Conceptual Questions: 9, 23, 26

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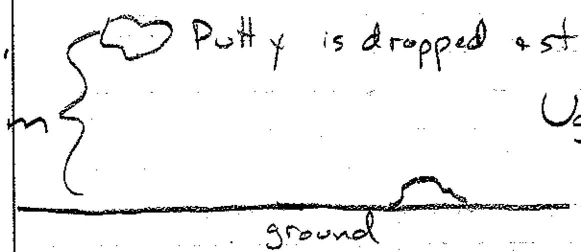
(2) 9.



$U_g \rightarrow K \rightarrow E_{th}$ is transformations

To be isolated; need to include: <u>Putty</u> (K), <u>Earth</u> (U_g), <u>Air</u> (E_{th}) and <u>Ground</u> (E_{th}).

(2) 23.

when spring compressed a distance Δx_i

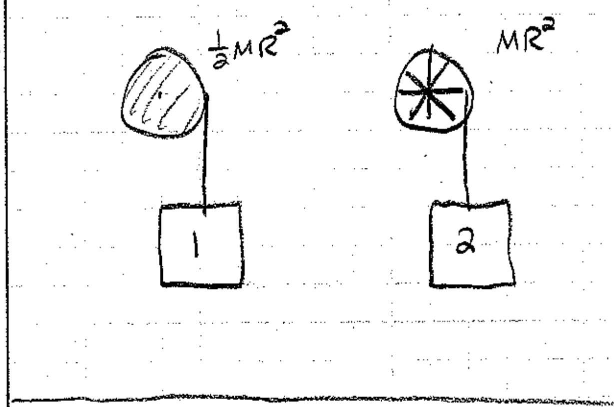
Now, $\Delta x = 2\Delta x_i$

a) $U_s = \frac{1}{2}k(\Delta x)^2 = \frac{1}{2}k(2\Delta x_i)^2 = 4\left(\frac{1}{2}k(\Delta x_i)^2\right) = \boxed{4\text{x greater}}$

b) $\Delta U_s = \Delta K \Rightarrow \Delta K = 4 \cdot \Delta K_i = 4\left(\frac{1}{2}mv^2\right) = \frac{1}{2}m(2v)^2$

Speed is only $\boxed{2\text{x greater}}$

(2) 26.



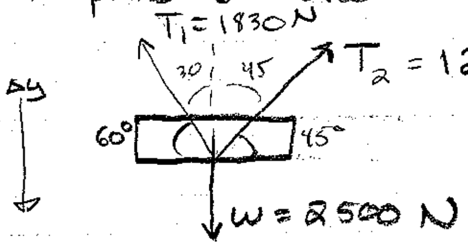
When released, both blocks exert same torque on each pulley. However, since 2 has a <u>greater</u> moment of inertia, it will have a <u>smaller</u> angular acceleration. Since the rope is not slipping, that means block #2 will have a smaller linear acceleration.

$\boxed{\text{Block \#1 hits the ground first.}}$

In terms of energy, since $I_2 > I_1$, it will have a greater K_{rot} for the same ω. However, since ΔU_g is same for both, ΔK is same as well, so $\omega_2 < \omega_1$, thus #2 doesn't fall as fast either.

2 Problems: 3, 10, 17, 21, | 28, 32, 34, 41, 53, | 60

(4) 3. A piano is moved $\Delta y = -5.\bar{0}$ m.



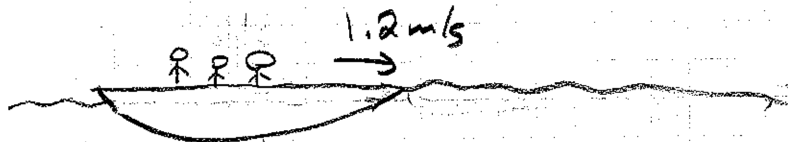
gravity: $W_g = (-2500\text{ N})(-5\text{ m}) = \boxed{12500\text{ J}}$

T_1 : $W_1 = (+1830\text{ N})(\cos 30°)(-5\text{m}) = \boxed{-7900\text{ J}}$

T_2 : $W_2 = (1295\text{ N})(\cos 45°)(-5\text{m}) = \boxed{-4600\text{ J}}$

(note: $W_g + W_1 + W_2 = 0$)

(6) 10.



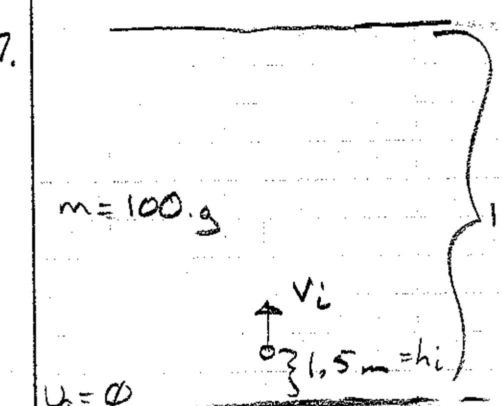
$m = 1200.$ kg

To bring it to a stop, $v_f = 0 \Rightarrow K_f = 0$

$\Delta K = K_f - K_i = 0 - \frac{1}{2}(1200\text{ kg})(1.2\text{ m/s})^2 = W$

$\therefore \boxed{W = -864\text{ J}}$

(4) 17.



a) Want to just barely hit ceiling $\Rightarrow K_f = 0$

$U_i = mgh_i \qquad K_i = \frac{1}{2}mv_i^2$

$U_f = mgh_f \qquad K_f = 0$

$\therefore U_i + K_i = U_f + K_f$

$\cancel{m}gh_i + \frac{1}{2}\cancel{m}v_i^2 = \cancel{m}gh_f + 0$

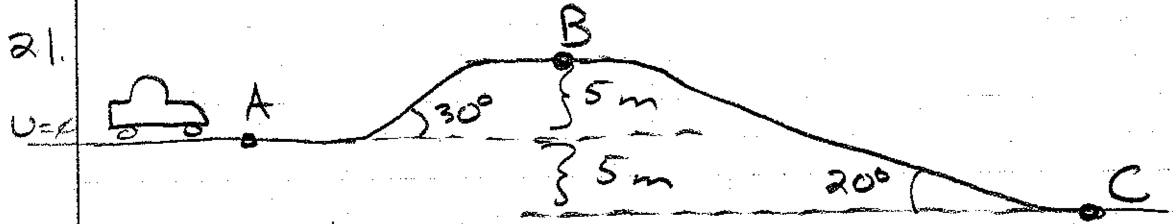
$\frac{1}{2}v_i^2 = gh_f - gh_i \Rightarrow v_i = \sqrt{2g(h_f - h_i)} = \boxed{13.\text{ m/s}}$

b) When it hits ground; $U_{gf} = 0 \qquad U_{gi} = mgh_f$

$K_f = \frac{1}{2}mv_f^2 \qquad K_i = 0$

$\therefore \frac{1}{2}\cancel{m}v_f^2 = \cancel{m}gh_f \Rightarrow v_f = \sqrt{2gh_f} = \boxed{14\text{ m/s}}$

(6) 21.



$m = 1500 \text{ kg}$

$v_A = 10. \text{ m/s}$

a) Car can make it to the top as long as its $K_B \geq 0$ there:

$E_A = U_A + K_A = 0 + \frac{1}{2}mv_A^2 = E_B = U_B + K_B = mgh_B + K_B$

$\therefore K_B = \frac{1}{2}mv_A^2 - mgh_B = 1425 \text{ J}$; so $\boxed{\text{Yes}}$

equivalently; its speed $v_B = \sqrt{\frac{2K_B}{m}} = 1.38 \text{ m/s} \geq 0$

b) $E_A = \frac{1}{2}\cancel{m}v_A^2 = E_C = \frac{1}{2}\cancel{m}v_C^2 + \cancel{m}gh_C$ $(h_C = -5 \text{ m})$

$\frac{1}{2}v_A^2 - gh_C = \frac{1}{2}v_C^2 \Rightarrow v_C = \sqrt{v_A^2 - 2gh_C} = \boxed{14 \text{ m/s}}$

(4) 28. $v_i = 35 \frac{\text{km}}{\text{hr}}\left(\frac{1000 \text{ m}}{1 \text{ km}}\right)\left(\frac{1 \text{ hr}}{3600 \text{ s}}\right) = 9.7\bar{2} \text{ m/s}$

$\Delta y = -15 \text{ m}$

You will get a ticket if $v_f \geq 70. \text{ km/hr}$

$\Delta K + \Delta U_g = 0$

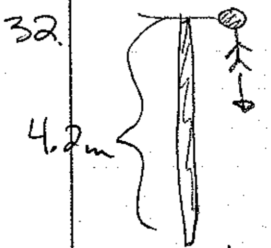
$\frac{1}{2}\cancel{m}v_f^2 - \frac{1}{2}\cancel{m}v_i^2 + \cancel{m}g\Delta y = 0 \Rightarrow \frac{1}{2}v_f^2 = \frac{1}{2}v_i^2 - g\Delta y$

$v_f = \sqrt{v_i^2 - 2g\Delta y} = 19.72 \text{ m/s}\left(\frac{1 \text{ km}}{1000 \text{ m}}\right)\left(\frac{3600 \text{ s}}{1 \text{ hr}}\right) = \boxed{70.99 \text{ km/hr}}$

Busted!

Though, accounting for air resistance & rolling friction, your actual speed will likely be under the limit.

(6) 32.



$v_i = 0 \Rightarrow K_i = 0$ let $U_i = 0$

$m = 80.\ \text{kg}$

$v_f = 2.2\ \text{m/s}$

$y_f = -4.2\ \text{m}$

$$\Delta K + \Delta U_g + \Delta E_{th} = 0$$

$$\Delta E_{th} = -\Delta K - \Delta U_g$$

$$= -(K_f - K_i) - (U_f - U_i)$$

$$= -K_f - U_f$$

$$= -\tfrac{1}{2}(80\ \text{kg})(2.2\ \text{m/s})^2 - (80\ \text{kg})g(-4.2\ \text{m})$$

$$= \boxed{3100\ \text{J}}$$

(2) 34.

$m_1 = 100.\ \text{g}$ $\quad$ $m_2 = 300.\ \text{g}$

$v_{1i} = 10.\ \text{m/s}$ $\quad$ $v_{2i} = 0$

a) (perfectly) elastic $\quad v_{1f} \quad v_{2f}$

$$v_{1f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) v_{1i} = \boxed{-5.0\ \text{m/s}}$$

$$v_{2f} = \left(\frac{2m_1}{m_1 + m_2}\right) v_{1i} = \boxed{+5.0\ \text{m/s}}$$

b) perfectly inelastic $\quad \rightarrow v_f$

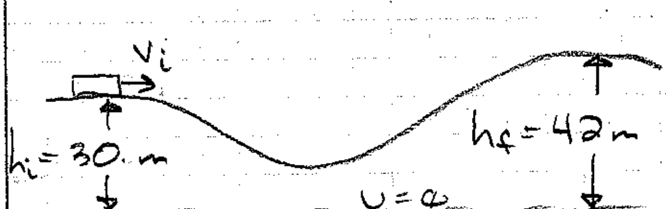
$$m_1 v_{1i} = (m_1 + m_2) v_f$$

$$\therefore\ v_f = \left(\frac{m_1}{m_1 + m_2}\right) v_{1i} = \boxed{+2.5\ \text{m/s}}$$

(6) 41. $m = 1000\ \text{kg}$ car goes from $0 \rightarrow 30\ \text{m/s}$ in $10.\ \text{s}$

$$P_{avg} = \frac{\Delta K}{\Delta t} = \frac{K_f - K_i}{\Delta t} = \frac{\tfrac{1}{2} m v_f^2}{\Delta t} = \boxed{45{,}000\ \text{W}} = 45\ \text{kW}$$

(6) 53.



To just make it over the next hill; will have $K_f = 0$

$$U_i + K_i = U_f + K_f = U_f$$

$$K_i = \tfrac{1}{2}\cancel{m} v_i^2 = U_f - U_i = \cancel{m} g(h_f - h_i)$$

$$v_i = \sqrt{2g(h_f - h_i)} = \boxed{15.3\ \text{m/s}}$$

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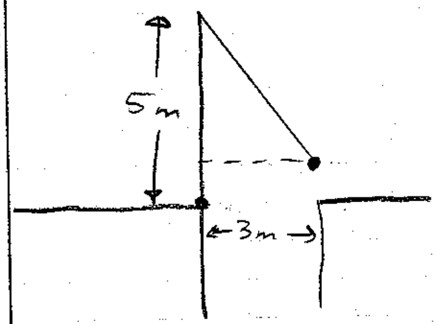
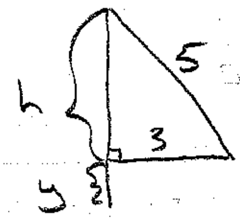
(4) 60.





$h = \sqrt{5^2 - 3^2} = 4\ m$

$h + y = 5\ m$

a) As she swings: $\boxed{K \rightarrow U_g}$

b) From geometry above; she is $\boxed{y = 1m}$ above start.

c) To just make it across; $K_i = U_{gf}$

$$\frac{1}{2}\cancel{m}v_i^2 = \cancel{m}gy$$

$$v_i = \sqrt{2gy} = \boxed{4.4\ m/s}$$