Chapter 9 Problem 19 [†]

Given

$m_{skater} = 60\ kg$
$m_{snow} = 12\ kg$
$\vec{v}_{snow} = \{3.0\hat{\imath} + 4.0\hat{\jmath}\}\ m/s$

Solution

Find the velocity of the skater.

Since the skater is motionless before throwing the snowball, the initial momentum is zero. After throwing the snowball, the momentum is conserved and is, therefore, also zero.

$$\vec{p}_{before} = 0 = \vec{p}_{skater} + \vec{p}_{snow}$$

$$\vec{p}_{skater} = -\vec{p}_{snow}$$

Using the definition of momentum

$$m_{skater}\vec{v}_{skater} = -m_{snow}\vec{v}_{snow}$$

$$\vec{v}_{skater} = -\frac{m_{snow}\vec{v}_{snow}}{m_{skater}} = -\frac{(12\ kg)\{3.0\hat{\imath} + 4.0\hat{\jmath}\}\ m/s}{(60\ kg)}$$

$$\vec{v}_{skater} = \{-0.60\hat{\imath} - 0.80\hat{\jmath}\}\ m/s$$

[†]Problem from Essential University Physics, Wolfson