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Page no : 1/5

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Q1. A)

→ Given: $a+b = \frac{1}{5500}$ cm, $n=2$, $\lambda_1 = 5890 Å$, $\lambda_2 = 5896 Å$.

Formula: $(a+b) \sin\theta = n\lambda$

Solution: $(a+b) \sin\theta_1 = n\lambda_1$

$$\theta_1 = \sin^{-1}\left(2 \times 5890 \times 5500 \times 10^{-8}\right)$$

$$\theta_1 = \sin^{-1}(0.6479) = 40.38°$$

Similarly $\theta_2 = \sin^{-1}\left(\frac{n\lambda_2}{a+b}\right)$

$$= \sin^{-1}\left(2 \times 5896 \times 5500 \times 10^{-8}\right)$$

$$\theta_2 = \sin^{-1}(0.6486) = 40.44°$$

$$\therefore \theta_2 - \theta_1 = 40.44° - 40.38°$$

$$= 0.06°$$

Conclusion: Angular separation = 0.06°.

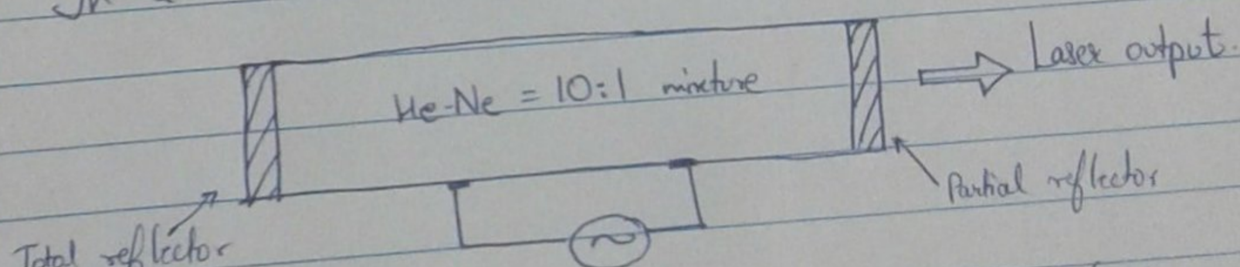
Q1.B)
→ In laser action,

Usually atoms have a tendency to return to the ground state releasing the absorbed energy. Hence, the population of the ground state is found to be greater than that of the higher excited state.

Thus the state of population inversion can not be achieved naturally. It has to be induced artificially by continuously raising a large number of atoms to the higher ~~of~~ energy state with continuous supply of external energy. This is called the pumping mechanism.

Population Inversion is a state of matter in which the number of atoms in the excited state is higher than that in ground state.

In a He-Ne Laser, (A 4 level gaseous source laser)




'He' is the host gas and 'Ne' is the activator, because 'Ne' takes part actively in lasing transition.

The pumping is electrical pumping due to the high voltage power source.

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Q2 c)

i) Curl of a vector field.

It signifies how much the vector quantity is twist around the given point.

For vector $\vec{A} = \hat{i}\vec{A_x} + \hat{j}\vec{A_y} + \hat{k}\vec{A_z}$

the curl is given by

$$\text{curl } \vec{A} = \vec{\nabla} \times \vec{A} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ \vec{A_z} & \vec{A_y} & \vec{A_z} \end{vmatrix}$$

$$= \hat{i}\left(\frac{\partial}{\partial y}\vec{A_z} - \frac{\partial}{\partial z}\vec{A_y}\right) - \hat{j}\left(\frac{\partial}{\partial x}\vec{A_z} - \frac{\partial}{\partial z}\vec{A_x}\right) + \hat{k}\left(\frac{\partial}{\partial x}\vec{A_y} - \frac{\partial}{\partial y}\vec{A_z}\right)$$

If curl of $\vec{A} = 0$, then the vector field $\vec{A}$ is irrational such a field is called conservative.

ii)

$\vec{A} = \hat{i}(2x^2+y^2) + \hat{j}(xy - y^2)$

$$\text{Curl } \vec{A} = \vec{\nabla} \times \vec{A}$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ (2x^2+y^2) & (xy-y^2) & 0 \end{vmatrix}$$

$$= \hat{i}\left(\frac{\partial}{\partial y}0 - \frac{\partial}{\partial z}(xy-y^2)\right) - \hat{j}\left(\frac{\partial}{\partial x}0 - \frac{\partial}{\partial z}(2x^2+y^2)\right) + \hat{k}\left[\frac{\partial}{\partial x}(xy-y^2) - \frac{\partial}{\partial y}(2x^2+y^2)\right]$$

$= \hat{i}(0-0) - \hat{j}(0-0) + \hat{k}(y-2y)$

$\text{Curl } \vec{A} = \hat{k}(y-2y)$

$\text{Curl at } (1,2,2) = \hat{k}(2-2(2))$

$\boxed{\therefore \text{Curl } \vec{A} \text{ at } (1,2,2) = -2\hat{k}}$