Forces

Keyword	Definition
Velocity	Speed in a particular direction
Acceleration	Speeding up, rate of change of velocity
Terminal Velocity	Steady speed reached when weight and drag balance. Resultant force = 0N
Balanced	Two forces are equal and opposite so resultant force = 0N.
Resultant Force	The sum of all the forces acting on an object
Friction	A force that opposes the motion of a moving object.
Work Done (Mechanical)	Energy transferred when a force moves an object through a distance.
Drag	A force that resits motion through the air.
Lift	A force that uses motion to make objects rise up.
Upthrust	An upwards force pushing on an object in fluids.
Reaction or Normal Force	A force that stops you falling through the floor.

Speed

The speed of an object tells you how fast or slow it is moving. You can find the average speed of an object if you know the distance it has travelled and the time taken to travel that distance.

The equation is:

Speed(m/s) = Distance(m) ÷ Time(s)

$$V = \frac{S}{t}$$

E.g. A car travels 100m in 20s. Calculate the speed of the car.

Speed = Distance ÷ Time

Speed = 100m ÷ 20s

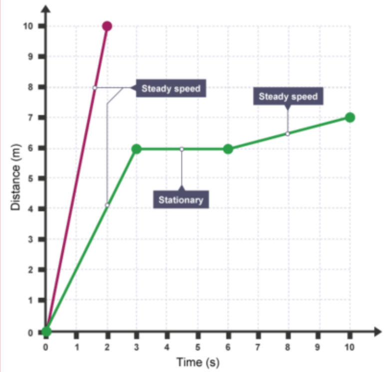
Speed = 5m/s

Further Reading:

https://www.bbc.co.uk/bitesize/guides/zttfyrd/revision/9

Distance Time Graphs

A distance time graph is a useful way to represent the motion of an object. It shows ho the distance move from a starting point changes over time.



If the line is horizontal, the object is stationary (because the distance stays the same).

If the line is a straight diagonal, the object is moving at a constant speed.

The steeper the line, the greater the gradient and the greater the speed.

E.g. Calculate the speed of the green line for the first 3s.

Speed = Distance ÷ Time

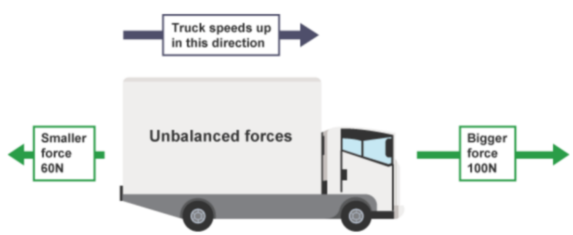
Speed = 6m ÷ 3s

Speed = 2m/s

Unbalanced Forces

If more than one force act along a straight line, the resultant force can be found by adding (acting in the same direction) or subtracting (acting in opposite direction) them.

100 – 60 = 40 N (to the right)



Contact & Non-Contact Forces

All forces between objects are either:

Contact Forces – The objects are physically touching

Non-Contact Forces – The objects are physically separated.

Contact: Friction, Air Resistance, Tension, Normal Contact

Non-Contact: Gravitational, Electrostatic, Magnetic

Acceleration:

Acceleration is the rate of change of velocity. It is the amount that velocity changes per unit time.

Metres per second (m/s)

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Time Taken}}$$

Metres per second squared (m/s^2)

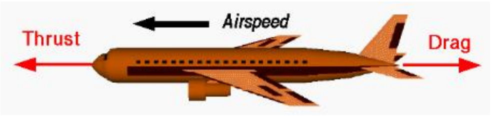
Seconds (s)

$$a = \frac{v - u}{t}$$

Change in velocity = final speed – initial speed

Newton's First Law

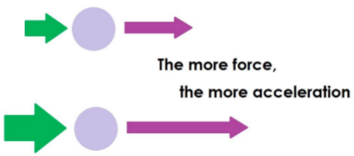
An object has a constant velocity unless acted on by a resultant force



Thrust = Drag. Zero resultant force and the plane moves at a constant velocity.

Newton's Second Law

The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object.



F = ma

F is Force in N

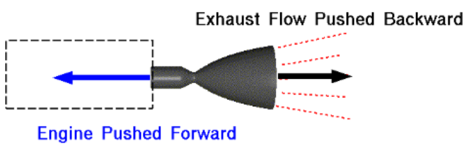
m is mass in Kg

a is acceleration in m/s^2.

Newton's Third Law

Wherever two objects interact, the forces they exert on each other are equal and opposite.

Rocket Engine Thrust



For every action, there is an equal and opposite re-action.

Forces

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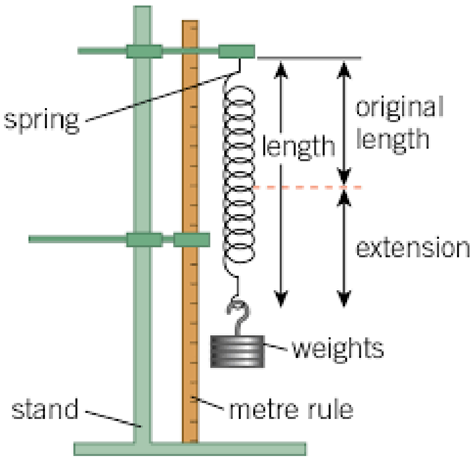
Hooke's Law Practical



Aim: To investigate how adding mass to a spring affects the springs extension.

Method:
1. Set up the equipment as shown in the diagram.
2. Add 10g mass to the holder and record the spring length.
3. Add another 10g and record the new spring length.
4. Take away the previous spring length from the new length to calculate extension.
5. Repeat by adding 100g masses until 100g is reached.

Independent Variable: Mass added (g)
Dependent Variable: Extension (mm/cm)
Controlled Variable: Spring and Slotted Mass

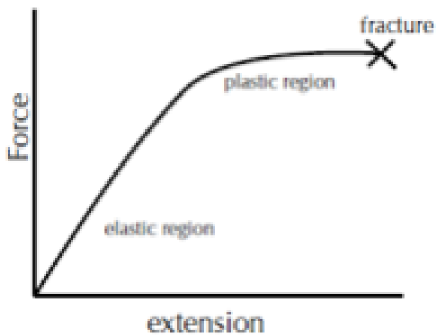
Results

Mass used	Force	Spring length	Extension
0 g	0 N	20 mm	20 mm
10 g	0.1 N	25 mm	5 mm (25 - 20 = 5)
20 g	0.2 N	30 mm	5 mm
30 g	0.3 N	35 mm	5 mm
40 g	0.4 N	40 mm	5 mm
50 g	0.5 N	46 mm	5 mm

The extension of an elastic object, such as a spring, is directly proportional to the force applied, provided that the limit of proportionality is not exceeded.

$F = k\,e$

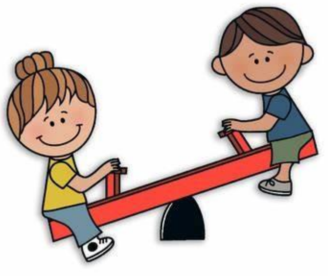
- force, F, in newton's, N
- spring constant, k, in newton's per metre, N/m
- extension, e, in metres, m



Moments:

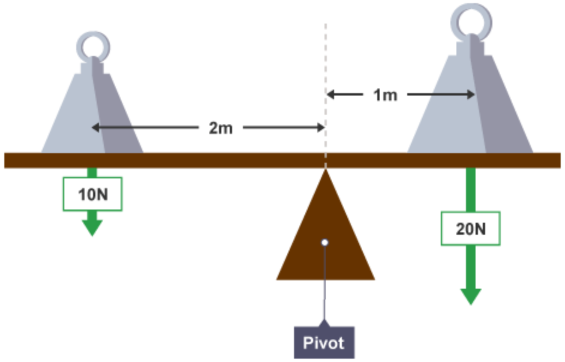
A moment is a turning effect of a force. Forces can make objects turn if there is a pivot.

Think of a see-saw in a playground. The pivot is the part in the middle. The see-saw is level when no-one is on it, but tips if someone gets on one of the ends. It is possible to balance the see-saw again if someone else gets on to the other end and sits in the correct place. This is because the turning forces are balanced.



To calculate moments, you need two things:
The distance from the pivot that the force is applied and the size of the force applied.

moment (Nm) = force (N) x distance (m)



Moment on the left:
moment = force (N) x distance (m)
moment = 10N x 2
Moment = 20Nm

Moment on the right:
moment = force (N) x distance (m)
moment = 20N x 1
Moment = 20Nm

Notice that the two moments in the example above are equal and opposite. They are both 20Nm but the left are acting in an anti-clockwise direction, whilst the right side is acting in a clockwise direction. This is why the beam is balanced.