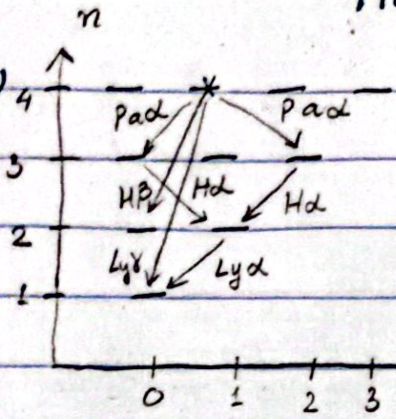
Homework 22

a)



$nl = 4p$ (starting point) ; $\Delta n > 0$ ($n \downarrow$)

$\Rightarrow n = 4, 3, 2, 1 \Rightarrow l = 3, 2, 1, 0$

· Lyman ($n' = 1$): $\alpha(2 \to 1)$, $\beta(3 \to 1)$, $\gamma(4 \to 1)$

· Balmer ($n' = 2$): $\alpha(3 \to 2)$, $\beta(4 \to 2)$

· Paschen ($n' = 3$): $\alpha(4 \to 3)$

b) From $nl: 4p$, we have in total 4 ways to get out:

$4p \to 3s$ (Paschen α), $4p \to 3d$ (Paschen α), $4p \to 2s$ (Balmer β), $4p \to 1s$ (Lyman γ)

$\Rightarrow A_{4p \to 3s} = 3.065 \cdot 10^{6}\ s^{-1}$ $\qquad \Rightarrow A_{4p \to 2s} = 9.668 \cdot 10^{6}\ s^{-1}$

$\Rightarrow A_{4p \to 3d} = 3.475 \cdot 10^{5}\ s^{-1}$ $\qquad \Rightarrow A_{4p \to 1s} = 6.818 \cdot 10^{7}\ s^{-1}$

Total rate of decay from 4p: $3.065 \cdot 10^{6} + 3.475 \cdot 10^{5} + 9.668 \cdot 10^{6} + 6.818 \cdot 10^{7}$

$\approx 8.126 \cdot 10^{7}\ s^{-1}$

$\Rightarrow P_{4p \to 3s} = \dfrac{3.065 \cdot 10^{6}}{8.126 \cdot 10^{7}} \approx 0.0377$ $\qquad \Rightarrow P_{4p \to 2s} = \dfrac{9.668 \cdot 10^{6}}{8.126 \cdot 10^{7}} \approx 0.1190$

$\Rightarrow P_{4p \to 3d} = \dfrac{3.475 \cdot 10^{5}}{8.126 \cdot 10^{7}} \approx 0.0043$ $\qquad \Rightarrow P_{4p \to 1s} = \dfrac{6.818 \cdot 10^{7}}{8.126 \cdot 10^{7}} \approx 0.8390$

$\Rightarrow$ The path that is most likely being taken is from $4p \to 1s$ (the Lyman γ path), with a whooping 83.9% probability. Following by the path to 2s, 3s, and then 3d with the lowest probability (0.43%)

Probability check: $0.0377 + 0.0043 + 0.1190 + 0.8390 = 1$. ✓