# Types of Quantity

15th May

A QUANTITY is anything that can be measured.

When measuring a quantity we usually take note of its MAGNITUDE (this is the size, or value of the measurement). Most quantities have units too.

Some quantities need a DIRECTION associated with them.

A quantity that just has a MAGNITUDE is called a SCALAR.

If it has MAGNITUDE and DIRECTION it is a VECTOR.

| Scalar | Vector |
|---|---|
| Mass | Forces |
| Time | Velocity |
| Energy | Displacement |
| Current | Acceleration |
| Distance | Momentum |
| Speed | |
| Density | |

We can represent directions with terms such as left, right, up, down etc.

We can also use compass directions, North, South East, West.

We can use bearings (an angle measured clockwise from North).

The most common way to represent directions is with an ARROW. The length of the arrow can also represent the MAGNITUDE of a vector e.g. a longer arrow means a larger value.

## Contact and Non-Contact Forces

All forces are vectors, they all have a size and direction. Forces are measured in NEWTONS using a NEWTONMETER.

Some forces only have an effect when objects touch each other. They are CONTACT forces.

Some forces can have an effect at distance. They are NON-CONTACT forces.

Contact: friction, reaction force, air resistance, water resistance, upthrust

Non-contact: weight, magnetic attraction or repulsion, electrostatic attraction or repulsion

# Mass and Weight

17th May

The MASS of an object is a measure of how much MATTER (stuff) the object contains.

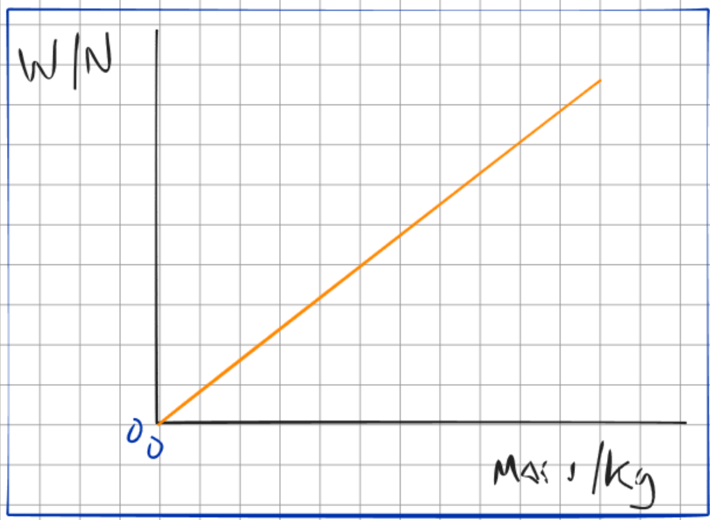
It has the unit of KILOGRAMS.

The mass of an object does not change unless the object itself changes.

The WEIGHT of an object is a measure of how strongly GRAVITY pulls on the object.

It is a FORCE and so has the unit of NEWTONS.

| Mass [kg] | Weight [N] |
|---|---|
| 0.1 | |
| 0.2 | |
| 0.3 | |
| 0.4 | |
| ⋮ | |
| 1.0 | |




- The WEIGHT of an object is DIRECTLY PROPORTIONAL to its mass.
- Weight and mass are linked by the GRAVITATIONAL FIELD STRENGTH.
- Gravitational field strength or 'g' tells us how much force gravity exerts on each kilogram of mass.
- On Earth g = 9.8 N/kg. This means gravity pulls on each kilogram of mass with a force of 9.8 N.

Weight = mass x gravitational field strength

$$W = mg$$

W: in newtons, N
m: in kilograms, kg
g: in newtons per kilogram, N/kg

LEARN.

# Drawing Forces

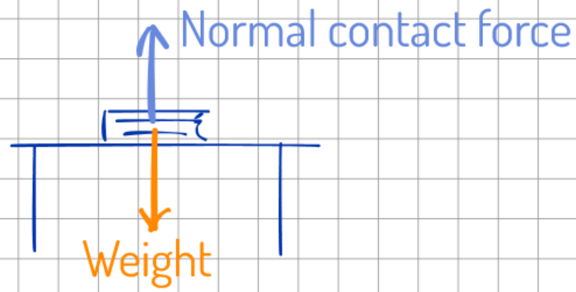
24th May

Generally we draw forces with labelled arrows. The names of the forces depend on the situation an object is in.

Weight: always acts on objects vertically downwards. We usually show an arrow from the CENTRE OF MASS of the object.

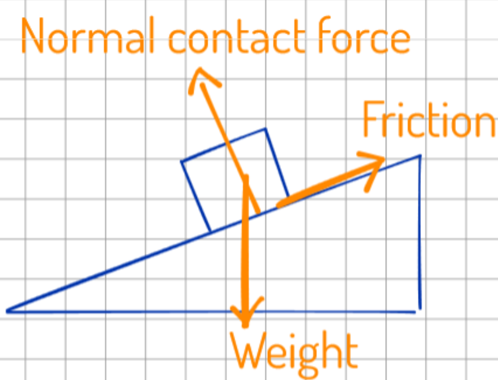
Normal contact force: acts on any object in contact with a surface. This always acts away from the surface and at 90 degrees to the surface.

e.g. A book sat on a desk




Friction: acts between moving objects. Friction always OPPOSES MOTION. It is a RESISTIVE FORCE. Other resistive forces include AIR RESISTANCE or WATER RESISTANCE. Sometimes these are called DRAG.

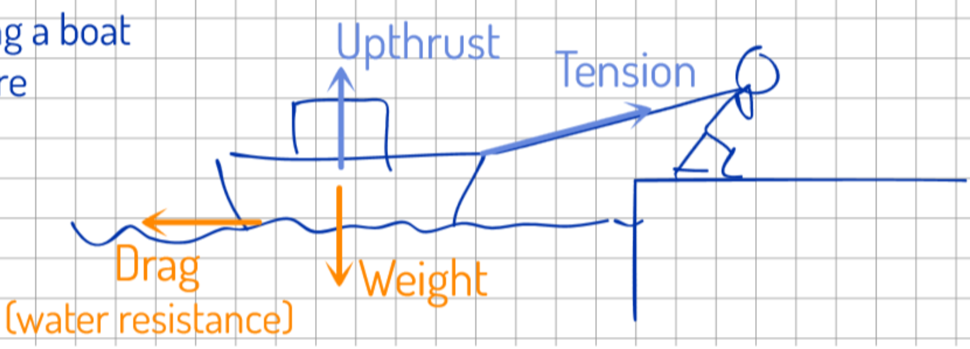
e.g. A box sliding down a ramp




Some other examples of forces include:

- Upthrust acts on objects in fluids i.e. boats on water. It acts upwards.
- Thrust is a driving force from engines and acts forwards.
- Tension is a pulling force that acts through ropes, cables etc

e.g. a Person pulling a boat towards shore

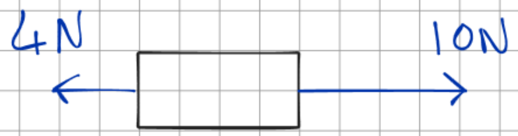


## Resultant Forces

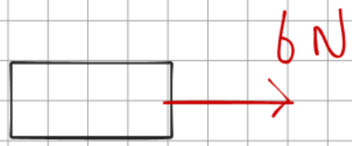
14th June

The RESULTANT FORCE is a SINGLE FORCE that has the same effect as all of the forces acting on an object.

If we need to know whether an object will speed up, slow down or change direction we need to find the resultant force.

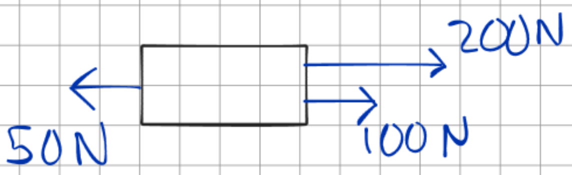



Actual forces

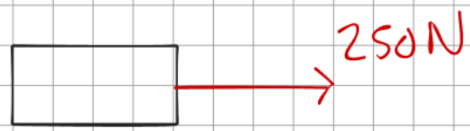



Resultant force

If forces are in OPPOSITE DIRECTIONS then we SUBTRACT THE SMALLER FORCE FROM THE LARGER ONE.




Actual forces




Resultant force

Here we ADD UP forces in the SAME DIRECTION and SUBTRACT any forces in the OPPOSITE DIRECTION.

## Scale Diagrams

18th June

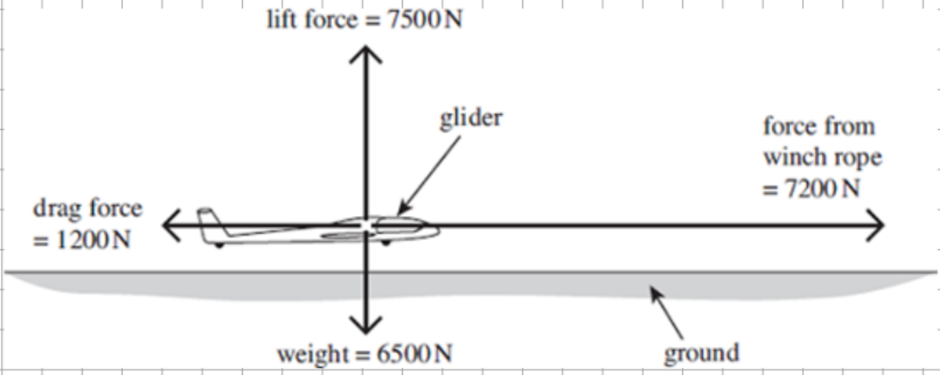
If we need to find a resultant force in a more complicated situation (where forces are at angles to each other, not just along the same line) we can do this using SCALE DIAGRAMS.

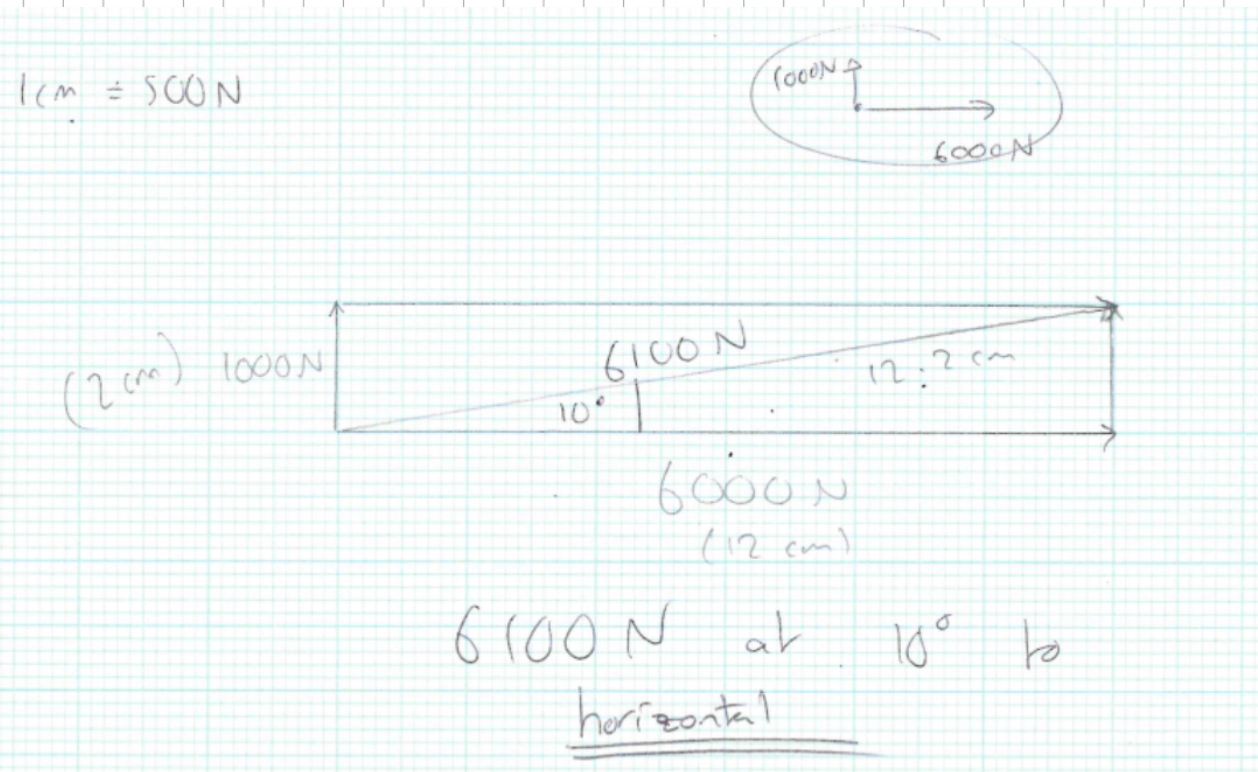
This is where we draw the forces to scale and take measurements to find the resultant.

Method:

1. Choose a scale (e.g. 1 cm = 10 N)
2. Draw arrows from a point to represent forces to scale
3. 'complete the rectangle (or parallelogram)'
4. Draw an arrow from where your forces started, to where they finished
5. Measure its length and use the scale to find size of resultant force
6. Measure the angle between the force and the horizontal to give direction

Example;



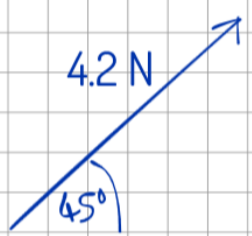

Components of Forces

19th June

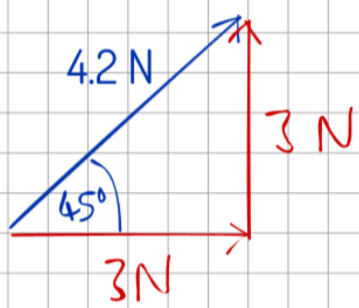
Sometimes we are shown forces that act at an angle. These can be tricky when we are trying to find a resultant force.

To make them easier to deal with we can break a diagonal force down into a HORIZONTAL and VERTICAL COMPONENT.

e.g.

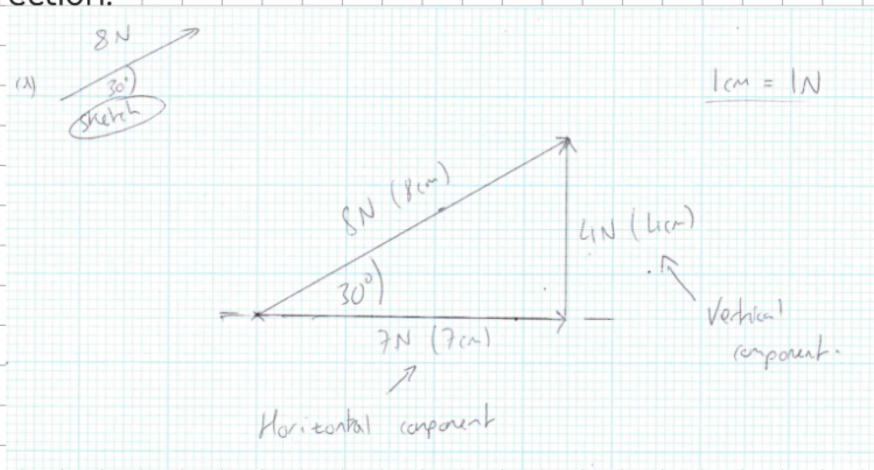



can be broken into;



To find the horizontal and vertical components of a force we use a SCALE DRAWING.

This is where we decide on a scale and draw the force we are shown to scale and in the correct direction.




## Forces doing Work

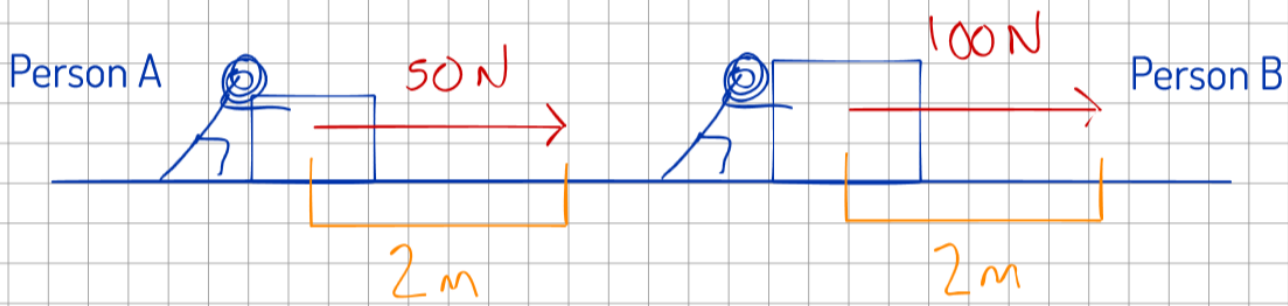
21st June

To DO WORK means to TRANSFER ENERGY.

Forces can transfer energy from one store to another e.g. friction from brakes transferring kinetic energy to thermal energy.

The amount of work done by a force depends on two things;

- The size of the force
- The distance over which the force acts




The person exerting the greater force is doing more work over the same distance.

Work done = force applied x distance moved

$$W = F \times s$$

W in joules, J; F in newtons, N; s in metres, m

Note: this distance must be PARALLEL to the force in the equation

LEARN

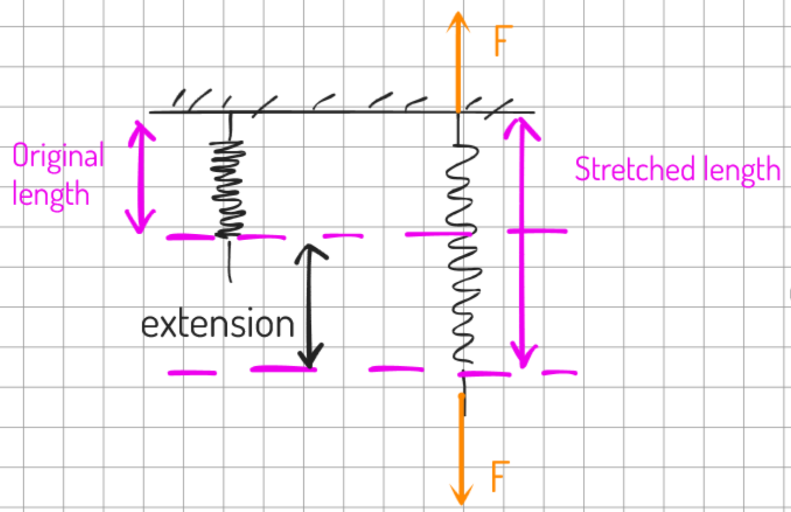
So person A: Work done = 50 x 2
= 100 J of work

person B: Work done = 100 x 2
= 200 J of work.

## Hooke's Law

2nd July

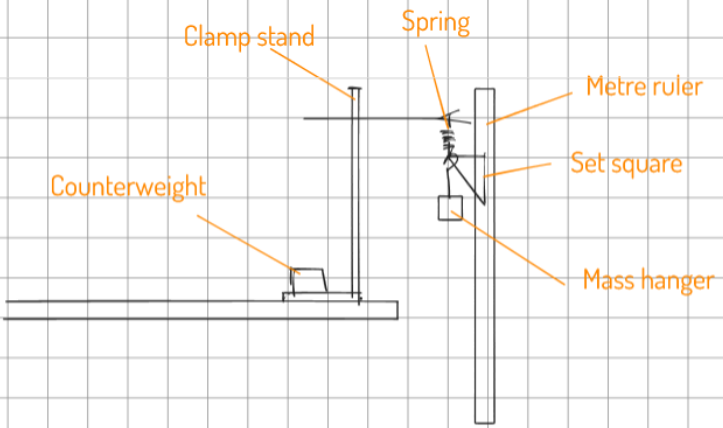
To stretch an object a minimum of TWO FORCES are required, acting in opposite directions.




To find the EXTENSION of a stretched object or the COMPRESSION of a squashed object:

extension = stretched length – original length

## Investigating force and extension; method




Independent variable: force applied

Dependent variable: extension (change in length)

Controls: use the same spring throughout

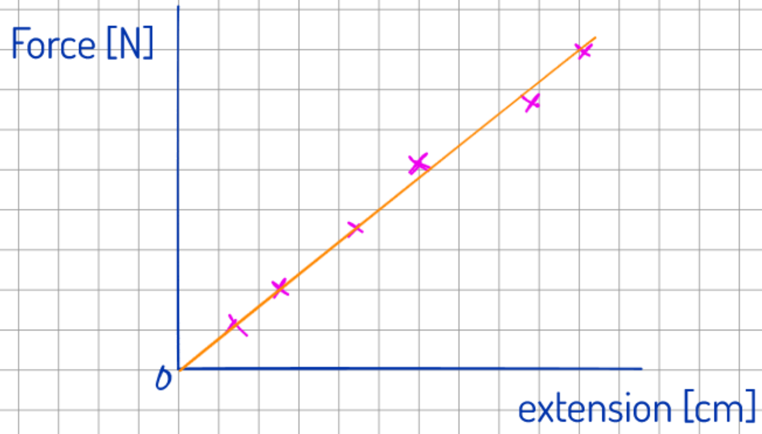
1. Measure the original length of the spring with a ruler.
2. Add a mass to the end of the spring
3. Measure the stretched length of the spring with a ruler
4. Calculate the extension (change in length)
5. Repeat this for increasing masses

## Recording results

Original length = ________ cm

100 g = 1 N

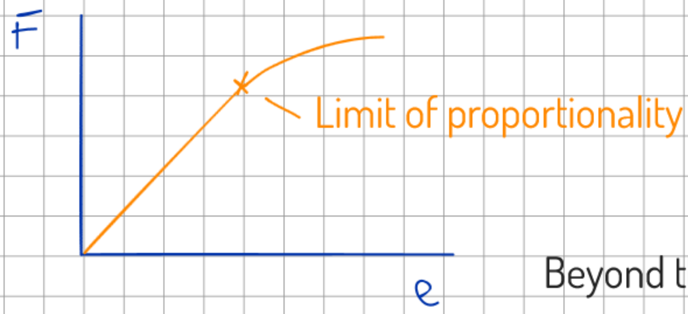
| Mass [g] | Force [N] | Stretched length [cm] | Extension [cm] |
|---|---|---|---|
| 0 | 0 | – | 0 |
| ⋮ | ⋮ | | |
| 700 | 7 | | |




The EXTENSION is DIRECTLY PROPORTIONAL to the FORCE APPLIED (up to the limit of proportionality).

(This is Hooke's Law).

If more and more weight was added then we may go past the limit of proportionality.




If the force is removed before this limit the object goes back to its original size.

This is ELASTIC behaviour.

Beyond the limit the object is PERMANENTLY STRETCHED.

This is called INELASTIC (or PLASTIC) behaviour. The object no longer obey's Hooke's law.

The GRADIENT of a graph of force against extension tells us the SPRING CONSTANT of an object.

$$\text{Gradient} = \frac{\Delta y}{\Delta x} = \frac{\text{Force}}{\text{extension}}$$

$$\text{spring constant} = \frac{\text{force}}{\text{extension}}$$

Which rearranges to give:

Force = spring constant x extension

$$F = k \times e$$

- F in newtons, N
- k in newtons per metre, N/m
- e in metres, m

LEARN

The greater the spring constant the stiffer the spring (need more force to get the same change in length), and the steeper the force against extension graph.