FIGURE 26.1 A technician-made fused jumper lead, which is equipped with a red 10 ampere fuse. This fused jumper uses terminals for testing circuits at a connector instead of alligator clips.

FIGURE 26.2 A 12 volt test light is attached to a good ground while cranking the engine.
FIGURE 26.3 A test light can be used to locate an open in a circuit. Note that the test light is grounded at a different location than the circuit itself.

FIGURE 26.4 A continuity light should not be used on computer circuits because the applied voltage can damage delicate electronic components or circuits.

FIGURE 26.5 An LED test light can be easily made using low-cost components and an old ink pen. With the 470 ohm resistor in series with the LED, the tester only draws 0.025 ampere (25 milliamperes) from the circuit being tested. This low current draw helps ensure the technician that the circuit or component being tested will not be damaged by excessive current flow.
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FIGURE 26.6 A logic probe connected to the vehicle battery. When the tip probe is connected to a circuit, it can check for power, ground, or pulses.

FIGURE 26.7 Typical digital multimeter. The black meter lead is always placed in the COM terminal. The red meter test lead should be in the volt-ohm terminal except when measuring current in amperes.

CHART 26.1 Common symbols and abbreviations used on digital meters.
FIGURE 26.8 Typical digital multimeter (DMM) set to read DC volts.

FIGURE 26.9 A typical autoranging digital multimeter automatically selects the proper scale to read the voltage being tested. The scale selected is usually displayed on the meter face. (a) From the display, it is obvious the range is set to 4 volts, meaning the meter can read up to 10 volts. (b) The range is now set to the 40 volt scale, meaning the meter can read up to 40 volts on the scale. Any reading above this level will cause the meter to reset to a higher scale. If not set on autoranging, the meter display would indicate OL if a reading exceeded the limit of the scale selected.

FIGURE 26.10 Using a digital multimeter set to read ohms (Ω) to test this light bulb. The meter reads the resistance of the filament.
Many digital multimeters can have the display indicate zero to compensate for test lead resistance. (1) Connect leads in the VΩ and COM meter terminals. (2) Select the Ω scale. (3) Touch the two meter leads together. (4) Push the Test or Test Lead button on the meter. (5) The meter display will now indicate zero ohms of resistance.

Measuring the current flow required by a horn requires that the ammeter be connected in series and the horn button be depressed by an assistant.

Note the blade-type fuse holder soldered in series with one of the meter leads. A 10-ampere fuse helps protect the internal meter fuse if accidentally shorted or damaged that may result from excessive current flow if accidentally used incorrectly.
FIGURE 26.14 An inductive ammeter clamp is used with starting and charging testers to measure the current flow through the battery cables.

FIGURE 26.15 A typical mini clamp-on type digital multimeter. This meter is capable of measuring alternating current (AC) and direct current (DC) without requiring that the circuit be disconnected to install the meter in series. The jaws are simply placed over the wires and current flows through the circuit is displayed.

FIGURE 26.16 Typical digital multimeter showing OL (over limit) on the readout with the ohms (Ω) unit selected. This usually means that the unit is measuring an open circuit (infinite resistance) and has no continuity.
Always look at the meter display when a measurement is being made, especially if using an autoranging meter.

A conversion chart showing the decimal point location for the various prefixes.

Sample meter readings using manually set and autoranging selection on the digital meter.

FIGURE 26.17
FIGURE 26.18: When reading AC voltage signals, a true RMS meter (such as Fluke 87) provides a different reading than an average responding meter (such as Fluke 88). The only place this difference is important is when reading it to be compared with specifications.

FIGURE 26.19: This meter display shows 052.2 AC volts. Notice that the zero beside the 5 indicates that the meter can read over 100 volts AC with a resolution of 0.1 volt.

FIGURE 26.20: Be sure to use only a meter that is CAT III rated when taking electrical voltage measurements on a hybrid vehicle.
Always use meter leads that are CAT III rated on a meter that is also CAT III rated, to maintain the protection needed when working on hybrid vehicles.

For most electrical measurements, the black meter lead is inserted into the terminal labeled COM and the red meter lead is inserted into the terminal labeled V.

To use a digital meter, turn the power switch and select the unit of electricity to be measured. In this case, the rotary switch is turned to select DC volts V.
For most automotive electrical use, such as measuring battery voltage, select DC volts.

Connect the red meter lead to the positive (+) terminal of a battery and the black meter lead to the negative (-) terminal of a battery. The meter reads the voltage difference between the leads.

This jump start battery unit measures 13.151 volts with the meter set on autoranging on the DC voltage scale.
Another meter (Fluke 87 III) displays four digits when measuring the voltage of the battery jump start unit.

To measure resistance, turn the rotary dial to the ohm (Ω) symbol. With the meter leads separated, the meter display reads OL (over limit).

The meter can read your own body resistance if you grasp the meter lead terminals with your fingers. The reading on the display indicates 196.35 kΩ.
When measuring anything, be sure to read the symbol on the meter face. In this case, the meter is reading 291.10 kΩ.

A meter set on ohms can be used to check the resistance of a light bulb filament. In this case, the meter reads 3.15 ohms. If the bulb were bad (filament open), the meter would display OL.

A digital meter set to read ohms should measure 0.00 as shown when the meter leads are touched together.
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**Figure 26.12** The large letter V means volts and the wavy symbol over the V means that the meter measures alternating current (AC) voltage if this position is selected.

**Figure 26.13** The next symbol is a V with a dotted and a straight line overhead. This symbol stands for direct current (DC) volts. This position is most used for automotive service.

**Figure 26.14** The symbol mV indicates millivolts or 1/1,000 of a volt (0.001). The solid and dashed line above the mV means DC mV.
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**Figure 26.15** The rotary switch is turned to Ω (ohms) unit of resistance measure. The symbol to the left of the Ω symbol is the beeper or continuity indicator.

**Figure 26.16** Notice that AUTO is in the upper left and the MΩ is in the lower right. This MΩ means that the meter is set to read in millions of ohms.

**Figure 26.17** The symbol shown is the symbol of a diode. In this position, the meter applies a voltage to a diode and the meter reads the voltage drop across the junction of a diode.
One of the most useful features of this meter is the MIN/MAX feature. By pressing the MIN/MAX button, the meter will be able to display the highest (MAX) and the lowest (MIN) reading.

Pushing the MIN/MAX button puts the meter into record mode. Note the 100 ms on the display. In this position, the meter is capturing any voltage change that lasts 100 ms (0.1 sec) or longer.

To increase the range of the meter, touch the range button, test the meter is set to read voltage up to 40 volts DC.
Pushing the range button one more time changes the meter scale to the 160-voltage range. Notice that the decimal point has moved to the left.

Pushing the range button again changes the meter to the 4,000-volt range. This range is not suitable to use in automotive applications.

By pushing and holding the range button, the meter will reset to autorange. Autorange is the preferred setting for most automotive measurements except when using MIN/MAX record mode.