

# Forces and Energy

Core Lesson 1	Option lesson 1a	Option lesson 1b	Option lesson 1c	Option lesson 1d	Core Lesson 2	Option lesson 2a
1 – 1 ¼ hours	20 - 30 minutes	40 – 60 minutes	2 lessons	30 – 40 minutes	20-30 minutes	30 - 40 minutes
Turning forces	Balancing Toys	Making a microbalance	Making a siege engine	Archimedes and his machines	Force interactions	Rocket propulsion
<p><b>Physics Objectives</b> Pupils explore the importance of effort size and effort-pivot distance on the turning effect of forces, moving from a qualitative to a quantitative understanding in the course of their work.</p>	<p><b>Physics Objectives</b></p>	<p><b>Physics Objectives</b></p>	<p><b>Physics Objectives</b></p>	<p><b>Physics Objectives</b></p>	<p><b>Physics Objectives</b> Pupils understand that interacting objects exert forces on each other and that to every action there is an equal and opposite reaction (Newton's 3rd Law of motion). They note that gravitational interactions can act at a distance, unlike contact force interactions</p>	<p><b>Physics Objectives</b></p>
<p><b>Key concepts and processes</b> Pupils use patterns in their results for balancing beams to determine the principle of moments. There are opportunities here to consider experimental error within data.</p>	<p><b>Key concepts and processes</b> Pupils make and investigate simple balancing toys, applying scientific ideas about the turning effect of forces and equilibrium to explain how they work. They communicate their explanations in quantitative terms and using diagrams.</p>	<p><b>Key concepts and processes</b> Pupils make, calibrate and use a simple microbalance. They suggest improvements to the apparatus to increase sensitivity and write a scientific report.</p>	<p><b>Key concepts and processes</b> Pupils make and test a model siege engine, and apply ideas about the turning effect of forces to explain the advantage of the long lever arm. They can test their model to determine the conditions that produce maximum range for projectiles. They adopt scientific report conventions to present their planning, results and conclusions. They appreciate that modern science has its roots in different societies and cultures.</p>	<p><b>Key concepts and processes</b> Pupils investigate the machines invented by the Greek scientist Archimedes. They produce a display to show how one of Archimedes' machines worked.</p>	<p><b>Key concepts and processes</b> Pupils plan and carry out an enquiry into interactions between colliding balls on a track. They communicate their observations and their explanations of the forces acting on each body.</p>	<p><b>Key concepts and processes</b> Pupils build a balloon or water rocket and use the abstract idea of force interactions and unbalanced forces to explain why the rocket accelerates. They analyse numerical data, presenting the data in a graphical format.</p>
<p><b>PLTS</b> - Support conclusions using reasoned arguments and evidence, by using their collected data to calculate moments and derive the principle of moments for a body in equilibrium</p>	<p><b>PLTS</b> - Support conclusions using reasoned arguments and evidence by using ideas about turning forces (i.e. the principle of moments) to explain the model's balancing</p>	<p><b>PLTS</b> - Work towards goals, showing initiative, commitment and perseverance, by patiently constructing the microbalance so that it works correctly</p>	<p><b>PLTS</b> - Try out alternatives or new solutions and follow ideas through by choosing parameters for the siege engines in order to maximise their performance</p>	<p><b>PLTS</b> - Ask questions to extend their thinking by considering how the principles of Archimedes' inventions can be applied to contemporary technologies</p>	<p><b>PLTS</b> - Support conclusions using reasoned arguments and evidence by identifying the bodies on which forces act and the direction of these forces</p>	<p><b>PLTS</b> -</p>
<p><b>Technician's notes</b> Engage: strong wooden plank, brick or wooden block as a pivot Explore: scissors and cards; claw hammers and nails in wood; large masses, planks and pivots (as Engage); spanners of different lengths and nuts for tightening Extend: masses (10g), metre rulers or wooden strips with numbered steps, pivots (e.g. wooden triangular block); or slotted masses, string, balance beams Take care that feet don't get injured by falling weights.</p>					<p><b>Technician's notes</b> Engage: Newton's cradle Explore and Extend: marbles and steel balls or rubber balls, bricks, cardboard to make arrows, scissors, 'conduit' track for balls to roll along; alternatively linear air track kit and vehicles with magnetic bumpers</p>	

**Assessment:** During each lesson each student should assess their own level using the pupil speak level ladders and show their partner where the evidence is for that level. They should record this in the grid at the front of the book. The member of staff should then assess the level of a maximum of 2 students work each lesson. At the end of each lesson there will be an end of topic test to check the content level.

**Homework:** For each topic there is a task booklet that students should use for homework.

Core Lesson 3	Option lesson 3a	Option lesson 3b	Option lesson 3c	Core Lesson 4	Option lesson 4a	Option lesson 4b
1 hour -1 ¼ hours	20 – 30 minutes + independent study	20-30 minutes	20-30 minutes + independent study	1 – 1 ¼ hour	20-30 minutes + independent study	30-40 minutes
Pressure	Physics of diving	Applying Pressure	Hydraulic breaking	Effect of force on speed	Forces for flight	Roller Coaster physics
<b>Physics Objectives</b> Pupils investigate how application of force over larger and smaller areas changes the effect of the force and learn that force/unit area is called pressure. They apply this quantitatively to explain pressure exerted by solids and pressure within liquids and gases.	<b>Physics Objectives</b>	<b>Physics Objectives</b>	<b>Physics Objectives</b>	<b>Physics Objectives</b> Pupils learn that an unbalanced force acting on an object causes acceleration in the direction of the force, changing the object's speed.	<b>Physics Objectives</b>	<b>Physics Objectives</b>
<b>Key concepts and processes</b> Pupils analyse primary data and use the relationship between pressure, force and area to determine practical applications.	<b>Key concepts and processes</b> Pupils carry out a focused research enquiry to investigate the problems for living organisms and ship hulls caused by great pressures at depth and present a report that identifies these problems and how they have been solved by technological innovations.	<b>Key concepts and processes</b> Pupils apply knowledge of forces, pressure and area to design a device to give a maximum or minimum pressure for a given load.	<b>Key concepts and processes</b> Pupils research the application of hydraulics to vehicle braking systems (or other applications of their choice) and present a report on their work, describing the technological applications in terms of the underpinning scientific ideas.	<b>Key concepts and processes</b> Pupils plan and carry out an enquiry into how balls move as they roll down a track.	<b>Key concepts and processes</b> Pupils build paper planes and carry out a fair-test enquiry or competition for the design that flies further or for a longer time. They analyse numerical data, presenting the data in a graphical format. They consider the forces involved in their flight and extend this to consider the flight of powered planes.	<b>Key concepts and processes</b> Pupils build a 'rollercoaster' and describe the forces and speeds at different points, using ideas about the effect of balanced and unbalanced forces on speed (i.e. Newton's first two laws) to account for changes in motion.
<b>PLTS</b> - Support conclusions using reasoned arguments and evidence, by determining from the depth of the tyre tracks the effect of force and area on the pressure exerted	<b>PLTS</b> - Identify questions to answer and problems to resolve by choosing an issue associated with diving, researching this and presenting a report to explain how the issue is resolved	<b>PLTS</b> - Explore issues, events or problems from different perspectives by designing devices to help elderly or disabled people who cannot push as hard as others	<b>PLTS</b> - Identify questions to answer and problems to resolve, by choosing a suitable area to study in relation to the application of hydraulics, and suitable lines of enquiry	<b>PLTS</b> - Support conclusions, using reasoned arguments and evidence, by using force diagrams to explain how unbalanced forces apply in this context	<b>PLTS</b> - Support conclusions using reasoned arguments and evidence by accounting for the motion of a paper plane using the idea of balanced and unbalanced forces	<b>PLTS</b> - Support conclusions using reasoned arguments and evidence by using the idea of unbalanced forces to account for changes in speed
<b>Technician's notes</b> Explore: small wooden cubes or blocks with faces of different areas, Plasticine, 10g and 100g masses bathroom scales calibrated in newtons (if possible), rulers, centimetre or millimetre squared paper, calculators tall can or large clear plastic bottle with small holes made at three different heights to show water flowing under different pressures Take precautions with sharp objects if used to demonstrate the effect of small areas on the pressure!				<b>Technician's notes</b> Engage and Explore: marbles, short lengths of large (15 cm diameter) guttering with raised foam strips fixed across it to create channels for the marbles to roll down and up the curved 'circumference' Explain and Extend: marbles or steel balls of a range of sizes, 2 m lengths of 'conduit track' for balls to roll along (this should be set up with one end raised so that the first metre of the run is 'downhill' and the following metre is level, on a flat surface), tape measures, stopwatches, electronic balance/s, a means of joining track in a rigid way (e.g. 15 cm rulers and masking tape).		
<p><b>Assessment:</b> During each lesson each student should assess their own level using the pupil speak level ladders and show their partner where the evidence is for that level. They should record this in the grid at the front of the book. The member of staff should then assess the level of a maximum of 2 students work each lesson. At the end of each lesson there will be an end of topic test to check the content level.</p> <p><b>Homework:</b> For each topic there is a task booklet that students should use for homework.</p>						

Option lesson 4c	Option lesson 4d	Core Lesson 5	Option lesson 5a	Option lesson 5b	Option lesson 5c	Option lesson 5d
20 – 40 minutes	30 – 40 minutes	1 ¼ - 1 ½ hours	30-40 minutes + independent study	20-30 minutes + independent study	20-30 minutes	30 – 40 minutes
Rolling ball challenge	Investigating more collisions	Transfer of Heat	Sweating to cool down	Heaters and air conditioners	The chimney effect	Boilers and Central heating
<u>Physics Objectives</u>	<u>Physics Objectives</u>	<u>Physics Objectives</u> Pupils study the process of heat transfer by convection, and relate this to models of heat transfer by conduction and radiation.	<u>Physics Objectives</u>	<u>Physics Objectives</u>	<u>Physics Objectives</u>	<u>Physics Objectives</u>
<u>Key concepts and processes</u> Pupils carry out a problem-solving enquiry to plan how they can get a marble to roll at constant speed. They select equipment to measure speed to an appropriate level of precision, comparing speeds at two points to check no acceleration has occurred.	<u>Key concepts and processes</u> Pupils extend the work they began in Core 2, on force interactions, observing collisions between different numbers of balls in different contexts and noting the effect of forces on speed. There is an opportunity for ICT datalogging and quantitative work to make numerical comparisons.	<u>Key concepts and processes</u> Pupils plan and carry out an enquiry into convection, using a homemade spinner. They plan how they will minimise risk.	<u>Key concepts and processes</u> Pupils design and carry out a fair-test enquiry using a model to investigate factors that affect how well sweat cools the body in different conditions. They explain their results using the particle model and scientific diagrams.	<u>Key concepts and processes</u> Pupils select information from secondary sources in order to produce a report explaining how heaters and/or air conditioners work.	<u>Key concepts and processes</u> Pupils investigate and explain the chimney effect, using the particle model and scientific diagrams to communicate their explanation.	<u>Key concepts and processes</u> Pupils investigate how a domestic central heating system works and build a physical model (or animated simulation) to explain it. They assess risk and work safely with hot water.
<b>PLTS</b> - Try out alternatives or new solutions and follow ideas through by testing predictions about the conditions that will make an object travel at constant speed	<b>PLTS</b> - Support conclusions using reasoned arguments and evidence by using the idea of equal and opposite forces during a collision to explain the outcome	<b>PLTS</b> - Anticipate, take and manage risks by planning how to avoid burning themselves and equipment	<b>PLTS</b> - Support conclusions using reasoned arguments and evidence by writing a report with scientifically expressed reasons for the cooling observed in the experiment	<b>PLTS</b> - Identify improvements that would benefit others by suggesting how a heating system with maximum efficiency could replace one that was less effective	<b>PLTS</b> - Communicate their learning in relevant ways for different audiences by using diagrams and appropriate terminology to provide a scientific explanation for the chimney effect	<b>PLTS</b> - Communicate their learning in different ways for different audiences by presenting a model, diagram and text to support their explanation of a central heating system.
		<b>Technician's notes</b> Explore: candles, matches Explain: convection demonstrations - smoke box (chimney) apparatus or potassium permanganate crystal, forceps to pick up, beaker, Bunsen burner, tripod, gauze Extend: scissors, candles, meths burners, beakers (250 ml), Bunsen burners, tripods, gauze, heatproof mats Make pupils aware of the risk of burnt fingers. Ensure that ice packs and/or access to running water is available in case pupils burn their fingers.				
<b>Assessment:</b> During each lesson each student should assess their own level using the pupil speak level ladders and show their partner where the evidence is for that level. They should record this in the grid at the front of the book. The member of staff should then assess the level of a maximum of 2 students work each lesson. At the end of each lesson there will be an end of topic test to check the content level.						
<b>Homework:</b> For each topic there is a task booklet that students should use for homework.						

Option lesson 5e	Core lesson 6	Option lesson 6a
30 – 40 minutes	1 – 1 ¼ hours	30-40 minutes + independent study
Which freezes or melts the quickest?	Reducing energy loss	Eco homes
<b><u>Physics Objectives</u></b>	<b><u>Physics Objectives</u></b> Pupils consolidate understanding of the three methods of heat transfer and investigate how these can be reduced. They understand that energy is conserved in transfers but that energy transferred to the surroundings can be 'wasted'.	<b><u>Physics Objectives</u></b>
<b><u>Key concepts and processes</u></b> Pupils investigate the freezing of water at different temperatures to see which freezes first, and the melting of ice cubes in different volumes of water as the water is heated. They make predictions and when provided with evidence, suggest and take into account other factors or scientific ideas that could help explain the phenomenon. They appreciate that there are some questions that the scientific process cannot yet completely answer but can contribute to.	<b><u>Key concepts and processes</u></b> Pupils plan and carry out a fair-testing enquiry comparing temperature change in containers with and without lids or in vacuum flasks and consider whether the data they have collected allows valid comparisons and is sufficient for the conclusions they have drawn.	<b><u>Key concepts and processes</u></b> Pupils research the various features of eco-homes, selecting and evaluating data and information from a range of sources, and prepare a report explaining the scientific basis of features that reduce energy loss. They relate dissipation of energy during energy transfer to applications that save money as well as conserve limited (nonrenewable) energy resources, and consider quantitative measures of energy transfer as an aid to informed decision making.
<b>PLTS</b> - Support conclusions, using reasoned arguments and evidence by making reasoned predictions and supporting conclusions with scientifically expressed reasons	<b>PLTS</b> - Analyse and evaluate information, judging its relevance and value by evaluating the primary data to decide whether using lids on hot drinks makes a difference	<b>PLTS</b> - Consider the influence of circumstances, beliefs and feelings on decisions and events by describing how homeowners come to decisions about how to make their homes more environmentally friendly