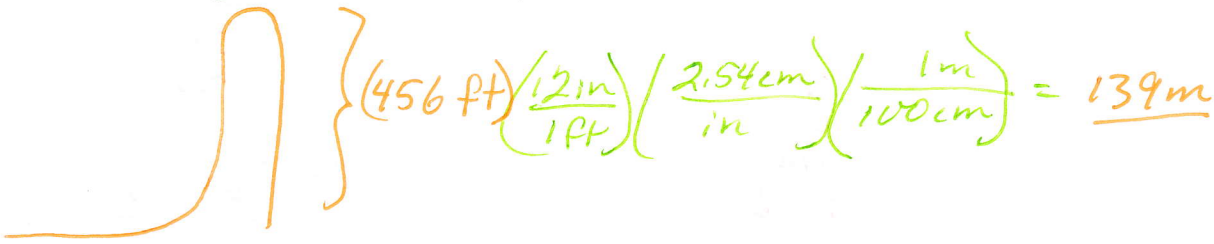
key Level I Physics Pd3

Work and energy

AT Work and Energy (15).doc

Directions: Solve the following problems to demonstrate your understanding of the concepts of work and energy. Show all work. Each is worth 5 points.

1) Kingda Ka is a launched roller coaster at Six Flags/Great Adventure in Jackson, New Jersey. What is the slowest possible speed the train can have at the end of the launch to make it to the top of the hill? Kingda Ka is 456 feet tall. (Conversion needed: 2.54 cm=1 inch)



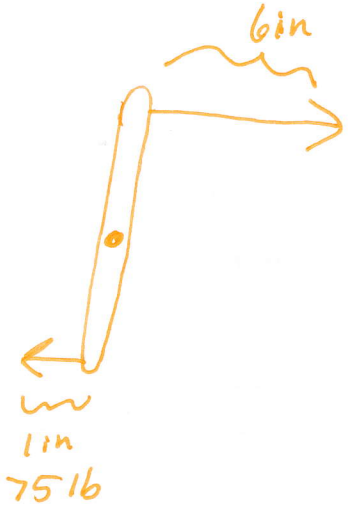
$PE = KE$

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

$gh = \frac{1}{2}v^2$

$\sqrt{2gh} = v = \sqrt{(2)(9.8\ m/s^2)(139\ m)} = 52\ m/s$

2) A machine operator pushes a lever through a distance of 6 inches. This movement causes another part (We'll call this "The foot") to move a distance of 1 inch. Determine the force needed by the operator if the machine is 62% efficient and "The Foot" applies a 75 pound force.



$$Eff = \frac{AMA}{IMA}$$

$$Eff = \frac{\frac{F_{out}}{F_{in}}}{\frac{x_{in}}{x_{out}}}$$

$$Eff = \frac{F_{out}\, x_{out}}{F_{in}\, x_{in}}$$

makes Sense, Ratio of Work

$$F_{in} = \frac{F_{out}\, x_{out}}{x_{in}\, Eff}$$

$$F_{in} = \frac{(75lb)(1in)}{(6in)(.62)}$$

$$F_{in} = 20.2\,lb$$

3) Determine the power that is needed to maintain a speed of 12 m/s if a constant resistive force of 242 N is present.

$$P = \frac{Work}{t} = \frac{Fx}{t} = Fv = (242\,N)(12\,m/s) = 2904 \text{ watts}$$

4) According to Ford's website, the 2016 F150 4x4 has a mass of 1933kg (depending on build and options). When this truck is moving at 20 m/s (45 mi/hr). Determine the force needed to slow the truck to 13 m/s (30 mph) in a distance of 18 m (about 60 feet).

$$\Delta KE = W$$

$$KE - KE_0 = F_x$$

$$\frac{KE - KE_0}{x} = F$$

$$\frac{\frac{1}{2}mv^2 - \frac{1}{2}mv_0^2}{x} = F$$

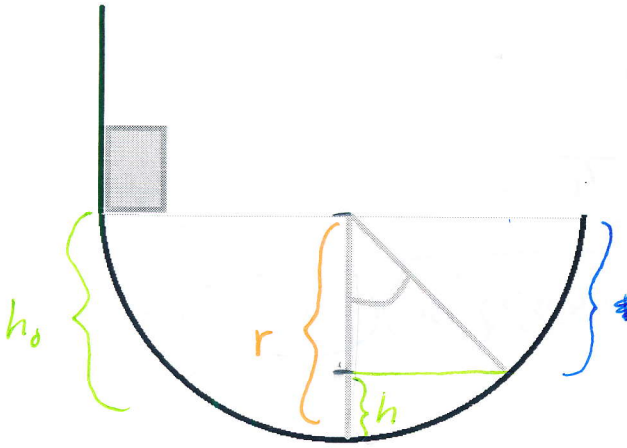
$$\frac{\frac{1}{2}m\left(v^2 - v_0^2\right)}{x} = F$$

$$\frac{m\left(v^2 - v_0^2\right)}{2x} = F$$

$$\frac{(1933kg)\left((13m/s)^2 - (20m/s)^2\right)}{(2)(18m)} = F$$

$$-12400N = F$$

5) A box starts at the top of a hemispherical bowl as indicated in the diagram. If the box loses 15% of its total energy due to friction, determine the angle indicated which will show the maximum height the boxes achieves on the other side of the bowl.



$h = r - r\cos\theta$

$PE_0 = PE$ (Ideally)

$.85PE_0 = PE$ (with Loss)

$.85mgh_0 = mgh$

$.85h_0 = h$ (hemispherical Bowl, so $h_0 = r$)

$(.85)r = r - r\cos\theta$

$(.85)r = r(1 - \cos\theta)$

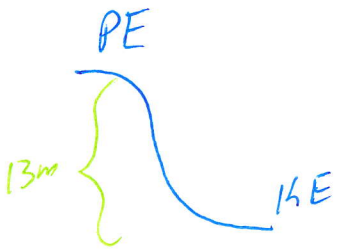
$.85 = 1 - \cos\theta$

$\cos\theta = .15$

$\theta = \cos^{-1}(.15)$

$\theta = 81^\circ$

6) Consider a nearly frictionless hill when sledding after a good solid freezing rain. Determine how fast you would be expecting to travel at the bottom of a 13 m tall hill.



$PE = KE$

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

$gh = \frac{1}{2}v^2$

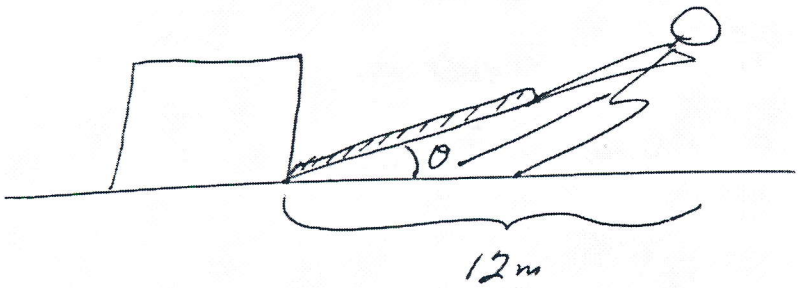
$\sqrt{2gh} = v$

$\sqrt{(2)(9.8\,m/s^2)(13m)} = 15.9\,m/s$

7) Determine the work done carrying at 23 kg box through a distance of 45 m.

zero

8) Determine the work done by the person pulling the box if the rope makes an angle of 40 degrees above the horizontal and the person applies 230 N of tension to the rope.



$W = F \times \cos\theta$

$(230N)(12m)\cos 40^{\circ}$

$W = 2114\ J$

9) Determine the weight of a 35 kg object.

343 N

10) Determine the mass of a 5kg object.