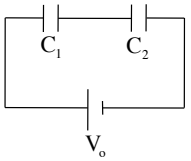
Problem 26.36

Determine the force one charged plate of a parallel plate cap exerts on the other plate:



If we can determine the electric field the plates are bathed in, we can determine the force the charges on the plates are feeling due to that field. To get the electric field, we need the voltage difference across the plates. To get that from the capacitance (just for fun):

$$C = \frac{Q}{V_C}$$

$$\Rightarrow \quad V_C = \frac{Q}{C}$$

$$= \frac{Q}{\left(\varepsilon_o A / x\right)}$$

$$\Rightarrow \quad V_C = \left(Q / \varepsilon_o A\right) x$$

Knowing that the general relationship between an electric field in the "x" direction and it's associated electrical potential field is

$$E = -\frac{dV}{dx}$$

and knowing that the electric field between the plates and the potential function for a capacitor V_C (defined as positive) across the plates is

$$E_{\text{between plates}} = \frac{dV_C}{dx}$$

we can write:

$$E = \frac{dV_C}{dx}$$

$$= \frac{d\left(\frac{Q}{\varepsilon_o A} x\right)}{dx}$$

$$= \frac{Q}{\varepsilon_o A}$$

By definition:

$$E = \frac{F}{q}$$

So we can write:

$$F = QE$$

$$= Q\left(\frac{Q}{\varepsilon_o A}\right)$$

$$= \frac{Q^2}{\varepsilon_o A}$$