SP212
Worksheet 6
Ch 23.(3-6) Using Gauss’ Law

NOTE: Whenever we want to try and use Gauss’ law to find the electric field due to a charge distribution, we need to find some surface over which the magnitude of the electric field is constant. This allows us to factor the electric field out of the flux integral.

Problem 1

A spherical conductor has a spherical cavity carved out of the middle of it. The conductor carries a net charge of +2 µC. In addition, a point charge of size −3 µC has been placed at the center of the cavity.

a) What is the total charge that resides on the interior surface of the conductor?
HINT: Consider a spherical Gaussian surface that is just larger than the radius of the cavity.
b) What is the total charge that resides on the exterior surface of the conductor?
c) If the outer radius of the conductor is $R = 0.35$ m, what is the surface charge density on the outer surface? What is the magnitude of the electric field just outside of the conductor near the outer surface? (The surface area of a sphere is $4\pi R^2$)

Problem 2

An infinitely long solid cylinder of radius $R$ has a non-uniform volume charge density that varies with the distance from the center as $\rho = Ar^2$ where $A$ is a constant.

a) Consider a Gaussian surface that is a cylinder of length $L$ and radius $r$ where $r < R$. What is the total charge enclosed by this surface?
HINT: Think of the portion of the cylinder enclosed by the surface as a series of concentric infinitesimally thin cylindrical shells. How much charge is in each shell?

How would your answer change for $r > R$?

b) Using Gauss’ law and your results from part (a), what is the electric field due to the cylinder of charge at a distance $r$ where $r < R$?
HINT: In terms of the magnitude of the electric field $E$ what is the electric flux through the Gaussian surface (you only have to worry about the side of the surface, not the top or bottom).