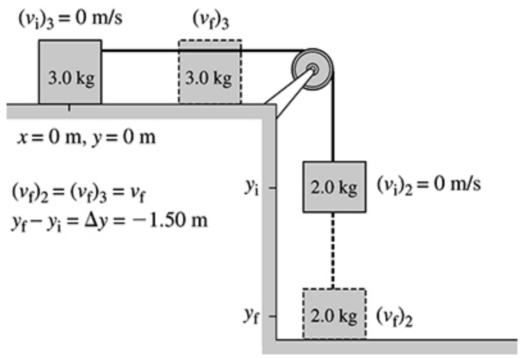
11.50. Model: Model the two blocks as particles. The two blocks make our system.

Visualize:



We place the origin of our coordinate system at the location of the 3.0 kg block.

Solve: (a) The conservation of energy equation is $K_f + U_{gf} + \Delta E_{th} = K_i + U_{gi} + W_{ext}$. Using $\Delta E_{th} = 0$ J and $W_{ext} = 0$ J we get

$$\frac{1}{2}m_2(v_f)_2^2 + \frac{1}{2}m_3(v_f)_3^2 + m_2g(y_f) = \frac{1}{2}m_2(v_i)_2^2 + \frac{1}{2}m_3(v_i)_3^2 + m_2g(y_i)$$

Noting that $(v_f)_2 = (v_f)_3 = v_f$ and $(v_i)_2 = (v_i)_3 = 0$ m/s, this becomes

$$\frac{1}{2}(m_2 + m_3)v_f^2 = -m_2g(y_f - y_i)$$

$$v_f = \sqrt{\frac{2m_2g(y_i - y_f)}{m_2 + m_3}} = \sqrt{\frac{2(2.0 \text{ kg})(9.8 \text{ m/s}^2)(1.50 \text{ m})}{(2.0 \text{ kg} + 3.0 \text{ kg})}} = 3.4 \text{ m/s}$$

(b) We will use the same energy conservation equation. However, this time

$$\Delta E_{th} = \mu_k(m_3g)(\Delta x) = (0.15)(3.0 \text{ kg})(9.8 \text{ m/s}^2)(1.50 \text{ m}) = 6.615 \text{ J}$$

The energy conservation equation is now

$$\frac{1}{2}m_2v_f^2 + \frac{1}{2}m_3v_f^2 + m_2gy_f + 6.615 \text{ J} = \frac{1}{2}m_2(v_i)_2^2 + \frac{1}{2}m_3(v_i)_3^2 + m_2gy_i + 0 \text{ J}$$

$$\frac{1}{2}(m_2 + m_3)v_f^2 + 6.615 \text{ J} = m_2g(y_i - y_f) \Rightarrow v_f = \sqrt{\left(\frac{2}{m_2 + m_3}\right)[m_2g(y_i - y_f) - 6.615 \text{ J}]}$$

$$= \sqrt{\left(\frac{2}{5.0 \text{ kg}}\right)[(2.0 \text{ kg})(9.8 \text{ m/s}^2)(1.50 \text{ m}) - 6.615 \text{ J}]} = 3.0 \text{ m/s}$$

Assess: A reduced speed when friction is present compared to when there is no friction is reasonable.