Forces and Energy

Core Lesson 1	Option lesson 1a	Core Lesson 2	Option lesson 2a	Option lesson 1d	Core Lesson 3	Option lesson 3a
20-30 minutes	30 - 40 minutes	1 hour -1 ¼ hours	20 – 30 minutes + independent study	20-30 minutes + independent study	1 – 1 ¼ hour	30-40 minutes
Force interactions	Rocket propulsion	Pressure	Physics of diving	Hydraulic breaking	Effect of force on speed	Roller Coaster physics
Physics Objectives 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	**Physics Objectives**	**Physics Objectives** 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.	**Physics Objectives**	**Physics Objectives**	**Physics Objectives** Pupils learn that an unbalanced force acting on an object causes acceleration in the direction of the force, changing the object's speed.	**Physics Objectives**
Key concepts and processes 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.	**Key concepts and processes** 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.	**Key concepts and processes** Pupils analyse primary data and use the relationship between pressure, force and area to determine practical applications.	**Key concepts and processes** 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.	**Key concepts and processes** 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.	**Key concepts and processes** Pupils plan and carry out an enquiry into how balls move as they roll down a track.	**Key concepts and processes** 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.
PLTS - Support conclusions using reasoned arguments and evidence by identifying the bodies on which forces act and the direction of these forces	**PLTS** - Anticipate, take and manage risks, by explaining how to take action to ensure the rocket launch is carried out safely	**PLTS** - 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	**PLTS** - 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	**PLTS** - 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	**PLTS** - Support conclusions, using reasoned arguments and evidence, by using force diagrams to explain how unbalanced forces apply in this context	**PLTS** - Support conclusions using reasoned arguments and evidence by using the idea of unbalanced forces to account for changes in speed
Technician's notes 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		**Technician's notes** 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!	.		**Technician's notes** 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).	

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.

Option lesson 3b	Core Lesson 4	Option lesson 4a	Option lesson 4b	Core Lesson 5	Option lesson 5a	Option lesson 5b
20 – 40 minutes	1 - ¼ hours	30 – 40 minutes	20 – 30 minutes	1 ¼ - 1 ¾ hours	20-30 minutes + independent study	30 – 40 minutes
Rolling ball challenge	Studying motion	Comparing running and walking	Calculating speeds in context	Falling objects	Gravity on other planets and the moon	The oscillating spring
Physics Objectives	**Physics Objectives** Pupils calculate the average speeds of trolleys on ramps, using average speed = distance travelled/time taken	**Physics Objectives**	**Physics Objectives**	**Physics Objectives** Pupils appreciate that a mass experiences a force (weight) due to an attraction between it and the earth. They investigate simple pendulums, considering the motion of the pendulum as it swings downwards and upwards, accelerating and decelerating due to gravity	**Physics Objectives**	**Physics Objectives**
Key concepts and processes 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.	**Key concepts and processes** Pupils carry out an investigation into the average speeds of trolleys down ramps of different elevation and plot graphs of their results.	**Key concepts and processes** Pupils calculate and compare their running and walking speeds, and also select data from secondary sources to obtain and record sufficient data systematically. They analyse the data to see if there are patterns or relationships, for example between preferred walking speed and sprint speed, and the effect of age on preferred walking speed or sprint speed.	**Key concepts and processes** Pupils complete a range of calculations, developing the ability to calculate speeds and interpret a context, selecting the information needed in order to find the answer.	**Key concepts and processes** Pupils identify variables and set up enquiry questions to determine haw a pendulum's swing time is affected by mass, length and displacement. They plot graphs with best fit lines and use interpolation and extrapolation to make predictions. They link the validity of their conclusion with the reliability of the data collected.	**Key concepts and processes** Pupils collect information on the gravitational forces of different planets and asteroids in the solar system, and assemble this information in a form that allows them to compare how weight is different on other planets, and use this to recommend a plan for human colonisation. In their report they describe and use the relationship between mass and weight. They recognise that gravitational attraction is greater for larger objects like the Earth compared with smaller objects like the Moon, and that the force gets smaller the further an object moves away from the Earth's surface.	**Key concepts and processes** Pupils investigate how a spring oscillates, in a similar way to the pendulum experiment in Core 5. They identify key variables and choose an appropriate range, number and values for the independent variable. They analyse and interpret the numerical data, suggesting reasons for their results.
PLTS - 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	**PLTS** – Collaborate with others to work towards common goals, by working in pairs or small groups to co-ordinate data collection.	**PLTS** - Plan and carry out research, appreciating the consequences of decisions, by deciding what information they will need to compare human speeds and taking the appropriate steps to collect it	**PLTS** - Review progress, acting on the outcomes, by assessing how well they are able to interpret the data to compare speeds, or to go further and calculate speeds	**PLTS** – Ask questions to extend their thinking, by speculating howa pendulum's swing time would change if the strength of gravity changed.	**PLTS** - Plan and carry out research, appreciating the consequences of decisions, by deciding which factors will be most significant (from their research) in determining the best new home for the human race	**PLTS** - Support conclusions using reasoned arguments and evidence, by explaining the change in motion of the oscillating spring with an account of the forces acting at key points in its journey
	Technician's notes Ramps, trolleys, light gates and data logging kit, metre rulers, stopwatches.			**Technician's notes** Clamp stands, string or cotton thread, scissors, split cork, plasticine, stopwatches		

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Core Lesson 6	Option lesson 6a	Core Lesson 7	Option lesson 7a	Core Lesson 8	Option lesson 8a	Option lesson 8b
1 ¼ - 1 ¾ hours	30 – 40 minutes	1 ¼ hours	20-30 minutes + independent study	! – 1 ¼ hours + independent study	20-30 minutes + independent study	30 – 40 minutes
Streamlining	Parachutes	Energy efficiency	Eco-appliances	Energy for electricity	Electric cars	The energy debate
Physics Objectives Pupils investigate streamlining, considering how changing the resistance a moving body experiences might affect its speed	**Physics Objectives**	**Physics Objectives** Pupils identify the energy transfers associated with a range of devices and calculate their efficiency. They understand that while the total amount of energy is conserved some is dissipated and the transfer becomes less efficient. They use quantitative measures of energy transfer to inform decisions about the sustainable use of energy resources.	**Physics Objectives**	**Physics Objectives** Pupils investigate energy transfers in different systems for generating electricity. They study in depth one electrical generation method and compare this with other technologies.	**Physics Objectives**	**Physics Objectives**
Key concepts and processes Pupils draw valid conclusions from the descent times the yobtain in their streamlining enquiry, deciding how the evidence supports their ideas about the most streamlined shape	**Key concepts and processes** Pupils make and test parachutes, comparing the loading and the shapes and sizes used to increase air resistance for the purpose of slowing descent. This enquiry could be a simple fair-testing project, or it could involve a problem-solving element for example, where an egg must descend for 2m to the floor in a 'parachute craft' and resources are restricted to a sheet of A4 paper, one polythene bag and a reel of cotton.	**Key concepts and processes** Pupils communicate their findings about energy transfers and efficiency, calculating and presenting their results in a percentage efficiency format, and using Sankey diagrams to display their results.	**Key concepts and processes** Pupils research the energy efficiency of kitchen appliances or low wattage replacement (energy saving) light bulbs. They use quantitative criteria to support an informed recommendation about which appliance to use.	**Key concepts and processes** Pupils describe the advantages and disadvantages of each system against the criteria such as cost, sustainability, efficiency, effect on the environment and reliability; they balance these to communicate, possibly using IT, an argument for or against a particular technology.	**Key concepts and processes** Pupils find out about the current 'state of play' in the development of electric cars, together with a consideration of possible future stages. They identify advantages and disadvantages.	**Key concepts and processes** Following on from issues raised in Core 2 about the sustainability of fuel resources and the need to find alternatives to limited oil, coal and gas supplies, this enquiry offers pupils a further opportunity to research the issues around energy sources for generating electricity and to present their findings and recommendations.
PLTS – Support conclusions, using reasoned arguments and evidence, by using their results to identify a rank order for their 3-D shapes in terms of their streamlining.	**PLTS** - Generate ideas and explore possibilities, by choosing the feature of their parachute they will alter and testing the effect of changing this	**PLTS** – Communicate their learning in relevant ways for different audiences, e.g. using percentage figures, bar charts or Sankey diagrams to show the efficiency of an individual device.	**PLTS** - Communicate their learning in relevant ways for different audiences, by including in their report key technical elements (efficiency, energy and cost) and a recommendation	**PLTS** – Question their own and others' assumptions, by exploring the evidence carefully to come up with an informed opinion, e.g. for example whether nuclear power is a good or a bad thing.	**PLTS** - Analyse and evaluate information, judging its relevance and value, by using information from the model cars and websites to inform a considered report on the current situation regarding electric vehicles	**PLTS** - Discuss issues of concern, seeking resolution where needed, by considering the sources of energy for generating electricity in terms of future solutions that meet our needs while preserving the planet
Technician's notes **Clear viscous liquid, e.g. dilute wallpaper paste, syrup, oil, glycerol: tall measuring cylinder, clamp stands, plasticine to make shapes, ball bearings, metre ruler, light gates and a large magnet.**	**Technician's notes**	**Technician's notes** **Hair-dryer, kettle, battery-powered car, radio, mp3 player, mobile phone, table lamp, normal light bulb, energy efficient light bulb, squared paper, scissors.**		**Technician's notes** Model steam engine, toy windmill, bicycle dynamo, solar powered car. Internet access		

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

Core lesson 9	Option lesson 9a	Option lesson 9b	Core lesson 10	Core lesson 11	Option lesson 11a	Option lesson 11b
1 – 1 ¼ hours	20-30 minutes + independent study	1 – 1 ½ hours	1 – 1 ½ hours	1 ¼ - 2 hours	1 – 1 ½ hours	20 – 40 minutes
Asteroids and comets	Comet study	Making craters	Ideas about the solar system	Space exploration	Exploring the Universe	Science stories: fact or fiction?
Physics Objectives Pupils learn about the nature of asteroids and comets, determining their similarities in orbits and composition. They learn that gravity determines the motion of all the bodies in the solar system.	**Physics Objectives**	**Physics Objectives**	**Physics Objectives** Pupils learn how Newton's insights about the gravity explain the motion of bodies in the solar system around the Sun	**Physics Objectives** Pupils learn about key discoveries provided by space exploration and the methods employed by astronomers and space researchers.	**Physics Objectives**	**Physics Objectives**
Key concepts and processes Pupils draw to scale the orbits of the planets and some of the short period comets, using a model and secondary data to plot elliptical orbits.	**Key concepts and processes** Pupils research comets, focusing on a particular comet and its scientific and cultural significance. They appreciate how a lack of data meant that comets were initially perceived as atmospheric, not celestial objects, and how data from telescopes and actual encounters with comets is providing more evidence about cometary orbits, origin and composition.	**Key concepts and processes** Pupils simulate the effect of meteorites bombarding the surface of the Moon or other rocky solar system bodies, by dropping marbles into trays of powder.	**Key concepts and processes** Pupils consider how different ideas about the solar system have held sway at different times in history and evaluate these ideas against observational evidence of the movement of bodies in the solar system. They explain the contributions of key scientists, e.g. Copernicus, Brahe, Keler, Galileo, Newton and Einstein, to current understanding about the solar system.	**Key concepts and processes** Pupils develop and refine their research skills, carefully selecting sources and the information they need to summarise developments in their chosen area of exploration, and the applications or implications of these developments.	**Key concepts and processes** Pupils identify a topic of interest in the Universe. They use secondary sources to research a question about this topic and produce a report or presentation explaining the topic for a younger audience. They appreciate that there are some questions about the Universe that the scientific process cannot yet completely answer but can begin to address, through astronomical observations and collaboration by scientists from the fields of theoretical physics, biology and earth and planetary science.	**Key concepts and processes** Pupils read two science fiction stories about space exploration and comment on these from a scientist's point of view.
PLTS – Collaborate with others to work towards common goals, by working in a team to plot the scale model elliptical orbits.	**PLTS** - Explore issues, events or problems from different perspectives by finding out about comet events from both scientific and historical perspectives	**PLTS** - Support conclusions, using reasoned arguments and evidence, by making clear links between the size of craters and the mass and speed of impacting objects	**PLTS –** Communicate their learning in relevant ways for different audiences by ensuring that new terminology is properly explained.	**PLTS –** Consider the influence of circumstances, beliefs and feelings on decisions and events, by considering a range of views on space exploration, including how people perceive costs and benefits.	**PLTS** - Identify questions to answer and problems to resolve, by deciding on a topic to research based on a pre-research task that helps to raise further questions	**PLTS** - Question their own and others' assumptions, by exploring the feasibility and scientific plausibility of the author's claims in the stories they read
Technician's notes String, cork, several pieces of chalk, string, 2 broom handles, tape measure						