

Physics with Synno – Motion-2 – Lesson 15

M.5 Impulse and Momentum

M.5.1 Momentum

If an object is moving with some speed, then to **change** its speed or direction a **force** must be applied, even then the object will be reluctant to change. This reluctance of a body to change its velocity is known as momentum.

The momentum of a body is defined by:

Momentum = **mass of body** \times **velocity of body**

$$\vec{p} = m \vec{v}$$

Momentum is a vector and should be treated as any vector would. The units of momentum are Kg ms^{-1} .

Example:

At what speed must a 60 Kg athlete be running if his or her momentum is to equal that of a 1000 Kg car travelling at a constant speed of 5 Km hr^{-1} .?

$$\text{Speed of the car} = 5 \text{ Km hr}^{-1} = \frac{5 \times 100}{60 \times 60} = 1.39 \text{ m s}^{-1}$$

Momentum of car

$$\begin{aligned} p &= m v \\ &= 1000 \times 1.39 \\ &= 1.39 \times 10^3 \text{ Kg m s}^{-1} \end{aligned}$$

Athlete

$$\begin{aligned} p &= 1.39 \times 10^3 \text{ Kg m/s} \quad m = 60 \text{ Kg} \\ p &= m v \\ 1.39 \times 10^3 &= 60 \times v \\ v &= \frac{1.39 \times 10^3}{60} \\ &= 23.15 \text{ m s}^{-1} \end{aligned}$$

M.5.2 Conservation of Momentum

In a closed system (of two or more objects) the momentum of the system remains the **same** before and after the collision.

$$\begin{aligned} \Sigma p_i &= \Sigma p_f \\ \text{or} \quad m_1 u_1 + m_2 u_2 &= m_1 v_1 + m_2 v_2 \end{aligned}$$

Example

A railway truck, of mass 80 g, on a model train track is moving with a speed of 15 cm s^{-1} and collides with a stationary truck of mass 90 g. the two trucks become coupled together. What is their common speed?

Mass in Kg, speed in m/s \rightarrow change those units

$$\Sigma p_i = \Sigma p_f$$

$$0.08 \times 0.15 + 0.09 \times 0 = (0.08 + 0.09) \times v$$

$$0.012 = 0.17 v$$

$$v = 0.07 \text{ m/s} = 7 \text{ cm/s}$$

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