Answer on question #77065 - Physics / Electric Circuits

A parallel plate capacitor has two plates of area separated by a distance in air. the capacitor is connected to a 9-volt battery. You insert between the two plates a slab of plastic that has a dielectric constant k=6. What will happen to the capacitance of the capacitor and to the energy stored in the capacitor when you insert the dielectric?

Input Data:

air permittivity: $\varepsilon_{air} = 1;$

plastic permittivity: $\varepsilon_{plastic} = 6;$

Solution:

The capacitance of the capacitor is found from the formula:

$$C = \varepsilon \frac{\varepsilon 0 * S}{d}$$

Energy stored in the capacitor:

$$W = \frac{CU^2}{2}$$

It is obvious that the capacitance is directly proportional to the dielectric constant, and the stored energy is directly proportional to the capacitance.
Then, substituting the values, we get:

$C_{air} = 1 * \frac{\varepsilon 0 * S}{d};$

$C_{plastic} = 6 * \frac{\varepsilon 0 * S}{d}$, then

$C_{plastic} = 6 * C_{air};$

$W_{air} = \frac{C_{air} U^2}{2};$

$W_{plastic} = \frac{6 * C_{air} U^2}{2};$

Answer:

When you insert a plastic plate into the air gap of the capacitor, the power and stored energy will increase by a factor of 6. At the same time, there will be additional power consumption from the battery.