Group-A (Theory)
(Answer any one of the following)

1. What is Photo-electric effect? Explain the Davisson-Germer experiment. Describe the concept of the wave packet and also briefly mention what is Group velocity and Phase velocity in this regard

2. Explain two-slit experiment with electrons. What is the Heisenberg Uncertainty principle? Using uncertainty principle estimate ground state energy of Hydrogen.
   Determine the minimum uncertainties in the positions of the following objects if their speeds are known with a precision of $1.0 \times 10^{-3} m/s 1.0 \times 10^{-3} m/s$:
   a. an electron and
   b. a bowling ball of mass 6.0 kg.

3. Solve Schrödinger equation for a one-dimensional particle in a box. What are the energy eigenvalues and eigenfunctions for that? Show that the eigenfunctions are orthogonal. Also, calculate the expectation values of position and momentum.

4. At time t = 0 a particle is represented by the wave function

$$\Psi(x,0) = \begin{cases} \dfrac{Ax}{a}, & if\ 0 \leqslant x \leqslant a \\ \dfrac{A(b-x)}{b-a}, & if\ a \leqslant x \leqslant b \\ 0, & otherwise \end{cases}$$

   where A, a, and b are constants.

   (a) Normalize Ψ (that is, find A in terms of a and b).

   (b) Sketch $\Psi(x,0)$ as a function of x.

   (c) Where is the particle most likely to be found, at t = 0?

   (d) What is the probability of finding the particle to the left of a? Check your result in the limiting cases b = a and b = 2a.

   (e) What is the expectation value of x?

5. For a finite square well solve Schrödinger equation and for shallow, narrow well calculate transmission coefficient.

6. What are the assumptions of the Nuclear Shell Model?
   State the law of radioactive decay. What are mean life and half-life?
   Write down the equations of alpha and beta decay.
   Explain briefly Einstein's A and B coefficients.
   State the difference between spontaneous and stimulated emission of a laser.

Group-B (Practical)
(Answer any one of the following)

1. Write down the procedure (in detail) to determine the value of e/*m* by magnetic focusing.
2. Describe the set up of Millikan oil-drop apparatus. Write down the working formula for this experiment and explain how to estimate the error from this.
3. Derive the Planck's formula for black body radiation. What is a photo-detector?
4. Write down the procedure (in detail) to determine the wavelength of a laser source using diffraction of a single slit.

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