

$$1. \quad p_{\text{at}} = n h \nu \quad n = \frac{p_{\text{at}}}{h \nu}$$

Date.

No.

$$\text{对于 } \lambda = 10 \text{ m} \quad n = \frac{1}{6.626 \times 10^{-34} \times \frac{3 \times 10^8}{10}} = 5.03 \times 10^{25}$$

$$\lambda = 1 \text{ m} \quad n = \frac{1}{6.626 \times 10^{-34} \times \frac{3 \times 10^8}{1}} = 5.03 \times 10^{24}$$

$$\lambda = 1 \mu\text{m} \quad n = \frac{1}{6.626 \times 10^{-34} \times \frac{3 \times 10^8}{1 \times 10^{-6}}} = 5.03 \times 10^{18}$$

$$\lambda = 100 \text{ nm} \quad n = \frac{1}{6.626 \times 10^{-34} \times \frac{3 \times 10^8}{100 \times 10^{-9}}} = 5.03 \times 10^{11}$$

$$2. \quad {}^{87}\text{Rb} \text{ 基态} \quad J = \frac{1}{2} \quad I = \frac{3}{2}$$

$$K_2 = 2 \times 3 - \frac{3}{2} \times \frac{5}{2} - \frac{1}{2} \times \frac{3}{2} = \frac{3}{2}$$

$$K_1 = 1 \times 2 - \frac{3}{2} \times \frac{5}{2} - \frac{1}{2} \times \frac{3}{2} = -\frac{5}{2}$$

$$\Delta E = \Delta E_{\text{Hfs}2} - \Delta E_{\text{Hfs}1} = \frac{1}{2} A_{\text{Hfs}} (K_2 - K_1) + B_{\text{Hfs}} \frac{\frac{3}{2} [K_2(K_2+1) - K_1(K_1+1)]}{4I(2I-1)J(2J-1)}$$

$$+ C_{\text{Hfs}} \frac{5K_2^2(\frac{K_2}{4}+1) - 5K_1^2(\frac{K_1}{4}+1) + (K_2-K_1)[I(I+1)+J(J+1)]}{I(I-1)(2I-1)J(J-1)(2J-1)} + 3+3I(I+1)J(J+1)$$

$$= \frac{A_{\text{Hfs}}}{2} \times 4 + \cancel{B_{\text{Hfs}}} + 0 + 0$$

$$= 2A_{\text{Hfs}} = 2 \times h \cdot 3.4173 \text{ J} = 2 \times 6.626 \times 10^{-34} \times 3.4173 \text{ J}$$

$$= 4.529 \times 10^{-33} \text{ J}$$

$$\text{根据玻尔兹曼分布} \quad \frac{N_2}{N_1} = e^{-\frac{\Delta E}{kT}} = e^{-\frac{4.529 \times 10^{-33}}{300 \times 1.380649 \times 10^{-23}}}$$

$$\text{考虑能级简并} \quad \Delta E = 5 \times \Delta E_{\text{Hfs}2} - 3 \times \Delta E_{\text{Hfs}1}$$

$$= \frac{1}{2} \times 5 \times \frac{3}{2} \times A_{\text{Hfs}} - (-\frac{5}{2}) \times 3 \times A_{\text{Hfs}} \times \frac{1}{2} = \frac{15}{2} A_{\text{Hfs}}$$

$$\frac{N_2}{N_1} = e^{-\frac{\Delta E}{kT}} = e^{-\frac{\frac{15}{2} \times 3.417341 \times 6.626 \times 10^{-34} \times 10^9}{300 \times 1.380649 \times 10^{-23}}} = 0.9959$$