FIGURE 28.1 The center wire is a solid color wire, meaning that the wire has no other identifying tracer or stripe color. The two end wires could be labeled “BRN/WHT,” indicating a brown wire with a white tracer or stripe.

FIGURE 28.2 Typical section of a wiring diagram. Notice that the wire color changes at connection C210. The “0.8” represents the metric wire size in square millimeters.
FIGURE 28.3 Typical electrical and electronic symbols used in automotive wiring and circuit diagrams.

FIGURE 28.4 In this typical connector, note that the positive terminal is usually a female connector.
FIGURE 28.5 The symbol for a battery. The positive plate of a battery is represented by the longer line and the negative plate by the shorter line. The voltage of the battery is usually stated next to the symbol.

FIGURE 28.6 The ground symbol on the left represents earth ground. The ground symbol on the right represents chassis ground.

FIGURE 28.7 Starting at the top, the wire from the ignition switch is attached to terminal B of connector C2, the wire is 0.5 mm² (20 gauge AWG), and is yellow. The circuit number is 5. The wire enters connector C202 at terminal B3.
FIGURE 28.8 The electrical terminals are usually labeled with a letter or number.

FIGURE 28.9 Two wires that cross at this dot indicate that the two are electrically connected.

FIGURE 28.10 Wires that cross, but do not electrically connect each other, are shown with one wire bridging over the other.
FIGURE 28.11 Connectors (C), grounds (G), and splices (S) are followed by a number generally indicating the location in the vehicle. For example, G209 is a ground connection located under the dash.

FIGURE 28.12 The ground for the battery is labeled G305 indicating the ground connector is located in the passenger compartment of the vehicle. The ground wire is black (BLK), the circuit number is 50, and the wire is 32 mm² (2 gauge AWG).

FIGURE 28.13 The symbol for light bulbs shows the filament inside a circle, which represents the glass envelope of the bulb.
FIGURE 28.14 An electric motor symbol shows a circle with the letter M in the center and two black sections that represent the brushes of the motor. This symbol is used even though the motor is a brushless design.

FIGURE 28.15 Resistor symbols vary depending on the type of resistor.

FIGURE 28.16 A rheostat uses only two wires—one is connected to a voltage source and the other is attached to the movable arm.
FIGURE 28.17 Symbols used to represent capacitors. If one of the lines is curved, this indicates that the capacitor being used has a polarity, while the one without a curved line can be installed in the circuit without concern about polarity.

FIGURE 28.18 The grid-like symbol represents an electrically heated element.

FIGURE 28.19 A dashed outline represents a portion (part) of a component.
FIGURE 28.20 A solid box represents an entire component.

FIGURE 28.21 This symbol represents a component that is case grounded.

FIGURE 28.22 (a) A symbol for a single-pole, single-throw (SPST) switch. This type of switch is normally open (N.O.) because nothing is connected to the terminal that the switch is contacting in its normal position. (b) A single-pole, double-throw (SPDT) switch has three terminals. (c) A double-pole, single-throw (DPST) switch has two positions (off and on) and can control two separate circuits. (d) A double-pole, double-throw (DPDT) switch has six terminals—three for each pole. Note the dashed line between the two arms, indicating that they are mechanically connected, called a "ganged switch."
FIGURE 28.23 (a) A symbol for a normally open (N.O.) momentary switch. (b) A symbol for a normally closed (N.C.) momentary switch.

FIGURE 28.24 A relay uses a movable arm to complete a circuit whenever there is a power at terminal 86 and a ground at terminal 85. A typical relay only requires about 1/10 ampere through the relay coil. The movable arm then closes the contacts (85 to 87) and conveys 30 amperes or more.

FIGURE 28.25 A cross-sectional view of a typical four terminal relay. Current flowing through the coil at terminals 86 and 85 causes the movable arm (the armature) to be drawn toward the coil magnet. The armature completes the electrical circuit connected to terminals 30 and 87.
FIGURE 28.26 A typical relay showing the schematic of the wiring in the relay.

FIGURE 28.27 All schematics are shown in their normal, nonenergized position.

FIGURE 28.28 A typical horn circuit. Note that the relay contacts supply the heavy current to operate the horn when the horn switch simply completes a low-current circuit to ground, causing the relay contacts to close.
FiguRe 28.29 When the relay or solenoid coil current is turned off, the stored energy in the coil flows through the clamping diode and effectively reduces voltage spikes.

FiguRe 28.30 A resistor used in parallel with the coil windings is a common spike reduction method used in many relays.

FiguRe 28.31 A typical wiring diagram showing multiple switches and bulbs powered by one fuse.
To add additional lighting, simply tap into an existing light wire and connect a relay. Whenever the existing light is turned on, the coil of the relay is energized. The arm of the relay then connects power from another circuit (fuse) to the auxiliary lights without overloading the existing light circuit.

Always check the simple things first. Check the fuse for the circuit you are testing. Maybe a fault in another circuit controlled by the same fuse could have caused the fuse to blow. Use a test light to check both sides of the fuse for voltage.

After removing the blown fuse, a pulsing circuit breaker is connected to the terminals of the fuse. The circuit breaker senses current to flow, then stops, then flows again, through the circuit up to the point of the short-to-ground. By observing the Gauss gauge, the location of the short is indicated near where the needle stops moving due to the magnetic field created by the flow of current through the wire.
FIGURE 28.35 A Gauss gauge can be used to determine the location of a short circuit even behind a metal panel.

FIGURE 28.36 A tone generator type tester used to locate open circuits and circuits that are shorted to ground. Included with this tester is a transmitter (tone generator), receiver probe, and headphones for use in noisy shops.

FIGURE 28.37 To check for a short-to-ground using a tone generator, connect the black transmitter lead to a good chassis ground and the red lead to the load side of the fuse terminal. Turn the transmitter on and check for tone signal with the receiver. Using a wiring diagram, follow the strongest signal to the location of the short-to-ground. There will be no signal beyond the fault, either a short-to-ground or an open circuit.
Antistatic spray can be used by customers to prevent being shocked when they touch a metal object like the door handle.

FIGURE 28.38 Antistatic spray can be used by customers to prevent being shocked when they touch a metal object like the door handle.