

Quiz # 7 (May 20, 2008)

Value: 10 points; Time: 10 minutes

Name _____ KEY _____

Section _____

Compare with problem

$$Z12.44 \quad E_n = +\frac{h^2 n^2}{8m L^2} \quad E_n = -2.178 \cdot 10^{-18} \left(\frac{Z^2}{n^2} \right) J \quad \lambda \nu = c \quad E_{phot} = h\nu$$

$$m_e = 9.1 \cdot 10^{-31} \text{ kg} \quad h = 6.626 \cdot 10^{-34} \text{ J} \cdot \text{s} \quad c = 2.99 \cdot 10^8 \text{ ms}^{-1}$$

Q7) An electron in a 10 nm one dimensional box is excited from the ground state into a higher energy state by absorbing a photon of electromagnetic radiation with a wavelength of approximately $1.4 \cdot 10^{-5} \text{ m}$.

a) Determine the Energy of the photon

$$E_n = +\frac{h^2 n^2}{8m L^2} \quad E_n = -2.178 \cdot 10^{-18} \left(\frac{Z^2}{n^2} \right) J \quad \lambda \nu = c \quad E_{phot} = h\nu$$

$$m_e = 9.1 \cdot 10^{-31} \text{ kg} \quad h = 6.626 \cdot 10^{-34} \text{ J} \cdot \text{s}$$

$$E_{phot} = h\nu = \frac{hc}{\lambda} = \frac{6.626 \cdot 10^{-34} \cdot 2.99 \cdot 10^8}{1.4 \cdot 10^{-5}} = 1.4 \cdot 10^{-20} \text{ J}$$

b) Determine the energy for the electron in the ground state:

$$\Delta E = E_{n2} - E_{n1} = E_{phot}$$

$$E_n = +\frac{h^2 n^2}{8m L^2}$$

$$E_1 = E_{n=1} = +\frac{h^2 n^2}{8m L^2} = \frac{1}{8 \cdot 9.1 \cdot 10^{-31}} \left(\frac{6.626 \cdot 10^{-34}}{10 \cdot 10^{-9}} \right)^2 = 6 \cdot 10^{-22} \text{ J}$$

c) Determine the final energy state for this transition.

$$E_{n2} = E_{phot} + E_{n1} = 1.4 \cdot 10^{-20} + 6 \cdot 10^{-22} = 1.46 \cdot 10^{-20} \text{ J}$$

d) Estimate the quantum number for the final energy state.

$$n^2 = \frac{E_{n2}}{E_{n1}} = \frac{E_{phot} + E_1}{E_1} = \frac{1.4 \cdot 10^{-20} + 6 \cdot 10^{-22}}{6 \cdot 10^{-22}} = \frac{1.46}{0.06} = 24 + \frac{1}{3} \sim 25$$

$$n = 5$$