Chemistry 542
Fall, 2002
Problem Set 8
Due Wednesday, November 13

Finish reading chapter 6.

1. Take the appropriate linear combinations of the spherical harmonics $Y_{22,}$ Y_{21}, Y_{20}, $Y_{2,-1}$, $Y_{2,-2}$ to derive the five d-orbitals.

2 .Evaluate the following quantities for the 2s orbital: r_{mp}, <r>, r_{rms}, $\sigma(r)$ (the standard deviation)

3. Kepler's third law (published in 1610!) says that for a potential of the form

$$V = -\frac{k}{r}$$

the orbital period, τ (also known as the Kepler period), is related to the semi-major axis of the orbit, a, by

$$\tau = 2\pi a^{3/2}(m/k)^{1/2}$$

where m is the mass. Calculate τ for a hydrogen atom in levels with n = 1, 10, 100, and 1,000. Pay careful attention to the order of magnitude of your answer. You may assume a circular orbit. (This is actually not a restrictive assumption).

Levine, problems 18, 19, 25, 26, 37, 38.