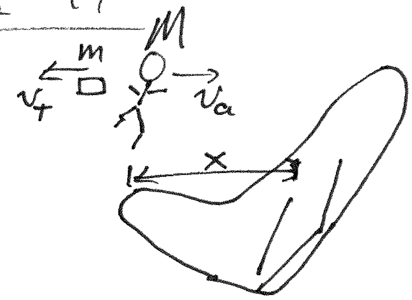
Chapter 9 Problem ~~9~~ 97



$M = 100\ kg$ $x = 10m$

$v_0 = 0.1 m/s$ (to the left)

$m = 10kg$

$v_t = 5.0 m/s$ (to the left)

How long will he take to return to the spaceship.

Initially the astronaut and tools are both moving at speed v_0.

Using conservation of momentum

$$P_0 = P_f$$

$$(m+M)\vec{v}_0 = m\vec{v}_t + M\vec{v}_a$$

[Note: I didn't take the sign of the vectors into account here, I will do that later.]

solving for v_a gives

$$(m+M)\vec{v}_0 - m\vec{v}_t = M\vec{v}_a$$

$$\vec{v}_a = \frac{(m+M)\vec{v}_0 - m\vec{v}_t}{M}$$

Be careful when substituting in values here. Velocity is a vector and direction is important.

From the diagram and information given in the problem

$\vec{v}_0 = -0.1 m/s$ (away from the spaceship)

$\vec{v}_t = -5.0 m/s$ (away from the spaceship)

$$\vec{v}_a = \frac{(10kg + 100kg)(-0.1 m/s) - 10kg(-5.0 m/s)}{100kg}$$

$$\vec{v}_a = \frac{-11 + 50}{100} = \frac{39}{100} = \boxed{+0.39 m/s}$$ towards the spaceship

The astronaut drifts back at constant speed. Therefore

$$x = v_a \cdot t \longrightarrow t = \frac{x}{v_a} = \frac{10m}{0.39 m/s} = 25.6 s$$

$$\boxed{t = 26 s}$$