Halliday ♦ Resnick ♦ Walker

FUNDAMENTALS OF PHYSICS
SIXTH EDITION

Selected Solutions

Chapter 9

9.19
9.37

19. There is no net horizontal force on the dog-boat system, so their center of mass does not move. Therefore by Eq. 9-16,

$$M\Delta x_{\text{com}} = 0 = m_b\Delta x_b + m_d\Delta x_d$$

which implies

$$|\Delta x_b| = \frac{m_d}{m_b}\ |\Delta x_d|\ \ .$$

Now we express the geometrical condition that *relative to the boat* the dog has moved a distance $d = 2.4$ m:

$$|\Delta x_b| + |\Delta x_d| = d$$

which accounts for the fact that the dog moves one way and the boat moves the other. We substitute for $|\Delta x_b|$ from above:

$$\frac{m_d}{m_b}\ |\Delta x_d| + |\Delta x_d| = d$$

which leads to

$$|\Delta x_d| = \frac{d}{1 + \frac{m_d}{m_b}} = \frac{2.4}{1 + \frac{4.5}{18}} = 1.92 \text{ m}\ .$$

The dog is therefore 1.9 m closer to the shore than initially (where it was 6.1 m from it). Thus, it is now 4.2 m from the shore.

37. Our notation is as follows: the mass of the original body is $M = 20.0$ kg; its initial velocity is $\vec{v}_0 = 200\hat{\text{i}}$ in SI units (m/s); the mass of one fragment is $m_1 = 10.0$ kg; ; its velocity is $\vec{v}_1 = 100\hat{\text{j}}$ in SI units; the mass of the second fragment is $m_2 = 4.0$ kg; ; its velocity is $\vec{v}_2 = -500\hat{\text{i}}$ in SI units; and, the mass of the third fragment is $m_3 = 6.00$ kg.

(a) Conservation of linear momentum requires

$$M\vec{v}_0 = m_1\vec{v}_1 + m_2\vec{v}_2 + m_3\vec{v}_3$$

which (using the above information) leads to

$$\vec{v}_3 = 1000\,\hat{\text{i}} - 167\,\hat{\text{j}}$$

in SI units. The magnitude of $\vec{v}_3$ is $v_3 = \sqrt{1000^2 + (-167)^2} = 1.01 \times 10^3$ m/s. It points at $\tan^{-1}(-167/1000) = -9.48°$ (that is, at 9.5° measured clockwise from the $+x$ axis).

(b) We are asked to calculate ΔK or

$$\left(\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 + \frac{1}{2}m_3v_3^2\right) - \frac{1}{2}Mv_0^2 = 3.23 \times 10^6 \text{ J}\ .$$