

Unit 4E Friction
Adapted from QCA Science Unit 4E

ABOUT THE UNIT

In this unit children build on their existing knowledge of forces and learn that forces can be measured and compared. The unit focuses on friction as a force which exists between objects moving across solid surfaces and opposes motion, and the forces of air resistance and water resistance which oppose the motion of objects moving through air and water.

Experimental and investigative work focuses on:

- deciding what evidence should be collected when planning and carrying out a fair test
- making measurements using a forcemeter
- looking for patterns in results, interpreting and suggesting explanations for these.

Work in this unit also offers opportunities to relate knowledge and understanding of frictional forces to everyday contexts and to recognise that science provides explanations for familiar phenomena related to friction.

WHERE THE UNIT FITS IN

Builds on Unit 3E 'Magnets and springs'

Children need to:

- recognise forces as pushes and pulls
- know vocabulary used to describe forces and their effects
- be accustomed to measuring using standard units
- be accustomed to planning fair tests and to presenting results as bar charts.

Links with Units 5C, 5E and design and technology and physical education.

VOCABULARY

In this unit children will have opportunities to use:

- words and phrases relating to forces
eg friction, air resistance, water resistance, forcemeter, Newtons, surface area
- expressions making generalisations related to patterns in data.

RESOURCES

- magnets and springs to illustrate forces
- forcemeters with a range of 0-10N
- samples of different surfaces
eg wood, carpet, vinyl, non-slip vinyl
- tall cylinder or other tall transparent container for water
- timers capable of reading to 0.1 second
- large sheet(s) of card
- plasticine
- material/paper for parachutes
- string

EXPECTATIONS

at the end of this unit

most children will:

describe some of the factors that increase friction between solid surfaces and increase air and water resistance; describe how to measure forces and describe how to investigate friction, explaining what their results show and relating what they found out to their everyday experience

some children will not have made so much progress and will:

identify friction as a force; describe some ways in which friction between solid surfaces can be increased and identify some trends or patterns in observations and measurements

some children will have progressed further and will also:

describe situations in which frictional forces are helpful as well as those in which frictional forces resist motion

LEARNING OBJECTIVES CHILDREN SHOULD LEARN	POSSIBLE TEACHING ACTIVITIES	LEARNING OUTCOMES CHILDREN	POINTS TO NOTE
	<ul style="list-style-type: none"> ◆ Review children's learning by asking questions to elicit ideas about forces they have already encountered <i>eg pushes and pulls, exemplified by attraction and repulsion between magnets, stretched and compressed springs; forces acting on objects in particular directions; effects of forces in relation to their size.</i> Reinforce by letting children explore magnets and springs, asking them to identify the directions in which the forces are acting. ◆ Children to list examples of pushes/ pulls; classify examples given as pushes or pulls 		<p>Children's responses to these questions and to the introductory activity will indicate their knowledge and understanding of forces and movement. Teachers will need to take this into account in their short-term planning.</p> <p>Teachers should bear in mind that each push acts upon one body only <i>eg the hand pushes down on the spring and the spring pushes up on the hand.</i></p>
<ul style="list-style-type: none"> • to use a forcemeter carefully to measure forces • that 'Newton' is the unit of force • that there is a force between an object and a surface which may prevent the object moving 	<ul style="list-style-type: none"> ◆ Show children forcemeters and point out the spring inside them. Ask them to suggest how they work. ◆ Help children to practise reading the forcemeter <i>eg when another child pulls on it, pulling open a drawer, dragging an object across the floor. Use "finger tug o' war" with forcemeters to show the readings of the two forcemeters are the same.</i> ◆ Children use forcemeters to pull weights across the top of the desk on a "sledge" to show that heavier weights require a greater force (as shown on the forcemeter) to get/keep them moving. ◆ Ask children to suggest whether it would be more or less difficult to get an object moving on a smooth or rough surface. Ask children how they might answer this question and, if appropriate, demonstrate using a forcemeter attached to an object <i>eg a weighted margarine tub or a weighted shoe</i>, how this question might be investigated. Discuss with the children what different forcemeter readings show. 	<ul style="list-style-type: none"> • use a forcemeter to measure forces, reading the scale accurately • explain that a bigger reading on the forcemeter shows it is more difficult to get an object moving than a smaller reading 	<p>Forcemeters are similar to scales used in some supermarkets to weigh fresh fruit and vegetables. These are usually calibrated in units of mass <i>eg kilograms</i>. It is important to ensure that forces (including weight) are measured in Newtons.</p> <p>RESOURCES: forcemeters weights empty margarine tub/tin lids</p>

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<ul style="list-style-type: none"> • to decide what evidence to collect • to predict what they think will happen and to plan a fair test • to make and record careful measurements and present them in a bar chart • to relate the results to the prediction • to explain conclusions in terms of the roughness or smoothness of the surfaces 	<ul style="list-style-type: none"> ◆ Ask children to investigate on which surfaces objects slide most easily. Present children with at least three different surfaces <i>eg wood, vinyl, carpet</i> and ask them what they think will happen. Help children to decide what to do <i>eg measuring the force needed just to start an object moving on a flat surface or measuring the height of a slope on which it will start to slide</i> and how to ensure their test is fair <i>eg by keeping the object to be moved identical on each surface or by keeping the same surface</i>. Ask children to present results in a bar chart, helping them where appropriate. Discuss with the children the different methods they chose to investigate the question, and whether some were better than others for answering the question. Ask children to suggest what this work indicates about surfaces for roads, if cars and bicycles are to be safe and not to slide. ◆ Some children will also have time to investigate the question of which type of shoe sole give the best grip ◆ Children will write up their experiment(s). 	<ul style="list-style-type: none"> • explain how the evidence collected answered the question, <i>eg if I have to make the slope steeper before it moves then the surface stops it sliding; or it will slide best on the surface where the reading on the forcemeter is smallest</i> • carry out a fair test • make measurements and construct a bar chart which matches the measurements • explain their results orally or in writing <i>eg by saying that the objects slid most easily on the smoothest surfaces. This is what I thought would happen</i> 	<p>Main focus of the investigation:</p> <ul style="list-style-type: none"> controlling variables making predictions making careful measurements and recoding them creating bar charts to present results <p>RESOURCES:</p> <ul style="list-style-type: none"> forcemeters weights cm squared paper
<ul style="list-style-type: none"> • that the force between two moving surfaces in contact is called friction • that friction can be useful 	<ul style="list-style-type: none"> ◆ Talk with children about surfaces between which there is low or high friction and make a list showing everyday situations where high friction is helpful <i>eg tyres on cars and bicycles, goal keeper's gloves, tying shoe laces</i> and everyday situations where low friction is useful <i>eg skating, playground slides</i>. ◆ Children classify "surfaces/parts" of a bicycle according to whether high friction or low friction is most beneficial including hands/handle grips; brake blocks/tyre rim; tyre/road; front wheel/frame; front fork/front axle; saddle/bottom; etc. 	<ul style="list-style-type: none"> • group surfaces into 'high friction' and 'low friction' • given an everyday context <i>eg holding the handlebars on a bicycle or pulling a drawer out of a desk</i> decide whether it is important for friction to be high or low 	<p>RESOURCES:</p> <ul style="list-style-type: none"> bicycle selection of goalie gloves/other gloves

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<ul style="list-style-type: none"> that water resistance slows an object moving through water to explain what evidence is to be collected and decide whether the test is fair to identify trends in results and draw conclusions explaining these in terms of the force between the object and the water 	<ul style="list-style-type: none"> Ask children to describe what it is like to walk through water <i>eg in a swimming pool</i> and to suggest why it is difficult. Elicit their ideas about why fish and boats can move through water. If necessary prompt them to think about shape. Show children a tall cylinder filled with water and talk with them about what they could do, using this apparatus and a small piece of plasticine, to find out which shapes move easily through water. Help children to decide what to measure <i>eg time from dropping the plasticine into the cylinder until it gets halfway down or to the bottom</i> and how to make the test fair <i>eg by always using the same piece of plasticine made into different shapes, always using the same height of water in the cylinder</i>. Ask children to record results in a table and to interpret these in terms of the shape of the object and water resistance. Discuss children's ideas with them. 	<ul style="list-style-type: none"> describe how they carried out a fair test identify which shapes move easily through water and explain this in terms of reduction of resistance 	<p>Main focus of the investigation:</p> <ul style="list-style-type: none"> controlling variables making predictions making careful measurements and recoding them creating bar charts to present results identify trends in the results to draw conclusions <p>Children sometimes think that friction only occurs between solids and surfaces. Air resistance and water resistance are also forces which oppose relative motion between an object and what it is touching.</p> <p>RESOURCES:</p> <ul style="list-style-type: none"> stopwatches plasticine/bluetac cylinder tubes
<ul style="list-style-type: none"> that air resistance is a force that slows objects moving through air that air resistance is a form of friction 	<ul style="list-style-type: none"> Take children outside and ask them to run across the playground with a large sheet of card held in front of them. Discuss what they can feel and ask them to try to explain what is happening. Extend the discussion to riding a bicycle into the wind or walking into the wind on a windy day. Ask children to draw a picture to illustrate what is happening and to annotate their picture to provide an explanation. Introduce the term 'air resistance'. Demonstrate how the size of its surface affects how fast something falls through air <i>eg by using small pieces of cotton wool squashed up and spread out</i>. 	<ul style="list-style-type: none"> explain in terms of forces why you need to pull hard on a large surface, <i>eg a kite, an umbrella, a sail</i> to hold it steady on a windy day <i>eg the air/wind is pushing the umbrella up so I have to pull hard to hold it steady</i> 	<p>RESOURCES:</p> <ul style="list-style-type: none"> stopwatches large boards

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<ul style="list-style-type: none"> to plan a fair test saying what they will change, what they will keep the same and what they will measure to make measurements of time to identify a pattern in the results and to explain it in terms of air resistance 	<ul style="list-style-type: none"> Ask children to investigate parachutes <i>eg does the size of a parachute affect how long it takes to fall?</i> Ask them what they plan to measure in order to answer the question. When children have made and recorded some measurements discuss them with the children and help them look for patterns in them. Help children to relate this to their understanding of air resistance. 	<ul style="list-style-type: none"> describe a fair test <i>eg I used a square parachute with the same weight each time and changed the size of the parachute</i> make measurements of the time taken for the parachute to fall explain patterns in their results in terms of air resistance, <i>eg the largest parachute took longest because it trapped most air which stopped it falling quickly</i> 	<p>Children may be aware of the term 'gravity'. However, at this point it is not necessary to talk about gravitational attraction or balanced forces unless teachers think it is appropriate for their classes. It is sufficient to think of the parachute as an object which is moving downwards and air resistance as a force which is opposing that motion.</p> <p>Main focus of the investigation:</p> <ul style="list-style-type: none"> controlling variables making predictions making careful measurements and recoding them creating bar charts to present results identify trends in the results to draw conclusions <p>In order to obtain satisfactory results with parachutes there needs to be an adequate drop <i>eg down a stairwell</i>. It is possible to modify the investigation using fairy cake cases with holes of different sizes in them. These work with a much smaller drop.</p> <p>This activity can provide an opportunity to discuss with children reasons for repeating measurements.</p> <p>SAFETY – Take care if children lean over stairwells or if they suggest standing on tables. This activity needs close supervision.</p>
<p>Review work on friction by asking children to write sentences showing problems if friction ceased to operate.</p>			