

PHYS 122-Lecture 8:

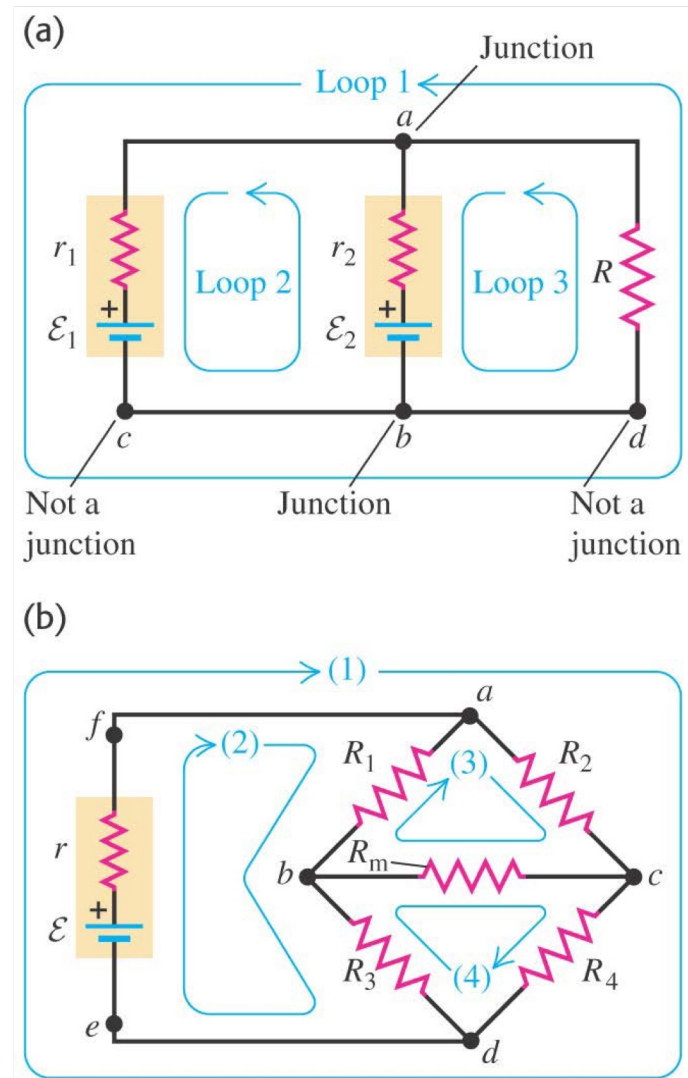
Kirchhoff's Rules

(aka, nodal and mesh analysis)

- Basics of DC Circuits of Chapter 26
- Examples

Kirchhoff's Rules I

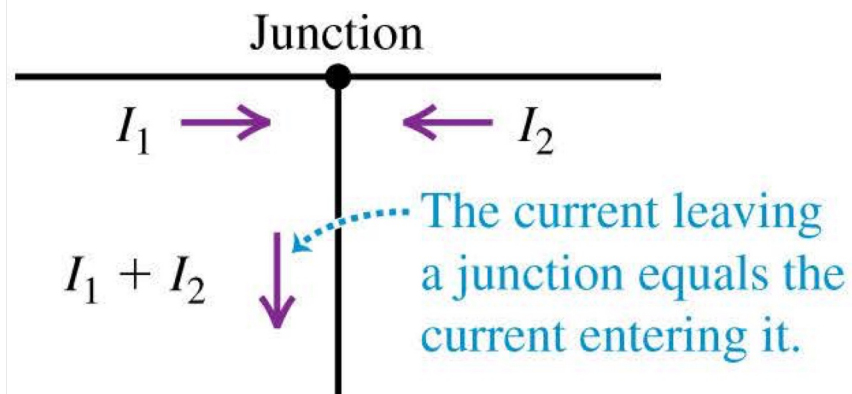
- A *junction* is a point where three or more conductors meet.
- A *loop* is any closed conducting path.
- See Figure 26.6 at the right.



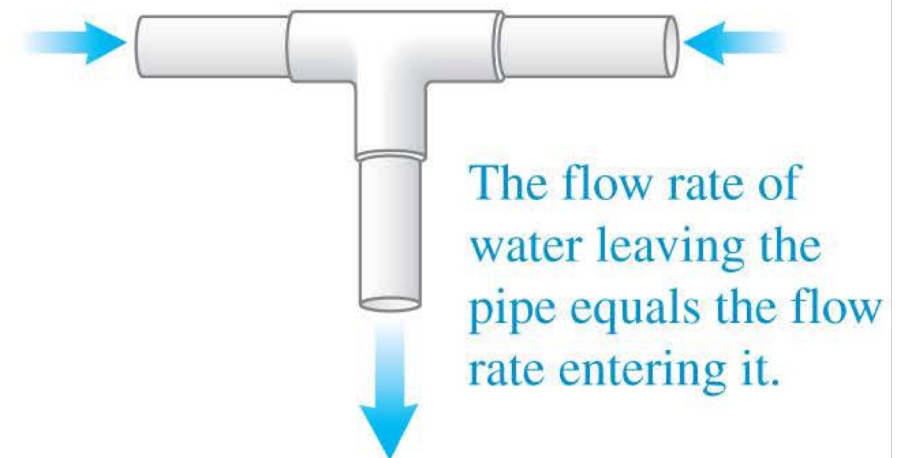
Kirchhoff's Rules II

- 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: $\Sigma V = 0$.

(a) Kirchhoff's junction rule



(b) Water-pipe analogy

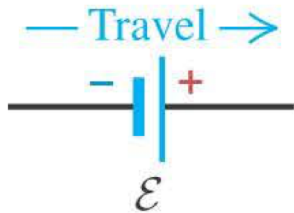


Sign convention for the loop rule

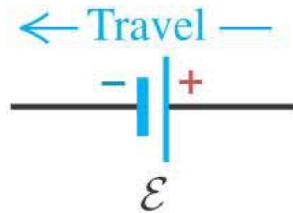
- Figure 26.8 below shows the sign convention for emfs and resistors.

(a) Sign conventions for emfs

$+\mathcal{E}$: Travel direction from $-$ to $+$:

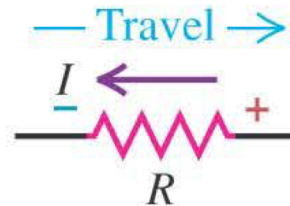


$-\mathcal{E}$: Travel direction from $+$ to $-$:

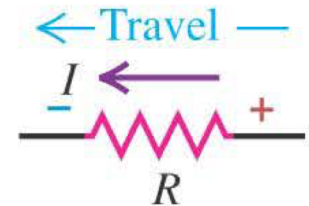


(b) Sign conventions for resistors

$+IR$: Travel *opposite* to current direction:

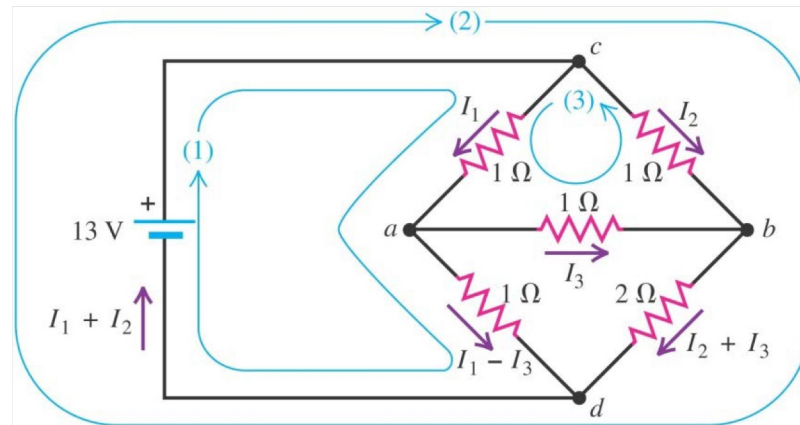


$-IR$: Travel *in* current direction:

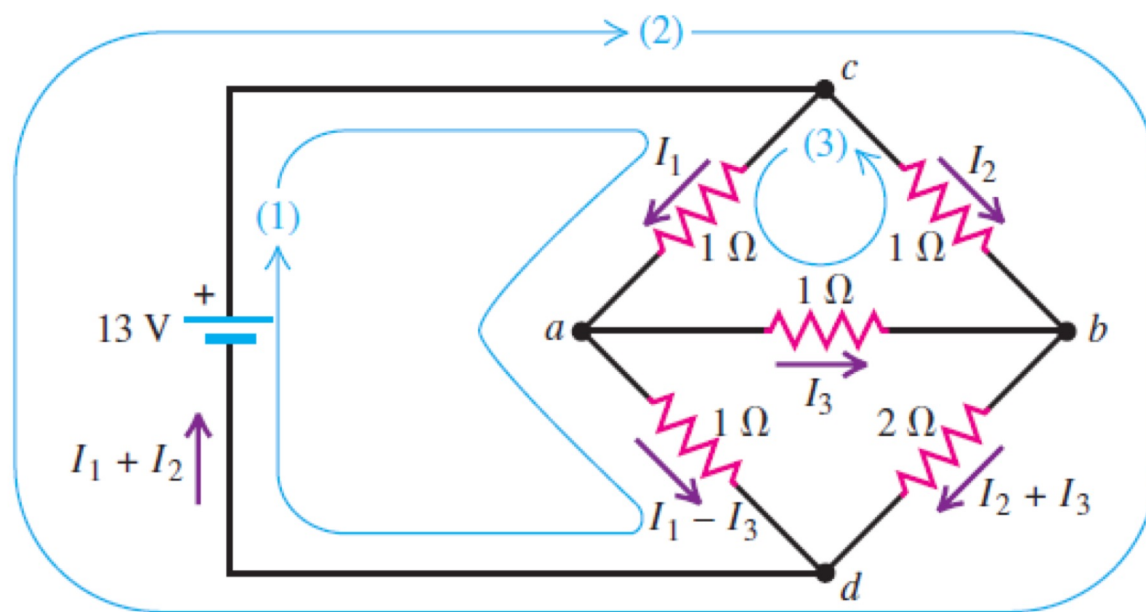


A complex network

- 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.



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

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

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

$$I_3 = -1 \text{ A},$$

$$I_2 = 5 \text{ A}.$$

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

- In the circuit shown in Fig. E26.32, the $6.0\ \Omega$ resistor is consuming energy at a rate of $24\ \text{J/s}$ 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

