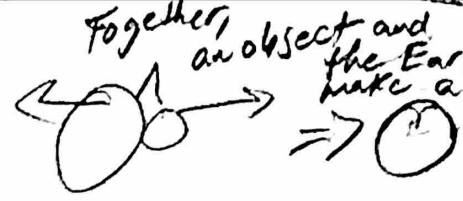

Work and Power Practice:

$W = 588N$

3. A 60kg student climbs 12m up a vertical rock wall in 50 seconds. The student's speed is constant.

a. Approximately how much work did the student do?

$W = Fd = 588N(12m) = 7,056J$

$F = \text{weight} = 60kg(9.8 m/s^2) = 588N$

b. What was the student's average power output, in Watts?

$P = \frac{W}{t} = \frac{7056J}{50s} = 141W$

c. How long would the climb have taken if the student's power output had been 1 horsepower?

$1hp = 746W \Rightarrow P = \frac{W}{t} \Rightarrow 746W = \frac{7056J}{t} \Rightarrow t = 9.46s$

d*. Just for fun, contemplate the amount of work done on the student.

$a = 0 \Rightarrow \Sigma F = 0 \quad W = 0(12m) = 0J \quad \Delta KE = 0 \Rightarrow W = 0$

4. When a 0.5kg water rocket is launching, the rocket's thrust (technically the push of the water) exerts a 400N upward force on the rocket over a vertical distance of 1m. By how much do the rocket's PE and KE change over this time?

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

$0 + 0 + 400N(1m) = 0.5kg(9.8 m/s^2)(1m) + KE$

$400J \qquad PE = 4.9J$ (They gain this much) $\qquad KE = 395.1J$

6. Assuming that the rocket from #5 started from rest, use the KE formula to find the rocket's velocity after accelerating for that one meter.

$KE = \frac{1}{2}mv^2 \Rightarrow 395.1J = \frac{1}{2}(0.5kg)(v^2)$

$v = 39.8 m/s$

7. A 2kg package is sliding across a surface with a velocity of 3m/s. The force of friction acting on the package is 1N. How far will the package slide before it stops?

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

$0J + \frac{1}{2}(2kg)(3m/s)^2 + F_f d = 0 + 0 \Rightarrow 9J - 1N(d) = 0$

$d = 9m$

Potential Energy Practice:

7. A 3kg watermelon is dropped from a height of 100m. What is its potential energy at its release point (100m)?

$PE = mgh = 3kg(9.8 m/s^2)(100m) = 2940J$

8. What is the watermelon's potential energy when it has fallen to an altitude of 25m?

$PE = 3kg(9.8 m/s^2)(25m) = 735J$

9. What is the watermelon's KE when its altitude is 25m?

No friction

$PE_0 + KE_0 = PE + KE$

$2940J + 0 = 735J + KE \qquad KE = 2,205J$

10. What is the watermelon's velocity when its altitude is 25m?

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

$2,205J = \frac{1}{2}(3kg)(v^2)$

$v = 38.3 m/s$

11. A 20kg child sits at rest at the top of a slide which is 5m long and 3m high. As the child slides down the slide, the child experiences a constant 5N force of friction.

a. What is the child's total energy at the top of the slide? What form of energy does the child have?

$PE = (20kg)(9.8 m/s^2)(3m) = 588J = PE$

b. How much work is done by friction?

$W = Fd = -5N(5m) = -25J$

c. How much PE and KE does the child have at the bottom of the slide?

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

$588J + 0 - 25J = 0 + KE \Rightarrow KE = 563J$

d. What is the child's speed upon reaching the bottom of the slide?

$563J = \frac{1}{2}(20kg)v^2 \Rightarrow v = 7.5 m/s$

Other Energy Units: 1 Joule is derived from the amount of energy required to raise 1kg of water by 1°C. **1calorie = 4.184 Joules. 1 "food calorie" = 1kcal = 1,000 calories = 4,184 Joules.** The "calories" used to describe nutrition values are actually kilocalories.

Work and Energy Practice Problems:

1. A stick pushes a 170g hockey puck with a constant force of 100N over a distance of 0.4m and a time of 0.1 seconds.
   a. How much work is done on the puck?
   b. How much power does the stick use while it is pushing the puck?
   c. Assuming that the puck starts from rest, what is its speed after being pushed by the stick?

2. A dad pulls his daughter in a sled. He drags the sled using a long rope, which is essentially horizontal, maintaining a constant tension of 100N.
   a. How much work does the dad do if he pulls his daughter for one mile?
   b. A Snickers Bar contains about 260,000 calories of energy. Assuming that the dad's body is 30% efficient (makes use of only 30% of its energy intake), how many Snickers bars must he eat to replace the energy lost by dragging his daughter around?

3. A 5kg bowling ball is hanging by a cable from the ceiling of a train. The cable makes a 70° angle with the ceiling. During a certain time interval, the train travels 30m.
   a. What is the horizontal component of the tension in the cable?
   b. How much net work is done on the ball during this time interval?
   c. If the velocity of the train and ball were both 10m/s at the beginning of this time interval, what are their velocities at the end of the time interval?

4. Suppose it takes 100J of energy to smash an apple. What horsepower is required to smash 5 apples in 1 seconds?