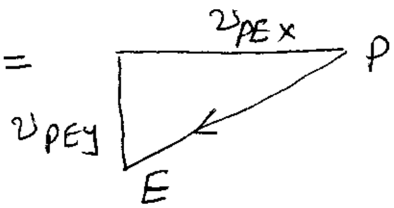
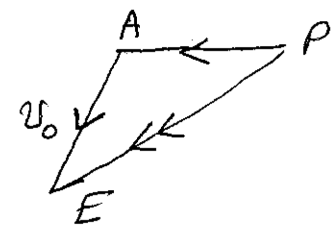
3-81) v_{PE} = plane with respect to E
$v_{A,E}$ = Air w.r.t Earth
$v_{P,A}$ = plane w.r.to Air = Air speed.

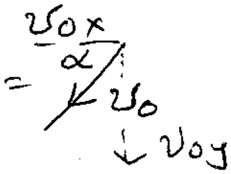
v_{PE} = 

, $v_{PEx} = -240\,km/h$, $v_{PEy} = -40\,km/h$

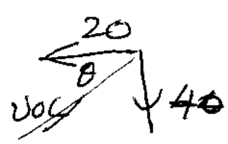
+y, +x

v_{PA} = A ⟵ P , $-220\,km/h$

$v_{PE} = v_{PA} + v_{AE} \Rightarrow$ 

v_{AE} = 

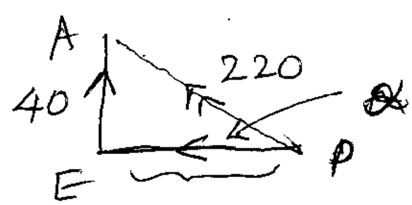
$v_{PEx} = v_{PA} + v_{ox} \Rightarrow -220 + v_{ox} = -240 \Rightarrow v_{ox} = -20\,km$
$v_{PEy} = v_{oy} \Rightarrow v_{oy} = -40\,km/h$

$\therefore v_o$ = 

$v_o = 20\sqrt{5}\ km/h$
$\theta = \tan^{-1} 2$

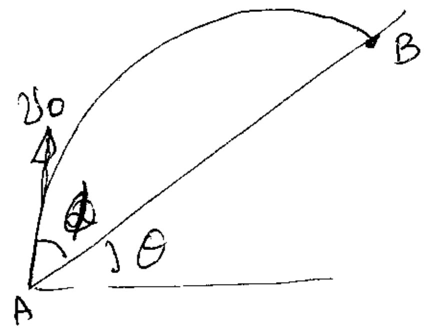
b) Need to go west , $v_{PA} = v_{PE} + v_{EA}$

$v_{AE} = \downarrow 40$



~~tan~~ $\sin\alpha = \frac{40}{220}$, $\alpha = ?$

3.89



There are many way to do this.
Here is an easy way.
Choose

then $a_x = -g\sin\theta$
$a_y = -g\cos\theta$

When it hit B
$y = 0$

$y = vt + \frac{1}{2}at^2 \Rightarrow 0 = v_0 \sin\phi\, t - \frac{1}{2} g\cos\theta\, t^2$

$\therefore t = 2v_0 \sin\phi / g\cos\theta$ -- (1)

$x = vt + \frac{1}{2}at^2 \Longrightarrow R = v_0 \cos\phi\, t - \frac{1}{2} g \sin\theta\, t^2$ -- (2)

put t from (1) in (2)

$$R = X = v_0 \cos\phi \cdot \frac{2v_0 \sin\phi}{g\cos\theta} - \frac{1}{2} g \sin\theta \cdot \frac{4v_0^2 \sin^2\phi}{g^2\cos^2\theta}$$

$$= \frac{2v_0^2}{g\cos^2\theta}\left[\cos\phi \sin\phi \cos\theta - \sin\theta \sin^2\phi\right]$$

Answer in the book will reduce to this

b) $R = \frac{v_0^2}{g\cos^2\theta}\left\{\sin 2\phi \cos\theta - 2\sin\theta\left[\frac{1-\cos 2\phi}{2}\right]\right\}$

$$= \frac{v_0^2}{g\cos^2\theta}\left[\sin 2\phi \cos\theta + \cos 2\phi \sin\theta - \sin\theta\right]$$

$$= (\ )\left[\sin(2\phi+\theta) - \sin\theta\right]$$

Maximum [only ϕ term is $\sin(2\phi+\theta)$] is when $\sin(2\phi+\theta) = 1$

$\therefore 2\phi + \theta = 90^\circ \Rightarrow \phi = 45^\circ - \theta/2$!

Answer in the book

$$R = \frac{2V_0^2}{g}\left[\tan(\theta+\phi) - \tan\theta\right]\frac{\cos^2(\theta+\phi)}{\cos\theta}$$

$$= \frac{2V_0^2}{g\cos\theta}\left[\frac{\sin(\theta+\phi)}{\cos(\theta+\phi)} - \frac{\sin\theta}{\cos\theta}\right]\cdot\frac{\cos^2(\theta+\phi)}{\cancel{\cos\theta}}$$

$$= \frac{2V_0^2}{g\cos^2\theta}\left[\frac{\sin(\theta+\phi)\cos\theta - \cos(\theta+\phi)\sin\theta}{\cos(\theta+\phi)\cos\theta}\right]\cos^2(\theta+\phi)$$

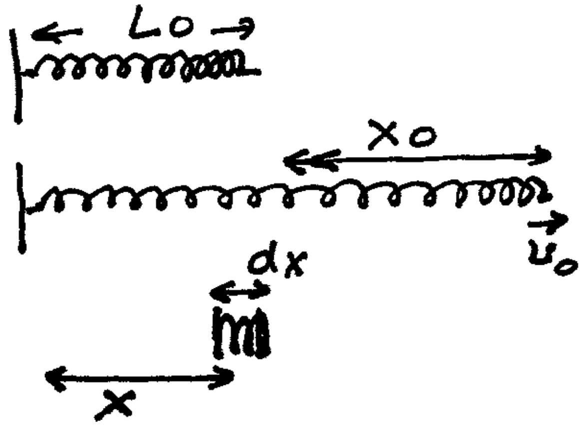
$$= \frac{2V_0^2}{g\cos^2\theta}\left[\frac{\sin[(\theta+\phi)-\theta]}{\cos(\theta+\phi)}\cos^2(\theta+\phi)\right.$$

$$= \frac{2V_0^2}{g\cos^2\theta}\sin\phi\cdot\cos(\theta+\phi)$$

$$= (\quad)\ \sin\phi\left[\cos\theta\cdot\cos\phi - \sin\theta\sin\phi\right]$$

$$= \frac{V_0^2}{g\cos^2\theta}\{\sin 2\phi\cos\theta + \cos 2\phi\sin\theta - \sin\theta)$$

6.101 Consider the spring is stretched and let it go. At a particular time end of the spring has a velocity V_0 and is stretched a length x_0



Consider a very small element dx at a distance x from the fixed end.

Mass of this element $= \frac{M}{(L_0+x_0)} \cdot dx = \frac{M}{L} dx$, $L = L_0 + x_0$

Velocity of this element $= v_x = \frac{v_0}{L} \times x = \frac{v_0 x}{L}$

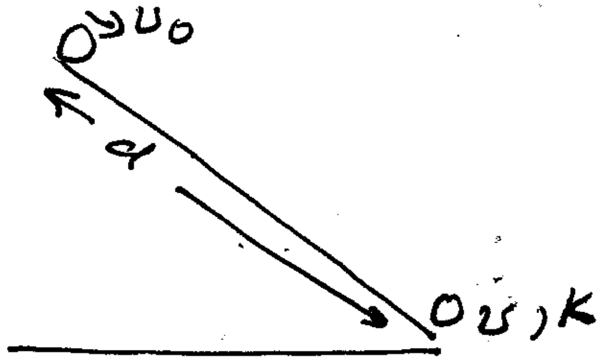
$\therefore$ K.E of this element $= \frac{1}{2} m v^2 = \frac{1}{2} dM \frac{v_0^2}{L^2} \cdot x^2$

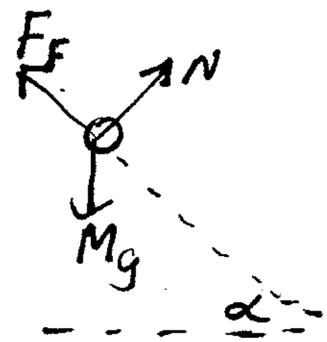
$\therefore$ total K.E $= \int dKE = \int_0^L \frac{1}{2} \frac{M}{L} dx \frac{v_0^2}{L^2} x^2$

$$= \frac{M}{L^3} \frac{v_0^2}{2} \int_0^L x^2 dx = \frac{M}{2L^3} v_0^2 \cdot \frac{L^3}{3}$$

$$= \frac{1}{3} \left(\frac{1}{2} M v_0^2 \right)$$

7.8





$N = Mg\cos\alpha$ and $F_f = \mu_K Mg\cos\alpha$

Work Energy says

$$\frac{1}{2}mv_0^2 + \Delta W = \frac{1}{2}mv^2 = K$$

$$\therefore \frac{1}{2}mv_0^2 + Mg\sin\alpha \cdot d - \mu_K Mg\cos\alpha \cdot d = K = \frac{1}{2}Mv^2$$

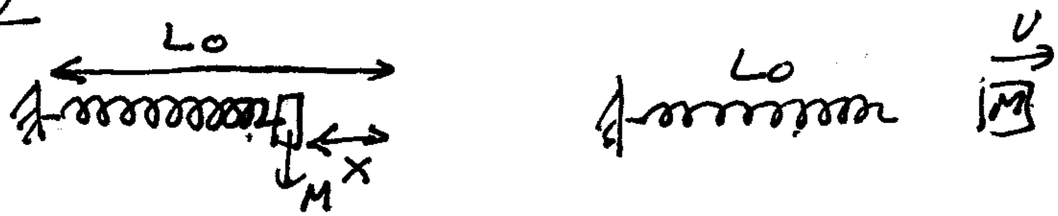
$$\therefore v^2 = v_0^2 + gd\underline{(\sin\alpha - \mu_K\cos\alpha)}$$

v does not depend on mass, so quadrupling mass does not effect v.

But kinetic energy $= \frac{1}{2}4Mv^2 = 4(\frac{1}{2}mv^2)$

$=$ is quadrupled

7.24



$$K_1 + U_1 = K_2 + U_2$$

$$0 + \frac{1}{2} k x^2 = \frac{1}{2} M v^2 + 0 \Rightarrow k x^2 = M v^2 \quad \text{--- (1)}$$

Maximum acceleration, when maximum force

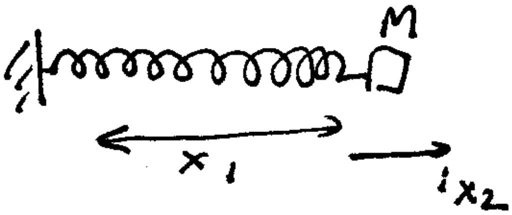
i.e maximum compression

$$\therefore \quad k x = M(5g) \quad \text{--- (2)}$$

$$k^2 x^2 = M^2 (25 g^2) \quad \text{--- (3)}$$

$$(3)/(2) \Rightarrow \quad k = \frac{25 M^2 g^2}{M v^2} = \frac{25 M g^2}{v^2} = \frac{1160 \times 25 \times (9.8)^2}{(2.5)^2} \ \mathrm{N}/$$

732



a) $W_{S12} = -\Delta U_{el} =$
$= -\left(\frac{1}{2}kx_2^2 - \frac{1}{2}kx_1^2\right)$

ending starting

b) $W_{el2} = -\left(\frac{1}{2}kx_1^2 - \frac{1}{2}kx_2^2\right)$

$W_{el1} + W_{el2} = 0$ x_1 to x_2 to x_1, ~~No displa~~
No displacement !!

c) $W_{el3} = -\left(\frac{1}{2}kx_3^2 - \frac{1}{2}kx_1^2\right)$

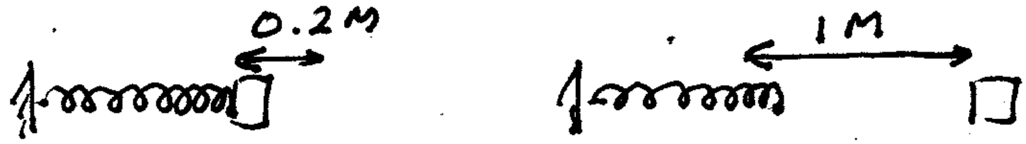
$W_{el4} = -\left(\frac{1}{2}kx_2^2 - \frac{1}{2}kx_3^2\right)$

$W_{Tot} = W_{el3} + W_{el4} = -\left(\frac{1}{2}kx_2^2 - \frac{1}{2}kx_1^2\right)$

x_1 to x_3 to x_2 It is like x_1 to x_2 !

W_{TOT} is independant of path !!

7-43

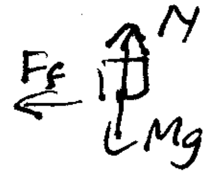


Initial and final K.Energies are zero!

so Work done by friction $= \frac{1}{2}kx^2$

$$\cancelto{0}{K_1} + U_1 + W_f = \cancelto{0}{K_2} + \cancelto{0}{U_2} \quad \text{(spring relaxed!)}$$

$$\therefore \frac{1}{2}kx^2 - F_f \cdot d = 0$$



$F_f = \mu_k Mg$

$$\therefore \mu_k Mg \cdot d = \frac{1}{2}kx^2$$

$$\mu_k = \frac{kx^2}{2\cancel{\mu_k}Mg} = \frac{100 \times (0.2)^2}{2 \times 0.5 \times 9.8} \simeq \underline{\underline{0.4}}$$