QUESTION:

A ball P of mass 0.25kg loses one-third of its velocity when it make a head on a collision with an identical ball Q at rest .After collision,Q moves off with a speed of 2m/s in the original direction of p.Calculate the initial velocity of P?

SOLUTION:

According to the momentum conservation law, the momentum before collision is equal to the momentum after the collision:

$$m_P\upsilon_P = m_B\upsilon_B + m_P\upsilon'_P$$

$$\upsilon'_P = \frac{2}{3}\upsilon_P \; - the\ velocity\ of\ a\ ball\ P\ after\ the\ collision. Hence$$

$$m_P\upsilon_P = m_B\upsilon_B + m_P\frac{2}{3}\upsilon_P$$

According to the law of energy conservation, kinetic energy before the collision is equal to the kinetic energy after the collision. $K_{before} = \frac{m_P\upsilon_P^2}{2}$, $K_{after} = \frac{m_P(\frac{2}{3}\upsilon_P)^2}{2} + \frac{m_B\upsilon_B^2}{2}$. Hence

$$\frac{m_P\upsilon_P^2}{2} = \frac{m_P(\frac{2}{3}\upsilon_P)^2}{2} + \frac{m_B\upsilon_B^2}{2}$$

$$m_P\upsilon_P^2 = \frac{4}{9}m_P\upsilon_P^2 + m_B\upsilon_B^2$$

So,

$$\begin{cases} m_P\upsilon_P = m_B\upsilon_B + m_P\frac{2}{3}\upsilon_P \\ m_P\upsilon_P^2 = \frac{4}{9}m_P\upsilon_P^2 + m_B\upsilon_B^2 \end{cases} \Rightarrow \begin{cases} m_P(\upsilon_P - \frac{2}{3}\upsilon_P) = m_B\upsilon_B \\ m_P(\upsilon_P^2 - \frac{4}{9}\upsilon_P^2) = m_B\upsilon_B^2 \end{cases} \Rightarrow$$

$$\Rightarrow \begin{cases} \frac{1}{3}m_P\upsilon_P = m_B\upsilon_B \\ \frac{5}{9}m_P\upsilon_P^2 = m_B\upsilon_B^2 \end{cases} \Rightarrow \begin{cases} \frac{1}{3}m_P\upsilon_P = m_B\upsilon_B \\ \frac{5}{9}m_P\upsilon_P^2 = m_B\upsilon_B^2 \end{cases} \Rightarrow \frac{\frac{5}{9}m_P\upsilon_P^2}{\frac{1}{3}m_P\upsilon_P} = \frac{m_B\upsilon_B^2}{m_B\upsilon_B} \Rightarrow$$

$$\Rightarrow \frac{5}{3}\upsilon_P = \upsilon_B$$

$$\upsilon_P = \frac{3}{5}\upsilon_B$$

$$\upsilon_P = 1.2\ m/s$$

ANSWER:

1.2 m/s