Answer on Question#74093 – Physics – Mechanics

A ball having a mass of 0.5 kg is moving towards the east with a speed of 8.0 ms-1. After being hit by a bat it changes its direction and starts moving towards the north with a speed of 6.0 ms−1. If the time of impact is 0.1 s, calculate the impulse and average force acting on the ball.

Solution.

We use the concept of linear momentum

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

where m is a mass of the ball, $\vec{v}$ is a velocity of the ball. (for our case)

By definition impulse is the change in momentum. Hence we can write

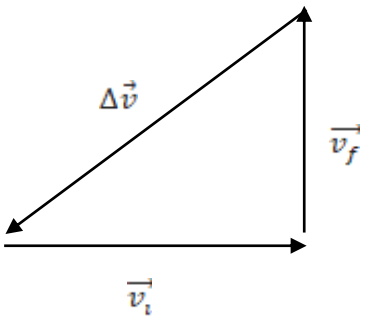
$\Delta\vec{p} = \overrightarrow{p_f} - \overrightarrow{p_i} = m\Delta\vec{v} = m(\overrightarrow{v_f} - \overrightarrow{v_i})$

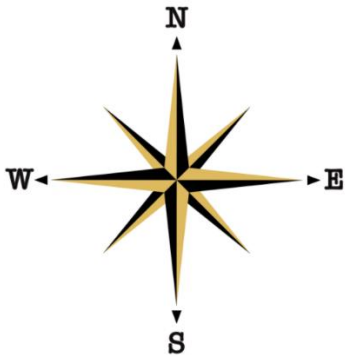
where $\overrightarrow{p_f}$ is final momentum, $\overrightarrow{p_i}$ is initial momentum, $\overrightarrow{v_f}$ is final velocity, $\overrightarrow{v_i}$ is initial velocity.

According to the condition of problem

$\overrightarrow{v_i} = 8.0\frac{m}{s}$ directed towards the east; $\overrightarrow{v_f} = 6.0\frac{m}{s}$ directed towards the north; $m = 0.5kg$ is a mass of the ball.

Draw a speed sketch





From a right triangle we find the magnitude of the vector $\Delta\vec{v}$

$$|\Delta\vec{v}| = \sqrt{|\overrightarrow{v_i}|^2 + |\overrightarrow{v_f}|^2} = \sqrt{8^2 + 6^2} = \sqrt{64 + 36} = \sqrt{100} = 10\frac{m}{s}.$$

Therefore impulse

$$\Delta\vec{p} = m\Delta\vec{v} = 0.5kg \cdot 10\frac{m}{s} = 5kg \cdot \frac{m}{s}.$$

On the other hand, we can calculate the impulse as

$\Delta\vec{p} = \vec{F}t$

where $\vec{F}$ is average force acting on the ball, $t = 0.1s$ is time of impact. Hence

$$\vec{F} = \frac{\Delta\vec{p}}{t} = \frac{5kg \cdot \frac{m}{s}}{0.1s} = 50N$$

Answer. $\Delta\vec{p} = 5kg \cdot \frac{m}{s}$; $\vec{F} = 50N$.