Department of Physics
IIT Kanpur, Semester II, 2017-18

PHY103A: Physics II **Homework # 3** **Instructors: AKJ & SC**

Problem 3.1: Finding potential, given a charge distribution (Griffiths 3rd ed. Prob 2.26)

A conical surface carries a uniform surface charge σ. The height of the cone is h, and the radius of the top is also h (see Fig. 1). Find the potential difference between points **a** and **b**.

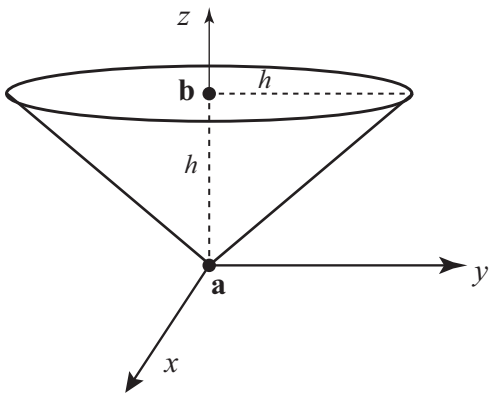

FIG. 1:

Problem 3.2: Finding field and charge density, given an electric potential, (Griffiths 3rd ed. Prob 2.46)

The electric potential of some configuration is given by the expression $V(\mathbf{r}) = A\dfrac{e^{-\lambda r}}{r}$, where A and λ are constants.

(a) Find the electric field $\mathbf{E}(\mathbf{r})$.

(b) What is the charge density $\rho(r)$?

(c) What is the total charge Q?

Problem 3.3: Verifying Poisson's Equation (Griffiths 3rd ed. Prob 2.29)

The potential $V(\mathbf{r})$ at $\mathbf{r}$ due to a localized charge distribution is given as

$$V(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\mathbf{r}')}{\imath}d\tau',$$

where $\rho(\mathbf{r}')$ is the charge density at $\mathbf{r}'$ and $\imath$ is the separation between $\mathbf{r}$ and $\mathbf{r}'$. Verify that the above equation satisfies Poisson's equation.

Problem 3.4: Electrostatic energy of two spherical shells (Griffiths 3rd ed. Prob 2.34)

Consider two concentric spherical shells, of radii a and b. Suppose the inner one carries a charge q, and the outer one a charge -q (both of them uniformly distributed over the surface).

(a) Calculate the energy of this configuration.

(b) How much of this is the interaction energy between the two shells?

Problem 3.5: Electrostatic Force

(a) A metal sphere of radius R carries a total charge Q. What is the force of repulsion between the northern and the southern hemispheres (see Fig. 2)? (Griffiths 3rd ed. Prob 2.38)

(b) A uniformly charged sphere of radius R carries a total charge Q. What is the force of repulsion between the northern and the southern hemispheres (see Fig. 2)? (Griffiths 3rd ed. Prob 2.43)

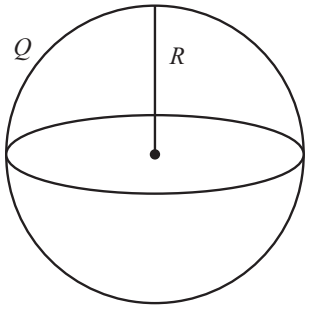

FIG. 2:

Problem 3.6: Capacitance of coaxial metal cylinders (Griffiths 3rd ed. Prob 2.39)

Find the capacitance per unit length of two coaxial metal cylindrical cylinders, of radii a and b (see Fig. 3).

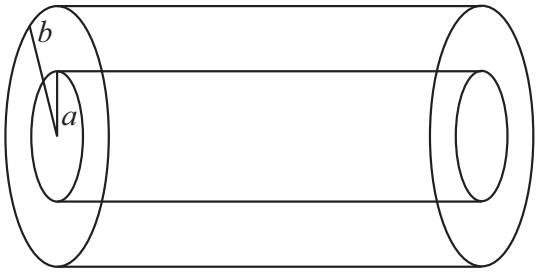

FIG. 3: