

Key Stage: KS2
Year: 5

Forces

Prior learning:

Yr 1

Pupils should be taught to:

- differentiate different sorts of movement and how to describe these.
- relate movement to pushes and pulls.

Yr 2

Pupils should be taught to:

- describe different kinds of movement.
- know that pushes and pulls can make things start or stop moving.

Yr 3

Pupils should be taught to:

- know that pushes and pulls are examples of forces.
- know vocabulary describing simple forces and movements.

Yr 4

Pupils should be taught to:

- know vocabulary describing simple forces and movements and use friction as an example.

Science PoS

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 force and motion can be transferred through mechanical devices such as gears, pulleys, levers and springs, allow a smaller force to have a greater effect.

Science PoS

Non statutory requirements:

Pupils should explore falling objects and raise questions about the effects of air resistance. They should explore 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. Pupils should explore the effects of friction on movement and find out how it slows or stops moving objects, for example, by observing the effects of a brake on a bicycle wheel. Pupils should explore the effects of levers, pulleys and simple machines on movement. Pupils might find out how scientists such as Galileo Galilei and Isaac Newton helped to develop the theory of gravitation.

Teacher assessment criteria

- Describe the effects of simple forces that involve contact (air and water resistance, friction)
- Describe the effects of simple forces that act at a distance such as gravity
- Identify simple mechanisms, including levers, gears and pulleys, that increase the effect of a force

Subject Knowledge:

- Pushes and pulls are examples of forces.
- Forces act in particular directions.
- When a force is applied it will make an object start moving, stop moving, change shape or change direction.
- The greater the force, the greater the movement or change in shape.
- The speed with which an object falls to the ground does not depend on its mass.
- The rate will vary if the object offers more resistance to the air because of its shape, e.g. a feather.
- Weight is another name for the gravitational force from a large object like the Earth.
- If a feather and a lead ball were dropped together they would both hit the ground at the same time if there was no air on this planet.
- The greater the mass, the greater the force needed to pull the mass. The steeper the incline, the greater the force required to pull the object up the ramp. The greater the mass/incline the more the elastic band will stretch. This can be measured with a ruler. Forces are measured in newtons.
- A boat shape will float if it includes a large volume of air even though the material from which it is made is heavier than water.
- The mass of the boat is being pulled down due to gravity.
- The water is pushing the boat up. This is called upthrust.
- The boat floats when these two forces are balanced.
- When an object does not move the forces are balanced.
- Objects will move when the force in one direction is greater than any other forces preventing it from moving.
- Objects move in the same direction unless a force is applied to change it.
- When a moving truck hits a barrier, the force will make the barrier move or change shape or cause the truck to change shape or move backwards.
- Softer materials will be able to absorb the force by changing shape. Harder materials will be more likely to move or cause the truck to crumple or move back.
- Magnets attract certain metals. Like ends of magnets repel each other. Unlike ends attract.
- Objects fall to the ground at the same rate regardless of their mass providing they offer the same resistance to the air. Air resistance slows down the rate of fall e.g. autogyros, sycamore seeds. *Galileo first proved this in the 1600s when he dropped three balls of different masses from the Leaning Tower of Pisa. They all hit the ground at the same time.*
- The greater the air resistance the slower the autogyro or parachute will fall. Air resistance will be increased if there is a greater surface area of fabric or card. Force **is** measured **in** newtons **with** a newton meter. When a scale is put on a meter it is called calibration. When a newton meter is used to measure the force needed to lift an object it is the same as its weight.
 - *100g is equal to 1N*
 - *1g is equal to 0.01N*
 - *1kg is equal to 10N*

- *Because the gravity of the Moon is only one sixth of the Earth, objects weigh 6 times less on the Moon. This means that if a 600g stone from Earth is lifted on the Moon it will only weigh 100g.*
- Friction is a force that reduces the sliding movements between two surfaces.
- It has many important applications in our lives - for instance - we slip on icy pavements, we could not walk without friction, braking depends on friction, a nail is held in a wall by friction, parachutes descend slowly due to friction.
- The moving parts of machines are lubricated to reduce friction.
- Forces can be represented with arrows showing the direction of the force. If equal and opposite forces are applied, the object does not move. If unequal and opposite forces are applied, the object moves in the direction of the greater force.
- If forces are applied at right angles, the object moves diagonally. Objects are balanced when the forces acting upon them are equal. According to Newton's law of motion - "action and reaction are equal and opposite".
- An object will stay at rest until a force is applied which changes the balance of the forces. The object will then move in the same direction as the greater force.
- When springs and elastic bands are stretched they exert a force on whatever is compressing them. When springs are compressed they exert a force on whatever is compressing them.
- A see-saw will be balanced when the forces on both sides are balanced.
- When a boat floats, the up thrust from the water equals the pull of gravity. *Sea water is more dense than fresh water so it has a greater up thrust. Heavily laden boats that float in sea water could sink when they sail into fresh water.*

Forces can:

1. Stretch an object
2. Tear things
3. Squash things
4. Bend things
5. Make an object turn or spin
6. Twist an object
7. Make an object move
8. Make a moving object go faster
9. Stop a moving object

Types of forces:

1. Springs and elastic bands

Materials that are elastic are able to be stretched. They return to their original shape when no longer being stretched.

2. Gravity and Weight

Gravity

Gravitational force is a pull towards the centre of an object such as the Earth. All objects have a gravitational force, but the size of the force is related to the mass of the object. Objects with big masses have very large gravitational forces. The Moon, having less mass than the Earth, has a gravitational pull one fifth of the Earth's.

Weight

Weight is the pull of the Earth's **gravity** on the mass of an object. All objects exert a force of **gravity** on each other; the size of the force depends on their masses. A bigger mass is being pulled down by a bigger force. For example, A 2 kilogram bag of salt is being pulled down with a force of twenty. An increase in mass does not affect how fast an object will fall towards Earth. The result of the bigger pull on the bigger object is the same as the effect of a smaller pull on a smaller object.

3. Friction in air and water

Friction

Friction is the resulting force from two surfaces rubbing together. These surfaces include solids, liquids and gases.

Air resistance

Objects moving through air experience the frictional force of the air, which acts in the opposite direction of their movement. So, when objects fall through the air, the air resistance is the force that acts in the opposite direction of gravity. In the air, the air particles rub against the object causing friction. The greater the rubbing, the greater the air resistance will be. An object falling faster will have more air resistance because there will be more particles rubbing against the object. The one with a large surface area will be more affected than one with a small surface area. Thus, the effect of air resistance depends on the surface area and the rate at which the object is falling. There can come a point for a falling object where effects of air resistance and gravity are balanced. At this point it will fall at a steady speed; it has reached terminal velocity. Different objects can take different amounts of time to reach terminal velocity. A person with a parachute will reach this more quickly because the parachute builds up air resistance more quickly. A heavier parachutist reaches Earth before a lighter parachutist because, although the air resistance is the same, the gravitational force is greater on the heavier one and so he/she accelerates for longer before reaching terminal velocity.

The effect of a parachute trapping air is like the upthrust that objects experience in water. The particles are squashed together, and so push back against the object.

Upthrust

Upthrust in water is the force pushing up against an object. If this force balances the gravitational force pulling the object down, then it will float.

A submerged object also has upthrust pushing against it. One can measure this by measuring the objects weight out of the water with a Newton meter, and then measuring its weight when in the water. The weight in the water is less, and the difference is the upthrust provided by the water