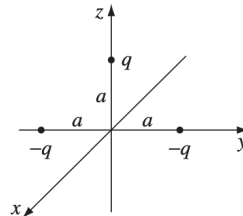


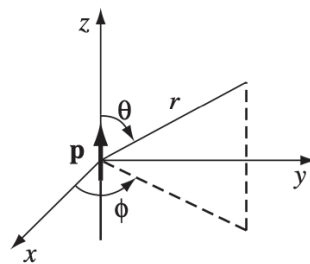
Exercise sheet #6

Problem 1. A circular ring in the xy plane (radius R , centered at the origin) carries a uniform line charge λ . Find the first three terms ($n=0,1,2$) in the multipole expansion of $V(r, \theta)$

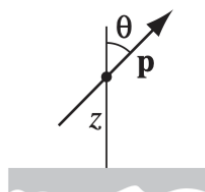
Problem 2. Three point charges are located as shown in the figure below, each a distance a from the origin. Find the approximate electric field at points far from the origin. Express your answer in spherical coordinates, and include the two lowest orders in the multipole expansion.



Problem 3. An ideal electric dipole is situated at the origin, and points in the z direction, as in the figure below. An electric charge is released from rest at a point in the xy plane. Show that it swings back and forth in a semi-circular arc, as though it were a pendulum supported at the origin



Problem 4. A perfect dipole $\mathbf{p}$ is situated at a distance z above an infinite conducting grounding plane (See figure below). The dipole makes an angle θ with the perpendicular to the plane. Find the torque on $\mathbf{p}$. If the dipole is free to rotate, in what orientation will it come to rest?



Problem 5. According to quantum mechanics, the electron cloud for a hydrogen atom in the ground state has a charge density

$$\rho(r) = \frac{q}{\pi a^3} e^{-2r/a}$$

where q is the charge of the electron and a is the Bohr radius. Find the atomic polarizability of such an atom. [Hint: First calculate the electric field of the electron cloud, $E_e(r)$; then expand the exponential, assuming $r \ll a$]