ACET Junior Academies'

Scheme of Work for Science

Big Idea - Forces

Year 5 – Forces

About this unit:

PoS - Forces

A force is a push, pull or turn. A force starts or stops a movement, speeds something up or slows it down, or can change an object's direction (if it's already moving) or its shape. In this unit, we are going to investigate forces, and examples of forces that push back against them. We're going to look at ways of making forces smaller, so we can make something happen without having to push or pull so hard.

We will look at resistance and streamlining, and there is a lot of scope to investigate levers, gears and pulleys. In all cases, try and make sure that the students identify the forces involved – where are the push and the pull coming from, and what is their effect? When discussing levers, gears and pulleys, always emphasise that these tools are used because they make the forces involved smaller. If you use a pulley, you don't have to pull so hard to get the same amount of work done. If you use a lever, you don't have to push so hard to get the work done. Students should be using the words push, pull and force repeatedly when discussing their work.

We use the term 'weight' in this unit, as we're discussing the how the force of gravity pulls down on the mass. Easy rule – if you are using Newton meters, you are measuring the **weight** of something. If you're using scales, or any other weighing equipment, you're measuring the **mass.** This is something that students perpetually confuse, and will be taught specifically at KS3, so don't worry too much about getting these terms exactly right.

As with other units in Y5, we will be looking at the scientists who discovered the facts we are learning, and what they did to make those discoveries.

Unit structure

This unit is structured around seven science enquiries:

1. What do you remember about forces?
2. Is friction good or bad?
3. Does gravity work underwater?
4. Who can make the best rocket?
5. How much can you lift with a lever?
6. How did the Victorians use gears and pulleys?
7. Who can build the best bridge?

Links to previous and future National Curriculum units

Y3 – Forces

KS3&4 Physics

<table>
<tr><th colspan="4">Enquiry 1: What do you remember about forces?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td rowspan="3">Y3 Forces</td><td>EA – Problem solving

Asking questions
Making predictions</td><td rowspan="3">Can your children:
- State that a force is a push, pull or turn
- Describe the effect a force may have on an object</td><td rowspan="3">Horizontal:

Vertical:
KS3&4 Physics</td></tr>
<tr><td>Key concepts:</td></tr>
<tr><td>Forces are a push, pull or a turn.
A force changes how an object moves, or changes its shape.</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Force, push, pull, turn, speed up, accelerate, slow down, decelerate, start, stop, change, direction, shape, contact, non-contact</td><td colspan="2">Students often confuse forces, objects and energy. A force is a pushing or pulling action – when I kick a ball the force is the pushing action of my leg. The force that pushes a car forward is the driving force of its engine. The force pulling a parachutist to Earth is the force of gravity pulling on them.</td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">Forces are a push, pull or turn (GD may note that a ‘turn’ is a simultaneous push and pull).

Forces make an object start to move, speed up, slow down, stop, change its direction or change its shape. Anything that changes how an object moves, or changes its shape, is a force.

Understanding these two concepts is fundamental to success in the rest of the unit – and to understanding physics at KS3&4.

Most pushes and pulls happen where there is contact between two objects (e.g. your foot and a ball, your hand and a door/pen). Magnets exert a force without any contact – they can feel the force before they have touched each other.

Review what you learnt in Y3 by looking at a lot of images of people doing things, particularly in sports. Can you identify where there is a push/pull happening? If you can see something moving, you should be able to identify the force that caused that movement.

Gravity is a force pulling down on objects. The more mass that something has (the more ‘stuff’ it’s made of), the more gravity will pull it down. We can tell how much gravity pulls on something by how heavy it is.</td><td>Images of sports, where a force is involved.

Newton meters and suitable objects for the students to compare the weight of</td><td></td></tr>
</table>

Use newton meters to investigate the weight of different objects. Notable scientists – Galileo and Newton.		

<table>
<tr><th colspan="4">Enquiry 2: Is friction good or bad?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td>Y3 Forces</td><td>EA – Comparative/fair testing

Asking questions
Making predictions
Observing and measuring
Setting up tests
Key concepts:
Friction is a force which pushes back against another force when an object is moving.
Friction is different on different surfaces.</td><td>Can your children:
- Tell you what friction is
- Tell you what they were trying to find out in this investigation</td><td>Horizontal:
Maths - measuring

Vertical:
KS3&4 Physics</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Force, gravity, contact, push back, slow down, rough, smooth, time</td><td colspan="2"></td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">Friction is a contact force that pushes back when two objects are moving over each other. It slows things down, because it makes the main pushing force smaller.

In the slide show in the links is a good image showing the two different soles side by side. One has a lot of friction which means that it pushes back when the foot is on the ice, so the foot doesn't move. The other has hardly any friction, so it doesn't push back against the ice - so when the foot is on the ice it keeps moving.

Watch some videos of curling. What makes the person start moving? How do they go faster? How does the person stop? What makes the stone stop? All answers should relate to: movement and acceleration happens because of a 'push' force from the foot or a hand, slowing and stopping happens because of friction pushing back. If there is a lot of friction (like a grippy shoe), the object will stop quickly, if there isn't much friction (like between the stone and the ice) the object will stop slowly. Keep emphasising that there is 'pushing' happening, and in what direction it's happening.

GD – how do they keep the stone moving? The idea that they're melting the water on the top of the ice so it can 'slide', because the water is slippy – less friction.</td><td>A smooth uniform slope about 1m long
Different materials to cover the slope – wood, foil, cotton, oil, water
A suitable object that will slide (not roll) down the slope
Stopwatches/timers</td><td>http://glennpaulley.ca/curling/2011/05/22/curling-shoes-choosing-a-slider/ - comparing curling shoes

https://www.youtube.com/watch?v=0U7rY0NfzYk
Curling in action</td></tr>
</table>

Investigating friction 'Pulling a shoe' with Newtonmeters on different surfaces rarely gives meaningful results and can lead to misunderstandings about the forces involved. Covering a slope with different materials (wood, foil, paper, cotton, oil, water) and timing how long an object takes to **slide** (not roll) down the slope is a better comparison. Again – emphasise that we're investigating which slope has the most friction – which means which surface is pushing back the most. Gravity is pulling the object down, friction is pushing back. Keep emphasising which slope has most friction, which has less. The slope HAS to stay the same angle and length for this to be true! **Measuring** – how will they measure the time in the most accurate and precise way? How will they decide when to start and stop? Review some of the investigations from earlier in the year – how fair is this test? How fair can we make it? Are there things we should control, that we can't?		

<table>
<tr><th colspan="4">Enquiry 3: Does gravity work under water?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td rowspan="3">Y3 Forces</td><td>EA – Comparative/fair testing

Asking questions
Making predictions</td><td rowspan="3">Can your children:
- Describe what upthrust is
- Describe how they could change upthrust on an object</td><td rowspan="3">Horizontal:

Vertical:
KS3&4 Physics</td></tr>
<tr><td>Key concepts:</td></tr>
<tr><td>When an object is in a liquid, the liquid pushes back against gravity. This force is called upthrust.
Upthrust changes depending on the shape of an object.</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Force, push, pull, gravity, upthrust, streamline, bigger, smaller</td><td colspan="2">Upthrust is not equal to the weight of a floating object. It is equal to the weight of the liquid that was displaced. Students do not need to know this, as we're not discussing relative sizes of the forces – just avoid them stating the misconception above, where possible.</td></tr>
<tr><th>Suggested activities</th><th>Resources</th><th colspan="2">Useful links</th></tr>
<tr><td>Gravity pulls objects down wherever they are on the planet. Gravity works underwater – but we don't fall as fast in water. Why is this? The water pushes back on us.

When gravity pulls an object down in water, the water pushes back up. We call this 'upthrust'. The size of the upthrust depends on how much an object is pushing on the water.

Give each group a piece of plastecine about the size of a golf ball. They need to investigate whether it always moves through liquid at the same speed.

Drop the plastecine into the liquid, and time how long it takes to reach the bottom. Change the shape of the plastecine, and see whether it takes more or less time to reach the bottom. Record your results. Make as many different shapes as you can, and see how it affects the time it takes to fall.

If timing is too difficult, you could just observe the differences, and then get the students to draw/design the object that will fall the fastest through water.

GD – can you predict whether a certain shape can fall faster or slower? Can you try and explain why some will move faster than others?</td><td>Plastecine
Tall, straight containers that will hold water – large measuring cylinders are ideal, but anything tall (about 30cm) and relatively narrow is fine
A large container of washing up liquid or similar*
A tuff tray or similar to contain mess.

*students could drop the plastecine into water, but it falls quickly and timing is difficult.</td><td colspan="2">https://www.youtube.com/watch?v=TUOEejJF4_w
Plastecine in liquid</td></tr>
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<table>
<tr><th colspan="4">Enquiry 4: Who can make the best rocket?</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td>Y3 Forces</td><td>EA - Comparative/fair testing

Asking questions
Making predictions
Interpreting and communicating data
Key concepts:
When something is being pushed forwards, air pushes back against it. This is a force called air resistance.
Streamlining makes the air resistance force smaller.</td><td>Can your children:
- Describe what air resistance is
- Describe the effect of streamlining, in terms of air resistance
GD – compare air resistance and upthrust, and discuss surface area</td><td>Horizontal:

Vertical:
KS3&4 Physics</td></tr>
<tr><th colspan="2">Key terms</th><th colspan="2">Common misconceptions</th></tr>
<tr><td colspan="2">Force, push, contact, air resistance, slow, streamlining, reduce, make smaller</td><td colspan="2"></td></tr>
<tr><th colspan="2">Suggested activities</th><th>Resources</th><th>Useful links</th></tr>
<tr><td colspan="2">Recap gravity as a force pulling downwards on objects.

Compare a picture of a person in freefall and a person with a parachute. Note that gravity is pulling them downwards and making them move.
Look at a picture of a dog, and then a similar dog with his head out of a moving car window.

There is a force pushing back against the person and the dog. Get the students to walk slowly in a straight line about 10m long. They are pushing themselves slowly through the air. Get them to run the same line – you could film them – what looks different? They should notice that their hair/clothes are being pushed back when they run. Whenever we move through air, the air pushes back against us. The faster we move, the more the air pushes back.

Streamlining – design a rocket
Students should concentrate on the front of the tube – compare jeeps with racing cars. Look at the design of real rockets – they may have different features, but they all have pointy ends. Students may be aware of other features that rockets and racing cars have, like spoilers and fins – some of these are for performance, such as improving steering. They can add these,</td><td>2L plastic bottles
PVC pipe that fits closely into the neck of the bottle
A4 Paper
Sellotape
Scissors</td><td>https://www.youtube.com/watch?v=GQ32ShfE6k4
How to make a paper rocket</td></tr>
</table>

but should be focusing on improving streamlining. Emphasise that this means giving less surface for the air to push against. Competition – whose rocket goes the furthest? That is an easy test of the best streamlining – however they should also discuss how they can keep the initial force/push from the bottle the same to make a fair test. They may not be able to actually accomplish a uniform 'push', but can come up with ideas for how they would try to do this next time. **Interpreting and communicating data** – students to communicate which rocket was the best, and try and link this with an explanation of streamlining. Discuss – boats have similar issues in water. What shape are boats, usually?		

<table>
<tr><th colspan="4">Enquiry 5: How much can you lift with a lever</th></tr>
<tr><th>Links to previous learning</th><th>Scientific skills</th><th>Assessment criteria</th><th>Curricular links</th></tr>
<tr><td rowspan="2">Y3 Forces</td><td>EA – Comparative/fair testing

Asking questions
Observing and measuring
Recording data</td><td rowspan="2">Can your children:
- Tell you that a lever decreases the size of a force needed to lift something
- Interpret information from a graph to illustrate the point above</td><td rowspan="2">Horizontal:
Maths – continuous data
History – Victorians & leisure time?

Vertical:
KS3&4 Physics</td></tr>
<tr><td>Key concepts:
A lever makes the force needed to lift something smaller.
The further from the fulcrum of the lever, the smaller the force needs to be.</td></tr>
<tr><td colspan="2">Key terms</td><td colspan="2">Common misconceptions</td></tr>
<tr><td colspan="2">Force, push, pull, weight, lever, fulcrum, bigger, smaller, increase, decrease</td><td colspan="2"></td></tr>
<tr><td>Suggested activities</td><td>Resources</td><td colspan="2">Useful links</td></tr>
<tr><td>See saw – potential link with the Victorians and leisure time? Parks etc?

Look at images of seesaws. Students could make one – some instructions available online. What if an 8 year old wanted to go on a see saw with their 4 year old sibling/cousin? Students should realise that the 4yo would be suspended, and the 8yo stuck on the ground.

A good demonstration is to get a student to use a door handle using one finger. It should be relatively easy to push the handle with one finger if they are at the very end of the handle. If they are closer to the fulcrum, they need to push down with much more force. Another demonstration is slamming a door – it's easy to slam a door if you push it from the edge furthest from the hinges. The nearer you are to the hinges, the bigger the force you will need in order to slam it.

Emphasise that in all these cases, what you are doing is making the force you need smaller – which is why it 'feels easier'.

Investigation – how much can you lift with a lever? This investigation leads to a line graph for interpretation. See resource for details. Students should be given the opportunity to make their own scale – but should be given a scale if they struggle. The key skill to develop here is interpreting continuous data from a line graph.</td><td>Ruler, pencil and two coins

1 x 1kg mass
10 x 100g masses*
1m ruler
A suitable fulcrum (such as a poster tube)

* or other uniform objects such as small wooden blocks

Y5 levers resource</td><td colspan="2"></td></tr>
</table>

<table>
<tr><td colspan="4">Enquiry 6: How did the Victorians use gears and pulleys?</td></tr>
<tr><td>Links to previous learning</td><td colspan="2">Scientific skills</td><td>Assessment criteria</td><td>Curricular links</td></tr>
<tr><td rowspan="2">Y3 Forces</td><td colspan="2">EA – Research

Asking questions
Making predictions
Interpreting and communicating data</td><td rowspan="2">Can your children:
- Tell you that gears and pulleys decrease the force needed
- Give examples of where Victorian industry used gears and/or pulleys</td><td rowspan="2">Horizontal:
History
D&T

Vertical:
KS3&4 Physics</td></tr>
<tr><td colspan="2">Key concepts:
Gears and pulleys decrease the forces needed to move objects.
Industry use gears and pulleys extensively.</td></tr>
<tr><td colspan="2">Key terms</td><td colspan="3">Common misconceptions</td></tr>
<tr><td colspan="2">Force, push, pull, weight, gear, pulley, bigger, smaller, increase, decrease</td><td colspan="3"></td></tr>
<tr><td colspan="2">Suggested activities</td><td>Resources</td><td colspan="2">Useful links</td></tr>
<tr><td colspan="2">Gears – Water wheels in cutlery works

A gear is where a big wheel can make a smaller wheel turn, and vice versa. They need to be attached to each other with cogs for this to happen.

Victorian era Sheffield – cutlery works. Many of these places used water wheels – the water turned a large wheel slowly. This wheel was connected by belts to smaller wheels. A large wheel turning slowly can turn many small wheels quickly.

Investigate the use of water wheels in cutlery works or other factories. Students could make models of working water wheels and associated belts/wheels.

Pulleys – Winding gear in collieries

Students could investigate how the winding gear worked – why didn't they just pull the coal and people up and down directly? Why did they use a pulley? Students could try pulling weights up to the height of a desk directly, and then by using a simple pulley.

Students could investigate Victorian era accidents relating to winding gear.

They can use history & D&T to investigate levers, gears and pulleys further.</td><td></td><td colspan="2"></td></tr>
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<table>
<tr><td colspan="5">Enquiry 7: Who can build the best bridge?</td></tr>
<tr><td>Links to previous learning</td><td colspan="2">Scientific skills</td><td>Assessment criteria</td><td>Curricular links</td></tr>
<tr><td rowspan="2">Y3 Forces</td><td colspan="2">EA – Problem solving

Asking questions
Making predictions
Evaluating</td><td rowspan="2">Can your children:
- Tell you that the weight of objects on a bridge cause a pushing force
- Describe why their bridge was particularly successful or unsuccessful</td><td rowspan="2">Horizontal:
History
D&T

Vertical:
KS3&4 Physics</td></tr>
<tr><td colspan="2">Key concepts:
Bridges have to withstand the force of large weights pushing down on them.
Different structures can withstand forces differently.
GD students might understand that the structures ‘push back’ against the force of the weight.</td></tr>
<tr><td colspan="2">Key terms</td><td colspan="3">Common misconceptions</td></tr>
<tr><td colspan="2">Force, push, gravity, weight, withstand, strong</td><td colspan="3">Students often don’t understand that ‘weight’ is a force.</td></tr>
<tr><td colspan="2">Suggested activities</td><td>Resources</td><td colspan="2">Useful links</td></tr>
<tr><td colspan="2">Look at some of the Victorian era bridges (or other local bridges) in the area. These bridges have a lot of weight going over them – some carry roads, others canals or railway tracks. They have to be very strong to push up against all the weight pushing down on them. How do they work?

Bridge building competition. Students should be given a set number of art straws, A4 paper and some sellotape to design a bridge.

The bridge that holds the most weight is the winner. You can award points for each 100g the bridge holds, and remove points for each extra straw they request.

They can investigate the shapes that are strongest first. Triangles are particularly strong shapes.

Students could investigate Tower Bridge, and the lifting mechanism, and design something similar. If so, they should look at what forces are involved, and whether they can make a force have a bigger effect.

Instead of a bridge competition, the students could design something using levers, gears and pulleys.

They should evaluate the winning design – what made it successful?</td><td>Art straws, or other long, thin structures
Sellotape
A4 paper

Small 100g masses, or other uniform objects such as small wooden blocks</td><td colspan="2"></td></tr>
</table>