The Thomas Alleyne Academy

Knowledge Organiser - Forces and Motion

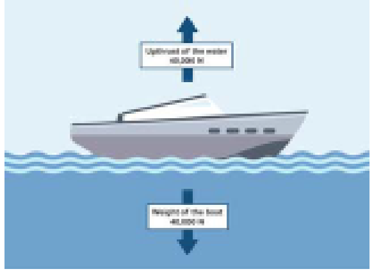
Science Department

KPI 7PF 1: Use diagrams with correctly labelled force arrows to display a range of forces in different situations

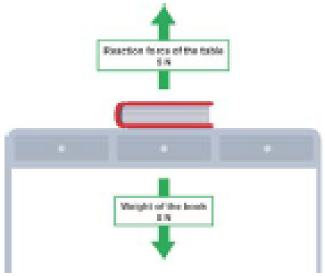
Force Diagrams

To show the forces acting on a body we use a free body force diagram. A **free body force diagram** shows all of the forces that are acting on the body. It has arrows that show the direction the force acts, the larger the arrow, the larger the force. A free body fore diagram should always have labelled arrows.

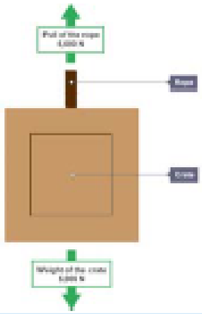
A boat floating



A book on a desk



A crate held up by a rope



Types of force

In the table below different forces are summarised:

Name of Force	What causes it?	Example
Friction	When two objects rub together	Car tyres moving on a road.
Air resistance	When an object rubs against air particles	A sky diver falling through the air
Reaction	A force that acts in the opposite direction	A book on a desk, the force acting up is a reaction force
Weight	The force an object exerts on the ground due to gravity	You will exert a force on the ground, that is your weight
Thrust	The force that drives on objects with an engine	Thrust moves a plane forwards

A force can be a **push or a pull**, for example when you open a door you can either push it or pull it. You can not see forces, you can only see what they do.

When a force is applied to an object it can lead to a change in the objects

- **Speed**
- **Direction of movement**
- **Shape (think about a rubber band)**

Forces can also be divided into 2 types, contact forces and non contact forces.

1. Contact forces for example friction, are caused when two objects are in contact.
2. Other forces for example gravity, are non contact forces. The two objects do not need to be in contact for the force to occur.

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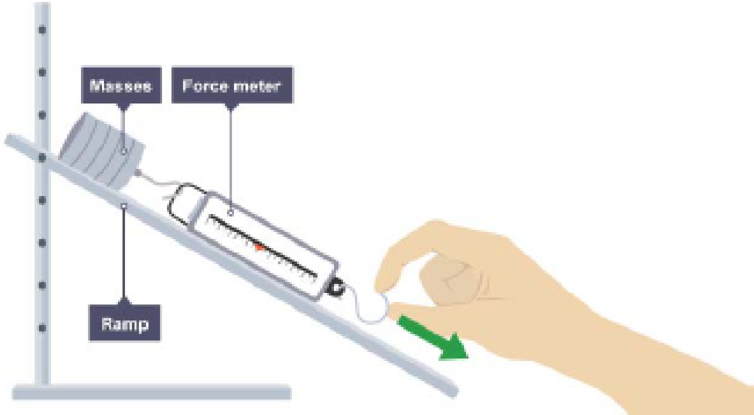
KPI 7PF 2: Interpret force diagrams to determine the motion of an object

Measuring the size of forces

To measure the size of frictional forces on different surfaces you can drag some masses along the different surfaces and record how much force is required.

For this experiment :

- Independent variable: Surface
- Dependent variable: Force
- Control variable: Mass



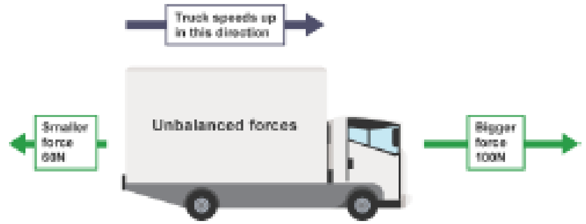
Unbalanced Forces

If the forces are unbalanced on an object there are two things that could happen:

1. If the object is stationary then it will move in the direction of the resultant force
2. If the object is moving, then the object will speed up or slow down in the direction of the resultant force.

For example, what is the resultant force on the lorry below?

100N-60N= 40N (to the right)



Remember the resultant force does not tell you what direction the lorry is moving in.

- If the resultant force is in the same direction as the movement of the lorry then the lorry will speed up
- If it is in the opposite direction the lorry will slow down

The larger the resultant force the larger the change in movement.

Balanced Forces

When we talk about the total force acting on object we call this the **resultant force.** When the forces acting in opposite directions are the same size we say the forces are **balanced.** This means one of two things:

1. The object is stationary (not moving)
2. The object is moving at a constant speed

This is known as Newton's first law.

For example, the resultant force acting on this object is 5N-5N=0N

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KPI 7PF 3: Calculate pressure, weight and average speed using appropriate equations

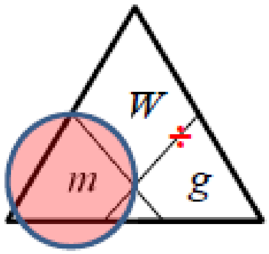
Setting out equations

e.g. A car travels 1,000m in a time of 40 seconds. What is the cars average speed?

Average speed = Distance ÷ Time
= 1,000 ÷ 40
= 25m/s

e.g. A crate has a weight of 500N. On Earth the gravitational field strength is 10N/kg. What is the mass of the crate?

Weight = Mass × Gravitational field strength



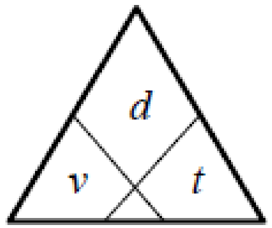
We need to find the mass so we cover up the mass term in the triangle and it tells us to find mass we do:

Mass = Weight ÷ Gravitational field strength
= 500 ÷ 10
= 50kg

Average speed

Average speed (m/s) = Distance (m) ÷ Time (s)

$$v = \frac{d}{t}$$



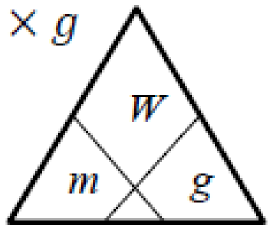
Average speed can also be measured in other units like km/h, mph or cm/s

You need to be careful which units you are using.

Weight

Weight (N) = Mass (kg) × Gravitational field strength (N/kg)

$$W = m \times g$$



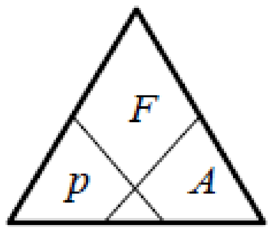
Weight is a measure of the size of the gravitational pull acting on an object.

This pull depends upon the size and mass of an object.

Pressure

Pressure (N/m^2) = Force (N) ÷ Area (m^2)

$$p = \frac{F}{A}$$



Pressure is caused by an object pushing on another.

The bigger the force applied by the object and the smaller the area over which the force is applied the larger the pressure

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KPI 7PF 4: Relate the description of a journey to a distance-time graph

Distance-time graphs

A distance-time graph shows how far an object has moved from its starting point over time.

Distance travelled is always plotted on the y-axis (vertical)
Time taken is always plotted on the x-axis (horizontal)

You can find the speed of an object from a distance-time graph by finding the gradient of the graph. This is the 'steepness' of the line.

Gradient = Change in y-axis ÷ Change in x-axis

Using the graph opposite we can find the speed of the object represented by the green line between 6 and 10 seconds by:

Gradient = Change in y-axis ÷ Change in x-axis
= (7-6) ÷ (10-6)
= 1 ÷ 4
= 0.25m/s

We can also find the average speed of the green object by drawing a line from the start of its motion to the end of its motion. This is shown opposite by the blue line and how to find the average speed is shown below.

Gradient = Change in y-axis ÷ Change in x-axis
= (7-0) ÷ (10-0)
= 7 ÷ 10
= 0.7m/s

Interpreting Distance-time graphs

- A straight diagonal line of a distance-time graph shows that the object is travelling at a steady/constant speed.
- A straight horizontal line on a distance-time graph shows that the object is not moving (stationary)
- If a curved line were to appear on a distance-time graph (orange line) this shows the object is accelerating.