straight line to the graph.
 |
| 5.20 | Key concept: Forces and acceleration | * Recognise examples of balanced and unbalanced forces.
* Apply ideas about speed and acceleration to explain

sensations of movement.* Apply ideas about inertia and circular motion to explain

braking and cornering. |
| 5.21 | Maths skills: Making estimates of calculations | * Estimate the results of simple calculations.
* Round numbers to make an estimate.
* Calculate order of magnitude.
 |
| TOPIC 6 - WAVES |
| 6.1 | Describing waves | * Describe wave motion.
* Define wavelength and frequency.
* Apply the relationship between wavelength, frequency and wave velocity.
 |
| 6.2 | Transverse and longitudinal waves | * Compare the motion of transverse and longitudinal waves.
* Explain why water waves are transverse waves.
* Explain why sound waves are longitudinal waves.
 |
| 6.3 | Key concept: Transferring energy or information by waves | * To understand that all waves have common properties.
* To understand how waves can be used to carry information.
* To understand various applications of energy transfer by different types of electromagnetic waves.
 |
| 6.4 | Measuring wave speeds | * Explain how the speed of sound in air can be measured.
* Explain how the speed of water ripples can be measured.
* Describe the use of echo sounding.
 |
| 6.5 | Required practical: Measuring the wavelength, frequency and speed of waves in a ripple tank and waves in a solid | * Develop techniques for making observations of waves.
* Select suitable apparatus to measure frequency and wavelength.
* Use data to answer questions.
 |
| 6.6 | Reflection and refraction of waves  | * Describe reflection, transmission and absorption of waves.
* Construct ray diagrams to illustrate reflection.
* Construct ray diagrams to illustrate refraction.
 |
| 6.7  | Required practical: Investigate the reflection of light by different types of surface and the refraction of light by different substances | * Make and record observations of how light is reflected and transmitted at different surfaces.
* Measure angles and discuss the method, apparatus and uncertainty in measurements.
* Draw conclusions from experimental results.
 |
| 6.8 | Sound waves | * Describe how we hear sound and state the range of frequencies we can hear.
* Explain that sound travels faster in a denser medium.
* Explain about reflection, absorption and transmission of sound.
 |
| 6.9 | Exploring ultrasound | * Explain what ultrasound is.
* Describe how ultrasound can be used in industry to investigate or detect hidden or buried objects.
* Explain how ultrasound is used in medicine.
 |
| 6.10 | Seismic waves | * Describe how earthquakes are detected.
* Describe the properties of P waves and S waves.
* Explain how the properties of seismic waves allow us to investigate the inside of the Earth.
 |
| 6.11 | The electromagnetic spectrum | * Recall the similarities and differences between transverse and longitudinal waves.
* Recognise that electromagnetic waves are transverse waves.
* Describe the main groupings and wavelength ranges of the electromagnetic spectrum.
 |
| 6.12 | Reflection, refraction and wave fronts | * Explain reflection and refraction and how these may vary with wavelength.
* Construct ray diagrams to illustrate refraction.
* Use wave front diagrams to explain refraction in terms of the difference in velocity of the waves in different substances.
 |
| 6.13 | Gamma rays and X-rays | * List the properties of gamma rays and X-rays.
* Compare gamma rays and X-rays.
 |
| 6.14 | Ultraviolet and infrared radiation | * Describe the properties of ultraviolet and infrared radiation.
* Describe some uses and hazards of ultraviolet radiation.
* Describe some uses of infrared radiation.
 |
| 6.15  | Required practical: Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface | * Explain reasons for the equipment used to carry out an investigation.
* Explain the rationale for carrying out an investigation.
* Apply ideas from an investigation to a range of practical contexts.
 |
| 6.16 | Microwaves | * List some properties of microwaves.
* Describe how microwaves are used for communications.
 |
| 6.17 | Radio and microwave communication | * Describe how radio waves are used for television and radio communications.
* Describe how microwaves are used in satellite communications.
* Describe the reflection and refraction of radio waves.
 |
| 6.18 | Colour | * Describe what happens when light of different wavelengths lands on an object.
* Explain what determines the colour of an opaque object.
* Explain the effect of coloured filters.
 |
| 6.19 | Lenses | * Understand what a lens does.
* Draw ray diagrams to show the formation of images by lenses.
* Describe the difference between a real and a virtual image.
 |
| 6.20 | Images and magnification | * Draw ray diagrams to show the formation of real and virtual images by lenses.
* Calculate the magnification of an image.
 |
| 6.21 | Emission and absorption of infrared radiation | * Realise that all bodies emit and absorb infrared radiation.
* Compare emission and absorption of radiation from different surfaces.
* Define a perfect black body.
* Explain that the intensity and distribution of wavelengths of any emission depend on the temperature of the body.
 |
| 6.22 | Temperature of the Earth | * Describe how the atmosphere absorbs radiation in a way that varies with wavelength.
* List the factors affecting the temperature of the Earth.
* Explain how the temperature of an object is related to the radiation absorbed and radiation emitted.
 |
| 6.23 | Maths skills: Using and rearranging equations | * Select and apply the equations *T* = 1/*f* and *v* = *f λ*
* Substitute numerical values into equations using appropriate units.
* Change the subject of an equation.
 |
| TOPIC 7 - ELECTROMAGNETS |
| 7.1 | Magnetism and magnetic forces | * Explain what is meant by the poles of a magnet.
* Plot the magnetic field around a bar magnet.
* Describe magnetic materials and induced magnetism.
 |
| 7.2 | Compasses and magnetic fields | * Describe the Earth’s magnetic field.
* Describe the magnetic field of a current.
* Explain the link between current and magnetic field.
 |
| 7.3 | The magnetic effect of a solenoid | * Draw the magnetic field around a conducting wire and a solenoid.
* Describe the force on a wire in a magnetic field.
* Apply the left-hand rule to work out the direction of a magnetic field, a current or a force around a wire.
 |
| 7.4 | Electromagnets in action | * Describe simple uses of electromagnets.
* Explain how an electric bell and relay works.
* Interpret diagrams of other devices that use electromagnets to explain how the devices work.
 |
| 7.5 | Calculating the force on a conductor | * Explain the meaning of magnetic flux density, *B*.
* Know the factors that make a more powerful motor.
* Calculate the force on a current-carrying conductor in a magnetic field.
 |
| 7.6 | Electric motors | * List equipment that uses motors.
* Describe how motors work.
* Describe how to change the speed and direction of rotation of a motor.
 |
| 7.7 | Loudspeakers | * Describe how a moving coil loudspeaker works.
* Link the vibration on a loudspeaker to the properties of the waves it produces.
* Compare loudspeakers and headphones.
 |
| 7.8 | The generator effect | * Describe how the current is induced in a wire when it moves in a magnetic field.
* Identify apparatus needed to demonstrate induced current.
* Identify the factors that affect the size and direction of the induced current or induced potential difference.
 |
| 7.9  | Key concept: The link between electricity and magnetism | * Explore how electricity and magnetism are connected.
* Describe how electromagnetic induction occurs.
* Describe the principle of the electric motor.
 |
| 7.10 | Using the generator effect | * Explain how moving coil microphones use the generator effect.
* Explain how a dynamo generates direct current and an alternator generates alternating current.
* For a dynamo and alternator, draw and interpret graphs of potential difference generated in the coil against time.
 |
| 7.11 | Transformers | * Explain how a transformer both uses and produces alternating current.
* Explain the relationship between the number of turns in the primary coil and the number of turns in the secondary coil.
* Calculate the current that needs to be provided to produce a particular power output.
 |
| 7.12  | Maths skills: Rearranging equations | * Know how to rearrange equations.
* Know how to use the transformer equation.
* Know how to calculate the force on a conductor.
 |
| TOPIC 8 - SPACE |
| 8.1 | The Solar System | * Describe the orbits of planets and moons in the Solar System.
* Distinguish between planets, dwarf planets and moons.
 |
| 8.2 | Orbits of planets, moons and artificial satellites | * Compare the orbital motion of moons, artificial satellites and planets in the Solar System.
* Describe what keeps bodies in orbit around planets and stars.
* Explain how, for circular orbits, an object can have a changing velocity but unchanged speed.
* Explain why bodies must move at a particular speed to stay in orbit at a particular distance.
 |
| 8.3 | The Sun and other stars | * Describe how the Sun and other stars formed.
* Describe the nuclear fusion reactions in the Sun.
 |
| 8.4 | Main sequence of a star | * Describe the main sequence stage of a star’s life cycle.
* Identify the forces that are in equilibrium in a stable star.
 |
| 8.5 | Life cycles of stars | * Describe the life cycles of a star like the Sun and a massive star.
 |
| 8.6 | How the elements are formed | * Understand how new elements are produced by nuclear fusion in stars.
* Recognise that the heavier elements are made in a supernova.
 |
| 8.7 | Red-shift | * Describe red-shift.
* Describe evidence for the expanding Universe.
 |
| 8.8  | Key concept: Gravity: the force that binds the Universe | * Understand that gravity provides the force that keeps planets and satellites in orbits.
* Understand that gravity is necessary at the start of a star’s life cycle and to maintain equilibrium in a stable star.
* Describe how the weight of an object depends on the gravitational field strength.
* Recognise that that there is still much about the universe that is not understood, e.g. dark mass and dark energy.
 |
| 8.9  | Maths skills: Using scale and standard form | * Understand the scale of objects in the Universe.
* Use standard form.
 |