

1. [30%] A point charge q is located at x_0 inside a grounded conducting sphere with radius a (centered at the origin).

(a) Find out the potential $\Phi(\mathbf{x})$ inside the sphere using the method of image.

(b) What is the potential $\Phi(\mathbf{x})$ outside the sphere?

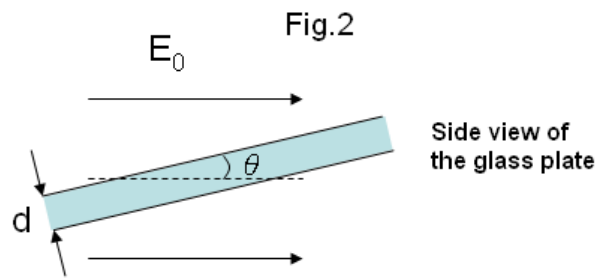
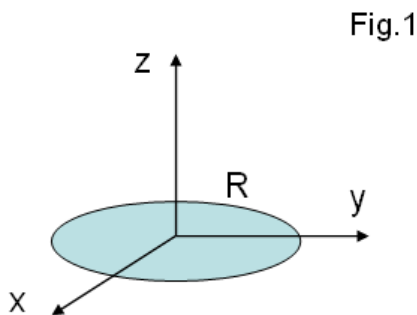
(c) What is the energy density $w(0)$ at the center of the sphere?

2. [40%] A thin disk with radius R is lying on the x - y plane (see Fig.1). The disk is uniformly charged with a total charge Q .

(a) Find out the potential $\Phi(z)$ along the positive z -axis.

(b) Find out the potential $\Phi(\mathbf{x})$ away from the z -axis, assuming $|\mathbf{x}| > R$. The answer only needs to be correct to order $1/z^3$.

(c) What is the normal component of the electric field on the surface of the disk?



3. [30%] (a) Prove the following statement: If an interface is not charged, then the tangential component of the \mathbf{E} field and the normal component of the \mathbf{D} have to be continuous across the interface.

(b) A large flat plate of glass of thickness d and dielectric constant $\epsilon_r = \epsilon/\epsilon_0$ is placed in a uniform electric field E_0 . The plate is inclined at an angle $\theta \ll 1$ with respect to the electric field (see Fig.2). What is the angle θ' (with respect to the surface of the plate) of the \mathbf{E} field inside the glass?

(c) What is the magnitude of the \mathbf{E} field inside the glass?

Note: $P_0(x)=1$, $P_1(x)=x$, $P_2(x)=(3x^2-1)/2$...