Momentum is a property linked to the motion of an object. It depends on its mass and velocity and is measured in kgm/s.

momentum = mass × velocity

This equation combined with *force = mass × acceleration* can give a new equation for **Newton's Second Law**.

$$force = \frac{change\ in\ momentum}{time}$$

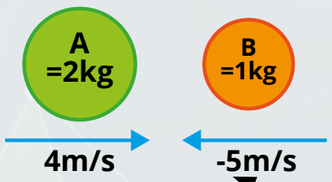
This equation can be used to calculate the forces acting on objects during a collision.

The law of **conservation of momentum** states that '*the total momentum before a collision is equal to the total momentum after a collision, if there is no external force acting on the objects.*'

Conservation of momentum

If a ball of mass 2kg was travelling to the right with a velocity of 4m/s and a ball of mas 1kg was travelling in the opposite direction at 5m/s, you could use the law of conservation of momentum to predict what would be the motion after they collide.

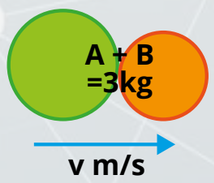
Before colliding
Momentum of the ball A
2kg × 4m/s = 8kgm/s
Momentum of ball B
1kg × -5m/s = -5kgm/s
Total momentum before colliding
8kgm/s + -5kgm/s = 3kgm/s



Note that the velocity to the left is negative.

Total momentum before and after are equal

If, **after they collide**, the balls stick together;
Total momentum after colliding = 3kgm/s
As:
momentum = mass × velocity
3kgm/s = 3 × v
v = 1m/s to the right



Equations of motion
When an object has a **constant** acceleration or deceleration, properties of its motion can be calculated with these equations.

$v = u + at$ $\quad x = \frac{u + v}{2} t$

$x = ut + \frac{1}{2} at^2$ $\quad v^2 = u^2 + 2ax$

Where

u = initial velocity (m/s)
v = final velocity (m/s)
a = acceleration (m/s²)
x = distance travelled (m)
t = time (s)

Key points when using these equations:

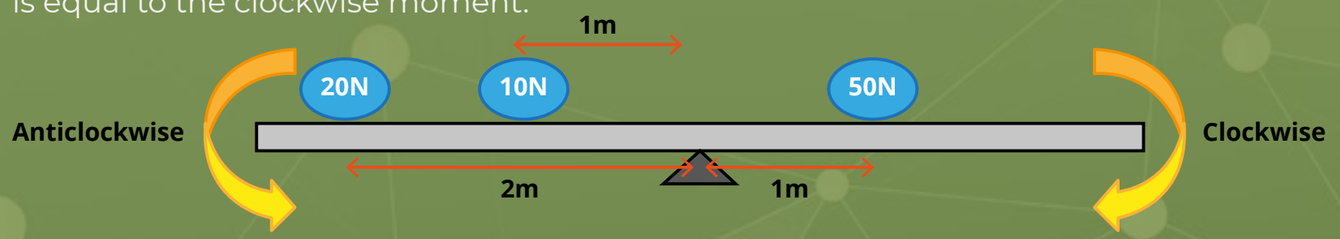
1. **Check the units** (e.g. make sure the distance is in meters not km.
2. If the object is stationary, at rest or stopped, its **velocity is 0m/s**. This could be the initial or final velocity.
3. Work out what information is in the question, then **choose and write out the equation** before you put any numbers in or rearrange it.

Moments
A moment is a turning force (*not to be confused with momentum*).
The moment can be calculated using this equation:

Moment = force × distance

The principle of moments states that when an object is **balanced**, the sum of the **clockwise moments** is **equal** to the sum of the **anticlockwise moments**.

For example, this see-saw is balanced because the sum of the anticlockwise moments is equal to the clockwise moment.



Anticlockwise moments
20N x 2m = 40Nm
10N x 1m = 10Nm

Total anticlockwise moments = 40Nm + 10Nm = 50Nm

Clockwise moments
50N x 1m = 50Nm

Total clockwise moments = 50Nm