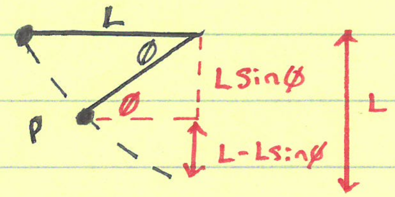
AP Physics - Unit 4

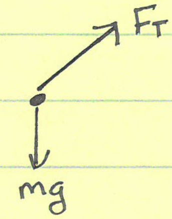
WKst - Unit 4 WorkBook

8/

① Given:

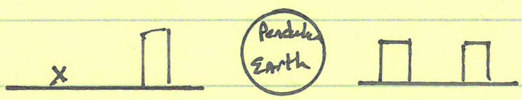


Ⓐ



Ⓑ a not constant ∴ use Conservation of Energy $ME_i = ME_f$

Initial



$$\emptyset + U_g = KE_P \; U_g@P$$

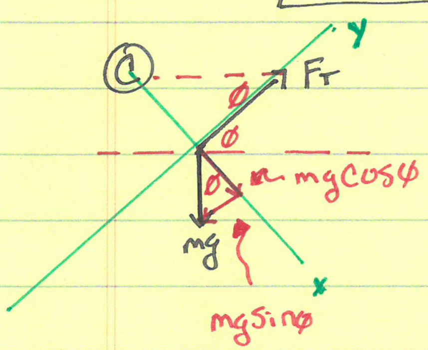
$$+\cancel{m}gL = \tfrac{1}{2}\cancel{m}V_p^2 + \cancel{m}g(L - L\sin\emptyset)$$

$$g\cancel{L} = \tfrac{1}{2}V_p^2 + \cancel{gL} - gL\sin\emptyset$$

$$V_p^2 = 2gL\sin\emptyset$$

$$\boxed{V_p = \sqrt{2gL\sin\emptyset}}$$

Ⓒ



$$F_{net} = F_c$$

$$F_T - mg\sin\emptyset = \frac{mV_T^2}{L} \qquad r = L$$

?

$$V = \sqrt{2gL\sin\emptyset}$$

?

$$F_T - mg\sin\emptyset = \frac{m(\sqrt{2gL\sin\emptyset})^2}{L}$$

$$F_T - mg\sin\emptyset = \frac{m\,2g\cancel{L}\sin\emptyset}{\cancel{L}}$$

$$F_T = mg\sin\emptyset + 2mg\sin\emptyset$$

$$\boxed{F_T = 3mg\sin\emptyset}$$

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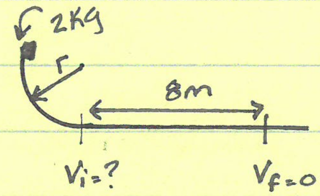
#2 Given:



$g = 10\,m/s^2$

$F_K = 8\,N$

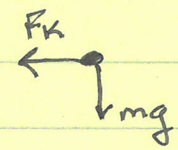
* a is constant over 8 m

Ⓐ $a = ?$ hor

Ⓑ $t = ?$ hor

Ⓒ $r = ?$

Ⓐ $a = ?$ @ hor



$F_{Net} = -F_K$

$-F_K = m\overset{?}{a}$

$$a = \frac{-F_K}{m} = \frac{-8\,N}{2\,Kg}$$

$$\boxed{a = -4\,m/s^2}$$

Ⓑ $t = ?$ @ hor

$\cancel{V_x}^{2\,0} = V_{xo}^2 + 2a\Delta X$ Need V_i first

$V_i^2 = -2a\Delta X$

$V_i^2 = -2(-4\,m/s^2)(8\,m)$

$V_i = 8\,m/s$

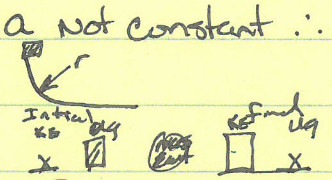
$V_x = V_{xo} + a_x \overset{?}{t}$

$a_x t = \cancel{V_f}^0 - V_i$

$$t = \frac{-V_i}{a} = \frac{-8\,m/s}{-4\,m/s^2}$$

$$\boxed{t = 2\,sec}$$

Ⓒ a not constant ∴ $ME_i = ME_f$



$r = h$

$\cancel{m}g\overset{?}{r} + 0 = \frac{1}{2}\cancel{m}V_f^2 + \emptyset$

$$r = \frac{V_f^2}{2g} = \frac{(8\,m/s)^2}{2(10\,m/s^2)}$$

$$\boxed{r = 3.2\,m}$$

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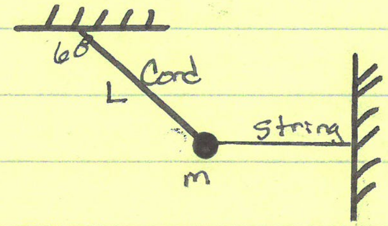
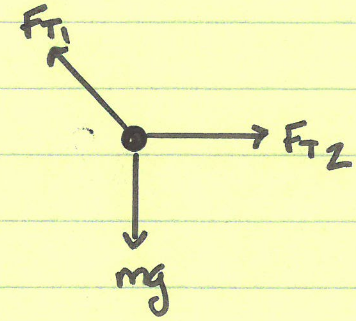
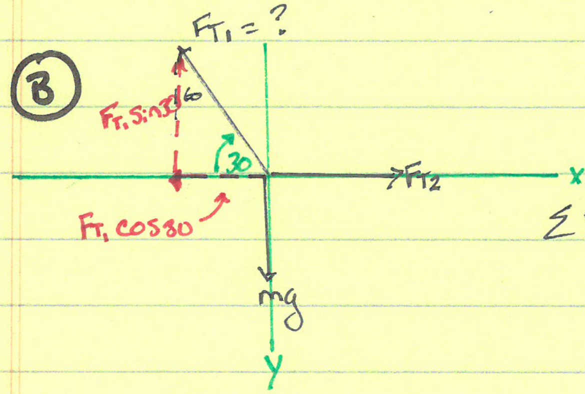
③ Given:



Ⓐ



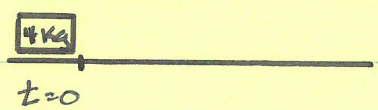
Ⓑ



$$\Sigma F_y = F_{T_1}\sin 30 - mg = m\cancel{a}^{0}$$

$$\boxed{F_{T_1} = \frac{mg}{\sin 30^\circ} \quad \text{or} \quad F_T = 2\,mg}$$

④ Given: $V_i = 6\,m/s$



Ⓐ $W = ?$ @ $V_f = 0$

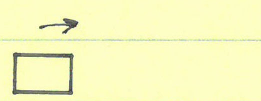
$W_{net} = \Delta KE$

$= \frac{1}{2} m \cancel{V_f}^{2\,0} - \frac{1}{2} m V_i^2$

$= -\frac{1}{2}(4kg)(6\,m/s)^2$

$$\boxed{W_{net} = -72\text{ J}}$$

Ⓑ



$F_K = 8N$

a = constant

$-F_{net} = ma$

$a = \frac{-F_{net}}{m}$

$a = \frac{-8N}{4kg}$

$a = -2\,m/s^2$

need a to find V

$\cancel{V_f}^{0} = V_i + at$

$at = -V_i$

$t = \frac{-V_i}{a} = \frac{-6m/s}{-2m/s^2}$

$$\boxed{t = 3\text{ sec}}$$

Ⓒ $d = ?$

$W = -Fd$

$d = \frac{W}{F}$

$= \frac{-(-72J)}{8N}$

$$\boxed{d = 9\,m}$$

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(5) Given:

P

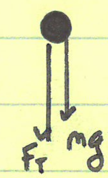
m=0.50kg Vertical Circle

$F_T = 20.N$

Q

g=10m/s

(A)



(B) V=? @ P

$F_{net} = F_c$

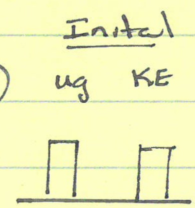
$F_T + mg = \frac{m V_T^2}{r}$?

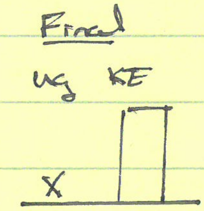
$V_T^2 = \frac{r(F_T + mg)}{m}$

$= \frac{2m(20.N + (0.50kg)(10m/s^2))}{0.50kg}$

$\boxed{V_T = 10 m/s}$

(C) Initial / Final





$U_g + KE_i = 0 + KE_f$ $\quad \Delta KE = KE_f - KE_i$

$\Delta KE = U_g$

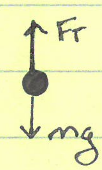
$= mgh \quad h = 2r$

$= mg2r$

$= (0.50kg)(10m/s^2)(2(2m$

$\boxed{\Delta KE = 20 J}$

(D) F_T @ Q



$F_{net} = F_c$

$F_T - mg = \frac{m V_T^2}{r}$? Don't know V@Q

$U_g + KE_i = KE_f$?

$2\cancel{m}(r2)g + \frac{1}{2}\cancel{m}V_i^2 = \frac{1}{2}\cancel{m}V_f^2$

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

$= 2(40. + \frac{1}{2}(10m/s)^2)$

$V_f^2 = 180 m^2/s^2$

$V_f = 13.4 m/s$

$F_T = mg + \frac{m V_T^2}{r}$

$= (0.50)(10m/s^2) + \frac{(0.50)(13.4m/s)^2}{2m}$

$\boxed{F_T = 50.N}$

* Note: Could have solved for V_f 1st then done

$\Delta KE = \frac{1}{2}mV_f^2 - \frac{1}{2}mV_i^2$

$= 20J$

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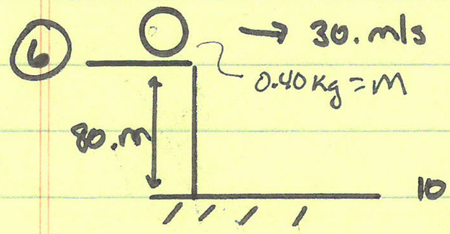
(6)



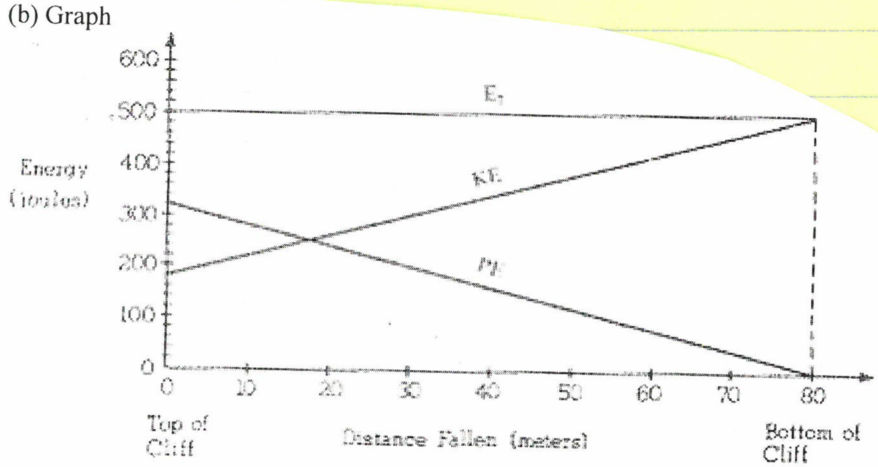
A) $U_g = ?$
$KE = ?$
$E_{Total} = ?$

$U_g = mgh$
$= (0.40\,kg)(10\,m/s^2)(80.\,m)$
$U_g = 320\,J$

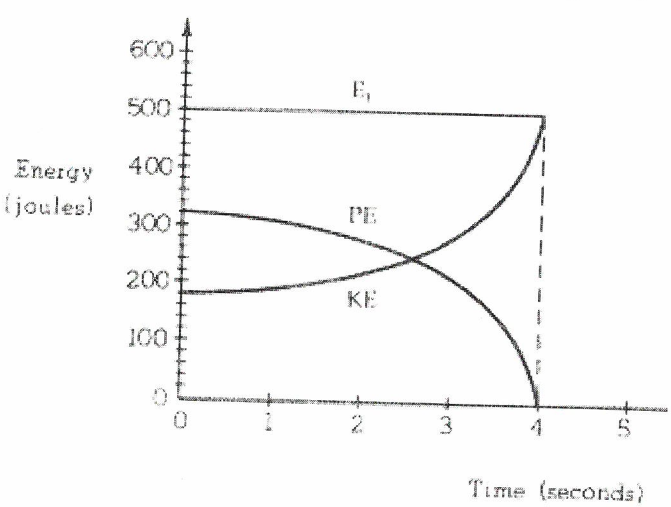
$KE = \frac{1}{2}mv^2$
$= \frac{1}{2}(0.40\,kg)(30.\,m/s)^2$
$KE = 180\,J$

$E_{Total} = U_g + KE$
$E_T = 500\,J$

(b) Graph



(c) First determine the time at which the ball hits the ground, using $d_y = 0 + \frac{1}{2} g t^2$, to find it hits at 4 seconds.



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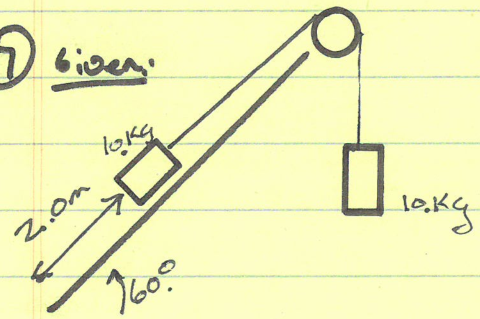
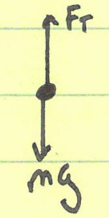
(7) Given:



A)



$\Sigma F_y = F_T - mg = m\cancel{a}^{0}$

$F_T = mg$

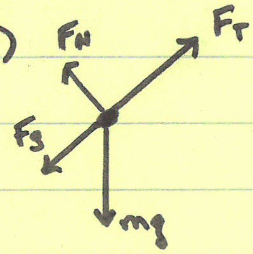
$= (10.kg)(10m/s^2)$

$$\boxed{F_T = 1\bar{0}0\ N}$$

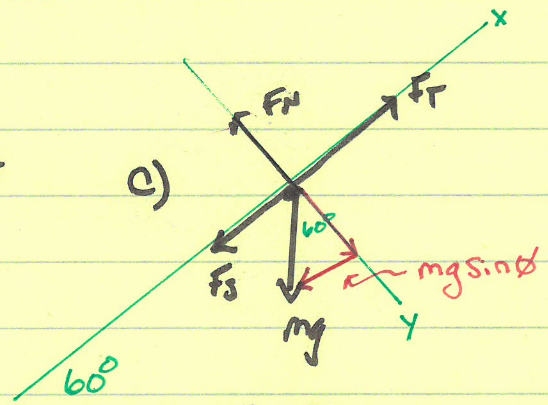
$u_K = .15$

$u_s = .30$

B)



C)



$F_s = ?$

$\Sigma F_x = F_T - mg\sin\theta - F_s = m\cancel{a}^{0}$

$F_s = F_T - mg\sin\theta$

$= 1\bar{0}0N - (10.kg)(10m/s^2)\sin 60°$

$F_s = 13\ N$

(D) loss of ME ⇒ work done By friction

$W_{fk} = F_K d$

$F_K = u_K F_N$

$F_N = mg\cos\theta$

$F_K = u_K mg\cos\theta$

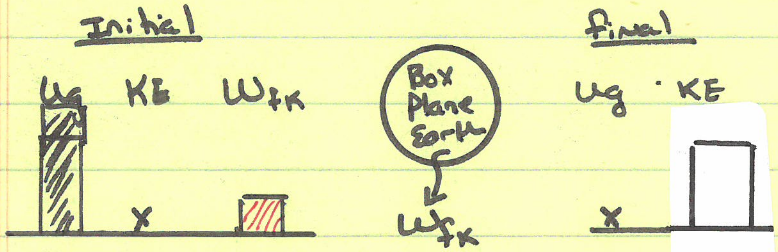
$W_{fk} = u_K mg\cos\theta\, d$

$= (.15)(10.kg)(10m/s^2)\cos 60° (2.0m)$

$$\boxed{W_{fk} = 15J}$$

7 Cont'd

(e) KE = ? at Bottom of plane ; Not constant a, use work-energy Theorem



$U_g - W_{fk} = KE$

$mgh - W_{fk} = KE$

$mg\,d\sin\theta - 15\,J = KE$

$(10.\,kg)(10\,m/s^2)(2.0\,m)\sin 60° - 15\,J = KE$

$\boxed{KE = 158\,J}$

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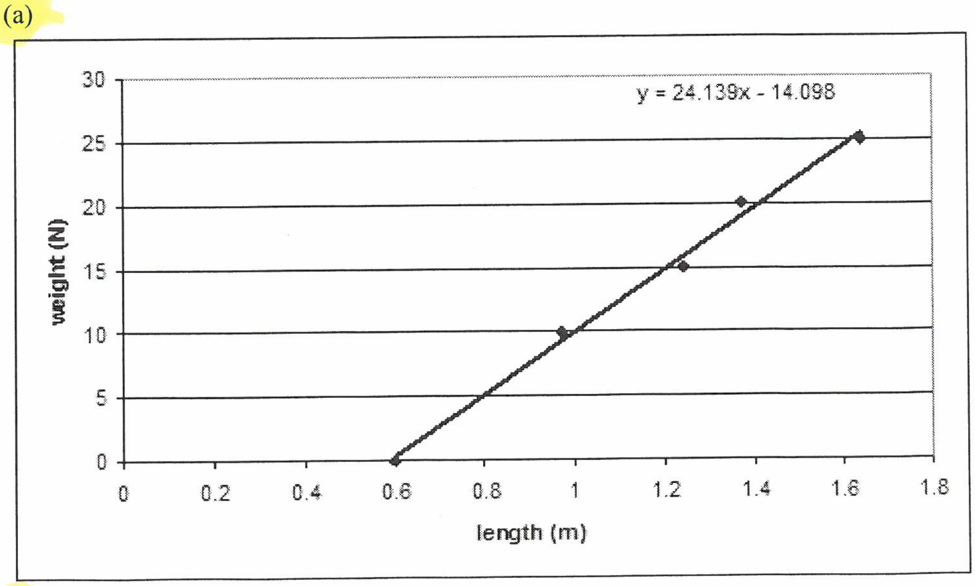
(a)



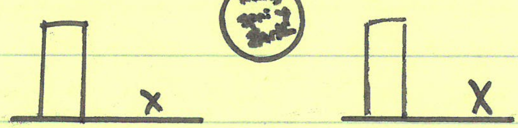
(b) The slope of the line is F / Δx which is the spring constant. Slope = 24 N/m

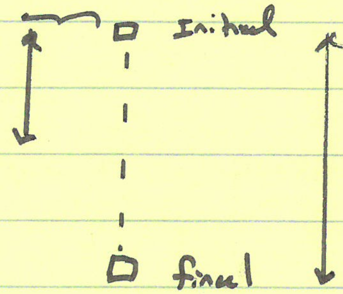
(8) cont.

(c) Initial U_g KE — Final U_{sp} KE

0.60 m Cord

KE = 0 only U_g





KE = 0 only U_{sp}

$$U_g + 0 = U_{sp} + 0$$

$$U_g = U_{sp}$$

?

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

x = final distance ⇒ $1.5 - 0.60 = 0.90\,m$

$$m = \frac{Kx^2}{2gh} = \frac{(24\,N/m)(0.90\,m)^2}{2(9.8\,m/s^2)(1.5\,m)}$$

$$\boxed{m = 0.66\,kg}$$

(D) At Equilibrium mass Net force is zero

$F_{sp} = ?$

mg

$$\Sigma F_{net} = F_{sp} - mg = \cancel{ma}\,0$$

$$F_{sp} = mg$$

$$= (0.66\,kg)(9.8\,m/s^2)$$

$$\boxed{F_{sp} = 6.5\,N}$$

(e) $\Delta x = ?$ $F_{sp} = K\overset{?}{X}$ $F_{sp} = F_{elastic}$ (also)

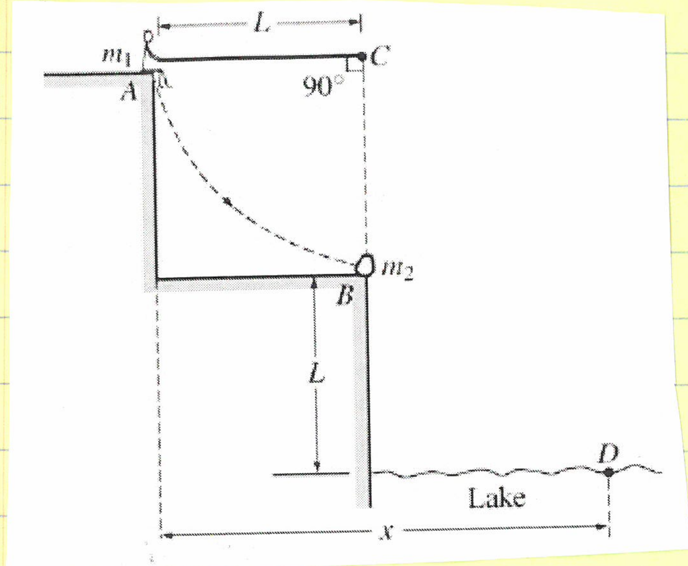
$$\Delta x = \frac{F_{sp}}{K}$$

$$= \frac{6.5\,N}{24\,N/m}$$

$$\boxed{\Delta x = 0.27\,m}$$

WKst - Unit 4 - Work Book

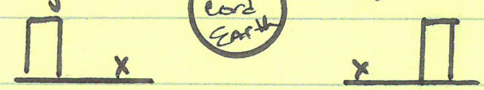
9 Given:



A) Solve for V @ Point B

A1 initial / final

Ug KE — mass cord Earth — Ug KE



$$mgh + 0 = 0 + \tfrac{1}{2}mV_B^2 \qquad h = L$$

$$\cancel{m}gL = \tfrac{1}{2}\cancel{m}V_B^2$$

$$V_B = \sqrt{2gL}$$

B) F_T @ B

F_T ↑, ↓ mg

$$F_{Net} = F_c$$

$$F_T - mg = \frac{mV_T^2}{r}$$

$$F_T = mg + \frac{mV_T^2}{r}$$

$r = L$

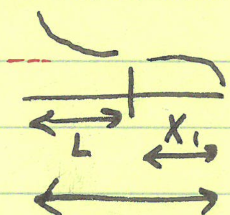
$V = \sqrt{2gL}$

$$F_T = mg + \frac{m(\sqrt{2g\cancel{L}})^2}{\cancel{L}}$$

$$F_T = mg + 2mg$$

$$\boxed{F_T = 3mg}$$

C) X ? when person + m_2 (m_1) Lands @ D



$$\text{Total } x = X_1 + L$$

i) Need X_1, But How Long to fall L? $\underline{\underline{\Delta t}}$

a = constant ∴ can use Kinematics

$$Y = \cancel{Y_0}^{\,0} + \cancel{V_0 t}^{\,0} + \tfrac{1}{2}gt^2$$

No Velocity in y direction at point B

$$y = \tfrac{1}{2}gt^2 \qquad y = L$$

$$t = \sqrt{\frac{2L}{g}}$$

C:ii) X = ? $\quad X = \cancel{X_0}^{\,0} + V_{x0}t + \cancel{\tfrac{1}{2}at^2}^{\,0}$

$V_{x0} = V'$ (given)

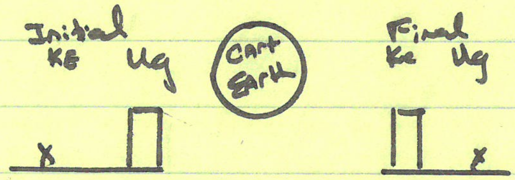
$$X = V't$$

$$X = V'\sqrt{\frac{2L}{g}}$$

$$\boxed{\text{Total Distance} = L + V'\sqrt{\frac{2L}{g}}}$$

Wkst - Unit14 - Work Book

10 (A) V = ? at Bottom of Incline

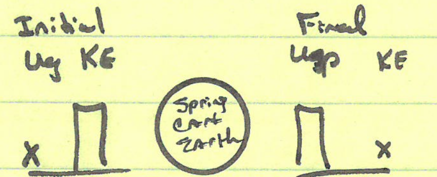


$0 + \cancel{m}gh = \frac{1}{2}\cancel{m}V_B^2 + 0$

$V^2 = 2gh$

$\boxed{V = \sqrt{2gh}}$

(B) Xm = ? Spring Compressed



$0 + \frac{1}{2}mV^2 = \frac{1}{2}Kx^2 + 0$

$m = 2m$

$\cancel{\tfrac{1}{2}}(2m)V^2 = \cancel{\tfrac{1}{2}}Kx_m^2$?

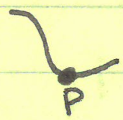
$v = \sqrt{2gh}$

$X_m^2 K = 2m(\sqrt{2gh})^2$

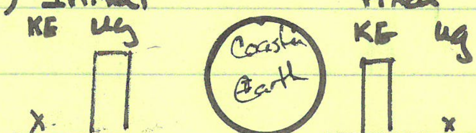
$X_m^2 = \frac{4mgh}{K}$

$\boxed{X_m = 2\sqrt{\frac{mgh}{K}}}$

11 A) i - At Bottom of 1st hill



ii) Initial Final



$m = 700\,kg$

$h = 90\,m$

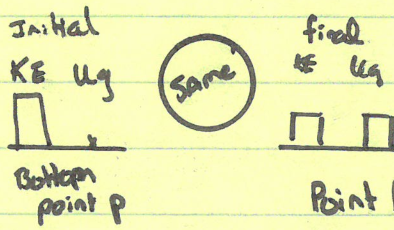
$0 + \cancel{m}gh = \frac{1}{2}\cancel{m}V^2 + 0$?

$V^2 = 2gh$

$= \sqrt{2(9.8\,m/s^2)(90\,m)}$

$\boxed{V = 42\,m/s}$

(B)



$\frac{1}{2}\cancel{m}V_p^2 = \frac{1}{2}\cancel{m}V_B^2 + \cancel{m}gh$?

$\frac{1}{2}V_p^2 - gh = \frac{1}{2}V_B^2$

$V_B^2 = V_p^2 - 2gh$

$= (42\,m/s)^2 - 2(9.8\,m/s^2)(50\,m)$

$\boxed{V_B = 28\,m/s}$

Work
Wkst - Unit 14 - Book

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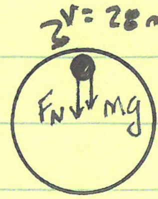
(11) conti i) $v = 28\ m/s$



ii) $F_N = ?$ $mg = ?$

$mg = (700\ kg)(9.8\ m/s)$

$\boxed{mg = 6860\ N}$

$F_{Net} = F_c$

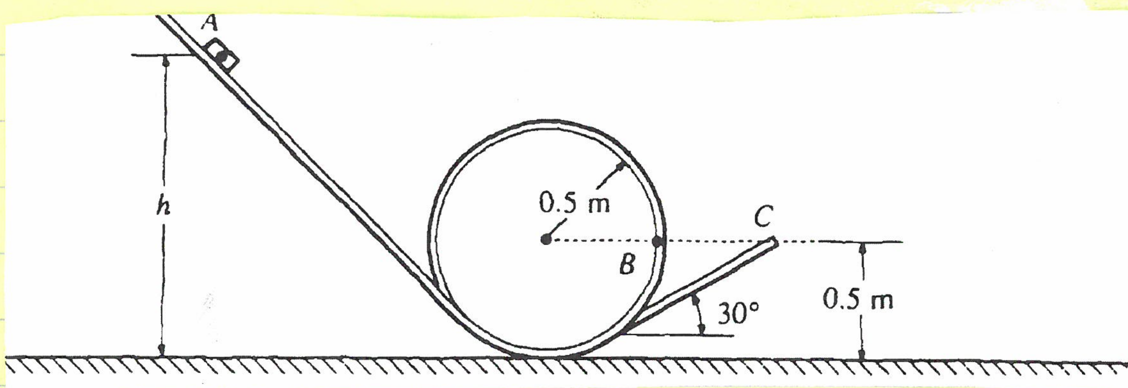
$\overset{?}{F_n} + mg = \frac{mv^2}{r}$

$F_N = \frac{mv^2}{r} + mg = \frac{(700\ kg)(28\ m/s)^2}{20\ m} - 6860\ N$

$\boxed{F_N = 20580\ N}$

(b) The friction will remove some of the energy so there will not be as much Kinetic energy at the top of the loop. In order to bring the KE back up to its original value to maintain the original speed, we would need less PE at that location. A lower height of the loop would reduce the PE and compensate to allow the same KE as before. To actually modify the track, you could flatten the inclines on either side of the loop to lower the height at B.

(12)



(A)

$U_g = KE + U_g$

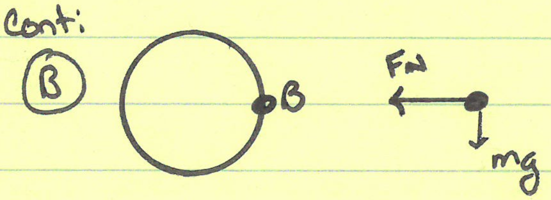
$\cancel{m}gh \overset{?}{=} \frac{1}{2}\cancel{m}v^2 + \cancel{m}gX$

$h = \frac{v^2}{2g} + X = \frac{(4.0\ m/s)^2}{2(9.8\ m/s^2)} + 0.50\ m$

$\boxed{h = 1.3\ m}$

(12) Cont:

(B)



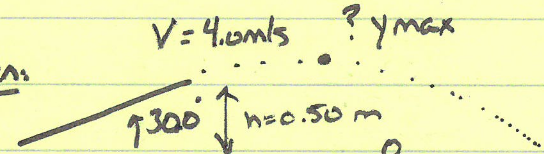
(C) Since the height at B & the height at C are the same, they would have to have the same velocities $V_b = 4.0\,m/s$

(D) $F_{Net} = F_c$

$F_{Net} = F_N$

$F_N = \frac{mv^2}{r} = \frac{(0.10\,kg)(4.0\,m/s)^2}{0.50\,m} = \boxed{3.2\,N}$

(e) Given:



Don't have t

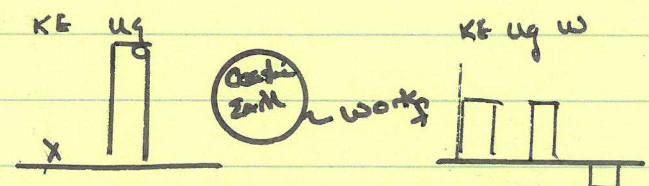
a = constant = g!

Kinematic eqn $\cancel{V_y^2}^{0} = V_{y0}^2 + 2g(\Delta y)$

$\Delta y = -\frac{V_{y0}^2}{2g} = -\frac{(4.0\,m/s \sin 30.)^2}{2(-9.8\,m/s^2)}$

$\Delta y = 0.20$

(f)



$\cancel{\Delta y}$ = $h_i + \Delta y$

$h_f = 0.50\,m + 0.20\,m$

$\boxed{h_f = 0.70\,m}$

$U_g = KE + U_g - W_f$

$mgh = \frac{1}{2}mv^2 + mgx - W_f$

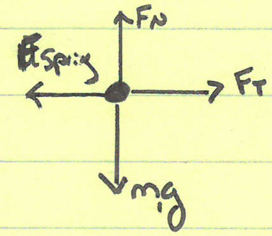
$W_f = \frac{1}{2}mv^2 + mg(x - h)$

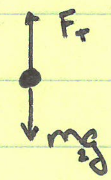
$= \frac{1}{2}(0.10\,kg)(4.0\,m)^2 + (0.10\,kg)(9.8\,m/s^2)(0.50\,m - 2.0\,m)$

$= 0.80\,J - 1.5\,J$

$\boxed{W_f = -0.70\,J}$

(13) (A) $M = 8.0\,kg$ $m = 4.0\,kg$





(B) $F_T = ?$

$F_{net} = \cancel{ma}^{\,0}$ equilibrium $\therefore a = 0$

$F_T - mg = 0$

$F_T = (4.0\,kg)(9.8\,m/s^2)$

$\boxed{F_T = 39\,N}$

(C) $F_{spring} = ?$ solve for K?

$\Sigma F_x = F_{spring} = F_T$

$F_s = K\Delta X$

unstretched 0.20m equilibrium 0.25m

$K\Delta X = F_T$ ΔX

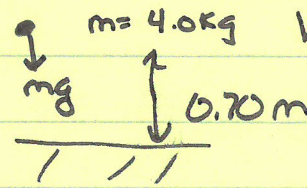
$K = \dfrac{39\,N}{(0.05\,m)}$

$\Delta X = .25 - .20$

$\Delta = 0.05\,m$

$\boxed{K = 780\,N/m}$

(D) String cut $t = ?$



$V_i = 0$ .... $y = 0$

$y = \cancel{y_0}^{\,0} + \cancel{V_{y0}t}^{\,0} + \frac{1}{2}gt^2$?

$V_{y0} = 0 = V_i$

$t^2 = \dfrac{2y}{g} = \sqrt{\dfrac{2(-0.70\,m)}{(-9.8\,m/s^2)}}$

$\boxed{t = 0.38\,sec}$