Final Examination

Sem 01 2023 - 2024

Q1 de Broglie wavelength.

$\lambda = 1.37 \times 10^{-10}$ m. $\frac{1}{2} m v^2$ $\frac{}{2}$ kg m^2/s^2 $1J = 1 kg m^2/s^2$.

a) $p = m_e v$.

$$\lambda = \frac{h}{p} = \frac{h}{m_e v} \rightarrow v = \frac{h}{m_e \lambda} = \frac{6.63 \times 10^{-34} \text{ J.s.}}{9.1 \times 10^{-31} \times 1.37 \times 10^{-10} m}$$

b) electric potential : $V = \frac{U}{q}$ $= 5.32 \times 10^{6}$ m/s.

Electric potential energy is equal to Kinetic energy of electron

$$\Delta E = \Delta U + \Delta K = 0$$

$$K_i = 0 \rightarrow K_f = \frac{1}{2} m_e v^2 \ (v = 5.32 \times 10^{6} \text{ m/s})$$

$$K = -qV = -eV$$

$$\frac{1}{2} m v^2 = (1.6 \times 10^{-19}) V.$$

$$V = \frac{m v^2}{2(1.6 \times 10^{-19})} = \frac{(9.1 \times 10^{-31})(5.32 \times 10^{6})^2}{2(1.6 \times 10^{-19})} = 80.48 V$$

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a) The lowest energy = The ground state: $E_1 = 2.0$ eV.

$$E_1 = \frac{h^2}{8 m_e L^2} (1)^2 \quad E_n = \frac{h^2}{8 m_e L^2} n^2$$

The relationship between E_1 and E_n:

$$E_n = E_1 \times n^2$$

The first excited-state energy $(n=2)$

$$E_2 = E_1 \times 2^2 = 2.0 \times 4 = 8 eV.$$

The second excited-state energy $(n=3)$

$$E_3 = E_1 \times 3^2 = 2 \times 9 = 18 eV$$

b)

$$E_1 = 2 eV = 2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19} J.$$

$$E_2 = 8 eV = 8 \times 1.6 \times 10^{-19} = 1.28 \times 10^{-18}$$

$$E_3 = 18 eV = 18 \times 1.6 \times 10^{-19} = 2.88 \times 10^{-18}$$

The photon wavelength needed to excite the .... n=1 to n=2

$$E_2 - E_1 = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E_2 - E_1} = \frac{(6.63\times10^{-34})(3\times10^{8})}{(1.28\times10^{-18}) - (3.2\times10^{-19})}$$

$$= 2.07\times10^{-7}\,(m)$$

The photon wavelengt... n=1 to n=3

$$\lambda = \frac{hc}{E_3 - E_1} = \frac{(6.63\times10^{-34})(3\times10^{8})}{(2.88\times10^{-18}) - (3.2\times10^{-19})}$$

$$= 7.76\times10^{-8}\,(m)$$

Q3

Balmer series: n=2

Lyman series: n=1.

The shortest wavelength of Balmer series:

$$\lambda_{\infty 2} = \frac{1}{R_H\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)} = \frac{1}{R_H\left(\frac{1}{4}\right)}$$

The shortest wavelength Lyman

$$\lambda_{\infty 1} = \frac{1}{R_H\left(\frac{1}{1} - \frac{1}{\infty^2}\right)} = \frac{1}{R_H}$$

$$\frac{\lambda_{\infty 1}}{\lambda_{\infty 2}} = \frac{\frac{1}{R_H}}{\frac{1}{R_H/4}} = \frac{1}{R_H} \times \frac{R_H}{4} = \frac{1}{4}$$

b)

$$\Delta E = 4.2\times10^{-19}\,J = \frac{4.2\times10^{-19}}{1.6\times10^{-19}} = 2.625\,eV$$

$$\Delta E = E_f - E_2 = -\frac{13.6}{m^2} - \left(-\frac{13.6}{2^2}\right) = 2.625$$

$$m \approx 4$$

It is possible..

Q5

^{225}Ra ; $\lambda = 5.38 \times 10^{-7}$ decays/s.

a)

$$T_{1/2} = \frac{\ln 2}{\lambda} = \frac{\ln 2}{5.38 \times 10^{-7}} = 1.288 \times 10^{6} \,(s)$$

$$T_{mean} = \frac{1}{\lambda} = \frac{T_{1/2}}{\ln 2} = 1.859 \times 10^{6} \,(s)$$

b).

$A = 7.2 \times 10^{4}$ decays/s.

$$A = \frac{dN}{dt} = N\lambda \rightarrow N(t) = \frac{A}{\lambda} = 1.338 \times 10^{11} \text{ nuclei}$$