PHY 5346
HW Set 1 Solutions – Kimel

1. 1.1

Background:

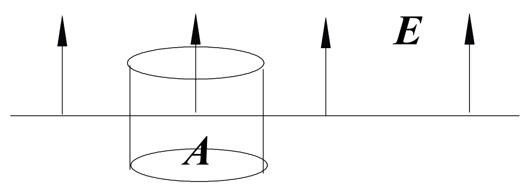
$$\text{Gauss's Law: } \int \vec{E} \cdot d\vec{a} = \frac{q_{enc}}{\varepsilon_0}$$

Also, a conductor is defined as a material in which the conducting electrons move freely if an external electric field is applied. Thus in static equilibrium, there is no electric field present within a conductor; similarly an electric field parallel to the surface of the conductor would cause charges to move on the surface, and so this electric field cannot exist in static equilibrium. We conclude only electric fields perpendicular to the suface of the conductor can exist.

a) From the above arguments, the excess charge lies completely on the surface.

b) Consider a closed hollow conductor. Now bring up a collection of charges on the outside (bring them slowly so that static equillibrium alway obtains.) From our above arguments, the electric field lines from the charges never penetrate the conductor, so the hollow region within is shielded. On the other hand, if charges are placed within the hollow part of the conductor, electric fields exist throughout the interior because Gauss's law shows the electric field is non-zero for any surface within the interior which encloses the charges brought in.

c) Consider the Gaussian pillbox



Gauss's Law gives

$$\int \vec{E} \cdot d\vec{a} = AE = \frac{A\sigma}{\varepsilon_0} \rightarrow E = \frac{\sigma}{\varepsilon_0}$$