Answer on Question #80962, Physics / Optics

For an emission of wavelength 5000 Angstrom, at what temperatures both spontaneous and stimulated emissions will be same?

Solution:

The relative rate at which spontaneous and stimulated processes occur in a system in equilibrium at temperature T is

$$R = \frac{A_{21}}{B_{21}\rho(\nu)} = 1$$

The spontaneous emission rate is A_{21} , which is independent of external radiation. B_{21} is called the Einstein coefficient for stimulated emission.

We choose the *ρ(ν)* appropriate to a black-body radiation field, since such radiation is always present to interact with an excited atom that is contained within an enclosure at temperature T.

$$R = \frac{A_{21}}{B_{21}\rho(\nu)} = e^{\frac{h\nu}{kT}} - 1 = 1$$

$$e^{\frac{h\nu}{kT}} = 2$$

$$\frac{h\nu}{kT} = ln2 = 0.69315$$

$$T = \frac{h\nu}{kln(2)} = \frac{hc}{k\lambda ln(2)} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{1.38 \times 10^{-23} \times 5000 \times 10^{-10} \times 0.69315} = 41562\ K$$

Answer: $41562\ K$