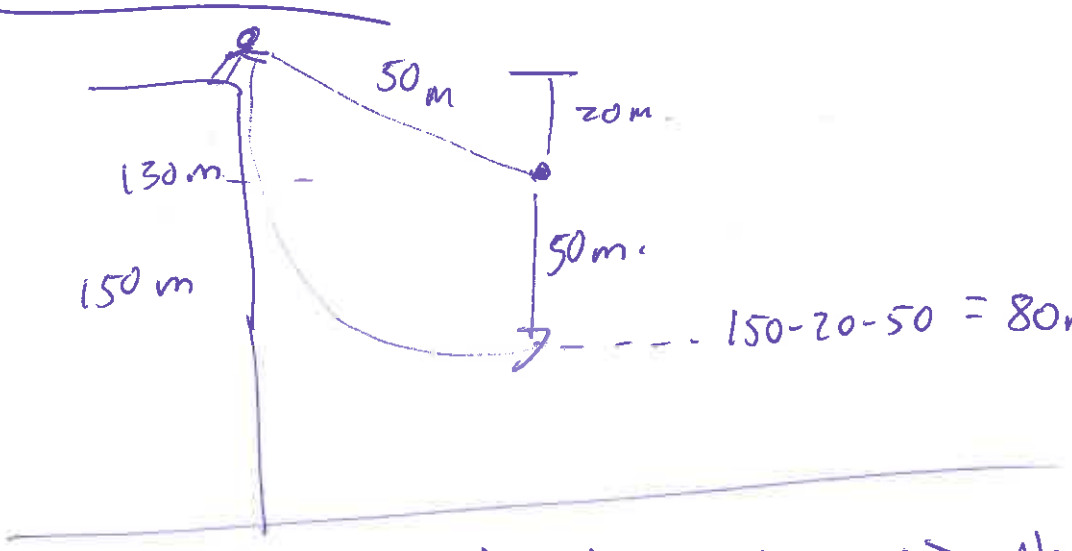
Exam 2 Solutions

1.



Tension $\perp$ to motion $\Rightarrow$ No work.

$K_1 + U_1 = K_2 + U_2$

0 "define=0" $\frac{1}{2}mv^2 + mgh$ (10, 70 m)

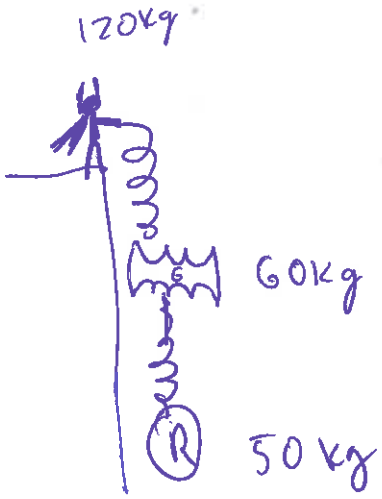
$70\,m\,g = \frac{1}{2}v^2$

$(1400)(10)\frac{m^2}{s^2} = v^2$

$v = \sqrt{1400}\ m/s = \boxed{37\ m/s}$

(82 mph!)

(2.)



$K = 5\ N/mm = 5000\ N/m$

Δs in each Spring?

$F = ks$

Robin: Force $= T = mg$ ($50\ kg$, $10\ m/s^2$)

$$s_R = \frac{mg}{k} = \frac{50 \cdot 10}{5000}\ m = \boxed{0.1\ m}$$

BatGirl: Same deal: $w = (m_R + m_{BG}) = 110\ kg$

$$s_{R+BG} = \frac{(110)(10)}{5000}\ m = \boxed{0.22\ m}$$

0.072
1.536
0.170

(3). Black Widow's Guns.

$$P_i = mV = 0 \qquad P_{final} = 0$$

$V = 0$

by conservation of momentum.

$$P_{final} = m_g V_g + m_B V_B = 0$$

$m_g = 615\,g$ V_g Recoil Velocity. $m_B = 7.5\,g$ $V_B = 370\,m/s$

Velocities in opposite directions.

$$|V_g| = \frac{m_B |V_B|}{m_g} = \frac{7.5\,g\,(370\,m/s)}{615\,g}$$

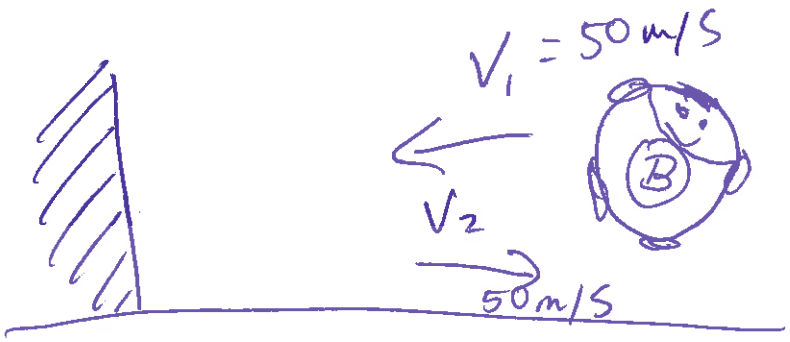
$$\boxed{V_g = 4.5\,m/s}$$

Kinetic Energy Ratio:

$$\frac{K_B}{K_G} = \frac{\frac{1}{2} m_B V_B^2}{\frac{1}{2} m_G V_G^2} = \frac{7.5\,(370)^2}{615\,(4.5)^2}$$

$$= \boxed{82}$$

(4.) **Bouncing Boy:**



$\Delta t = 0.1 sec$

+ x direction →

$m_{BB} = 100 kg$

$J = \Delta p \qquad p = mv$

1 Dimensional – no angles – easy.

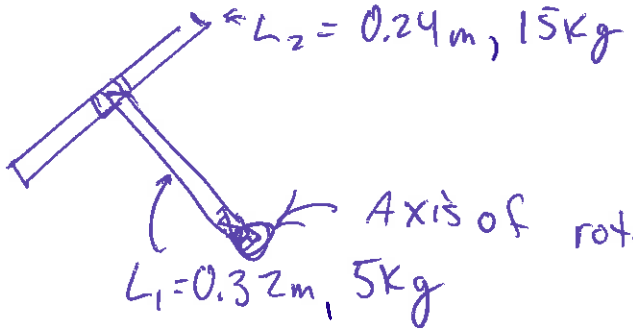
$J = p_2 - p_1 = 100\ kg\ (50_{m/s} - -50_{m/s})$

$\boxed{J = 10{,}000\ kg \cdot m/s}$

$F_{AVE} = \frac{J}{\Delta t} = \frac{10{,}000}{0.1} = \boxed{100{,}000\ N}$

Big!

(5) Thor's Hammer



$I_{tot} = I_{head} + I_{handle}$

$I_{handle} = \frac{1}{3} M_1 L_1^2$ (Fig. b)

$I_{head} = \frac{1}{12} M_2 L_2^2 + M_2 d^2$ (parallel-axis Th)

(L_2 (fig. a); $d = L_1$)

Plug in #5; use kg, m.

$$I_{tot} = 1.77\ kg \cdot m^2$$

(6.) Rolling Racers

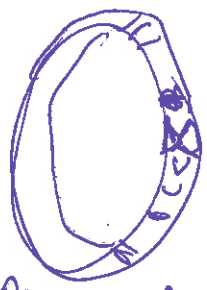
$I = \frac{2}{5}MR^2$

Mr. Fantastic

$I = \frac{1}{2}MR^2$

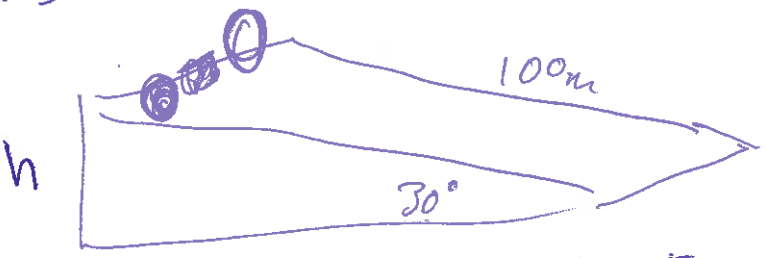
Elastigirl

$I = MR^2$



Plastic man.

Lots of Extra Info, not needed!



Use Conservation of Energy

$K_1 + U_1 = K_2 + U_2$

$0 \quad mgh \quad \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 \quad 0$

$I = CMR^2 \qquad \omega = \frac{V}{R}$

$mgh = \frac{1}{2}mv^2 + \frac{1}{2}CmR^2\frac{v^2}{R^2}$

↑ Figure.

$$V = \sqrt{\frac{2gh}{1+C}}$$

Largest Velocity is for smallest C.

$C_{MF} = \frac{2}{5}$ ← Winner

$C_{EG} = \frac{1}{2}$ 2nd

$C_{PM} = 1$ Loser.