Power

Power is the rate at which work is done or is the amount energy produced or consumed in a given time. If work W is done in a time t, then the average power P for the time interval t is given by

$$P = \frac{W}{t}$$

Power is a scalar quantity and its SI unit is the watt (W). **One watt** is the power developed when **one joule** of work is done **per second**.

If the force doing work is in the same direction as the displacement, then the equation of work is

$$W = Fs$$

Substituting this into the equation of power above

$$P = \frac{W}{t} = \frac{Fs}{t} = F\bar{v}$$

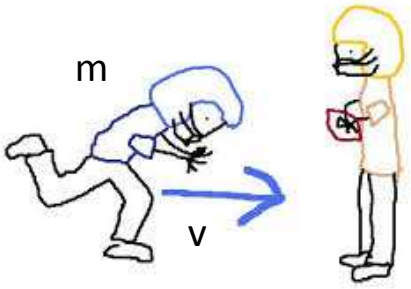
where $\bar{v}$ is an **average velocity**.

Example 4.5: The power generated by an accelerating car

A car whose mass is 1000 kg accelerates constantly from rest at 2.0 ms^{-2} for 10 s. Determine the average power generated by the net force accelerating the car.

Momentum

The **linear momentum** of an object is the product of the object's mass and velocity.



Momentum has magnitude and direction and thus is a vector quantity, whose direction is that of the velocity. Thus, in SI unit of momentum is kg ms^{-1} . We shall refer to **p** as the momentum of the object. Mathematically, it is given as

$$P = mv$$

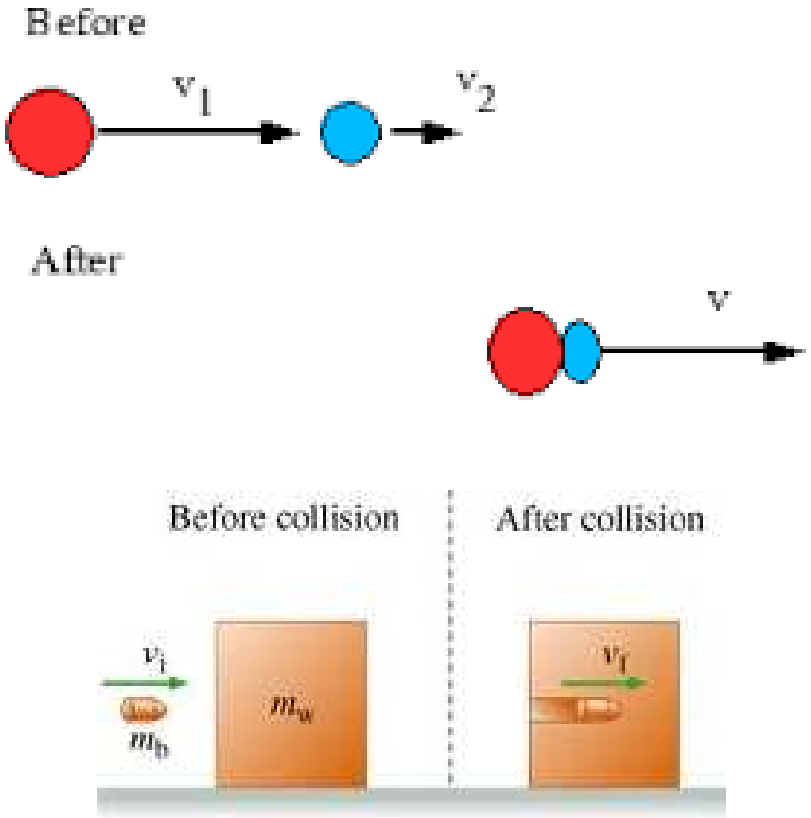
Conservation of momentum

The principle of conservation of momentum

If no external force acts on a system, the total momentum of the system remains constant, i.e. momentum before the collision is equal to the momentum after the collision.

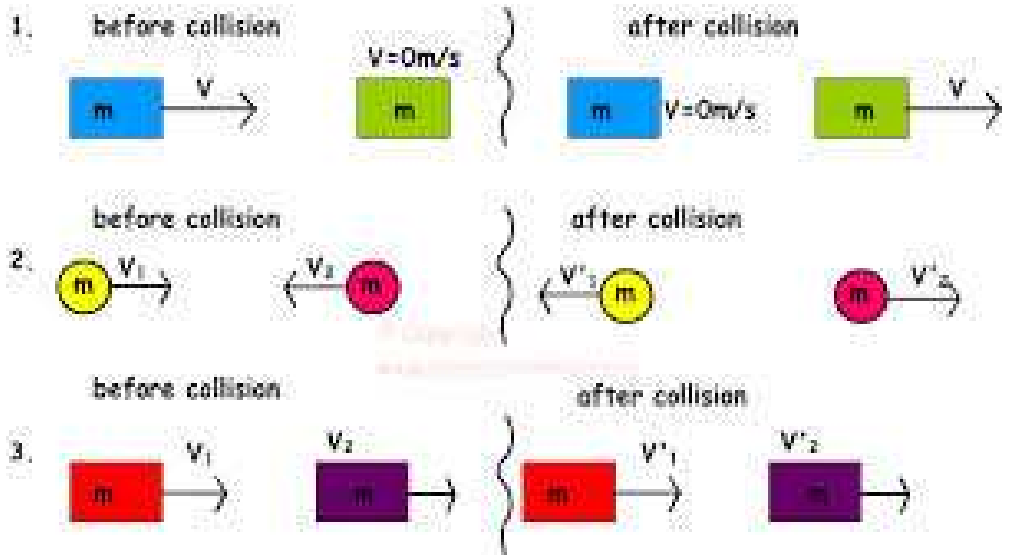
We will only be concerned with cases where momenta are along one straight line, such as in 'head-on collisions'. Since momentum is a vector quantity, it must be remembered that if we choose the momentum in a certain direction to be positive, the momentum in the opposite direction is negative.

Inelastic collision



$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

Elastic collision



$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

The direction of momentum is the same as the direction of the velocity. It is convenient to choose the direction to right as positive and to the left as negative.

Example

Example 4.6: A bullet fired into a block of wood

A 2 kg block of wood hangs by a cord of negligible mass. A bullet of mass 80 g is fired with a velocity of 300 ms^{-1} into the block. Calculate the initial velocity with which the block is set in motion.

G23 Two skaters push off from each other on smooth level ice. One is a man of mass 88 kg and the other is a child of mass 33 kg, who moves away with a velocity of +4.0 ms^{-1} . Calculate the velocity of the man.