

Physics 251: In lab Electrostatics Problems (Lab 02)

In answering these problems, you must show complete details, providing vectors and correct SI units.

(1) Consider 2 charges: 1: ($1\mu\text{C};0,-b,0$); 2:($-1\mu\text{C},0,+b,0$). Find the vector electric field along the $+x$ axis. If a charge ($3\mu\text{C};a,0,0$) is placed, find the vector force on the charge. Provide numerical answers with correct SI units for the case $b=0.1\text{ m}$ and $a=0.5\text{ m}$. Also, make a sketch of the electric field map (without the last charge).

(2) A sphere of charge of radius a has a total charge Q spread uniformly over its volume. (a) Find the volume charge density, ρ . (b) Find the vector electric field outside the sphere. (c) Find the vector electric field inside the sphere. (d) Show that at the surface of the sphere, the two fields are the same. (e) Suppose an extra charge q is placed at the center of the sphere. Provide answers for the vector electric field inside and outside the sphere.

(3) A long wire has a charge per unit length λ . Find the vector electric field at a distance s from the wire.

(4) An infinite plane in the xy plane has a surface charge density σ . Find the vector electric field in the $+z$ and $-z$ regions of space.

(5) An infinite plane in the xy plane is located at $z=0$ and has a surface charge density $-\sigma$. A second parallel plane is located at $z=d$ and has a surface charge density $+\sigma$. (1) find the vector electric field in all regions of space. (2) Suppose the plane has a total area A and a total charge Q . Express, again, your answer in terms of A and Q .

(6) **Calculus:** A sphere of radius a has a volume charge density given by:
 $\rho=\rho_0\left(\frac{r}{a}\right)^2$. (1) If the sphere has a total charge Q , find ρ_0 . (2) Find the vector electric field inside and outside the sphere.

(7) **Non-Calculus:** A sphere of radius a has a total charge Q . The inside of the sphere is hollowed out and is of the form of a sphere of radius b , $b<a$. (1) if the sphere has a uniform volume charge density, find ρ . (2) Find the vector electric field for the 3 cases: $r<b$, $b<r<a$, $r>a$.

(8) A sphere is electrically uncharged and consists of two spheres, one of radius b ($b<a$) with a total charge $-Q$ and the other with a radius a ($a>b$) with a total charge $+Q$ (a) Find the volume charge density in each of the two regions, assuming the charge is uniformly distributed in the sub sections. (b) Find the vector electric field for $r<b$, $b<r<a$, $r>a$.