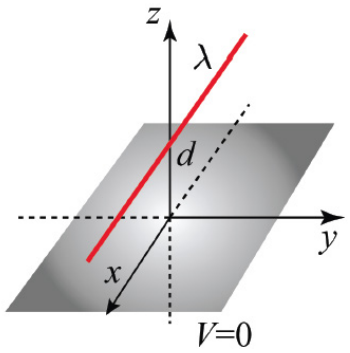
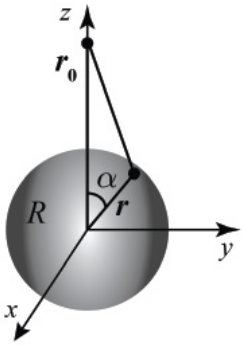
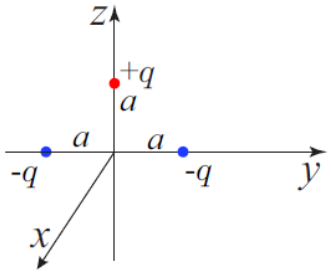
Problem 6.1: An infinite line charge runs parallel to the *x*-axis at a distance *d* from the *xy* plane, which is an infinite grounded conductor as shown in the figure.
(a) What is the potential in the region above the plane.
(b) Find the charge density σ induced on the conducting plane.



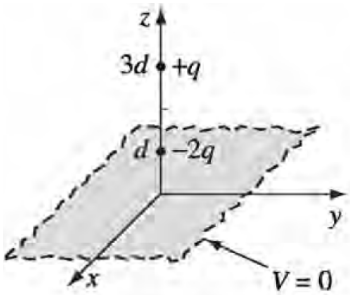
Problem 6.2: A sphere of radius *R*, centered at the origin, carries charge density $\rho(r,\theta) = k\frac{R}{r^2}(R-2r)\sin\theta$, where *k* is a constant and *r*, θ are the usual spherical coordinates [see attached figure]. Find the approximate potential for points $\mathbf{r_0}$ on the *z* axis, far from the sphere.



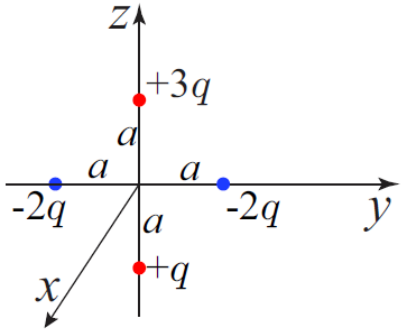
Problem 6.3: Calculate the potential, up to two lowest orders in the multipole expansion, at a far-away point due to the three-charge system shown in the figure. Use the potential to calculate the electric field.



Problem 6.4: Find the force on charge +*q* in the figure in which the *xy* plane is an infinite grounded conductor.



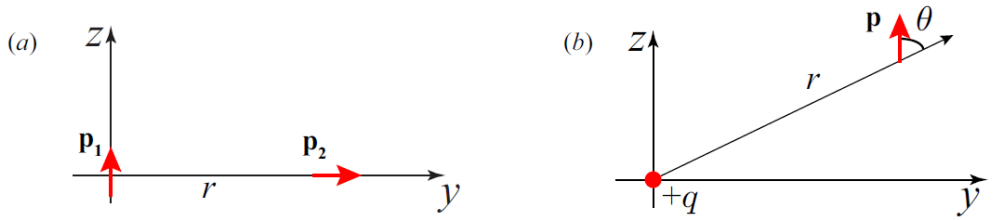
Problem 6.5: For the charge distribution shown in figure, find the approximate potential at points far from the origin.



Problem 6.6: 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 ($r >> R$)

Problem 6.7: Show that the electric field of a pure dipole field can be written in the coordinate-free from as $\mathbf{E}_{\text{dip}}(r) = \frac{1}{4\pi\varepsilon_0}\frac{1}{r^3}[3(\mathbf{p}\cdot\hat{\mathbf{r}})\hat{\mathbf{r}} - \mathbf{p}]$

Problem 6.8: (a) In figure (*a*), $\mathbf{P}_1$ and $\mathbf{P}_2$ are two perfect dipoles separated by a distance r. What is the torque on $\mathbf{P}_1$ due to $\mathbf{P}_2$.
(b) In figure (*b*), a dipole $\mathbf{P}$ is at a distance r from a point charge q, and oriented so that $\mathbf{P}$ makes an angle θ with the vector $\mathbf{r}$ from q to $\mathbf{P}$. What is the force on $\mathbf{P}$?



Problem 6.9: A spherical shell with inner radius a and outer radius b is made of dielectric material with polarization $\mathbf{P} = \frac{k}{r}\hat{\mathbf{r}}$ where k is a constant r is the distance from the center (see figure). Assume no free charge anywhere.
(a) Calculate all the bound charges.
(b) Use Gauss's law for electric fields to calculate the electric field in all the three regions.
(c) Use Gauss's law for electric displacement to calculate the electric field in all the three regions.