Chem 20A Worksheet 3

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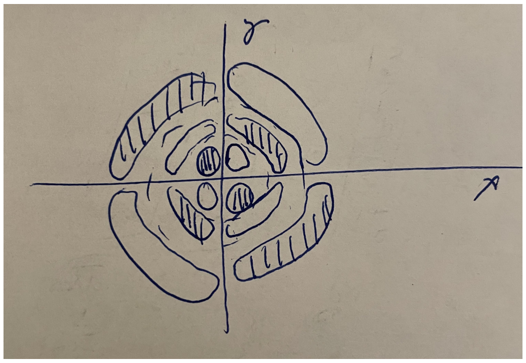
Problem 1

We have that the 4d orbitals have 1 radial node and 2 angualr nodes, the possible quantum states are: (4,2,-2),(4,2,-1),(4,2,0),(4,2,1),(4,2,2). For the 5f orbitals, the possible quantum states are (5,3,-3),(5,3,-2),(5,3,-1),(5,3,0),(5,3,1),(5,3,2),(5,3,3). The 5f Orbitals have 1 angular and 3 radial nodes.

Problem 2

(a)

We have that the 5dxy orbital has 2 radial nodes, and 2 angular node planes, one along the xz plane and one along the zy plane. See the figure below for the sketch of the 5dxy orbital.



We have that the angular nodes occur when

$$40 - 14\sigma + \sigma^2 = 0$$

We have that this occurs where $\sigma = 4$ and $\sigma = 10$. Since $\sigma = \frac{2Zr}{na_0}$, we have that the corresponding radiuses from the origin is

$$r = \frac{na_0\sigma}{2Z}$$

Thus we have that the radiuses from the origin where the angular nodes occur are $r = \boxed{13.229\mathring{A}}$ and $\boxed{5.291\mathring{A}}$.

(b)

We have that the average readius is given by

$$r = \frac{5^2 a_0}{Z}\left(1 + \frac{1}{2}\left(1 - \frac{6}{25}\right)\right) = \boxed{18.256\mathring{A}}$$

Problem 3

(a)

We have that the radial probability function is given by

$$P(r) = 4r^2\left(\frac{1}{a_0}\right)e^{-\frac{2r}{a_0}}dr$$

Therefore

$$P(a_0) = \frac{4}{a_0} e^{-2} \cdot 10^{-3} a_0 = 4e^{-2} \cdot 10^{-3} = 0.000541$$

(b)

We have that

$$P(1) = 0$$