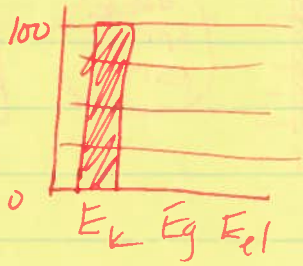
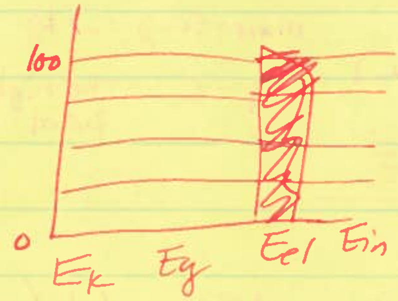
Physics – Energy
WS #3a

1.



cart
Earth
spring



The system is the cart, the Earth & spring.

Initial – $\Delta E_K = \frac{1}{2} m (V_f^2 - V_i^2)$

$= \frac{1}{2}\, 8kg\, (0^2 - 5^2)$

$\Delta E_K = -100J$

~~The energy Ek~~ This loss of energy K (loss because negative so it is positive in Eel equation) goes into Eel

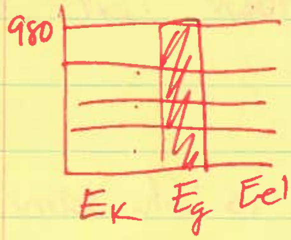
$\Delta E_{el} = \frac{1}{2} K (X_f^2 - X_i^2)$

$100J = \frac{1}{2}(50 N/m)(X_f^2 - 0_m^2)$

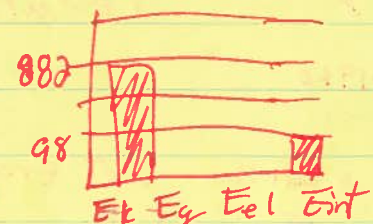
$100J = \frac{1}{2}(50 N/m) X_f^2$

$4_m = X_f^2$ $\boxed{X_F = 2m}$

2.



cart
Earth
~~Spring~~



System = cart, Earth, spring   There is friction in this system

~~At~~ top of hill $\Delta E_g = mg\Delta h$ $g = 9.8\ N/kg$ $\boxed{\text{NOT Negative}}$

$= 20kg(9.8 \frac{N}{kg})(0_m - 5_m)$

$= 20kg(9.8 N/kg)(-5_m)$

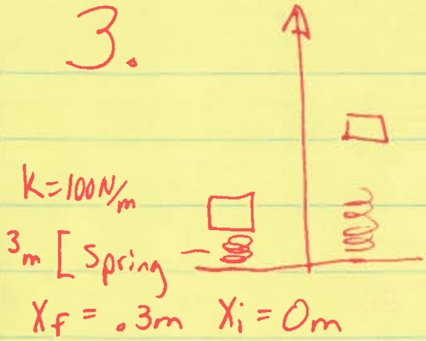
$\Delta E_g = -980J$

10% of the Energy becomes internal (98J) Eint

$980 - 98 = 882J$ E_K $\Delta E_K = \frac{1}{2} m (V_f^2 - V_i^2)$

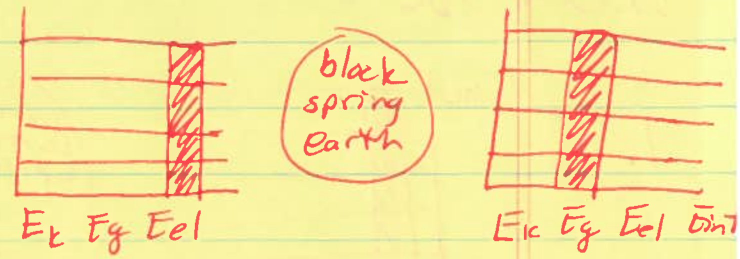
$882 = \frac{1}{2}(20kg)(V_f^2 - 0^2)$ $\boxed{V_f = 9.4\ m/s}$

3.



mass = 500g = .5 kg

V = 0 The highest point



Initially $\Delta E_{el} = \frac{1}{2}k(x_f^2 - x_i^2)$

$= \frac{1}{2}(100\ N/m)(0^2 - .3^2)$

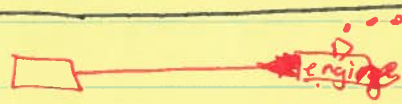
$\Delta E_{el} = {}^-4.5\ J$ This loss of E goes into E_g - No friction mentioned so frictionless

$\Delta E_g = mgh$

$4.5\ J = (.5 kg)(9.8\ N/kg)(\Delta h)$

$\boxed{\Delta h = 0.92\ m}$

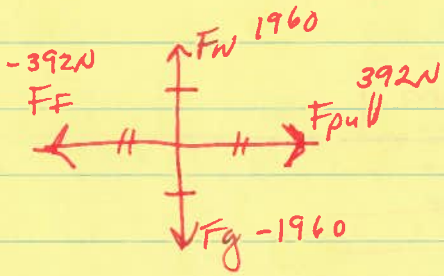
4.



friction is present $\mu_k = 0.2$

$m = 200kg$ $X_F = 2.5m$ Constant Velocity

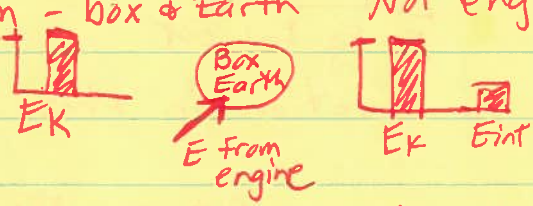
a.



$F_g = -9.8(200) = -1960N$ $F_N = +1960N$

$F_F = \mu F_N = .2(1960) = 392N$ $F_{pull} = 392N$

b. system - box & Earth Not engine



E_K is the same because CV but E_{int} is increasing so E from engine has to keep coming into system

c. $E = Fx$ (really $W = Fx$)

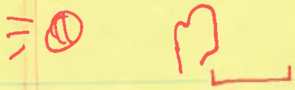
$= 392N(2.5m) = \boxed{980J}$

d. $\Sigma F = F_{pull} - F_F = 500N - 392N = 108N$ - $\Sigma F \neq 0$ so acceleration

$F = ma$ $108N = 200kg\ a$ $a = 0.54\ m/s^2$

e. This box could be pulled $E = FX$

(The box in #4 at #5) $8000J = 392N\ X$ $\boxed{X = 20.4m}$

5. 

35cm = .35m

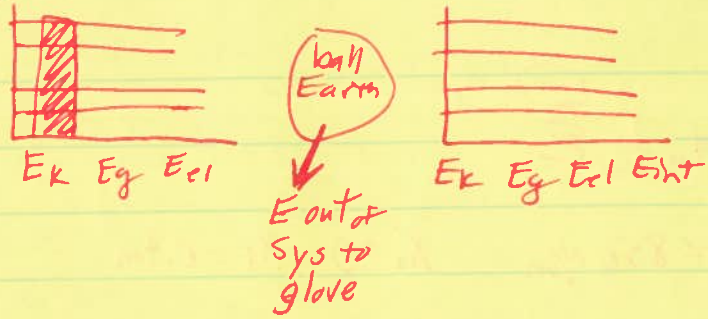
m = 140g = .14 kg

$V_i = 30\ m/s$ $V_f = 0\ m/s$

No Friction

System only ball & earth

a



b Initially E_K

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

$$\Delta E_K = \frac{1}{2}(.14)(0^2 - 30^2)$$

$$\Delta E_K = -63\ J$$

This E_K transfer to the glove (work)

$$W = F x$$

$$63\ J = F(.35m)$$

$$\boxed{F = 180\ N}$$

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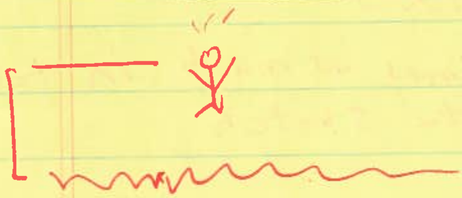
6. 

10m

m = 60kg

a. $\Delta E_g = mgh$

$= 60\ kg(9.8\ N/kg)(10m)$

$$\boxed{\Delta E_g = 5880\ J}$$

b. No friction mentioned so all Eg transfers to EK

$V_f = ?$ Use $\Delta E_K = \frac{1}{2} m(V_f^2 - V_i^2)$

$5880\ J = \frac{1}{2}(60\ kg)(V_f^2 - 0^2)$

$$\boxed{V_f = 14\ m/s}$$

c. m = 75 Kg $\Delta E_g = mgh = 75\ kg(9.8\ N/kg)(10m) = 7350$

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

$$7350\ J = \frac{1}{2}(75)(V_f^2 - 0^2)$$

$$V_f = 14\ m/s$$

This one has more Energy so he will hit with more force but the V_f is the same!

7.

0.4m 

$K = 850\ N/m \quad X_i = 0 \quad X_f = 0.4m$

$m_{ball} = 500g = .5kg \quad V_i = 0\ m/s$

$\Delta E_{el} = \frac{1}{2}k(X_f^2 - X_i^2)$

$= \frac{1}{2}(850)(.4^2 - 0^2)$

$\Delta E_{el} = 68J$

All of this energy goes into E_k

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

$68J = \frac{1}{2}(.5)(V_f^2 - 0^2)$

$\boxed{V_f = 16.49\ m/s}$

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8. $X_f = 2(0.4) = 0.8m$

$\boxed{\text{use spring in \#7 not \#3}}$

$\Delta E_{el} = \frac{1}{2}K(X_f^2 - X_i^2)$

$= \frac{1}{2}(850)(.8^2 - 0^2)$

$\Delta E_{el} = 272J$

Energy $_{el}$ $\frac{272J}{68J}$ => 4 times as much in twice the stretch

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

$272J = \frac{1}{2}(.5)(V_f^2 - 0^2)$

$V_f = 32.98\ m/s$ — this is twice as fast as in #7

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9. Bullet

$m = 10g = 0.1\ kg$

$\Delta x = 85cm = 0.85m$

$V_i = 0\ m/s$

F applied to bullet $= 5500N$

system only bullet

a. The work done to the bullet is $W = Fx$

$W = Fx \quad W = (5500N)(0.85m) = 4675J$

This work is transferred to E_K

$E_K = \frac{1}{2}m(V_f^2 - V_i^2) \quad 4675J = \frac{1}{2}(0.1kg)(V_f^2 - 0^2)$

$\boxed{V_f = 967\ m/s}$

b. System bullet + gun

E_{chem} | E_{chem} E_K | E_K

E_{chem} = bonds in gun powder

10. 

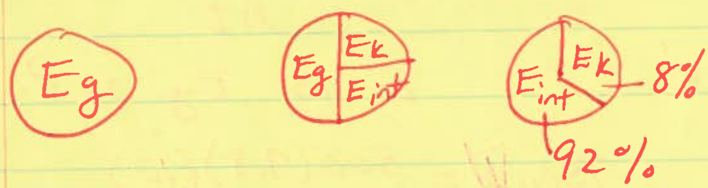
$m_{child} = 24\,kg$
$\Delta h = 5\,m$
$V_f = 2.8\,m/s$
$V_i = 0$

a. $\Delta E_g = mgh$
$= (24)(9.8)(5)$
$= 1176\,J$

$\Delta E_K = \frac{1}{2} m (V_f^2 - V_i^2)$
$= \frac{1}{2}(24)(2.8^2 - 0^2)$
$= 94.08$

$$\begin{array}{r} 1176\,J \\ -\ 94.08\,J \\ \hline 1081.92\,J \end{array}$$

1081.92 J are "missing"
They have been transferred to friction

b. 

94.08 is 8% of 1176 J
1081.92 is 92% of total

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11. $M = 20\,kg$
$V_i = 50\,m/s$
$V_f = 0$ at max height
$h_{max} = ?$

1st there is ΔE_k
Then it is transferred to ΔE_g
So $\Delta E_K = \Delta E_g$ – No friction

$$\Delta E_K = \Delta E_g$$
$$\frac{1}{2} m (V_f^2 - V_i^2) = mg\Delta h$$
$$\frac{1}{2}(20)(0^2 - 50^2) = 20(9.8)(\Delta h)$$
$$-25000 = 196\,\Delta h$$
$$\boxed{\Delta h = 127.6\,m}$$

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12. $M = 60\,kg$
$\Delta x = 10\,m$
$\Delta t = 5\,s$

$P = \frac{\Delta E}{\Delta t}$ $\quad \Delta E$ is ΔE_g so $P = \frac{mgh}{\Delta t}$

$$P = \frac{(60)(9.8)(10\,m)}{5\,s} = \boxed{1176\,W}$$

1 2 3
6 7 12

6

13. Hulky

$m = 100\,kg$
$\Delta x = 2\,m$
$\Delta t = 3\,s$

Bulky

$m = 200\,kg$
$\Delta x = 5\,m$
$\Delta t = 20\,s$

$P = \frac{\Delta E}{\Delta t} = \frac{\Delta E_g}{\Delta t}$

Hulky

$P = \frac{mgh}{\Delta t} = \frac{100(9.8)(2)}{3s}$

$\boxed{P = 653.3\,W}$

Bulky

$P = \frac{200(9.8)(5m)}{20s}$

$\boxed{P = 490\,W}$

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14. $m = 500\,kg$
$\Delta x = 10\,m$
$P = 7.5\,KW = 7500\,W$
$\Delta t = ?$

$P = \frac{\Delta E}{\Delta t}$

E is E_g so $P = \frac{mgh}{\Delta t}$

$7500\,W = \frac{500(9.8)(10)}{\Delta t}$

$\boxed{\Delta t = 6.53\,s}$

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15. a. Kilowatt·hours
→ 1000 W·hours
→ $1000\,J/s$ ·hours
→ $1000\,J/\cancel{s} \cdot 3600\,\cancel{s}$
→ 3,600,000 J

You are being charged for Joules so Energy

b. 1600 W for 5 min

$5\,min = 5\,\cancel{min}\left(\frac{60\,s}{1\,\cancel{m}}\right) = 300\,s$

$P = \frac{\Delta E}{\Delta t}$

$1600\,W = \frac{\Delta E}{300\,s}$

$\boxed{\Delta E = 480{,}000\,J}$