Example: A force of 2N is applied on a particle for 2 sec, then what is change in momentum of the particle.

Solution: We know $\vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \vec{F} \times dt = \vec{d}p$

$$\Rightarrow 2 \times 2 = d\vec{p} \Rightarrow 4 = d\vec{p}$$

Therefore, change in momentum = 4 Ns

Example:

A batsman hits back a ball straight in the direction of bowler without changing its initial speed of 12 m/s. If mass of the ball is 0.15 kg, determine the impulse imparted to the ball.

Solution: u = 12 m/s ; v = – 12 m/s ; m = 0.15 kg

$$Impulse = \Delta p = P_f - p_i = mv - mu$$

Or Impulse = 0.15 × (–12) – 0.15 × 12 = – 1.80 – 1.80

= –3.60 kg m/s (or Ns)

Example: A body of mass 2kg is moving along x-direction with velocity 2m/sec. If a force of 4N is applied on it along y-direction for 1 sec, what will be the final velocity of particle.

Solution: Given m =2kg, $\vec{F} = 4\hat{j}\,N$ and $\vec{V}_1 = 2\hat{i}\ m/s$

We know $\vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \vec{F}\ dt = d\vec{p}$

Or $\vec{F}\ dt = \vec{p}_2 - \vec{p}_1 = m\,\vec{v}_2 - m\,\vec{v}_1$

$\Rightarrow \quad 4\hat{j} \,.\, 1 = 2 \,.\, \vec{v}_2 - 2(2\hat{i})$

$\Rightarrow \quad 2\,\vec{v}_2 = 4\,\hat{j} + 4\,\hat{i} \quad \Rightarrow \quad \vec{v}_2 = 2\,\hat{j} + 2\,\hat{i}$

$\Rightarrow \quad |\,\vec{v}_2\,| = 2\sqrt{2}\ ms$

Example: A billiard ball strike a rigid wall normal to its surface with some speed u and then it gets reflected back opposite, without any change in speed as shown in figure. What is

(i) The magnitude of impulse imposed to the balls by the wall.

(ii) If the ball remains in contact of wall for a time interval Δt, find the magnitude and direction of force on the wall due to the ball.

Solution:

$\vec{v_1} = u\hat{i}$; $\vec{v_2} = -u\hat{i}$