

Homework questions #6

The hydrogen atom

1. How much energy must be supplied to a hydrogen atom to cause a transition from the ground state to the $n = 4$ state?
2. A hydrogen atom in its ground state absorbs a photon of energy 12.1 eV. To what energy level is the atom excited?
3. Use the Bohr theory to find the energy necessary to remove the electron from a hydrogen atom initially in its ground state.
4. How much energy is required to ionize a hydrogen atom initially in the $n = 2$ state?

Matter waves

1. What is the de Broglie wavelength of a basketball of mass 0.50 kg when it is moving at 10 m/s? Why don't we see diffraction effects when a basketball passes through the circular aperture of the hoop?
2. A fly with a mass of 1.0×10^{-4} kg crawls across a table at a speed of 2 mm/s. Compute the de Broglie wavelength of the fly and compare it to the size of a proton (about 1 fm, $1 \text{ fm} = 10^{-15} \text{ m}$).
3. An 81-kg student who has just studied matter waves is concerned that he may be diffracted as he walks through a doorway that is 81 cm across and 12 cm thick. (a) If the wavelength of the student must be about the same size as the doorway to exhibit diffraction, what is the fastest the student can walk through the doorway to exhibit diffraction? (b) At this speed, how long would it take the student to walk through the doorway?
4. What are the de Broglie wavelengths of electrons with the following values of kinetic energy? (a) 1.0 eV; (b) 1.0 keV.