Chapter 7

Q5:

$$KE = \frac{1}{2} m V^2$$

$$\boxed{K_{E_s} = \frac{1}{2} m V_s^2} \longrightarrow (1)$$

$$\boxed{K_{Ef} = \frac{1}{2}(2m) V_f^2 = m V_f^2} \longrightarrow (2)$$

$$K_{Ef} = \frac{1}{2} K_{Es}$$

$$m v_f^2 = \frac{1}{2}\left(\frac{1}{2} m v_s^2\right)$$

$$4 V_f^2 = V_s^2 \Rightarrow \underline{V_s = 2 V_f}$$

$$K'_{Ef} = K'_{Es}$$

$$\frac{1}{2} 2m (V_f + 1)^2 = \frac{1}{2} m V_s^2$$

$$(V_f + 1)^2 = \frac{V_s^2}{2}$$

$$(V_f + 1)^2 = \frac{4V_f^2}{2} \Rightarrow \sqrt{(V_f+1)^2} = 2 V_f^2$$

$$V_f + 1 = \sqrt{2}\, V_f$$

$$1 = \sqrt{2}\, V_f - V_f$$

$$\frac{1}{(\sqrt{2}-1)} = \frac{V_f(\sqrt{2}-1)}{(\sqrt{2}-1)}$$

a) $V_f = 2.4$ m/s

b) $V_s = V_f * 2 = 4.8$ m/s

Q_{10}:

$|F| = 2.5\ N$

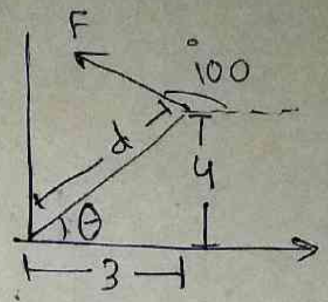
$|d| = 5m$

$100 - \theta = \Phi$

$100 - 53 = 47$

$W = |5|\,|2.5|\cos 47$

$= 8.5 J$



$\cos\theta = \frac{3}{5}$

$\theta = 53$

Q_{11}:

$d = (5\hat{i} - 3\hat{j} + 4\hat{k})_m$ $|d| = \sqrt{5^2 + 3^2 + 4^2}$

$|F| = 22\ N$

$\theta = ?$

$W = \Delta K$

(a) $7 * 22\cos\theta = 45.0$

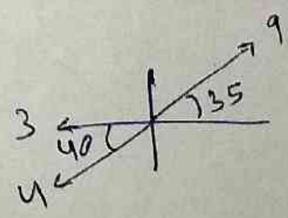
$\cos\theta = 0.289$

$\theta = 73.18°$

(b) $7 * 22\cos\theta = -45.0$

$\theta = 106.9°$

Q_{14}:



$F_x = 9\cos 35 - 3 - 4\cos 40 = 1.3$

$F_y = 9\sin 35 - 4\sin 40 = 2.59$

$F = \sqrt{(1.3)^2 + (2.6)^2} = 2.89\ N$

$W = 2.9 * 4 = 11.6\ J$

Q16 :

$x = 5m$ $\quad k = 0$

$x = 0$ $\quad k = 30J$

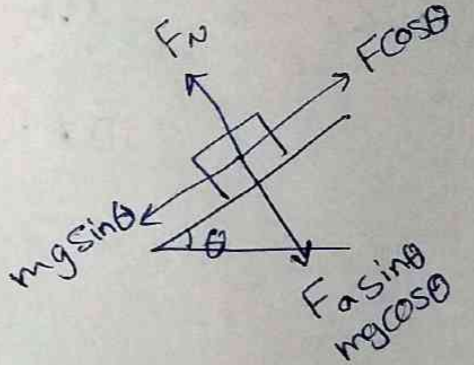
$$k - k_0 = \left(\frac{\Delta k}{\Delta x}\right) * (x - x_0)$$

$$k - 30 = \left(\frac{30 - 0}{0 - 5}\right)(x - 0)$$

$$k(x) = -6x + 30$$

$$K_s = \frac{1}{2} m v^2 \Rightarrow V = \sqrt{\frac{2K_s}{m}} = \sqrt{\frac{2 \times 48}{7}} = 3.7 \ m/s$$

Q24 :



$$w = (F_a \cos\theta - mg \sin\theta)\, d$$

$$w = (23 \cos 30 - 10 * 3 \sin 30)\ 0.58$$

$$w = 2.85 \ J$$

$w = \Delta K_s$ $\quad K_{s_1} = \text{zero}$

$w = K_{s_2} - K_{s_1} \Rightarrow 2.85 = \frac{1}{2} m v^2$

$$2.85 = \frac{1}{2} * 3 * V^2$$

$$V = 1.3 \ m/s$$

Q ... from the spring.

Q16: $K = 5000$ $x_i = 0.05\,m$ $x_f = 0.1\,m$

$W_{required} = W_{spring} = \Delta \frac{1}{2} k (\Delta x)^2 = \frac{1}{2}(5000)(0.1^2 - 0.05^2)$

$= 18.75 J$

Q34:

$W = \int F dx = m \int a\, dx = 15(\frac{1}{2} \times 8 \times 24) =$

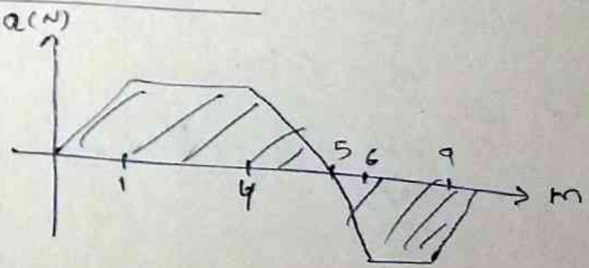
$= 1440\, J$

Q36: the area bound the curve = W

$10 * 2 + \frac{1}{2} * 2 * 10 - \frac{1}{2} * 2 * 5 = W$

$W = 30 - 5 = 25 J$

Q37:



a) $W\big|_{x=4} = \int_0^4 F_x dx = \frac{1}{2} * 12 * 1 + 3 * 12 = 42\, J$

b) $W\big|_{x=7} = 42 + \frac{1}{2} * 12 * 1 - \frac{1}{2} * 12 * 1 - 1 * 12 = 30\, J$

c) $W\big|_{x=9} = 30 - 1 * 12 - \frac{1}{2} * 12 * 1 = 12\, J$

d) $W = \Delta K_s \rightarrow \frac{1}{2} m v^2 = W \rightarrow 42 = \frac{1}{2} * 2 * V^2 \rightarrow V = \sqrt{42} = 6.4\, m/s$

e) $V = \sqrt{30} \rightarrow 5.5\, m/s$

f) $V = \sqrt{12} \rightarrow 3.5\, m/s$.

$m = 1\,kg$
$v_i = 0$
$F = (2.5 - x^2)\hat{i}\,N$

Q38:

a) $\Delta K_i = W$

$$K_{s2} - K_{s1} = \int_0^2 (2.5 - x^2)\,dx \quad (K_{s1} = 0)$$

$$K_{s2} = 2.5x - \frac{x^3}{3}\Big|_0^2$$

$$K_{s2} = 2.33\ J$$

b) $W = \int_0^x F \cdot dx$

$$W' = F(x) \rightarrow F(x) = 0$$

$$2.5 - x^2 = 0$$

$$2.5 = x^2$$

$$\rightarrow x = 1.58\ m$$

$$K_f - 0 = \int_0^{1.58} (2.5 - x^2)\,dx$$

$$K_f = \left(2.5x - \frac{x^3}{3}\Big|_0^{1.58}\right)$$

$$= 2.63\ J$$

Q39:

$W = \Delta K$

$$|V_1| = \sqrt{5^2 + 18^2} = 18.6\ m/s$$

$$|V_2| = \sqrt{9^2 + 22^2} = 23.7\ m/s$$

$$\Delta K = \Delta\left(\frac{1}{2}mv^2\right) = \frac{1}{2} * 0.2\,(23.7^2 - 18.6^2) = 2.2\ J$$

Q40:

$$W = \int F\,dx$$

$$= \int_{0.25}^{2.25} e^{-4x^2}\,dx = 0.212\ J$$

Chapter 8
"outline soultion"
118 students

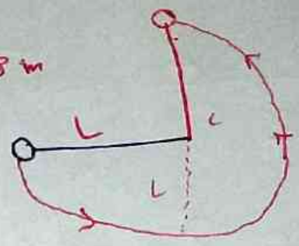
Q. 1

Adam Strechers the spring x meter

John Streches the spring $3x$ met.

$$\frac{U_{s\,Adam}}{U_{s\,John}} = \frac{\frac{1}{2}kx^2}{\frac{1}{2}k(3x)^2} = \frac{x^2}{9x^2} = \frac{1}{9}$$

Q.4 $m = .382$ kg $L = .498$ m



a)

$W_g = -\Delta U$

$W_g = (U_i - U_f) = mgh_1 - mgh_2$ (zero) $= .382 \times 10 \times .498 = 1.9$ J

b) at the highest point , $W_g = -\Delta U$

$= -(U_f - U_i) = U_i - U_f = mgh_1 - mgh_2$

$= mgh_1 - mg2L$

C) at the point in the right $= -mgL = -1.9$ J

$W_g = -\Delta U = U_i - U_f = mgh_1 - mgh_2 = mgL - mgL = $ Zero

d) U_g at lowest point $U_g = mgh = -1.9$ J ~~but ΔU~~ =
because at the initial point $U = $ Zero

e) $U_g = mgh = mgL = 1.9$ J

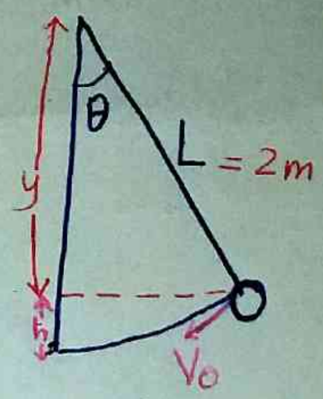
f) $U_g = mgh = $ Zero because it's at the same level with initial point

g) $E_{Mec} = \Delta K + \Delta U_g$ / At highest point "$V = 0$"

then $\Delta K = 0$

$\Delta U_g = E_{Mec} \Rightarrow$ then ΔU_g would be greater

⑦ $m = 5\,Kg$, $L = 2m$, $V_0 = 0$, $\theta = 30^\circ$



$\cos 30^\circ = \frac{\sqrt{3}}{2}$

$\frac{y}{L} = \frac{\sqrt{3}}{2}$

$y = \frac{\sqrt{3} \cdot 2}{2} = \sqrt{3} = 1.73\,m$

$h = L - y = 2 - 1.73 = 0.27\,m$

ⓐ $W = -\Delta U_g = -(U_f - U_i)$

$= U_i - U_f^{\nearrow 0}$

$= +U_i$

$= +mgh$

$= 13.39\ J$

ⓑ $W = -\Delta U_g$

$\Delta U_g = -W = -13.39\ J$

ⓒ $\Delta E_{Mec} = \Delta U + \Delta K$

$0 = (U_f^{\nearrow 0} - U_i) + (K_f - K_i^{\nearrow 0})$

$K_f = U_i$

$\frac{1}{2} m V^2 = 13.39$

$V = 2.3\ m/s$

ⓓ If θ increase ⇒ the hight increase

⇒ mgh increase

⇒ then ΔU_g increase

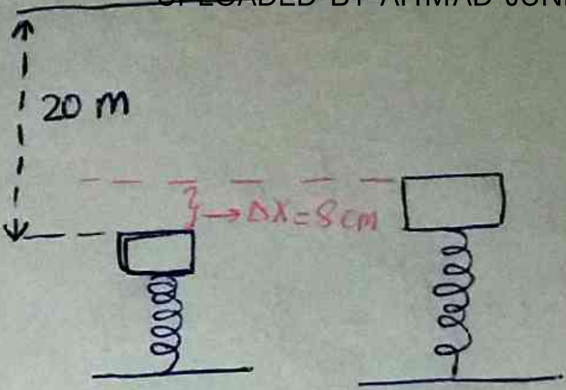
لأن طاقة الوضع عند أسفل نقطة = صفر

و بالتالي تعتمد على طاقة الوضع البدائية "U_i"

وبالتالي جميع القيم سوف تزداد

 10/05/2019

(13) $m = 5g = 0.005\ Kg$



(a) $\Delta U_g = U_f - \cancel{U_i}^{\,0}$

$= mgh = 0.005 \times 10 \times 20 = 1\ J$

(b) $\Delta U_s = -\Delta U_g = -1\ J$

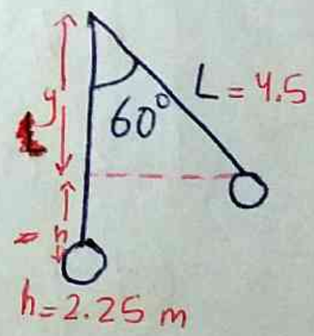
(c) $\Delta U_s = -\frac{1}{2} K \Delta X^2$

$+1 = +\frac{1}{2} K (6.4 \times 10^{-3})$

$K = 312.5\ \frac{N}{m}$

(20) $m = 2\ Kg$, $V_i = 8\ m/s$

$L = 4.5\ m$



$\cos 60° = \frac{1}{2}$

$\frac{y}{4.5} = \frac{1}{2}$

$y = 2.25\ m$

(a) $E_{mec_i} = E_{mec_f}$

$K_i + \cancel{U_i}^{\,0} = K_f + U_f$

$\frac{1}{2} m V_i^2 = \frac{1}{2} m V_f^2 + mgh$

بعد تعويض الأرقام

$V_f = 4.3\ m/s$

⟹

(b) تكون الزاوية "θ" أكبر ما يمكن عندما $V_f = 0 \Rightarrow K_f = 0$

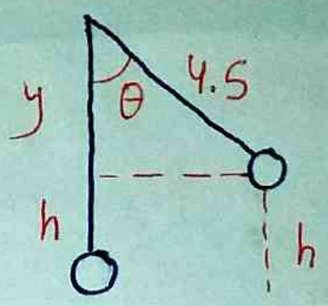
$$E_{mec_i} = E_{mec_f}$$

$$K_i + \cancel{U_i}^{0} = \cancel{K_f}^{0} + U_f$$

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

$$32 = 10h$$

$$h = 3.2$$



$$\cos\theta = \frac{y}{4.5}$$

$$\boxed{y = 4.5 - h}$$

$$\cos\theta = \frac{4.5 - h}{4.5}$$

$$\cos\theta = \frac{4.5 - 3.2}{4.5}$$

$$\cos\theta = 0.288$$

$$\theta = 73.2^\circ$$

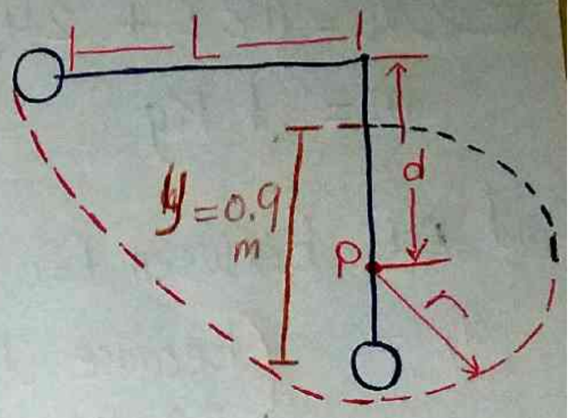
(c) $$E_{mec_i} = K_i + \cancel{U_i}^{0}$$

$$= \frac{1}{2} m V_i^2$$

$$= \frac{1}{2} \cdot 2 \cdot (8)^2$$

$$= 64 \text{ J}$$

(23) $L = 1.2\ m$, $d = 0.75\ m$



$L - d = 1.2 - 0.75$
$= 0.45 = r$

$y = 2r = 0.9\ m$

(a) $E_{mec_i} = E_{mec_f}$

$U_i + K_i^{\nearrow 0} = U_f^{\nearrow 0} + K_f$

$mgh = \frac{1}{2} m V_f^2$

$12 = \frac{1}{2} V_f^2$

$V_f = 4.9\ m/s$

(b) $E_{mec_i} = E_{mec_f}$

$U_i + K_i^{\nearrow 0} = U_f + K_f$

$mgh = mgy + \frac{1}{2} m V_f^2$

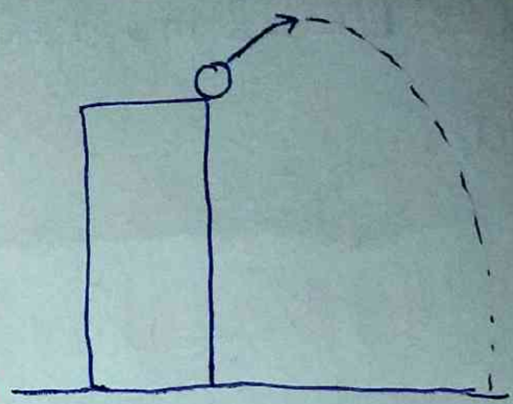
$12 = 9 + \frac{1}{2} V_f^2$

$V_f^2 = 6$

$V_f = 2.45\ m/s$

(25) $V_i = (18\hat{i} + 24\hat{j})$ m/s at $t=0$

$m = 1$ Kg



find ΔU between $t=0$ and $t=6$?

$a_x = 0$ (because its free fall and no acceleration on x-axis)

☆ $V_{fx} = V_{ix} = 18\hat{i}$ m/s

☆ $V_{fy} = V_{iy} - gt$

$V_{fy} = 24 - 60$

$= -36\hat{j}$ m/s

$V_f = \sqrt{(18)^2 + (-36)^2} = 40.25$ m/s

$V_i = \sqrt{(18)^2 + (24)^2} = 30$ m/s

$\Delta U = -\Delta K$

$\Delta U = -\left(\frac{1}{2} m V_f^2 - \frac{1}{2} m V_i^2\right)$

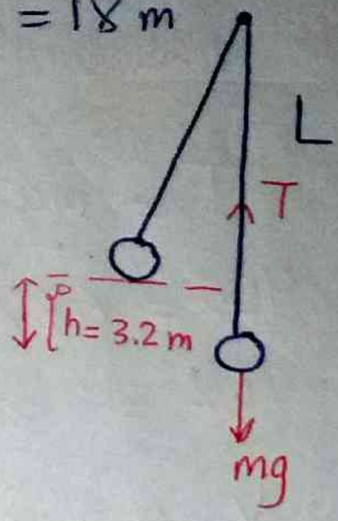
$= \frac{1}{2} m V_i^2 - \frac{1}{2} m V_f^2$

$= \frac{1}{2} m (V_i^2 - V_f^2)$

$= \frac{1}{2}(900 - 1620)$

$= -360$ J

(27) $mg = 688\ N$, $h = 3.2\ m$, $L = 18\ m$



(a) $T - mg = \frac{mV^2}{r}$ a

$$T = mg + \frac{mV^2}{r} \quad \text{-----} (1)$$

$$E_{mec_i} = E_{mec_f}$$

$$U_i + K_i^{\nearrow 0} = U_f^{\nearrow 0} + K_f$$

$$mgh = \frac{1}{2} m V^2$$

$$V^2 = 64$$

$$V = 8\ m/s$$

$$T = 688 + \frac{68.8 \times 64}{18}$$

$$= 932.6\ N$$

then the vine doesn't break

(b) the greatest force = 932.6 N

(c) ⇒

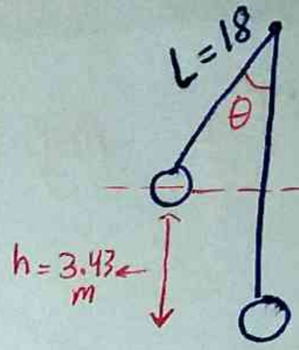
(c) The vine will break If T = 950 N

$$T = mg + \frac{mV^2}{r}$$

$$950 = 688 + \frac{68.8\,V^2}{18}$$

$$262 = 3.82\,V^2$$

$$V = 8.3\ m/s$$



$$\cos\theta = \frac{14.57}{18}$$

$$\theta = 36^\circ$$

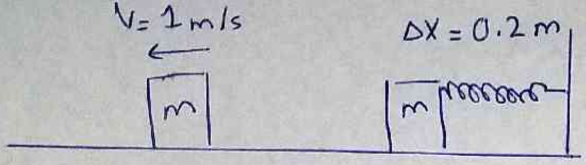
$$E_{Mec_i} = E_{Mec_f}$$

$$U_i + K_i = U_f + K_f \quad (K_i = 0,\ U_f = 0)$$

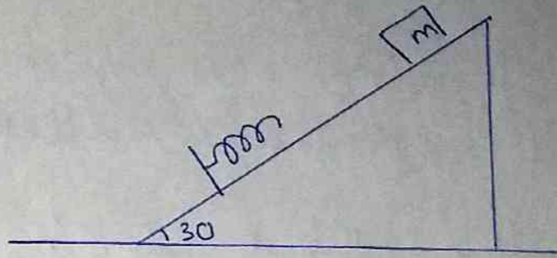
$$mgh = \frac{1}{2} mV^2$$

$$h = 3.43\ m$$

(29) $m = 4\ kg$



①



②

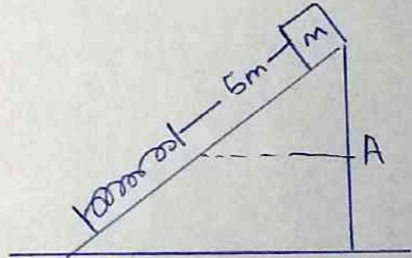
from figure ① $\Rightarrow$ $E_{mec_i} = E_{mec_f} \Rightarrow U_s + \cancel{K_i}^{0} = K_f$

$$\frac{1}{2} K (\Delta X)^2 = \frac{1}{2} m V^2$$

$$0.04K = 4$$

$$K = 100\ \frac{N}{m}$$

(a) from figure ② :-



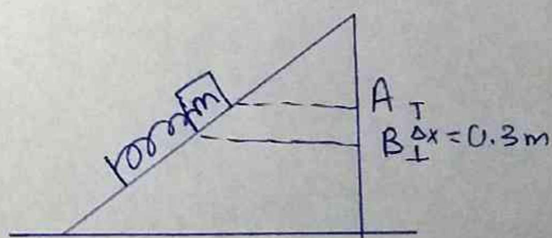
$$E_{mec_i} = E_{mec_f}$$

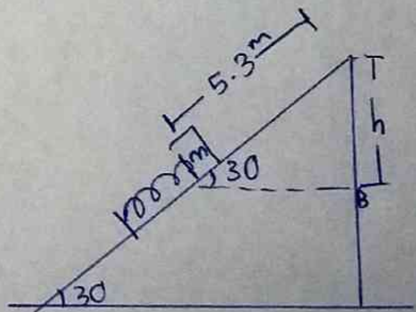
$$U_i = U_s + \mu_s\ mg \cos\theta\ d$$

$$mgh = \frac{1}{2} K(\Delta X)^2 + \mu_s (40 \cos 30 * 3.5)$$

$$106 = 4.5 + 183.5\ \mu_s$$

$$\mu_s = 0.55$$





PS $\Rightarrow$ $\sin 30 = \frac{1}{2}$

$$\frac{h}{5.3} = \frac{1}{2}$$

$$\boxed{h = 2.65m}$$

(b) $E_{mec\,i} = E_{mec\,f}$

$$U_s + U_i^{0} + K_i^{0} = U_s^{0} + U_f + K_f^{0} + \Delta E_{th}$$

$$4.5 = mgh + \mu_s \, mg \cos 30 \, d$$

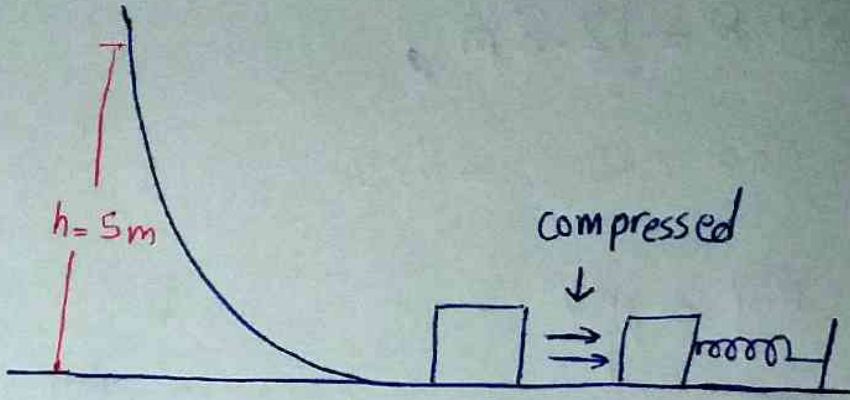
$$4.5 = mg\,h + 0.55 * 4 * 10 * 0.87 * 2h$$

$$4.5 = 40h + 38.28\,h$$

$$h = 0.057$$

$$d = 2h = 0.1149 \text{ m}$$

(31) $\Delta X = 0.25$ m
$m = 1$ Kg



(a)

$$E_{mec_i} = E_{mec_f}$$

$$U_i + K_i^{\nearrow 0} = U_s + K_f^{\nearrow 0}$$

$$mgh = \frac{1}{2} K \Delta x^2$$

$$\frac{50}{\Delta x^2} = \frac{1}{2} K$$

$$K = \frac{100}{(0.25)^2} = 16000 \frac{N}{m}$$

(b)

$$E_{mec_i} = E_{mec_f}$$

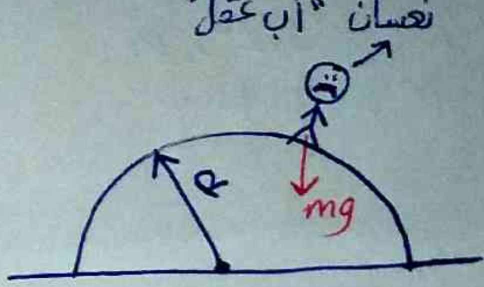
$$U_i + K_i^{\nearrow 0} = U_f^{\nearrow 0} + K_f$$

$$50 = \frac{1}{2} m V_f^2$$

$$V_f^2 = 100$$

$$V = 10 \ m/s$$

(c) No change, because E_{mec} is conservation



(34) $R = 12.8\,m$

lose contact $\Rightarrow N = 0$

$$mg = \frac{mV^2}{r}$$

$$V^2 = 128\ m^2/s^2$$

$$E_{mec_i} = E_{mec_f}$$

$$U_i + K_i^{\nearrow 0} = U_f + K_f$$

$$mgh_1 = mgh_2 + \frac{1}{2}mV^2$$

$$128 = 10\,h_2 + 64$$

$$h_2 = 6.4\ m$$

(38) $E_{mec} = U_B + K_B = 16\ J$

ⓐ $X = 3.5$ → $U = 9\ J$
→ $K = 16 - 9 = 7\ J$

$$K = \frac{1}{2}mV^2$$

$$7 = 0.1\ V^2 \quad \Longrightarrow$$

$$V^2 = 70$$

$$V = 8.36\ m/s$$

(b) $X = 6.5\ m$ → $U = 0$
→ $K = 16\ J$

$$K = \frac{1}{2} m V^2$$

$$16 = 0.1 V^2$$

$$V = \sqrt{160} = 12.6\ m/s$$

(C) $slope_1 = slope_2$

X_t when $\Delta K = 0$
$U = E = 16\ J$

$$\frac{24 - 16}{8 - X_t} = \frac{16 - 0}{X_t - 7}$$

$$\frac{8}{8 - X_t} = \frac{16^{2}}{X_t - 7}$$

$$X_t - 7 = 16 - 2X_t$$

$$3X_t = 23$$

$$X_t = 7.67$$

(D) $slope_1 = slope_2$

$$\frac{20 - 16}{1 - X_t} = \frac{16 - 9}{X_t - 3}$$

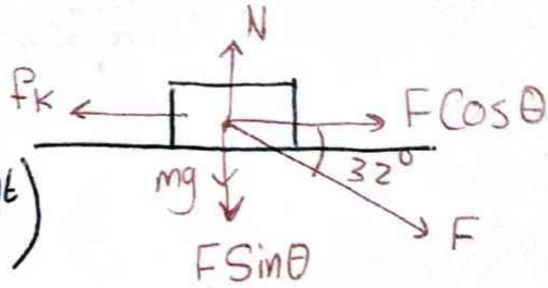
$$\frac{4}{1 - X_t} = \frac{7}{X_t - 3}$$

$$7 - 7X_t = 4X_t - 12$$

$$11X_t = 19 \longrightarrow X_t = 1.73$$

(42) $m = 23\ Kg$, $\mu_K = 0.2$

$\theta = 32^\circ$, $d = 8.4\ m$



(a) $F\cos\theta - f_K = \cancel{ma}^{\,0}$ (because constant speed)

$F\cos\theta = f_K$

$F\cos\theta = \mu_K F\sin\theta + \mu_K mg$ $(\theta = 32^\circ)$ $(N = mg + F\sin\theta)$

$0.85F = 0.11F + 46$

$F = 62.2\ N$

$W = F d \cos\theta$

$= 62.2 \times 8.4 \times \cos(32)$

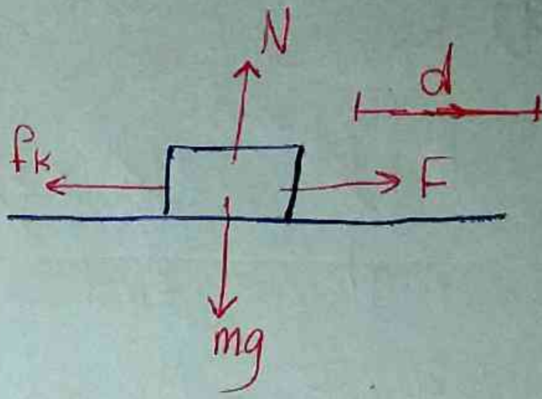
$= 443\ J$

(b) $\Delta E_{thermal} = f_K d$ " $f_K = \mu_K F\sin\theta + \mu_K mg$ "

$= 52.8 \times 8.4$

$= 443.5\ J$

(44) $\mu_k = 0.6$, $F = 41\ N$
$m = 4\ Kg$, $d = 2\ m$



ⓐ $W = \vec{F} \cdot \vec{d}$
$= Fd \cos\theta$
$= 41 \times 2 \times \cos(0)$
$= 82\ J$

ⓑ $\Delta E_{thermal} = f_k\, d \cos(180)$
$= -\mu_k\, mg\, d$
$= -0.6 \times 4 \times 10 \times 2$
$= -48\ J$

طاقة مفقودة
(لا تعوض سالب عند الحل)

ⓒ $W = \Delta K + \Delta E_{thermal}$
$82 = K_f - K_i + 40$
$K_f - K_i = 42$
$\Delta K = 42\ J$

(49) $E_{mec_i} = E_{mec_f}$

$U_i + K_i^{\nearrow 0} = U_f^{\nearrow 0} + K_f^{\nearrow 0} + \Delta E_{thermal}$

$mgh = f_k d$

$520 \times 7 = \mu_k mg d$

$3640 = 156 d$

$d = 23.3 \ m$

★ P.S: $m = 50 + 2$
$= 52 \ kg$

M.S

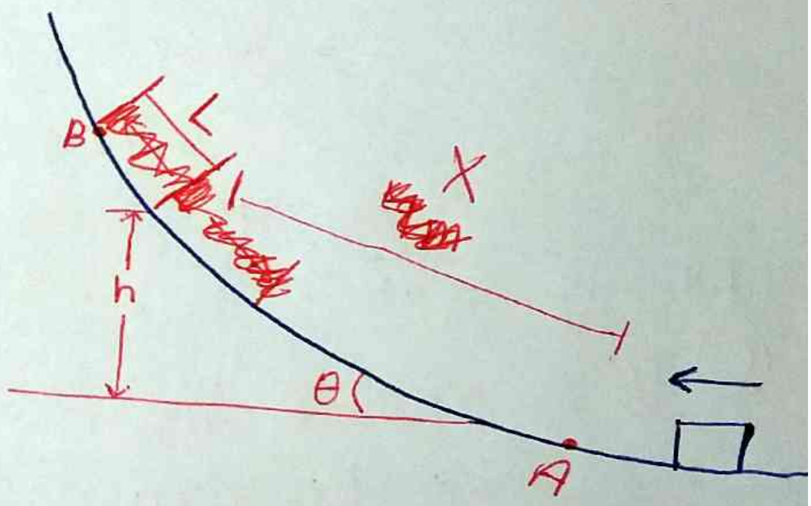
(62) $L = 0.65 m$

$\theta = 30^\circ$

$h = 2 m$

$\mu_k = 0.4$

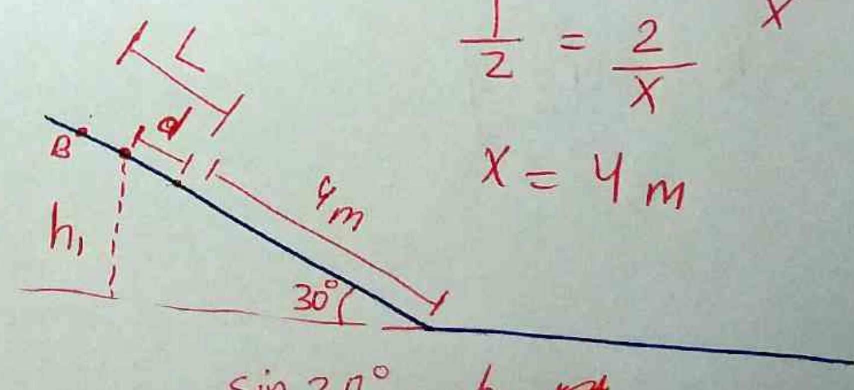
$V_0 = 8 \ m/s$



$\sin 30^\circ = \frac{h}{X}$

$\frac{1}{2} = \frac{2}{X}$

$X = 4 m$



$\sin 30^\circ = \frac{h_1}{4+d}$

$\frac{1}{2} = \frac{h_1}{4+d}$

$h_1 = 2 + \frac{1}{2} d$

(a) $E_{mec_i} = E_{mec_f} \Rightarrow \cancel{U_i}^{0} + \cancel{K_i} = U_f + \cancel{K_f}^{0} + \Delta E_{ther}$

$\frac{1}{2} \cancel{m} V_i^2 = \cancel{m} g h_1 + \mu_k \cancel{m} g \cos 30 \, d$

$32 = 20 + 5d + (0.4 \times 10 \times \frac{\sqrt{3}}{2}) d$

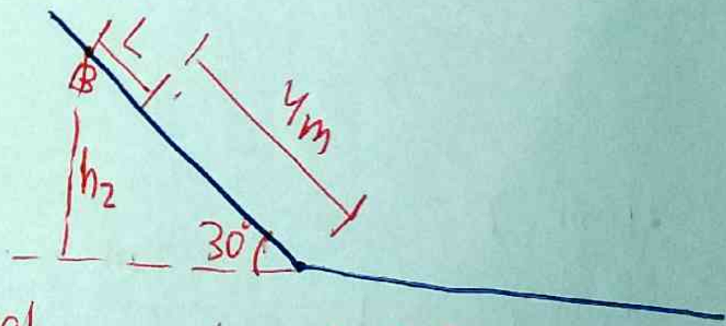
$12 = 5d + 2\sqrt{3} d$

$12 = 8.4 d$

$d = 1.41 \text{ m}$

the particle will pass the point B

(b)



$E_{mec_i} = E_{mec_f}$

$\cancel{U_i}^{0} + K_i = U_f + K_f + \Delta E_{thermal}$

$\frac{1}{2} \cancel{m} V_i^2 = \cancel{m} g h_2 + \frac{1}{2} \cancel{m} V_f^2 + \mu_k \cancel{m} g \cos 30 \, L$

$32 = 23.2 + \frac{1}{2} V_f^2 + 2.25$

$V_f^2 = 12.7$

$V_f = 3.5 \text{ m/s}$

$\sin 30° = \frac{h_2}{4.65}$

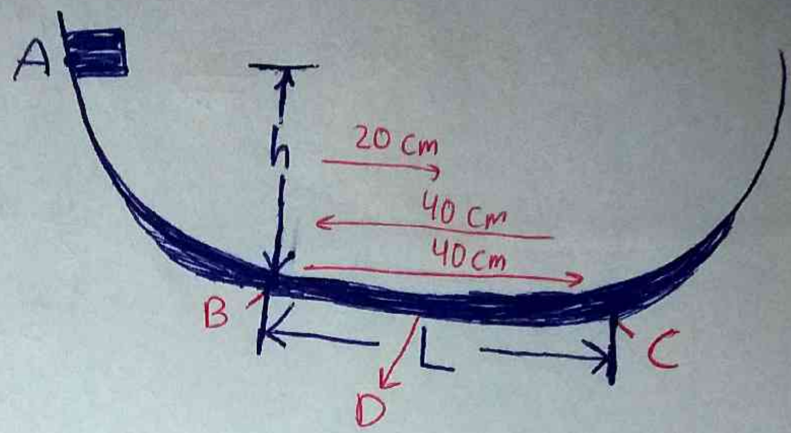
$\frac{1}{2} = \frac{h_2}{4.65}$

$h_2 = 2.32 \text{ m}$

(65) $L = 0.4\,m$

$h = \frac{L}{2} = 0.2\,m$

$\mu_k = 0.2$



$E_{mec_i} = E_{mec_f}$

$U_i + K_i^{\nearrow 0} = U_f^{\nearrow 0} + K_f^{\nearrow 0} + \Delta E_{thermal}$

$mg\frac{L}{2} = \mu_k mg\, d$

$d = \frac{L}{2\mu_k} = \frac{0.4}{0.4} = 1$

$\boxed{d = 1\,m}$

- from $B \rightarrow C$: 0.4 m
⇒ from $C \rightarrow B$: 0.4 m
⇒ from $B \rightarrow D$: 0.2 m

then the particle is located 0.2 m from the left

Chapter 9 "Center of Mass and linear momentum"

Lecture questions (1, 6, 13, 20, 32)

(1)

$$X_{com} = \frac{(0\times1)+(3\times1)+(2(0.5))}{6} \qquad m_c = (0.5\ ,\ 0.87)$$

$$= \frac{4}{6}\ m$$

$\frac{1}{2}$ ضلع (نقص ضلع عمودي) — فيثاغورس $= \sqrt{(1)^2 - (.5)^2}$

$$y_{com} = \frac{1(0) + 3(0) + 2(0.87)}{6} = 0.29m$$

$$\vec{r}_{com} = 0.67\hat{i} + 0.29\hat{j}$$

---

(6)

$$r_1 = (0 + \tfrac{L}{2}\hat{j} + \tfrac{L}{2}\hat{k}) \qquad r_2 = (\tfrac{L}{2}\hat{i} + 0 + \tfrac{L}{2}\hat{k})$$

$$r_3 = (\tfrac{L}{2}\hat{i} + \tfrac{L}{2}\hat{j} + \tfrac{L}{2}\hat{k}) \qquad r_4 = (\tfrac{L}{2}\hat{i} + L\hat{j} + \tfrac{L}{2}\hat{k})$$

$$r_5 = (\tfrac{L}{2}\hat{i} + \tfrac{L}{2}\hat{j} + 0)$$

$L = 50cm = .5m$

$$\vec{r}_{com} = \frac{1}{5m}(m\vec{r}_1 + \cdots + m\vec{r}_5)$$

$$\vec{r}_{com} = \frac{1}{5}\left(\tfrac{5}{2}L\hat{i} + \tfrac{5}{2}L\hat{j} + 2L\hat{k}\right)$$

$$\vec{r}_{com} = \frac{L}{2}\hat{i} + \frac{L}{2}\hat{j} + \frac{2L}{5}\hat{k}$$

---

(13)

$$\Delta y = v_{0y}t + \frac{1}{2}a_y t^2$$

من قوانين المقذوفات

	x	y
v_0	20cos60	20sin60
v	20cos60	0
a	0	-9.8
t	1.767	1.767
Δx	17.67	15.3m

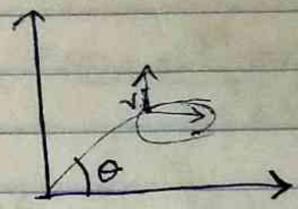
$$\Delta y = 20\sin60(1.767) + \frac{1}{2}(-9.8)(1.767)^2$$

$$\Delta y = 15.3m$$

(20)

$P_0 = 6 \quad P_1 = 4$

$\theta = ?$



~~$\Delta p = J$~~

$\cos\theta = \frac{P_1}{P_0} = \frac{4}{6}$

كمية التحرك الأفقية ثابتة

$\theta = \cos^{-1}(0.67)$

$= 47.93^\circ$

(32)

(a) P? at t=4s

$\Delta P = J$ Area under the curve of (F vs t)

$P - P_0 = \frac{1}{2}(2)(10) + 2(10) = 30$ ~~kg~~

(b) P=? at t=7s

$P - 0 = 30 + \frac{1}{2}(2)10 + \frac{1}{2} - 5 \times 1$

$P = 37.5$ kg.m/s (+X)

(c) v=? at t=9s

$P - P_0 = 37.5 + 1(-5) + \frac{1}{2} \times 1 \times -5 = m v_f$

$30 = \overset{2.5}{(m)} v \rightarrow v = 12$ m/s +X

الاتجاه الموجب لمحور السينات

discussion problems (4, 5, 16, 25, 35, 52, 59)

4) $X_{com} = \frac{X_1 m_1 + X_2 m_2 + X_3 m_3}{m_1 + m_2 + m_3} = \frac{0 m_1 + \frac{24}{2} \cdot 42 + 24 \cdot 14}{42 + 14 + 14} = 12cm$

$y_{com} = \frac{-\frac{24}{2} \cdot 14 + 0 + \frac{-24}{2} \cdot 14}{42 + 14 + 14} = -4.8cm$

5) $X_{com} = \frac{2L \cdot 4 + -L \cdot 6 + -L \cdot 8 + L \cdot 4}{22} = -0.09L = -0.45cm$

$y_{com} = \frac{2 \cdot .5L \cdot 4 + 1.5L \cdot 6 + -2 \cdot 8L + -3 \cdot 4}{22}$

$\delta = \frac{M}{A}$ ← السطحية ثابتة كثافة

$m_1 = \delta \cdot 4L^2$ مثلا

* موجوده في الملخص

(16) $X_{com} = \frac{m_g x_g + m_c X_c + m_b X_b}{\Sigma m}$

$X_{com} = \frac{m_g \times 0 + 30 \times 1.5 + 80 \times 3}{m_g + 80 + 30}$

$X_{com} = \frac{285}{m_g + 110}$

$X'_{com} = \frac{m_g X_g + m_c X_c + m_b X_b}{\Sigma m}$

$X_{com} = \frac{m_g \cdot (3 - 0.45) + 30 \times (1.5 - 0.45) - 80 (0.45)}{m_g + 30 + 80}$

$= \frac{285}{m_g + 110}$ ---- m_g كذا

(25) $m = 5\,g$ $v_0 = 100\,m/s$ $d = 6.00\,cm$

a) $\overset{0}{V^2} = V_0^2 + 2a\,\Delta X$

$(100)^2 = 2\,a * 6*10^{-2} \Rightarrow a = \frac{-10^4}{0.12}\,m/s^2$

$\overset{0}{V} = V_0 + at \rightarrow 0 = 100 - \frac{10^4}{0.12}t \rightarrow t = 1.2\,ms$

b) $\Delta P = J = m(V_f - V_i)$

$= 5\times10^{-3}(0 - -100) = 0.5\,kg.m/s$

c) $F = \frac{\Delta P}{\Delta t} = \frac{-5}{1.2\times10^{-3}} = 417\,N$

---

(35) $m = 58g$ $v_0 = 34\,m/s$

$J = m(v_f - v_i) = 2mv_i$

$J = 2\times0.058(kg)\times34 = 3.944\,N.s$

$J = Area$ $ms = 10^{-3}s$

$3.944 = f_{max}(1\times10^{-3}) + f_{max}(2\times10^{-3}) + f_{max}(1\times10^{-3})$

$f_{max} = 986\,N$

---

(52) $(m_b)(v_i)_b = (m_{block})v + (m_b)(v_f)_b$

$v = \frac{0.010\times1000 - 0.010\times400}{5}$

$v = 1.2\,m/s$

$\frac{1}{2}(m_{block})v^2 = (m_{block})gh$

$\frac{1}{2}\times5\times(1.2)^2 = 5\times9.8\times h \rightarrow h = 7.3\,cm$

5a) $U = \frac{1}{2} K x^2$

$X = \sqrt{\frac{2u}{K}} = \sqrt{\frac{2(k.E_f - k.E_i)}{K}}$

(1) $= \sqrt{\frac{(m_1 + m_2) v_f - (m_2 v_2 - m_1 v_1) i}{K}}$

$\vec{P_i} = \vec{P_f} \quad (m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_f$

$v_f = \frac{2(kg) \times 10 + 5 \times 3}{2 + 5} = 5 \, m/s$

$X = 25 cm \leftarrow$ 1 في ون عوض

(quiz questions) (2, 9, 18, 29, 37, 64)

2)

a) $x_{com} = \frac{(2.0) + (4.2) + (8.1)}{2 + 4 + 8} = 1.07 m$

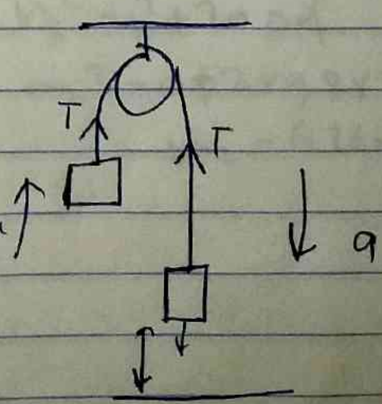
b) $y_{com} = \frac{2.0 + 4.1 + 8.2}{14} = 1.33 m$

c) if mass 3 increased, then centre of mass shifts towards the particle

9)

$T - g = a$

(1) $T = a + g$



$m_A \times g - T = m_A \times a$

$2g - T = 2 \times a$

(2) $T = 2g - 2a$

$a = \frac{g}{3}$ (2) و (1) حل

a) $a_{com} = \frac{-g/3 \times 2 + g/3 \times 1}{2+1} = \frac{-g}{6} = -1.1 m/s^2$

b) displacement $= vt + \frac{1}{2}at^2$

$v = 0 \quad t = 2s \quad a = -1.1$

$= \frac{1}{2} \times -1.1 \times 2^2 \quad = -2.2m$

c) displacement when $h = 10$ cm

$10 = \frac{1}{2} \times (3.2) \times t^2 \rightarrow g/3$

$t = 2.47s$

$V = v_0 + at \quad a = 1.1 m/s^2 \quad t = 2.47s$

$v_0 = 0$

$v = 1.1 \times 2.47 = 2.7 m/s$

(18) $m = 0.7kg \quad v_0 = 6m/s \quad v_c = \pm 3.5 m/s$

$|\vec{\Delta P}| = |-3.5(0.7) - 6(0.7)| = 6.65 kg \cdot m/s$

(29) $m = 1kg \quad d = 2m$

$v_2^2 = v_1^2 + 2a\Delta d$

$v_2^2 = 0 + 2 \times 9.8 \times 2$

$v_2 = 6.26 m/s$

impulse $= J = \Delta P$

$= 1(v_2 - \overset{0}{v_1})$

$J = 6.26 kg \cdot m/s$

37) $\vec{F} = 100 e^{-2t} \hat{i}$ $\quad t = 0s \rightarrow t = 2s$

a) $J = ? = \int_{t_i}^{t_f} f(t)\, dt$

$= \int_0^2 100 e^{-2t}\, dt$

$= 100 \frac{e^{-2t}}{-2} \Big|_0^2$

$= -50 (e^{-4} - 1)$

$= 49.1 \hat{i}$ N.S

(b) $F_{avg} \rightarrow J = f_{avg} \times \Delta t$

$49.1 \hat{i} = f_{avg} \times (2 - 0)$

$\rightarrow f_{avg} = 24.5 \hat{i} N$

---

64) $mgh = \frac{1}{2} m v^2$

$v = \sqrt{2gh}$ $\quad \rightarrow h = 0.7m$

$\rightarrow v_1 = 3.7 m/s$

a) $v_1' = \frac{m_1 - m_2}{m_1 + m_2} \times v_1$

$v_1' = \frac{0.6 - 2.8}{0.6 + 2.8} \times 3.7 = -2.4 m/s$

(b) $v_2' = \frac{2 m_1}{m_1 + m_2} \times v_1 \rightarrow v_2' = \frac{2 \times 0.6}{0.6 + 2.8} \times 3.7$

$v_2' = 1.31 m/s$

Good luck

Chapter ten

Q1)

$R = 1m$
$r = 0.25\ m$
$W_{o,R} = 100\ rev/min$
$W_{o,r} = ??$
$d = ??$

a) $V_{Rear} = V_{Front} \Rightarrow R\,W_{o,R} = r\,W_{o,r}$
$\Rightarrow (1)(100) = (\frac{1}{4})(W_{o,r})$
$\Rightarrow W_{o,r} = 400\ rev/min$

b) You can find the distance in 2 ways:

$t = 10\,min \Rightarrow 600\ sec$
$W_{o,R} = 100\ rev/min$
$\Rightarrow 10.47\ rad/s$
$W_{o,r} = 400\ rev/min$
$\Rightarrow 41.88\ rad/s$

① $V = \frac{d}{t} \Rightarrow R\,W_{o,R} = \frac{d}{t}$

$\Rightarrow (1)(10.47)(600) = d$
$d = 6283.18\ m$

② $V = \frac{d}{t} \Rightarrow r\,W_{o,r} = \frac{d}{t}$

$\Rightarrow (\frac{1}{4})(41.88)(600) = d \Rightarrow d = 6283.18\ m$

Q5) $t = 0$

$V_{o,x} = 49$ m/s | $W_{avg} = ?$

$V_{o,y} = 0$

$V_{f,y} = 49$ m/s

$\theta = 40$ revs $\Rightarrow 80\pi$

$V_{fy} = V_{o,y} + gt \Rightarrow 49 = 0 + 9.8t$
$\Rightarrow t = 5$

$W_{avg} = \frac{\Delta\theta}{\Delta t} \Rightarrow \frac{80\pi}{5} \Rightarrow 16\pi$

Q9) $\Delta t = 5$s | $\alpha_{avg} = ??$

$m = 2$kg | $I = ??$

$r = 2$m

$W_o = 0$

$W_f = 4$ revs/s $\Rightarrow 8\pi$

$\alpha_{avg} = \frac{\Delta W}{\Delta t} \Rightarrow \frac{8\pi}{5} \Rightarrow 5$ rad/s^2

$I = mR^2 \Rightarrow 2(4) \Rightarrow 8$ kg.m^2

Q12) $W_o = 1200$ rev/min , $\Delta t = 12$s | $\alpha = ??$

$W_f = 3200$ rev/min $\Rightarrow \Delta t = 0.2$ min | $\theta = ??$

~~$W_f = W_o t + \frac{1}{2}\alpha t^2$~~ $W_f = W_o + \alpha t$

~~$\Rightarrow 3200 = 1200(0.2) + \frac{1}{2}\alpha(0.2)^2 \Rightarrow \alpha =$~~

$\Rightarrow 3200 = 1200 + \alpha(0.2) \Rightarrow \alpha = 10{,}000$ rev/min^2

$\theta = \frac{1}{2}(W_f + W_o)t \Rightarrow \theta = \frac{1}{2}(335.1 + 125.7)(12)$

note: convert W_f, W_o to rad/s. $\Rightarrow \theta = 2764.8$ rad

Q13) $\theta = 40 \text{ revs} \Rightarrow 80\pi$
$W_0 = 1.5$ rad/s
$W_f = 0$

$t = ??$
$\alpha = ??$
time to complete First 20 revs.

$$W_f^2 = W_0^2 + 2\alpha\theta \Rightarrow 0 = (1.5)^2 + 2(\alpha)(80\pi)$$
$$\Rightarrow \alpha = -4.5 \times 10^{-3} \text{ rad/s}^2$$

$$W_f = W_0 + \alpha t \Rightarrow 0 = 1.5 + (-4.5 \times 10^{-3})(t)$$
$$\Rightarrow t = 335.1 \text{ s.}$$

c) time to complete first 20 revs? (40π)

$$\theta = W_0 t + \frac{1}{2}\alpha t^2 \Rightarrow 40\pi = (1.5)t + \frac{1}{2}(-4.5 \times 10^{-3})($$
$$\Rightarrow -2.25 \times 10^{-3} + 1.5t - 40\pi = 0$$

$t = 98.25$ s ✓
or
$t = 568.4$ s ✗ $\Rightarrow$ because (time to stop = 335

Q16) $\alpha = 1.2\ rad/s^2$

$w_0 = 0$

time to rotate twice ($\theta = 2$ revs).

$\theta = 4\pi$

time to rotate 4 times ($\theta = 4$ revs).

$\theta = 8\pi$

$4\pi = 0 + \frac{1}{2}(1.2)(t)^2$

$t = 4.6s$

$8\pi = 0 + \frac{1}{2}(1.2)(t)^2$

$t = 6.4\ s$

Q32) $V_0 = W_0 = 0$

$R = 32\ m$

$a_T = 0.6\ m/s^2$

$t = 15\ s$

$a_{net} = ??$

Angle between a_{net} and Velocity?

~~$W_f = W_0 +$~~

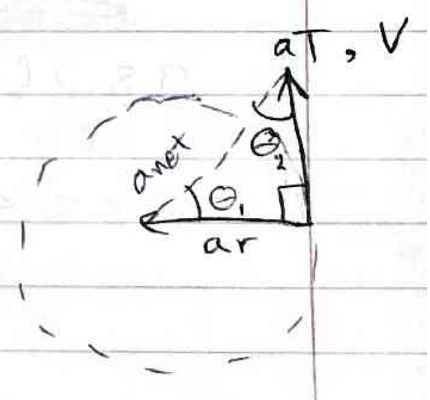
$V_f = V_0 + (0.6)(15) \Rightarrow V_f = 9\ m/s$

$a_r = \frac{V^2}{R} \Rightarrow \frac{9}{32} \Rightarrow a_r =$ ~~0.28125 m/s²~~ $2.5\ m/s^2$

$a_{net} = \sqrt{(a_r)^2 + (a_T)^2} = 2.6\ m/s^2$

~~Angle = $\tan\theta_2 = \frac{a_r}{a_T}$~~

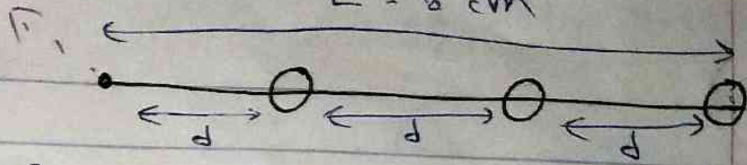
~~$\theta = \tan^{-1}\left(\frac{2.6}{2.5}\right)$~~



Angle - $\tan\theta_2 = \frac{a_r}{a_T}$

$\theta_2 = \tan^{-1}\left(\frac{2.5}{0.6}\right) \Rightarrow 76^0$

Q 38)



$I_{total} = md^2 + m(2d)^2 + m(3d)^2$

$= md^2(1+4+9) \Rightarrow 14\,md^2$

a) Percentage if we remove Inner most one?

$I_{new} = m(2d)^2 + m(3d)^2$

$= md^2(4+9) \Rightarrow 13\,md^2$

$\text{Percentage} = \frac{14\,md^2 - 13\,md^2}{14\,md^2} * 100 = 7\%$

b) Percentage if ~~inner~~ outermost is removed?

$I_{new} = md^2(1+4) \Rightarrow 5\,md^2$

$\text{Percentage} = \frac{14\,md^2 - 5\,md^2}{14\,md^2} * 100 = 64\%$

Q 45) $F_1 = 4.2 \quad r_1 = 1.3 \quad \theta_1 = 75^\circ$; $\tau_{net} = ??$

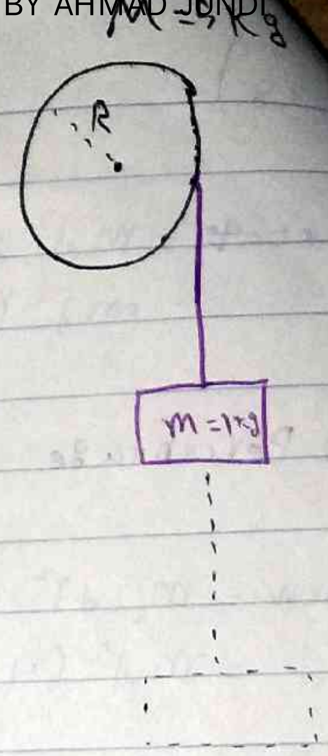
$F_2 = 4.9 \quad r_2 = 2.15 \quad \theta_2 = 60^\circ$

$\tau_{net} = \tau_1 - \tau_2$

$\tau_1 = F_1 r_1 \sin\theta_1 \Rightarrow 4.2(1.3)\sin 75$

$\tau_2 = F_2 r_2 \sin\theta_2 \Rightarrow 4.9(2.15)\sin 60$

$\tau_{net} = -3.85$ N.M $\Rightarrow$ Clock wise.



49)

$\tau = F_{net} R$

$F_{net} = mg - T \Rightarrow T = mg - ma$

$I = \frac{1}{2} M R^2$

$\alpha = \frac{a}{R}$

$\Rightarrow I\alpha = F_{net} R \Rightarrow (\frac{1}{2} M R^2)(\frac{a}{R}) = (mg - ma)(R)$

$a = \frac{mg}{m + \frac{1}{2}M} \Rightarrow a = \frac{9.8}{1 + 2.5} \Rightarrow 2.8 \ m/s^2$

$\alpha = \frac{a}{R} \Rightarrow \alpha = 9.3 \ rad/s^2$

$\theta = 0 + \frac{1}{2}\alpha t^2 \Rightarrow \frac{1}{2}(9.3)(25)$

$\Rightarrow 116.25$ rads $\Rightarrow 18.5$ revs.

50) $\tau = 42$ N.m

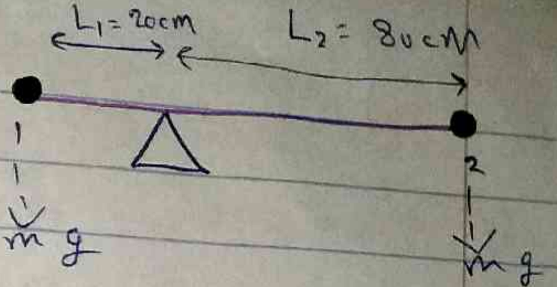
$\alpha = 25 \ rad/s^2$

$\tau = I\alpha \Rightarrow I = \frac{42}{25} \Rightarrow 1.68 \ Kg.m^2$

Q56) $m_1 = m_2 = m$

$L_1 = 0.2\ m$

$L_2 = 0.8\ m$



Find the acceleration of both objects?

$\tau_{net} = \tau_1 - \tau_2$

$\tau_1 = m g L_1$

$\tau_2 = m g L_2$

$I_{net} = I_1 + I_2$

$I_1 = m L_1^2$

$I_2 = m L_2^2$

$$(m L_1^2 + m L_2^2)\alpha = m g (L_1 - L_2)$$

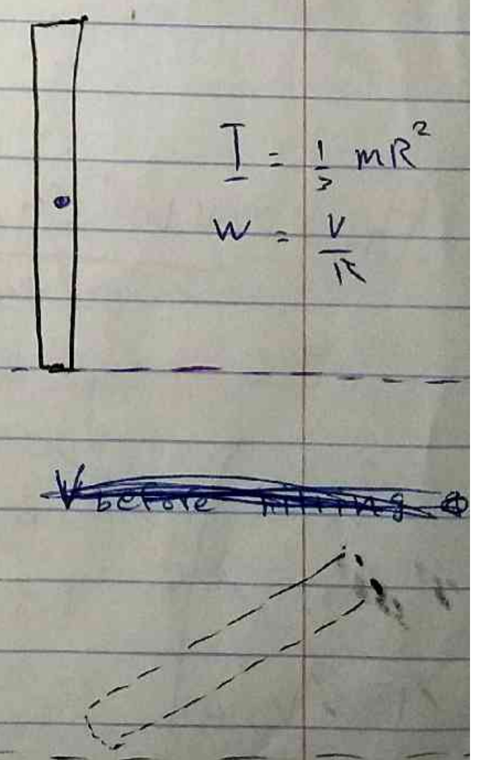
$$\alpha = 8.65\ rads/s^2$$

$a_1 = L_1 \alpha \Rightarrow a_1 = 1.73\ m/s^2$

$a_2 = L_2 \alpha \Rightarrow a_2 = 6.92\ m/s^2$

59) $L = 30\ m$ $V = ??$

$m = 100\ kg$



$I = \frac{1}{3} m R^2$

$w = \frac{V}{R}$

$$m g \frac{L}{2} = \frac{1}{2}\left(\frac{1}{3} m R^2\right)\frac{V^2}{R^2}$$

$$g L = \frac{1}{3} V^2 \Rightarrow V = \sqrt{9.8(30)(3)}$$

$$\Rightarrow V = 29.7\ m/s,$$