Work and Energy - Spring Energy and Review

1. $F_{spring} = kx = 300\, N/m\,(0.05\,m) = 15\,N$

2. $PE_s = \frac{1}{2}kx^2 = \frac{1}{2}(300\,N/m)(0.05\,m) = 0.375\,J$

3. Do part b first!

b. $F_{spring} = -kx$

$F_{spring} = -\text{weight of } 50g \text{ object} = -mg = -kx$

$-[0.05\,kg\,(9.8\,m/s^2)] = -k(0.2\,m)$

$k = 2.45\,N/m$

a. $PE_s = \frac{1}{2}kx^2 = \frac{1}{2}(2.45\,N/m)(0.2\,m)^2$

$PE_s = 0.049\,J$

c. Energy is conserved, so the PE_{grav} lost by the falling object = PE stored in the spring.

$PE_{spring} = \frac{1}{2}kx^2 = \frac{1}{2}(2.45\,N/m)(0.8\,m)^2 = 0.784\,J$ 1.6m

$0.784\,J = \text{Original Object } PE = mgh$

$0.784\,J = 0.05\,kg\,(9.8\,m/s^2)(h)$ $h = 1.6\,m$

4. a) $W = Fd = 400N(0.85m) = 340J$

b) $P = \frac{W}{t} = \frac{340J}{0.05s} = 6{,}800W = 9.1hp$

5. $F_{gravity} = mg = 50kg(9.8m/s^2) = 490N$

$$P = \frac{W}{t} \quad W = Fd$$

$$\Downarrow$$

$$P = F\frac{d}{t}$$

$$1hp = 490N\left(\frac{d}{t}\right)$$

$$746W = 490N\left(\frac{d}{1s}\right)$$

$$\frac{746W(s)}{490N} = d = 1.52m$$

The human must fall at a rate of 1.52m/s

6. $150 \text{ pound} \left(\frac{.453 \text{ kg}}{\text{pound}}\right) = 68.0 \text{ kg}$

$PE = mgh = 68 \text{kg}(9.8 \text{m/s}^2)(8{,}848 \text{m})$

↑ on everest = work to get to top.

$PE_{\text{at top}} = 5.89 \times 10^6 \text{ J}$

$5.89 \times 10^6 \text{ J} \left(\frac{1 \text{ calorie}}{4.184 \text{ J}}\right) = 1.4 \times 10^6 \text{ cal}$

$(1.4 \times 10^6 \text{ cal}) \left(\frac{1 \text{ waffle}}{(82{,}000 \text{ cal})(0.3)}\right) = 57.3 \text{ waffles}$

7. $P = \frac{W}{t}$ $\qquad 200hp = 149{,}200 W \leftarrow \frac{J}{s}$

a)

$149{,}200W = \frac{W}{6s}$ $\qquad$ Work $= 895{,}200 J$

$W = \Delta KE = 895{,}200 J$

Assuming the car starts from rest...

$895{,}200 J = KE = \frac{1}{2}mv^2 = \frac{1}{2}(1600kg)v^2$

$v = \sqrt{\frac{895{,}200J(2)}{1600kg}} = 33.5 m/s$

b) Skidding means $\mu_{kinetic}$ should be used to calculate stopping force.

$F_{Fr} = \mu_k(F_N) = \mu_k w = \mu_k(mg) = 0.5(1600kg)(9.8 m/s^2)$

$F_{Fr} = 7{,}840 N$

$\Delta KE = W = F_{Fr} d$

$-895{,}200 J = -7{,}840 N(d)$

$d = 114m$

8. $\Delta KE = W = F_{friction} d$ ← stopping distance

This applies in a stopping situation.

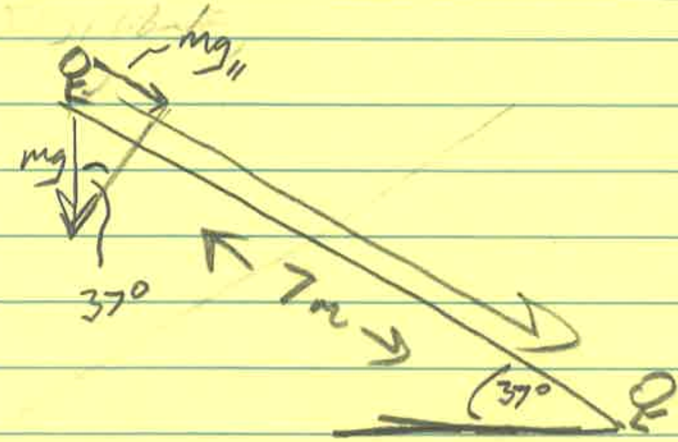
$d \propto \Delta KE$

($KE \propto v^2$, so $d \propto v^2$, not v)

9.

	h (m)	E (J)	PE (J)	KE (J)	v (m/s)
1	35	171,500	171,500	0	0
2	0	171,500	0	171,500	26.2
3	28	171,500	137,200	34,300	11.7
4	15	171,500	73,500	98,000	19.8

10. a)



$mg = 196N$

$mg_{\parallel} = (196N) \sin 37°$

$mg_{\parallel} = 118N$

$\Delta KE = W = Fd = 118N(7m) = 826J$

b) $KE_{end} = 826J = \frac{1}{2}(20kg)v^2$

$v = \sqrt{\frac{826J(2)}{20kg}} = 9.1 m/s$

11. a) Add up work done in each of 5 intervals. Each interval has a distance of 0.1m.

Interval	Average Force	Distance	Work
1	10N	0.1m	1J
2	25N	0.1m	2.5J
3	35N	0.1m	3.5J
4	50N	0.1m	5J
5	100N	0.1m	10J
		Total	22J

b) $\%\text{Effic} = \left(\frac{\text{Output}}{\text{Input}}\right) 100\%$

$60\% = \frac{\text{Output}}{22J} (100\%) \Rightarrow \text{output} = 13.2J$

c) $KE = \frac{1}{2} m v^2$

$13.2J = \frac{1}{2} m (30\ m/s)^2$

$m = 0.029\,kg = 29\ \text{grams}$