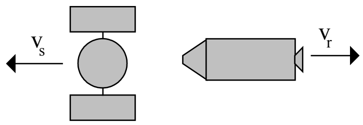
Chapter 9 Problem 63 †



Given
$m_s = 950\ kg$
$m_r = 640\ kg$
$I = 350\ N \cdot s$

Solution
Find the relative speed between the rocket and the satellite after they separate.

By Newton's 3^{rd} law, the impulsive force exerted on the rocket by the satellite is equal and opposite to the force exerted on the satellite by the rocket. The satellite and rocket are stationary relative to each other before they separate. Since impulse is the change in momentum, then the velocity is

$$\vec{I} = \Delta\vec{p} = m(\vec{v}_1 - \vec{v}_i)$$

The impulse on the satellite is to the left and the initial velocity is zero. Therefore,

$$-350\hat{\imath}\ N \cdot s = 950\ kg(\vec{v}_s - 0)$$

$$\vec{v}_s = -0.368\hat{\imath}\ m/s$$

The impulse on the rocket is to the right and the initial velocity is zero. Therefore,

$$350\hat{\imath}\ N \cdot s = 640\ kg(\vec{v}_r - 0)$$

$$\vec{v}_r = 0.547\hat{\imath}\ m/s$$

The relative speed between the rocket and the satellite is then

$$\Delta\vec{v} = \vec{v}_r - \vec{v}_s = (0.547\hat{\imath}\ m/s) - (-0.368\hat{\imath}\ m/s)$$

$$\Delta\vec{v} = 0.915\hat{\imath}\ m/s$$

The relative speed between the rocket and the satellite is 91.5 cm/s.

†Problem from Essential University Physics, Wolfson