Haldia Institute of Technology
Department of Applied Science

Assignment - IV
Course: PH 101/PH 201
Module – 4: *Quantum Mechanics*

1. State the characteristics of Black-Body Radiation? Deduce Plank's distribution law in black-body radiation and hence find out Wein's and Rayleigh-Jean's distribution law. Critically comment on three statistics with graphical presentation. What is ultra-violet catastrophe?
2. Show that the temperature dependence in Stephan's law can be derived from Planck's radiation law.
3. Write down the relativistic relation of mass with velocity. What do you mean by mass-energy equivalence?
4. Calculate the number of photons emitted by a 10 watt source of monochromatic light having wavelength of 100 nm.
5. What is Compton Effect? Find out the expression for Compton Wavelength in terms of Compton Shift when a photon collided with an electron.
6. Why Compton Effect is not visible for ordinary light? Why does the unmodified line appear in Compton Effect?
7. A photon of energy E is incident on a stationary electron target and the angle of Compton scattering of the photon is Θ. Show using non-relativistic kinetic energy that the KE of recoil of the electron is

$$\frac{E^2(1-\cos\theta)}{mc^2+E(1-\cos\theta)}$$ where m is the mass of the electron.

8. Define Einstein's Photoelectric Effect.
9. State and explain de Broglie's hypothesis and hence find out the equation of wave particle momentum and energy.
10. Describe Davison-Germer Experiment to confirm de Broglie's hypothesis.
11. Define phase and group velocity and relate them. Find out the relation between de Broglie's Phase & Group velocities.
12. Show that the de Broglie's wavelength λ of electrons of charge e and energy E (in eV) is given by

$$\lambda = \frac{h}{\sqrt{2meV}}$$

13. X-rays of wavelength 10^{-11}m are scattered by loosely bound electrons. Find the maximum wavelength present in the scattered rays and maximum kinetic energy of the recoil electrons.
14. Define Heisenberg's Uncertainty Relation and describe its significance.
15. i) An electron of energy 200 eV is passed through a hole of radius 10-4 cm. What is the uncertainty in the angle of emergence? ii) What would be the uncertainty for a 0.1 gm. lead ball thrown with a velocity 103 cm/s through a hole of 1 cm. radius? iii) Compare the K.E. of an electron and a proton to localize them within an atomic radius of 10-8 cm, assuming the momentum of the particles to be equal to the uncertainties in their momentum. iv) Let a source (λ = 5 x 10-5 cm.) of power 1 watt be used in an experimental arrangement. Calculate the number of photons that are being emitted by the source per second.