Physics 3323 Quiz 2 September 23, 2016

A spherical shell has potential

$$V(R,\theta) = V_0 \cos \theta$$

The general solution to Laplace's equation in spherical coordinates is

$$V(r,\theta) = \sum_{l=0}^{\infty} \left(A_l r^l + \frac{B_l}{r^{l+1}} \right) P_l(\cos\theta)$$

The potential is zero at $r \to \infty$.

1. Write a general expression for the potential outside the sphere, consistent with the boundary condition at infinity.

2. Write a general expression for the potential inside the sphere, that is finite at the origin.

3. Use the boundary condition at r = R to determine which of the B_l and A_l are non-zero.

4. Use the fact that the potential is continuous on the boundary to determine the non-zero coefficients.

5. At large distances does the potential behave like that of a monopole, a dipole or a quadrupole? Explain.

FYI

$$P_0(x) = 1$$

$$P_1(x) = x$$

$$P_2(x) = (3x^2 - 1)/2$$

$$P_3(x) = (5x^3 - 3x)/2$$