

## YEAR 5 UNIT 4: Let's Get Moving! (Forces)

### Enquiry Question: What are forces and how do they work?

**Related units:** Year 3 unit 5: What are the similarities and differences between magnets and forces?

#### Unit overview

##### National Curriculum Links Year 5: Forces

Children will explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. Children will identify the effects of air resistance, water resistance and friction that act between moving surfaces. Children should explore falling objects and raise questions about the effects of air resistance by observing how different objects such as parachutes and sycamore seeds fall. They should experience forces that make things begin to move, get faster or slow down; the effects of friction on movement; explore the effects of levers, pulleys and simple machines. They will find out how scientists e.g. Galileo Galilei and Isaac Newton helped to develop the theory of gravitation. Children will recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect. This builds on children's knowledge from Year 3, when they compare how things move on different surfaces and notice that some forces need contact between two objects, but magnetic forces can act at a distance. They know a little about forces from the magnets topic in Year 3, and in the previous unit, they have learnt about air resistance and how it slows down objects that move through the air.

#### Scientific vocabulary

- Gravity
- Weight
- Newton
- Non-contact
- Friction
- Air resistance
- Water resistance
- Force meter
- Reliable
- Spring
- Gear
- Pulley
- Machine
- Force
- Lever

#### Working Scientifically

- 1. Down we go:** Take measurements (Newton Meters) with increasing accuracy and precision, record data and results. Report and present findings, including conclusions. To know about the life and work of scientists – Galileo and Isaac Newton (not statutory).
- 2. Falling objects:** Plan a fair test recognising and controlling variables where necessary, taking measurements, recording data and results, reporting and presenting findings, including conclusions.
- 3. Rubbing together:** Plan a fair test recognising and controlling variables where necessary, taking measurements, recording data and results, reporting and presenting findings, including conclusions.
- 4. Water resistance:** Plan a fair test recognising and controlling variables where necessary, taking measurements, recording data and results reporting and presenting findings, including conclusions.
- 5. Simple machines:** Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect. Record using diagrams
- 6. Make a machine:** To know about the life and work of an inventor and engineer – Rube Goldberg (not statutory).

#### Assessment

1. Explain what makes objects fall to the Earth
2. Explain how levers, springs, pulleys and gears transmit force and motion
3. Explain what gravity is and its effect on objects
4. Explain who Rube Goldberg is

#### Cross-curricular links

##### English:

- Write up a fair test using the correct scientific vocabulary
- Write a biography of Rube Goldberg

##### Maths opportunities:

- Calculate averages
- Produce bar charts and record data in tables

## Teacher knowledge

**Gravity** is an attractive, non-contact force. It is measured in newtons (N). Any two objects have a force of gravity between them. This only becomes obvious when the objects have a very large mass, such as the Earth, Moon or Sun. Gravity gives weight to objects with mass and causes them to fall towards the centre of the Earth when dropped. The force of gravity on the Moon is less than on the Earth.

**Galileo** discovered that everything falls at the same speed. In 1658, he dropped two balls of different masses from the leaning tower of Pisa. He discovered they hit the ground at the same time. This contradicted the ideas of **Archimedes** and the accepted view that heavy objects fall faster than light objects.

**Sir Isaac Newton** first set out the laws of gravity. His universal law of gravitation states that every mass in the universe attracts every other mass with a force that is directly proportional to their combined masses and inversely proportional to the square of the distance between them.

**Albert Einstein** further developed the theory of gravity. He did not believe it was a force at all. Instead, he said gravity was a distortion in the shape of space-time, otherwise known as 'the fourth dimension'. According to him, moving objects move in space-time, which fits with Newton's theory.

**Friction:** This is a contact force caused by two objects rubbing together, such as a bike brake and the wheel rim. Air and water resistance are two good examples of friction. The effect in each case is to slow the object down. In addition, remember – friction can be reduced by lubrication and streamlining. Friction is a force. It occurs when any two things rub against each other. These can be solid things, like your two hands rubbing together or a hammer hitting a nail. They can be gases, like the air slowing down your car. In this case, we call the friction air resistance. Finally, friction can occur in liquids, such as when water slows down a boat. The size of the friction force can be very big. Bear in mind that two rough surfaces will generate more friction than two smooth surfaces. Air and water resistance are what is known as drag forces. These depend on the shape, size and speed of the object that is moving through the air or water. Streamlining jet planes or submarines reduces the water resistance, allowing the objects to move through air or water much better.

**A lever** is a machine consisting of a beam or rigid rod pivoted at a fixed hinge, or fulcrum. You can exert a large force over a small distance at one end by exerting only a small force over a greater distance at the other. Levers are found in scissors, wheelbarrows and staplers.

**A pulley** is a wheel with two raised edges so that a rope or a string will run along the wheel without coming off. A single or fixed pulley is very useful for lifting loads vertically. It is easier to pull downwards than it is to pull upwards. More than one pulley can be connected to one another by ropes. In this case the pulleys can move. These have the advantage of not only moving the load but making them easier to move. For example, pulleys are used in cranes to lift heavy objects.

**Springs** are coiled pieces of wire that can be compressed or stretched. The more a spring is compressed or stretched, the greater the force it can exert. Spring-loaded ballpoint pens contain springs, and cars have them to provide a smoother ride.

**Gears** are wheels with teeth that fit together. When one moves, the other moves in the opposite direction. In addition, when a gear with a small number of teeth drives a gear with a large number of teeth, such as in a hand whisk, they can magnify a force. If a gear with a large number of teeth drives a gear with a small number of teeth, it makes the small gear move faster. This is very useful in cars.

**Rube Goldberg** is best known for a series of popular cartoons depicting complex gadgets that perform simple tasks in indirect, convoluted ways. People make them into multi-step machines that transfer force and motion. Levers, pulleys, springs and gears can be used in them as well as other simple machines such as the inclined plane, wedge, screw and wheel and axle.

### Did you know?

- Albert Einstein did not believe that gravity was a force at all. He believed that gravity was a distortion of space and time.
- Modern submarines have a teardrop-shaped hull, which is the best shape to help them reduce water resistance.
- The ancient Greeks, Egyptians, Indians and Chinese all used simple machines to build marvellous structures like the pyramids and the Great Wall of China.
- Some racing bikes can have as many as 27 or 33 speed gears.
- Rube Goldberg's cartoons are actually mocking modern society's dependence on complex technology.

### **Misconceptions. Children might think that....**

- heavy objects fall faster than lighter objects. In fact, they both fall at the same speed.
- objects come to a stop when there is no friction. In fact, they'll keep on moving forever if they're left alone.
- friction only occurs between solids and surfaces. Water and air resistance are examples of friction that involves a liquid and a gas.
- the bigger the gears, the faster the object moves. In fact, speed depends on the number of teeth on two gears. machines are always complicated but in fact, simple machines do many useful jobs.

### **Resources**

A detailed YouTube clip about gravity for teachers: [www.youtube.com/watch?v=Yi1H\\_9JOwkl](http://www.youtube.com/watch?v=Yi1H_9JOwkl)

A useful clip about air resistance: [www.bbc.co.uk/learningzone/clips/air-resistance/10595.html](http://www.bbc.co.uk/learningzone/clips/air-resistance/10595.html)

A useful clip about Galileo's falling objects off the Leaning Tower of Pisa: [www.bbc.co.uk/learningzone/clips/testing-air-resistance/1634.html](http://www.bbc.co.uk/learningzone/clips/testing-air-resistance/1634.html)