







20 ELECTRICAL FUNDAMENTALS

FIGURE 20.3 This figure shows a balanced atom. The number of electrons is the same as the number of protons in the nucleus.

The diagram shows a central nucleus containing six green circles representing protons, numbered 1 through 6. Surrounding the nucleus are two concentric red orbits. The inner orbit contains three blue circles representing electrons, numbered 1, 2, and 3. The outer orbit contains three blue circles representing electrons, numbered 4, 5, and 6. Red arrows on the orbits indicate a clockwise direction of electron movement.

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FIGURE 20.4 Unlike charges attract and like charges repel.

The diagram shows four cylindrical magnets. The first magnet has a North (N) pole on the left and a South (S) pole on the right. The second magnet has a South (S) pole on the left and a North (N) pole on the right. A double-headed arrow between the two magnets indicates attraction. The third magnet has a South (S) pole on the left and a South (S) pole on the right. A double-headed arrow between the two magnets indicates repulsion. The fourth magnet has a South (S) pole on the left and a North (N) pole on the right.

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FIGURE 20.5 A conductor is any element that has one to three electrons in its outer orbit.

CONDUCTORS

The diagram shows an atom with a central nucleus (orange circle) and two concentric black orbits. The inner orbit contains three yellow circles representing electrons, each with a minus sign (-). The outer orbit contains three yellow circles representing electrons, each with a minus sign (-). One of the electrons in the outer orbit is shown as being in the process of moving away from the atom.

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FIGURE 20.6 Copper is an excellent conductor of electricity because it has just one electron in its outer orbit, making it easy to be knocked out of its orbit and flow to other nearby atoms. This causes electron flow, which is the definition of electricity.

COPPER

NUCLEUS (29 PROTONS + 35 NEUTRONS)

ORBIT

ELECTRON

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FIGURE 20.7 Insulators are elements with five to eight electrons in the outer orbit.

INSULATORS

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FIGURE 20.8 Semiconductor elements contain exactly four electrons in the outer orbit.

SEMICONDUCTORS

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FIGURE 20.9 Current electricity is the movement of electrons through a conductor.

COPPER WIRE

POSITIVE (+) CHARGE **NEGATIVE (-) CHARGE**

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FIGURE 20.10 Conventional theory states that current flows through a circuit from positive (+) to negative (-). Automotive electricity uses the conventional theory in all electrical diagrams and schematics.

FLOW OF CURRENT (CONVENTIONAL THEORY)

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FIGURE 20.11 One ampere is the movement of 1 coulomb (6.28 billion billion electrons) past a point in 1 second.

COPPER WIRE

POSITIVE (+) CHARGE **NEGATIVE (-) CHARGE**

6.28 BILLION BILLION ELECTRONS PER SECOND

(1 AMPERE)

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FIGURE 20.12 An ammeter is installed in the path of the electrons similar to a water meter used to measure the flow of water in gallons per minute. The ammeter displays current flow in amperes.

AMMETER

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FIGURE 20.13 Voltage is the electrical pressure that causes the electrons to flow through a conductor.

VOLTAGE IS PRESSURE

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FIGURE 20.14 This digital multimeter set to read DC volts is being used to test the voltage of a vehicle battery. Most multimeters can also measure resistance (ohms) and current flow (amperes).

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FIGURE 20.15 Resistance to the flow of electrons through a conductor is measured in ohms.

The diagram shows a horizontal pipe. On the left, a red arrow labeled 'VOLTAGE' points into the pipe. Inside the pipe, there are several yellow circles with minus signs, representing electrons. A hand is shown from the right side, with fingers spread, blocking the pipe's opening. A red arrow labeled 'CURRENT' points out of the pipe on the right. Below the pipe, the word 'RESISTANCE' is written with an arrow pointing to the hand.

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