Consider an electrostatic situation. A parallel plate system has a plate charge \( +Q \) on the left-hand plate and a plate charge \( -Q \) on the right-hand plate. Each plate has an area \( A \).

Determine the force \( F \) the right-hand plate exerts on the left-hand plate.

A) \( \vec{F}_{left} = \frac{Q^2}{\varepsilon_0 A} \), to the right.

B) \( \vec{F}_{left} = \frac{Q^2}{\varepsilon_0 A} \), to the left.

C) \( \vec{F}_{left} = \frac{Q^2}{2 \varepsilon_0 A} \), to the right.

D) \( \vec{F}_{left} = \frac{Q^2}{2 \varepsilon_0 A} \), to the left.
The areal charge density is \( \sigma = \frac{Q}{A} \), therefore

\[
E_{gap} = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}.
\]

The electric field due to be right-hand plate alone contributes to one-half of the total field in the gap; \( i.e., \)

\[
E_{left} = \frac{\sigma}{2 \varepsilon_0} = \frac{Q}{2 \varepsilon_0 A} \quad \Rightarrow \quad \vec{F}_{left} = \frac{Q^2}{2 \varepsilon_0 A}, \quad \text{to the right}.
\]

Answer C.

24.04-02 Field Between Plates 2005-9-15