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BATCH : B10

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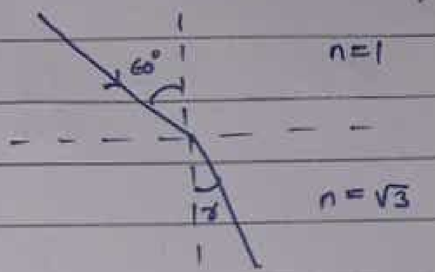
Physics - 2 (15B11PH211)

Tutorial - 6

Q.1. $n = \sqrt{3}$, $i = 60^\circ$



$$1 \times \sin 60 = \sqrt{3} \sin r$$

$$\frac{\sqrt{3}}{2} = \sqrt{3} \sin r$$

$$r = 30^\circ$$

$$r_{\parallel} = \left(\frac{E_{0R}}{E_{0I}}\right)_{\parallel} = \frac{n_1 \cos\theta_2 - n_2 \cos\theta_1}{n_1 \cos\theta_2 + n_2 \cos\theta_1} = \frac{\sqrt{3}/2 - \sqrt{3} \times 1/2}{\sqrt{3}/2 + \sqrt{3} \times 1/2} = 0$$

$$t_{\parallel} = \left(\frac{E_{0T}}{E_{0I}}\right)_{\parallel} = \frac{2 n_1 \cos\theta_1}{n_1 \cos\theta_2 + n_2 \cos\theta_1} = \frac{2 \times 1 \times 1/2}{\sqrt{3}} = \frac{1}{\sqrt{3}} = 0.57$$

$R = 0$, $T = 1$

Q.2. (i) Spontaneous emission :

is the process by which a quantum system such as an atom, molecule, nanocrystal or nucleus in an excited state undergoes a transition high energy to a state with a lower energy and emits quanta of energy.

(ii) Stimulated emission :

is the process by which an atomic electron from an excited state when interacts with EM wave of a certain frequency (ν), drops to a lower energy level and emits the energy with same frequency. In this process, the incident photon ($h\nu$) is not absorbed and the process is called Stimulated emission.

(iii) meta-stable state : is particular excited state of an atom, nucleus etc that has a longer lifetime than the ordinary excited state and that generally has a shorter lifetime.

(iv) Population inversion : describes that more atoms are in an excited State than in ground state, which is achieved by optical pumping ~~Such condition is called Population inversion.~~

(v) optical pumping : is a process in which light is used to raise electrons from lower energy level in an atom or molecule to higher one.

Q.3. $P = \frac{E}{t \times A} = \frac{4\times10^{-3}}{10^{-9}\times3.14\times(1.5\times10^{-5})^2} = \frac{4\times10^{-3}}{3.14\times2.25\times10^{-19}}$

$= 5.7\times10^{+15}$ watt/m² Ans

Q.4. $n = 2.8\times10^9$, $\lambda = 700nm$

$$E = \frac{nhc}{\lambda} = \frac{2.8\times10^9\times6.6\times10^{-34}\times3\times10^8}{700\times10^{-9}}$$

$$= 0.0792\times10^{-8}\ J$$

Q.5. $$\frac{N_2}{N_1} = \exp\left(-\frac{(E_2-E_1)}{K_BT}\right) = \exp\left(-\frac{hc}{\lambda K_BT}\right)$$

$$\left.\frac{N_2}{N_1}\right]_{T=300K} = \exp\left(-\frac{6.6\times10^{-34}\times3\times10^8}{700\times10^{-9}\times1.38\times10^{-23}\times300}\right)$$

$$= \exp\left(-\frac{19.8\times10^{-26}}{289800\times10^{-32}}\right) = \exp\left(-68.3\times10^{-6}\times10^{6}\right)$$

$$= e^{-68.3}$$

$$\left.\frac{N_2}{N_1}\right]_{T=500K} = e^{-41.1}$$

Q.6. $$\frac{B_{21}}{A_{21}} = \frac{\lambda^3}{8\pi h} \qquad \therefore\ A_{21} = \frac{1}{\tau} = 10^6 \quad -①$$

$$B_{21} = \frac{10^6\times(600\times10^{-9})^3}{8\times3.14\times6.64\times10^{-34}} = 1.365\times10^{19}$$

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Q.7. $P_0 = 10^{-2} W$

$\eta = 1\%$

$\frac{P_0}{P_i} = \frac{1}{100}$ $\therefore$ $P_i = P_0 \times 100 = 1$ watt

Energy for 1 atom $= 20\,eV = 20 \times 1.6 \times 10^{-19}$

$N = \frac{1}{20 \times 1.6 \times 10^{-19}}$ /s

$= 3.12 \times 10^{17}$ atoms/sec.