Science Curriculum

Year 5 Forces: What forces act upon everyday objects?

National Curriculum

Statutory requirements pupils should be taught to:

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

Working Scientifically

During years 5 and 6, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content:

- planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary
- taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate
- recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs
- using test results to make predictions to set up further comparative and fair tests
- 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
- identifying scientific evidence that has been used to support or refute ideas or arguments.

Powerful Knowledge

Enquiry 1. How can a force act on an object?

- A force causes an object to start moving, stop moving, speed up, slow down or change direction.
- Gravity is a force that acts at a distance. Objects are pulled downwards because of the gravitational attraction between them and the Earth, everything is pulled to the Earth by gravity. This causes unsupported objects to fall.
- The amount of matter in an object is its mass. One of the properties of mass is its inertia (its laziness), its reluctance to move. As the mass increases, so does the inertia which cancels out its effect when things fall so all fall under the same pull of gravity which makes them fall at the same speed.
- Weight is a force and is measured in Newtons and that the greater the weight the greater the force.

Enquiry 2. Why do some objects move through air and water with ease and some do not?

- Air resistance is the force of the air pushing on an object as the object moves through the air. The air pushes as it moves round the object.
- A streamlined object such as a rocket has a shape which allows the air to move over it more easily and reduces the push of the air on it. A non-streamlined object such as a box has large flat surfaces which the air pushes against strongly and slows down as it moves.
- Water resistance is the pushing force of water on an object moving through it. Fish with streamlined shapes like the tuna can move quickly whereas angelfish with a less streamlined shape move more slowly.
- Boats have streamlined shapes so they can part the water with their hulls as they move forwards.

Enquiry 3. What are the effects of friction between moving surfaces?

- Friction works against objects on the ground –provides the grip on the ground!
- Friction is the force between two touching surfaces when one surface is pushed or pulled over the other.
- Static friction is working to stop the movement. If you push more strongly, you overcome the static frictional force and the book begins to move.
- A frictional force develops between a book and a desk when you gently push it but it does not move. The book still pushes against your push with a force called sliding friction.
- The sliding friction force is reduced if the two surfaces in contact are very smooth such as ice and the runner of a skate.

Enquiry 4. Mechanisms

- Some objects require large forces to make them move; gears, pulley and levers can reduce the force needed to make things move.

- The term ‘load’ for weight and ‘effort’ for the force being applied. A machine is a device that makes work easier by allowing a small force to move a larger load.

Thematic progression

Prior Knowledge –

From Year 3 – Forces

- Compare how things move on different surfaces
- Notice that some forces need contact between two objects, but magnetic forces can act at a distance
- Observe how magnets attract or repel each other and attract some materials and not others.
- Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials.
- Describe magnets as having two poles.
- Predict whether two magnets will attract or repel each other, depending on which poles are facing.

Future Knowledge – Forces

In KS 3: -

- Magnetic fields by plotting with compass, representation by field lines.
- Earth’s magnetism, compass and navigation.
- Forces as pushes or pulls, arising from the interaction between two objects.
- Using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces.
- Moment as the turning effect of a force.

Common Misconceptions

Some children may think:

• the heavier the object the faster it falls, because it has more gravity acting on it

• forces always act in pairs which are equal and opposite

• smooth surfaces have no friction

• objects always travel better on smooth surfaces

• a moving object has a force which is pushing it forwards and it stops when the pushing force wears out

• a non-moving object has no forces acting on it

• heavy objects sink and light objects float.

Concepts

Consequences
Balance
Change

Vocabulary

Air resistance, water resistance, friction, gravity, acceleration, element, force meter, Newton, gears, pulleys, force, push, pull, opposing, streamline, brake, mechanism, lever, cog, machine, sliding friction, static friction, load and effort

• Forces: associated with deforming objects; stretching and squashing – springs; with rubbing and friction between surfaces, with pushing things out of the way; resistance to motion of air and water. • Forces measured in Newtons, measurements of stretch or compression as force is changed.		

Cross Curricular Links

	Key Question/ Enquiry Approach	Science SOLO develping skills for working scientifically/ Enquiry Skill	Learning Objective Knowledge Working Scientifically	Science Powerful Knowledge	Outcome
Enquiry 1. How can a force act on an object?					
1.	How does gravity act as a force? *Identify and Classify*	**Asking questions and recognising that they can be answered in different ways** • **Suggest** their own scientific questions using their own prior knowledge or based on a previously taught scientific enquiry. **Recording and presenting evidence** • **Discuss** and sometimes **decide** how to **record** and **present** observations and evidence. *E.g using photographs, videos, pictures, labelled diagrams or writing.* **Answering questions and concluding** • **Explain** how the evidence gathered from a number of sources supports their answers. Also **conclude** by also explaining why they might not.	I can review my knowledge, explain what a force is and give examples to illustrate this. I can explain how gravitiy acts as a force. I can suggest scientific questions to ask based on prior knowledge and understanding. I can discuss and decide how to record and present my evidence to support my answer. I can explain how evidence gathered supports my answers and conclude by explaining why they might not.	A force causes an object to start moving, stop moving, speed up, slow down or change direction. Gravity is a force that acts at a distance. Objects are pulled downwards because of the gravitational attraction between them and the Earth, everything is pulled to the Earth by gravity. This causes unsupported objects to fall.	Consider a world without gravity. Positive and negative consequences.
	Retrieval Activity: Magnetism is a type of force – what can you remember about magnets? Brain dump. **Think and Link: If I throw a ball up and down, why doesn't it float away? What is happening scientifically?** Schema Mapping – what do we know about forces? What can you remember? What type of vocabulary would you need to use to describe the forces? Explanation of lesson: **Key Questions:** What is a force? How does it effect our daily life? Give the children a ball, ask them to make the ball move in different ways? What types of movement can you make? Push/ Pull/ Up and Down. What makes the ball fall down to the ground? What is this called? Explain gravity – the pull towards the Earth.				

<table>
<tr><td></td><td colspan="5">Share Issac Newton story of apple under the tree.
Is Gravity everywhere? Discuss living on a space station and show video clip of eating/sleeping/ floating around. Imagine there was no gravity on earth – what would like be like? How would the earth be different? Would these things be good or bad? What would like be like?
Outcome: As a group, discuss the positive and negative implications of gravity on our world. Give children the opportunity to discuss how they will record it. Capture the learning in working in science book.
Plenary: As individuals, write a response to ‘Why is gravity important?’ Support explanantion with scientific detail discussed in group.
Stretch Descriptor:
Generate their own scientific questions to ask. This may be stimulated by a scientific experience or asking further questions based on their developed understanding following an enquiry.
Decide how to record and present evidence.
Discuss and justify whether other evidence e.g. from other groups, secondary sources and their scientific understanding, supports or refutes their answer.</td></tr>
<tr><td>2.</td><td>What is the relationship between weight and a force and how can it be measured?

Comparative & Fair testing</td><td>Making observations and taking measurements
• Apply knowledge of how to use a range of equipment for taking accurate measurements of: length, time, temperature and capacity using standard units of measurement.

Recording and presenting evidence
• Record measurements with guidance E.g using tables, tally charts and bar charts

Evaluating and raising further questions and predictions
• Use scientific experience gained to formulate further questions which can be answered by using comparative and fair tests.</td><td>I know and can explain that weight is a force and can understand how it is measured.

I can explain that is measured in Newtons.

I can select and use measuring equipment that will give the most precise results.

I can record measurements with some guidance in a table.

I can use scientific knowledge gained to formulate further questions which can be answered by testing.</td><td>The amount of matter in an object is its mass. One of the properties of mass is its inertia (its laziness), its reluctance to move. As the mass increases, so does the inertia which cancels out its effect when things fall so all fall under the same pull of gravity which makes them fall at the same speed.
Weight is a force and is measured in Newtons and that the greater the weight the greater the force.</td><td>Using force meters investigate same or different pull & take measurements.</td></tr>
<tr><td></td><td colspan="5">Retrieval Activity: In 60 seconds, write down what you can remember about gravity.
Think and Link: Which would harder to move? An elephant or rhino? Why? How is gravity affecting these animals?

Key Questions: Does the size of the object affect it’s weight? Give images of different objects and discuss. Mass is the amount of matter in an object.Tell chn the weight is a measurment of heaviness. In science, we talk about weight which is how much the force of gravity is affecting the object. Children could explore different weights, measuring this is Newtons. Why do you think they are call Newtons? Think and link back to previous story.

Outcome: Does the weight of an object affect how much force is needed to move it? Children to explore pulling a range of materials using the newton meter to measure the force needed to move the object.

When children have collated information into the table, can they identify any patterns of links between the weight of the item and the amount of force needed to push or pull it? Children present table in book and write a conclusion to show what they have found out. Children to sketch image of experiment and label with push/ pull force and gravity acting on the object.

Stretch Descriptor:
Select measuring equipment to give the most precise results. (E.g. ruler, tape measure or trundle wheel, force meter with a suitable scale.)</td></tr>
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	Record measurements confidently. (*E.g. using tables, tally charts, bar charts, line graphs and scatter graphs.* **Relate** the scientific knowledge gained from enquiry work to make **predictions** that they can investigate using comparative and fair tests.				
Enquiry 2. Why do some objects move through air and water with ease and some do not?					
3.	How does the shape of an object affect the air resisitance between moving surfaces and how can we measure this?  *Comparative & Fair testing* *Plan and complete an investigation.*	**Asking questions and recognising that they can be answered in different ways** • Carry out fair tests, **recognise** variables and **suggest** how to **control** them. **Making observations and taking measurements** • **Apply** knowledge of how to use a range of equipment for taking accurate measurements of: length, time, temperature and capacity using standard units of measurement. **Recording and presenting evidence** • **Record** measurements with guidance *E.g using tables, tally charts and bar charts* **Evaluating and raising further questions and predictions** • **Compare** similarities and differences in results which may reduce the degree of trust in data.	I can investigate and explain what air resistance is. I can understand that air resistance is the force of air pushing on an object as the object moves through the air. I can carry out fair tests to compare what happens during an investigation. I can use a range of equipment to take measurements and make observations. I can record measurements with support. I can compare similarities and differences in results and explain why it might reduce our trust in the data.	Air resistance is the force of the air pushing on an object as the object moves through the air. The air pushes as it moves round the object. A streamlined object such as a rocket has a shape which allows the air to move over it more easily and reduces the push of the air on it. A non-streamlined object such as a box has large flat surfaces which the air pushes against strongly and slows down as it moves.	How does adding holes to a parachute affect the time it takes to fall? How does the length of a piece of a paper helicopter's wings affect the time it takes to fall?
	Retrieval Activity: What is gravity? What other forces can you name? What unit do we measure forces in? **Think and Link:** How do parachutes work? What happenss? What force is acting on a parachute? **Key questions**: Share image/video a parachute. Can you explain what is happening here? What forces do you know are acting, pulling the parachute down? Why does the parachute slow the man down? Use small model parachute and demonstrate dropping the parachute from a height. Make link with air resistance – the air is resisting the gravity and slowing it down. Can you make a better parachute than me? What would a really good parachute look like? What would help? Discuss the size of the parachute. Introduce the term surface area and explain. **Outcome**: Children to work in small groups to make a range of parachute sizes – one size per group. Make a prediction of a post it note – which will be the best and why? What do we need to keep the SAME (control) to make sure everyone's parachute gets the same opportunity. E.g. Same height, weight underneath, material. What is out VARIABLE? Size of parachute. Perform experiment and record results in a table – surface are cm2 vs time to fall. Written investigation – Question – Predicton – Result – Conclusion. **Plenary**: What would you do different next time? Will changing the material of the parachute change your results?			

	Stretch Descriptor: Carry out fair tests, **recognise** and **control** variables. **Select** measuring equipment to give the most precise results. **Identify** any limitations that reduced the trust in their data.				
4.	How does the shape of an object affect water resistance between the moving surfaces and how can we test our theories?  *Comparative & Fair testing* *Plan and complete an investigation.*	**Asking questions and recognising that they can be answered in different ways** • **Suggest** their own scientific questions using their own prior knowledge or based on a previously taught scientific enquiry. **Engaging in practical enquiry to answer questions** • **Explain** patterns and relationships. **Recording and presenting evidence** • **Discuss** and sometimes **decide** how to **record** and **present** observations and evidence. *E.g using photographs, videos, pictures, labelled diagrams or writing.* **Evaluating and raising further questions and predictions** • **Use** scientific experience gained to **formulate** further questions which can be answered by using comparative and fair tests.	I can investigate and explain what water resistance is. I can understand that water resistance is the pushing force of water on an object moving through it. I can suggest my own scientific questions using prior knowledge. I can explain patterns and relationships in the information gathered. I can discuss and decide how to record and present evidence and observations. I can use scientific knowledge gained to pose other questions linked to the investigation.	Water resistance is the pushing force of water on an object moving through it. Fish with streamlined shapes like the tuna can move quickly whereas angelfish with a less streamlined shape move more slowly. Boats have streamlined shapes so they can part the water with their hulls as they move forwards.	How does the saltiness (salinity) of water affect the water resistance? How does the changing the shape of a piece of plasticine affect water resistance?
	Retrieval Activity: What is air resistance? Which one would fall down slower – a larger parachute or a smaller one? Explain why. **Think and Link:** Share two sized helipcopters – which one will fall more slowly to the ground? Why? Using gravity/ air resistance? Give a piece of plastacine – can you make a model boat? Give little guidance and ask children to test their boats in a box of water. Whose boats were successful? What do you need to do improve it? Can you improve your design? Compare boats, identify boat most likely to succeed. Why? Can you explain the forces involved or make a link to another force we have studied? Model how gravity acts on the boat, but the water resists the gravity like air did eg. Water resistance. We can also call this Upthrust. Outcome: Evidence of the experiment in the science in action book and a written conclusion in their science books. **Plenary:** Pose the question: Why does an olympic swimmer, wear tight clothes and cap to swim? Show image for discussion. Then they can discuss the techniques to reduce water resistance and making them streamlined as they move through the water. Can they make links to other things or objects that are streamlined? **Stretch Descriptor:** **Examine** for patterns and relationships using a suitable sample. OR **Gather and record** observations *E.g. using annotated photographs, videos, labelled diagrams, observational drawings, labelled scientific diagrams or writing. OR*				

	Relate the scientific knowledge gained from enquiry work to make **predictions** that they can investigate using comparative and fair tests.				
Enquiry 3. What are the effects of friction between moving surfaces?					
5.	What happens to the amount of force required for an object to move over different surfaces?  *Comparative & Fair testing*	**Engaging in practical enquiry to answer questions** • Carry out fair tests, **recognise** variables and **suggest** how to **control** them. **Making observations and taking measurements** • **Apply** knowledge of how to use a range of equipment for taking accurate measurements of: length, time, temperature and capacity using standard units of measurement. *E.g using thermometers and data loggers.* **Answering questions and concluding** • **Interpret** data to **generate** simple comparative statements based on the evidence they have gathered.	I can explain why the amount of frictional force created between two surfaces is different. I can understand the force of friction and its effects on different surfaces. I can carry out fair tests to compare what happens during an investigation. I can use a force meter to take accurate measurements. I can interpret data to generate comparative statements based on the evidence gathered.	Friction works against objects on the ground –provides the grip on the ground! Friction is the force between two touching surfaces when one surface is pushed or pulled over the other. Static friction is working to stop the movement. If you push more strongly, you overcome the static frictional force and the book begins to move. A frictional force develops between a book and a desk when you gently push it but it does not move. The book still pushes against your push with a force called sliding friction. The sliding friction force is reduced if the two surfaces in contact are very smooth such as ice and the runner of a skate.	*How does the amount/depth of tread affect the friction between a shoe and a surface? OR trainers pulled on different surfaces and the force required.*
6.	How does friction impact on the the speed an obect travels?  *Comparative & Fair testing*	**Making observations and taking measurements** • **Gather** systematic and careful observations to **explain** outcomes, **discuss** when decisions need to be made about what to do next. **Recording and presenting evidence** • **Record** measurements with guidance *E.g using tables, tally charts and bar charts* **Evaluating and raising further questions and predictions** • **Explain** ways in which they adapted their method as they progressed or how they would do it differently if they repeated the enquiry.	I can know that friction between surfaces creates heat and slows down moving objects. I can understand the effects of friction on different surfaces. I can gather systematic observations and discuss what the next steps are. I can record measurements using a chart with support. I can explain how things might have been adapted things or what they would do differently next time.		*Zip wire investigation and the time it takes.*

5	**Retrieval Activity:** What is water resistance? What shape does not experience much water resistance? **Think and Link:** When an object slides, or is pushed or pulled across a surface, what happens to it? What force is acting on the object? Children to carry out an experiement testing a shoe on different types of surfaces (table, carpet, tarmac, sand) using a newton meter to test the amount of force needed to pull the shoe on the surface. Outcome: Children to record their results (in the form of a bar chart) and evidence of experiment in science in action books. **Plenary:** What do you think would happen if we changed the type of shoe? **Stretch Descriptor:** Carry out fair tests, **recognise** and **control** variables. **Select** measuring equipment to give the most precise results. *E.g. ruler, tape measure or trundle wheel, force meter with a suitable scale.* **Summarise,** talking about how their scientific ideas change due to new evidence that they have gathered.				
6	**Retrieval Activity:** **Think and Link:** Ahoy my hearties! We need to send messages from the top of the ship to the bottom by the zip line! We need to get there a quickly as we can. What force would slow the descent? Can you pick the best material to help Sir Francis in his mission. E.g. String/ Paperclips/ Clothe/ Wood. Work in teams to design the most effective way of sending down a message. What is our variable? What can we control to make sure it's a fair test? Recorded in science in action. **Stretch Descriptor:** During an enquiry, **recognise** when any decisions need to be made and **identify** what needs to happen next. *E.g. whether they need to: take repeat readings (fair testing); in order to get accurate data (closer to the true value).* **Record** measurements confidently *E.g. using tables, tally charts, bar charts, line graphs and scatter graphs.*				
Enquiry 4. Mechanisms					
	Taught through the DT curriculum		• How can we use levers to lit more? • What is the most effective way to move an object? • How do see-saws work? • Can you create a pulley system to life a given load?	Some objects require large forces to make them move; gears, pulley and levers can reduce the force needed to make things move. The term 'load' for weight and 'effort' for the force being applied. A machine is a device that makes work easier by allowing a small force to move a larger load.	