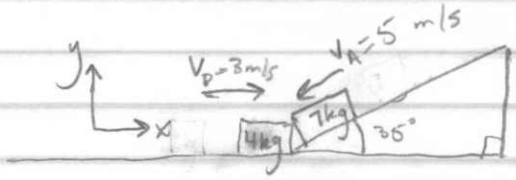
Solutions

1)



Momentum in the x-direction is conserved, but not in the y-direction, since the blocks will move to the left.

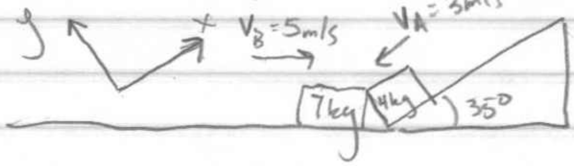
$$P_{ix} = P_{fx} \qquad P_{fy} = 0$$

$$m_A v_{Ax_i} + m_B v_{Bx_i} = (m_A + m_B)\, v_{ABxf}$$

$$(7\text{ kg})(-5\cos 35^\circ \text{ m/s}) + (4\text{ kg})(3\text{ m/s}) = (7\text{kg} + 4\text{kg})\, v_{ABxf}$$

$$v_{ABxf} = -1.52 \text{ m/s} \quad \text{or} \quad 1.52 \text{ m/s } (-\hat{i})$$

Now reversing the masses and velocities of the blocks, they will move up the ramp.



$$P_{ix} = P_{fx} \qquad P_{fy} = 0$$

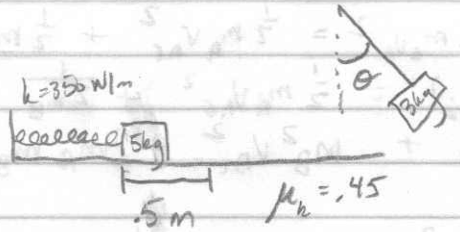
$$m_A v_{Ax_i} + m_B v_{Bx_i} = (m_A + m_B)\, v_{ABxf}$$

$$(4\text{kg})(-3 \text{ m/s}) + (7\text{kg})(5\cos 35^\circ \text{ m/s}) = (4\text{ kg} + 7\text{kg})\, v_{ABxf}$$

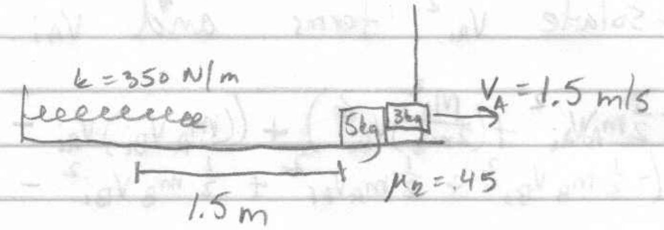
$$v_{ABxf} = 1.52 \text{ m/s}$$

Solutions

2) Initially



After Collision



To find θ, we need the velocity of A before the collision. Using energy techniques, we can find the velocity of B before the collision, and then use momentum and energy conservation to find what we want. Analyzing Block B first:

$$W_{OTHER} = \Delta K + \Delta U_g + \Delta U_{ela}$$

$$-\mu_k m g d = \tfrac{1}{2} m v_{Bf}^2 - 0 + 0 - \tfrac{1}{2} k x^2$$

$$-(.45)(5\,kg)(9.81\,m/s^2)(1.5\,m) = \tfrac{1}{2}(5\,kg)\,v_{Bf}^2 - \tfrac{1}{2}(350\,N/m)(.5\,m)^2$$

$$v_{Bf} = 2.06\ m/s$$

Now we can analyze the collision, with the v_{Bf} we just calculated becoming v_{Bi}.

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

$$(2)\quad \tfrac{1}{2} m_A V_{Ai}^2 + \tfrac{1}{2} m_B V_{Bi}^2 = \tfrac{1}{2} m_A V_{Af}^2 + \tfrac{1}{2} m_B V_{Bf}^2$$

I don't know the final velocity of B, so I'll eliminate that variable and solve for V_{Ai}. Solve (1) for V_{Bf} and substitute

$$\frac{m_A V_{Ai} + m_B V_{Bi} - m_A V_{Af}}{m_B} = V_{Bf}$$

Solutions

$$\frac{1}{2}m_A v_{Ai}^2 + \frac{1}{2}m_B v_{Bi}^2 = \frac{1}{2}m_A v_{Af}^2 + \frac{1}{2}m_B\left(\frac{m_A v_{Ai} + m_B v_{Bi} - m_A v_{Af}}{m_B}\right)^2$$

$$\frac{1}{2}m_A v_{Ai}^2 + \frac{1}{2}m_B v_{Bi}^2 = \frac{1}{2}m_A v_{Af}^2 + \frac{1}{2m_B}\Big[m_A^2 v_{Ai}^2 + 2m_A m_B v_{Ai} v_{Bi} - 2m_A^2 v_{Ai} v_{Af} + m_B^2 v_{Bi}^2 - 2m_A m_B v_{Af} v_{Bi} + m_A^2 v_{Af}^2 \Big]$$

Isolate v_{Ai}^2 terms and v_{Ai} terms

$$0 = \left(-\frac{1}{2}m_A v_{Ai}^2 + \left(\frac{m_A^2}{2m_B}\right)v_{Ai}^2\right) + \left((m_A v_{Bi})v_{Ai} - \left(\frac{m_A^2 v_{Af}}{m_B}\right)v_{Ai}\right) + \left(-\frac{1}{2}m_B v_{Bi}^2 + \frac{1}{2}m_A v_{Af}^2 + \frac{1}{2}m_B v_{Bi}^2 - m_A v_{Af} v_{Bi} + \frac{m_A^2 v_{Af}^2}{2m_B}\right)$$

$$0 = \left(\frac{m_A^2}{2m_B} - \frac{m_A}{2}\right)v_{Ai}^2 + \left(m_A v_{Bi} - \frac{m_A^2 v_{Af}}{m_B}\right)v_{Ai} + \left(\frac{1}{2}m_A v_{Af}^2 - m_A v_{Af} v_{Bi} + \frac{m_A^2 v_{Af}^2}{2m_B}\right)$$

$$0 = \underset{a}{-0.6}\, v_{Ai}^2 + \underset{b}{3.48}\, v_{Ai} \underset{c}{- 3.87}$$

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad v_{Ai} = 1.5,\ 4.3$$

Well look at that, I made a mistake. One of those solutions should be negative to be valid, which means that the current behavior isn't possible. If Block A has a mass of 7 kg instead, things work out nicely.

Now, just because it turned out to be unsolvable does not mean that you could not set up the problem correctly. Credit will be given for a correct <u>process</u>.

Using $m_A = 7\text{kg}$, $v_{Ai} = -1.3$ m/s

$$m_A g h = \frac{1}{2} m v_a^2$$

$$h = 1 - \cos\theta$$

$$\theta = \cos^{-1}\left(1 - \frac{v_A^2}{2g}\right) = 24°$$