Answer on Question #45156-Physics-Electromagnetism

Show that, when a dielectric material is filled between the plates of a capacitor, the value of capacitance increases by a factor of e_r . e_r is the relative permittivity of the dielectric.

Solution

The dielectric of constant e_r drops the electric field by the same factor,

$$E_{diel} = \frac{E_0}{e_r},$$

where E_0 is the field with no dielectric.

The difference in potential is proportional to the electric field

$$V \sim E \rightarrow \frac{V_{diel}}{V_0} = \frac{E_{diel}}{E_0} = \frac{1}{e_r}.$$

The capacitance is defined as $= \frac{Q}{V}$, and so

$$C_{diel} = \frac{Q}{V_{diel}} = \frac{Q}{V_0/e_r} = e_r \frac{Q}{V_0} = e_r C_0.$$