Answer on Question #54152-Physics-Mechanics-Kinematics-Dynamics

An object ejects 12% of its initial mass at time t = 0 along the negative x-axis. The ejected mass has a speed of 2.0 m/s. Shortly after, it ejects another 12% of its initial mass along the negative y-axis with the same speed.

(a) Assume the object started from rest and calculate the magnitude and direction of its final velocity.

magnitude m/s

direction ° counterclockwise from the +x-axis

(b) If the object started at an initial speed

v = (4.0 m/s, 6.0 m/s),

would the change in speed of the object be different than the change in speed in part (a)?

Yes

No

(c) If the object ejected 24% of its initial mass at time

t = 0

in the direction opposite to the direction found in part (a), what would be the magnitude and direction of its final velocity? (Assume the mass is ejected with a speed of 2.0 m/s and the object is initially at rest.)

magnitude m/s

direction ° counterclockwise from the +x-axis

Solution

(a) According to the conservation of momentum law:

$$\vec{0} = \overrightarrow{P_{in}} = \overrightarrow{P_f} = \overrightarrow{m_{part} v_1} + \overrightarrow{m_{part} v_2} + \overrightarrow{m_f v_f},$$

where $\overrightarrow{P_{in}}$ is initial momentum of the system, $\overrightarrow{P_f}$ is final momentum of the system, $m_{part} = 0.12\ m$, $m_f = 0.76\ m$, m is the initial mass of object, $\overrightarrow{v_1} = -v\vec{\imath}$ is the velocity of first part, $\overrightarrow{v_2} = -v\vec{\jmath}$ is the velocity of second part, $\overrightarrow{v_f}$ is the final velocity of the object.

So,

$$\begin{cases} 0.76\ m\ v_{fx} = 0.12\ m\ v \\ 0.76\ m\ v_{fy} = 0.12\ m\ v \end{cases} \rightarrow v_{fx} = v_{fy} = \frac{0.12}{0.76} v.$$

$$v_f = \sqrt{2}\frac{0.12}{0.76} v = \sqrt{2}\frac{0.12}{0.76} 2.0 \frac{\text{m}}{\text{s}} = 0.45 \frac{m}{s}.$$

$$v_{fx} = v_{fy} \rightarrow \alpha = 45°.$$

(b) The change in speed of the object is independent from initial speed of the object according to the conservation of momentum law.

(c) The change in momentum would be the same as in part (a), so the final velocity of the object will be the same.

Answer: (a) $0.45\,\frac{m}{s}$; $45°$; (b) No; (c) $0.45\,\frac{m}{s}$; $45°$.