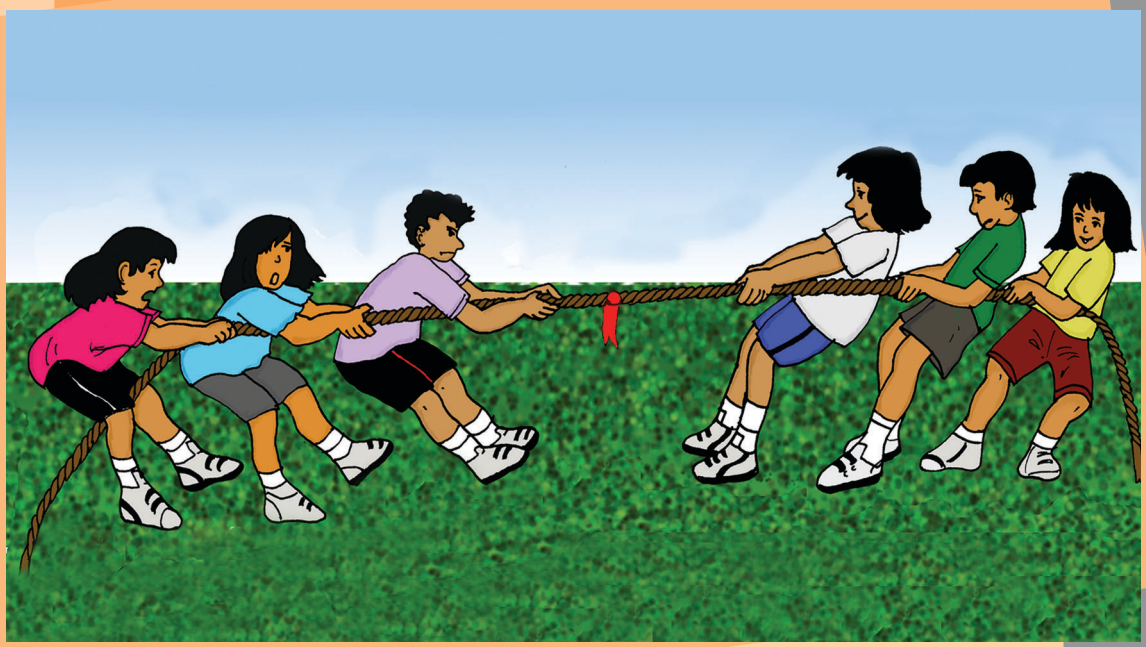
# 4 Forces and Motion



## What you will learn

- What is a force
- Forces around you
- Moving along
- Speed

4a

# What is a force?

Sometimes you get lazy and it is difficult to get up while you are lying down watching television or reading a book.

In such instances you may need someone to give you a **push** or a **pull** to start you moving.

Pushes and pulls are forces. You are using forces everyday. Opening a door, squeezing a lemon or kicking a football are examples of forces in use.

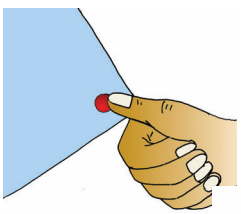
Look at the three pictures opposite and say which one is a push or a pull.

## What can forces do?

What do the forces do? You don't see force but you see what they do to objects. You cannot see wind, but you can see a tree bending or a sailing boat moving.

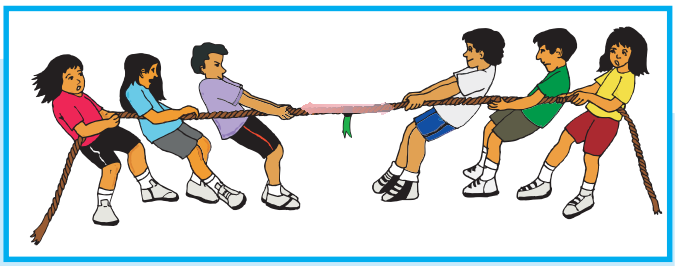
## Forces large and small

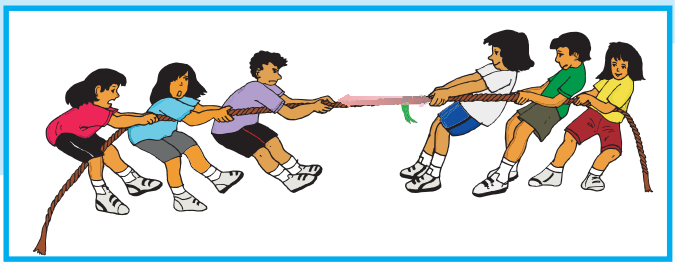
You need a force to make something move which is still.
Here are some forces. Each force is making something to start moving. Some forces are much bigger than others.



## Balancing forces

The two teams are often evenly matched in a tug of war. They pull on the rope with equal forces, and the rope does not move. In this case, the two pulling forces are balanced. When one team gets tired and its force gets smaller. The rope starts to move because the forces are unbalanced, and one team wins. You need an unbalanced force to start something moving.





## The right direction

The shopper provides the push to start the trolley moving. You can show the force by drawing an arrow. The arrow shows us the direction in which the force is pushing or pulling.

## Measuring forces

Forces can be measured. Forces are measured in **newtons(N)**. One newton is a very small force. A mango weighs about one newton. You would need to pull with a force of about 350 newtons to lift an average Grade 6 student up!

To measure forces we use a **force meter**. We can also call it a **newtonmeter.**

**1** Draw diagrams to show the following forces and label the arrows.

**a.** the push of a bat on a ball.
**b.** the pull of a hand on a drawer.

**2** You can easily take a book away from a baby.

**a.** Draw the book, and add arrows to show your pulling force and the baby's pulling force.
**b.** Which of these is bigger?
**c.** Are the forces balanced or unbalanced?

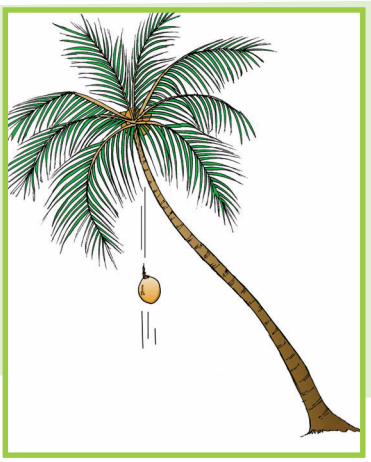
### Ideas

- *A force is a **push** or a **pull.***
- *A force can change the shape of an object or move a still object.*
- *An **unbalanced force** is needed to start something moving.*
- *Forces are measured in **newtons (N)** using a **newtonmeter.***

# Forces around you

There are different kinds of forces. Here are some of the different forces which act on or around you.

## Weight or force of gravity



Gravity is a force which pulls all things towards the Earth. It is this force which makes things feel heavy. Scientists call the force of gravity pulling on an object, its **weight.**

Why does the coconut always fall to the ground and not float away?

## What's weight?

This crane is using a force to lift a heavy object. The pull of the crane must be big enough to lift the weight of the object. The weight of the object is the pull of the Earth's gravity on it. If the chain breaks, the object's weight will pull it down to the ground.

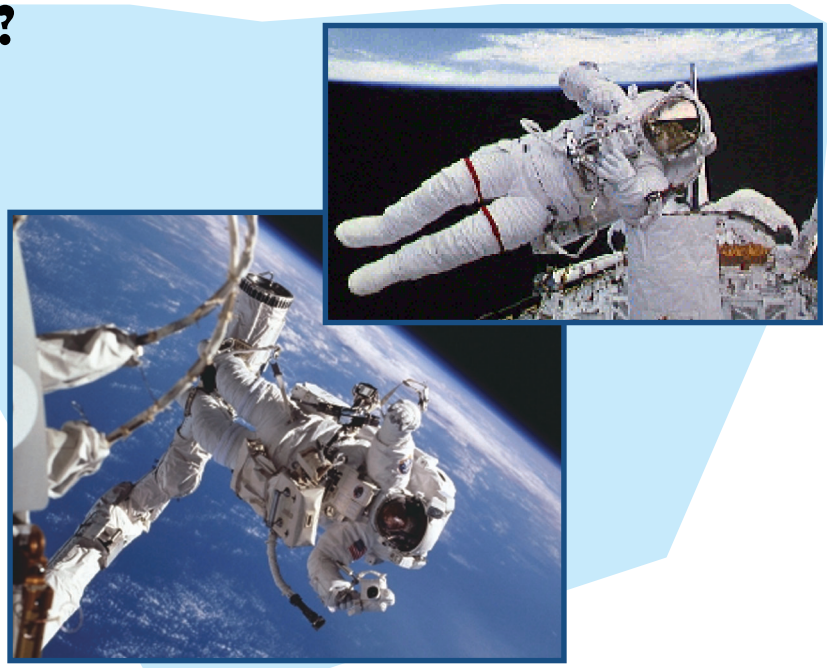
Since weight is a pull, it is a force. So weight is measured in newtons (N). You can measure weight using a newtonmeter.

The weight of a mango is about 1N. Estimate the weight of each of these:

- five mangoes
- ten oranges
- a book
- the person sitting next to you in the class

# What's the matter?

If you go to the Moon, you weigh a lot less. But something about you stays the same. You are still made of just as much 'stuff' as when you were on the Earth. Your mass doesn't change.



## Mass and weight

If you weigh an object whose mass is 1kg, like a bag of rice, you will find that its weight is 10N. If you know the mass of something (in kg), you can easily work out its weight (in N). You simply multiply by 10.

**1** Fill in the blanks using the words below.

| Force | weight | gravity | pull |
|---|---|---|---|

The..... of an object is a ....., caused by the..... of the Earth's ..... on it.

**2** Choose the correct words from each pair.

| | |
|---|---|
| measured in kilograms | mass / weight |
| a force | mass / weight |
| less on the Moon | mass / weight |
| measured in newtons | mass / weight |
| stays the same in empty space | mass / weight |

### Ideas

- *The weight of something is the pull of the Earth's gravity on it.*
- *The weight of something is a force measured in newtons (N).*
- *The mass of something tells us how much matter it is made of.*
- *The mass of something is measured in Kilograms (kg).*

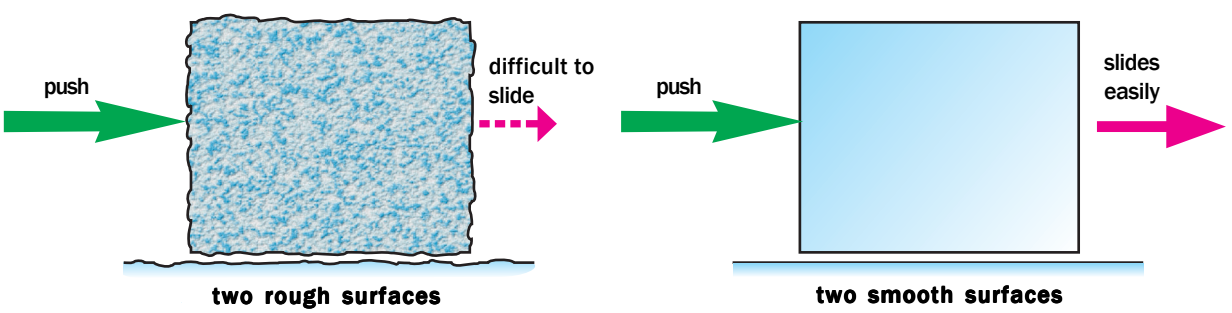
# Moving along


The car had a problem with its engine. It wouldn't move. So the people in the car have solved the problem of how to make the car move. They have very strong muscles, and they can push with a big enough force to start the car moving.

## Rubbing along

It is easier to move something if you can get rid of friction. You can feel friction when you rub your hands together. If something is moving, friction slows it down. Things would move faster without friction. Friction is a force. We can draw a force arrow to show how friction works.

Smooth surfaces have less friction than rough surfaces. It is difficult for one rough surface to slide over another.



## Overcoming friction

Here are some ways of reducing friction, so that it is easier for something to start moving, or to move faster.

How do these things reduce friction?

## Increasing friction

Friction can be a nuisance, but it can also be very useful. The brakes on a bicycle use friction to help you stop. The rubber pads press on the wheel rim, and the friction slows the wheel down. Car tyres have a pattern of tread to give good grip on the road. If the tyres are bald, there is less friction. The car may slide out of control.

**1** Fill in the blanks using the words below.

**start surface less force**

Friction is a ..... It is found when one ..... rubs against another. Friction can make it difficult to ..... something moving. Friction is ..... when surfaces are smooth.

### Ideas

- *Friction is a force which happens when one surface rubs against another.*
- *Friction can make it difficult to start something moving.*
- *Friction can also be useful because it gives you grip.*

# Speed

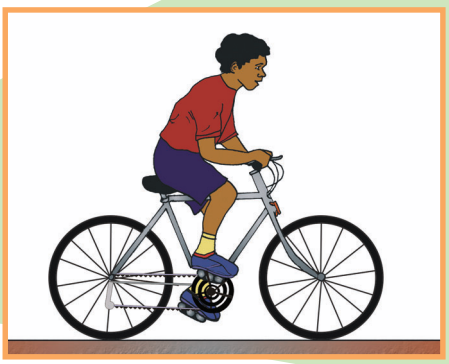
An Olympic runner can run 100 metres in about 10 seconds. A speed boat can travel 120 kilometres in five hours. An aeroplane can fly 2000 kilometres in two hours.

The **speed** of an object is the distance it travels in one second (or one hour). Speed tells us how fast an object is moving. The areoplane has the highest speed because it covers the largest distance in the shortest time.

## Getting things moving

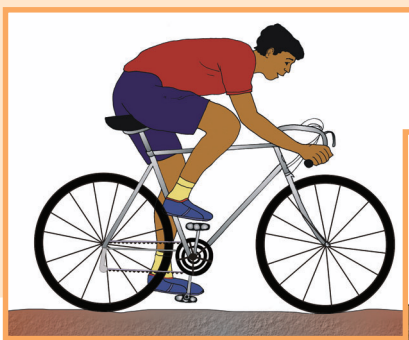
Imagine you getting on a bicycle, you need to push hard on the pedals. Friction makes it difficult to get started.

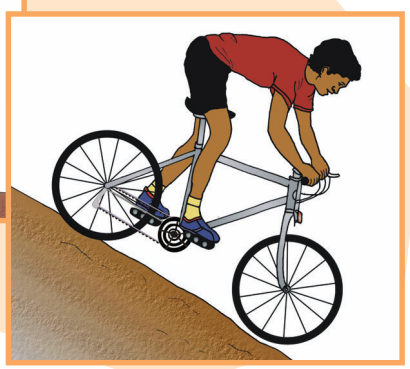
Once you start going, You only need a small force to travel at a steady speed.



## Speeding up and slowing down

A bicycle moving at a steady speed increases its speed when you pedal harder. When speed is increasing the bicycle is **accelerating**. When the brakes of a bicycle are put on, its speed decreases. The bicycle is then **decelerating**.





# Measuring speed

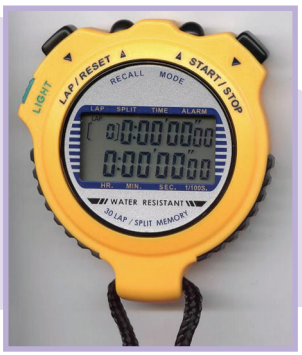
Car drivers need to know the car's speed, to make sure they do not break the speed limit. The speedometer shows how fast the car is travelling.

The police use a radar gun to tell how fast a car is travelling. They will stop anyone who is going too fast.

# How can you measure speed?

To work out the speed of a runner, we need to know two things:
The distance she moves. The time she takes.

The tape measure is used to measure the distance she runs, and the stopwatch times how long she takes.




# Calculating speed

We can calculate his speed using this formula:

$$\text{Speed} = \frac{\text{distance moved}}{\text{time taken}}$$

In science, we have to be careful about the units we use. The table shows the correct units

| Quantity | Unit | Symbol for unit |
|---|---|---|
| distance moved | metres | m |
| time taken | seconds | s |
| speed | metres per second | m/s |

## Ideas

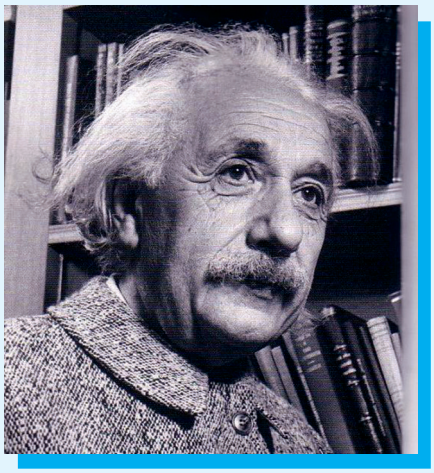
- *Your **speed** tells you how fast you are moving. If you travel a long distance in a short time, your speed is high.*
- *When speed of something is increasing it is accelerating.*
- *When it is slowing down it is decelerating.*

**1** A speed boat travels 35km from Male' to Alif atoll in 1 and half hours. What is its speed, in metres per seconds for the journey?

**2** On sports day, Ahmed ran 400m in 50s. Aminath ran 1500m in 250s. Who was faster, and what werer their speed?

# Albert Einstein

## Born in 1879.



Albert Einstein was born in Germany in 1879. He did not enjoy school very much. After going to Zurich Polytechnic, he went to work for the Swiss Patent Office (a patent is a description of a new invention).

While he was there, he did a lot of thinking about the way things move. At the age of 26 he wrote about his thinking. His work was a great success and it was talked about all the world.

Albert Einstein described the movement of objects as being relative and so his theory was called the theory of relativity. He worked out that the speed of light was the fastest possible speed in the universe. Light travels about 300 000 kilometres every second. Light can therefore travel from London to Edinburgh and back 250 times in one second.

He also worked out that there was a connection between mass and energy. The equation $E= mc^2$ describes this. This discovery led to the development of the atomic bomb and nuclear reactors.

Albert Einstein's work has also been important in modern mathematics and astronomy. His ideas predicted some amazing results. For example, did you know that you increase in mass as you move faster? So when you run for the bus you get heavier! Did you know that time goes faster when you stand still? So if you are on a ride at the fair then you are getting older more slowly than a fried who is watching you! However, on earth, these changes in mass and time are very tiny. You will never notice them.
*(J. Boyd & W.WhiteLaw 1989 John Murray)*