1 Problem 1

The d orbitals have the nomenclature d_{z^2}, dxy, d_{xz},d_{yz}, and $d_{x^2-y^2}$. Show how the d orbital given below can be written in the form $y\ z\ F(r)$.

$$\psi_{3d_{yz}} = \frac{\sqrt{2}}{81\ \sqrt{\pi}} \left(\frac{1}{a_o}\right)^{3/2} \frac{r^2}{a_o^2}\ e^{-r/3a_o}\ sin(\theta)\ cos(\theta)\ sin(\phi)$$

1.1 Solution

$$z = r\ cos\,(\theta)$$
$$x = r\ sin\,(\theta)\ \ cos\,(\phi)$$
$$y = r\ sin\,(\theta)\ \ sin\,(\phi)$$

Thus,

$$\psi_{3d_{yz}} = \frac{\sqrt{2}}{81\ \sqrt{\pi}} \left(\frac{1}{a_o}\right)^{3/2} \frac{r^2}{a_o^2}\ e^{-r/3a_o}\ sin(\theta)\ cos(\theta)\ sin(\phi)$$

$$\psi_{3d_{yz}} = \frac{\sqrt{2}}{81\ \sqrt{\pi}} \left(\frac{1}{a_o}\right)^{3/2} \frac{1}{a_o^2}\ e^{-r/3a_o} \left(\underbrace{r\ sin(\theta)\ sin(\phi)}_{\mathbf{y}}\right) \left(\underbrace{r\ cos\,(\theta)}_{\mathbf{z}}\right)$$

$$\psi_{3d_{yz}} = F(r)\ y\ z$$