(Set-1)

Int. MSc-4th
Modern Physics

Full Marks : 70

Time : 3 hours

Answer **six** questions including **Q. No. 1**

The figures in the right-hand margin indicate marks

1. Answer the following questions : 2 × 10

   (*i*) Determine the shortest wavelength of the Lyman series of Hydrogen atom. (Rydberg constant $R = 1{\cdot}097 \times 10^7\ m^{-1}$).

   (*ii*) What voltage must be applied to an electron microscope to produce electrons of wavelength 0·40 Å ?

   (*iii*) The uncertainity in the location of a particle is equal to its de-Broglie wavelength. Show that the uncertainity in its velocity is equal to its velocity.

   (*iv*) Calculate the wavelength associated with an electron subjected to a potential difference of 1·25 kV.

   (*v*) Prove that if A is Hermitian operator, then e^{iA} is unitary.

   (*vi*) What is the essential difference between a nuclear bomb and a nuclear reactor ?

   (*vii*) A radio-isotope has a half life of 5 hours. Find its decay constant.

   (*viii*) For which value of scattering angle is the Compton shift equal to the Compton wavelength ?

   (*ix*) What do you mean by tunneling through a barrier ?

   (*x*) Show that $[\hat{x}, \hat{p}_x] = i\hbar$

2. Give the Bohr theory of hydrogen atom and derive expressions for the observed spectral series of Hydrogen. Draw the energy level diagram showing transitions for different spectral series. 5 + 5

3. Outline the experimental arrangement for observing the normal Zeeman effect. Derive an expression for Zeeman shift. 5 + 5

4. (*a*) Show graphically the variation of the Binding Energy per nucleon with mass number. Discuss the significance of the curve. 5

   (*b*) Assuming that mass is uniformly distributed inside the nucleus and also assuming that it is spherical, derive a relation between the size of the nucleus and its mass number. 5

5. What is Compton effect ? Derive an expression for Compton shift. Estimate the change in wavelength of the scattered radiation if the angle of scattering is 60°. 2 + 6 + 2

6. What are matter waves ? Describe with necessary theory, the Davisson-Germer experiment for confirmation of matter waves. 3 + 7

7. Write down the Schrödinger equation for a particle in a box. Solve it to obtain the eigen-function and show that the eigenvalues are discrete. 2 + 8

8. Establish the Schrödinger equation for a linear Harmonic oscillator. Find its eigenvalues and eigen functions. 2 + 8
