DPP – 3

SOLUTION

1. Energy of n^{th} state in hydrogen will be equal to energy of $3n^{th}$ state in Li^{++}.

$\therefore$ $3 \rightarrow 1$ transition in H would give same energy as the $3 \times 3 \rightarrow 1 \times 3$ i.e., $9 \rightarrow 3$ transition in Li^{++}.

2. $\frac{1}{\lambda_\alpha} = \frac{3R}{4}(Z-1)^2$

$$(Z-1) = \sqrt{\frac{4}{3R\lambda_\alpha}} = \sqrt{\frac{4}{3 \times 1.1 \times 10^7 \times 1.8 \times 10^{-10}}}$$

$$= \frac{200}{3}\sqrt{\frac{5}{33}} = \frac{78}{3} = 26 \Rightarrow Z = 27$$

3. λ_m will increase to $3\lambda_m$ because of decrease in the energy of bombarding electrons. So, no characteristic X-rays will be visible, only continuous X-ray will be produced.

4. The cut-off wavelength when $V = V_1 = 10kV$ is

$$\lambda_1 = \frac{hc}{eV_1} = 1243.125 \times 10^{-13}\ m$$

The cut-off wavelength when $V = V_2 = 20kV$ is,

$$\lambda_2 = \frac{hc}{eV_2} = 621.56 \times 10^{-13}\ m$$

The wavelength corresponding to K_α line is

$$\frac{1}{\lambda} = \frac{3R}{4}(Z-1)^2$$

As given in questioin, $(\lambda - \lambda_2) = 3(\lambda - \lambda_1)$

Solving above equation, we get $Z = 29$

5. (1) explains the production of X-rays on the basis of electromagnetic theory of light, which is not able to explain the characteristic X-rays and cut-off wavelength.

(2) correctly explains the production of characteristic X-rays.

(3) is wrong as X-ray spectra is a continuous spectra having some peaks representing characteristic X-rays.

6. The K, L, and M lines have different intercepts. The intercept of K is more than that of L, which in turn is more than that of M.

7. $P = VI$

So, total power drawn by Coolidge tube $P_T = VI = 200$ W.

As 0.5% of the energy is carried by electron, Power carried by X-rays is 0.5% of

$P_T = \frac{0.5}{100} \times 200 = 1$ W

8. Moseley's law, $\sqrt{v} = a(Z - 1)$ for K_α X-ray

i.e., $\frac{1}{\sqrt{\lambda}} = a(Z - 1)$

Given, $\frac{1}{\sqrt{\lambda}} = a(11 - 1)$ and $\frac{1}{\sqrt{4\lambda}} = a(Z - 1)$

$Z = 6.$