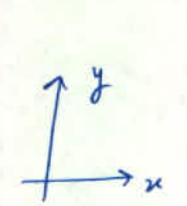
HW #4

PHYS 4A
WINTER '15

Ch-7

4.) a) $F_{\text{applied on barrel}} = mg$



$\therefore W_{barrel} = (mg)\,h$

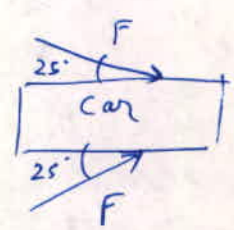
$= 45 \times 9.8 \times 2.5$

$= 1102.5 \text{ J}$

b) 0. As the displacement of barrel is 0.

c) -1102.5 J as the displacement is in the opposite direction of force applied. $\therefore \vec{F}\cdot d\vec{r} < 0$

8.)

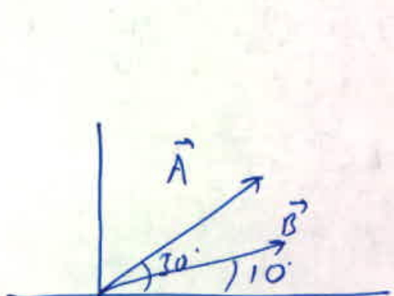


Work done by each person $= (F\cos 25^\circ)(\Delta x)$

$= 280 \cos 25^\circ \times 5.6$

$= 1421.09 \text{ J}$

14.)



$\vec{A} = 10\left(\cos 30\,\hat{i} + \sin 30\,\hat{j}\right)$

$\vec{B} = 4\left(\cos 10\,\hat{i} + \sin 10\,\hat{j}\right)$

a) $\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y$

$= 40 \, (\cos 10 \cos 30 + \sin 10 \sin 30)$

$= 40 \cos(30-10)$

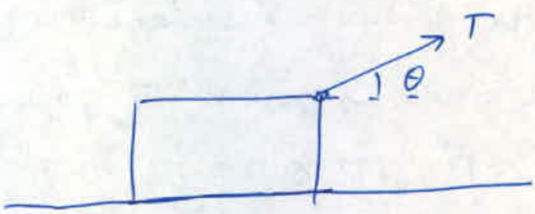
$= 37.58$

b) $\vec{C} \cdot \vec{D} = (5.6)(1.9) + (-3.1)(7.2)$

$= -11.68$

c) $\vec{B} \cdot \vec{C} = (5.6)(4 \cos 10) - (3.1)(4 \sin 10)$

$= 19.91$

22.) 

$W_{\text{done on Box}} = (T \cos\theta)(\Delta x)$

$\Rightarrow 2500 = 120 \cos\theta \times 23$

$\Rightarrow \theta = 25.07°$

26.) $k = 200 \text{ N/m}$

a) $W_{\text{done on spring}} = \frac{1}{2} k x^2$

$= \frac{1}{2}(200) \left(\frac{10}{100}\right)^2$

$= 1 \text{ J}$

b) $\Delta x = 20 - 10 = 10 \text{ cm}$

$\therefore W_{\text{done on spring}} = 1 \text{ J}$

44.) Work done $= \Delta K.E.$

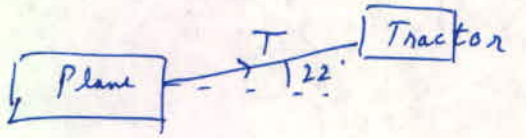
$$= \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$= \frac{1}{2}(60)\,10^2 - \frac{1}{2}(60)\,5^2$$

$$= 30 \times 75$$

$$= 2250\ \text{J}$$

70.)



$$W_{\text{done on Plane}} = 8.7\ \text{MJ}$$

$$\Rightarrow T\cos 22^\circ (\Delta x) = 8.7\ \text{MJ}$$

$$\Rightarrow \Delta x = \frac{8.7 \times 10^6}{4.1 \times 10^5 \cos 22}$$

$$\Rightarrow \Delta x = 22.89\ \text{m}$$

82.)

When the mass begins to leave the ground, the stretch in spring is

$$k x_f = mg$$

$$x_f = mg/k$$

Work done $= \int_{x_i}^{x_f} \vec{F} \cdot d\vec{x}$

$$= \int_{x_i}^{x_f} kx \, dx$$

$$= \frac{1}{2} k x^2 \Big|_{x_i}^{x_f}$$

$x_i = 0$

& $x_f = mg/k$

$\therefore$ Work done $= \frac{1}{2} k \left(\frac{mg}{k}\right)^2$

$$= \frac{1}{2} \frac{m^2 g^2}{k}$$

Ch-8

6.) 

$$h = x\sin\theta$$

$$\therefore \Delta U = mgh$$

$$\Rightarrow U_x - U_0 = mgh = mgx\sin\theta$$

$$\Rightarrow U_x = mgx\sin\theta$$

16.) $\vec{F} = \frac{A\hat{i}}{x^2}$

a) $$\Delta U = -\int_{x_1}^{x_2} \vec{F}\cdot d\vec{r}$$

$$= -\int_{x_1}^{x_2} \frac{A}{x^2}\,dx$$

$$= \frac{A}{x}\Big|_{x_1}^{x_2}$$

$$= A\left(\frac{1}{x_2} - \frac{1}{x_1}\right)$$

b) If $x_1 \to \infty$

$\Delta U = \frac{A}{x_2}$ which is finite

26.)

$$\Delta U + \Delta K = W_{nc} = 0.$$

$$\Rightarrow U_f - U_i + K_f - K_i = 0.$$

$$U_i = mg(2.8)$$

$$U_f = 0 + \tfrac{1}{2} k x^2$$

$$K_i = 0$$

$$\Delta K_f = 0$$

$$U_i = U_f$$

$$\Rightarrow \tfrac{1}{2} k x^2 = mg(2.8)$$

$$\Rightarrow x = \sqrt{\frac{2 \times 57000 \times 9.8 \times 2.8}{4.3 \times 10^6}}$$

$$\Rightarrow x = 0.853 \text{ m}$$

28.) a) Conserving energy between the 2 points when Left & Right spring are compressed maximum

$$\Delta U + \Delta K = W_{nc} = 0$$

$$\Delta K = 0 \quad \text{as } (K_L = K_R = 0)$$

$$U_L = U_R$$

$$\Rightarrow \frac{1}{2} k_L x_L^2 = \frac{1}{2} k_R x_R^2$$

$$\Rightarrow x_R = \sqrt{\frac{k_L x_L^2}{k_R}}$$

$$\Rightarrow x_R = 10.90 \text{ cm}$$

b) When the block is in the Middle, Non-of the springs are compressed.

$$\therefore \quad U_M = 0$$

Conserving energy between this as 1 Point and another point when the spring was compressed maximum (you can choose any side left or right).

$\therefore \quad \Delta U + \Delta K = W_{nc} = 0$

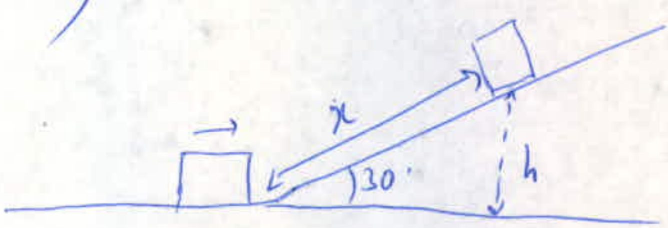
$$\cancel{U_M}^{0} - U_L + K_M - \cancel{K_L}^{0} = 0$$

$$\Rightarrow K_M = U_L$$

$$\Rightarrow \frac{1}{2} V_M^2 m = \frac{1}{2} k_L x_L^2$$

$$\Rightarrow V_M = 4.08 \text{ m/s}$$

30.)



$- - - U_0 = 0$

$$x = \frac{h}{\sin 30^\circ} \Rightarrow h = x \sin 30 = \frac{x}{2}$$

$$\Delta U + \Delta K = W_{nc} = 0.$$

$$\Rightarrow U_x - \cancel{U_0}^{0} + \cancel{K_x}^{0} - K_0 = 0$$

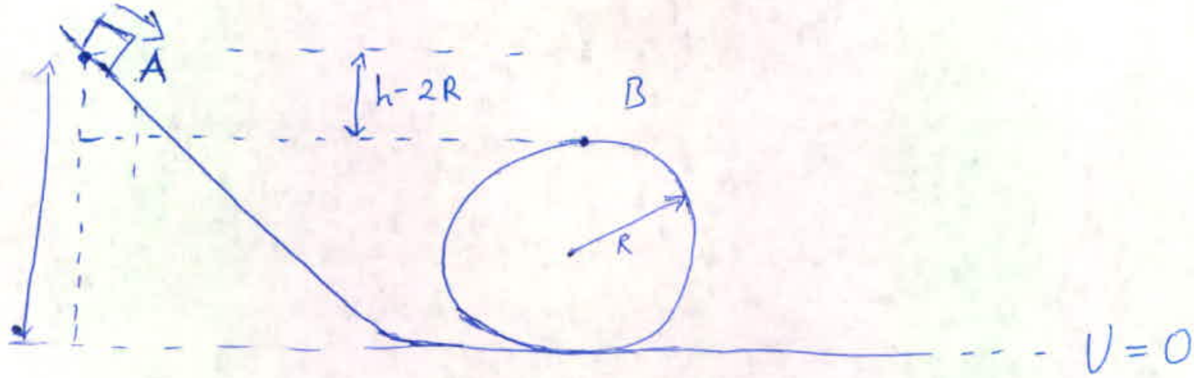
$$\Rightarrow U_x = K_0$$

$$\Rightarrow \cancel{m} g h = \frac{1}{2} \cancel{m} v_i^2$$

$$\Rightarrow x = \cancel{2} \times \frac{v_i^2}{\cancel{2} g} \qquad \left\{ \text{as } h = \frac{x}{2} \right\}$$

$$\Rightarrow x = 95.27 \text{ m}$$

32.)



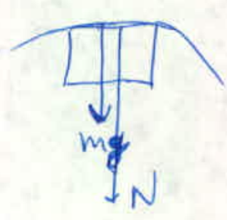
A → when it starts from height h.

B → Top most point in the loop.

First, calculate minimum velocity required to make it around the loop.

This is calculated by Force-Acceleration equation at Point B.

At B →



$$\frac{m v_{min}^2}{R} = mg + \cancel{N}^{\,0} \leftarrow \text{for } v_{min}$$

$$\Rightarrow v_{min} = \sqrt{Rg}$$

Now, Conserving Energy between points A & B.

$$\Delta U + \Delta K = W_{nc} = 0$$

$$\Rightarrow \underbrace{U_B - U_A}_{-mg(h-2R)} + K_B - K_A = 0$$

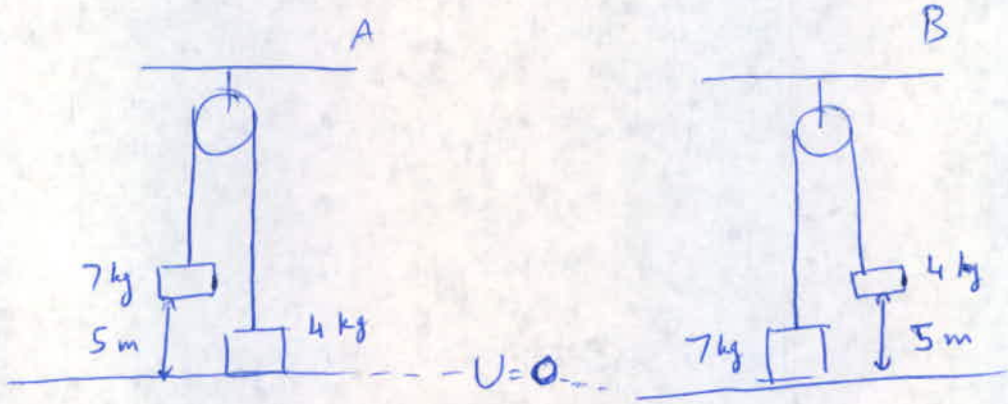
$$K_B = \frac{1}{2} m v_{min}^2 = \frac{1}{2} mgR. \qquad K_A = 0$$

$$\therefore \quad mg(h-2R) = \frac{1}{2} m V_{min}^2 = \frac{1}{2} mgR$$

$$\Rightarrow \quad h - 2R = \frac{R}{2}$$

$$\Rightarrow \quad h = \frac{5R}{2}$$

36.)



a) Conserving Energy,

$$\Delta U_{AB} + \Delta K_{AB} = W_{nc} = 0.$$

$$\Rightarrow \quad U_B - U_A + K_B - K_A = 0.$$

$$U_B = \left(\underset{7kg}{0} + \underset{4kg}{4g(5)}\right) \qquad U_A = \left[\underset{7kg}{7g(5)} + \underset{4kg}{0}\right] \qquad K_B = \frac{1}{2} 7 V_7^2 + \frac{1}{2} 4 V_4^2 \qquad K_A = 0.$$

But $V_7 = V_4$ {By constraint}

$$\therefore \quad 4g(5) - 7g(5) + \frac{1}{2}(7+4) V^2 - 0 = 0$$

$$\Rightarrow \quad V = 5.17 \text{ m/s}$$

b) 5 m {By Constraint}

c) Initial Mechanical Energy $= 7g(5)$

$= 343 \text{ J}$

Final Mechanical Energy after 7kg comes to stop $= 4g(5) + \frac{1}{2} 4 v^2$

$= 249.46 \text{ J}$

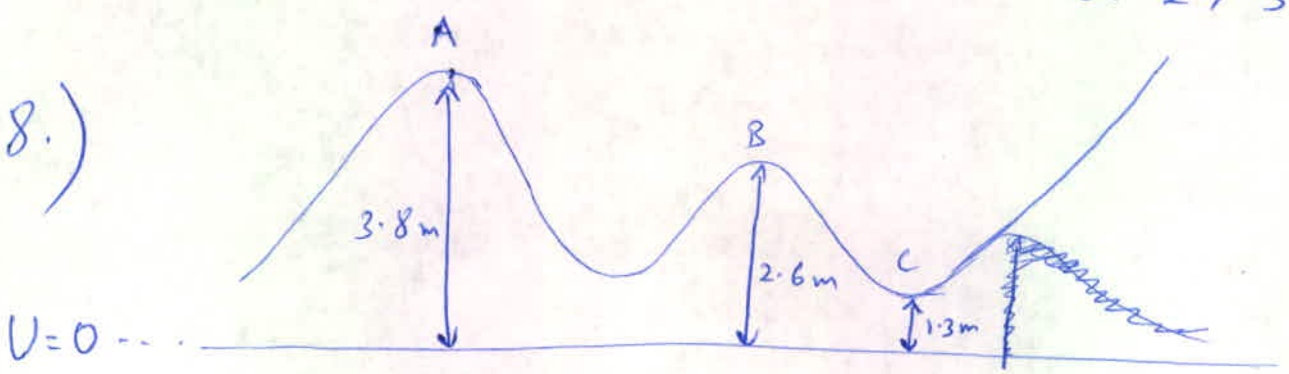
$\therefore$ Mechanical Energy Lost $= 343 - 249.46$

$= 93.54 \text{ J}$

$\therefore$ Fraction of Initial $= \dfrac{93.54}{343} = 0.273$

or 27.3%

38.)



a) $\Delta U_{AB} + \Delta K_{AB} = 0$

$\Rightarrow K_B = -\Delta U_{AB} = -mg(2.6 - 3.8)$

$\Rightarrow \frac{1}{2}\cancel{m} v_B^2 = \cancel{m}g(1.2)$

$\Rightarrow v_B = 4.85 \text{ m/s}$

b) Similarly,

$$V_c = \sqrt{2g\,(3.8 - 1.3)}$$
$$= 7\ m/s$$

c) For right-hand turning point,

$$V_f = 0.$$

$\therefore$ $\underline{\underline{3.8\ m}}$

As $\Delta U_{AT} + \cancel{\Delta K_{AT}}^{\,0} = 0.$ {T is Turning point}

$$\Rightarrow \cancel{mg}\,h_A = \cancel{mg}\,h_T$$
$$\Rightarrow h_T = h_A = \underline{\underline{3.8\ m}}.$$