

27. (a) To calculate the electric field at a point very close to the center of a large, uniformly charged conducting plate, we may replace the finite plate with an infinite plate with the same area charge density and take the magnitude of the field to be $E = \sigma/\varepsilon_0$, where σ is the area charge density for the surface just under the point. The charge is distributed uniformly over both sides of the original plate, with half being on the side near the field point. Thus,

$$\sigma = \frac{q}{2A} = \frac{6.0 \times 10^{-6} \text{ C}}{2(0.080 \text{ m})^2} = 4.69 \times 10^{-4} \text{ C/m}^2 .$$

The magnitude of the field is

$$E = \frac{4.69 \times 10^{-4} \text{ C/m}^2}{8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2} = 5.3 \times 10^7 \text{ N/C} .$$

The field is normal to the plate and since the charge on the plate is positive, it points away from the plate.

- (b) At a point far away from the plate, the electric field is nearly that of a point particle with charge equal to the total charge on the plate. The magnitude of the field is $E = q/4\pi\varepsilon_0 r^2 = kq/r^2$, where r is the distance from the plate. Thus,

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