भारतीय प्रौद्योगिकी संस्थान पटना
INDIAN INSTITUTE OF TECHNOLOGY PATNA

PH103 (Physics-I) **Tutorial-VI (October 11, 2018)**

1. Estimate the de Broglie wavelength for: (a) a proton of kinetic energy 100 MeV kinetic energy, and, (b) a 100 g bullet moving at 1 km-s^{-1}.

2. Ultraviolet light with wavelengths λ_1 =80 nm and λ_1 =100 nm (incident on a sheet of lead) produce photoelectrons with maximum energies 11.390 eV and 7.154 eV, respectively.
   (a) Obtain Plancks constant based on above data.
   (b) Make an estimation of work function, cut-off frequency and cut-off wavelength for lead.

3. Obtain the following commutators: (a) $[x, p_x]$, (b) $\left[x^2, p_x\right]$, (c) $\left[x, p_x^2\right]$, (d) $\left[x^2, p_x^2\right]$.

4. Normalize the following wavefunction:
   $\Psi(x,t) = sin(\frac{\pi x}{a})e^{\frac{i}{\hbar}E_1 t}$ for, $-a \leq x \leq a$, and, $\Psi(x,t) = 0$, otherwise.

5. "The rotational motion of a rigid body is stable about the axis about which the moment of inertia is either a maximum or a minimum. Prove this. [Hint: Use conservation of energy and angular momentum.]

6. **(Done as a special topic in Class)** Obtain the equations of motion for a 1D-Simple Harmonic Oscillator (1D-SHO) within the Lagrangian and Hamiltonian formalism. Using suitable operators for position and momentum, convert the classical Hamiltonian for the (1D-SHO) into a quantum mechanical Hamiltonian. Please repeat the steps in the tutorial class and demonstrate the same to your tutor.