POINTS TO REMEMBER (Module 1 and 2)

- ✓ Black body is an object which absorbs all the electromagnetic radiation incident on it and hence appears black. The absorption power of a black body is 1 for all frequencies.
- ✓ Planck arrived at his black body formula by making two assumptions. (1) the energy of a charged oscillator of frequency ν is limited to discrete values nh and (2) during light emission or absorption the charge in energy of an oscillator is h.
- ✓ Classical theory cannot be applies to atomic phenomenon e.g. motion of an electron in an atom, stability of the atom or nucleus, spectrum of hydrogen atom.
- ✓ According to Thomson Scattering, there is no change in wavelength of the scattered light.
- ✓ According to Compton Scattering, the scattered radiation has larger wavelength.
- ✓ Compton Scattering is an experimental evidence for the particle nature of electromagnet radiation.
- ✓ The unmodified peak in the Compton's scattering results is due to the interaction between the photon and the electron which is very strongly attached to the nucleus.
- ✓ Compton shift does not depend on the incident wavelength.
- ✓ Exchange of energy between electromagnetic radiation and matter is only in discrete packets called **Photons.** Because the photon travels at the speed of light, it must have zero mass, otherwise its momentum and energy would be infinite. Similarly, a photon's rest energy also zero.

- ✓ The wave nature associated with a moving particle is known **matter wave or de Broglie wave**. The following reasons inspired Louis de Broglie to propose the concept of matter waves. (1) the universe is symmetrical. (2) the radiation possesses dual nature. If radiation possesses dual nature. The matter will also possess dual nature.
- ✓ Davisson and Germer experiment: Accelerated electrons are diffracted by crystals as X-rays. By Bragg's law, $2d\sin\theta = n\lambda$. Using a Nickel crystal electrons accelerated by 54 V produce the first diffraction maximum at θ=50˚.
- ✓ According to uncertainty principle the position and momentum, or energy and time, of an electron cannot be measured simultaneously with unlimited precision.
- ✓ The variable quantity characterizing de Broglie waves associated with moving particles is called the **wave function or state function** and is denoted by ψ.
- ✓ The equation that describes the wave nature of a particle in mathematical form is known as **Schrodinger wave equation**. $-i\hbar\frac{\partial\psi}{\partial t} = \frac{\hbar^2}{2m}\nabla^2\psi - V\psi$ is known as **Schrodinger three dimensional time dependent** wave equation, where ∇^2 is a Laplacian operator.
- ✓ $\nabla^2\psi + \frac{2m}{\hbar^2}(E-V)\psi = 0$ is known as three dimensional **Time independent Schrodinger wave equation**. For a free particles, the potential energy, V=0.
- ✓ Application of Schrodinger wave equation:
    - Particle in a box (like electrons in metals)
    - Particles in a potential well (radioactive disintegration).
    - Hydrogen atom
    - Rotating molecule.

- ✓ Energy of a free particle in a box, $E_n = \frac{n\hbar^2}{2ma^2} = \frac{n\pi^2 h^2}{8ma^2}$
- ✓ The application of quantum concepts does not lead to any observable effects in macro would but assumes significance in the micro world. The underlying reason for this difference is that the magnitude of Planck's constant is extremely small.
- ✓ The quantum mechanical penetration of particle through the potential barrier even when the energy is less than the height of the barrier is called **tunnel effect.**
- ✓ Transmission coefficient is defined as the ratio of probability flux transmitted through the barrier to the probability flux incident upon the barrier. Reflection coefficient is defined as the ratio of probability flux reflected from the barrier to the probability flux incident upon the barrier.
- ✓ The probability of particles being transmitted r reflected is determined by the ratio of the appropriate $\psi^*\psi$, the probability of the wave being either transmitted or reflected has to be unity.
- ✓ In STM, the tunneling current is an experimental function of distance. Based on quantum mechanics, the tunneling current $(I_t) = e^{-kd}$, where d is the distance between tip and sample surface.