Answer on Question #40875, Physics, Mechanics | Kinematics | Dynamics

James bond (mass 78 kg) is running to catch a bag (mass 23 kg) containing an antiserum to a deadly disease. Initially Mr. Bond is running 4.4 m/s north and the bag is travelling 2.9 m/s east. What is the final velocity (magnitude and direction) of James and the bag immediately after the catch (collision).

Solution

Mass of James bond $M = 78\ kg$, mass of the bag $m = 23\ kg$, initial velocity of James bond $\vec{V} = 4.4\frac{\text{m}}{\text{s}}$ north, initial velocity of the bag $\vec{v} = 2.9\frac{\text{m}}{\text{s}}$ east, the final velocity of James and the bag immediately after the catch $\vec{V}_{final}$.

According to the conservation of momentum:

$$m\vec{v} + M\vec{V} = (m + M)\vec{V}_{final}.$$

Y (north)-component of the final velocity of James and the bag:

$$V_{Yfinal} = \frac{MV}{m + M} = \frac{78 \cdot 4.4}{78 + 23} = 3.4\frac{m}{s}.$$

X (east)-component of the final velocity of James and the bag:

$$V_{Xfinal} = \frac{mv}{m + M} = \frac{23 \cdot 2.9}{78 + 23} = 0.66\frac{m}{s}.$$

A magnitude of the final velocity of James and the bag:

$$V_{final} = \sqrt{V_{Xfinal}^2 + V_{Yfinal}^2} = \sqrt{3.4^2 + 0.66^2} = 3.5\frac{m}{s}.$$

A direction of the final velocity of James and the bag:

$$\tan\alpha = \frac{V_{Xfinal}}{V_{Yfinal}} = \frac{0.66}{3.4} = 0.19 \rightarrow \alpha = \tan^{-1} 0.19 = 11°.$$

Answer: $3.5\frac{m}{s}$, $11°$ east of north.