Gravitational Potential Energy

Potential Energy is the Stored energy that an object has that can be released into another form of energy.

Examples: chemical: gasoline, food, batteries
elastic: trampoline, bow

Gravitational Potential Energy, E_g, is energy stored as the result of the vertical position (height) of an object.

Gravitational Energy is always measured... relative to a reference point ie. ground level or an arbitrary location eg. top of a cliff

Measured in J, E_g depends on an object's mass and height according to:

$E_g = mgh$ or $E_g = mg\Delta y$ (especially if using)

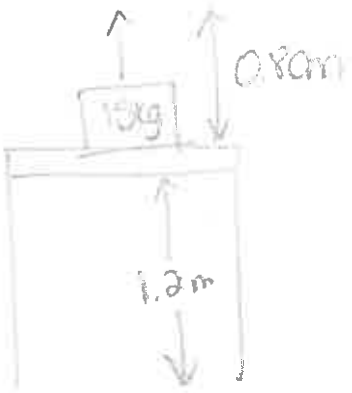
Example: A 15.0 kg textbook is sitting on a 1.20 m tall table. If the book is lifted 0.80 m above the table, how much gravitational potential energy does it have:

a. with respect to the table?

$E_g = mg\Delta y$
$= 15kg \cdot 9.8\frac{m}{s^2} \cdot 0.80m$
$= \boxed{120J}$

b. with respect to the floor?

$E_g = mg\Delta y$
$= 15 \cdot 9.8 \cdot 2m$
$= 294J = \boxed{290J}$



Example: How high would you have to lift a 1500kg truck to give it a potential energy of 3100 J?

$E_g = mg\Delta y$

$\Delta y = \frac{E_g}{mg} = \frac{3100J}{1500kg \cdot 9.8\frac{m}{s^2}} = \boxed{0.21m}$

Kinetic energy and potential energy have a close relationship, as one form often transforms into the other as work is done. Example: basketball is picked up then dropped - potential energy converted into kinetic

This illustrates the Law of Conservation of Energy:

energy is neither created nor destroyed, it simply changes forms

Thus, the sum of the kinetic energy and potential energy (known as Total Mechanical Energy, E_T), remains Constant in any (isolated or closed) system.

$$E_T = E_g + E_K$$

Example: a. Determine the total mechanical energy of a 48 g golf ball if it has a velocity of 25 m/s when it leaves a golf club.

given: $m = \frac{48\,g}{1000\,g/kg} = 0.048\,kg$

$v_f = 25\,m/s$

assume $\Delta y = 0$

Need: E_T

$E_T = E_g + E_K$

$= 0 + \frac{1}{2}mv^2$

$= \frac{1}{2}(0.048\,kg)\left(\frac{25\,m}{s}\right)^2$

$= 15\,J$

b. If the golf ball goes in an arc and slows to 15 m/s at the peak of its trajectory, calculate the maximum height of the golf ball. Hint: Use your answer from (a)!

$E_T = E_g + E_K$

$E_T = mg\Delta y + \frac{1}{2}mv^2$

$mg\Delta y = E_T - \frac{1}{2}mv^2$

$\Delta y = \frac{E_T - \frac{1}{2}mv^2}{mg} = \frac{15\,J - \frac{1}{2}(0.048)(15\,m/s)^2}{0.048\,kg \cdot 9.8\,\frac{m}{s^2}}$

$= 20.4\,m \rightarrow 2.0 \times 10\,m$