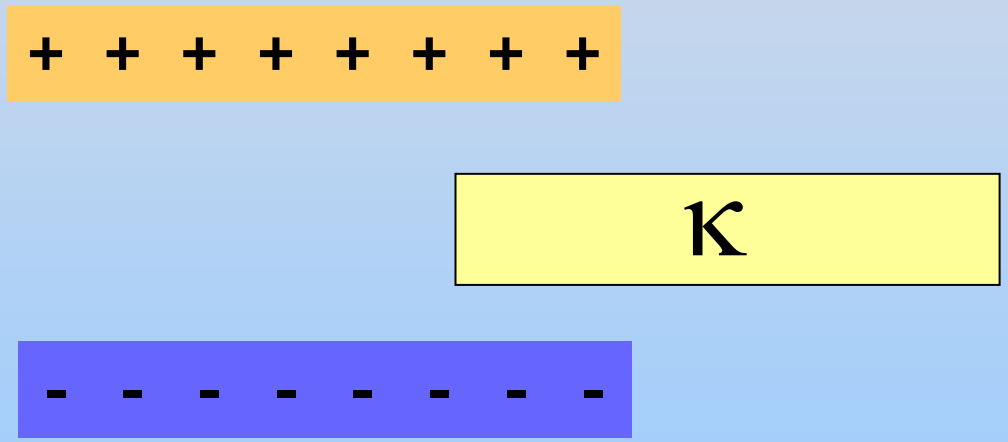
Concept Question: Dielectric

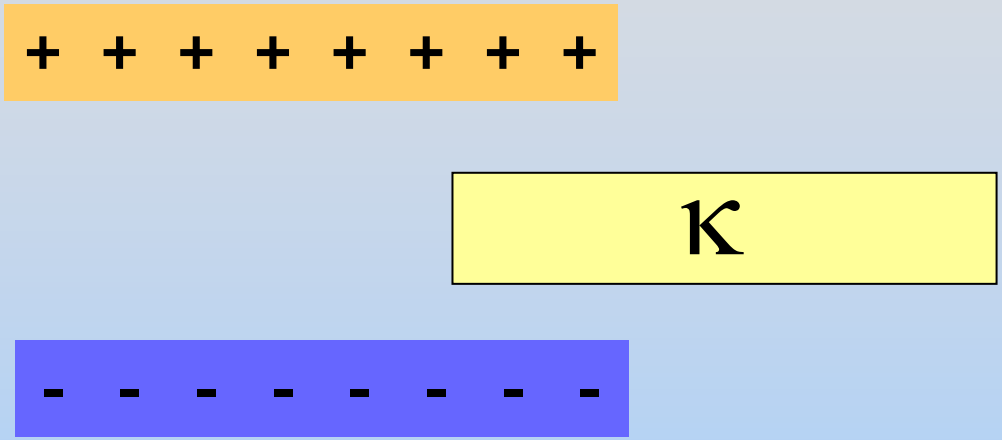
A parallel plate capacitor is charged to a total charge Q and the battery removed. A slab of material with dielectric constant κ in inserted between the plates. The **charge** stored in the capacitor



1. Increases
2. Decreases
3. Stays the Same

Concept Question Answer: Dielectric

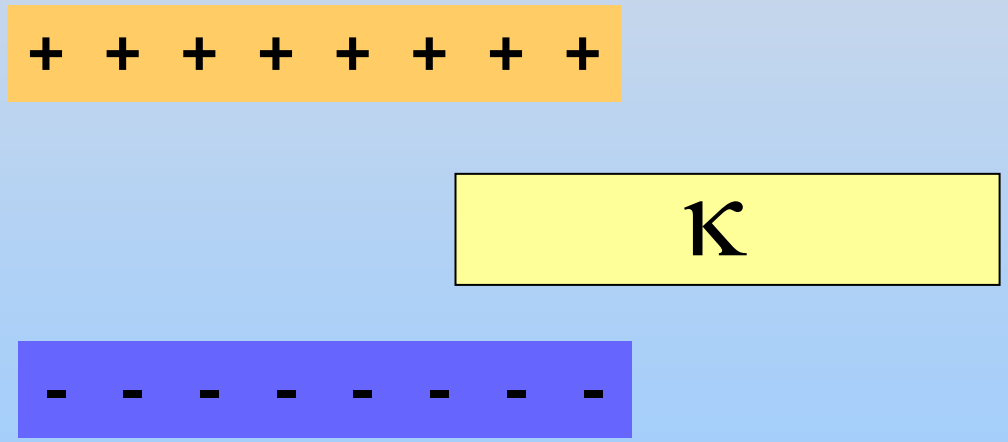
Answer: 3. Charge stays the same



Since the capacitor is disconnected from a battery there is no way for the amount of charge on it to change.

Concept Question: Dielectric

A parallel plate capacitor is charged to a total charge Q and the battery removed. A slab of material with dielectric constant κ in inserted between the plates. The **energy** stored in the capacitor



1. Increases
2. Decreases
3. Stays the Same

Concept Question Answer: Dielectric

Answer: 2. Energy stored decreases

The dielectric reduces the electric field and hence reduces the amount of energy stored in the field.

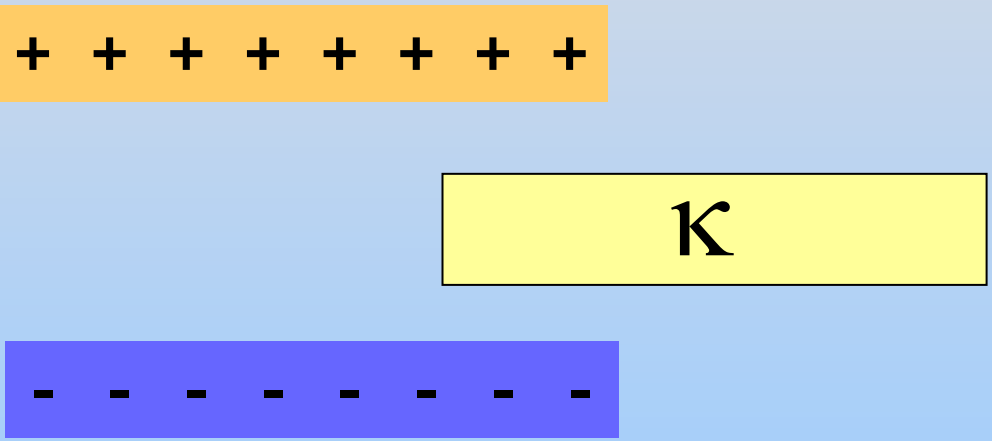
The easiest way to think about this is that the capacitance is increased while the charge remains the same so $U = Q^2/2C$

Also from energy density:

$$u_{E,0} = \frac{1}{2}\varepsilon_0 E^2 \Rightarrow \frac{1}{2}(\kappa\varepsilon_0)\left(\frac{E}{\kappa}\right)^2 < u_{E,0}$$

Concept Question: Dielectric

A parallel plate capacitor is charged to a total charge Q and the battery removed. A slab of material with dielectric constant κ in inserted between the plates. The **force on the dielectric**



1. pulls in the dielectric
2. pushes out the dielectric
3. is zero

Concept Question Answer: Dielectric

Answer: 1. The dielectric is pulled in

We just saw that the energy is reduced by the introduction of a dielectric. Since systems want to reduce their energy, the dielectric will be sucked into the capacitor.

Alternatively, since opposing charges are induced on the dielectric surfaces close to the plates, the attraction between these will lead to the attractive force.

8.02SC Physics II: Electricity and Magnetism

Fall 2010