Chapter E6: Analyzing Circuits

E6.2 Circuit Diagrams

Circuit diagrams are a useful and handy mental unwrappings of real circuits.

E6.3 Circuit Elements in Parallel

The voltage difference across circuit elements in parallel are the same:

$$|\Delta\mathcal{V}_b| = |\Delta\mathcal{V}_1| = |\Delta\mathcal{V}_2| = |\Delta\mathcal{V}_3| = \dots , \tag{1}$$

where $|\Delta\mathcal{V}_n|$ is the potential difference across the n^{th} object. You should understand why these equations have to be true.

The current, however, is *not* the same through all objects placed in a parallel circuit:

$$I_{\text{tot}} = I_1 + I_2 + \dots , \tag{2}$$

where I_n is the current flowing through the n^{th} object.

For a set of resistors in parallel, the following relationship holds:

$$\frac{1}{R_{\text{set}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots , \tag{3}$$

where R_n is the resistance of the n^{th} object.

E6.4 Total Resistance in a Series Circuit

Repeatedly apply the basic equations for series and parallel circuits. Working neatly and using lots of space will help.

E6.5 Electrical Safety Issues

Current is bad for you.

Circuit Summary

The **potential difference** between two points in a circuit measures change in potential energy per unit charge between these two points. Potential difference is measured in volts; one Volt is one Joule per Coulomb.

The **EMF** of a battery is a property of the battery. It measures the potential energy per charge delivered by the battery. Its units are also volts. A battery's EMF doesn't depend on the sort of circuit hooked up to it.

Current is measured in Amps. One Amp = One Coulomb per second. The current at a point measures how much charge is flowing by per unit time.

An object's **resistance** is defined via $R \equiv V/I$, where V is the voltage drop across that object. If R is independent of V and I, we say that the object is ohmic. The unit of resistance is the Ohm. One Ohm (Ω) = One Volt per Amp.

Series Circuit

$$\Delta\mathcal{V}_1 + \Delta\mathcal{V}_2 = \Delta\mathcal{V}_{\text{total}} \,. \tag{4}$$

$$I_1 = I_2 \; = \; I_{\text{total}} \,. \tag{5}$$

$$R_1 + R_2 \; = \; R_{\text{total}} \,. \tag{6}$$

Parallel Circuit

$$\Delta\mathcal{V}_1 = \Delta\mathcal{V}_2 = \Delta\mathcal{V}_{\text{total}} \,. \tag{7}$$

$$I_1 + I_2 \; = \; I_{\text{total}} \,. \tag{8}$$

$$\frac{1}{R_1} + \frac{1}{R_2} \; = \; \frac{1}{R_{\text{total}}} \,. \tag{9}$$

Except for Eq. (9), these equations should be "obvious," in that they should be viewed as logical and inevitable consequences of the definitions of V and I and the conservation of energy and charge.

Practice

For the circuit drawn below, calculate the voltage drop across, and the current flowing through each resistor.