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

PHY103A: Physics II **Homework # 4** **Instructors: AKJ & SC**

Problem 4.1: Force with image charges (Griffiths 3rd ed. Prob 3.6)

Find the force on charge $+q$ in Fig. 1(a), in which the xy plane is an infinite grounded conductor.

Problem 4.2: Infinite-line image charge (Griffiths 3rd ed. Prob 3.9)

An infinite line charge runs parallel to the x-axis at a distance d from the $x-y$ plane, which is an infinite grounded conductor [see Fig. 1(b)].

(a) What is the potential in the region above the plane.

(b) Find the charge density σ induced on the conducting plane.

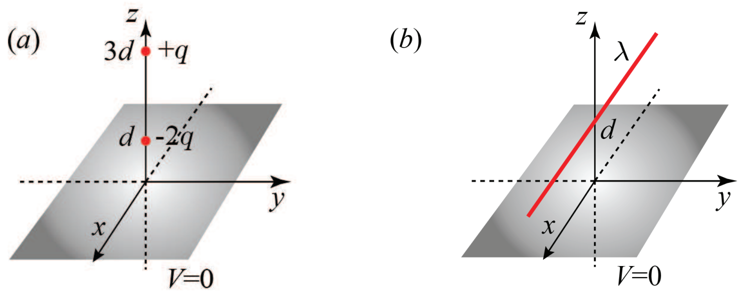

FIG. 1:

Problem 4.3: Far-field potential (Griffiths 3rd ed. Prob 3.26)

A sphere of radius R, centered at the origin, carries charge density $\rho(r, \theta) = k\frac{R}{r^2}(R-2r)\sin\theta$, where k is a constant, and r,θ are the usual spherical coordinates [see Fig. 2]. Find the approximate potential for points $\mathbf{r_0}$ on the z axis, far from the sphere.

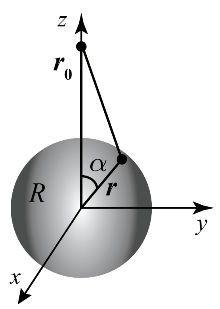

FIG. 2:

Problem 4.4: Potential due to a four-charge system (Griffiths 3rd ed. Prob 3.27)

For the charge distribution shown in Fig. 3, find the approximate potential at points far from the origin.

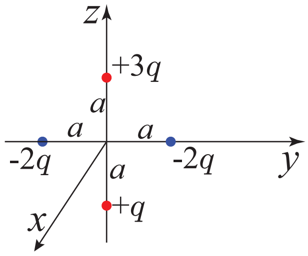

FIG. 3:

Problem 4.5: Far-field Potential due to a spherical-charge distribution (Griffiths 3rd ed. Prob 3.28)

Let's consider a spherical shell of radius R having a surface charge density $\sigma = k\cos\theta$.

(a) Calculate the dipole moment of this charge distribution.

(b) Find the approximate potential at points far from the sphere ($r \gg R$)

Problem 4.6: Electric field of a pure dipole (Griffiths 3rd ed. Prob 3.33)

Show that the electric field of a pure dipole field can be written in the coordinate-free from as

$$\mathbf{E}_{\mathrm{dip}}(\mathbf{r}) = \frac{1}{4\pi\epsilon_0}\frac{1}{r^3}[3(\mathbf{p}\cdot\hat{\mathbf{r}})\hat{\mathbf{r}} - \mathbf{p}]$$

Problem 4.7: Field and potential due to a three-charge system (Griffiths 3rd ed. Prob 3.32)

Calculate the potential, up to two lowest orders in the multipole expansion, at a far-away point due to the three-charge system shown in Fig. 4. Use the potential to calculate the electric field.

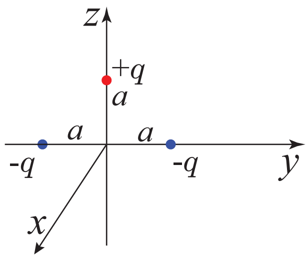

FIG. 4: