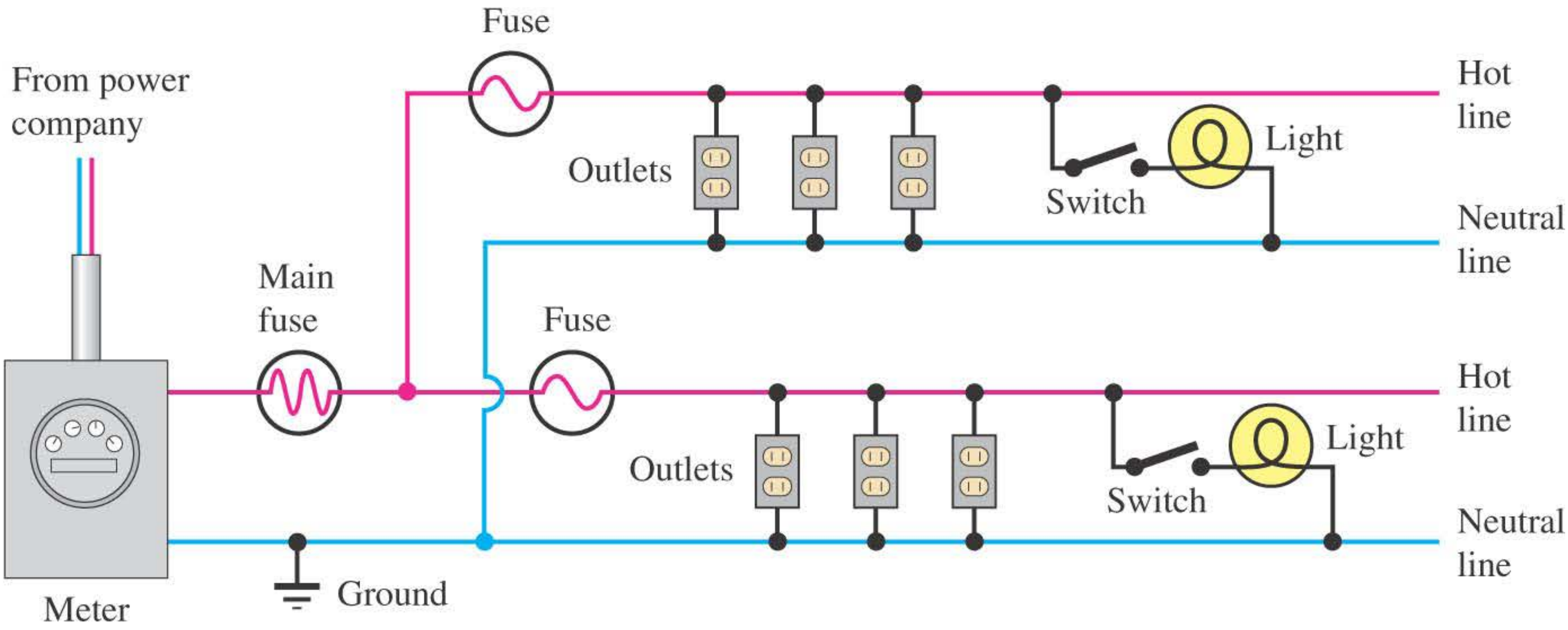
PHYS 122-Lecture 8:
Kirchhoff's Rules
(aka, nodal and mesh analysis)

- Basics of DC Circuits of Chapter 26
- Examples

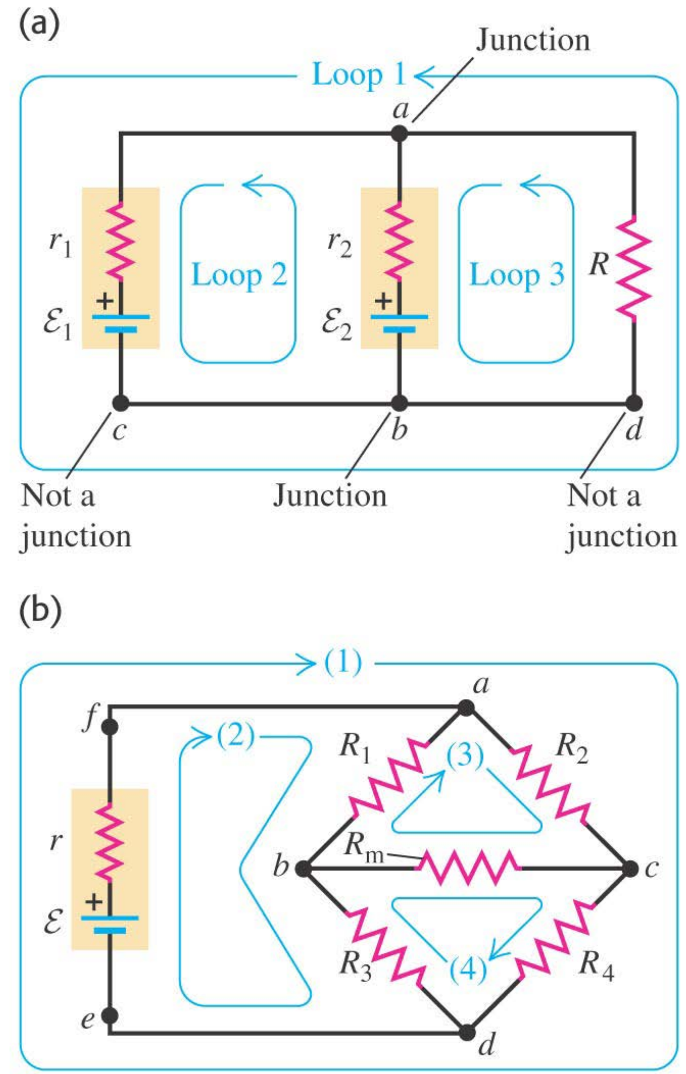
Power distribution systems

- Follow the text discussion using Figure 26.24 below.



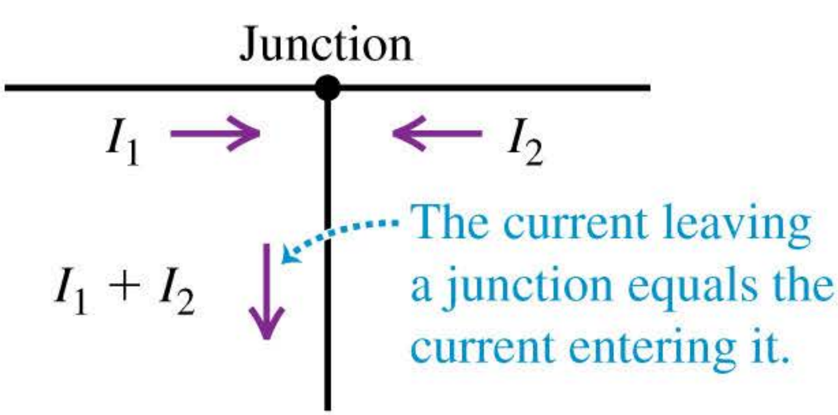
Kirchhoff's Rules I

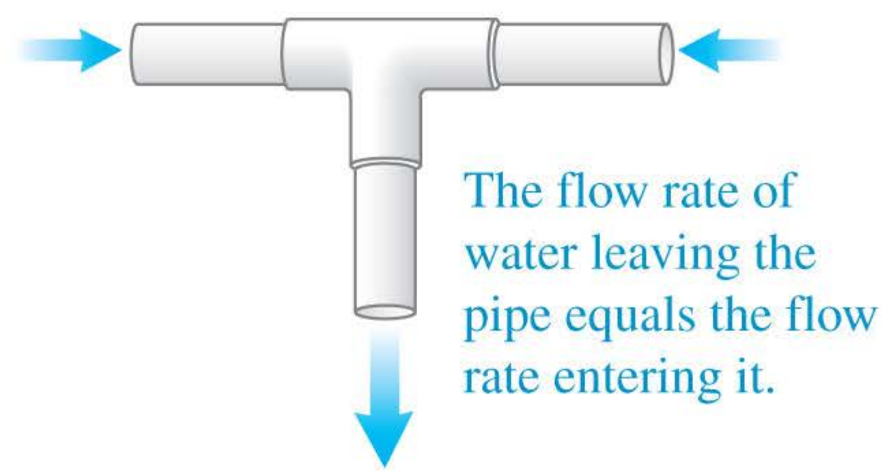
- A *junction* is a point where three or more conductors meet.
- A *loop* is any closed conducting path.
- See Figure 26.6 at the right.



Kirchoff's Rules II

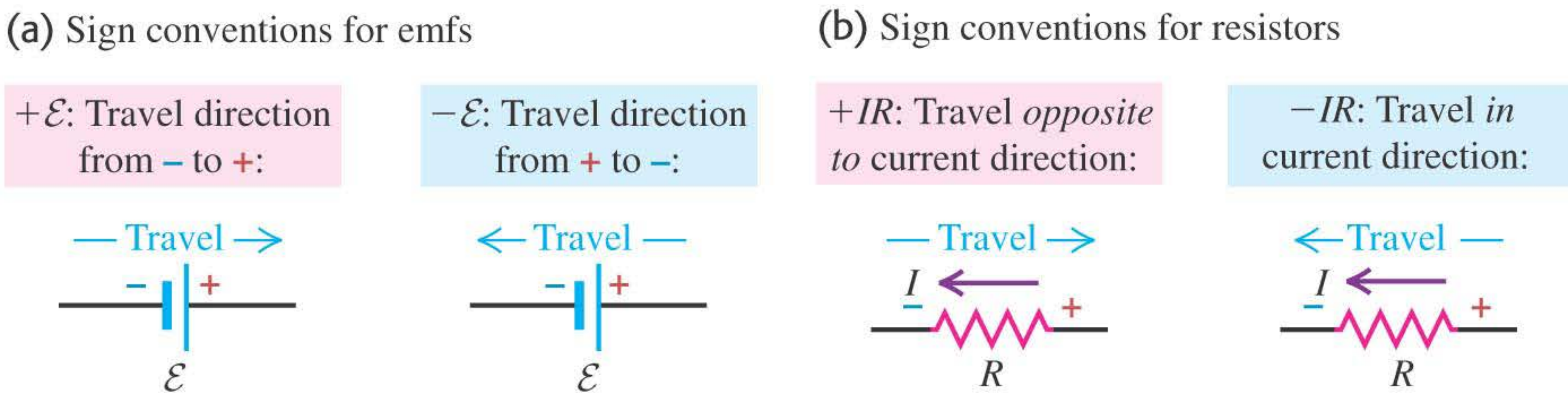
- Kirchhoff's *junction rule*: The algebraic sum of the currents into any junction is zero: $\Sigma I = 0$. (See Figure 26.7 below.)
- Kirchhoff's *loop rule*: The algebraic sum of the potential differences in any loop must equal zero: $\Sigma V = 0$.





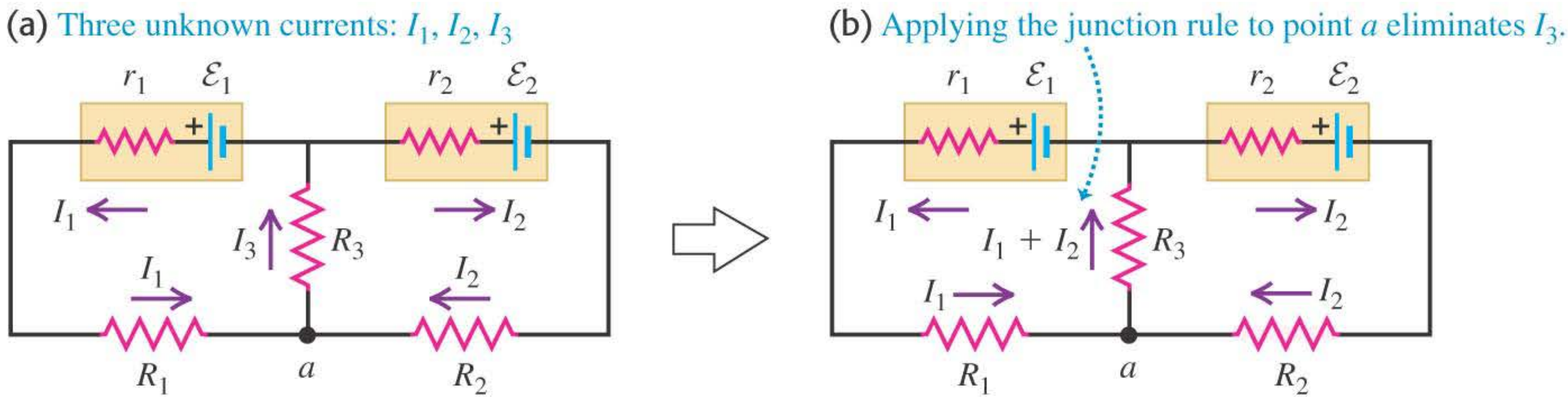
Sign convention for the loop rule

- Figure 26.8 below shows the sign convention for emfs and resistors.



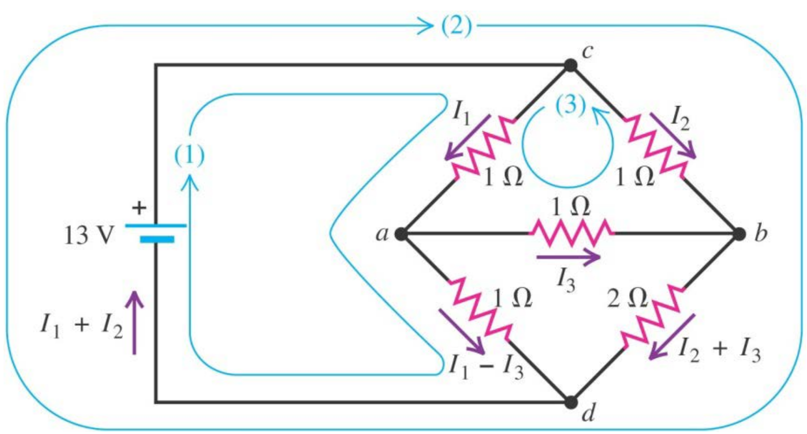
Reducing the number of unknown currents

- Read Problem-Solving Strategy 26.2.
- Figure 26.9 below shows how to use the junction rule to reduce the number of unknown currents.

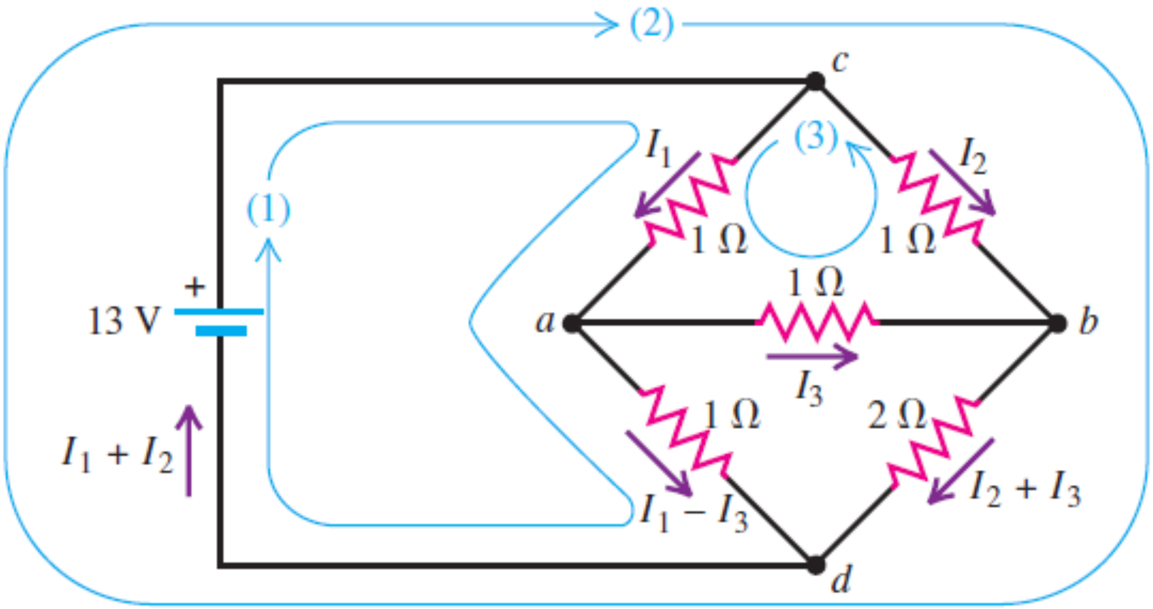


A complex network

- Follow Example 26.6, using Figure 26.12 below.
- Follow Example 26.7 which looks at the same circuit as above.



26.12 A network circuit with several resistors.



$$13\ \text{V} - I_1(1\ \Omega) - (I_1 - I_3)(1\ \Omega) = 0$$
$$-I_2(1\ \Omega) - (I_2 + I_3)(2\ \Omega) + 13\ \text{V} = 0$$
$$-I_1(1\ \Omega) - I_3(1\ \Omega) + I_2(1\ \Omega) = 0$$

$$13\ \text{V} = I_1(2\ \Omega) - I_3(1\ \Omega)$$
$$13\ \text{V} = I_1(3\ \Omega) + I_3(5\ \Omega)$$

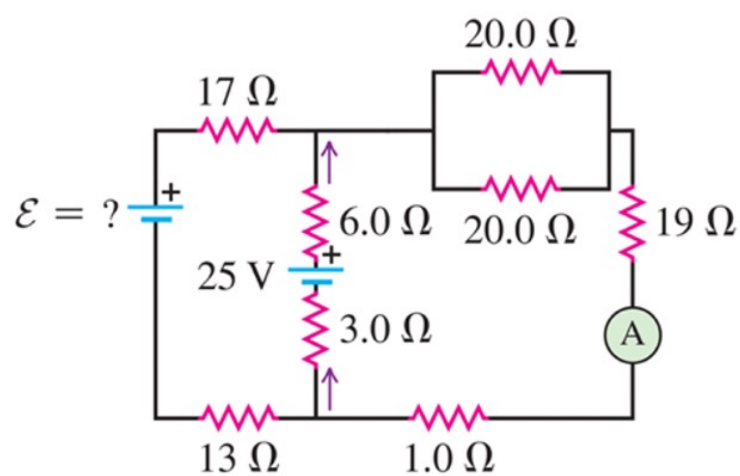
$$78\ \text{V} = I_1(13\ \Omega) \qquad I_1 = 6\ \text{A}$$

$$I_3 = -1\ \text{A},$$
$$I_2 = 5\ \text{A}.$$

$$R_{eq} = \frac{13\ \text{V}}{11\ \text{A}} = 1.2\ \Omega$$

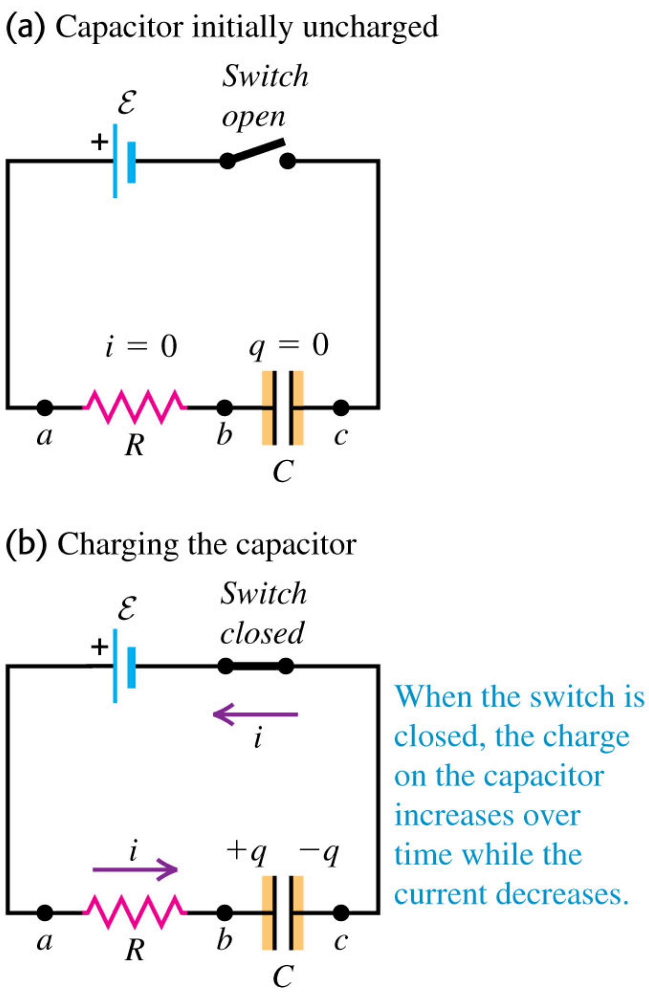
•• In the circuit shown in Fig. E26.32, the 6.0 Ω resistor is consuming energy at a rate of 24 J/s when the current through it flows as shown. (a) Find the current through the ammeter A. (b) What are the polarity and emf $\mathcal{E}$ of the unknown battery, assuming it has negligible internal resistance?

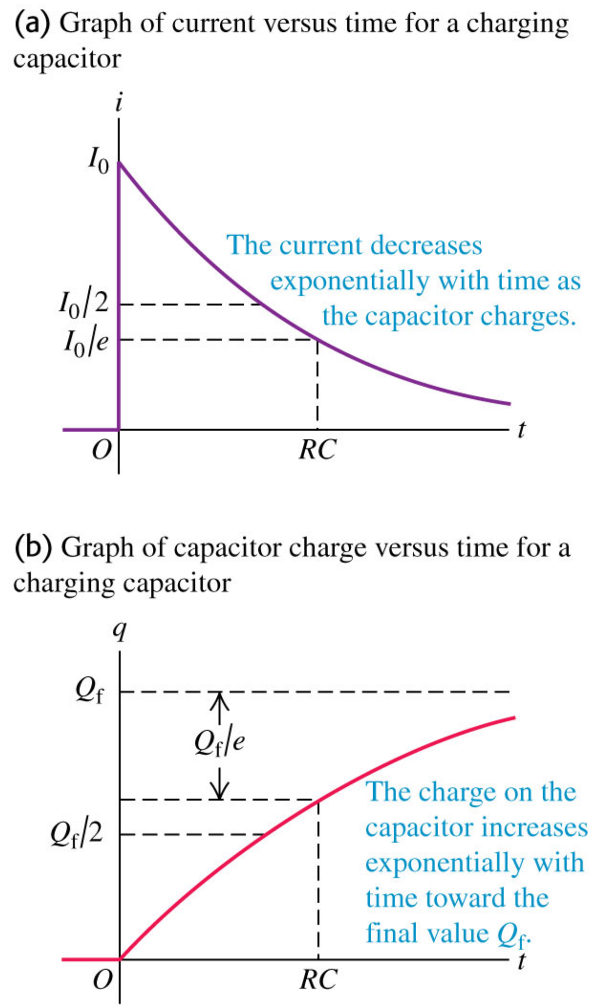
Figure E26.32



Charging a capacitor

- Read the discussion of charging a capacitor in the text, using Figures 26.20 and 26.21 below.
- The *time constant* is $\tau = RC$.





Discharging a capacitor

- Read the discussion of discharging a capacitor in the text, using Figures 26.22 and 26.23 below.
- Follow Examples 26.12 and 26.13.