Physics 122 Homework # 3
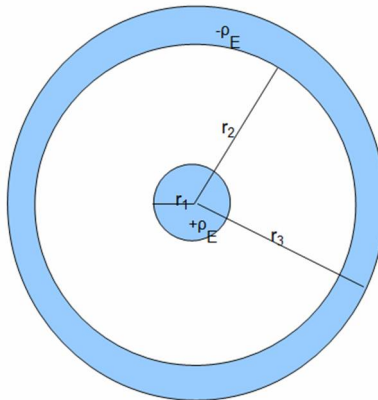
1. What does the following equation mean and how is it analogous to the relationship between the electric field and the the electrostatic force?

$$V(\vec{r}) = \frac{U(\vec{r})}{q}$$

2. Consider the charge distribution from HW 2, problem 2, shown below. Choosing $V = 0$ at infinity, find the electric potential in terms of r for:

   (a) $0 < r < r_1$
   (b) $r_1 < r < r_2$
   (c) $r_2 < r < r_3$
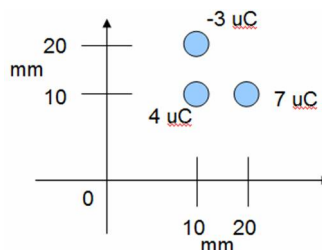   (d) $r > r_3$

3. Consider an electric potential given by

$$V(x, y, z) = \frac{3x^2 y}{z} + \ln(z)$$

   for $z \neq 0$. What is the electric field in the region $z \neq 0$?

4. Given the system of charges below, what is the total potential energy in the system? (Assume $U = 0$ for the same charges displaced infinitely far from one another.)

5. An alpha particle (the nucleus of a helium atom) is at rest at the origin of a Cartesian coordinate system. A proton is moving with a velocity of v towards the alpha particle in the $\hat{x}$ direction. If the proton is initially far enough away to have no potential energy, how close does the proton get to the alpha particle? Your answer should be in terms of v, m_p (mass of a proton) and e (charge of a proton).