The Nature of Energy

1) Energy - ability to do work.

2) Forms of energy - 1) Mechanical 2) Heat 3) Light
4) Chemical 5) Electrical 6) Nuclear

3) Mechanical energy - energy due to the position and motion of an object.

4) Heat energy - 1) Total kinetic energy of a system
2) Energy that transfers from one object to another because of a temperature difference between them.

5) Light energy - 1) energy that consist of particles of concentrated electromagnetic energy called photons.

6) Chemical energy - 1) energy from creation or breaking of chemical bonds between atoms.

7) Electrical energy - 1) Flow of a electrical charge on a conductor.

8) Nuclear energy - 1) energy from the nucleus of the atom

9) Transformation of energy - energy changing from one form of energy into another form.

10) Law of Conservation of energy - energy can not be created or destroyed, but it can change forms.

11) Kinetic energy – energy of motion or in motion.

12) Calculations (kinetic energy) KE or E_K

$E_K = \frac{1}{2} m v^2$

E_K = kinetic energy = Joule = J
m = mass = kg
v = Velocity = m/s

Example #1

KE = _____ $m = 2.00\ kg$ $V = 5.00\ m/s$
$V^2 = 25.0\ m^2/s^2$

$KE = \frac{m v^2}{2} = \left(2.00\ kg\right)\left(25.0\ \frac{m^2}{s^2}\right)$

$= 50.0\ \frac{kg\,m^2}{s^2} = \boxed{50.0\ J}$

Example #2

$KE = 5.00\ J$ $m =$ _____ $V = 10.0\ m/s$
$= 5.00\ \frac{kg\,m^2}{s^2}$ $V^2 = 100.\ \frac{m^2}{s^2}$

$KE = \frac{m v^2}{2}$

$\frac{(2)}{(v^2)} KE = \frac{m v^2}{2} \frac{(2)}{(v^2)}$

$m = \frac{2KE}{V^2} = \frac{(2)\left(5.00\ \frac{kg\,m^2}{s^2}\right)}{100\ \frac{m^2}{s^2}} = \boxed{.100\ kg}$

Example #3

$KE = \underline{100.0\ J}$ $\quad m = 2.00\ kg \quad V = \_\_\_\_$

$100.0\ \frac{kg\,m^2}{s^2}$

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

$$\frac{2}{m} KE = \frac{mv^2}{2}\left(\frac{2}{m}\right)$$

$$\sqrt{v^2} = \sqrt{\frac{2\,KE}{m}}$$

$$v^2 = \sqrt{\frac{2\,KE}{m}} = \sqrt{\frac{2\left(100.0\ \frac{kg\,m^2}{s^2}\right)}{2.00\ kg}} = \sqrt{100\ \frac{m^2}{s^2}} = \boxed{10.0\ \frac{m}{s}}$$

13) Potential energy – Stored energy or energy of Position.

14) Calculations (Potential energy) PE or E_p

$E_p = m\,g\,H$

E_p = Potential energy = Joules = J
m = mass = kg
H = height = m
g = Acceleration of gravity = $9.8\ m/s^2$

Example #1

$PE = \_\_\_\_ \quad m = 10.0\ kg \quad H = 3.00\ m$

$PE = m\,g\,H$

$= (10.0\ kg)(9.8\ m/s^2)(3.00\ m) = 294\ \frac{kg\,m^2}{s^2} = \boxed{294\ J}$

Example #2

$PE = 10.0\ J = 10.0\ \frac{kg\,m^2}{s^2}$ $\quad m = \_\_\_\_$ $\quad H = 5.00\ m$

$PE = mgH$

$\frac{PE}{gH} = \frac{mgH}{gH}$

$m = \frac{PE}{gH} = \frac{10.0\ \frac{kg\,m^2}{s^2}}{\left(9.8\ \frac{m}{s^2}\right)(5.00\ m)} = \boxed{.204\ kg}$

Example #3

$PE = 20.0\ J = 20.0\ \frac{kg\,m^2}{s^2}$ $\quad m = 5.00\ kg$ $\quad H = \_\_\_\_$

$\frac{PE}{mg} = \frac{mgH}{mg}$

$H = \frac{PE}{mg} = \frac{20.0\ \frac{kg\,m^2}{s^2}}{(5.00\ kg)\left(9.8\ \frac{m}{s^2}\right)} = \boxed{.408\ m}$

15) Relationship of Matter and Energy — Matter and energy Conversion

$E = mc^2$

E - energy - Joules - J

m = mass - kg

C = Speed of light = $3.00 \times 10^8 \frac{m}{s}$

Example #1

$E =$ _____ $m = 1.00 \times 10^{-20}$ kg $c = 3.00 \times 10^8 \frac{m}{s}$

$c^2 = 9.00 \times 10^{16} \frac{m^2}{s^2}$

$E = mc^2 = (1.00 \times 10^{-20} kg)(9.00 \times 10^{16} \frac{m^2}{s^2})$

$= 9.00 \times 10^{-4} \frac{kg\, m^2}{s^2} = \boxed{9.00 \times 10^{-4} J}$

Example #2

$E = 1.00 \times 10^{-4} J$ $\quad 1.00 \times 10^{-4} \frac{kg\, m^2}{s^2}$ $\quad m =$ _____ $\quad c = 3.00 \times 10^8 \frac{m}{s}$

$= 9.00 \times 10^{16} \frac{m^2}{s^2}$

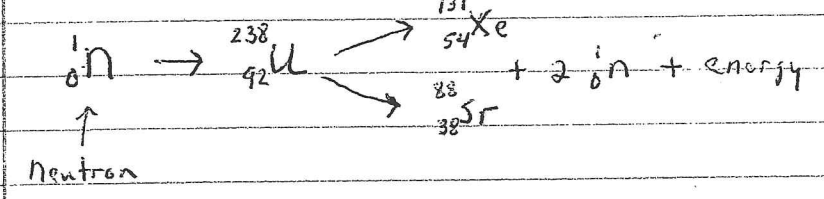
$\frac{E}{c^2} = \frac{mc^2}{c^2}$

$m = \frac{E}{c^2} = \frac{1.00 \times 10^{-4} \frac{kg\, m^2}{s^2}}{9.00 \times 10^{16} \frac{m^2}{s^2}} = \boxed{1.11 \times 10^{-21} kg}$

16 Nuclear Fission — process in which the nucleus of an atom is split creating two smaller atoms and converting some mass into energy.

17) Nuclear Fusion - process in which 2 nuclei are fused together to form one larger nucleus of an atom and converting matter in energy.

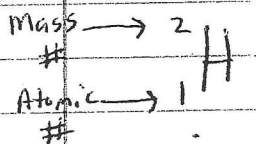
Example #1 Nuclear Fission



Example #2 Nuclear Fusion

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n + \text{energy}$$

Notes:
Atomic Number = Number of Proton
Mass Number = # Protons + # Neutrons



Problems (Energy)

1) How much energy is produced when a .432 kg object moves 40.0 m/s?

2) What is the velocity of a 250. G object moving with 355 J of energy?

3) How much energy is a 400. G object 20.0 m above the ground?

4) What is the distance above the surface for a 2.52×10^{6} G object with 4.92×10^{-4} J of energy?

5) How much energy is produced from a Nuclear Fission reaction when 6.21×10^{-31} G of matter is converted to energy?

6) What mass of matter is needed to change 3.00×10^{-10} J of energy in Nuclear Fusion?