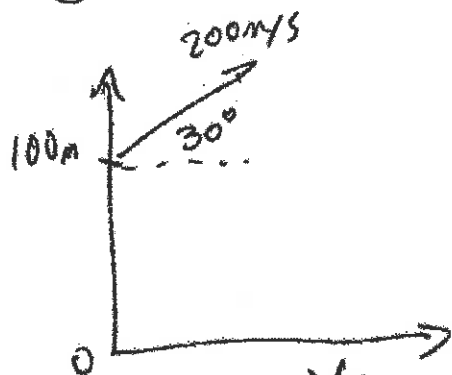


# Practice Final Solutions



①. Godzilla vs. Hulk.



when  $y=0$ ,  $x=?$

$$x = \underset{\substack{\text{''} \\ 200 \text{ m/s}}}{V_0} (\underset{\substack{\text{''} \\ 0.866}}{\cos 30^\circ}) t = (173 \text{ m/s}) t$$

$$y = y_0 + V_0 \sin 30^\circ t + \frac{1}{2} a_y t^2$$

$$y = 100 \text{ m} + (200 \text{ m/s})(0.5)t + \frac{1}{2} (-10 \text{ m/s}^2) t^2$$

$$0 = y = 100 \text{ m} + (100 \text{ m/s})t - 5 \text{ m/s}^2 t^2$$

$$a = -5 \quad b = 100 \quad c = 100$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-100 \pm \sqrt{10000 + 2000}}{-10}$$

$$t = +21 \text{ sec.}$$

$$x = (173 \text{ m/s}) \cdot 21.0 = 3633 \text{ m}$$

$\sim 3.6 \text{ km}$

w/ sig figs.

## ② Batman Revised

$$(m_R g) - T = m_R a$$

$$m_B g \sin 45^\circ + T + (-\mu_k) g \cos 45^\circ = m_B a$$

$$\rightarrow a = g - \frac{T}{m_R}$$

$$(1 - \mu_k) m_B g (0.707) + T = (m_B) \left( g - \frac{T}{m_R} \right)$$

$$\underbrace{\begin{matrix} 0.3 \\ 0.7 \end{matrix}}$$

$$0.49 g + \frac{T}{m_B} = g - \frac{T}{m_R}$$

$$T \left( \frac{1}{m_B} + \frac{1}{m_R} \right) = 5.1 g$$

$$\underbrace{\hspace{10em}}_{0.03 \text{ kg}^{-1}}$$

use  $10 \text{ m/s}^2$

$$\boxed{T = 170 \text{ N}}$$

③ Wonder Woman vs. Cheetah

$m_{ww} = 80 \text{ kg}$

$m_c = 60 \text{ kg}$



$v_{ww} = 10 \text{ m/s}$

$v_c = 8 \text{ m/s}$

Inelastic collision. Momentum conserved, Energy Not.

$$p = m_{ww} v_{ww} + m_c v_c = (m_{ww} + m_c) v_{final}$$

$\begin{matrix} \text{"} & \text{"} & \text{"} & \text{"} & \text{"} & \text{"} \\ 80 & 10 & 60 & 8 & 140 \text{ kg} & \text{"?} \end{matrix}$

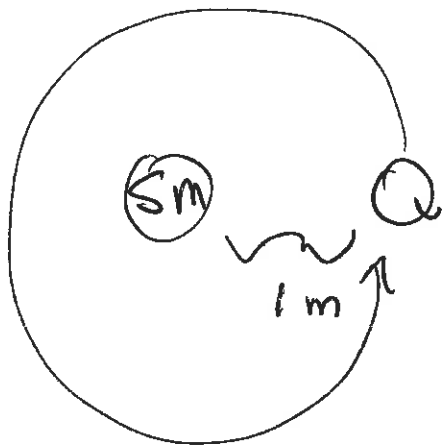
$1280 \text{ kg}\cdot\text{m/s} = 140 \cdot v_{final}$

$v_{final} = 9.1 \text{ m/s}$

$$\frac{K_1}{K_2} = \frac{\frac{1}{2} m_{ww} v_{ww}^2 + \frac{1}{2} m_c v_c^2}{\frac{1}{2} (m_{ww} + m_c) v_{final}^2} = \frac{8000 \text{ J} + 3840 \text{ J}}{(140)(9.1)^2 \text{ J}}$$
$$= \frac{11840}{11593}$$

$= 1.02$

④ Quicksilver Hits Spider-man



$a = 10 \text{ m/s}^2$  for  $t = 10 \text{ s}$ .

5 hits per circle.

$m_Q = 70 \text{ kg}$

- a. What is final speed in m/s? 100 m/s
- b. Final Kinetic Energy? 350 kJ
- c. Final angular speed  $\omega$ ? 100 rad/sec.
- d. Number of hits total? 398

$a = \frac{dv}{dt}$  So  $v_f = v_0 + at = 0 + 10 \text{ m/s}^2 \cdot 10 = 100 \text{ m/s}$   
"constant."

$K = \frac{1}{2} m_Q v_Q^2 = \frac{1}{2} (70 \text{ kg}) (100 \text{ m/s})^2 = 350,000 \text{ J}$   
 Not a rigid rotator, not spinning! Only  $\frac{1}{2} m v_Q^2$ .

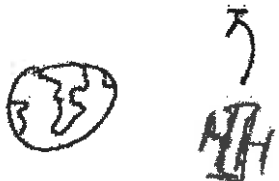
$v = r\omega$  so  $\omega = \frac{v_{\text{final}}}{r=1\text{m}} = 100 \text{ rad/s}$

# Hits =  $\left( \frac{\text{total distance}}{2\pi r} \right) \times 5$

$x = x_0 + v_0 t + \frac{1}{2} a t^2 = 500 \text{ m}$

$= \left( \frac{500 \text{ m}}{2\pi \text{ m}} \right) 5 = 398$

5) Geo synchronous JLA Watch tower


 $T = P = 1 \text{ day} = 86400 \text{ sec}$   
 $M_E = 5.97 \times 10^{24} \text{ kg}$

Kepler  $T = 2\pi r^{3/2} / \sqrt{GM_E}$

$\text{"}6.67 \times 10^{-11} \text{" N} \cdot \text{m}^2 / \text{kg}^2$

$r = \left( \frac{T^2 GM_E}{4\pi^2} \right)^{1/3}$

$\swarrow 1.99 \times 10^7$

$r = \left( \frac{86400^2}{4\pi^2} \sqrt{6.67 \times 10^{-11} \times 5.97 \times 10^{24}} \right)^{1/3}$

$\text{"}39.8 \times 10^{13} \text{"}$

$\text{"}15800 \text{"}$

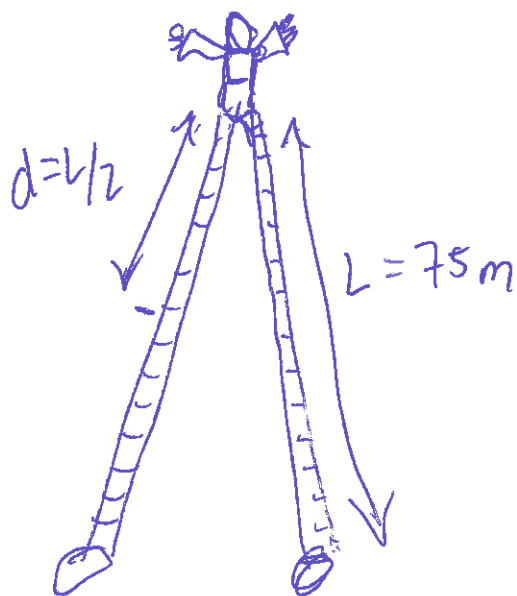
$r = (2.75 \times 10^{12})^{1/3}$

$r = 4.27 \times 10^6 \text{ m} = 42,700 \text{ km}$

$(26,500 \text{ miles})$

Note: often altitude is given above sea level,  $R_E \approx 6400 \text{ km}$

# ⑥ Stilt-Man Walks!



Stride = 25 m

Mass Per Leg = 100 kg.

$$I_{\text{rod}} = \frac{1}{3} M L^2 \quad (\text{pivot at end})$$

$$\omega = \sqrt{\frac{mgd}{I}} \quad d = \text{c.o.m. distance}$$

$$\omega = \sqrt{\frac{100 \text{ kg} \cdot 10 \text{ m/s}^2 \cdot (75/2 \text{ m})}{\frac{1}{3} 100 \text{ kg} (75 \text{ m})^2}}$$

$$\omega = \sqrt{0.20} \text{ s}^{-1}$$

$$\omega = 0.447 \text{ s}^{-1}$$

$$\text{Period } T = \frac{2\pi}{\omega} \approx 14 \text{ sec.}$$

$$\text{Velocity} = \frac{\text{Stride}}{T} = \frac{25 \text{ m}}{14 \text{ sec.}} = \boxed{1.8 \text{ m/s}}$$

7

## Black Canary's Cry

$$V_{\text{sound}} = 344 \text{ m/s}$$

$$f = 50 \text{ kHz}$$

$$a) \lambda = \frac{V_{\text{sound}}}{f} = \frac{344 \text{ m/s}}{50,000/\text{s}} = \boxed{0.00688 \text{ m}}$$

$$B_1 = 150 \text{ dB}$$

$$\approx 7 \text{ mm}$$

$$b) \text{ ~~150~~ } 150 \text{ dB} \text{ but need to convert to } \underline{w/m^2}$$

$$\frac{d_1}{d_2} = \frac{1}{2}$$

$$150 \text{ dB} = 10 \text{ dB} \log \left( \frac{I_1}{10^{-12} \text{ W/m}^2} \right)$$

$$15 = \log \frac{I_1}{10^{-12} \text{ W/m}^2}$$

$$\text{W/m}^2 (10^{15} \times 10^{-12}) = I_1$$

$$I_1 = 1000 \text{ W/m}^2$$

$I_2$  is 2x distance,  $\Rightarrow \frac{1}{4}$  the Intensity

$$\boxed{I_2 = 250 \text{ W/m}^2}$$

$$10 \text{ dB} \neq \log \left( \frac{250 \text{ W/m}^2}{10^{-12} \text{ W/m}^2} \right) = ? \quad 144 \text{ dB}$$