

## HOMEWORK SET #6

due Friday Nov 13, 2015

- ① a) The charge distribution in Fig. 1 has a dipole moment  $\vec{p} = q\vec{d}$

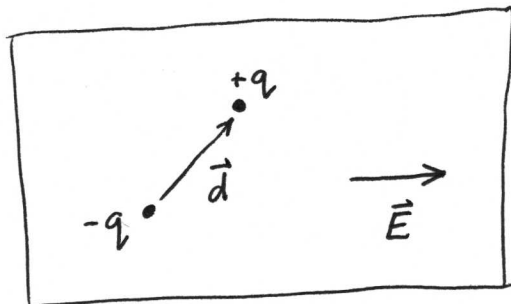


Figure 1

Show that the torque on the dipole is  $\vec{\tau} = \vec{p} \times \vec{E}$

- b) In Fig. 2,  $\vec{p}_1$  and  $\vec{p}_2$  are (perfect) dipoles a distance  $r$  apart. What is the torque on  $\vec{p}_1$  due to  $\vec{p}_2$ ? What is the torque on  $\vec{p}_2$  due to  $\vec{p}_1$ ?

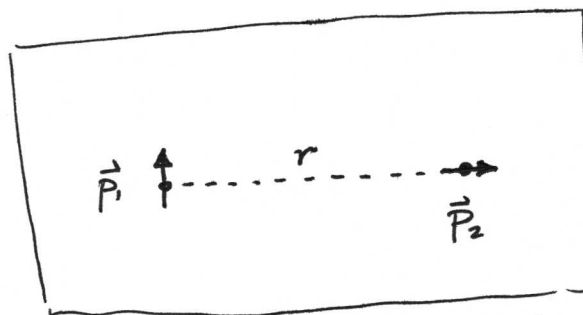


Figure 2

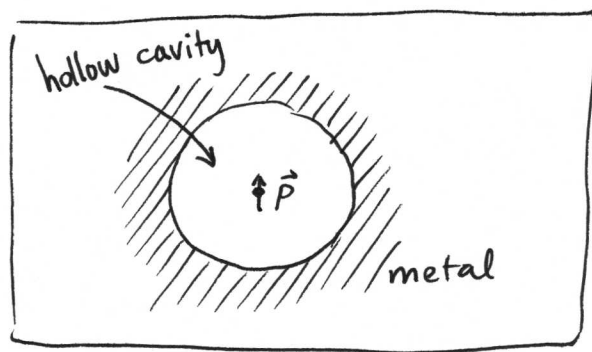
- c) Show that the energy of an ideal dipole  $\vec{p}$  in an electric field  $\vec{E}$  is given by

$$U = -\vec{p} \cdot \vec{E}$$

- ② A perfect dipole, aligned to the  $z$ -axis, generates a potential

$$\bar{\Phi}(r, \theta) = \frac{p}{4\pi\epsilon_0} \frac{1}{r^2} \cos\theta$$

This dipole is placed at the center of a grounded, ~~hollow~~ metal spherical cavity, as shown in Fig 3



The radius of the hollow cavity is  $b$ . A surface charge  $\sigma(b, \theta)$  is induced such that  $\bar{\Phi}(b, \theta) = 0$ .

- a) Find the potential  $\bar{\Phi}(r, \theta)$  for  $r < b$ .

Hint:  $\nabla^2(r^l P_l(\cos\theta)) = 0$

- b) Find  $\sigma(b, \theta)$