

Homework 12 for September 17 2008
Due 8AM on September 18 2008
Physics 221 with Professor Jeff Terry

1. A large square plate of copper with 50.0-cm sides has no net charge and is placed in a region of uniform electric field of 80.0 kN/C directed perpendicular to the plate. Find (a) the charge density of each face of the plate and

This problem is a little trickier, conceptually, than first glance would tell you. The way to solve it is to first realize that the external field will pull protons in the direction of the field and pull electrons in the opposite direction. As they do, the charge will build up on the faces of the plate and create a field in opposition to the external field. At some point, the net field internally will be zero and no more charge will be pulled on to the faces. At this point, the plates (parallel and of opposite charge) will be generating a field equal and opposite to the external field, satisfying

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

$$\sigma = \epsilon_0 E = \left(8.85 \cdot 10^{-12} \frac{C^2}{Nm^2} \right) \left(8.00 \cdot 10^4 \frac{N}{C} \right) = 7.08 \cdot 10^{-7} \frac{C}{m^2}$$

This is the magnitude. It will be positive charge on one face and negative on the other – this has to be the case because otherwise charge conservation would be violated. The positive charge side will be in the direction of the field.

2. (b) the total charge on each face.

$$\sigma = \frac{Q}{A} \therefore Q = A\sigma = (0.500m)^2 \left(7.08 \cdot 10^{-7} \frac{C}{m^2} \right) = 1.77 \cdot 10^{-7} C$$

Once again, this is the magnitude and the sign of the charge is the same as in problem 1.