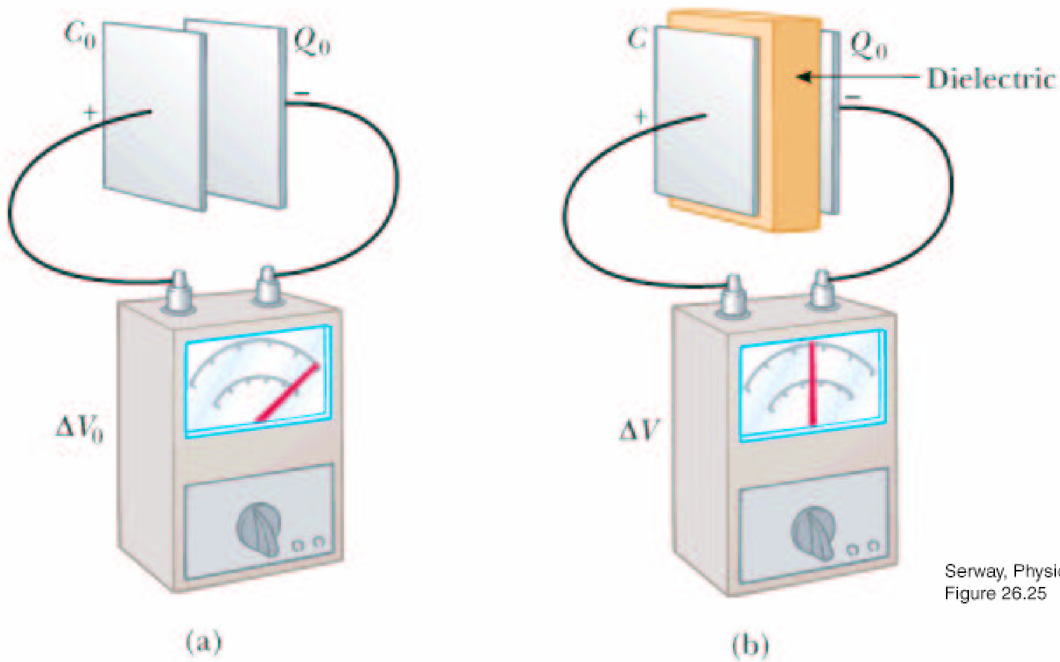
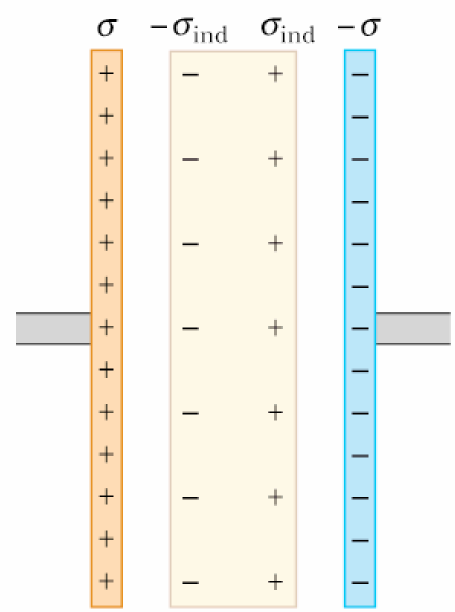
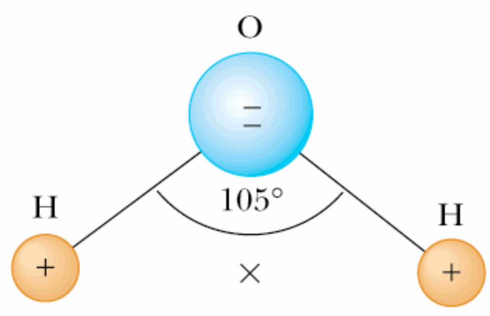
Serway, Physics for Scientists and Engineers, 5/e
Figure 26.14



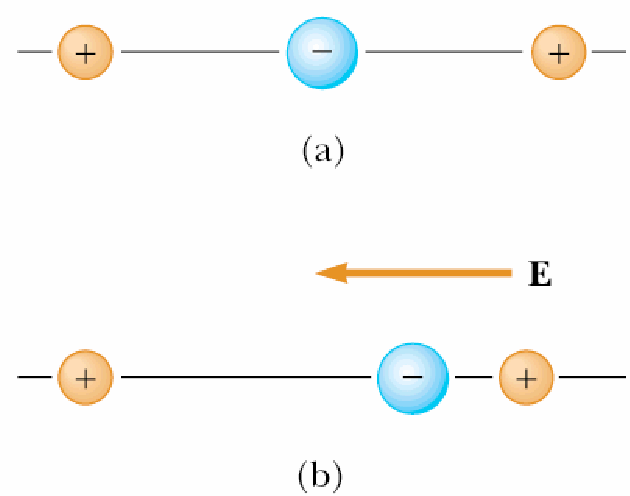
Serway, Physics for Scientists and Engineers, 5/e
Figure 26.25



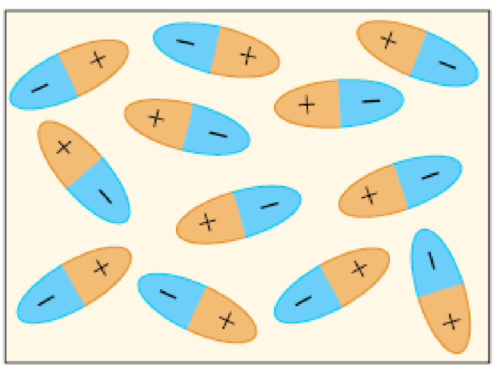
Serway, Physics for Scientists and Engineers, 5/e
Figure 26.21



Serway, Physics for Scientists and Engineers, 5/e
Figure 26.22

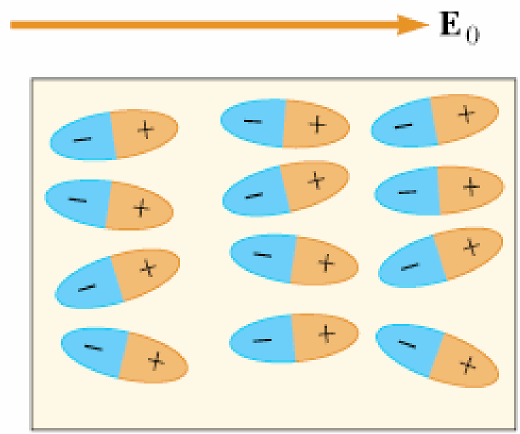


Serway, Physics for Scientists and Engineers, 5/e
Figure 26.23

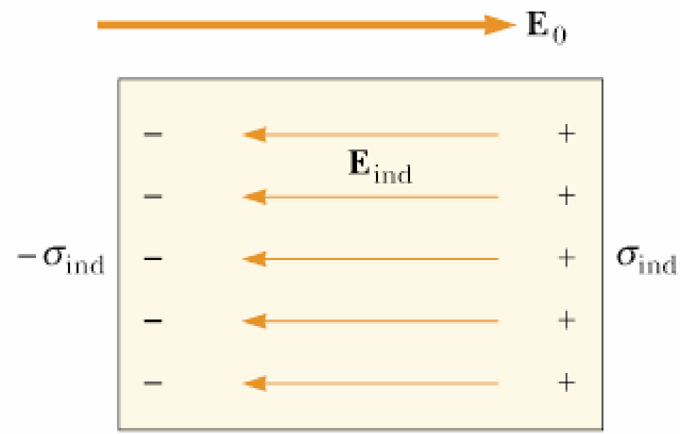


(a)

Serway, Physics for Scientists and Engineers, 5/e
Figure 26.24

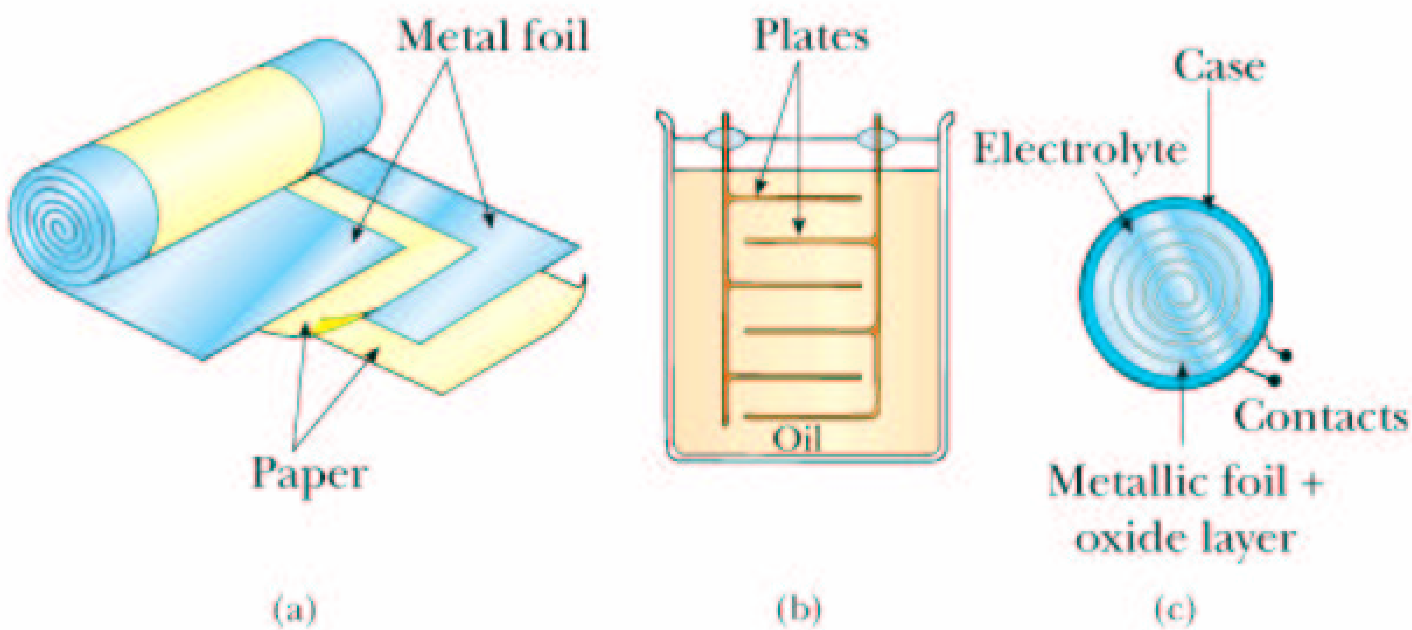


(a)



(b)

Serway, Physics for Scientists and Engineers, 5/e
Figure 26.15



Capacitors with Dielectrics

- A dielectric in a non-conducting material that lowers the electric field, hence the voltage of a capacitor for a given charge Q.

$$\Delta V = \frac{\Delta V_0}{\kappa} \tag{53}$$

- κ is the **dielectric constant** of the material and is larger than 1. ($\kappa = 1$ for vacuum)

- If the capacitance, charge and the voltage of the capacitor without dielectric are C_0, Q_0, and ΔV_0, capacitance C of the capacitor with the dielectric:

$$C = \frac{Q_0}{\Delta V} \tag{54}$$

$$= \frac{Q_0}{\Delta V_0/\kappa} \tag{55}$$

$$= \kappa \frac{Q_0}{\Delta V_0} \tag{56}$$

$$C = \kappa C_0 \tag{57}$$

- **The capacitance increases by factor κ when the dielectric completely fills the region between the plates.**

- For a parallel plate capacitor with a dielectric in:

$$C = \kappa \frac{\epsilon_0 A}{d} \tag{58}$$

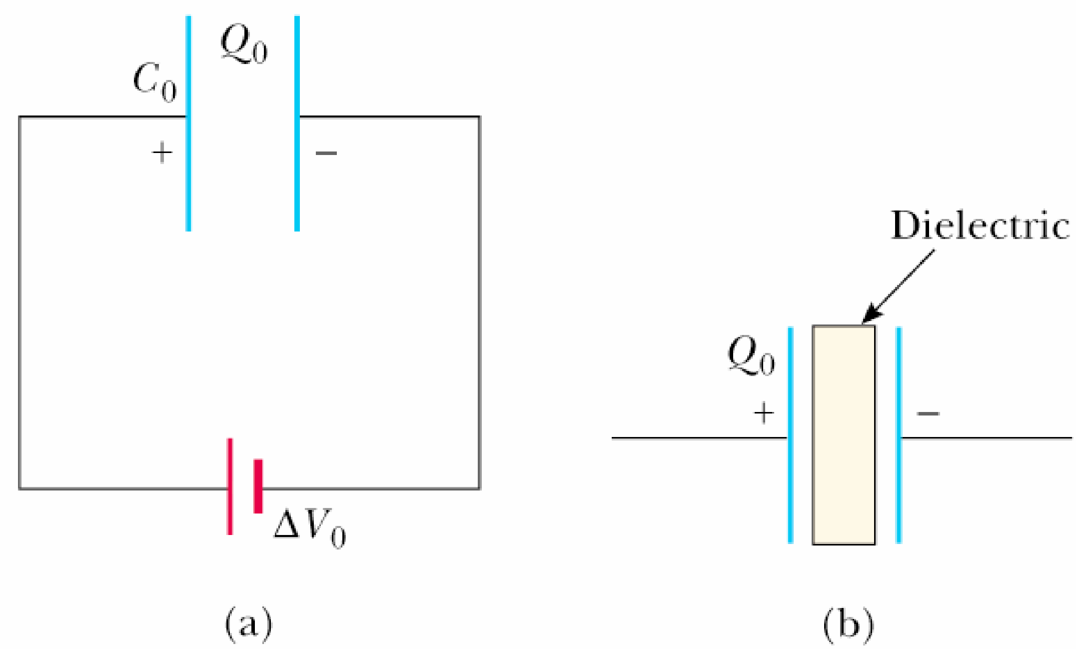
- In addition to increasing the capacitance of a capacitor, dielectrics also increase the maximum electric field that can be applied on a capacitor without causing a discharge. This maximum electric field is known as the **dielectric strength**

Example 26.7

A parallel plate capacitor is charged with a battery to a charge Q_0. Battery is then removed and a slab of material with dielectric constant κ is inserted between the plates. Find the energy stored in the capacitor before and after the dielectric is inserted.

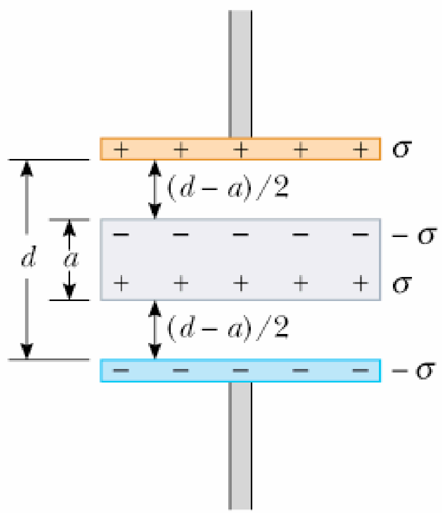
$$U = \frac{Q^2}{2C} \qquad (59)$$

Serway, Physics for Scientists and Engineers, 5/e
Figure 26.17

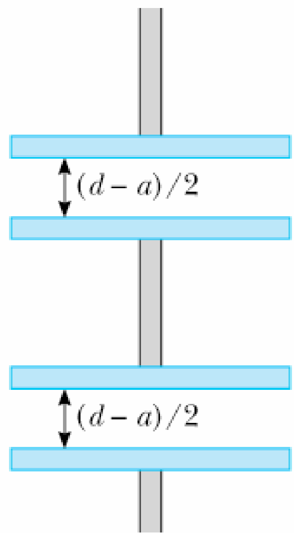


Harcourt, Inc.

Serway, Physics for Scientists and Engineers, 5/e
Figure 26.26



(a)



Example 26.9

An uncharged metalic plate is inserted midway between the plates of a parallel plate capacitor.

- Find the capacitance of the device

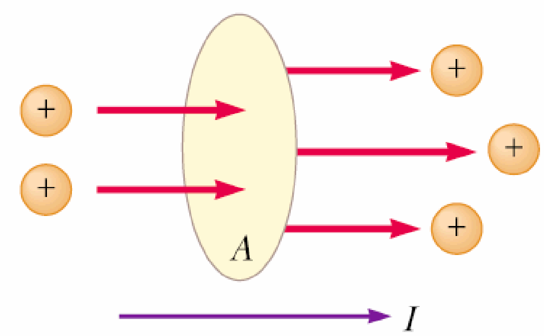
  The slab has created two capacitors, each with separation $(d - a)/2$, connected in series.

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \tag{60}$$

$$= \frac{1}{\frac{\epsilon_0 A}{(d-a)/2}} + \frac{1}{\frac{\epsilon_0 A}{(d-a)/2}} \tag{61}$$

$$\Rightarrow C = \frac{\epsilon_0 A}{(d - a)} \tag{62}$$

Serway, Physics for Scientists and Engineers, 5/e
Figure 27.1



Harcourt, I

Current and Resistance

- When there is a net flow of charge in a region an electric **current** is said to exist.
- A current through a surface is defined as the **rate at which charge flows through this surface**
- If ΔQ amount of charge passes through a surface in a time interval Δt, the average current I_{av} is the charge that passes through that surface per unit time:

$$I_{av} = \frac{\Delta Q}{\Delta t} \qquad (1)$$

- The instantaneous current I through a surface:

$$I = \frac{dQ}{dt} \qquad (2)$$

-
- The unit of current is the **ampere**

$$1\ A = \frac{1\ C}{1\ S} \qquad (3)$$

- The direction of the current is defined to be along the flow of **positive charges**
- It is the negatively charged electrons that really flow to generate the current. The direction of the current is opposite to the direction of the electron flow.

Serway, Physics for Scientists and Engineers, 5/e
Figure 27.2