Energy Problems

1. A 65 kg diver is poised at the edge of a platform 10.0 m above the water.
   a. Calculate the diver's gravitational potential energy relative to the water's surface.

   PE_g = (65 kg)(9.80 m/s^2)(10.0 m) = 6400 J

   b. The pool is 4.5 m deep. Calculate the diver's gravitational potential energy relative to the bottom of the pool.

   PE_g = (65 kg)(9.80 m/s^2)(14.5 m) = 9200 J

2. What is the linear kinetic energy of a 1250 kg car moving at 45.0 km/h?

   Speed must be in fundamental units of m/s v = 45.0/3.6 = 12.5 m/s
   KE = ½ (1250 kg)$(12.5 \text{ m/s})^2$ = 97700 J

3. The force constant of a spring in a child's toy car is 550 N/m. How much elastic potential energy is in the spring if it is compressed a distance of 1.2 cm?

   PE_e = ½ (550 N/m)$(0.012 \text{ m})^2$ = 0.040 J

4. A 1050N rock sits on the edge of a cliff that is 20.4 m high.
   a. What is the potential energy of the rock?

   PE_g = (1050 N)(20.4 m) = 21400 J Note: the weight (gravitational force) is given and not the mass.

   b. If the rock falls, what is its kinetic energy the instant before it hits the ground?

   Since gravity is a conservative force, conservation of energy tells us total energy remains constant. PE at top = KE at bottom of cliff, just before impact. KE = 21400 J

   c. How fast will the rock be moving at this point?

   $mg\Delta y = \frac{1}{2}mv^2 \quad v = \sqrt{2g\Delta y} = \sqrt{2(9.80\, {}^{m}\!/\!{}_{s^2})(20.4m)} = 20.0\, {}^{m}\!/\!{}_{s}$ Note: the mass cancels out of the equation, but you could solve for *v* using the KE formula and the answer to part b also.

5. A force of 22 N is exerted horizontally on a 18 kg box to move it 7.6 m across the floor. If the box was initially at rest and is now moving at 3.2 m/s, calculate:
   a. The total work done.

   W = (22N)(7.6 m) = 170 J

   b. The final kinetic energy of the box

   KE = ½ (18 kg)$(32 \text{ m/s})^2$ = 92 J

   c. The net force acting on the box

   The work done by the net force equals the change in kinetic energy. The kinetic energy increased by 92 J, therefore: $F_{net} = \frac{92J}{7.6m} = 12N$

d. The energy lost due to friction (converted to thermal energy).

$W_f = W_t - KE$ $W_f = 170 - 92 = 78$ J Work done on system should result in equal increase in energy. Energy in system is decreased by amount of work done against friction.

6. A 350 kg roller coaster car is poised at the top of a 42.0 m high hill.

a. How fast will it be going at the bottom of the incline? (Ignore friction)

$$v = \sqrt{2gh} = \sqrt{2(9.80\, m/s^2)(42m)} = 29\, m/s$$

b. How fast will it be moving at the top of the next hill, 30.0 m high?

$$v = \sqrt{2gh} = \sqrt{2(9.80\, m/s^2)(12m)} = 15\, m/s$$

If the car's load is increased by 150 kg, how will these speeds be changed

Since mass is not involved in the calculation, there will be no change. (See 4c)