DPP 01

SOLUTION

Link to View Video Solution: Click Here

1. **Transition of electron from 4-2**

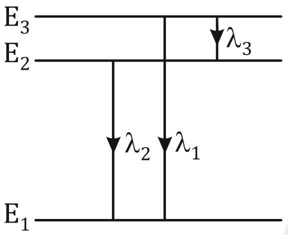
$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$

or $\frac{f}{c} = R\left[\frac{1}{4} - \frac{1}{16}\right]$

or $f = cR\left[\frac{1}{4} - \frac{1}{16}\right] = 3 \times 10^8 \times 10^7 \times \frac{3}{16} = \frac{9}{16} \times 10^{15}$ Hz

x=9

2.



$E = hf = \frac{h}{\lambda}$ or $E \propto \frac{1}{\lambda}$ (given $\lambda_1 < \lambda_2 < \lambda_3$)

Thus, for the three wavelengths, we have

$E_3 - E_2 = \frac{h}{\lambda_3}$ ..... (i)

$E_2 - E_1 = \frac{h}{\lambda_2}$ ..... (ii)

$E_3 - E_1 = \frac{h}{\lambda_1}$ ..... (iii)

Now, $E_3 - E_1 = (E_3 - E_2) + (E_2 - E_1)$

$\Rightarrow \frac{h}{\lambda_1} = \frac{h}{\lambda_3} + \frac{h}{\lambda_2} \Rightarrow \frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$

$\alpha + \beta = 2$

3. $f = cZ^2R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\Rightarrow 2.7 \times 10^{15} = cz^2R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$

$f' = cZ^2R\left[\frac{1}{1^2} - \frac{1}{3^2}\right]$

Divide and solve to get: $f = 3.2 \times 10^{15}$ Hz

$\alpha + \beta = 15$

Link to View Video Solution: Click Here

4. $E_p = -\frac{ke^2}{r}, E = -\frac{ke^2}{2r}$

So, $E_p = 2E = 2(-13.6)eV = -27.2eV$.

Potential energy of electron in the ground state of Li^{2+} ion

$= -3^2 \times 27.2eV$

or $-244.8eV$.

5. $F = \frac{mv^2}{r}$

But $v \propto \frac{1}{n}$ and $r \propto n^2$

$\Rightarrow F \propto \frac{1}{n^4}$

6. $U = -\frac{ke^2}{2R^3}, F = -\frac{dU}{dR} = -\frac{3ke^2}{2R^4}$

But, $F = \frac{mv^2}{R} \Rightarrow \frac{mv^2}{R} = \frac{3ke^2}{2R^4}$

Angular momentum of electyron , $mvR = \frac{nh}{2\pi}$

After solving , value of $R = \frac{6\pi^2 ke^2 m}{n^2 h^2}$

7. $\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$

or $R = \frac{36}{5\lambda} = \frac{36}{5 \times 6563 \times 10^{-10}}\ m^{-1}$

$= \frac{36000}{5 \times 6563} \times 10^7\ m^{-1} = 1.097 \times 10^7\ m^{-1}$

8. l will be same for both because it does not depend upon Z. But for energy

$(E_n)_{Li} = -\frac{Z^2 \times 13.6}{n^2}$ and $(E_n)_H = -\frac{13.6}{n^2}$

Clearly, $|E_H| < |E_{Li}|$

9. We know that frequency of orbital motion:

$f \propto \frac{1}{n^3}$ and given $f_1 = \frac{1}{27} f_2$

$\Rightarrow \left(\frac{n_2}{n_1}\right)^3 = \frac{f_1}{f_2} \Rightarrow \frac{n_2}{n_1} = \left(\frac{1}{27}\right)^{1/3} = \frac{1}{3}$

Link to View Video Solution: Click Here

10. As magnetic moment, $\mu_B = \frac{1}{2}evr$

$L = mvr \Rightarrow vr = \frac{L}{m}$

$\therefore\ \mu_B = \frac{1}{2}\frac{eL}{m} \Rightarrow \frac{\mu_B}{L} = \frac{e}{2m}$

11. Given that $E_1 = -15.6eV, E_\infty = 0eV$.

Ionization energy of the atom: $E_\infty - E_1 = 0 - (-15.6eV) = 15.6eV$

So, ionization potential $= 15.6$ V

12. For short wavelength limit of the series terminating at $n = 2$, a transition must take place from $n = \infty$ state to $n = 2$ state. For this, $\Delta E = 5.30eV$

$$\lambda = \frac{12400}{\Delta E(eV)}\text{Å} = \frac{12400}{5.30}\text{Å} = 2339\text{Å}$$

13. The excitation energy for the $n = 3$ state is

$\Delta E = E_3 - E_1 = 15.6 - 3.08 = 12.52eV$

Excitation potential $= 12.52$ eV

14. $\lambda = \frac{12400}{E_3 - E_1} = \frac{12400}{12.52}\text{Å} = 990\text{Å}$

Wave number $= \frac{1}{\lambda} = \frac{1}{990 \times 10^{-10}\ m} = 1.009 \times 10^7\ m^{-1}$