Cedar, Cherry, Rowan
Fascinating Forces

Lesson	IPC Learning Goal	NC Coverage	Activities	Resources / Vocabulary / Personal Goals
Entry Point	Activity 1 (All 3 classes could go onto the field and have competitions?) Start the units by playing tug-of-war games. Begin with small groups of children and then have a whole class tug-of-war. Add to the fun by challenging other classes to a competition or you could form mixed teams with a spread of different ages (and, therefore, strengths). Create team names and invite other classes in the school to cheer the teams on. Take the opportunity to get the whole school involved and working on this together. Discuss tactics: Should smaller/bigger children go at the front or the back? How long should the rope be? Is it easier with a shorter or longer rope? A force that we call 'friction' played a key part in the tug-of-war game. Find out what the children know about how friction helped them in the tug-of-war. When two rough/bumpy surfaces meet a force called friction stops them from moving over each other. Friction on the rope stopped it from slipping through our fingers and friction on the ground stopped us from being pulled over. Ask the children what difference they think it might have made to the game had they worn gloves or different footwear.			Ropes
Knowledge Harvest	Activity 1 Give groups of children a big piece of paper and ask them to draw examples of pushes and pulls on the paper. Ask them to indicate with an arrow the direction of each force. Encourage the children to come up with as many ideas as possible, for example: (LA could sort these phrases) **Push** Pushing the pedals on a bicycle Pushing someone on a swing Kicking a ball into a net Hitting a ball with a bat Pushing a pram Pushing a car that won't start **Pull** A dog pulling on a lead Towing a broken-down car A tug boat pulling a ship Pulling a drawer or door to open it Pulling up on to a climbing frame Pulling on a rope			Sentences to sort: LA

	Find out what the children know about the following forces: Gravity Friction Air resistance Water resistance Activity 2 Write questions for the learning wall/display – What do you want to find out about forces?			
Big Picture	A force is a 'push' or a 'pull' or a combination of them. These pushes and pulls create movement and changes of speed or direction; they can also stop movement. We cannot actually see a force, but we can experience its effects or results. The greater the force, the greater effect it has. Forces act in opposition to one another. If one force is greater than another, an object will move in that direction. Forces include gravity, friction, magnetic and electrical forces. Forces can be measured in 'Newtons' (N) using a force meter. Newton devised three laws of motion which form the basis of theories of movement. Newton's First Law - An object at rest will remain at rest unless an outside force acts on it. If an object is moving, it will continue to move in a straight line at the same speed until an outside force acts on it. Newton's Second Law - A force acting on an object causes it to accelerate in the direction of the force; the amount of acceleration depends upon the size of the force and the mass of the object. Newton's Third Law - For every action there is an equal and opposite reaction. Meaning that for every force there is a reaction force that is equal in size, but opposite in direction. Whenever an object pushes another object it gets pushed back in the opposite direction equally hard.			
Science 1	Understand the importance of using evidence to test scientific ideas	Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.	In this first task, we will be investigating the effects of gravity and air resistance on moving objects. Set up a target on the school playing field and ask the children to hit the target with a variety of balls of different sizes and weights. Ask the children to consider the following questions: Do you need to throw with more or less force to hit the target with a heavier ball? Do you need to throw with more or less force to hit the target with a smaller-sized ball? Now you could ask the children to compare the flight of a ball and a Frisbee by throwing each at the target. Observe what happens. Did they both reach the target? What forces were acting on the ball and the Frisbee? (i.e. gravity and air resistance) Is the difference in their shape and weight significant? How and why? Compare the surface area of the Frisbee and the ball – does this explain any differences in performance? (See Mathematics link below.) The Frisbee has a thin pointed edge that helps it to slice a path through the air but it also has a large surface area underneath that provides an 'uplift', lifting the Frisbee in the air so that it appears to be floating.	Balls Frisbees

			Video-record the children's research so that, back in the classroom, they can replay the action and draw flight paths for the ball and the Frisbee. They should identify and label the forces that act on each object as it travels through the air, i.e. air resistance and gravity. Draw directional arrows to indicate the direction in which the forces are pulling or pushing. How significant is the shape and weight of the ball and the Frisbee? Relate the findings to the children's everyday lives and encourage them to make connections, e.g. refer to the sports the children play in school where they throw objects of different shapes and weights at a target, e.g. javelin, netball, basketball. Compare their different shapes, weights and flight paths. The children could add their findings and conclusions to the knowledge harvest.	
Science 2	Be able to conduct scientific investigations posing scientific questions.	Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.	In this next task, we will be exploring air resistance and gravity in more detail by investigating and comparing the speed of falling objects. In advance of the lesson, you could ask the children to source objects from home that they could test, e.g. a feather, shuttlecock, paper circle, crayon, marble, table tennis ball, golf ball, football – objects of different weights and shapes. Ask them to select two objects and drop them both at the same time from the same height. Which will hit the ground first? Encourage the children to make hypotheses and predictions, and then carry out a test to see if they are correct. They may be surprised to find that most objects they test will fall to the ground at the same speed. How is this possible? Now explore objects of the same weight but different shapes. Activity Give the children two identical sheets of A4 paper: tell them to scrunch one sheet into a ball but leave the other sheet flat. When they drop both at the same time, what happens? The scrunched-up paper falls to the ground first. Why? Less air resistance acts on the ball of paper so it falls faster, but more air resistance acts on the flat sheet of paper (it has a bigger surface area) so this falls at a slower speed. Ask the children to consider the pairs of objects they tested originally and see if they can modify one of them so that their test is fair. The table below could help the children to organise their investigations. schoolsworld.tv/node/2990 – SchoolsWorld TV has this video that demonstrates air resistance by using homemade parachutes and eggs. youtube.com/watch?v=O-KYLXp2MG4 – YouTube has this video from Howcast.com that explains how air resistance acts on sheets of falling paper. This video supports advertising.	Objects to test: ball, feather, stone, pen, paper, etc

Science 3	Be able to identify the direction of forces.	Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.	Now let's look at the air around objects and what happens when air moves. Divide the class into two groups. Each group should carry out one of the following investigations: Take a short strip of writing paper and blow over the top of it – why does the paper lift? Place a sheet of A4 paper to make a 'bridge' between two books on the desk (see diagram p33). Blow underneath the paper. Why does the paper bridge drop down? See p33 The children should be able to draw annotated diagrams to explain their research with directional arrows to label the forces: air pressure, air resistance, gravity and uplift. Longer arrows should be used to show a stronger force and shorter arrows to indicate a smaller force. Try to relate the children's research findings to their everyday lives and experiences. Ask them: How can a heavy aircraft stay in the air? Why doesn't air resistance and gravity pull it down? What have we learned that will help us to explain this? Encourage the children to find an explanation using their own words, e.g. they might say that an aircraft uses its engines to push it along the runway until the lift it achieves overcomes its weight and it can fly.	Paper P33
Science 4 Links to Maths	Be able to measure forces.	Taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.	How strong is gravity and can we measure it? Gravity is everywhere in our world and in the wider Universe – it is the reason why things fall or roll. It is a force that pulls us and everything else down to the ground. We can measure this force as the 'weight' of an object. Gravity pulls on objects. The weight of an object is a measure of the pull of gravity on it. The greater the pull of gravity, the more an object weighs. The following video provides a useful starting point for a discussion about mass, weight and gravity: youtube.com/watch?v=1whMAIGNq7E – YouTube has this fun song that explains the difference between mass and weight. Now ask the children to use a force meter to measure the pull of gravity on different objects (masses). Discuss how they could do this using a fair test, e.g. if they place objects in a bag and weigh them using the force meter then the weight of the bag must be the same each time. Record the mass in grams and the weight in Newtons of a variety of objects. The children could record their results in a line graph. See p37	Force meters

Science 5	Know that the study of science is concerned with investigating and understanding the animate and inanimate world around them.	Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object.	Challenge the children, in groups, to find out the answers to these three questions about gravity in space: What does 'weightlessness' mean? How does weightlessness affect moving objects? Why would we all lose weight on the Moon? exploratorium.edu/ronh/weight/index.html – Exploratorium website allows you to check your weight on other planets. teacher.scholastic.com/activities/explorations/space/level1/MoonOlympics.htm – Scholastic website has an animation about playing sport on the Moon – what would it be like? **Activity** Encourage the children to record the findings of their research in a variety of ways, as they prefer. They might want to create classroom displays or posters, annotated diagrams, computer animations or cartoons Mathematics link: ask the children to work out the answer to this gravity puzzle: if you weighed 42 kilograms on Earth what would you weigh on the Moon? (7 kilograms) You would weigh six times less on the Moon than you do on Earth because the pull of gravity on the Moon is six times less than on Earth. To put it another way, we could say that because the Moon is smaller than the Earth so its gravitational pull is less.	Laptops
Science 6	Be able to record and communicate their findings accurately using the most appropriate medium and the appropriate scientific vocabulary and conventions.	Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.	In this next task, we are going to investigate and measure the weight of objects in water. Ask the children, in their groups, to tie a length of string around a large stone (or put it in a net) and pull it along the floor. They should use a force meter to measure the force of the pull. What forces make the stone hard to pull? (friction and gravity) Hang the stone from a force meter. How much does it weigh? Now lower the stone into a bucket of water, but hide the scale reading with your hand. Ask the children if they think the stone will weigh more or less in the water; and then to explain their reasoning. Check the result. How much does the stone weigh when suspended in the water? What has happened? How much does the water push up? The push (or force) of the water upwards (upthrust) is the same as the weight of the water that is pushed out of place by the stone. The children should use the force meter to measure different masses in and out of the water. Is there a pattern in the results? The objects will weigh less in the water than in the air.	Force meters Stones Buckets Water

			The children could draw labelled diagrams to show how they carried out their investigation and present the details of their findings, including the measurements they recorded, in tables and graphs. They should be able to name the forces acting on the stone: gravity and 'upthrust'. They should know what is meant by 'displacement', i.e. water pushed out of the way by the stone is displaced.	
Science 7	Be able to identify the direction of forces.	Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.	We know that water 'pushes up' on floating objects (recall Task 7) but can it also slow objects down? Has anyone ever tried to run in a swimming pool? What does it feel like? Is it difficult or easy? Why? The water pushes back against your legs and slows you down. This is called 'water resistance' (or 'drag'). Do we feel water resistance when we swim? How do we minimise water resistance (think of our shape and movements in the water). Talk about competitive swimmers or divers and the design of their swimming costumes and caps. Think about the shape of boats, submarines, dolphins, sharks and otters, etc. Their pointed streamlined shapes help them 'cut through' the water more easily and reduce drag. Ask the children to tell you about the different swimming strokes they can perform. Draw and name them, e.g. breaststroke, backstroke, front crawl (freestyle), etc. Which of these movements are pushes and which are pulls? Can any of the children float on the water? Can they explain how they do this? When we float the force of the water pushing us up is the same as the force of our body pushing down. When the water pushes up this is called 'upthrust'. Try this experiment with the children: fill a bowl or sink with water. Push an empty plastic drinks bottle (with the top on) under the water. Can you feel the force of the water pushing against the bottle? What happens if you let go of the bottle? It pushes back up because the upward force of the water is greater than the weight of the bottle. What happens if you unscrew the top and fill the bottle halfway/three-quarters full/full to the top? Will the bottle stay under the water this time? Predict what you think will happen. The children should draw labelled pictures or make videos to show what they did in their experiment above and what their findings were. They should be able draw directional arrows to show the forces acting on the bottle, including upthrust.	Plastic bottle with lid Bucket Water
Science 8	Understand the importance of using evidence to test scientific idea.	Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.	We all know that some objects will float in water while other objects will sink. But do we know why? Ask the children for their suggestions and hypotheses. Now ask the children to sort a variety of objects (e.g. tennis ball, stone, apple, potato, paper clip, pencil, coin, ball of clay, block of wood, etc.) into two groups	Buckets Water Objects for testing: Tennis ball

			– those that they predict will float and those that will sink. The children should be able to justify their predictions. Invite the children to test the objects and relate the outcomes to their predictions. Can they explain their findings? Through their explanations, the children should be trying to answer these questions: Does the shape of an object make a difference? Does the weight of an object make a difference? Do small objects float more easily than large ones? Does the volume of water make a difference? More of the big picture: Objects that have a high density compared to their size will sink. Objects with a lower density for their size will float. Water weighs one gram per cubic centimetre so if an object has a density greater than one it will sink in water. An object with a density less than one will float in water. Record findings in a table: see p51 ***Introduce the term 'density' and discuss what this means. For example, an empty plastic bottle has a low density; if we fill it with sand its density increases but its size stays the same. Put an empty plastic bottle in water– does it float? Put a plastic bottle filled with sand in water – does it float? The plastic bottle filled with sand will sink because it has a density higher than water.***	Bottle Pencil Scissors Spoon
Science 9	Be able to choose an appropriate way to investigate a scientific issue.	Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.	Recall the previous task then pose the following question to the class: in determining whether an object floats or sinks which is more important – the weight of the object or its shape? Invite the children to share their ideas and form hypotheses. Give each group of children a ball of clay. Instruct them to roll the clay into a ball shape and ask them: will it float or sink in water? Encourage the children to make predictions first, then drop the clay into a bowl of water and watch what happens. Does it sink? Why? Because it is heavier than the water around it – refer to Task 9. Now challenge the children to mould the clay into a shape that will float in water. This can be quite tricky! You could turn this into a competition for the children to make it more exciting. Tip: make a thin, flat saucer shape then curl up the edges so that your boat doesn't take in water. The children should know that the density and the shape of an object will determine whether it floats or sinks in water. When you mould the clay into a boat shape more water is pushed out of the way (displaced) – you can see this because the level of the water rises. The clay weighs the same as before (when	Clay Bucket Water

			it was a ball shape) but now it displaces more water and its weight is equal to the weight of water displaced and so it floats. This is what the Greek mathematician and scientist Archimedes found when he was taking a bath and shouted "Eureka!" Record what they did.	
Technology 1	Be able to test and evaluate their own work and improve on it.	Show that I can test and evaluate my products.	Divide the children into two groups: one group could design and make a sailing boat while the other group could make a flying paper plane. You could add an element of competition or a challenge, for example: Whose boat will carry the most cargo? Can you add a mast and sail to your boat? Whose paper plane will fly the furthest? Can you design a plane that will fly to the left or right, or loop-the-loop? Test them and record what they did.	Paper Tubs Plasticene
International 1	Know about the key features related to the lives of people in their home country and, where appropriate, their parents' home countries.		Countries around the world use the natural forces of the wind, water and waves to provide energy and power supplies for people and industry. Help the children to find out about the following: Wind energy – wind turbines constructed off-shore and inland can provide electricity for nearby towns Wave energy – the powerful force of the waves can be used to drive turbines and provide electricity Falling water – hydro-electric power stations use falling water from dams to produce electricity Research some examples from the children's host and home countries where natural forces are being harnessed to provide energy supplies for people and industry. kids.esdb.bg/newenergy.html – Kids ESD website has information for children about energy sources. planete-energies.com/en/energy-sources-/water-78.html – Planete-energies website has information and videos about renewable energy sources. fwee.org/nw-hydro-tours/walk-through-a-hydroelectric-project/ – Foundation for Water and Energy Education website features a tour of a hydro-electric power station. Collect together information and pictures to illustrate how different countries around the world use natural forces to provide energy supplies.	iPads
Exit Point			The parents can be invited in for the children to share their scientific findings. They can show demonstrations of the different experiments.	
Reflection				