National Curriculum Objectives:
(Statutory Requirements)

a) Explain that unsupported objects fall towards Earth because of the force of gravity acting between the Earth and the falling object.
b) Identify the effects of air resistance, water resistance and friction, that act between moving surfaces
c) Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Experimental and investigative work focuses on:

Planning an investigation:	**Obtaining and evaluating evidence:**
1. Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.	2. Taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate. 3. Recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs. 4. Using test results to make predictions to set up further comparative and fair tests. 5. Reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations. 6. Identifying scientific evidence that has been used to support or refute ideas or arguments.

Most children will:

- **Identify** that weight is a force and **recognise** a force is measured in newtons
- **Describe** some situations in which there is more than one force acting on the object
- Draw diagrams to illustrate forces acting on an object and the directions in which the forces act
- Use a forcemeter accurately to measure forces
- Present measurements in simple line graphs and **identify** patterns in these
- Evaluate **explanations**

Some will progress less and will:

- Identify weight as a force
- To recognise that more than one force can act on an object
- Measure forces using a forcemeter
- Present measurements in tables

Others will progress further and will also:

- Describe and explain the motion of some familiar objects in terms of several forces acting on them
- Accurately estimate the size of a force in newtons

Key vocabulary:

Previously taught:
Push, pull, twist, direction, distance, force, friction, air resistance, water resistance, force meter, newton, and surface area.

New:

Session	Learning Objectives	Introduction	Main activity	Application and review	Resources
1	**To understand that gravity is a force that pulls unsupported objects towards the centre of the Earth.** **Assessment : a**	**Teaching the knowledge** Ask: *'What is a force?'* Take suggestions to assess current understanding based on previous years, record all suggestions. Encourage the children to think about everyday examples of forces in action. They can start something moving, stop something moving, speed something up, slow it down, change the direction of something or even change its shape! Everything that moves has had a force applied to it; even objects that aren't moving are still under the action of forces! At arm's length hold a small object. *What will happen if I let go?* *It will fall to the floor! Why?* (chn record ideas on wbs/sheets of paper) The force of **gravity** – demonstrate to prove it!! *What is gravity?* Gravity is the natural phenomenon by which objects attract each other with a force (the size of the force of attraction depends on: the masses involved – the bigger the masses the greater the force; and the distance between them - the greater the distance the smaller the force). The attractive force of gravity acts between the centres of two objects. Use link but stop at the picture of the world and the girl with the apple. http://www.askaboutireland.ie/learning	**Teaching the understanding** Show chn the first picture of the girl standing on top of the earth and ask which way they think the apple will fall and why.(show the chn the use of arrows to show the direction of a force) Provide chn with a picture of the Earth marked with A at the top, B at the right and C at the bottom. Ask the chn children to draw people holding an apple at each of these points (North pole, China and South America) and then to show the direction the apple will fall and explain why. ***The apple falls…. because….*** Discuss what they have drawn and demonstrate by sticking figures onto a globe. Reinforce that for people standing on the Earth's surface, the effect of gravity is to attract us towards the centre of the Earth. As a result, no matter where you stand on the Earth, you don't fall off. (flipchart p7) Children to record a definition of gravity. Gravity is different on the moon- How would it be different if you jumped on the moon? (Ideas? Time to discuss). Amount of gravity is different according to the size of the planet. Define the difference between weight and mass Record key words- gravity, mass, force, newtons, weight Chn to write sentence starters Gravity is…(force making things fall to the earth/ pull of the Earth Weight is…(the pull of gravity) Mass is… (how much matter it contains)	Tell the children that with all these forces in action (remember we can't always see them - only the effect of them!) it is important they know how to measure them. Show the children a force meter Now hang a bag containing an object from the force/newton meter at arm's length. What do the children notice now? – *The bag hangs in the air.* The measure in newtons (N) shown on the scale on the force meter is the force needed to hold the object up (its weight, not its mass!) which is equal to the force pulling it down. Give the chn a short opportunity to measure the weight of some objects. Discuss what the readings mean in terms of the weight of the object. Assessment cues: • Do the children know that gravity is a pulling force that occurs on Earth? • Do the chn recognise that weight is a force and it is measured in newtons?	Picture of earth Blutack Globe Lego figures Force meters Bags

		-zone/primary-students/5th-+-6th-class/science/gravity/introduction/index.xml			
Session	Learning Objectives	Introduction	Main activity	Application and review	Resources
2	**To be able to measure and estimate forces** **Assessment : a, 2**	**Teaching the understanding:** Remind the children that weight is a force. The measure in newtons (N) shown on the scale on the force meter is the force needed to hold the object up (its weight, not its mass!) which is equal to the force pulling it down. Draw this on the board demonstrating how to use arrows to show in which direction the forces are pulling. Look at mass (g) and weight (n) on a force meter (through the easy view). Can they relate one measurement to the other? Look at the different scales on the force meters. How many newtons will we need to pick up a … The children could estimate the amount of newtons required to pick up a selection of objects. They then must select an appropriate force meter and measure how many newtons were actually needed.	Allow the children to measure the force acting on different common classroom objects by hanging them in a plastic bag from a force meter. Ask the children to draw one object being measured complete with arrows and record the force acting on other objects in a simple table (Use template or draw their own). Compare results, what do they show? Place some of the commonly measured items in a line based on how many newtons were recorded. Can the chn see any correlation between the mass of the objects and the force needed to pull objects to the centre of the Earth (force caused by the pull of gravity)? *What does this show? (**The larger the object and its mass, the greater the weight- more force is needed to pull it to the centre of the Earth**).Demonstrate this pulling something along that is light and then heavy. Show that although I am moving the same both times I have to pull harder to get the heavier item moving in the first place.*	Q: why do objects of larger mass fall at the same speed as objects of smaller mass? Encourage the chn to use what they know to explain this. (E.G. larger masses have a larger weight because more force is needed to pull them to the centre of the earth/gravity pulls harder on them/they take a larger pull to make them move. Although they take a greater pull initially to fall towards the Earth, they fall at the same speed. The pull of gravity on large masses is large and pull of gravity on small masses is small so they fall at the same rate.	Force meters Classroom objects Bags
Session	Learning Objectives	Introduction	Main activity	Application and review	Resources
3	**To understand that applying a force to an object creates a change in that object and that several**	Remind children that the force meters they used in the last session used units called newtons (N), named after Sir Isaac Newton. Do children know anything about this famous scientist? Show them his biography. Link back to our English work on biographies. Show the chn the concept cartoon about forces. Remind them that gravity is the force of attraction between **two** objects. All objects exert a pull on other	Explain that Newton also discovered that 'every action has an equal & opposite reaction' (his third 'law of motion'). Ask the children what stops us being sucked to the centre of the Earth? The *Earth actually pushes back!* Place a book on a table and ask the chn what forces are acting on the book– the book is pushing on the table because of the pull of gravity & the table is pushing back. Forces are balanced so the book doesn't move! Show the chn a diagram of an object (book) on a table. Discuss the use of arrows to show the size and direction of the forces. Establish/reinforce the idea of a stationary object having	Discuss scenarios and ensure the children understand that when forces are balanced the object will not move or change its speed but if the forces are unbalanced, the object will speed up, slow down or change direction. In groups give the chn	Pictures for chn to annotate (force diagrams) Toy car Pictures of object at start, when accelerating etc.

	forces may be acting on an object at one time. *assessment a, b*	objects nearby, but the Earth is by far the biggest object so exerts the biggest force. Look at the second speech bubble and remind chn of the findings from the last session. Explain that today we are going to think about the idea in the last bubble and begin to think about why the apple might stop rolling. We they are going to identify forces acting on an object and draw arrows to represent their direction and size.	balanced opposite forces acting on it by using the idea of tug of war (if the rope is still both teams are pulling with equal force) or ask the chn to explain to you how an arm wrestle works. What are the forces involved? How does someone win? If the push from each person was equal, what would happen? Explain to the children that if the forces (push from each person) were the same (balanced) the arms would not move anywhere but if one force was greater than the other, the arm would be pushed down. Show the chn further pictures of objects (on flipchart: man standing still, parachutist, car driver- include arrows) that have forces acting upon them. Discuss the different forces acting on the object (gravity, upthrust/upward force, friction, air resistance/drag-we will talk about what these are next lesson).List. Explain that the size and direction of these forces can be shown using arrows. Look at arrows- which are the biggest forces? Which is the smallest force? In which direction are they acting? Children to complete sheets showing balanced and unbalanced forces **(LA Forces in Action sheet - first 4 boxes)** Look at the 'parachute travelling at a steady speed' example. How should they draw the arrows? Ensure the chn understand that the forces will be balanced even though the object is not still. Explain this again in terms of a stationary toy car or a person on a bike. Discuss the forces involved. What do we know about the forces when the car is stationary? What happens if I push the car/start peddling? When will the forces be balanced again? Make sure the children understand that the forces can be balanced when an object is travelling at a constant speed as well as when it is stationary. Show children this with rolling a ball. Children to show forces, size and direction of an object when stationary, starting to move, at a constant speed and slowing down. Encourage them to say whether the forces are balanced or not. They can draw pictures of anything they think shows this or use the flipchart page of the cars. **MA: pictures of parachutist to order and explain.**	cards with arrows of different sizes and wbs. Show the chn a picture- chn show their understanding by acting out scenario, recording the forces involved and the size and direction of the force in a freeze frame.	Arrows on card of different sizes. Pictures from schools net:forces

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4	**LO: To understand that friction is a force against motion caused by two surfaces rubbing against each other.** Assessment: 1, b.	Remind the chn that one of the forces we talked about last lesson was the resisting force of friction. Today we are going to think about what friction is. **Teaching the knowledge:** *How can we define friction?* The resistance that one surface or object encounters when moving over another or the action of one object rubbing against another, which tends to slow it down or stop it completely. Show the chn a picture of two surfaces rubbing against each other and ask them to draw what they think is happening. Discuss the children's drawings (take photos if drawn onto A3 paper in pairs) and show them the close up picture of what is happening between the two surfaces.	**Teaching the understanding:** Show the chn the flipchart page of the two bricks with different surfaces. What do they think will happen if we were to slide the bricks down a slope? Encourage the children to draw pictures and annotate them with their ideas, using the knowledge taught earlier to demonstrate their understanding of what friction is. Assess those who are getting it and those who are not. Demonstrate what happens and why when bricks with different surfaces are put on the ramp (possibly even with oil?) and slid/pulled with newton meter. Show the children the picture of the jam packed car of someone going on holiday. Explain the scenario that when we travelled to France in the summer I moaned at my husband for bringing too much (the BBq, his comfy mattress for his bed etc) and I had said that more mass will increase the friction and slow us down. However he didn't believe me so I need to find evidence before next summer so I can prove my theory! What would be the question we want to investigate? Show flipchart page introducing the problem. Discuss ideas about the type of enquiry necessary to answer this question (fair test- looking for relationships between variables) In their books get the children to record the question to be investigated and their prediction.	Discuss possible ideas for investigations and record ideas on paper flipchart.	Camera Different bricks. ramps oil
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5	**To show their understanding of how and why friction causes objects to slow down.**	Remind chn of the question they are investigating and the ideas gathered from the end of last session. On sugar paper, encourage the children to plan their investigation in groups using the headings: (could use wbs for each heading so they can be altered and will photograph better? Or use A3 paper in pairs so all	Once ideas are planned, encourage the children to do a trial run of their investigation. What information/details haven't they thought about? What equipment haven't they recorded? (Could swap plans with another group and try to carry out other group's investigation from their plan?) Feedback what they have discovered about each other's plans. What adjustments did they have to make? Why? Ensure the chn have controlled the variables (controlling them to the best degree possible) and have a means of	Show the children through pictures what is happening to the heavier object and why this increases friction and makes the object slower. When would increased friction be useful?	Force meters Sugar paper and pens

	Assessment : 1, 2, 3, 5, b .	children more involved) work with those not getting it to plan an investigation. Encourage the children to think about what they are going to measure or observe, for how long and using what equipment.	recording their results. Carry out the experiment- work with those children not getting it. Discuss the children's findings. Can they see any relationships/patterns in their results? (E.g. when dragged across a surface, more downward force=more friction. With two objects of similar size, the heavier object will have more drag/friction). Draw conclusions and encourage the chn to explain their findings using their understanding of friction.		
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6	**To know that air resistance is a form of friction that slows objects down as they move through the air.** **Assessment : b, 1, 5**	**Teaching the knowledge and understanding.** Remind the children of their friction experiments from the previous session and the fact that when two surfaces come into contact with each other friction occurs. If moving over a surface is difficult then surely moving through air is easier? Briefly discuss with the children situations where they have felt the 'force' of moving air – *running into the breeze on a windy day, holding an umbrella being pushed inside out, cycling on a windy day..* Explain to the chn that we are going to look more closely at air resistance this lesson. To do this we are going to drop a piece of paper when it is in different forms (different stages of being screwed up – flat, folded in half, tightly screwed up. What do they predict will happen? Carry out the together (timing the fall of the paper and repeating tests or trying to drop them at the same time). Discuss keeping it as a fair test. Record results and show chn how to find the mean average. Discuss the results and why they think they show this pattern. Show friction	Pose the question: What affects how fast a parachute will fall? Show children a made parachute. What variables/factors could we test to see what affects the time taken for the parachute to fall. How can we increase/decrease the force of air resistance? List. Choose one example and show the children how to make it into a question. Chn choose a variable to test in groups and plan their investigation using the planning headings. Encourage the children to make a prediction. Chn carryout their investigations in groups. (teacher-observing who can carry out a fair test independently and who cannot) *Mini plenaries to share different groups work or discuss misconceptions/errors you have notice.*	What do the children's results show? How does this compare to their predictions? How can they relate their findings to their understanding of friction and air resistance?	Sheets of paper

		pages on flip chart. Reinforce the idea of air resistance in further ways if necessary- take them outside with large sheets of card and try and run across the playground. Use the next few flipchart pages to reinforce.			
Session	Learning Objectives	Introduction	Main activity	Application and review	Resources
7	**To know that water resistance is a form of friction that slows objects down as they move through the water.** *Assessment: b,1*	Give each gp of chn the same object to weigh using a force meter. Record the result. Did everyone get the same result? If they are different, what factors could be influencing the difference? Discuss the importance of repeating measurements for validity. Ensure children beginning to understand that we can have more confidence in results when repeated measurements are close together. Discuss what forces are acting on an object when it is suspended in air. Pose the question: Do objects weigh the same in water as they do in air? What same forces are acting on the object in water as they are in air? What different forces may be acting in water? Can these forces make a difference to the weight of an object? Does the object change when it is placed in water? Encourage chn to use their own experience (e.g. swimming pool- do the chn change when they are in the swimming pool?) In a large space ask the children to imagine that they are standing in water up to their necks, how does it feel as they start to move around? *It's hard work - there is a lot of <u>resistance</u> (drag force) - discuss why it's so much easier to move around on dry land – less resistance/lower drag force*. Discuss how when you swim (actually kicking	What test are we going to do to find the answer to this question (discuss). Show the chn how each part of the experiment links to planning charts often found in a test paper. (i.e. what variable would you change? What would you measure/ observe/record? What would you use to measure/record?) Complete together and give chn a copy. Take ideas from children (using whiteboards) for recording answers. Show them the table on the flipchart. Give groups of children items to measure and ask them to record in the table on the flipchart. <u>Work with those who are not sure:</u> Set up a demonstration for the children. Weigh two pieces of plasticine so that they have the same mass and roll each into a ball. Fill a tall clear cylinder with water and place it so that the children can see it. Tell the children that you are going to drop both balls from the same height at the same time. One into the water and one onto the table. Get the chn to countdown… 3, 2, 1, Drop! What do they notice? *The ball in water falls slower than that falling through the air.* What is the explanation for this? *Water resistance slows the ball travelling through the water in the same way that air resistance can slow a parachute. Get the chn to draw and explain what they saw. Can we change the result? Can we get them to fall at a similar rate? What else do we know affects the rate of fall? (Think about increasing the surface area of the plasticine falling through the air. Does this have an effect?*	Discuss patterns in the results and any 'errors' in results. Discuss what the children think has happened. Return to prior learning about upthrust. Ensure the children understand the weight (pull of gravity) stays the same but objects appear to weigh less because the upthrust of water is greater than the upward push of air. – *Gravity still works under water, even though the weight <u>seems</u> different – water resistance is greater than air resistance.* Remember the mass stays the same! Note: floating occurs when objects weight and upthrust are balanced. (An object is buoyed upwards by a force equal to the weight of the liquid displaced by the object).	Containers Force meters Range of objects Plasticine.

		your legs and moving your arms) you can move through the water, but if you stop applying the forces you slow down (similar to when you are moving through air - compare to cycling, when you stop pedalling you slow down). Tell the children that you are now going to fill the pool with different liquids. What about oil? Syrup? How does it feel now? Why is it different? Ask the chn to make a prediction.			
Session	Learning Objectives	Introduction	Main activity	Application and review	Resources
8	To recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect Assessment: c,	Write gears, pulleys, levers and springs on f/c. *Do children know what any of these are and if so how they might be related to forces?* Explain that these are mechanical devices that can help us to transfer forces or motion (make it easier). Gears, pulleys & levers are simple machines. *Can children think of anywhere that these mechanical devices are used?* List ideas on f/c, e.g. crane, bicycle, car, scissors, can ring pull, force meter, stapler, retractable pen, armchairs, etc. Show children an introductory video about gears, http://www.sciencekids.co.nz/videos/physics/gears.html. Basically a gear is a wheel with teeth (often called a cog). One gear/cog with its teeth interlocking (fitting into) another gear/cog allows you to move the second gear/cog by turning the first gear/cog. Gears have many uses in our lives. They are used to: multiply or reduce speed and force; change the direction of motion; transmit a force over a distance. Briefly discuss ratio using gears - it is important that children realise that gear ratio is based on the number of rotations made by each gear. This is worked out by	Show a simple animation at http://www.watchknowlearn.org/Video.aspx?VideoID=56666&CategoryID=1745 or http://www.robives.com/mechanisms/pulley#.VRVcbrAfzIU and then together explore the activity at http://www.walter-fendt.de/ph14e/pulleysystem.htm Try out the broomstick activity . Write lever on f/c. *Can anyone explain what a lever might do? Hint: Does anyone ever use the word 'lever' as a verb to describe doing something?* E.g. Lever the lid off the paint can. Show some examples of levers, pointing out the load, effort & fulcrum or pivot in each case (label second diagram in each case). Discuss the three types of lever – 1, 2 & 3, depending on relationship between load, effort & fulcrum: First class lever: fulcrum between load & effort; Second class lever: load between fulcrum & effort; Third class lever: effort between fulcrum & load. *Which of these levers have children used?* Model drawing force arrows on the diagrams of levers. Useful diagrams & animated diagrams for all simple machines at http://www.technologystudent.com/gears1/geardex1.htm Children draw an example of each type of lever, labelling the effort, load & fulcrum (pivot).	Can children explain how simple machines can make work easier? Ask them to describe how forces and motion can be transferred by mechanical devices.	

		comparing the number of teeth. As a smaller gear has fewer teeth, it will rotate more times than a larger gear, e.g. gears with 8 and 16 teeth will therefore have a ratio of 2:1. Record other examples. Where do we use gears in everyday life? List suggestions on f/c: cars, bicycles, clocks & watches, wind-up toys, etc. A pulley is also a wheel – with a grooved rim! Instead of interlocking like gears they drive one another using cords, ropes, belts, etc that fit in the grooves. Download PowerPoint from http://teacherweb.com/ON/ThornhillPublicSchool/Sweeney/Pulleys-in-Everyday-Life.ppt for an introduction to pulleys. Point out that although you need to apply less force when you use a pulley, you have to move the load over a greater distance!.			