PHYSICS II

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Content

- Summary from last lecture

1-Capacitors

2-Dielectrics

3-Ohm's Law

- Resistors

(Aim of this lecture is to learn the codes of resistors)

- Resistivity

1-Capacitors

A **capacitor** is a device that can store electric charge, and normally consists of two conducting objects (usually plates or sheets) placed near each other but not touching.

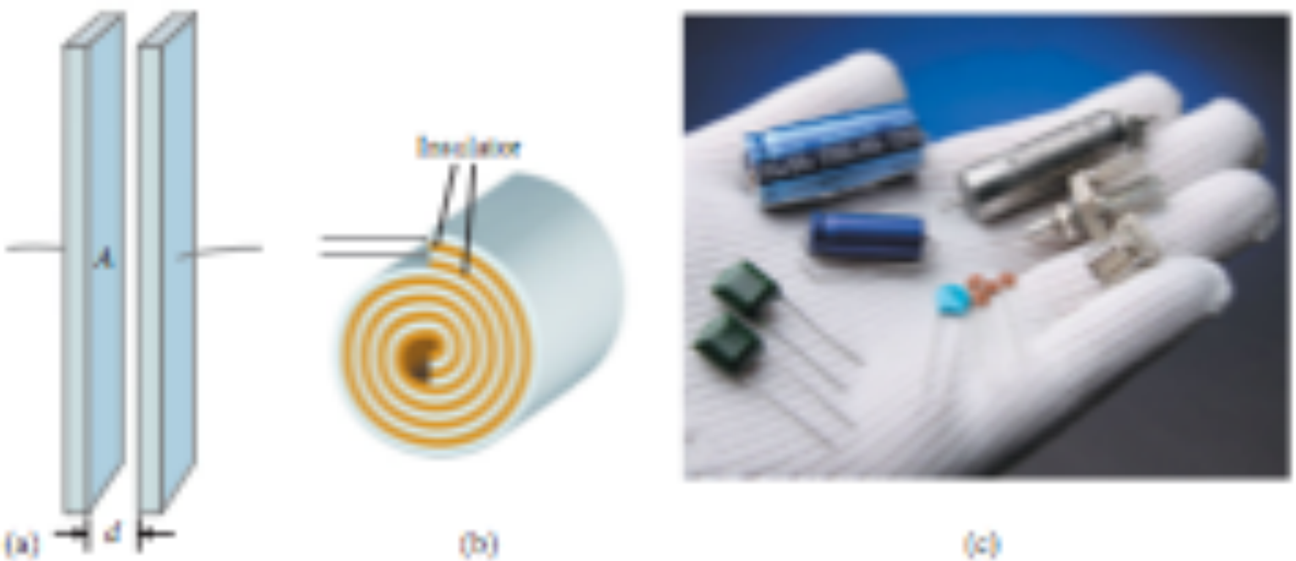
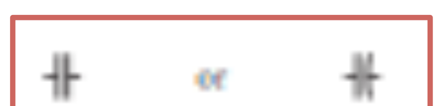
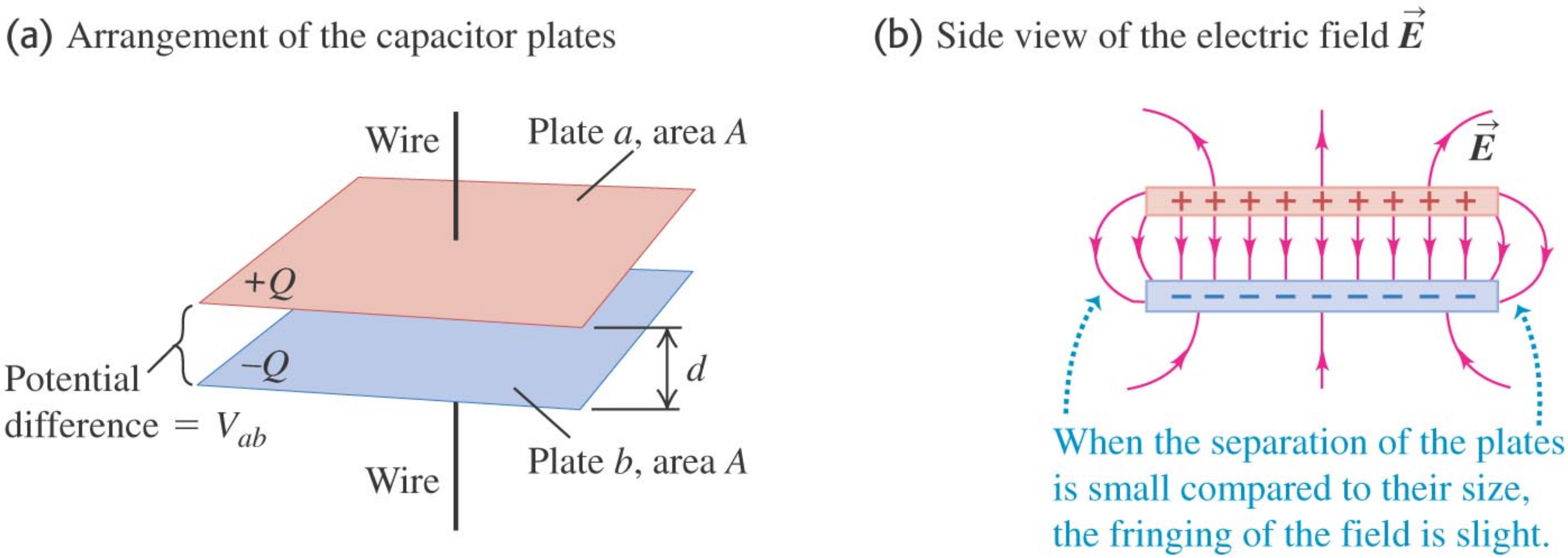


FIGURE 17-13 Capacitors: diagrams of (a) parallel plate, (b) cylindrical (rolled up parallel plate). (c) Photo of some real capacitors.

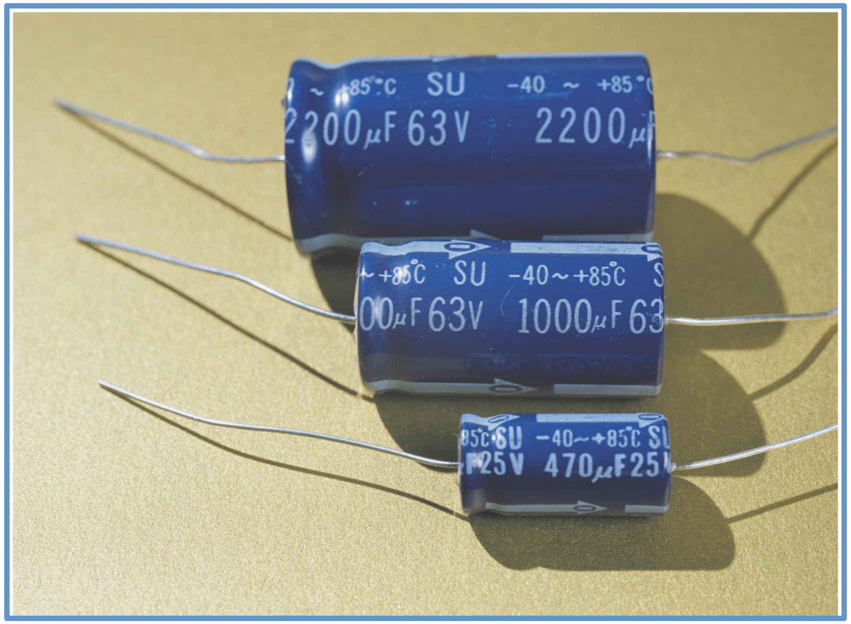


How do we build a capacitor?

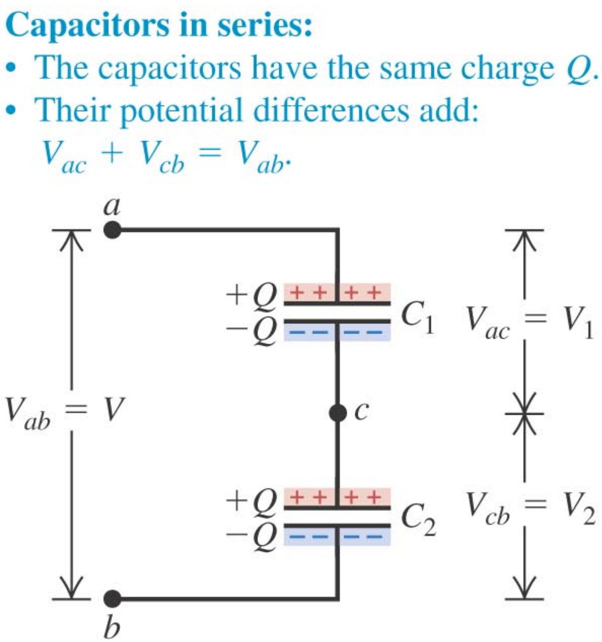


The unit of capacitance, the farad

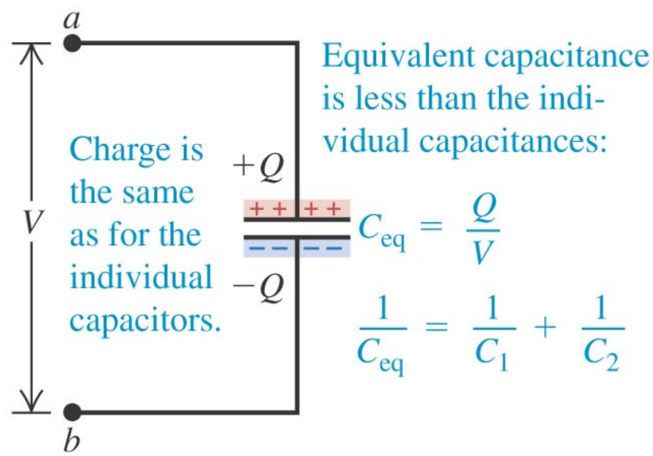
– Commercial capacitors for home electronics are often cylindrical, from the size of a grain of rice to that of a large cigar.
– Capacitors like those mentioned above and pictured at right are microfarad capacitors.



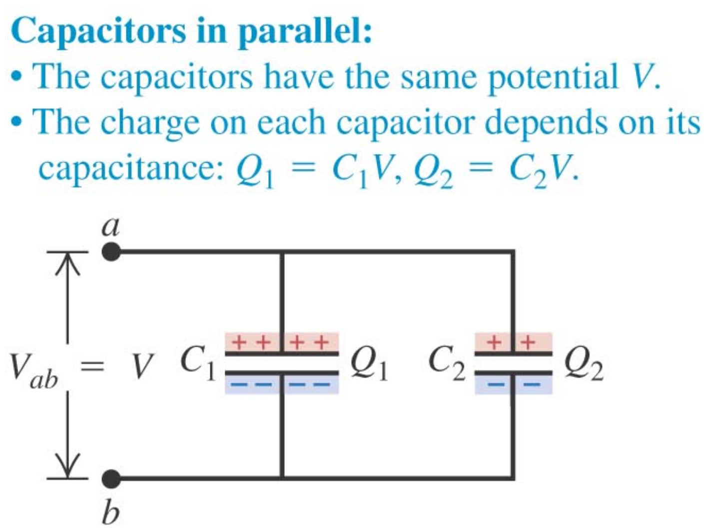
(a) Two capacitors in series



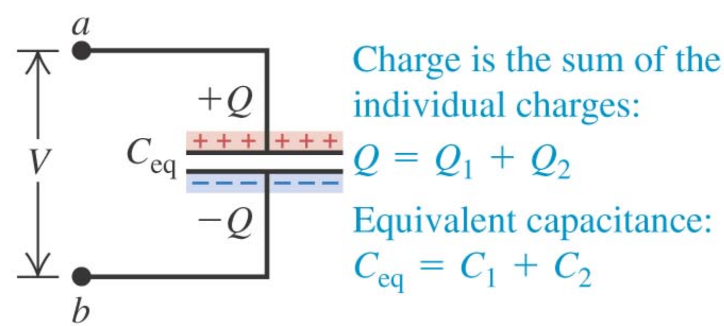
(b) The equivalent single capacitor



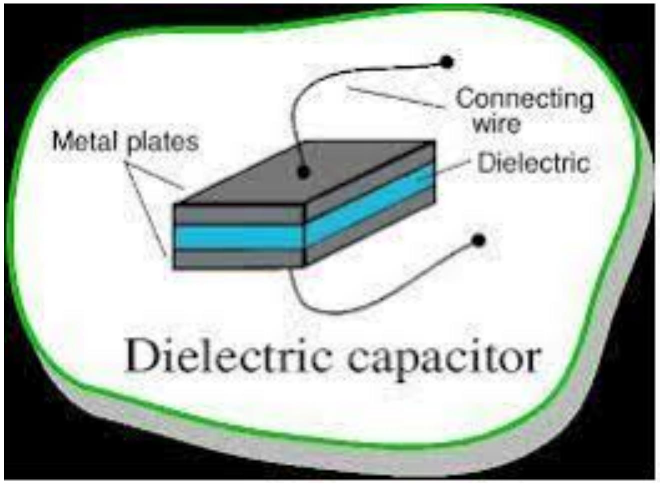
(a) Two capacitors in parallel

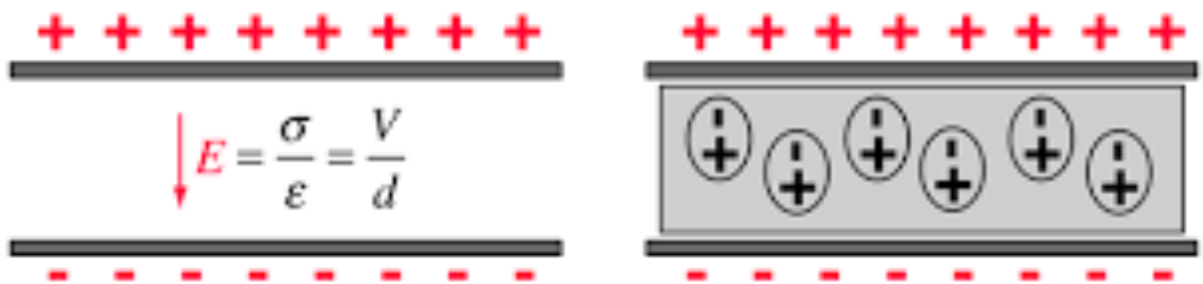


(b) The equivalent single capacitor



2-Dielectrics





For air, $\varepsilon = \varepsilon_0$

$E_{effective} = E - E_{polarization} = \frac{\sigma}{k\varepsilon_0}$

$$C = \frac{\varepsilon_0 A}{d}$$

The capacitance is increased by the factor k.

$$C = \frac{k\varepsilon_0 A}{d}$$

3-Ohm’s Law

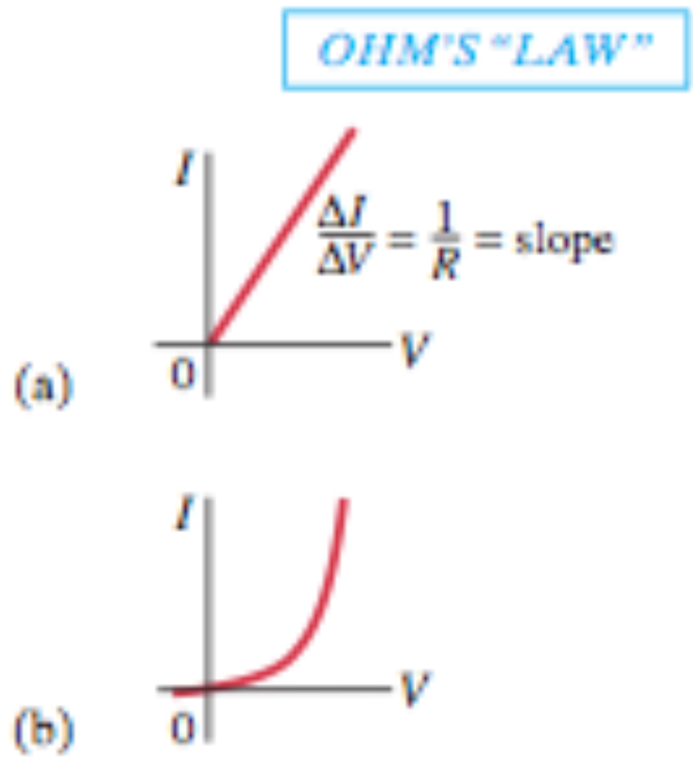


FIGURE 18–9 Graphs of current vs. voltage (a) for a metal conductor which obeys Ohm’s law, and (b) for a nonohmic device, in this case a semiconductor diode.

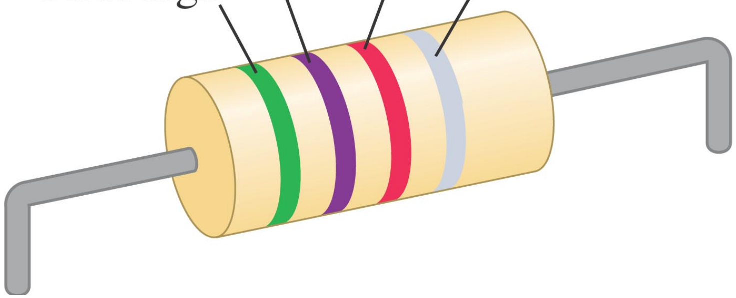
- The electrical **resistance** *R* as the proportionality factor between the voltage *V* (between the ends of the wire) and the current *I* (passing through the wire):

$$V=IR$$

Resistors

- In many circuits, particularly in electronic devices, **resistors** are used to control the amount of current.

Resistors are color-coded



The first two colors represent the first two digits in the value of the resistance, the third color represents the power of ten that it must be multiplied by, and the fourth is the manufactured tolerance.

Resistor Color Code

Color	Number	Multiplier	Tolerance
Black	0	1	
Brown	1	10^1	1%
Red	2	10^2	2%
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold		10^{-1}	5%
Silver		10^{-2}	10%
No color			20%

Resistivity

- It is found experimentally that the resistance *R* of a uniform wire is directly pro- portional to its length l and inversely proportional to its cross-sectional area *A*.

$$R = \rho \frac{\ell}{A}$$

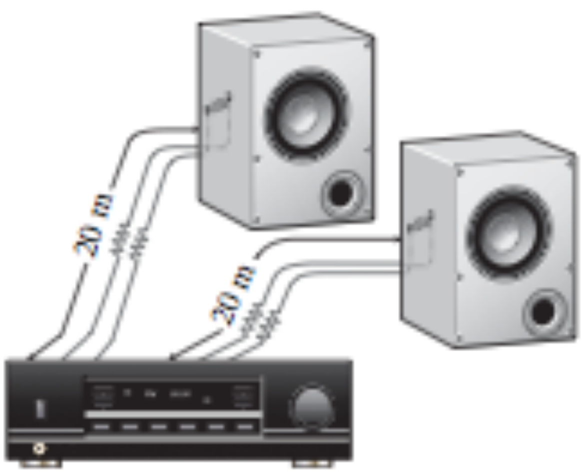
where r (Greek letter "rho"), the constant of proportionality, is called the **resistivity** and depends on the material used.

Material	Resistivity, ρ ($\Omega \cdot$ m)
Conductors	
Silver	1.59×10^{-8}
Copper	1.68×10^{-8}
Gold	2.44×10^{-8}
Aluminum	2.65×10^{-8}
Tungsten	5.6×10^{-8}
Iron	9.71×10^{-8}
Platinum	10.6×10^{-8}
Mercury	98×10^{-8}
Nichrome (Ni, Fe, Cr alloy)	100×10^{-8}

Ex-1:Resistivity

EXAMPLE 18–5 **Speaker wires.** Suppose you want to connect your stereo to remote speakers (Fig. 18–14). (*a*) If each wire must be 20 m long, what diameter copper wire should you use to keep the resistance less than 0.10 Ω per wire? (*b*) If the current to each speaker is 4.0 A, what is the potential difference, or voltage drop, across each wire?

APPROACH We solve Eq. 18–3 to get the area A, from which we can calculate the wire's radius using $A = \pi r^2$. The diameter is $2r$. In (*b*) we can use Ohm's law, $V = IR$.



Ref.: Giancoli, Physics, pg. 509, Ex.18-5

SOLUTION (*a*) We solve Eq. 18–3 for the area A and find ρ for copper in Table 18–1:

$$A = \rho \frac{\ell}{R} = \frac{(1.68 \times 10^{-8}\,\Omega\cdot\mathrm{m})(20\,\mathrm{m})}{(0.10\,\Omega)} = 3.4 \times 10^{-6}\,\mathrm{m}^2.$$

The cross-sectional area A of a circular wire is $A = \pi r^2$. The radius must then be at least

$$r = \sqrt{\frac{A}{\pi}} = 1.04 \times 10^{-3}\,\mathrm{m} = 1.04\,\mathrm{mm}.$$

The diameter is twice the radius and so must be at least $2r = 2.1$ mm.

(*b*) From $V = IR$ we find that the voltage drop across each wire is

$$V = IR = (4.0\,\mathrm{A})(0.10\,\Omega) = 0.40\,\mathrm{V}.$$

References for this lecture: