AP PHYSICS - CH 5 HWK

Q3: THE POTENTIAL ENERGY THAT WILL BE CONVERTED TO KINETIC ENERGY IS ONLY DEPENDENT ON THE TWO END POINTS... NOT THE PATH BETWEEN THEM. THUS THIS SLIDE ↘ WOULD HAVE THE KIDS UP TO THE SAME VELOCITY AS THIS ONE ↘ (IF YOU IGNORE FRICTION)

Q4: KINETIC ENERGY CANNOT BE NEGATIVE (UNLESS MASS WAS NEGATIVE...)

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

$+ \quad + \quad +$

POTENTIAL ENERGY CAN BE NEGATIVE IF YOU DROP BELOW THE ARBITRARY REFERENCE LEVEL

$U = mgh$

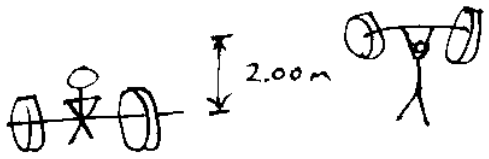
$+ \quad + \quad +$ or $-$

$U = +$

$h = 0$

$U = -$

Q8: THE PENDULUM CAN NEVER RISE ABOVE THE HEIGHT THAT IT STARTS OUT AT DUE TO CONSERVATION OF ENERGY. IF YOU START IT WITH A PUSH, HOWEVER, YOU ARE IN DANGER BECAUSE YOU JUST GAVE IT SOME K TO GO WITH ITS U... NOW IT CAN RISE ABOVE ITS STARTING HEIGHT.

① 

$W = F \cdot \Delta x = 350\,N \cdot 2.00\,m$

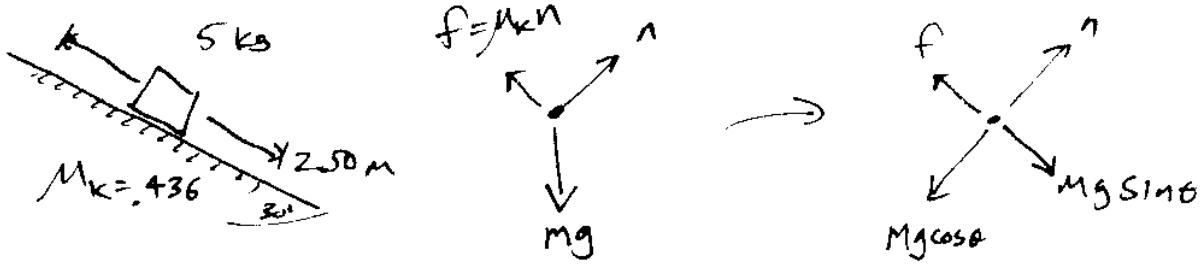
$= 700\,N \cdot m = 700\,J$

③ 

$F = 5.00 \times 10^3\,N \quad \Delta x = 3000\,m$

$W = F \cdot \Delta x = 5.00 \times 10^3\,N\,(3000\,m)$

$= 15{,}000{,}000\,J$

⑤ 

a) THE PART OF GRAVITY DOING THE WORK IS $mg\sin\theta$

SO $W = F \cdot \Delta x = mg\sin\theta \cdot \Delta x = 5(10)\sin 30°(2.50)$

$= 62.5\,J$

b) $W = F \cdot \Delta x = f \cdot \Delta x = \mu_k n\,\Delta x = \mu_k mg\cos\theta \cdot \Delta x$

$= (.436)(5)(10)\cos 30°\,(2.50)$

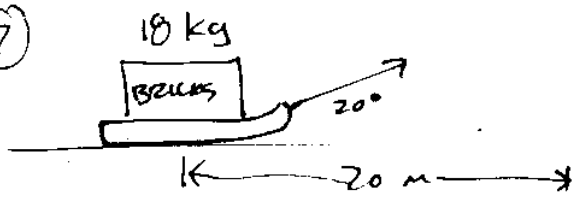
$= -47.2\,J$

WHY NEGATIVE? CUZ f IS OPPOSITE TO Δx!

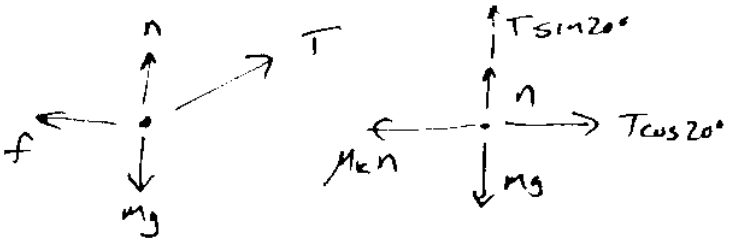
c) $W = F \cdot \Delta x$ BUT n IS PERPENDICULAR TO Δx

SO $W = 0\,J$

(7)



$\mu_k = .500$



So $T\cos 20° = \mu_k n$

And $T\sin 20° + n = mg$

$n = mg - T\sin 20°$

$T\cos 20° = \mu_k mg - \mu_k T\sin 20°$

$T\cos 20° + \mu_k T\sin 20° = \mu_k mg$

$T = \dfrac{\mu_k mg}{\cos 20° + \mu_k \sin 20°} = 81\ N$

$W = F\cdot\Delta x$

$= T\cos 20°\cdot\Delta x$

$= 81\cos 20°\,(20)$

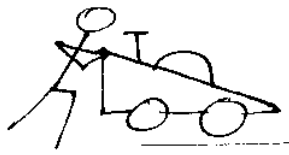
1523 J

$W = F\cdot\Delta x$

$= f\cdot\Delta x = \mu_k n\,\Delta x = \mu_k(mg - T\sin 20°)(20.0) =$ 1523 J

OH MY! OF COURSE IT HAS TO BE THE SAME!

(9)



$M = 2.5\times10^3$ kg

$x = 25.0$ m

$V_i = 0$ $V_f = V$

TWO WAYS TO DO THIS.... $W \rightarrow F \rightarrow a \rightarrow$ 1-D MOTION

$W = 5000$ J

so $W = F\cdot\Delta x \Rightarrow F = \dfrac{W}{\Delta x} = \dfrac{5000\text{ J}}{25} = 200\text{ N}$ AND

$F = ma$ so $a = \dfrac{F}{m} = \dfrac{200\text{ N}}{2.5\times10^3\text{ kg}} = .08\ m/s^2$

$x = 25.0$ m
$V_i = 0$
$V_f = ?$
$a = .08$
$t = ?$

$V_f^2 = V_i^2 + 2ax$

$V_f^2 = 2(.08)(25)$

$V_f^2 = 4 \Rightarrow$ $V_f = 2$ m/s OR ...

WORK - ENERGY THEOREM !

(9) cont

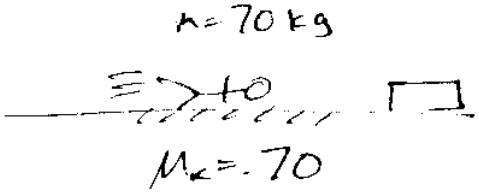
$W = \Delta KE$

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

$5000\ J = \frac{1}{2}(2.5\times10^3\ kg)\left(V_f^2 - 0^2\right)$

$\frac{10{,}000}{2.5\times10^3} = V_f^2 = 4$ $\quad V_f = 2\ m/s$ EASIER

(13)



THE RUNNER STARTS WITH $K = \frac{1}{2}mv^2 = \frac{1}{2}(70)(4)^2 = 560\ J$

WHEN HE FINISHES HE HAS $K = 0$

SO HE LOSES 560 J! SO 560 J IS DISSIPATED

$W = F\cdot\Delta x \Rightarrow \Delta x = \frac{W}{F} = \frac{W}{\mu mg} = \frac{560\ J}{(.7)(70)(10)} = 1.14\ m$

(19)

$U = K$

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

~~$2gh$~~ $\quad h = \frac{v^2}{2g} = \frac{(9.8)^2}{2(9.8)} = \frac{9.8}{2} = 4.9\ m$

SO SIMPLE EVEN DANNY CAN DO IT!

(22)

FOR THE FIRST Y_0 OF COMPRESSION $K_R = 5.25 \times 10^5 \text{ N/m}$

AFTER THAT $K_T = 5.25 \times 10^5 + 3.6 \times 10^5 = 8.85 \times 10^5 \text{ N/m}$

START BY LOOKING AT JUST THE LEAF SPRING . . .

$F = 5.00 \times 10^5 \text{ N}$ SO $F = -kx$ ← HOOKE'S LAW

$$x = \frac{F}{k} = \frac{5 \times 10^5}{5.25 \times 10^5} = .952 \text{ m}$$

SO IT'LL DEFINITELY GET TO THE HELPER . .

$$F_{TOT} = F_{REG} + F_{\substack{HELPER \\ + REG}} = K_R Y_0 + (K_T(Y - Y_0)) = 5 \times 10^5 \text{ N}$$

$$5.25 \times 10^5 (.5) + 8.85 \times 10^5 y - 8.85 \times 10^5 (.5) = 5 \times 10^5$$

$$8.85 \times 10^5 y = 680{,}000$$

$$Y = .768 \text{ m}$$

$$E = 1.268 \text{ m}$$

AND THE WORK DONE IN COMPRESSING IS JUST EQUAL TO THE U_S WHEN IT IS COMPRESSED

$$U_S = U_{REG} + U_{HELP}$$

$$= \tfrac{1}{2} k x^2 + \tfrac{1}{2} k x^2 = \tfrac{1}{2} k_R Y_0^2 + \tfrac{1}{2} k_T (Y - Y_0)^2$$

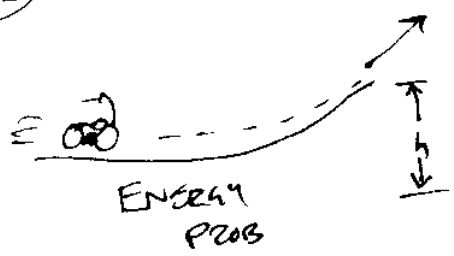
$$= \tfrac{1}{2}(5.25 \times 10^5)(.5)^2 + \tfrac{1}{2} 8.85 \times 10^5 (.268)^2$$

$$65625 \text{ J} + 31782 \text{ J}$$

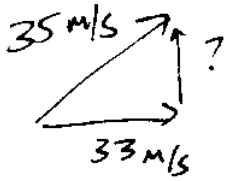
$$97400 \text{ J}$$

NOTE: THIS IS A MESS . . . LETS DO SPRINGS IN CLASS

(23)



OR WE COULD BE CLEVER...



$? = \sqrt{35^2 - 33^2}$

$= 11.66 \text{ m/s}$

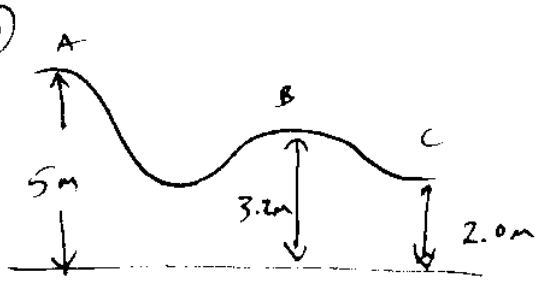
SO IT IS JUST AS IF HE LEAPT STRAIGHT INTO THE AIR AT 11.66 m/s ....

$K = U$

$\frac{1}{2}mv^2 = mgh$ $\quad h = \frac{v^2}{2g} = \frac{(11.66)^2}{2(9.80)} =$ 6.94 m

ABOVE THE END OF THE RAMP

(30)



a) $U_A = K_B + U_B$

$mgh_A = \frac{1}{2}mv_B^2 + mgh_B$

$2g(h_A - h_B) = v_B^2$ $\quad v_B = \sqrt{2g(h_A - h_B)}$

$v_B = 5.9 \text{ m/s}$

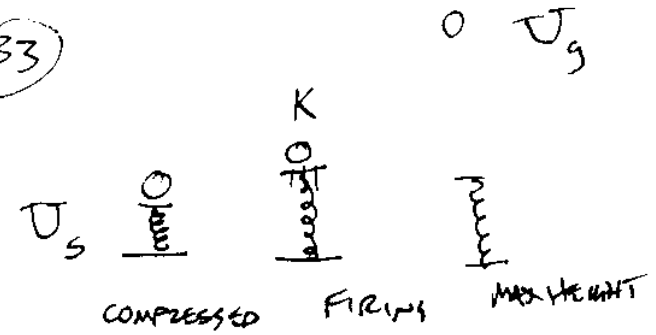
SIMILARLY FOR $v_C = 7.7 \text{ m/s}$

b) WORK DONE BY GRAVITY IS THE FORCE OF GRAVITY TIMES THE VERTICAL DISPLACEMENT

$F \cdot \Delta x = mg(h_A - h_C) = 5(9.8)(3) = 147 \text{ J}$

OR IT IS THE POTENTIAL ENERGY THAT HAS CONVERTED TO K...

(33)



a) FIND k

so $U_g = U_s$

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

$\frac{2mgh}{x^2} = k$

$\frac{2(.020\ kg)(9.80)(20)}{.12^2}$

$k = 8.0 \times 10^5\ N/m$

b) FIND V

$U_g = K$

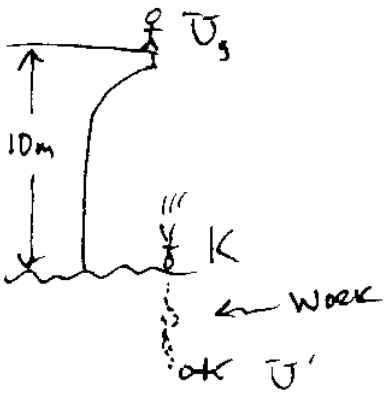
$mgh = \frac{1}{2}mv^2$

$\sqrt{2gh} = v$

$v = \sqrt{2(9.80)(20)} \approx 19.8\ m/s$

YOU'LL PUT YOUR EYE OUT....

(39)



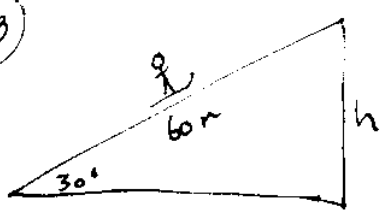
$U_g = \text{Work} + U$

$mgh = F \cdot \Delta x + mgh'$

$F = \frac{mg(h-h')}{\Delta x} = \frac{70(9.80)(.5)}{5.0}$ = [illegible] N

BY THE WAY... $a = \frac{F}{m} = 19.6\ m/s^2 \approx 2g$'s

(48)



$$P = \frac{\text{ENERGY}}{\text{TIME}} = \frac{U}{\text{TIME}} = \frac{mgh}{t} = \frac{mgl\sin 30°}{x/v}$$

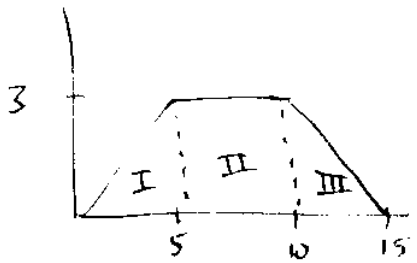
$$P = \frac{70(9.80)60\sin 30°}{60/2} = 686\ W$$

$$\text{Work} = F\cdot\Delta x = mgh = U = mgl\sin 30° = 20580\ J$$

(51)

$$\text{Power} = F\cdot v \text{ or } P = \frac{K}{t} = \frac{\frac{1}{2}mv^2}{t} = \frac{1(.875)(.62)^2}{2(21\times10^{-3})} = 8.0\ W$$

(56) WORK IS THE AREA UNDER THE CURVE OF F vs X



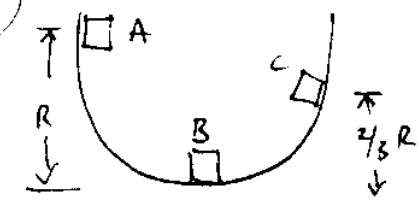
$$\text{Work}_I = \frac{1}{2}F\cdot x = \frac{1}{2}(3)(5) = 7.5\ J$$

$$\text{Work}_{II} = F\cdot x = 3(5) = 15\ J$$

$$\text{Work}_{III} = \frac{1}{2}F\cdot x = \frac{1}{2}(3)(3) = 7.5\ J$$

$$30\ J$$

(65)



$R = .030\ m$ $\quad U_A = mgh = mgR = (.200)(10)(.030)$

$$= .06\ J$$

$$K_B = U_A = .06\ J \qquad v_B = \sqrt{\frac{2K_B}{m}} = .774\ m/s$$

$$U_C = mg\tfrac{2}{3}R = (.200)(10)\tfrac{2}{3}(.03) = .04\ J$$

$$K_C = U_A - U_C = .06 - .04 = .02\ J$$

(66) 1 kCAL = 4186 J

1 g FAT = 9.00 kCal

$$1\text{ lb FAT}\left(\frac{4.448\text{ N}}{1\text{ lb}}\right)\left(\frac{1\text{ kg}}{9.8\text{ N}}\right)\left(\frac{1000\text{ g}}{1\text{ kg}}\right)\left(\frac{9.00\text{ kcal}}{1\text{ g}}\right)\left(\frac{4186\text{ J}}{1\text{ kCal}}\right)\left(\frac{.2\text{ J}_{\text{work}}}{1\ \frac{\text{J}}{\text{FAT}}}\right) = 3.4\times10^6\text{ J}$$

80 STEPS

80 STEPS (.150 m) = 12 m

$$U = W$$
$$mgh = 3.4\times10^6\text{ J}$$
$$50(9.8)(h) = 3.4\times10^6\text{ J} \Rightarrow h = 6939\text{ m}$$

OR 578 FLIGHTS!

$$P = \frac{\text{WORK}}{\text{TIME}} = \frac{3.4\times10^6\text{ J}}{578\,(65)} = 90.4\text{ W} = .12\text{ hp}$$

(80) 375,000 KIDS will JUMP .38m

so $375{,}000 \times mgh = 375{,}000 \times 36 \times 10 \times .38 = 5.\ldots \times 10^7$ J

BUT ONLY 1% MAKES IT INTO A WAVE $5.\ldots \times 10^5$ J

$$M = \frac{\text{Log } E - 4.8}{1.5} = \frac{\log(5.\ldots \times 10^5) - 4.8}{1.5} = \text{~~7.4~~ .9 MAGNITUDE}$$