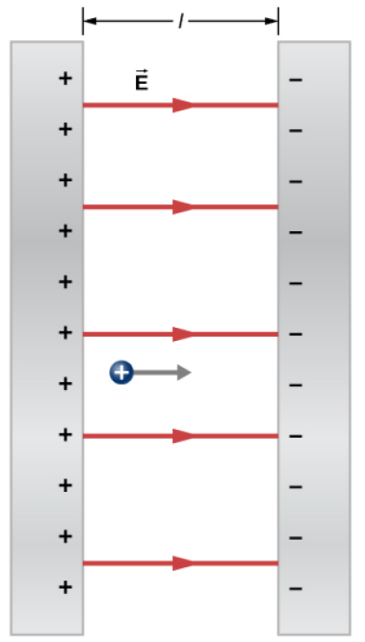
Chapter 6 Problem 68 †



Given
$q = 1.0 \times 10^{12} e$
$A = 400\ cm^2 = 0.0400\ m^2$
$e = 1.60 \times 10^{-19}\ C$
$\epsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$

Solution
a) Find the charge density on each plate.

Surface charge density is just the charge divided by the area. The charge is just the number of electrons multiplied by the fundamental charge.

$$\sigma = \frac{q}{A} = \frac{(1.0 \times 10^{12})(1.60 \times 10^{-19}\ C)}{0.0400\ m^2} = 4.0 \times 10^{-6}\ C/m^2$$

Note: The area was converted to square meters. When doing that, you need to apply the conversion factor between centimeters and meters twice. Therefore, the number is 10,000 times smaller.

b) Find the electric field between the plates.

We know for a large single plate, the electric field is

$$E = \frac{\sigma}{2\epsilon_0}$$

The combination of two plates with opposite charge results in twice this electric field between the plates and no electric field outside the combination of two plates. Therefore,

$$E = \frac{\sigma}{\epsilon_0}$$

Notice that this is the same equation for finding electric field above the surface of a conductor. The electric field is then

$$E = \frac{4.0 \times 10^{-6}\ C/m^2}{8.85 \times 10^{-12}\ C^2/Nm^2} = 4.51 \times 10^5\ N/C$$

†Problem from Univesity Physics by Ling, Sanny and Moebs (OpenStax)