Phys11 Momentum : Notes - 10

Momentum is the quantity of motion.

It is given the symbol **P**.

The mathematical definition of momentum is : $\mathbf{P = m\ V}$.

The momentum of a body equals the mass multiplied by the velocity. It is a vector quantity. The units are; kg m/s or N s.

Examples.

A 7.0 gram bullet travels at 650 m/s to the right. Its momentum is 0.0070x650 = 4.6 kg m/s [right] or +4.6 kg m/s.

A 150 g ball is thrown with a velocity of -18 m/s or 18 m/s [left]. The momentum is 0.15x(-18) = -2.7 kg m/s or 2.7 kg m/s [left].

Change in momentum

The momentum of an object will change if a force acts on the object.

The change in momentum is : $\Delta\mathbf{P = P_f - P_i}$ or; $\Delta\mathbf{P} = m\ \Delta\mathbf{v}$

Example.

If the velocity of an 1800 kg truck increases from 5.0 m/s to 8.0 m/s, the momentum changes from 5.0x1800 or $9.0x10^3$ kg m/s to 8.0x1800 = $1.4x10^4$ kg m/s. The change in momentum = $5.4x10^3$ kg m/s.

Impulse

The impulse is defined as $\mathbf{F\ \Delta t}$. A force acts on an object for a time Δt. The impulse is a vector quantity. The units are kg m/s or N s.

Since $\mathbf{F = ma = m\ \Delta v/\Delta t}$, we have;

$$\mathbf{F\ \Delta t = m\ \Delta v = \Delta P}.$$

The impulse on an object causes a change in the momentum of the object.

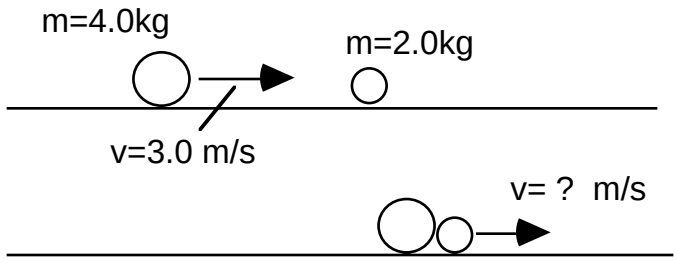
If the time for the momentum change in the example involving the truck above is $\Delta t = 4.0$ s, then we can find the force exerted by the motor. $F = \Delta P/\Delta t = 5.4 \times 10^3/4.0 = 1.4 \times 10^3$ N.

Conservation of Momentum

The law of conservation of momentum is : "In an isolated system, the total momentum remains constant". That is, $\mathbf{P_f = P_i}$.

Example.

Suppose a moving object collides and sticks to an object that is initially at rest. Assume friction is zero. Since the final total momentum must equal the initial total momentum, we can find the final velocity v for the situation shown below.



The initial total momentum is 4.0x3.0 = 12 kg m/s. The final total momentum = 12 kg m/s. The final velocity = 2.0 m/s since the total final mass = 6.0 kg.