Potential Energy

Potential energy of an object at height h:

$$E_{pot} = m\ g\ h \longrightarrow [E_{pot}] = [E_{kin}] = J$$

Total mechanical energy:

$$E_{mech} = E_{kin} + E_{pot} = \frac{m\ v^2}{2} + m\ g\ h$$

When the object moves only under the influence of gravity:

$$E_{mech} = const \longrightarrow \Delta E_{kin} = -\Delta E_{pot}$$

Homework 16

Problem 1.
Show that if the object is moving only under the influence of gravity, then the change in kinetic energy is equal to minus the change in potential energy: $\Delta E_{kin} = -\Delta E_{pot}$.

Problem 2.
A $50\ g$ ball is falling. As the ball passes a certain distance, its potential energy changes by $2\ J$. Calculate this distance. Does this distance depend on the initial velocity of the ball?

Problem 3.
Potential energy could be used for energy storage (and converted into electricity when necessary). A prominent example of this idea is a water power plant where a massive amount of water is stored in an elevated reservoir. The largest US power plant is Grand Coulee in Washington. It contains 10 cubic kilometers of water elevated at approximately 100 meters. Calculate how much energy in joules is stored in the Grand Coulee power plant.
Hint: you may need some unit conversions for this problem. One cubic meter contains 1000 kilograms of water (think carefully about how many cubic meters are in one cubic kilometer).

Homework 16

Problem 3. (bonus question)
Ask your parents about your house's average annual electric energy consumption. Then, estimate how many years the Grand Coulee power plant reservoir could supply your home with electric power if all of its potential energy could be converted into electricity without losses.
Hint: A common unit of electric energy is kilowatt-hour (kWh), $1\ kWh\ =\ 3.6 \cdot 10^6\ J.$

Problem 4* (bonus problem).
During the class, we only discussed the potential energy of small objects, for which their size is much smaller than their elevation. In this problem, you need to think about how one could generalize the concept of potential energy without the limitation that an object is small. Find the potential energy of a thin rod of mass m and length l, placed vertically on the floor (height is measured from the floor).