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Assignment-2

1. Calculate the de Broglie wavelength of an electron having a kinetic energy of 1 keV. Compare the result with the wavelength of X-rays having the same energy.

2. Why the wave nature of matter is not apparent in our daily observations?

3. Consider a mass–spring system where a 4 kg mass is attached to a mass less spring of constant k 196 N m^{-1} ; the system is set to oscillate on a frictionless, horizontal table. The mass is pulled 25 cm away from the equilibrium position and then released.

   (a) Use classical mechanics to find the total energy and frequency of oscillations of the system
   (b) Treating the oscillator with quantum theory, find the energy spacing between two consecutive energy levels and the total number of quanta involved. Are the quantum effects important in this system?

4. Calculate the group and phase velocities for the wave packet corresponding to a relativistic particle?

5. Assuming the potential seen by a neutron in a nucleus to be schematically represented by a one-dimensional, infinite rigid walls potential of length 10 fm, estimate the minimum kinetic energy of the neutron.

6. Calculate the energy required for an electron to jump from ground state to the second excited state in a potential well of width L.

7. The wave function

$$\psi(x) = A \sin (n\pi x/L)$$

   describes a state of a particle. Calculate the normalization constant A.

8. Find the probability of finding a particle in a box of length L in the region from 0.45 L to 0.55 L for the ground state?

9. Calculate the energy required for a quantum particle to jump from ground state to the second excited state when it is oscillating quantum mechanically with frequency ω.