18PYB101J MODULE-5

LECTURE 4

- **Solving Problems**

1. **What fraction of sodium atom is in the first excited state in a sodium vapour lamp at a temperature of 250°C.**

$$T = 250 + 273 = 523\ K$$

$$K = 1.38 \times 10\text{-}23\ \ J/K$$

$$\lambda = 5900 \times 10^{-10} m$$

$$N_2/N_1 = e^{-(E_2 - E_1)/kT} = e^{-h\nu/kT}$$

$$\nu = C/\lambda$$

$$N_2/N_1 = 5.364 \times 10^{-21}$$

2. A He-Ne laser emits light at a wavelength of 632.8nm and has an output power of 3 mw. How many photons are emitted in each minute by this laser when operating?

$$\lambda = 6328 \times 10^{-10} m \quad P = 3mw = 3 \times 10^{-3} w$$

$$\nu = c/\lambda = 4.74 \times 1014 \text{ Hz}$$

$$E = h\nu = 3.14 \times 10^{-19} J$$

$$\text{Photons /minute} = n \times 60$$

$$5.7324 \times 10^{10} \text{ photons / minute.}$$

3. For a He-Ne laser at 1 m and 2 m distances from the laser the output beam spot diameters are 4mm and 6mm respectively , calculate the divergence.

$$d1 = 1m$$

$$d2 = 2m$$

$$a_1 = 4mm = 4 \times 10^{-3} m$$

$$a_2 = 6mm = 6 \times 10^{-3} m$$

$$\Phi = a_2 - a_1 / 2(d_2 - d_1)$$

$$\Phi = (6-4) \times 10^{-3} / 2(2-1)$$

$\varphi = 10^{-3}$ radian = 1 milli radian

4. Find the relative population of the two states in Nd:YAG laser that produces a light beam of wavelength 1.06μm at 300ºC.

$$T = 300 + 273 = 573\ K$$

$$K = 1.38 \times 10^{-23}\ J/K$$

$$\lambda = 1.06 \times 10^{-6} m$$

$$\frac{N_2}{N_1} = e^{-(E_2 - E_1)/kT} = e^{-h\nu/kT} = 2.39 \times 10^{-20}$$