

321.

**Problem 29.19 (RHK)**

*A metal plate 8.0 cm on a side carries a total charge of  $6.0 \mu\text{C}$ . We will calculate in the infinite plate approximation (a) the electric field 0.50 mm above the surface of the plate near the plate's centre; (b) the field at a distance of 30 m.*

**Solution:**

(a)

The area of the metal plate which is 8.0 cm on a side is

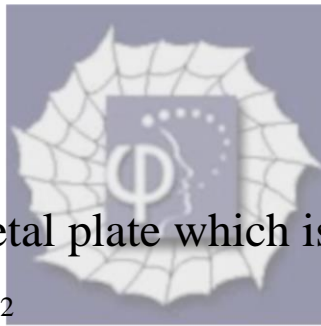
$$A = (8.0 \times 10^{-2})^2 \text{ m}^2.$$

Total charge on the plate is  $Q = 6.0 \times 10^{-6} \text{ C}$ .

On a metallic plate charge will be equally divided on its two sides, front and back. Therefore, the surface charge density on each side of the plate will be

$$\sigma = \frac{Q}{2A} = \frac{6.0 \times 10^{-6}}{2 \times 64 \times 10^{-4}} \text{ C m}^{-2} = 4.69 \times 10^{-4} \text{ C m}^{-2}.$$

In the infinite plate approximation the electric field at a distance of 0.50 mm above the surface and for that



matter at any other distance from the plate will be given by

$$E = \frac{\sigma}{\epsilon_0} = \frac{4.69 \times 10^{-4}}{8.85 \times 10^{-12}} \text{ N C}^{-1} = 5.3 \times 10^7 \text{ N C}^{-1} = 53 \text{ MN C}^{-1}.$$

(b)

If we want to estimate the field at a distance of 30 m from the plate, we can assume that the total charge of  $6.0 \mu\text{C}$  is concentrated at a point and in this approximation the electric field will be

$$E(30 \text{ m}) = \frac{6.0 \times 10^{-6}}{4\pi\epsilon_0 \times 30^2} \text{ N C}^{-1} = \frac{8.99 \times 10^9 \times 6.0 \times 10^{-6}}{9 \times 10^2} \text{ N C}^{-1} = 60 \text{ N C}^{-1}.$$

