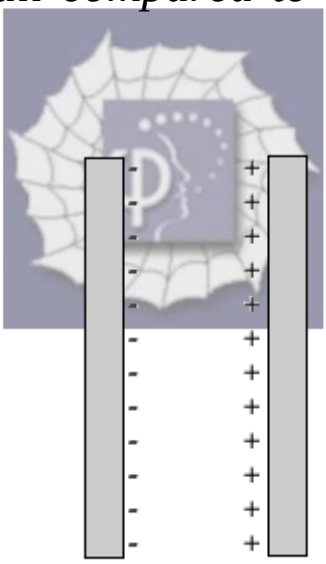
322.

Problem 29.23 (RHK)

Two large metal plates face each other with surface charge density $+\sigma$ *and* $-\sigma$, *respectively. We have to find* $\vec{E}$ *at points* (a) *to the left of the sheets,* (b) *between them, and* (c) *to the right of the sheets. We may consider points which are not near the edges and whose distances from the sheets are small compared to the dimensions of the sheet.*



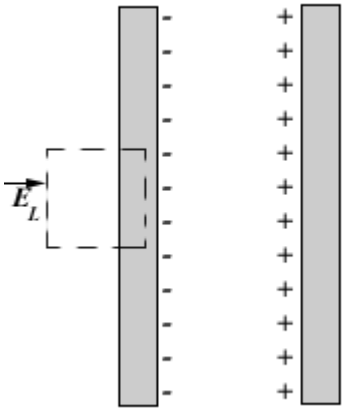
Solution:

We will find the electric field in the three regions by assuming that the field is uniform and is perpendicular to the plates.

Surface charge density on the inner side of the left-plate is $-\sigma$.

Surface charge density on the inner side of the right-plate is $+\sigma$.

(a)

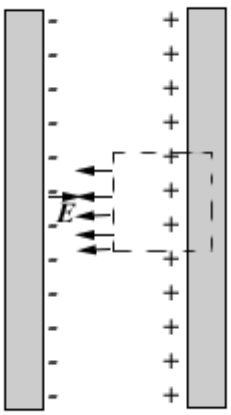


We consider a Gaussian surface as shown in the following figure. We note that one face of the Gaussian surface is inside the metallic conductor. We use the fact that the electric field inside a conductor is zero. Also the Gaussian surfaces are far away from the edges of the plates, so the electric field is assumed to be uniform and is perpendicular to the plate.

As no charge is enclosed by the Gaussian surface shown in the figure, by Gauss' law we find

$E_L = 0.$

(b)



We consider a Gaussian surface as shown in the figure. The direction of the electric field is as shown. Therefore, the flux through the Gaussian surface will be

EA. The total charge enclosed by the Gaussian surface will be

$$Q = \sigma A.$$

By Gauss' law we find

$$\varepsilon_0 EA = \sigma A.$$

Or

$$E = \frac{\sigma}{\varepsilon_0}.$$

(c)

Using reasoning similar to that used in part (a) and Gaussian surface as shown in the figure, we find that the electric field to the right of the right-plate will be zero.