. An imaginary particle has a charge equal to that of an electron and mass 100 times the mass of the electron. It moves in a circular orbit around a nucleus of charge $+4e$. Take the mass of the nucleus to be infinite. Assuming that Bohr's model is applicable to this system:

a. Derive an expression for the radius of nth Bohr orbit.

b. Find the wavelength of the radiation emitted when the particle jumps from fourth orbit to second orbit.

a. We have

$$\frac{m_p v^2}{r_n} = \frac{1}{4\pi\varepsilon_0}\frac{4e^2}{r_n^2} \qquad \text{(i)}$$

The quantization of angular momentum gives

$$m_p v r_n = \frac{nh}{2\pi} \qquad \text{(ii)}$$

Solving Eqs. (i) and (ii), we get

$$r = \frac{n^2 h^2 \varepsilon_0}{2\pi m_p} e^2$$

Substituting $m_p = 100\ m$, where m = mass of electron, we get

$$r_n = \frac{n^2 h^2 \varepsilon_0}{400\pi m e^2}$$

b. As we know, $E_1 = -13.60$ eV (For H-atom)

and $E_n \propto \left(\frac{z^2}{n^2}\right) m$

For the given particle,

$$E_4 = \frac{(-13.60)(4)^2}{(4)^2} \times 100 = -1360 \text{ eV}$$

and $$E_2 = \frac{(-13.60)(4)^2}{(2)^2} \times 100 = -5440 \text{ eV}$$

$$\Delta E = E_4 - E_2 = 4080 \text{ eV}$$

$$\lambda(\text{in Å}) = \frac{12375}{\Delta E\,(\text{in eV})} = \frac{12375}{4080} = 3.03\ \text{Å}$$