

PHY 415
Homework 2

Due September 28, 2009

1. Given the following two vectors, \mathbf{E} , which do you think would describe a true static electric field?

$$(i) \quad \mathbf{E} = k[xy\hat{\mathbf{x}} + 2yz\hat{\mathbf{y}} + 3xz\hat{\mathbf{z}}],$$

$$(ii) \quad \mathbf{E} = k[y^2\hat{\mathbf{x}} + (2xy + z^2)\hat{\mathbf{y}} + 2yz\hat{\mathbf{z}}].$$

Here, k is a constant. For the true electric field, determine the potential with the origin as the reference point.

2. Consider a spherical shell of radius R with a uniform surface charge density σ . What is the electrostatic energy stored in such a system. What happens as the radius of the sphere decreases? What is the electrostatic energy for a solid sphere of radius R carrying a uniform volume charge density ρ ?

3. Consider a spherical distribution of charge for which the volume charge density is nonzero only for $0 \leq r \leq R$ and has the form

$$\rho(\mathbf{r}) = k r^{-n},$$

where both k and n are positive constants. Calculate the electrostatic energy associated with such a distribution of charges. For what values of n is the energy finite?

4. Consider a dipole centered at the origin in a uniform electric field. Calculate the torque on the dipole due to the electric field. If the dipole is initially parallel to the electric field, how much work would be needed to rotate it by an angle θ ?