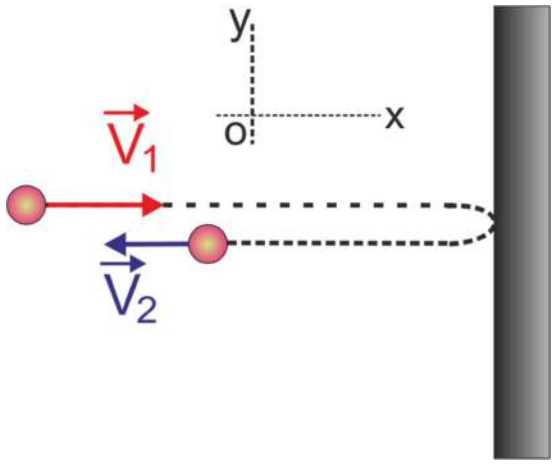
$$\Delta p_x = p_{fx} - p_{ix} = m(-u) - m.u$$

or $$\Delta p_x = -2mu \qquad \text{.......... (i)}$$

$$\Delta p_y = p_{fy} - p_{iy} = m \times 0 - m \times 0$$

$$\Delta p_y = 0$$




Thus the change in momentum of the ball or the impulse on it, is along –ve x-axis. So the force applied by the wall on the ball is along –ve x-axis. So according to III$^{rd}$ law force on the wall due to the ball is along +ve x-axis (⊥ to the surface of the wall).

Force on ball is $F = \dfrac{\Delta p}{\Delta t} = \dfrac{-2mu}{\Delta t}$

So, by third Law $F' = -F = \dfrac{2mu}{\Delta t}$

**Method II**

$$\Delta \vec{P} = \vec{p}_f - \vec{p}_i$$

$$= m\vec{v_2} - m\vec{v_1}$$

$$= m - \left(-u\hat{i}\right) - m\left(u\hat{i}\right)$$

$$= -2mu\hat{i}$$

In this case magnitude of impulse is

$$I = |\Delta p|$$

Or $$I = |\Delta p_x| = 2mu \qquad \text{.......... (ii)}$$

Force on ball is $\vec{F} = \dfrac{\Delta p}{\Delta t} = \dfrac{-2mu}{\Delta t}\hat{i}$

So, by third Law $\vec{F}' = -\vec{F} = \dfrac{2mu}{\Delta t}\hat{i}$

**Example:** A billiard ball strike a rigid wall with some speed u, at angle $30^0$ to the normal and then get reflected without any change in speed at the same angle. What is

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

(iv) 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:**

$$|\vec{v_1}| = |\vec{v_2}| = u$$

Or $$v_1 = v_2 = u$$

$$\Delta p_x = p_{xf} - p_{xi} = m\left(-v_2 \cos\ 30^0\right) - m\left(v_1 \cos\ 30^0\right)$$

$$= -mv_2 \cos 30^0 - mv_1 \cos\ 30$$