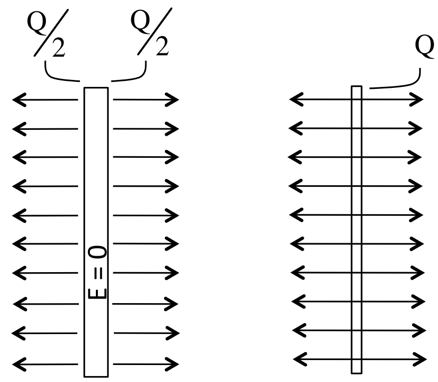
Problem 24.39

What's tricky about this is the fact that the charge on the conductor will be distributed over *both* sides of the aluminum plate, whereas *all* of the charge will be on the single glass surface. A diagram of each situation is shown to the right. Playing this out:



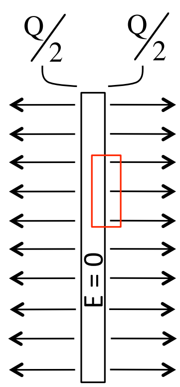
surface charge density for aluminum plate:

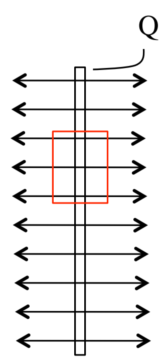
$$\sigma_{Al} = \frac{\text{charge}}{\text{plate area}} = \frac{Q/2}{A_{plate}} = \frac{Q}{2A_{plate}}$$

surface charge density for glass plate:

$$\sigma_{glass} = \frac{\text{charge}}{\text{plate area}} = \frac{Q}{A_{plate}}$$

Let's use Gaussian plugs with the same cap-end area *A'*. Placing as shown, the *charged enclosed* is the same for each situation but we get flux through only one end-cap for the aluminum whereas we get flux through two end-caps for the glass. With that, Gauss's Law yields:





$$\int \vec{E}_{Al} \bullet d\vec{A} = \frac{q_{encl}}{\varepsilon_o}$$

$$\Rightarrow \quad E_{Al}A' = \frac{\sigma_{Al}A'}{\varepsilon_o}$$

$$\Rightarrow \quad E_{Al}A' = \frac{\left(\frac{Q}{2A_{plate}}\right)A'}{\varepsilon_o}$$

$$\Rightarrow \quad E_{Al} = \frac{Q}{2\varepsilon_o A_{plate}}$$

$$\int \vec{E}_{glass} \bullet d\vec{A} = \frac{q_{encl}}{\varepsilon_o}$$

$$\Rightarrow \quad 2E_{glass}A' = \frac{\sigma_{glass}A'}{\varepsilon_o}$$

$$\Rightarrow \quad 2E_{glass}A' = \frac{\left(\frac{Q}{A_{plate}}\right)A'}{\varepsilon_o}$$

$$\Rightarrow \quad E_{glass} = \frac{Q}{2\varepsilon_o A_{plate}}$$

Huzzah! Apparently, they will be the same!