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Chemistry Class 11 NCERT Solutions: Chapter 2 Structure of Atom Part 14

Q: 49. Lifetimes of the molecules in the excited states are often measured by using pulsed radiation source of duration nearly in the nano second range. If the radiation source has the duration of ns and the number of photons emitted during the pulse source is 2.5×10^{15}, calculate the energy of the source.

Answer:

Frequency of radiation (υ),

$$\upsilon = \frac{1}{2.0 \times 10^{-9} s}$$

$$\upsilon = 5.0 \times 10^{8} S^{-1}$$

Energy (E) of source = $Nh\upsilon$

Where,

N = number of photons emitted

h = Planck's constant

= frequency of radiation

Substituting the values in the given expression of (E) :

$$E = \left(2.5 \times 10^{15}\right) \left(6.626 \times S^{-34} Js\right) \left(5.0 \times 10^{8} S^{-1}\right)$$

$$E = 8.282 \times 10^{-10} J$$

Hence, the energy of the source (E) is $8.282 \times S^{-10} J$.

Q: 50. The longest wavelength doublet absorption transition is observed at 589 and 589.6 nm. Calculate the frequency of each transition and energy difference between two excited states.

Answer:

For $\lambda_1 = 589\, nm$

Frequency of transition $(\upsilon_1) = \frac{c}{\lambda_1}$

$$= \frac{3.0 \times 10^8 ms^{-1}}{589 \times 10^{-9} m}$$

Frequency of transition (V_1) = $5.093 \times 10^{14} S^{-1}$

Similarly, for $\lambda_2 = 589.6\, nm$

Frequency of transition $(V_2) = \frac{c}{\lambda_2}$

$$= \frac{3.0 \times 10^8 ms^{-1}}{589.6 \times 10^{-9} m}$$

Frequency of transition $(V_2) = 5.088 \times 10^{14} S^{-1}$

Energy difference (ΔE) between excited states $= E_1 - E_2$

Where,

E_2 = energy associated with λ_2

E_1 = energy associated with λ_1

$\Delta E = hV_1 - hV_2$

$= h(V_1 - V_2)$

$= (6.626 \times 10^{-34} Js)(5.093 \times 10^{14} - 5.088 \times 10^{14}) S^{-1}$

$= (6.626 \times 10^{-34} J)(5.0 \times 10^{-3} \times 10^{14})$

$\Delta E = 3.31 \times 10^{-22} J$