

Cosmology - Prof. Tomkiewicz

Formulas and Laws:

Kepler's Laws:

- 1st. Planets travel in elliptical orbits with the Sun at one focus.
- 2nd. Planets travel faster when they are closer to the Sun, such that a line connecting a planet to the Sun sweeps out equal areas in equal intervals of time.
- 3rd. The square of planet's orbital period is proportional to the cube of the semimajor axis.

Newton's Laws:

- 1st. Every body continues in its state of rest or of uniform speed in a straight line unless it is compelled to change that state by forces acting on it.
- 2nd. The acceleration of a body is directly proportional to the net force acting on it and inversely proportional to its mass. The direction of the acceleration is in the direction of the applied force.

$$\mathbf{a} = \frac{\mathbf{F}}{M}$$

- 3rd. Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first.

Weight = mg

Law of Universal Gravitation:

Every body in the universe is attracted to every other body with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. The force acts along the line joining the two bodies.

$G = 6.7 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$

$$F = G \frac{mm'}{d^2}$$

Energy:

**Kinetic Energy = $\frac{1}{2}mv^2$
height = mgh**

Gravitational Potential Energy = Weight x

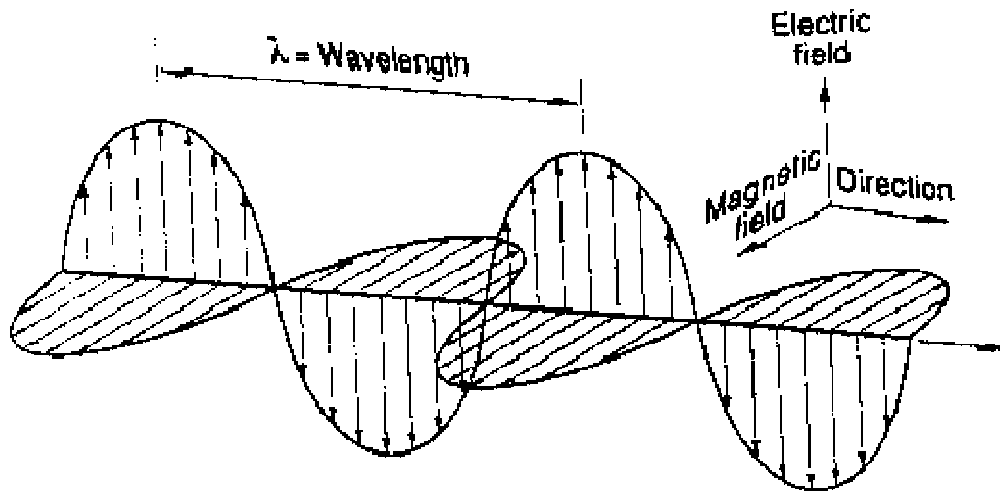
**Work » Heat » Energy---4180 Joule = 1 Cal = 1 Kcal.
1 MeV = 1.6×10^{-13} Joule.**

Temperature - Measure of internal energy.

**Temperature Scales: $^{\circ}\text{F} = 32 + (9/5)^{\circ}\text{C}$
 $^{\circ}\text{K} = 273 + ^{\circ}\text{C}$**

Ideal Gas Law: $PV = NkT$

**(P - pressure, V - volume, N - No. of molecules, T - Absolute (Kelvin)
Temperature, k - Boltzmann Constant = 1.38×10^{-23} Joule/ $^{\circ}\text{K}$)**



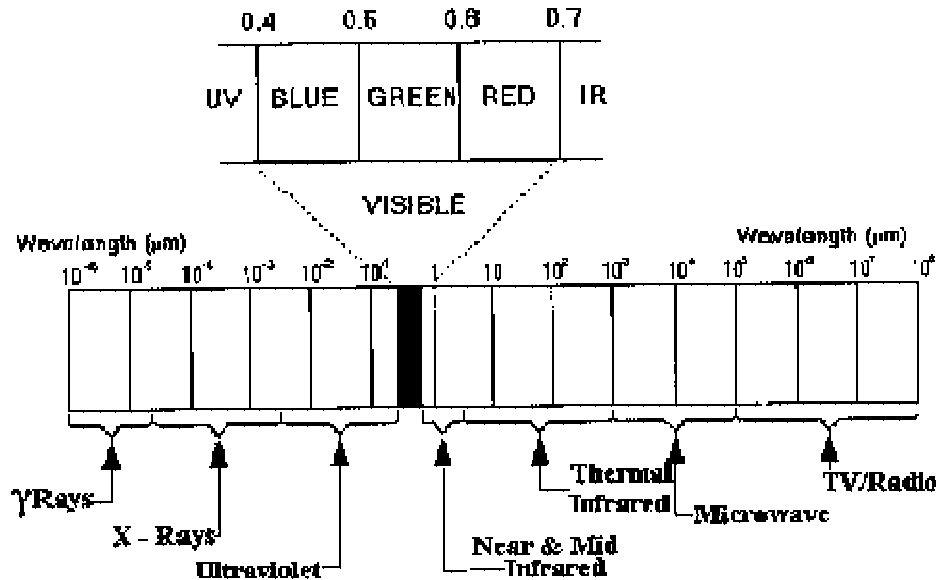
Speed of light – $c = 3 \times 10^8$ m/sec.

$C = \lambda/T$ λ wavelength; T – period; c – speed of light

$f = 1/T$ frequency ; $c = f \lambda$

1nm = 10 Angstroms = 10^{-3} micrometers = 10^{-9} m = 10^{-7} cm.

The Electromagnetic Spectrum:



Stefan Boltzman Law:

For ideal blackbody the total rate of emission is:

$$P_e = sAT^4$$

T – temperature in ^0K ; A – area in m^2 ; s – Stefan Boltzman constant = $5.67 \times 10^{-8} \text{W}/\text{m}^2 \cdot ^0\text{K}$

P_e – total emitted power in watts.

Wien Law:

$$\lambda_{\text{max}} = 2.9 \times 10^{-3} / T.$$

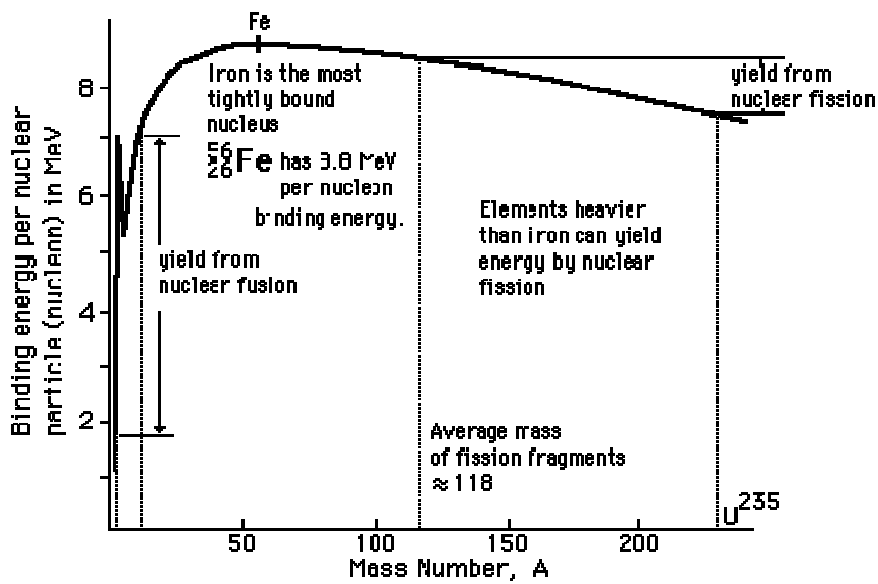
λ_{max} in meters – wavelength of the maximum of the spectral distribution

Doppler Effect:

$$\frac{\Delta\lambda}{\lambda} = v/c$$

V – velocity of source ; $C = 330\text{m/sec}$ for sound waves and; $C = 3 \times 10^8\text{m/sec}$ for electromagnetic waves

Nuclear Binding Energy – Fusion and Fission:



Mass – Energy equivalence:

$$E = mC^2$$