GCE Physics Unit 1.3 Dynamics

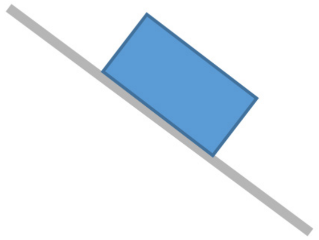
Force:

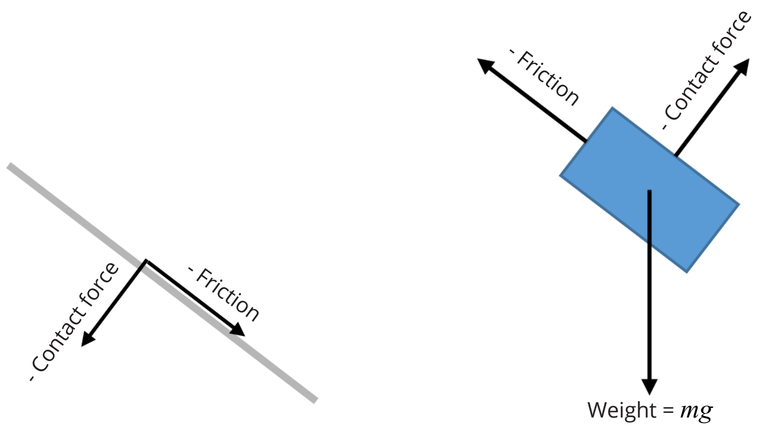
A force is a **push or a pull** which can change an objects motion. Newton's first law states that an object will continue with a constant velocity or remain stationary if there is no resultant force acting on it. Therefore, **if an object is accelerating or changing direction there must be an unbalanced force** acting on it.

Newton's 3rd law (N3) states that **if body A exerts a force on body B, body B will exert an equal and opposite force on body A**. For example, a Physics teacher has a weight of 800N. This means the gravitational force of the Earth pulling the teacher is 800N, so there is also an 800N force pulling the Earth towards the teacher.

Free body diagrams:

In most situations there are many forces acting on an object one time and trying to draw a diagram of every force, including N3 pairs will become very cluttered and unclear. **Free body diagrams** help avoid this by **separating the objects** and drawing the forces on each independently. For the diagram above of a box on a slope we can separate them to look at the forces on the box and the slope separately.





Newton's 2nd law tells us that the force is equal to the rate of change of momentum.

$$F = \frac{\Delta p}{\Delta t}$$

Where **momentum** is defined according to this equation:

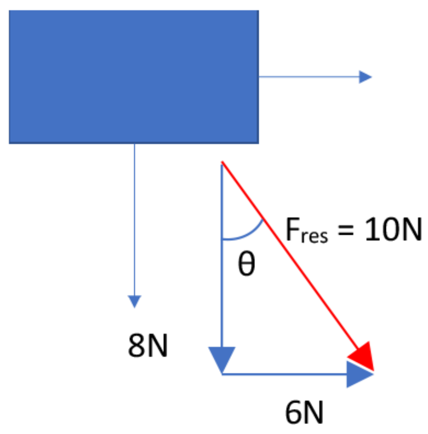
$p = mv$

As $p = mv$ and $a = {}^{\Delta v}/_{t}$ **Newton's 2nd law** can be written as follows:

$$\sum F = ma$$

Where $\sum F$ is the sum of the forces acting on the object.

Remember there may be multiple forces acting on an object so you must calculate the resultant force by adding vectors (see unit 1.1) before you can calculate the acceleration.



Conservation of momentum:

The law of conservation of momentum states, **the vector sum of the momenta of bodies in a system stays constant even if forces act between the bodies, provided there is no external resultant force**. Which means the total momentum before an interaction must be equal to the total momentum after an interaction.

Consider this example:

Before colliding

The total momentum before is:

$p = mv$ = 2.0 × 8.0 + 1.5 × (-4.0)

= 10 kg m s^{-1}

Remember momentum is a vector quantity so the velocity of the green ball is -4.0 m s^{-1}

After colliding

The total momentum after must be 10 kg m s^{-1}.

10 = 2.0 × v + 1.5 × 2.0

Therefore, v = 3.5 m s^{-1}.

This is an example of an **inelastic collision** as the kinetic energy of before the collision is not equal to the kinetic energy after the collision, some **kinetic energy has been lost**.

In an **elastic collision** the kinetic energy before colliding is equal to the kinetic energy afterwards.

F = force in N m = mass in kg a = acceleration in m s^{-2} p = momentum kg m s^{-1} v = velocity in m s^{-1}