**1. Employing Thomson's model, calculate the radius of a hydrogen atom and the wavelength of emitted light if the ionization energy of the atom is known to be equal to E = 13.6 eV.**

Solution:

The Thomson model consists of a uniformly charged nucleus in which the electrons are at rest at certain equilibrium points (the plum in the pudding model). For the hydrogen nucleus, the charge on the nucleus is + e while the change on the electron is electron is -e. The electron by symmetry must be at the centre of the nuclear charge where the potential is

$$\phi_0 = (\frac{1}{4\pi\varepsilon_o})(\frac{3e}{2R})$$

where R is the radius of the nuclear charge distribution. The potential energy of the electron is $-e\phi_o$ and since the electron is at rest, and this is also the total energy. To ionise such an energetic electron will require an energy of $E=e\phi_o$

From this we find

$$R = (\frac{1}{4\pi\varepsilon_o})(\frac{3e^2}{2E})$$

In Gussian system the factor

$$\frac{1}{4\pi\varepsilon_o}$$

is missing

Light is emitted when the electron vibrates. If we displace the electron slightly inside the nucleus by giving it a push r in some radial direction and an energy δE of oscillation then since the potential at a distance r in the nucleus is

$$\varphi(r) = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{e}{R}\left(\frac{3}{2}-\frac{r^2}{2R^2}\right)$$

The total energy of the nucleus becomes

$$\frac{1}{2}m\dot{r}^2-\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{e^2}{R}\left(\frac{3}{2}-\frac{r^2}{2R^2}\right) = -e\varphi_0+\delta E$$

$$\delta E = \frac{1}{2}m\dot{r}^2+\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{e^2}{2R^3}r^2$$

This is the energy of a harmonic oscillator whose frequency is

$$\omega = \frac{1}{4\pi\varepsilon_o}\frac{e^2}{mR^3}$$

The vibrating electron emits radiation of frequency ω whose wavelength is

$$\lambda = \frac{2\pi c}{\omega} = \frac{2\pi c}{e}\sqrt{mR^3}(4\pi\varepsilon_o)^{\frac{1}{2}}$$

In Gaussian units the factor

$(4\pi\varepsilon_o)^{\frac{1}{2}}$

is missing

Putting the values we get λ=0.237μm.