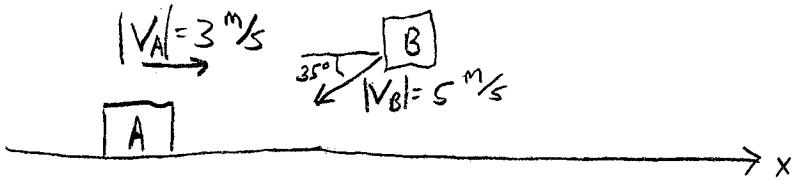
Chapter 8 homework solutions

① 

Momentum is only conserved in the x-direction:

$$P_{xi} = P_{xf}$$

$$m_A V_{Axi} + m_B V_{Bxi} = (m_A + m_B) V_{xf}$$

$$(4kg)\,3\,m/s - (7kg)(5\,m/s)\cos 35° = (11kg)\,V_{xf}$$

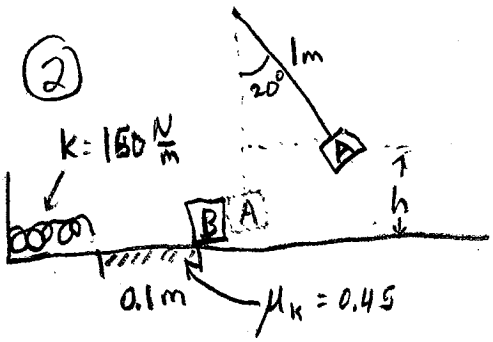
$$\boxed{V_{xf} = -1.5\ m/s}$$

Switching the masses and speeds:

$$(7kg)\,5\,m/s - (4kg)(3\,m/s)\cos 35° = (11kg)\,V_{xf}$$

$$\boxed{V_{xf} = 2.3\ m/s}$$

---

② 

We first use energy conservation to find the velocity of block A just before it collides with block B:

$$W_{oth} = \Delta KE + \Delta U_g = KE_f - \cancel{KE_i}^{0} + \cancel{U_{gf}}^{0} - U_{gi}$$

$$0 = \tfrac{1}{2} m_A V_A^2 - m_A g h$$

$$= \tfrac{1}{2} \cancel{m_A} V_A^2 - \cancel{m_A} g (L - L\cos 20°) \Rightarrow$$

$$V_A = 1.09\ \tfrac{m}{s}$$

(2) cont'd

Now, in the collision with Block B, momentum is conserved:

$$P_{xi} = P_{xf} \quad (+x \text{ direction to left on drawing})$$

$$m_A V_A = m_A V_{Af} + m_B V_{Bf} \quad (1)$$

and, since it is elastic, KE is also conserved:

$$\tfrac{1}{2} m_A V_A^2 = \tfrac{1}{2} m_A V_{Af}^2 + \tfrac{1}{2} m_B V_{Bf}^2$$

from (1) $\Rightarrow$ $m_B V_{Bf} = m_A V_A - m_A V_{Af} = m_A (V_A - V_{Af})$ (3)

from (2) $\Rightarrow$ $m_B V_{Bf}^2 = m_A V_A^2 - m_A V_{Af}^2 = m_A (V_A - V_{Af})(V_A + V_{Af})$ (4)

dividing $\frac{(4)}{(3)}$ $\Rightarrow$ $V_{Bf} = V_A + V_{Af} \Rightarrow V_{Af} = V_{Bf} - V_A$ (5)

substituting into (1) $\Rightarrow$

$$m_A V_A = m_A (V_{Bf} - V_A) + m_B V_{Bf} \Rightarrow$$

$$V_{Bf} = \frac{2 m_A V_A}{(m_A + m_B)} = 1.52 \text{ m/s} \quad (\text{to left})$$

Now use conservation of energy again:

$$W_{oth} = \Delta KE + \Delta U_{el} = \cancel{KE_f}^{\,0} - KE_i + U_{el_f} - \cancel{U_{el_i}}^{\,0}$$

$$-m_B g \mu_k d = -\tfrac{1}{2} m_B V_{Bf}^2 + \tfrac{1}{2} k x^2$$

$$-3\text{kg} \cdot 9.8 \tfrac{\text{m}}{\text{s}^2} \cdot 0.45 \cdot 0.1 + \tfrac{1}{2} 3\text{kg} \cdot \left(1.52 \tfrac{\text{m}}{\text{s}}\right)^2 = \tfrac{1}{2} 150 \tfrac{\text{N}}{\text{m}} \cdot x^2$$

$$\boxed{x = 0.17 \text{ m}}$$