1. PHY 9A Discussion 7 May 14, 2018

1.

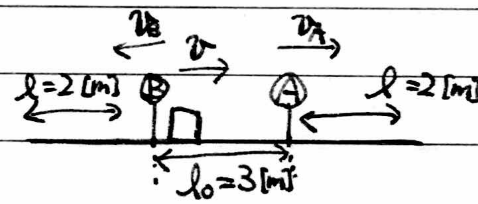
i) $0 = mv + m_B v_B$. $\therefore v_B = -\frac{m}{m_B} v$.

$\rightarrow v_B = \frac{m}{m_B} v = 1/28$ [m/s]. (≈ 3.57 [cm/s])

ii) $mv = mv_A + m_A v_A$. $\therefore v_A = \frac{m}{m+m_A} v$.

$\rightarrow v_A = \frac{m}{m+m_A} v = 1/24$ [m/s]. (≈ 4.17 [cm/s])

iii) At $t=0$, Bob releases the box.



$$t_B = \frac{l}{v_B} = \frac{l \cdot m_B}{v \cdot m} = 56 \text{ [s]}.$$

$$t_A = \frac{l_0}{v} + \frac{l}{v_A} = \frac{l_0}{v} + \frac{l \cdot (m+m_A)}{v \cdot m} = 54 \text{ [s]}.$$

$\therefore$ Alice moves by 2 [m] first.

iv) Let $\tilde{m}$ denote the mass we want to find.

$$\frac{l \cdot m_B}{v \cdot \tilde{m}} = \frac{l_0}{v} + \frac{l \cdot (\tilde{m}+m_A)}{v \cdot \tilde{m}}$$

$$\Leftrightarrow l \cdot m_B = l_0 \cdot \tilde{m} + l \cdot (\tilde{m}+m_A)$$

$$\therefore \tilde{m} = \frac{l \cdot (m_B - m_A)}{l_0 + l} = 6 \text{ [kg]}.$$

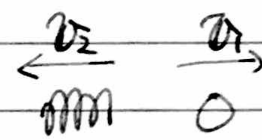
$$v_B = \frac{\tilde{m}}{m_B} v = \frac{3}{70} \text{ [m/s]} \approx 4.29 \text{ [cm/s]}.$$

$$v_A = \frac{\tilde{m}}{\tilde{m}+m_A} v = \frac{3}{61} \text{ [m/s]} \approx 4.92 \text{ [cm/s]}.$$

2.

2.

i) $PE = \frac{1}{2}k\Delta l^2 = 2.7$ [J].



ii) $0 = m_1 v_1 + m_2 v_2$.

iii) From the energy conservation,

$$\frac{1}{2}k\Delta l^2 = \frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2.$$

$$= \frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2\left(\frac{m_1}{m_2}v_1\right)^2$$

$$= \frac{1}{2}m_1 v_1^2 + \frac{1}{2}\cdot\frac{m_1^2}{m_2}v_1^2$$

$$= \frac{1}{2}m_1\left(1+\frac{m_1}{m_2}\right)v_1^2$$

$$\therefore\ v_1^2 = \Delta l^2\cdot\frac{k}{m_1}\cdot\frac{m_2}{m_1+m_2}$$

$$\therefore\ v_1 = \Delta l\sqrt{\frac{m_2}{m_1}\cdot\frac{k}{m_1+m_2}} \qquad (\because v_1 = \|v_1\| \geq 0)$$

$$\approx 4.39\ [m/s].$$

$$v_2 = \frac{m_1}{m_2}\cdot v_1 = \Delta l\cdot\sqrt{\frac{m_1}{m_2}\cdot\frac{k}{m_1+m_2}}$$

$$\approx 1.76\ [m/s].$$

3.

iv) The spring cannot be massless.

If we set $m_2 = 0$, we'd get $v_f = 0$ from the momentum conservation, but we'd also get $v_i \neq 0$ from the energy conservation, thereby suffering from a contradiction.