

Forces

National curriculum objectives covered in this lesson:

Year 5 - Forces

- 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

Science in the news today

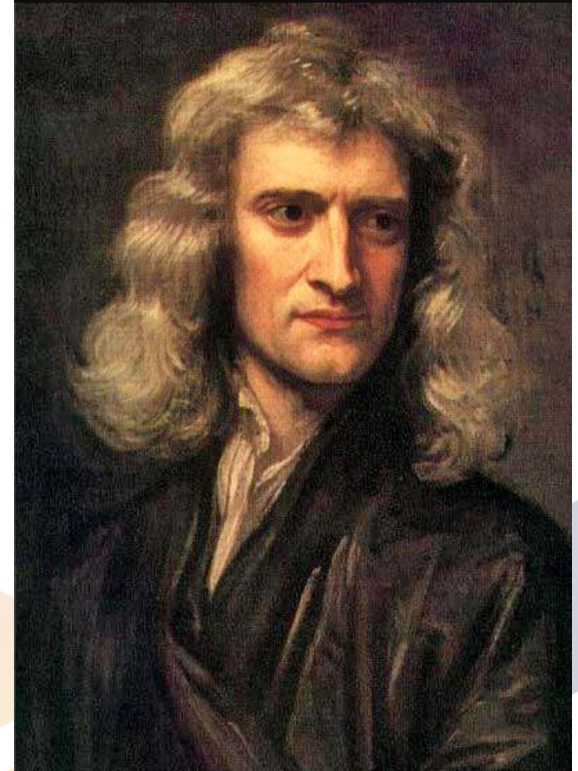
Have you heard of Isaac Newton? He is the person that discovered gravity and changed people's view of the world. You may have heard the story of Isaac Newton and the apple falling from the tree? It is said that Issac was sitting underneath an apple tree when an apple fell out of the tree and landed straight onto his head, suddenly making him realise that there must be a force that was causing the apple to fall down to earth. He called that force gravity. Gravity is the attractive force that causes all objects to fall towards Earth. It is the reason we don't all float off into space whenever we jump in the air. He described his theory using mathematics that had never been done before.

Of course, it took Isaac Newton many years before he got his calculations about gravity just right but he made his initial studies of gravity during quarantine from the plague all the way back in 1665. He left his university, his friends and his life in Cambridge and spent a whole year in isolation, during which time he developed his theory on one of the most groundbreaking scientific discoveries of his time; gravity.

Here are some paintings of Isaac Newton



This is a depiction (image) of Isaac Newton when he was isolating himself at his family farm in Woolsthorpe.



What is gravity?

Gravity is another **force** that is in effect all the time on Earth. It is a force that exists between the Earth and every single object on the Earth, causing the object to fall towards it.

It is because of gravity that you can run and jump, and land back down safely without flying off into the air. It's because of gravity that when you drop something it falls to the ground.

Find an object that isn't fragile e.g. a football, soft toy, cushion, pencil etc, hold it in your hand and let go of it. No matter how many times you do that, the object will fall to the floor. It will never zoom upwards into the air or off to the left or right. It will always fall to the floor because the force of gravity is acting between the Earth and the falling object, causing the object to fall.

More force!

Another force we encounter every day is friction.

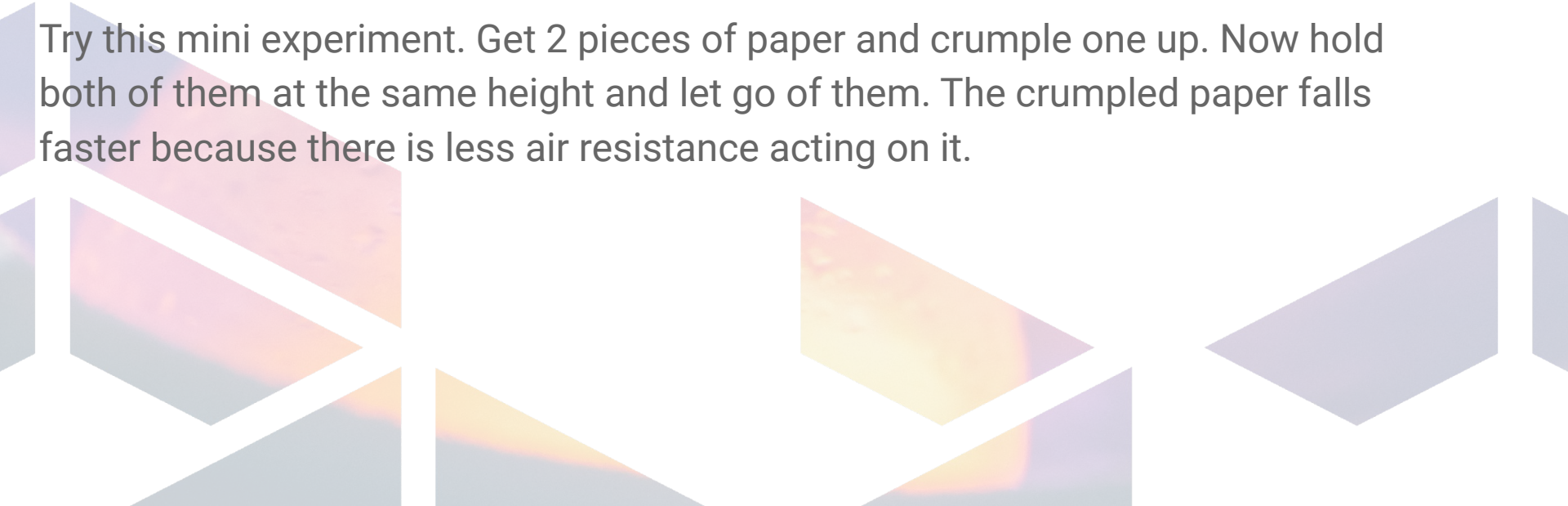
Friction is the force that acts between any two objects that are touching or sliding past one another, and slows them down.

Friction causes an object to move slowly across another object, and how slowly depends on the surface of both. A smooth surface like metal or glass, will cause less friction than a bumpy surface like sandpaper or carpet. So an object will slide (or roll) faster over a smooth metal surface than a bumpy carpeted surface, because there is less friction. If the surface of the object is smooth AND the surface is smooth, there will be even less friction allowing the object to slide easily.

Is there friction in the air?

Air resistance is a force that causes objects to slow down when they are travelling through air. Air resistance works with surface area, so the more surface area, the more air resistance there is.

Try this mini experiment. Get 2 pieces of paper and crumple one up. Now hold both of them at the same height and let go of them. The crumpled paper falls faster because there is less air resistance acting on it.



Racing cyclists crouch down low to their bikes and wear smooth, rounded helmets to help them go faster as there is **less** air resistance. If they sat up straight on their bike, all that air would be hitting their chests and shoulders, causing them to slow down.



When using a parachute, the shape is designed very precisely to give **more** air resistance so the user can move slowly through the air.

Gravity is acting on the person and the parachute, causing them to fall, but the air resistance acts in the opposite direction and slows them down.

Is there friction in water?

Water resistance is another type of friction.

Water resistance causes objects to slow down when they are travelling through water.

Have you ever tried to run in water? How did that go? Certainly you were slower than running in the park. Maybe you couldn't run at all! However not all animals find it hard to move in water. Many animals have certain features that help them in water.

Think about fish, whales and boats. They all have certain shapes, smooth surfaces and features that make them 'streamlined'. Streamlined means a reduction in resistance (either in water or air).



A professional swimmer will try and cause **less** water resistance so they can move quickly through the water. They do this by wearing a swimming hat that is smooth, and by keeping their body straight in the water so they are more *streamlined*.

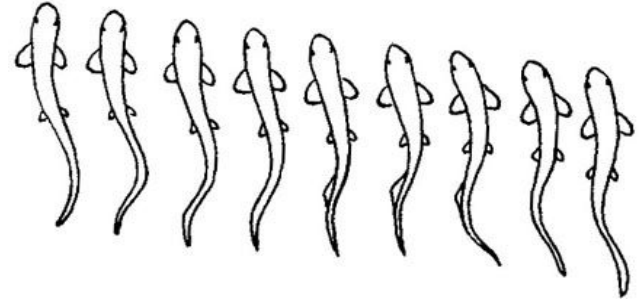


Boats are also designed to give a small amount of water resistance so they can glide along smoothly. They have a point at the front which allows water to easily slide past as the boat travels.

How does shape affect resistance?

If something is streamlined it means it has an ideal shape for moving through water or air quickly by reducing the amount of resistance (this is sometimes called drag). For fish and swimming animals, drag is minimised by having streamlined heads, bodies and tails that allow water to flow over them smoothly, often a little like a teardrop shape, with rounded heads leading to thinner tails of various shapes and sizes.

An aeroplane is streamlined to reduce resistance from the air and allow it to move more quickly.



A friction experiment

What do you need?

- A toy that has wheels e.g a toy car
- A ramp - you may have a ramp as part of a toy set, otherwise use a large book, chopping board or other flat object
- A ruler or tape measure
- A few books to rest your ramp on
- A few different materials e.g a towel, a t-shirt, a bobbly jumper, crinkled tin foil



Instructions:

1. First, put a pile of books on the floor and place your ramp from the books to the floor. Avoid carpet if possible.
Top tip - Don't make the ramp too steep. You want your cars to glide off it at the bottom if possible.
1. Next, put one of your chosen materials on the ramp e.g lay a towel over it or cover it in bumpy tin foil.
2. After that, hold your toy vehicle at the top of the ramp and gently let go
Top tip - Do not push the vehicle down the ramp.
1. Then, measure the distance between the bottom of the ramp and the back wheels of the car. Write this down.
2. Repeat steps 2, 3 and 4 but with a different material on the ramp each time. First

Which material allowed the car to travel the furthest? There was least friction between this material and the wheels.
Which material created the most friction with the toy wheels?

Gravity vs air resistance - make a parachute

What do you need?

- A plastic bag, or something to make a small parachute with e.g. tissue paper or a napkin
- String
- Scissors
- A small toy person or object, to use as a weight

Instructions:

1. First, cut a 5cm x 5cm square from your plastic bag. Always ask an adult before using scissors.
2. Next, make small holes in the corners of the square and tie a piece of string to each.
Top tip - if you have some sellotape put some on the corners before you make the holes, as this will make them stronger.
1. After that, gather the 4 pieces of string and tie them to your small toy person or object
2. Next, choose a height to drop your parachute from, make sure you remember this or write it down.
3. Then, drop your parachute from that height. Observe and, if possible, time how long it takes for it to reach the ground.
4. Now repeat the experiment a few times with the same toy and the same lengths of string but different sized parachutes e.g. 15cm x 15cm and 25cm x 25cm squares.
5. Finally, see if you can make a parachute that takes even longer to reach the ground than any of the ones you have tested, using what you have learnt about air resistance and shape & size.



Gravity vs water resistance

What do you need?

- Moldable material e.g. blu tac, plasticine or tin foil
- A vase, glass or sink full of water



Instructions:

1. First, roll your material into a ball shape
2. Next, hold it at the top of the container and let go. Observe and, if possible, time how long it takes for it to reach the bottom. Write your results down.
3. Now, repeat the experiment a few times with the same amount of plasticine each time, but different shapes e.g. a cube, a triangle, a flat piece, a bowled/boat shaped piece. Time each shape and record how long it takes to hit the bottom. What happens when you increase or decrease the surface area? Think about the water resistance you are placing on that object each time.
4. Finally, see if you can make a shape that has takes a longer amount of time to reach the bottom than any of the ones you have tested so far. What do you have to do?