Ocean Academy Poole
an Aspirations Academy
Self-Worth | Engagement | Purpose

Learning Journey Map

Year: **5** Term: **Autumn 2**

Subject: **Science** Topic: **Forces**

Driving Question: How can we design, develop and refine a rocket which will defy the laws of gravity?
Power Skill: Critical thinking - I can share and compare multiple solutions to a problem based on how well they meet the needs and limits of the overall solution. With adult support, I can order my thinking to solve problems.

National Curriculum Learning Objectives

- 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.

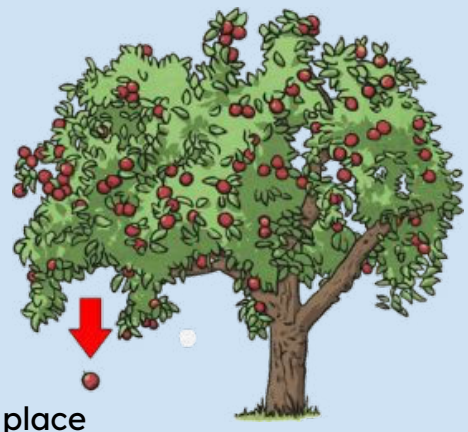
Key Vocabulary

gravity	air resistance	water resistance	counteracts	weight
mass	Newton	Galileo	streamline	opposing forces
surface area				

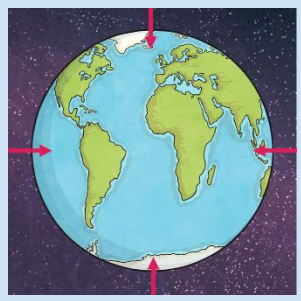
Key Learning

Revisit and revise: Year 3 Forces and Magnets Learning Journey Map.

Thinking Point
What do you remember about forces and magnets from Year 3?
Tell your partner.



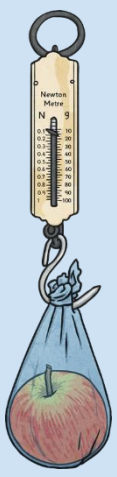
Gravity:
Gravity is an invisible force that pulls. An important example is how the Earth and other planets are kept in place by the Sun. Another important example is how it also keeps us and other objects on the ground.
We can represent gravity with an arrow pointing down towards the Earth.
Gravity is a pulling force exerted by the any massive object. The gravitational force from the Earth, for example, pulls towards the centre of the Earth. Gravity is pulling the apple and these skydivers towards the middle of the Earth.



Anything which has mass exerts a gravitational force. The larger the mass, the greater the gravitational force.
For example, the Sun has a mass so huge that it creates a gravitational force strong enough to hold the entire solar system in place. Planet Earth has a mass big enough to exert a gravitational force strong enough to keep everything on it in place and to keep a natural satellite (the moon) in orbit. The Moon's gravity is one-sixth (1/6) of Earth's gravity, so an object with the same mass will weigh differently on Earth than it does on the Moon. For example, an astronaut weighs 120kg on Earth. Even though the astronaut does not change size or mass, their weight on the Moon would be just 20kg.

Thinking Point
Why is the gravity on the moon different to the gravity on Earth?

Weight and Mass:



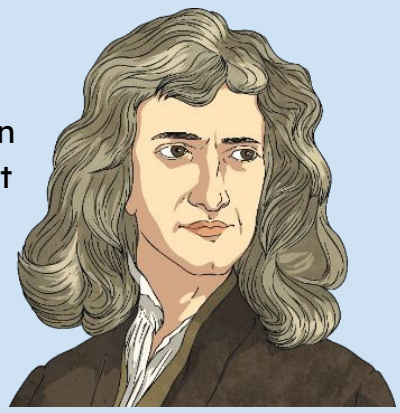
Mass is a measure of how much matter or 'stuff' is in an object. Small objects may contain a lot of matter, like a metal ball. Larger objects may contain very little matter, like a polystyrene block. Mass is measure in grams and kilograms (and sometimes pounds (lbs) and stone)
Weight is the mass of an object, affected by how strong the gravity is. Therefore, weight is also a force. Weight is the force of a mass pushing down (by gravity) on the surface on which it is standing. Weight is measured in Newtons.

Thinking Point
Why does large not always mean heavy?

Explore and Investigate
Investigating air resistance.
Conduct an investigation into parachutes, to discover how the surface area of a parachute affects the speed at which it falls.

Resources:
Newton meters, parachute investigation equipment including timers, K'nex to demonstrate pulleys and gears.

Key Learning



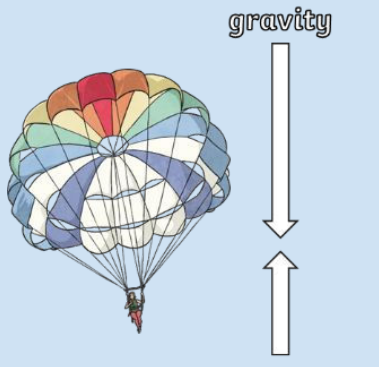
Sir Isaac Newton

Sir Isaac Newton was born in 1642 and is known as one of the greatest scientists to have lived, as he was the man who published his theory of gravity in 1687. Legend has it that Newton was hit on the head with an apple and that is how he discovered gravity.

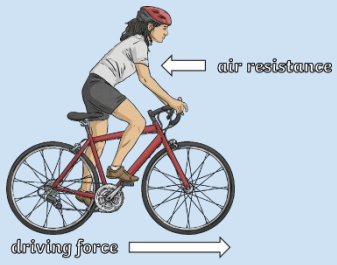
Newton discovered that Earth must have a force, which pulls things down instead of letting things float upwards. We call this force gravity. Newton discovered that gravity attracts all objects towards each other. The heavier an object, the more gravity it would have. He developed this theory to work out that gravity kept the moon in orbit around Earth.

What is air resistance?

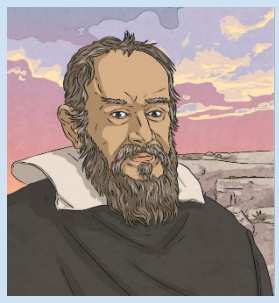
Air resistance is the name of the force that is pushing up against the parachute. Gravity is pulling the skydiver towards the ground. However, they are slowed down because a force (air resistance) pushes against the inside of the parachute and they descend more slowly. Gravity and air resistance are opposing forces in this situation but gravity is still the stronger of the two. The forces are unbalanced. When parachuting, air resistance is a useful force as it counteracts the force of gravity to slow the speed down so that the passenger can land safely.



Air resistance can be a useful force, but it can also be unhelpful in certain situations.
In a cyclist's situation, the air resistance is unhelpful as it is slowing down the speed being generated by pedalling; making it harder work to move forward.



Thinking Point
Can you think of any other ways where air resistance can be useful?



Galileo Galilei, (1564-1642)

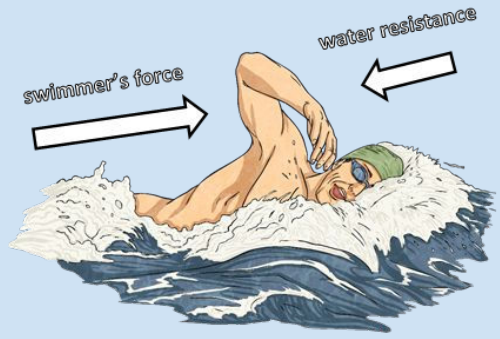
Galileo Galilei was an Italian scientist who wondered about air resistance. In 1590, he decided to carry out an investigation to find the answer. He climbed to the top of the Leaning Tower of Pisa with two balls of similar shape and size, but with different masses. He dropped both of the balls from the top of the tower at the same time. Both balls hit the ground at the same time.

Galileo's experiment proved that all objects fall at the same speed, no matter what their mass is. But this can seem hard to believe! Think about a feather and a hammer. If you dropped both objects at the same time, would they hit the ground at the same time? No, they wouldn't. However, that isn't because of their mass, it is because of their ability to 'catch air'. What do you think happened when astronauts stood on the Moon and dropped these two items at the same time? The feather and the hammer hit the surface of the Moon at the same time! This proved that Galileo's findings are correct because there is no air on the Moon. Air pushes against any object moving through it: air resistance. On Earth, air resistance acts on both the hammer and the feather. The feather has a large surface area in comparison to its mass. The hammer has a small surface area in comparison to its mass. Therefore, air resistance has a greater upwards force on the feather causing the hammer to reach the ground first.

Thinking Point
If you dropped two equal containers of different weights, would they hit the ground at the same time? Why?

What is water resistance?

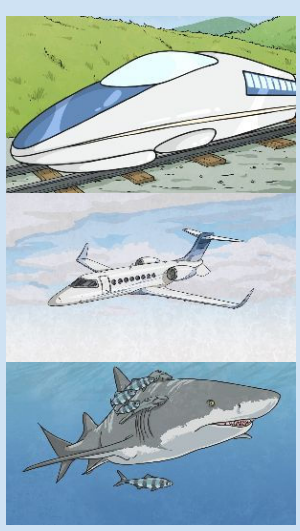
In the same way that air can cause resistance to moving objects, so can water. If you have ever walked through water, you will have felt the effects of water resistance pushing against you. However, water resistance is a useful force as it helps you to swim. When you push against the water with your hands, the water resistance pushes back and helps you to move forward.



Thinking Point
Can you think of any ways where water resistance can be useful?

Streamline shapes to reduce resistance:

It is possible to reduce the effects of water and air resistance to make things move faster. For example, cars, trains, planes and boats are designed to reduce the effects of air and water resistance. This is called streamlining. This high-speed train and jet aircraft have been designed to be streamlined and reduce the impact of air resistance. Both examples have a pointed (cone-shaped) nose so that they can 'cut' through the air, a low, curved top to allow the air to flow over and around it easily and they are both also made of smooth, shiny materials.



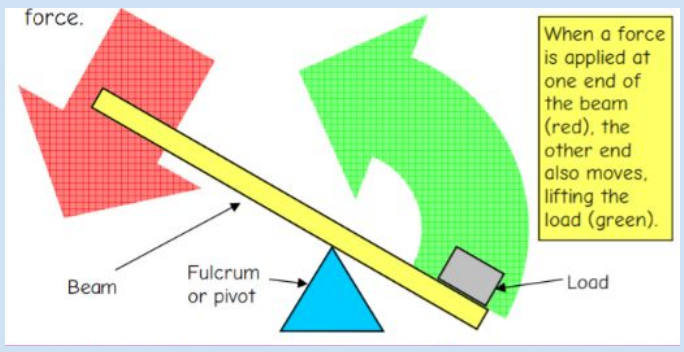
Looking at nature too, we can see how certain animals have adapted to be more streamlined.
The great white shark, for example, has a pointed nose to cut through the water, and a smooth, low, curved back to allow the water to flow over and around it. It does not create much water resistance so it can move through the water quickly.

‘Bringing Learning to Life: No Limits.No Barriers.’

Key Learning

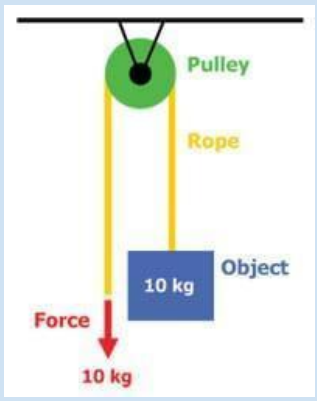
Machines:
Machines are devices that change the direction or size of a force. There are six types of simple machines: wheels, ramps, wedges, levers, gears and pulleys. Most simple machines reduce the force you need to apply to lift or move a heavy object by making the distance over which you apply the force larger than the distance the object moves.

Levers:
A lever is one of the oldest and simplest machines used by humans. A lever consists of just 2 parts: a beam (the long part) and a fulcrum or pivot (hinge).
The beam rotates along the fulcrum like in this diagram here.



Levers are particularly useful because they allow humans to lift heavy objects by applying less force than if trying to lift without the lever. The boy in the picture is lifting a heavy log. It is so heavy he can hardly lift it. His friend is lifting a similar heavy log. He is lifting it more easily because he is using a small log resting on another log as a lever. The lever makes lifting the heavy log easy. A lever always rests on a pivot. In this case, the log on the ground is acting as a pivot. A lever always has three things – the point where you push or pull, the point where it pivots, and the point where the force is applied.

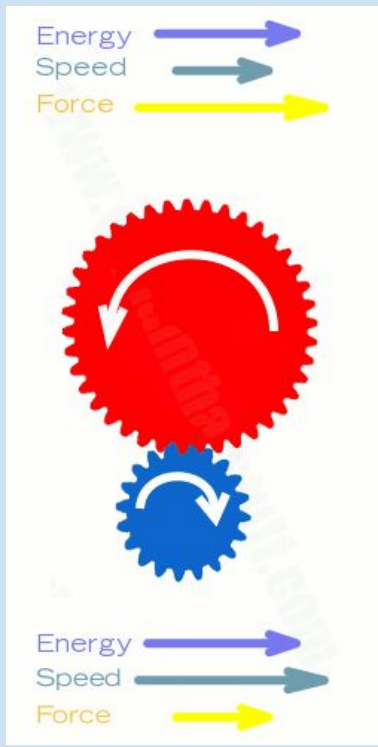
Thinking Point
Can you draw a quick diagram to show how a lever works?



Pulleys:
A pulley is a wheel with a grooved rim around which a cord passes. The pulley acts to change the direction of a force applied to the cord and is used to raise heavy weights.
In the picture, the boy and the girl are both lifting a bucket full of wood. The girl finds it difficult, but the boy is using a pulley tied to a tree and is lifting the bucket with the rope passing under the pulley. He has to exert the same pull as his friend, but he finds it easier to pull on the rope than she does to lift the bucket up by the handle.

Thinking Point
Why do pulleys make it easier to lift heavy objects?

Cogs and Gears:
Gears are wheels that have teeth, or cogs, around the edges. The cogs of one gear fit into the cogs of another. They move in opposite directions. In other words, when one gear turns to the right (clockwise), the gear attached to it will turn to the left (anticlockwise). This pattern continues to repeat, regardless of how many gears are attached to each other. As gears turn, energy is transferred from one gear to another. They can either increase or decrease speed or force.
If a large gear is attached to a small gear with the large gear as the drive gear (first turn), this will cause the small gear to turn. As the larger gear (drive gear) turns, the small gear will speed up to keep up with it. This type of gear sequence increases speed.
Gears are very useful for transferring energy in to larger movements, speed or power.
They are used widely in bikes, motorbikes and cars.



Thinking Point
Looking at the diagram, can you explain how cogs and gears work?