1. Work : J $\left(Nm, \frac{kg\,m^2}{s^2}, Ws\right)$

Energy: Same as work

Power: W $\left(\frac{J}{s}, \frac{Nm}{s}\right)$

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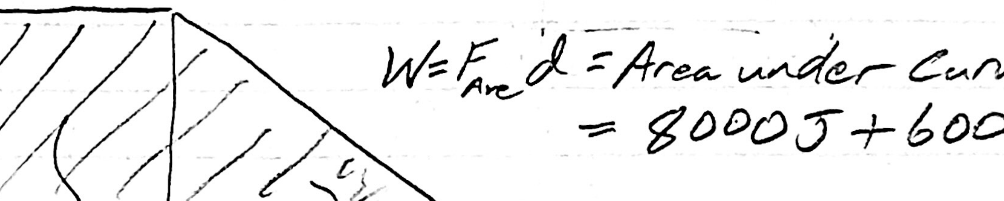
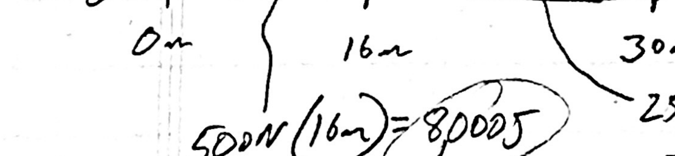
2. You must do a specific amount of work on it. Work = Fd. The same work can be done with different forces and distances, as long as the product remains equal.
For example: $W = F_d = Fd = Fd = {}_F d$
Power is the rate at which work is done. You can do the same work at a higher power if you do it faster, or you can do it at a slower rate, which will mean a lower power.

3.





$W = F_{Ave} d$ = Area under curve
= 8000J + 6000J = 14,000J

500N (16m) = 8000J

250N (24m) = 6000J

#3, Continued.

$PE_0 + KE_0 + W_{NC} = PE + KE$

$0 + 0 + 14{,}000 J = 0 + \frac{1}{2}(500 kg)v^2$

$v = 7.48 m/s$

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4. $PE_0 + KE_0 + W_{NC} = PE + KE$

$0 + 0 + W_{NC} = 0 + \frac{1}{2}(0.02 kg)v^2$

Pretend tabletop = 0 m

$P = \frac{W}{t} \Rightarrow 1{,}500 W = \frac{W}{2 s} \Rightarrow W = 3{,}000 J$

$3{,}000 J = \frac{1}{2}(0.02 kg)v^2$

$v = 548 m/s$ — over the speed of sound!

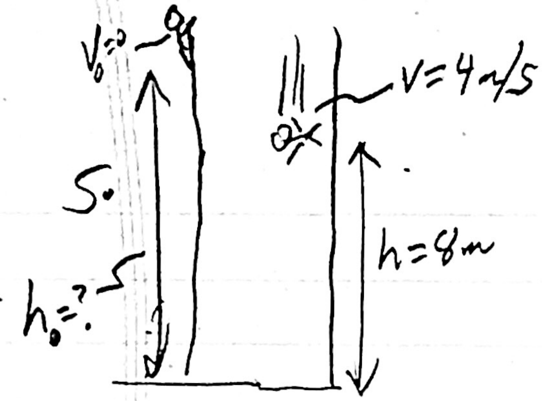
$\% \text{ Efficiency} = \frac{\text{Output } E}{\text{Input } E}(100\%)$

$40\% = \frac{\text{Output } E}{3{,}000 J}(100\%)$

$\text{Output } E = 1{,}200 J$

$1200 J = \frac{1}{2}(0.02 kg)v^2$

$v = 346 m/s$ — Apx. speed of sound



$$PE_0+KE_0+W_{nc}=PE+KE$$

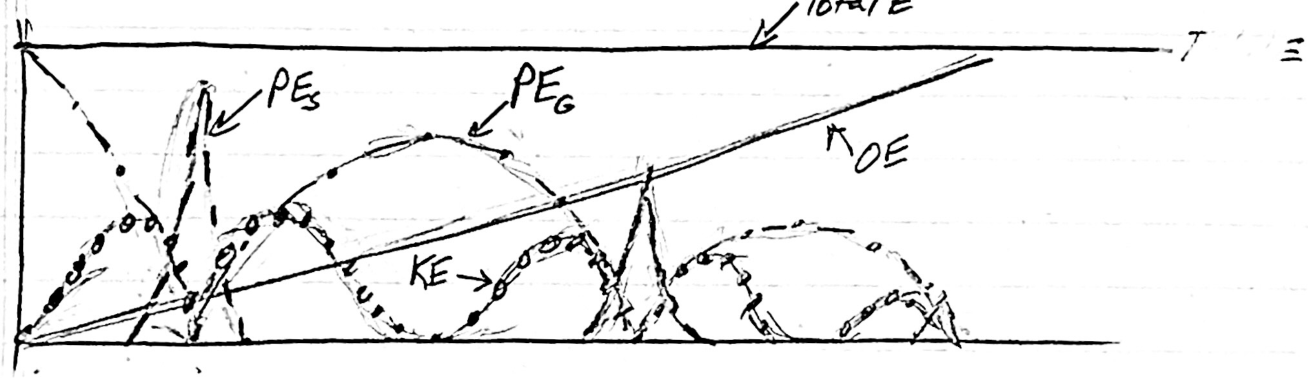
$$mgh_0+0+0=mg(8m)+\tfrac{1}{2}m(4m/s)^2$$

$$gh_0-8m\,g=8\,\frac{m^2}{s^2}$$

$$9.8m/s^2(h_0)-8m(9.8m/s^2)=8\,\frac{m^2}{s^2}$$

$$h_0=8.82m$$

6.



PE_G: Highest at top; zero at bottom. Gets lower over time

PE_S: Zero except when spring is compressing. highest when spring stops compressing. Decreases with each bounce.

KE: Increases during fall. Highest just before and after spring compresses. Zero at bottom and top. Decreases with each bounce.

OE: Increases from zero at beginning to total at end.

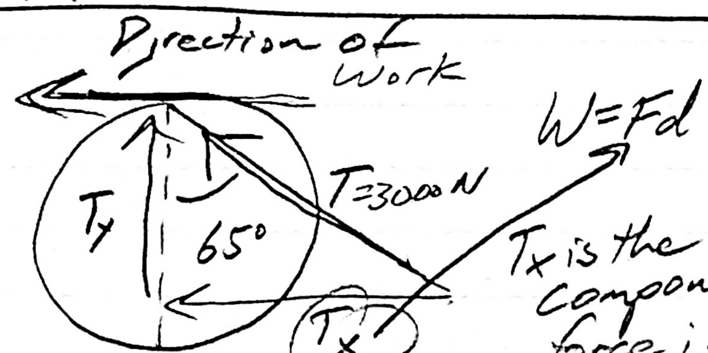
Total: Remains constant Always

7. <u>OE → mechanical E</u> : Gasoline makes a car move; heat makes air rise; electricity turns fan blades

<u>Mechanical E → OE</u> :

- A sliding baserunner heats up the ground with friction
- A turning windmill generates electricity
- Compression by a diesel engine piston creates thermal energy.

8.



$\sin 65° = \frac{T_x}{3000N}$

$T_x = 2{,}719 N$

$distance = 2\pi r = 2\pi(50m) = 314m$

$W = Fd = 2{,}719N(314m) = \boxed{854{,}000 J}$

9. There's positive work between A+B. Negative work in the tube (between C+D)

Part i

Position A) $PE_S = 0J$, $PE_G = 0J$, $KE = 0J$, $Total_{ME} = 0J$

Position B) $PE_S = 0J$ $PE_G = mgh = 0.0392J$ $KE = \frac{1}{2}mv^2 = 0.0025J$

$Total_{ME} = 0.0417J$ — No W_{NC} done →

Position C) $PE_G = mgh = 0.02548J$ $KE = 0J$ $Tot_{ME} = 0.0417J$

$PE_S = Tot_{me} - PE_{mg} = 0.01622J$

Negative W_{NC} ↓

Position D) $PE_S = 0$ $PE_G = mgh = 0.00196J$

$KE = \frac{1}{2}mv^2 = 4\times10^{-6}J$ $Tot_{me} = 0.001964J$

Part ii) Total ME (Position C) + W_{NC} = Total ME ← Position D

$0.0417J + F_{Fr}(0.18m) = 0.001964J$

$F_{Fr} = -0.221N$

Part iii) Positive work is done between A+B, the total ME goes from 0J to 0.0417J, so the W_{NC} = 0.0417J part iv) $P = \frac{W}{t} = \frac{0.0417\,J}{5\,s} = 0.00834\,W$

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part v) $P = \frac{W}{t}$ $\quad 0.00834\,W = \frac{10{,}000\,J}{t}$

$t = 1.2$ million seconds (13.87 days)

Part vi)

$\%\,Effic = \frac{output_E}{input_E}(100\%)$

$30\% = \frac{Output}{10{,}000\,J}(100\%) \Rightarrow output = 3{,}000\,J$

$P = \frac{W}{t} = 0.00834\,W = \frac{3000\,J}{t}$

$t = 360{,}000\,s$ (4.2 days)

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part vii) $PE_s = 0.01622\,J = \frac{1}{2}kx^2$

$0.01622\,J = \frac{1}{2}k(0.02\,m)^2$

$k = 81.1\,N/m$

Part viii) $F_{spring} = kx = 81.1\,N/m\,(0.02\,m)$

$F_{sp.} = 1.622\,N$

10. $PE_0 + KE_0 + W_{NC} = PE + KE$

$$mgh + \frac{1}{2}mv^2 + F_{Hay}d = 0 + 0$$

$$\frac{1}{2}mv^2 = -mgh - F_{Hay}d$$

$$v = \sqrt{-2gh - \frac{2F_{Hay}d}{m}}$$

$$v = \sqrt{-2(9.8\,m/s^2)(3m) - \frac{2(-187N)(4m)}{20kg}}$$

$$v = \sqrt{-58.8\frac{m^2}{s^2} + 74.8\frac{m^2}{s^2}} = \sqrt{16\frac{m^2}{s^2}}$$

$$v = 4\,m/s$$