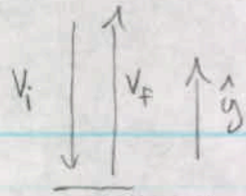
[1]




$\vec{v}_i = -v_i\hat{y}$

$\vec{v}_f = v_f\hat{y}$

#1

$$\vec{F} = m\frac{\Delta\vec{p}}{\Delta t} = \frac{m(3.5+6.5)}{0.025} = \boxed{60\,N}.$$

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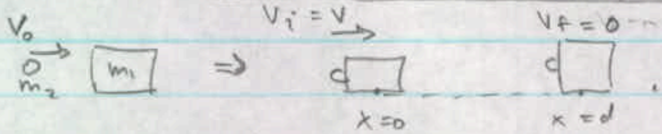
#2




. Solve for $v_0$:

Collision: $(m_1+m_2)v = m_2 v_0 \Rightarrow v = m_2v_0/m_1+m_2$. Also, for the system,

$\vec{F} = m\vec{a} = -f = -\mu_k mg = ma \Rightarrow a = -\mu_k g$. $v_f^2 = v_i^2 + 2a(\Delta x)$. At $v_f = 0$,

$$-v_i^2 = -2\mu_k g(\Delta x) \Rightarrow v_i = (2\mu_k g\Delta x)^{1/2} = v = \frac{m_2 v_0}{m_1+m_2}.$$

$$v_0 = (2\mu_k g\Delta x)^{1/2}\cdot(m_1+m_2)\cdot\frac{1}{m_2} = (2\tfrac{1}{2}g\cdot 2.1)^{1/2}\left(\frac{0.6}{0.1}\right)$$

$$v_0 = (9.8\cdot 2.1)^{1/2}\cdot 6 = \boxed{27\,m/s}$$

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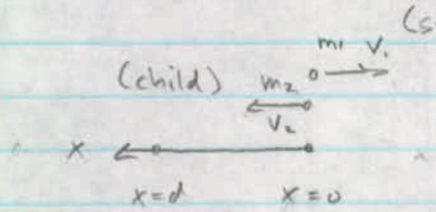
#3




Momentum Conservation:

$\vec{p}_i = \vec{p}_f \Rightarrow 0 = m_2v_2 - m_1v_1 \Rightarrow$

$m_2v_2 = m_1v_1 \Rightarrow$

$v_2 = \left(\frac{m_1}{m_2}\right)v_1$.

No Force $\Rightarrow$ $x_2(t) = v_2 t$;

$$x_2(T) = 12 = v_2T \Rightarrow T = 12/v_2 = \frac{12}{v_1}\cdot\frac{m_2}{m_1} = \boxed{60\text{ sec}}$$

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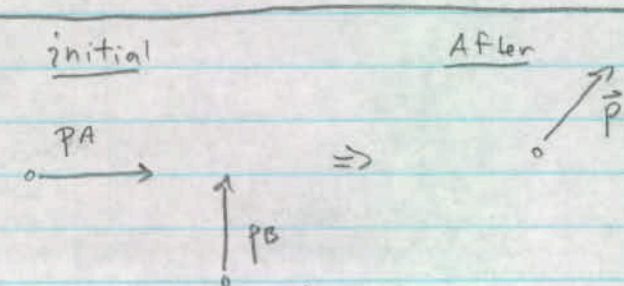
#4


Momentum Conservation:

$$\vec{p} = \vec{p}_A + \vec{p}_B = m_Av_A\hat{x} + m_Bv_B\hat{y} = (m_A+m_B)\vec{v}$$

$m_A = M$ & $m_B = 3M$

Solving for $|\vec{v}| = v$: $v = \sqrt{v_x^2 + v_y^2}$ ; $v_x = \frac{m_A v_A}{m_A + m_B} = \left(\frac{M}{4M}\right) 14 \frac{m}{s}$

& $v_y = 3M\, v_B / 4M = \left(\frac{3}{4}\right) 13 \frac{m}{s}$. So, $v = \left(\left(\frac{14}{4}\right)^2 + \left(\frac{39}{4}\right)^2\right)^{1/2} = \boxed{10.4 \text{ m/s}}$

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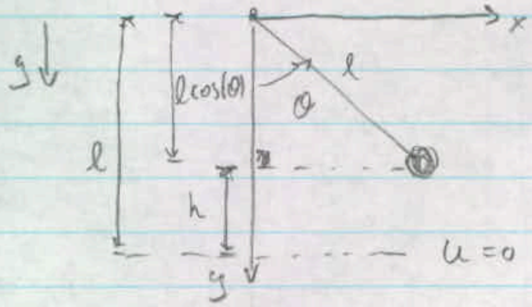
$\boxed{\#5}$




$U = mgl$

- $h = l - l\cos(\theta)$.
- $U = mgl(1-\cos(\theta))$

- $E_{Bottom} = E_\theta = \frac{1}{2}\cancel{m}v^2 = \cancel{m}gl(1-\cos(\theta))$, $\frac{v^2}{2gl} = 1 - \cos(\theta)$

$\cos(\theta) = 1 - \frac{v^2}{2gl} = 0.426$; $\theta = 64.7° \simeq \boxed{65°}$.

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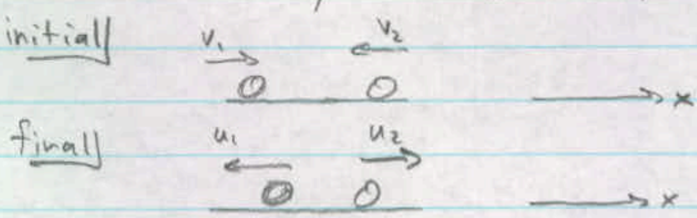
$\boxed{\#6}$ Elastic Collision implies $KE_i = KE_f$; Also, $p_i = p_f$ & $m_1 = m_2 = m$




- $\cancel{m}v_1 + \cancel{m}v_2 = \cancel{m}u_1 + \cancel{m}u_2 \Rightarrow u_2 = v_1 + v_2 - u_1$

- $\cancel{\frac{1}{2}}\cancel{m}v_1^2 + \cancel{\frac{1}{2}}\cancel{m}v_2^2 = \cancel{\frac{1}{2}}\cancel{m}u_1^2 + \cancel{\frac{1}{2}}\cancel{m}u_2^2 \Rightarrow u_2^2 = v_1^2 + v_2^2 - u_1^2$

$u_2 = (v_1^2 + v_2^2 - u_1^2)^{1/2} = v_1 + v_2 - u_1$. Solve for $u_1$:

$v_1 = 2$, $v_2 = -1$ :

$(4 + 1 - u_1^2)^{1/2} = 2 - 1 - u_1 = 1 - u_1 = (5 - u_1^2)^{1/2}$.

$5 - u_1^2 = (1-u_1)^2 = 1 + u_1^2 - 2u_1 = 5 - u_1^2$

$$2u_1^2 - 2u_1 - 4 = 0 = u_1^2 - u_1 - 2 = 0 = (u_1+1)(u_1-2) = 0.$$

$u_1 = -1, +2$. It moves in the opposite direction since it's a head-on collision $\Rightarrow \boxed{u_1 = -1 \text{ m/s}}$

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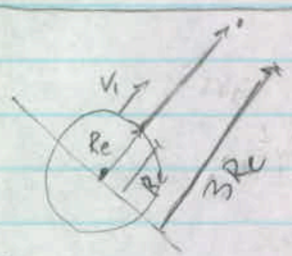
#7




$$E_i = E_f = \tfrac{1}{2} \cancel{m} v^2 - \frac{GM_e \cancel{m}}{R_e} = -\frac{GM_e \cancel{m}}{3R_e}$$

$$\tfrac{1}{2} v^2 = \frac{GM_e}{R_e}\left(1 - \frac{1}{3}\right) = \frac{GM_e}{R}\left(\frac{2}{3}\right) \Rightarrow$$

$U_{earth} = -\frac{GM_e m}{R}$.

$$v_1^2 = \frac{GM_e}{R_e}\left(\frac{4}{3}\right); \quad v_1 = \left(\frac{GM_e}{R_e}\,\frac{4}{3}\right)^{1/2}.$$

$$v_1 = 9139 \text{ m/s} = \boxed{9.1 \text{ km/s}}.$$

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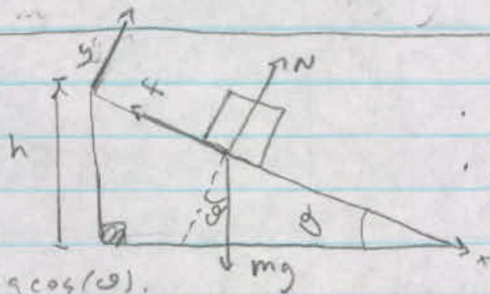
#8




- $h = \Delta x \sin(\theta)$
- $mg = 20N \Rightarrow m = 2$ kg.

$F_x = ma_x = -f$

$F_y = ma_y = 0 = N - mg\cos(\theta)$.

$\Rightarrow N = mg\cos(\theta)$. $\quad f = -\mu N = -\mu mg\cos(\theta)$.

$W_{frict} = \Delta E = E_f - E_i = -f\Delta x = \frac{1}{2}mv_1^2 - mgh$; Solve for $v_1$:

$W_{fric} = -30\text{ J} = \frac{1}{2}mv_1^2 - mgh$; $\frac{1}{2}mv_1^2 = mgh - 30$:

$$v_1^2 = \frac{2}{m}(mgh - 30) = \frac{2}{m}(mg\,\Delta x\sin(\theta) - 30).$$

$$v_1^2 = 12.26 \Rightarrow \boxed{v_1 = 3.5 \text{ m/s}}.$$