Vehicle Servicing and Repairing

Level II

Learning Guide- #44

Unit of Competence: - Install, Test and Repair Vehicle Lighting and Wiring Systems

Module Title: - Installing, Testing and Repairing Vehicle Lighting and Wiring Systems

LG Code: **EIS VSR2 M12 LO2-LG-44**

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LO2: Identify faults/ Install, test & repair lighting and wiring

Instruction Sheet	Identify faults/ Install, test & repair lighting and wiring

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- ✓ Install Low voltage lighting and wiring systems inappropriate testing procedures
- ✓ Carry-out tests to determine faults
- ✓ Carry-out repair options
- ✓ Carry-out post-repair testing

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- ➢ Low voltage lighting and wiring systems are installed according to manufacturer and component supplier specifications without causing damage to components or systems as a result of inappropriate testing procedures
- ➢ Tests are carried out to determine faults using tools and diagnostic techniques
- ➢ Preferred repair options are determined and carried out
- ➢ Post-repair testing is carried out according to workplace procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 61.
3. Read the information written in the "Information Sheets 1". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the "Self-check 1" in page 22 .
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to "Information Sheet 2". However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Install Low voltage lighting and wiring systems inappropriate testing procedures

2.1. Install Low Voltage Lighting And Wiring Systems Automotive Wiring

Electrical power and control signals must be delivered to electrical devices reliably and safely so that the electrical system functions are not impaired or converted to hazards. To fulfil power distribution military vehicles, use one-and two-wire circuits, wiring harnesses, and terminal connections.

Among your many duties will be the job of maintaining and repairing automotive electrical systems. All vehicles are not wired in exactly the same manner; however, once you understand the circuit of one vehicle, you should be able to trace an electrical circuit of any vehicle using wiring diagrams and color codes.

ONE-AND TWO-WIRE CIRCUITS

Tracing wiring circuits, particularly those connecting lights or warning and signal devices, is no simple task. The branch circuits making up the individual systems have one wire to conduct electricity from the battery to the unit requiring it and ground connections at the battery and the unit to complete the circuit. These are called **one-wire circuits** or branches of a Ground Return System. In automotive electrical systems with branch circuits that lead to all parts of the equipment, the ground return system saves installation time and eliminates the need for an additional wiring to complete the circuit. The all-metal construction of the automotive equipment makes it possible to use this system.

Two-Wire Circuit requires two wires to complete the electrical circuit- one wire from the source of electrical energy to the unit it will operate, and another wire to complete the circuit from the unit back to the source of the electrical power.

Two-wire circuits provide positive connection for light and electrical brakes on some trailers. The coupling between the trailer and the equipment, although made of metal and a conductor of electricity, has to be jointed to move freely. The rather loose joint or coupling does not provide the positive and continuous connection required to use a ground return system between two vehicles. The two-wire circuit is commonly used on equipment subject to frequent or heavy vibrations. Tracked equipment, off-road vehicles (tactical), and many types of construction equipment are wired in this manner.

Wiring assemblies

Wiring assemblies consist of wires and cables of definitely prescribed length, assembled together to form a subassembly that will interconnect specific electrical components and/ or equipment. The two basic types of wiring assemblies are as follows:

Cable Assembly consists of a stranded conductor with insulation or a combination of insulated conductors enclosed in a covering or jacket from end to end.

Terminating connections seal around the outer jacket so that the inner conductors are isolated completely from the environment. Cable assemblies may have two or more ends.

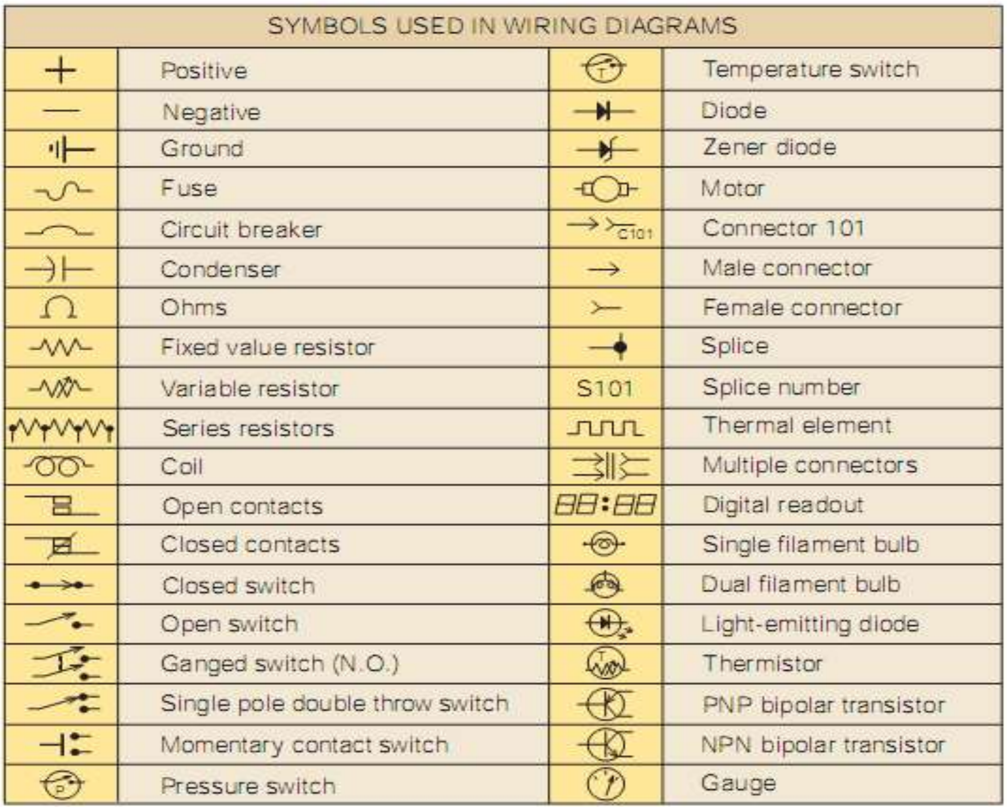
Wiring Harness assemblies (fig. 2-1) serve two purposes. They prevent chafing and loosening of terminals and connections caused by vibration and road shock while keeping the wires in a neat condition away from moving parts of the vehicle. Wiring harnesses contain two or more individual conductors laid parallel or twisted together and wrapped with binding material, such as tape, lacing cord, and wire ties. The binding materials do not isolate the conductors from the environment completely, and conductor terminations may or may not be sealed. Wiring harnesses also may have two or more ends.

Figure 2- 1typical partial wiring harness that connects to a connector on the fire wall.

Wiring color codes are used by manufacturers to assist the mechanics in identifying the wires used in many circuits and making repairs in a minimum of time. No color code is common to all manufacturers. For this reason, the manufacturer's service manual is a must for speedy troubleshooting and repairs.

WIRING DIAGRAMS

Wiring diagrams (Figure2-3) are drawings that show the relationship of the electrical components and wires in a circuit. They seldom show the routing of the wires within the electrical system of the vehicle. Often you will find ELECTRICAL SYMBOLS used in wiring diagrams to simulate individual components. Figure 2-3 shows some of the symbols you may encounter when tracing individual circuits in a wiring diagram.



SYMBOLS USED IN WIRING DIAGRAMS

	Positive		Temperature switch
	Negative		Diode
	Ground		Zener diode
	Fuse		Motor
	Circuit breaker		Connector 101
	Condenser		Male connector
	Ohms		Female connector
	Fixed value resistor		Splice
	Variable resistor	S101	Splice number
	Series resistors		Thermal element
	Coil		Multiple connectors
	Open contacts	88:88	Digital readout
	Closed contacts		Single filament bulb
	Closed switch		Dual filament bulb
	Open switch		Light-emitting diode
	Ganged switch (N.O.)		Thermistor
	Single pole double throw switch		PNP bipolar transistor
	Momentary contact switch		NPN bipolar transistor
	Pressure switch		Gauge

Figure 2- 2 Wiring diagram of a passenger vehicle showing standard equipment and color code for wires.

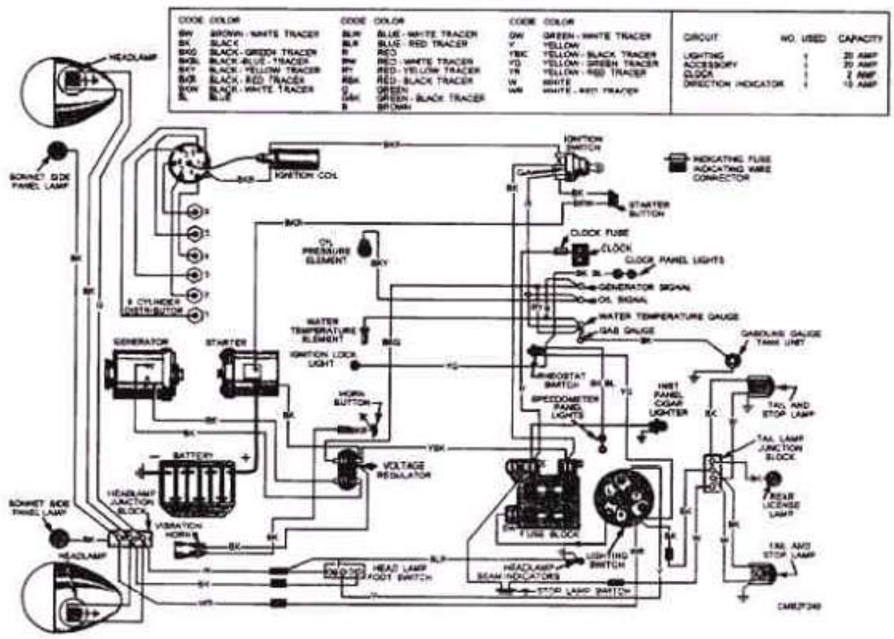


Figure 2- 3 Common electrical symbols used on wiring diagrams.

Lamps

A lamp generates light through a process of changing energy forms called incandescence.

The lamp produces light as a result of current flow through a filament. The filament is enclosed within a glass envelope and is a type of resistance wire that is generally made from tungsten.

As current flows through the tungsten filament, it gets very hot (Figure 2-5). The changing of electrical energy to heat energy in the resistive wire filament is so intense that the filament starts to glow and emits light. The lamp must have a vacuum surrounding the filament to prevent it from burning so hot that the filament burns in two. The glass envelope that encloses the filament maintains the presence of vacuum. When the lamp is manufactured, all the air is removed and the glass envelope seals out the air. If air is allowed to enter the lamp, the oxygen would cause the filament to oxidize and burn up.

Many lamps are designed to execute more than one function. A double-filament lamp has two filaments so the bulb can perform more than one function (Figure 2-6). It can be used in the stop light circuit, taillight circuit, and turn signal circuit combined.

It is important that any burned-out lamp be replaced with the correct lamp. The technician can determine what lamp to use by checking the lamp’s standard trade number (Table 2-1).

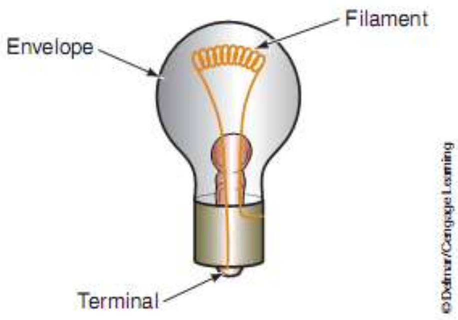


Figure 2- 4 A single-filament bulb.

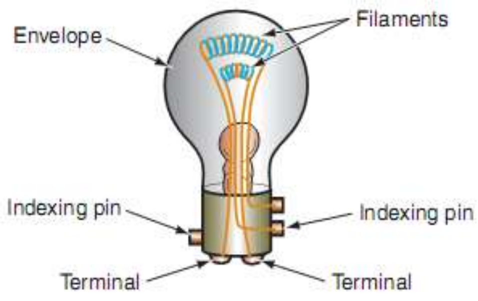


Figure 2- 5 A double-filament lamp.

Table 2-1 A Table of Some typical automotive light bulb examples.

TYPICAL AUTOMOTIVE LIGHT BULBS			
Trade Number	Design Volts	Design Amperes	Watts: P = A × V
168	14.0	0.35	4.9
192	13.0	0.33	4.3
194	14.0	0.27	3.8
194E-1	14.0	0.27	3.8
194NA	14.0	0.27	3.8
912	12.8	1.00	12.8
921	12.8	1.40	17.92
1141	12.8	1.44	18.4
1142	12.8	1.44	18.4
1156	12.8	2.10	26.9
1157	12.8	2.10/0.59	26.9/7.6
1157A	12.8	2.10/0.59	26.9/7.6
1157NA	12.8	2.10/0.59	26.9/7.6
2057	12.8	2.10/0.48	26.9/6.1
2057NA	12.8	2.10/0.48	26.9/6.1
3057	12.8–14.0	2.1/0.48	26.9/6.72
3156	12.8	2.10	26.9
3157	12.8–14.0	2.1/0.59	26.9/8.26
3457	12.8–14.0	2.23/0.59	28.5/8.26
4157	12.8–14.0	2.23/0.59	28.5/8.26
6411	12.0	0.833	10.0
6418	12.0	0.417	5.0
7440	12.0	1.75	21.0
7443	12.0	1.75/0.417	21.0/5.0
7507	12.0	1.75	21.0

Headlights

There are four basic types of headlights used on automobiles today: (1) standard sealed beam, (2) halogen sealed beam, (3) composite, and (4) high-intensity discharge (HID).

1) Sealed-Beam Headlights

From 1939 to about 1975, the headlights used on vehicles remained virtually unchanged. During this time, the headlight was a round lamp. The introduction of the rectangular head-light in 1975 enabled the vehicle manufacturers to lower the hood line of their vehicles. Both the round and rectangular headlights were sealed-beam construction

(Figure 2-6). The sealed-beam headlight is a self-contained glass unit made up of a filament, an inner reflector, and an outer glass lens .the standard sealed-beam headlight does not surround the filament with its own glass envelope (bulb). The glass lens is fused to the parabolic reflector, which is sprayed with vaporized aluminium that gives a reflecting surface that is comparable to silver.

The inside of the lamp is filled with argon gas. All oxygen must be removed from the standard sealed-beam headlight to prevent the filament from becoming oxidized. The reflector intensifies the light that the filament produces and the lens direct the light to form the required light beam pattern.

The lens is designed to produce a broad, flat beam. The light from the reflector is passed through concave prisms in the glass lens (Figure 2-7). Lens prisms redirect the light beam and create a broad, flat beam. The illustration (Figure 2-8) shows the horizontal spreading and the vertical control of the light beam to prevent upward glaring.

Figure 2- 6 Sealed-beam headlight construction

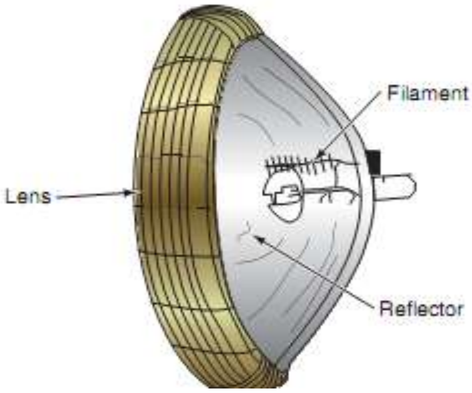


Figure2- 7 the lens uses prisms to redirect the light.

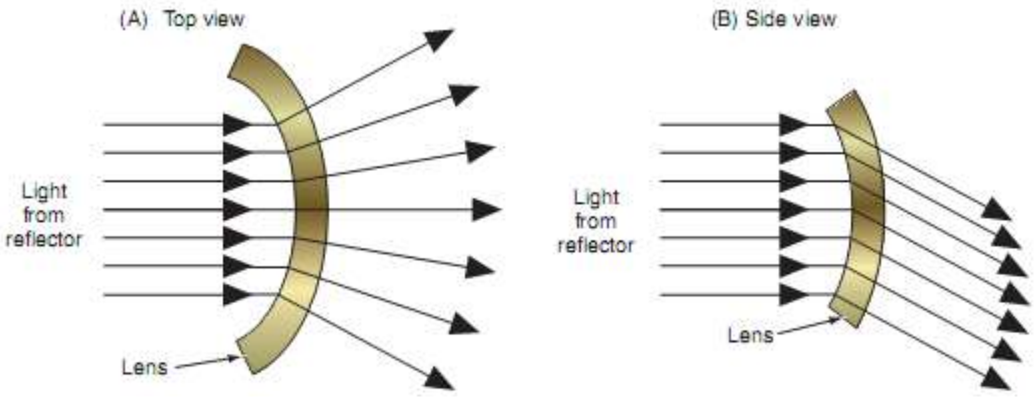


Figure2- 8 Filament placement controls the projection of the light beam.

By placing the filament in different locations on the reflector, the direction of the light beam is controlled (Figure 2-9). In a dual-filament lamp, the lower filament is used for the high beam and the upper filament is used for the low beam.

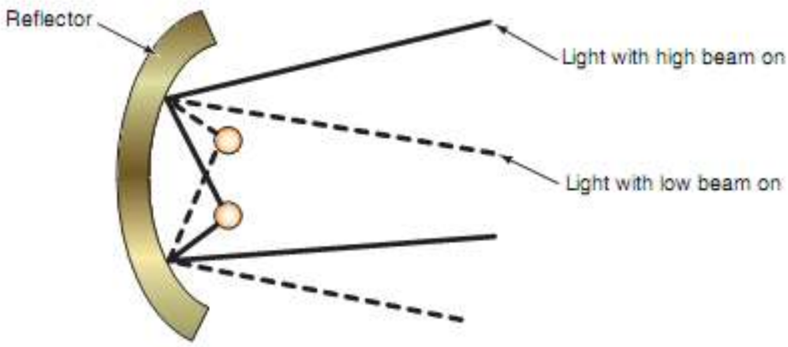


FIGURE 2-9 The prism directs the beam into (A) a flat horizontal pattern and (B) downward.

2) Halogen Headlights

The halogen lamp most commonly used in automotive applications consists of a small bulb filled with iodine vapor. The bulb is made of high-temperature-resistant quartz that surrounds a tungsten filament. This inner bulb is installed in a sealed glass housing (Figure 2-10). With the halogen added to the bulb, the tungsten filament is capable of withstanding higher temperatures than that of conventional sealed-beam lamps. The halogen lamp can withstand higher temperatures and thus is able to burn brighter.

In a conventional sealed-beam headlight, the heating of the filament causes atoms of tungsten to be released from the surface of the filament. These released atoms deposit on the glass envelope and create black spots that affect the light output of the lamp. In a halogen lamp, the iodine vapor causes the released tungsten atoms to be redeposited onto the filament. This virtually eliminates any black spots. It also allows for increased high-beam output of 25% over conventional lamps and for longer bulb life.

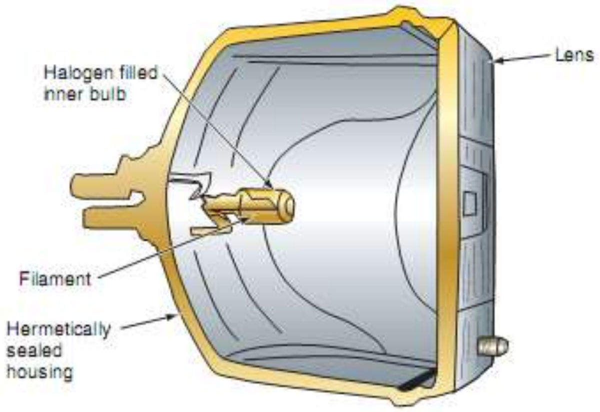


FIGURE 2-10 A halogen sealed-beam headlight with iodine vapor bulb.

3) Composite Headlights

By using the composite headlight system, vehicle manufacturers are able to produce any style of headlight lens they desire (Figure 8-8). This improves the aerodynamics, fuel economy, and styling of the vehicle. Composite headlight systems use a replaceable halogen bulb.

Many manufacturers vent the composite headlight housing because of the increased amount of heat these bulbs develop. Because the housings are vented, condensation may develop inside the lens assembly. This condensation is not harmful to the bulb and does not affect headlight operation. When the headlights are turned on, the heat generated from the halogen bulbs will dissipate the condensation quickly. Ford uses integrated non-vented composite headlights. On these vehicles, condensation is not considered normal. The assembly should be replaced.

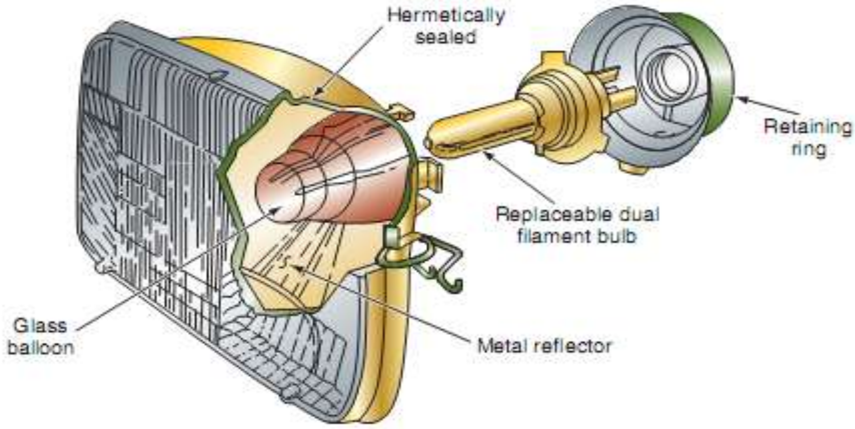


FIGURE 2-11 A composite headlight system with a replaceable halogen bulb.

4) **High-intensity discharge (HID)**

Headlamps are the latest headlight development. HID headlights use an inert gas to amplify the light produced by arcing across two electrodes. These headlamps (Figure 2-12) put out three times more light and twice the light spread on the road than conventional halogen headlamps (Figure 2-13). They also use about two-thirds

FIGURE 2-12 HID headlamps; note the reduced size of the headlamp assemblies.

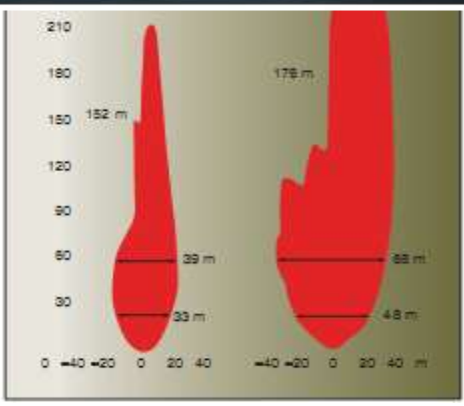


FIGURE 2-13 Comparison between light intensity and patter. Halogen lamp is shown on the left and the xenon (HID) lamp is on the right.

Less power to operate and will last two to three times longer. HID lamps produce light in both ultraviolet and visible wavelengths. This advantage allows highway signs and other reflective materials to glow. This type of lamp first appeared on select models from BMW in 1993, Ford in 1995, and Porsche in 1996.The HID lamp (Figure 2-14) consists of an outer bulb made of cerium-doped quartz that houses the inner bulb (arc tube). The inner bulb is made of fused quartz and contains two tungsten electrodes. It also is filled with xenon gas, mercury, and metal halides (salts). The HID lamp does not rely on a glowing filament for light. Instead it uses a high-voltage arcing bridge across the air gap between the electrodes. The xenon gas amplifies the light intensity given off by the arcing. The HID system requires the use of an ignitor and ballast to provide the electrical energy required to arc the electrodes (Figure 2-15). The ignitor is usually built into the base of the HID bulb and will provide the initial 15,000 to 25,000 volts to jump the gap. Once the gap has been jumped and the gas warms, then the ballast will provide the required voltage to maintain current flow across the gap. The ballast must deliver 35 watts to the lamp when the voltage across the lamp is between 70 and 110 volts. The greater light output of these lamps allows the headlamp assembly to be smaller and lighter. These advantages allow designers more flexibility in body designs as they attempt to make their vehicles more aerodynamic and efficient. For example, the Infiniti Q45 models are equipped with a seven-lens HID system (Figure 2-16) to provide stylish looks and high lamp output.

FIGURE 2-14 HID bulb elements.

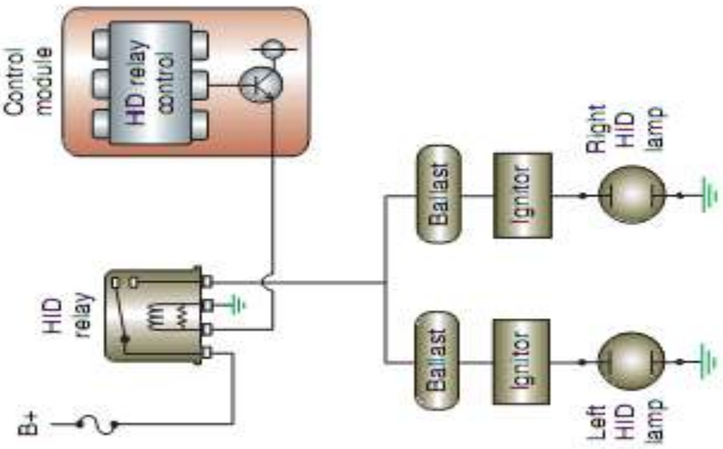


FIGURE 2-15 HID headlight schematic showing the use of a ballast and ignitor.

FIGURE 8-13 Seven-lens HID headlamps.

Bi-Xenon Headlamps

Due to the increased amount of light that the HID headlamp produces, they are not used in a quad headlight system as a high beam lamp. Instead they are used as the low beam lamp only and a halogen bulb for the high beam. Since the quad headlamp system uses all four bulbs for high beam operation, using a quad lamp system with HID lamps would blind any oncoming drivers due to the excessive amount of light output. Also, it is not possible to reduce the light intensity of an HID by PWM of the current to the element.

To overcome these issues and to still be able use the HID, manufacturers have started to use bi-xenon headlamps in their dual headlamp systems. Bi-xenon refers to the use of a single xenon lamp to provide both the high beam and the low beam operation. The full light output is used to produce the high beam. Low beam is formed by either moving the xenon bulb within the lens or by moving a shutter between the bulb and the lens.

Systems that use the shutter will have a motor within the headlamp assembly that raises and lowers the shutter. The position of the shutter dictates the amount of the projected light that will be allowed to escape from the lens and its pattern.

In some systems a motor is used to change the position of the bulb. The bulb is physically raised in the reflector housing to produce the high beam output. In low beam mode, the bulb is lowered in the reflector housing. The amount of reflection dictates the light intensity and pattern.

Using the same lamp for both low and high beam operation permits both modes to have the same light color. This produces less visual contrast when switching between modes and is less stressful to the eyes of the driver.

Concealed Headlights

A vehicle equipped with a concealed headlight system hides the lamps behind doors when the headlights are turned off. When the headlight switch is turned to the HEADLIGHT position, the headlight doors open (Figure 2-17). Early systems used vacuum-controlled doors. Today most systems use electric motors.

FIGURE 2-17 Concealed headlights enhance the vehicle's styling and aerodynamics.

Electrically controlled systems can use either a torsion bar or a single motor to open both headlight doors, and a separate motor for each headlight door. Most systems will use limit switches to stop current flow when the doors are full up or full down. These switches generally operate from a cam on the reaction motor (Figure 2-18). Only one limit switch can be closed at a time. When the door is full up, the opening limit switch opens and the closing limit switch closes. When the door is full down, the closing limit switch is open and the opening limit switch closes. This prepares the reaction motor for the next time that the system is activated or deactivated. The electrically operated concealed headlight system provides a provision for manually opening the doors in the event of a system failure (Figure 2-19).

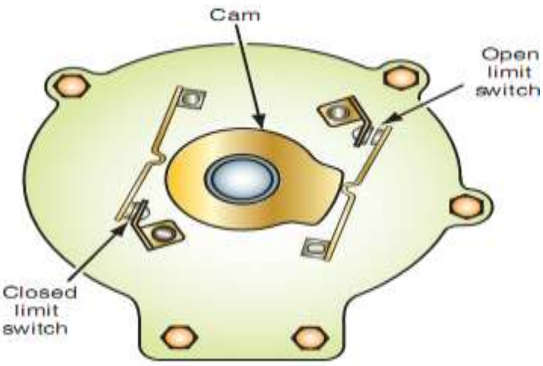


FIGURE 2-18 most limit switches operate off of a cam on the motor

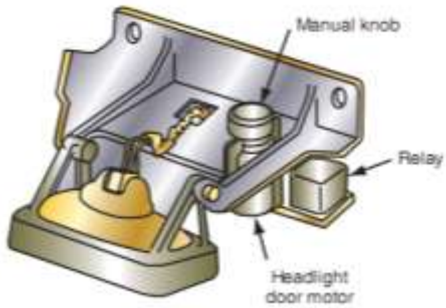


FIGURE 2-19 an electrically controlled concealed headlight system with a manual control knob.

Headlight Switches

The headlight switch may be located either on the dash by the instrument panel or on the steering column (Figure 2-20). It controls most of the vehicle's lighting systems. The most common style of headlight switch is the three-position type with OFF, PARK, and HEADLIGHT positions. The headlight switch will generally receive direct battery voltage to two terminals of the switch. This allows the light circuits to be operated without having the ignition switch in the RUN or ACC (accessory) position.

When the headlight switch is in the OFF position, the open contacts prevent battery voltage from continuing to the lamps. When the switch is in the PARK position, battery voltage that is present at terminal 5 is able to be applied through the closed contacts to the side marker, taillight, license plate, and instrument cluster lights (Figure 2-21). This circuit is usually protected by a 15- to 20-ampere fuse that is separate from the headlight circuit.

When the switch is located in the HEADLIGHT position, battery voltage that is present at terminal 1 is able to be applied through the circuit breaker and the closed contacts to light the headlights. Battery voltage from terminal 5 continues to light the lights that were on in the PARK position (Figure 2-22). The circuit breaker is used to prevent temporary overloads to the system from totally disabling the headlights.

FIGURE 2-20 (A) Instrument panel-mounted headlight switch. (B) Steering column-mounted headlight switch.

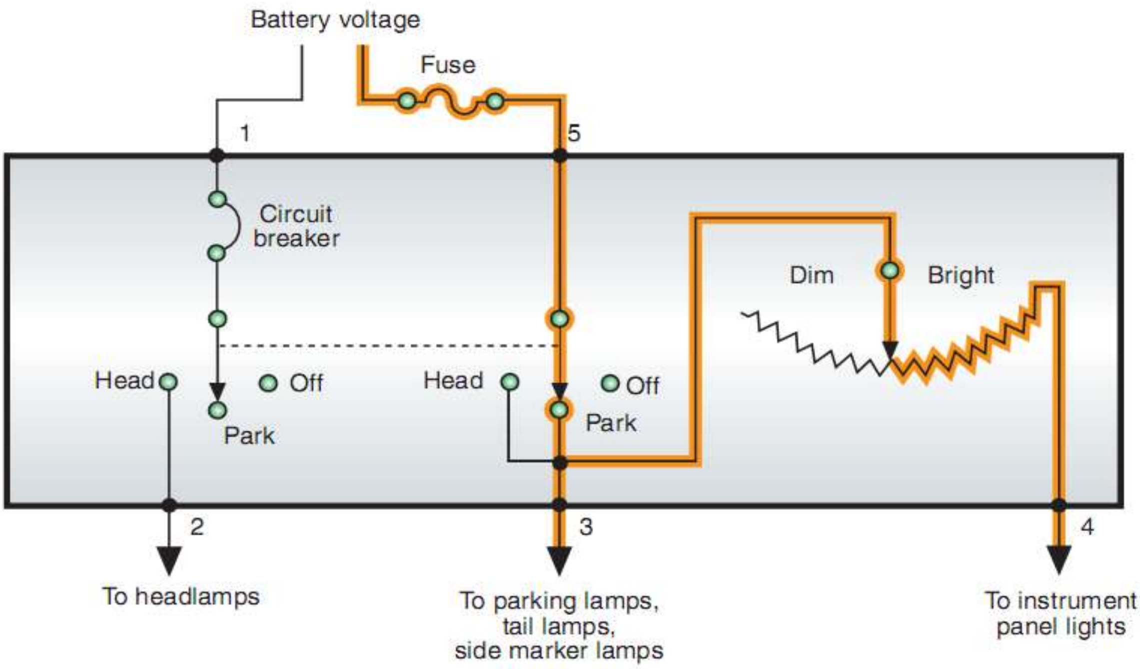


FIGURE 2-21 Operation with the headlight switch in the PARK position.

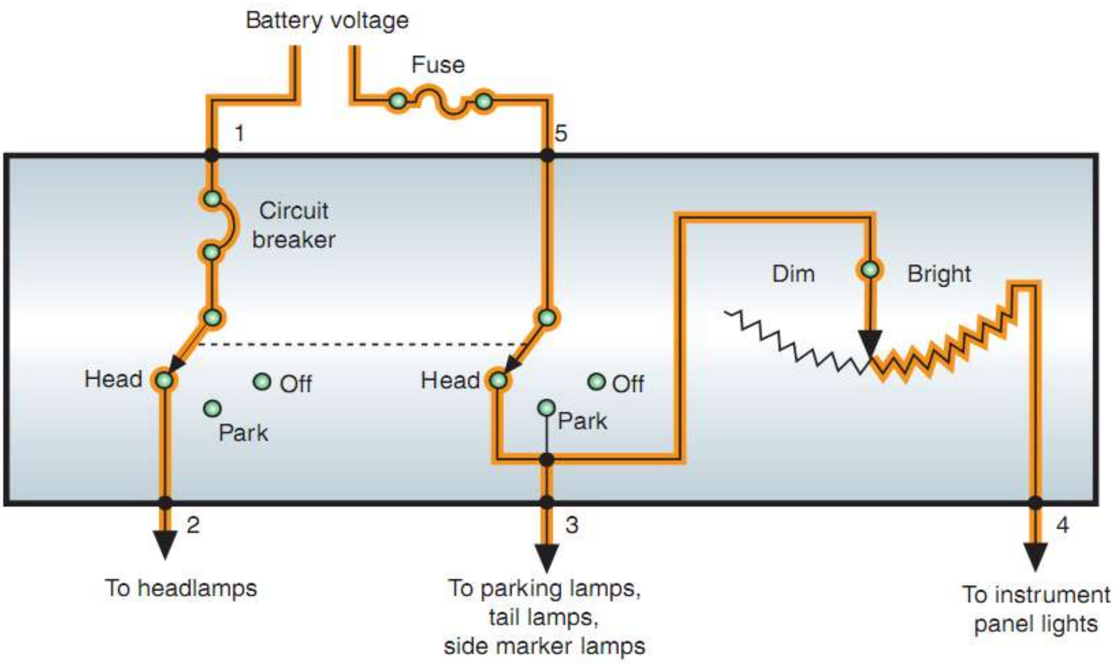


FIGURE 2-22 Operation with the headlight switch in the HEADLIGHT position.

The rheostat is a variable resistor that the driver uses to control the instrument cluster illumination lamp brightness. As the driver turns the light switch knob, the resistance in the rheostat is changed. The greater the resistance, the dimmer the instrument panel illumination lights glow. In vehicles that have the headlight switch located in the steering column, the rheostat may be a separate unit located on the dash near the instrument panel.

Dimmer Switches

The dimmer switch provides the means for the driver to select either high- or low-beam operation, and to switch between the two. The dimmer switch is connected in series within the headlight circuit and controls the current path for high and low beams. In the past, the most common location of the dimmer switch was on the floor board next to the left kick panel. The driver operates this switch by pressing on it with a foot. Positioning the switch on the floor board made the switch subject to damage because of rust, dirt, and so forth. Most newer vehicles locate the dimmer switch on the steering column to prevent early failure and to increase driver accessibility (Figure 2-23). This switch is activated by the driver pulling the stock switch (turn signal lever) rearward.

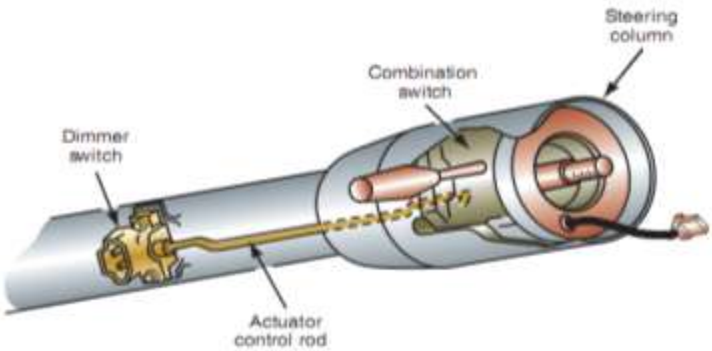


FIGURE 2-23 A steering column—mounted dimmer switch.

Headlight Circuits

The complete headlight circuit consists of the headlight switch, dimmer switch, high-beam indicator, and the headlights. When the headlight switch is pulled to the HEADLIGHT position, current flows to the dimmer switch through the closed contacts (Figure 2-24). If the dimmer switch is in the LOW position, current flows through the low-beam filament of the headlights. When the dimmer switch is placed on the HIGH position, current flows through the high-beam filaments of the headlights.

The headlight circuits just discussed are designed with insulated side switches and grounded bulbs. In this system, battery voltage is present to the headlight switch. The switch must be closed in order for current to flow through the filaments and to ground. The circuit is complete because the headlights are grounded to the vehicle body or chassis. Many import manufacturers use a system design that has insulated bulbs and ground side switches. In this system, when the headlight switch is located in the HEADLIGHT position, the contacts are closed to complete the circuit path to ground. The headlight switch is located after the head-light lamps in the circuit. Battery voltage is applied directly to the headlights when the relays are closed. But the headlights will not light until the switch completes the ground side of the relay circuits. In this system, both the headlight and dimmer switches complete the circuits to ground.

No matter if the headlights use insulated side switches or ground side switches, each system is wired in parallel. This prevents total headlight failure if one filament burns out.

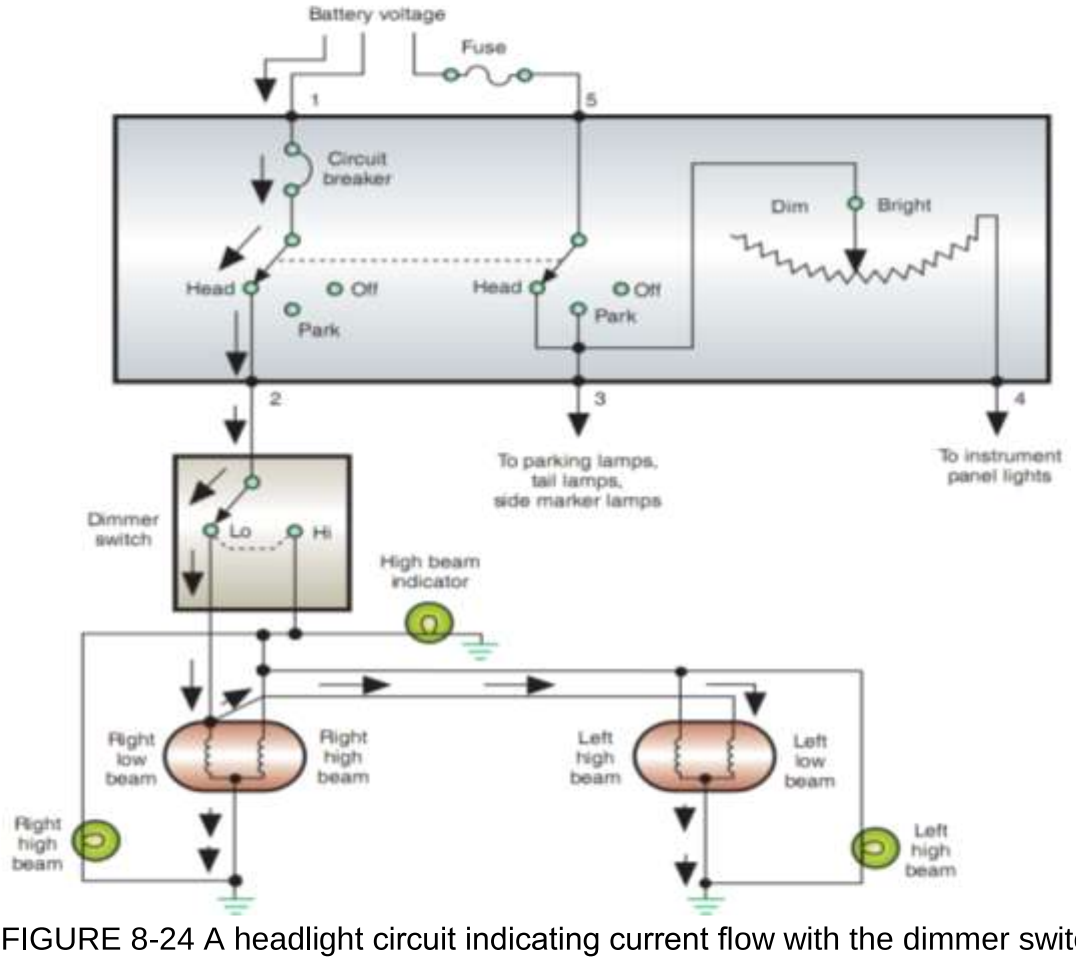


FIGURE 8-24 A headlight circuit indicating current flow with the dimmer switch in the LOW-BEAM position.

Exterior Lights

Exterior lighting is controlled by the headlight switch, which is connected directly to the battery on most vehicles. Therefore, if the light switch is left on manually, the lights could drain the battery. Older headlight switches contained a built-in circuit breaker. If excessive current flows through the headlight circuit, the circuit breaker will momentarily open the circuit, then close it again. The result is headlights that flicker on and off rapidly. This feature allows the headlights to function, as a safety measure, in spite of current overload.

The headlight switch controls the following lights on most vehicles, usually through a module.

1. Headlights
2. Taillights
3. Cornering Lights
4. Front parking lights
5. Turn Lights
6. Dash lights
7. Interior (dome) light(s)

Headlights

Headlights are mounted on the front of a vehicle to light the road ahead during darkness or other times when normal visibility is poor. Headlight designs and construction have been influenced by the changes in technology. In the past, all cars had two or four round or rectangular headlights. Now head-lights are an integral part of a vehicle's overall design (Figure 2–25).

Figure 2–25 Today's headlights are an integral part of the appearance of vehicles.

Taillight Assemblies

The headlight switch controls parking lights and taillights. They can be turned on without having to turn on the headlights. Usually, the first detent on the headlight switch is provided for this function. Figure 2-26 illustrates a parking light and taillight circuit. This circuit is controlled by the headlight switch. Thus the lights can be operated with the ignition switch in the OFF position.

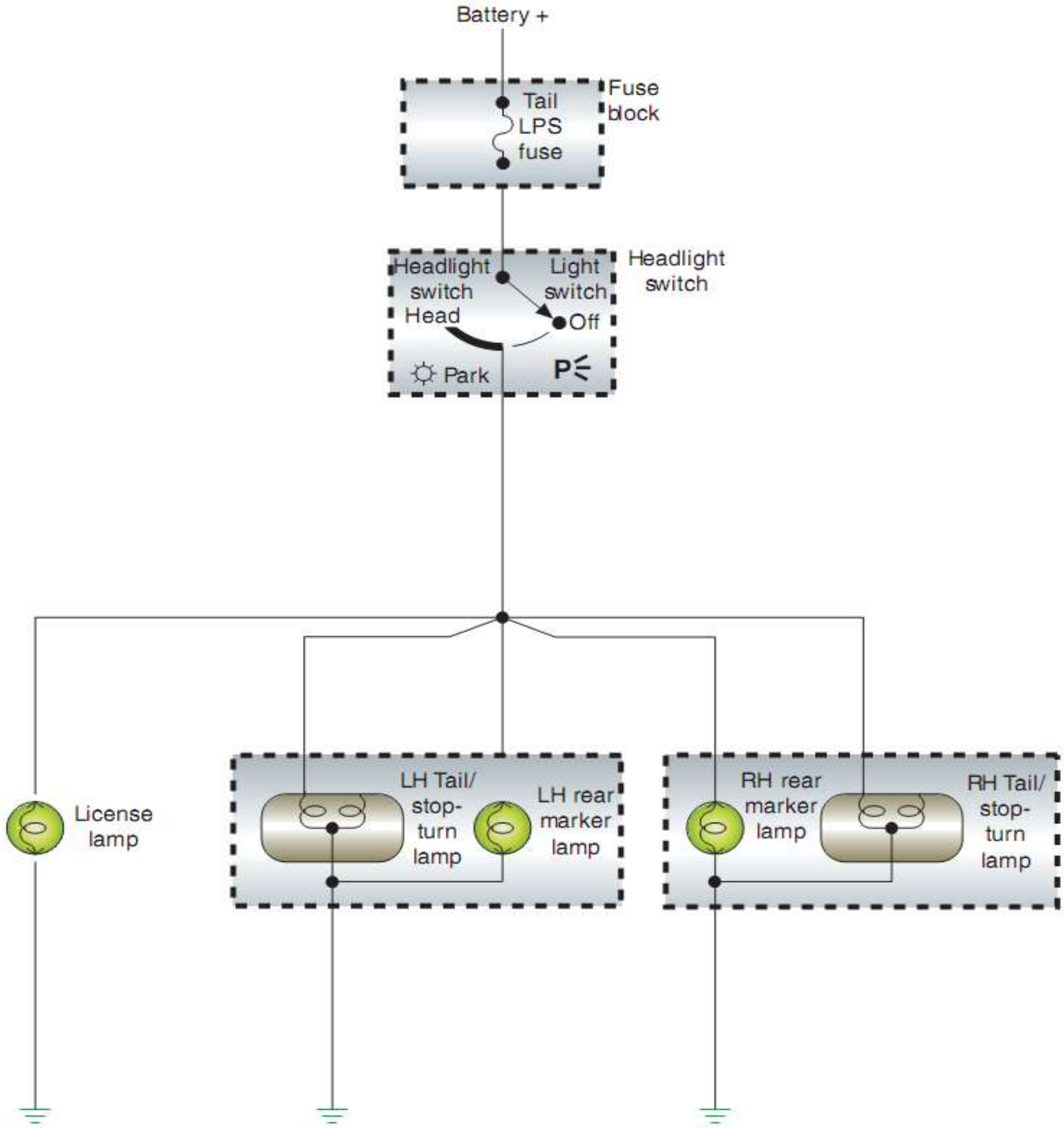


FIGURE 2-26 An example of a two-bulb taillight circuit.

Cornering Lights

Cornering lights are lamps that illuminate when the turn signals are activated. They burn steady when the turn signal switch is in a turn position to provide additional illumination of the road in the direction of the turn (Figure 2-27). Vehicles equipped with cornering lights have an additional set of contacts in the turn signal switch. These contacts operate the cornering light circuit only. The contacts can receive voltage from either the ignition switch or the headlight switch. If the ignition switch provides the power, the cornering lights will be activated any time the turn signals are used (Figure 2-28). If the contacts receive the voltage from the headlight switch, the cornering lights do not operate unless the headlight switch is in the PARK or HEADLIGHT position.

FIGURE 8-27 Cornering lights are used to provide additional illumination during turns.

Stoplights and reverse lights

Stoplights, or brake lights, are used to warn drivers behind that you are slowing down or stopping. Reverse lights warn other drivers or pedestrians that you are reversing, or intend to reverse (Figure 2-28). The circuits are quite simple; one switch in each case operates two or three bulbs via a relay.

Figure 2-28 Stop and reverse lights form part of the rear light cluster

The circuits for these two systems are similar. Brake lights come on when the driver presses the brake pedal. The movement of the brake pedal closes a switch. This sends electrical current to the brake lights and they glow behind the red plastic lanes in the taillight.

The stoplights are about three times as bright as taillight. This makes sure that any driver behind you can see your car parking even in the daytime. The stoplights have power rating of 21 watts. In some cars, the brake light and taillights are combined into one double filament bayonet base bulb. In some other cars, a separate bulb is used for each light.Figure 2-29 shows a typical stoplight or reverses light circuit. Most incorporate a relay to switch on the lights, which in turn is operated by a spring-loaded switch on the brake pedal or gearbox. Links from the stoplight circuit to the cruise control system may be found. This is to cause the cruise control to switch off as the brakes are operated. A link may also be made to the antilock brake system.

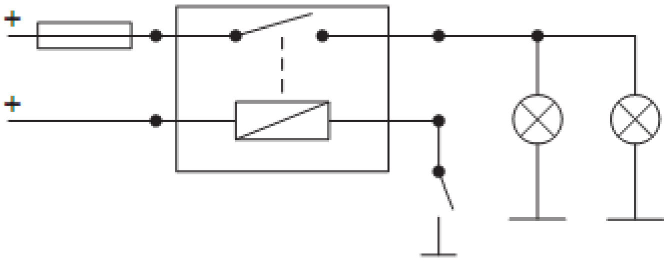


Figure 2-29 Stoplights or reverse light circuit

Operation of Brake Lights

Brake lights, also called stop lights, use the high-intensity filament of a double-filament bulb. (The low- intensity filament is for the taillights.) (figure 2-30)When the brakes are applied, the brake switch is closed and the brake lamps light.

The brake switch receives current from a fuse that is hot all the time. The brake light switch is a normally open (N.O.) switch, but is closed when the driver depresses the brake pedal. Since 1986, all vehicles sold in the United States have a third brake light commonly referred to as the center high-mounted stop light (CHMSL).

The brake switch is also used as an input switch (signal) for the following:

1. Cruise control (deactivates when the brake pedal is depressed)
2. Antilock brakes (ABS)
3. Brake shift interlock (prevents shifting from park position unless the brake pedal is depressed)

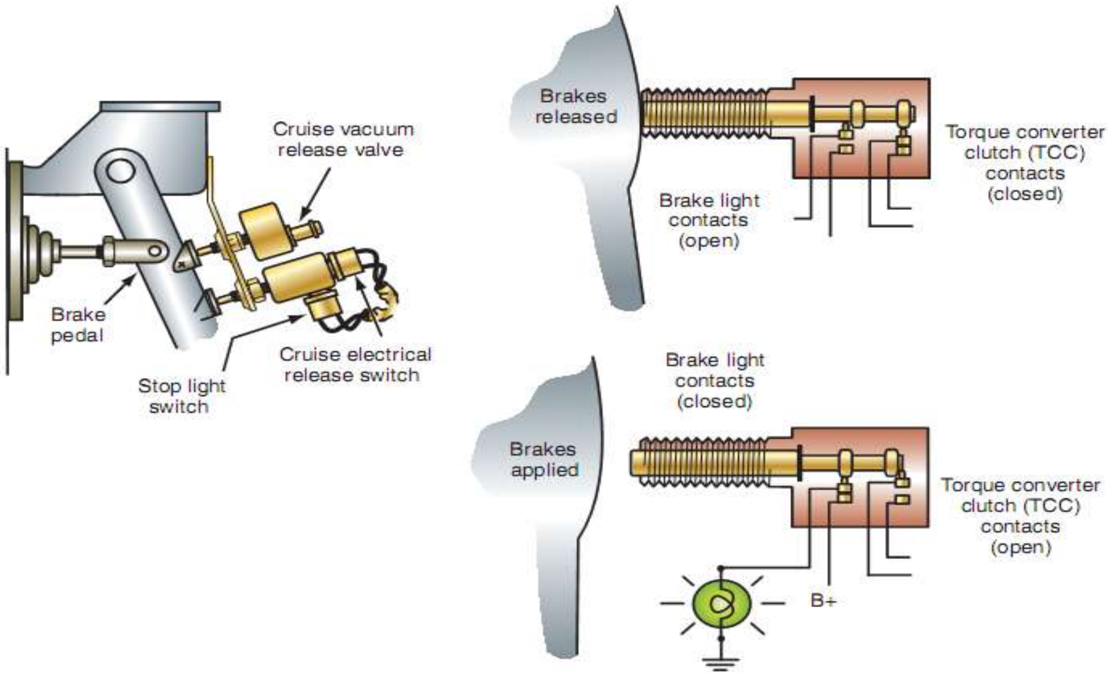


FIGURE 8-30Operation of a brake light switch.

Interior Lights

Interior lighting includes courtesy lights, map lights, and instrument panel lights.

Courtesy Lights

Courtesy lights illuminate the vehicle's interior when the doors are open. Courtesy lights operate from the headlight and door switches and receive their power source directly from a fused battery connection. The switches can be either ground switch circuit (Figure 2-31) or insulated switch circuit design (Figure 2-32). In the insulated switch circuit, the switch is used as the power relay to the lights. In the grounded switch circuit, the switch controls the grounding portion of the circuit for the lights. The courtesy lights may also be activated by the headlight switch. When the headlight switch knob is turned to the extreme counter clockwise position, the contacts in the switch close and complete the circuit.

Reading and Map Lights

Individual switches and controls to allow passengers in the vehicle to turn on individual lights are incorporated within most courtesy light systems (refer to Figure 2-32). The system shown has individual two-position switches that allow the passenger to turn on a light. When the switch is pressed, it completes the circuit to ground for that light only.

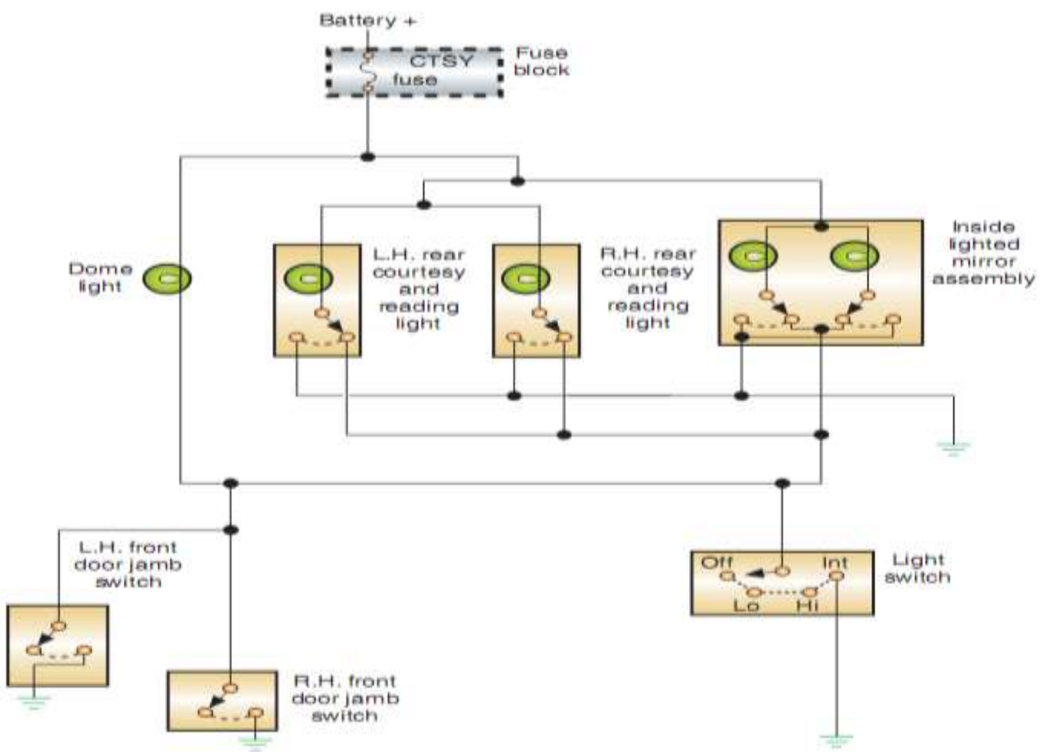


FIGURE 2-31Courtesy lights using ground side switches.

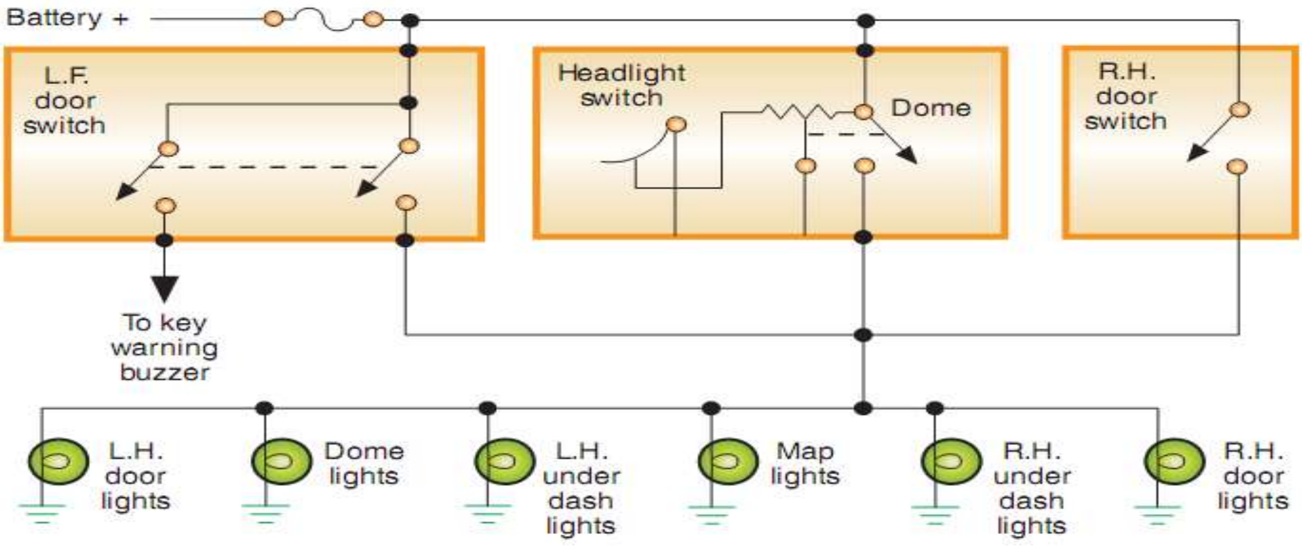


FIGURE 2-32 Courtesy lights using insulated side switches.

Instrument Cluster and Panel Lights

Consider the following three types of lighting circuits within the instrument cluster:

1. Warning lights alert the driver to potentially dangerous conditions such as brake failure or low oil pressure.
2. Indicator lights include turn signal indicators.
3. Illumination lights provide indirect lighting to illuminate the instrument gauges, speedometer, heater controls, clock, ashtray, radio, and other controls. The power source for the instrument panel lights is provided through the headlight switch. The contacts are closed when the headlight switch is located in the PARK or HEADLIGHT Position. The current must flow through a variable resistor (rheostat) that is either a part of the headlight switch or a separate dial on the dash. the resistance of the rheostat is varied by turning the knob. By varying the resistance, changes in the current flow to the lamps control the brightness of the lights (Figure 2-33).

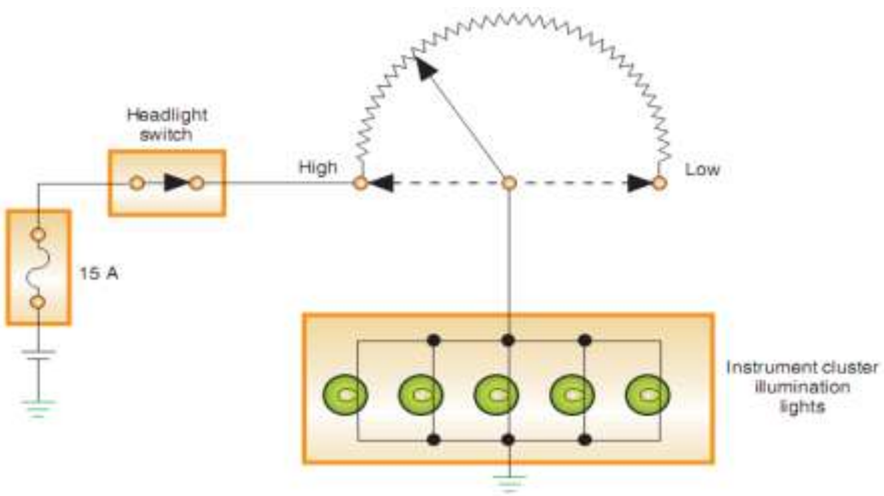


FIGURE 2-33 A rheostat controls the brightness of the instrument panel lights

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

i. Short-Answer Essays

1. What are the purposes of wiring harness assemblies?
2. Explain One and Two-Wire Circuits
3. What lighting systems are controlled by the headlight switch?
4. What is CHMSL?
5. What is the purpose of the lamp filament?
6. List and describe the four types of headlight lamps used.
7. The operation of the brake lights in a two-bulb taillight assembly.
8. Describe the purpose of bi-xenon headlights.

ii. Multiple Choice

1. In the two-bulb taillight assembly:
   A. the brake lights use the high-intensity fi lament of the taillight bulb.
   B. the current to the brake lights flows through the turn signal switch.
   C. All of the above.
   D. None of the above.
2. In a composite headlight:
   A. The bulb is replaceable.
   B. A cracked lens will prevent lamp operation.
   C. All of the above
   D. None of the above.
3. Current to the brake light switch usually comes from the:
   A. Ignition switch feed.
   B. Headlight switch feed.
   C. Turn signal switch feed.
   D. Direct battery feed.
4. The concealed headlight system is being discussed. Technician A says the system can use vacuum to operate the doors. Technician B says the system can use electric motors to operate the doors. Who is correct?
   A. A only C. Both A and B
   B. B only D. Neither A nor B
5. Which statement about the cornering light system is NOT correct?
   A. The cornering lights use an additional set of contacts in the turn signal switch.
   B. The cornering lights can receive voltage from the ignition switch.
   C. The cornering lights can receive voltage from the headlight switch.
   D. The cornering lights can operate only if the vehicle speed sensor input indicates speeds over 3 mph (4.8 kph).
6. Technician A says the side marker lights can be wired to flash with the turn signals.

Technician B says wrap-around lenses can be used for side marker lights.
Who is correct?

A. A only C. Both A and B
B. B only D. Neither A nor B

7. Which of the following best describes the function of the bi-xenon headlight system?
   A. Uses double filament headlights to provide the high beam output.
   B. Use a chamber filled with multiple xenon gases that are ignited at different temperatures to provide high beam and low beam operation.
   C. Uses multiple chamber of xenon gas that are ignited based on dimmer switch position. One chamber is for low beam, and both chambers are ignited for high beam.
   D. None of the above.

Note: **Satisfactory rating – 60%** **Unsatisfactory - below 60%**

Answer Sheet

Score = ____________

Rating: _____________

Name: ____________________________ **Date:** _________________

Operation Sheet 1	**How to testing lamp Using the Multimeter**

Tools and Materials:
1. Multimeter
2. bulb

Description: Bulbs can be tested using two basic tests. (Figure 2–34)
1. Perform a visual inspection of any bulb. Many faults, such as a shorted filament, corroded connector, or water, can cause weird problems that are often thought to be wiring issues. See figures 2-35 and 2-36 .
2. Bulbs can be tested using an ohmmeter and checking the resistance of the filaments(s). Most bulbs will read low resistance at room temperature between 0.5 and 20 ohms depending on the bulb. Test results include:
   a. **Normal resistance.** The bulb is good. Check both filaments if it is a two-filament bulb. See figure 2–37.
   b. **Zero ohms**. It is unlikely but possible for the bulb filament to be shorted.
   c. **Electrically open (OL).** The reading indicates that the bulb filament is broken.

Steps and Procedures:

Figure 2–34 Close-up a 2057 dual-filament (double contact)bulb that failed. Notice that the top filament broke from its mounting and melted onto the lower filament. This bulb caused the dash lights to come on whenever the brakes were applied.

FIGURE 2–35 Corrosion caused the two terminals of this dual-filament bulb to be electrically connected.

FIGURE 2–36 often the best diagnosis is a thorough visual inspection. This bulb was found to be filled with water, which caused weird problems.

FIGURE 2–37 this single-filament bulb is being tested with a digital multimeter set to read resistance in ohms. The reading of 1.1 ohms is the resistance of the bulb when cold. As soon as current flows through the filament, the resistance increases about 10 times. It is the initial surge of current flowing through the filament when the bulb is cool that causes many bulbs to fail in cold weather as a result of the reduced resistance. As the temperature increases, the resistance increases.

LAP Test 1	**Practical Demonstration**

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1:00 hour.

Task 1. Identify type lamp and check functionally (Normal resistance, Zero ohms or electrically open) by visually and instrumental (1:00 minute)

Operation Sheet 2	**Headlight replacement**

Instructions:

1. Read Information Sheet No. 1
2. Gather the tools and materials listed below.
3. Ask your instructor for a demonstration on the steps involved in this operation.
4. Following the steps below, practice this skill until you are confident in your ability to perform it. At that time, ask your instructor.

Tools and Materials:

1. unit multitester (analog)
2. Steel brush
3. Working table
4. Screw drive
5. Wrench

Steps and Procedures:

Photo Sequence 12 illustrates a common procedure for replacing a sealed-beam headlight. After confirming proper headlight operation, replacing a Sealed-Beam Headlight All photos in sequence.

1. Place fender covers around the work area.
2. Sealed-beam headlight replacement usually requires the removal of the bezel. Some vehicles may require that the turn signal light assembly be removed before the headlight is accessible.
3. Remove the retaining ring screws and the retaining trim. Do not turn the two headlight aiming adjustment screws.
4. Remove the headlight from the shell assembly.
5. Disconnect the wire connector from the back of the lamp.
6. Check the wire connector for corrosion or other foreign material. Clean as necessary.
7. Coat the connector terminals and the prongs of the new headlight with dielectric grease to prevent corrosion.
8. Install the wire connector onto the new headlight's connector prongs.
9. Place the headlight into the shell assembly. When positioning the headlight, be sure that the embossed number is at the top. Many headlights are marked "TOP."
10. Install the retainer trim and fasteners. .
11. Install the headlight bezel.
12. Check operation of the headlight


P15-1 Place fender covers around the work area.


P15-2 Sealed-beam headlight replacement usually requires the removal of the bezel. Some vehicles may require that the turn signal light assembly be removed before the headlight is accessible.


P15-3 Remove the retaining ring screws and the retaining trim. Do not turn the two headlight aiming adjustment screws.


P15-4 Remove the headlight from the shell assembly.


P15-5 Disconnect the wire connector from the back of the lamp.


P15-6 Check the wire connector for corrosion or other foreign material. Clean as necessary.


P15-7 Coat the connector terminals and the prongs of the new headlight with dielectric grease to prevent corrosion.


P15-8 Install the wire connector onto the new headlight's connector prongs.


P15-9 Place the headlight into the shell assembly. When positioning the headlight, be sure that the embossed number is at the top. Many headlights are marked "TOP."


P15-10 Install the retainer trim and fasteners.


P15-11 Install the headlight bezel.


P15-12 Check operation of the headlight.

LAP Test 2	**Practical Demonstration**

Name: ______________________________ Date: ________________

Time started: _________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 0:30 hour.

Task1:- Replace Headlight lamp (0:30 minute)

Operation Sheet 3	Terminal Identification of lighting system circuit diagrams

Tools and Materials:

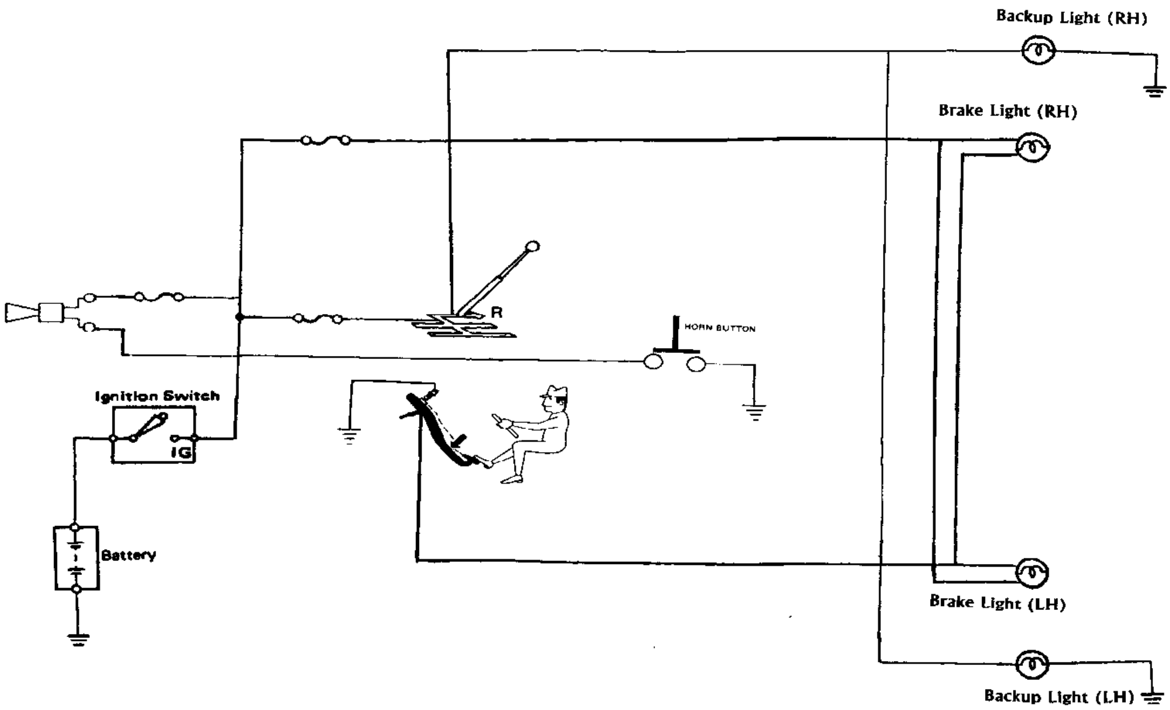
1. Multimeter
2. Headlight switch (combination switch)
3. circuit diagram
4. vehicle or lighting board with all full parts(lamp, lamp holder, switches, fuses ,etc)

Steps and Procedures:

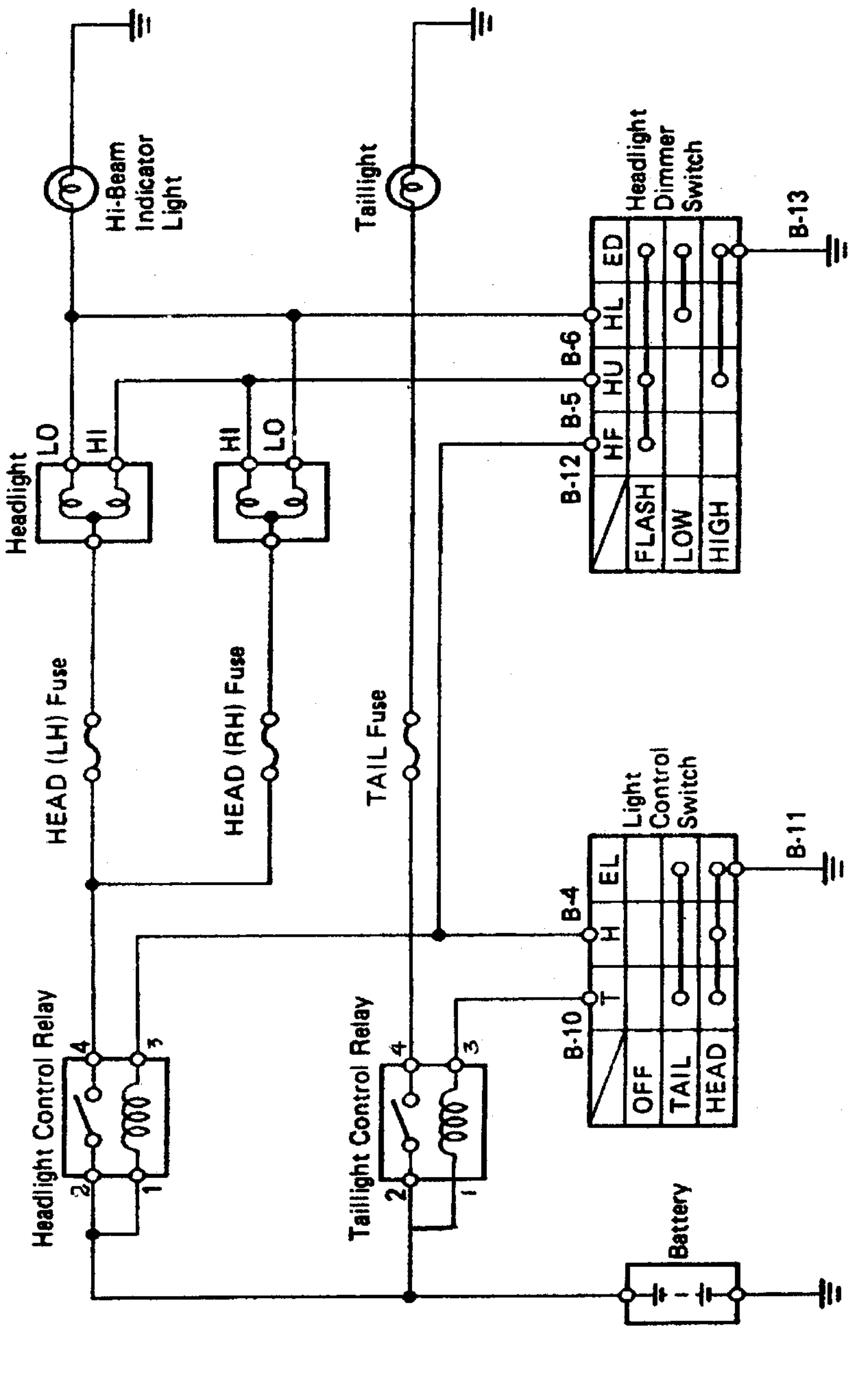
1. identity Headlight switch (combination switch) terminal (figure2-39)
2. understand all lighting system circuit from circuit diagrams

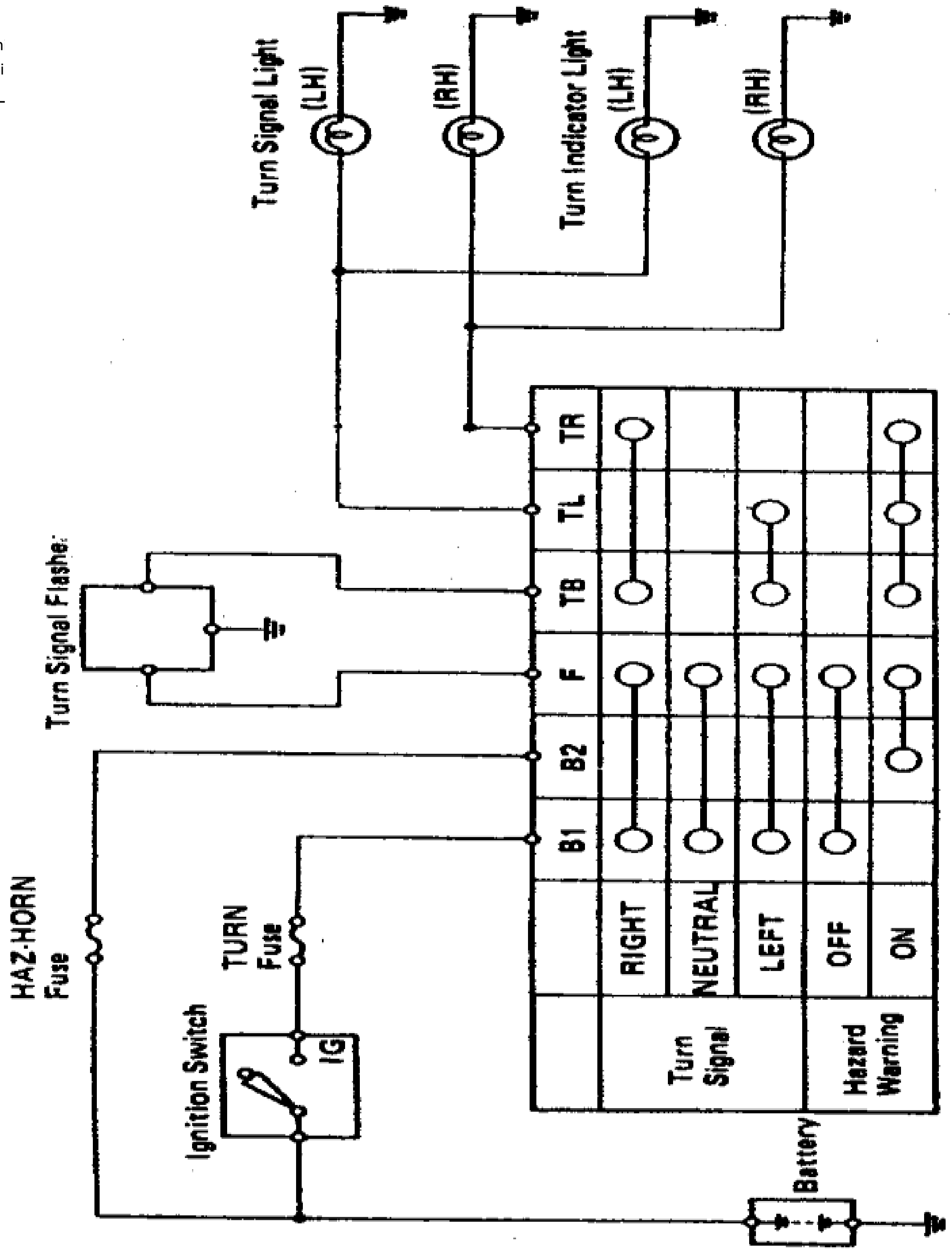
Figure2-39combination switch terminal

i. Brake light, back-up Light and horn Circuit diagram



ii. Head Lights & Tail Lights Circuit diagram




Turn Signal Light
(LH)
(RH)
Turn Indicator Light
(LH)
(RH)
Turn Signal Flashe:
HAZ-HORN
Fuse
TURN
Fuse
Ignition Switch
IG
Battery
TR
TL
TB
F
B2
B1
RIGHT
NEUTRAL
LEFT
OFF
ON
Turn Signal
Hazard Warning

LAP Test 3	**Practical Demonstration**

Name: _____________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1:30 hour.

Task1. Identify Headlight switch (combination switch) terminal (1:30 minute)

Operation Sheet 4	Installing wiring/lighting system

Purpose: - for installing lighting system properly to give illumination for the driver

Equipment, Tools and Materials:

- Multimeter
- Headlight switch (combination switch)
- circuit diagram
- vehicle or lighting board with all full parts(lamp, lamp holder, switches, fuses ,etc)
- Hand Tools **:** pliers ,
- Measuring tools : multi-meter
- Wire, test lamp, terminal (male and female), electrical tap, battery.

PROCEDURE

1. Identify, select and prepare Components, tooling and equipment in accordance with manufacturer instructions and site procedures.
2. Find a suitable place on your dashboard for the switch.
3. Mount the relay, placing it as close to the battery as possible, while avoiding areas of excessive exhaust and engine hot spots. Drill a hole or use any preexisting holes to mount the relay.
4. Run a ground wire from the relay to the chassis or earthling point.

5. Run a wire from one terminal on the dashboard switch through the firewall (following a preexisting loom or other appropriate hole) to the high-beam wire on your vehicle's headlamp. Use the T-piece connector to join to this wire.
6. Run the appropriately colored wire out of the relay through the firewall and on to the other terminal on the dashboard switch.
7. Run the wire from the relay to the driving lights. Each light should also have a ground wire connected to an earthling point or the chassis.
8. Run the battery wire from the relay to the battery, with a fuse in between.
9. Test to see if the driving lights are working on high beam, and also test the operation of the dashboard switch.
10. Finally, adjust the light beams..

PRECAUTIONS:-

- ✓ Wear working clothes properly which fit with your body
- ✓ Use proper tools/equipment's the purpose designed for.
- ✓ Keep yourself from electric shock

LAP Test 4	**Practical Demonstration**

Name: ____________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00 hour.

Task1. Installing wiring/lighting system

Information Sheet-3	Carry-out tests to determine faults

Electrical Problems/faults

All electrical problems can be classified into one of three categories: opens, shorts, or high-resistance problems. Identifying the type of problem allows technicians to identify the correct tests to perform when diagnosing an electrical problem. An explanation of the different types of electrical problems follows.

i. Open circuits

An open occurs when a circuit is incomplete. Without a completed path, current cannot flow (Figure 2-41) and the load or component will not work. An open circuit can be caused by a disconnected wire or connector, a broken wire, or a switch in the off position.

When a circuit is off, it is open. When the circuit is on, it is closed. Switches open and close circuits, but at times a fault will cause an open. Opening a circuit stops current flow through the circuit. Voltage is still applied up to the open point, but there is no current flow. Without current flow, there are no voltage drops across the various loads.

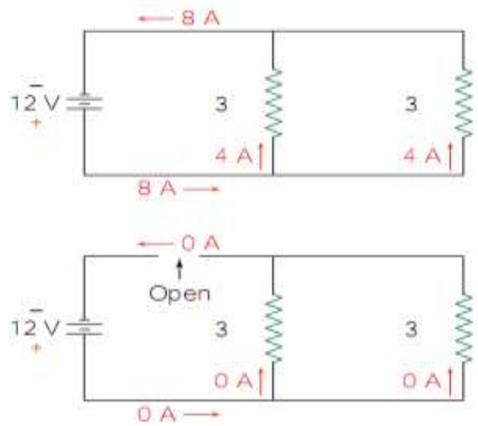


Figure 2-41 in an open circuit, there is no current flow.

(A) is a normal circuit, and (B) is the same circuit with an open.

ii. Short circuits

When a circuit has an unwanted path for current to follow, it has a short. When an energized wire accidentally contacts the frame or body of the car or another wire, circuit current can travel in unintended directions through the wires. This can cause uncontrollable circuits and high current through the circuits. Shorts are caused by damaged wire insulation, loose wires or connections, improper wiring, or careless installation of accessories.

A short creates an unwanted parallel leg or path in a circuit. As a result, circuit resistance decreases and current increases. The amount that the current will increase depends on the resistance of the short.

The increased current flow can burn wires or components. Preventing this is the purpose of circuit protection devices. When a circuit protection device opens due to higher than normal current, a short is the likely cause. Also, if a connector or group of wires show signs of burning or insulation melting, high current is the cause, which is most likely caused by a short.

A short can be caused by a number of things and can be evident in a number of ways. It can be an unwanted path to ground. The short is often in parallel to a load and provides a low-resistance path to ground. Look at Figure 2-42; the short is probably caused by bad insulation that is allowing the power feed for the lamp to touch the ground for the same lamp. This problem creates a parallel circuit.

Figure 2-43 represents Figure 2-42 but is drawn to show the short as a parallel leg with very low resistance. The resistance assigned to the short may be more or less than an actual short, but the value 0.001 ohm is given to illustrate what happens. With the short, the circuit has three loads in parallel: 0.001, 3, and 6 ohms. The total resistance of this parallel circuit is less than the lowest resistance or 0.001 ohm. Using this value as the total resistance, circuit current is calculated to be more than 12,000 amps, which is much more than the fuse can handle. The high current will burn the fuse and the circuit will not work. Some call this problem a “grounded circuit” or a “copper-to-iron” short.

Sometimes two separate circuits become shorted together. When this happens, each circuit is controlled by the other. This may result in strange happenings, such as the horn sounding every time the brake pedal is depressed (Figure 2-44), or vice versa. In this case, the brake light circuit is shorted to the horn circuit. This is often called a “copper-to-copper” short.

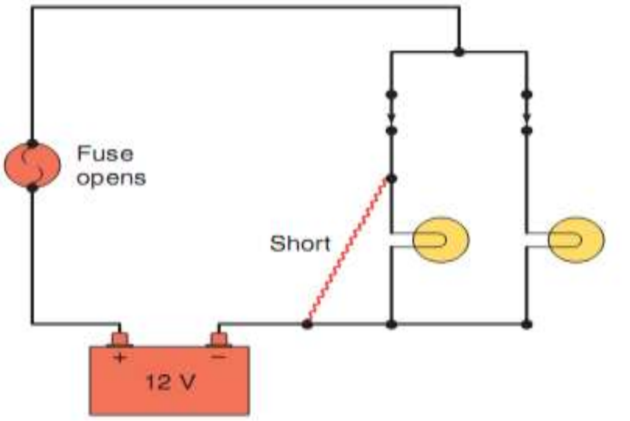


Figure 2-42 A short to ground.

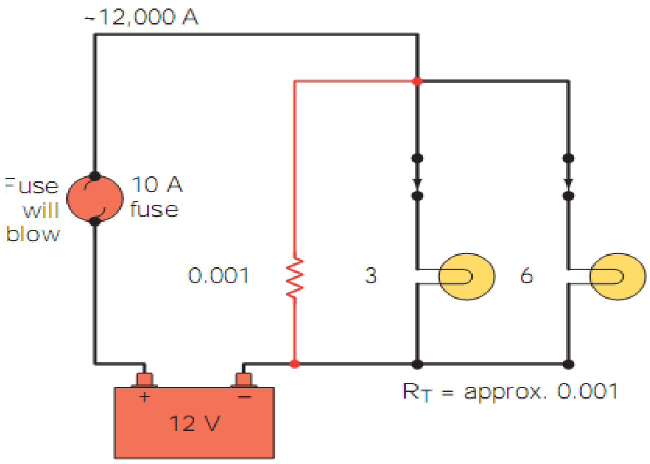


Figure 2-43 Ohm’s law applied to Figure 16–3. Notice the rise in circuit amperage.

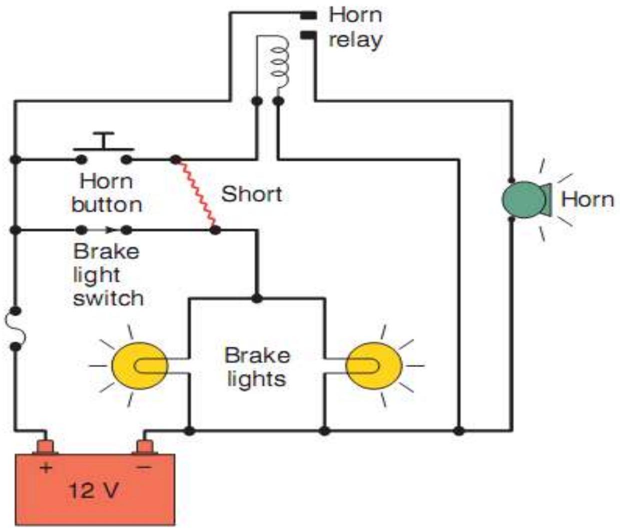


Figure 2-44 A wire-to-wire short.

iii. High-resistance circuits

High-resistance problems occur when there is unwanted resistance in the circuit. The higher than normal resistance causes the current flow to be lower than normal and the components in the circuit are unable to operate properly. A common cause of this type of problem is corrosion at a connector. The corrosion becomes an additional load in the circuit (Figure 2-45). This load uses some of the circuit's voltage, which prevents full voltage to the normal loads in the circuit.

Many sensors on today's vehicles are fed a 5-volt reference signal. The signal or voltage from the sensor is less than 5 volts depending on the condition it is measuring. A poor ground in the reference voltage circuit can cause higher than normal readings back to the computer. This seems to be contradictory to other high-resistance problems. However, if you look at a typical voltage divider circuit used to supply the reference voltage you will understand what is happening.

Look at Figure 2-46. There are two resistors in series with the voltage reference tap between them. Because the total resistance in the circuit is 12 ohms, the circuit current is 1 amp. Therefore, the voltage drop across the 7-ohm resistor is 7 volts, leaving 5 volts at the tap.

Figure 2-47 is the same circuit, but a bad ground of 1 ohm was added. This low of resistance could be caused by corrosion at the connection. With the bad ground, the total resistance is now 13 ohms.

This decreases our circuit current to approximately 0.92 amp. With this lower amperage, the voltage drop across the 7-ohm resistor is now about 6.46 volts, leaving 5.54 volts at the voltage tap. This means the reference voltage would be more than one-half volt higher than it should be. As a result, the computer will be receiving a return signal of at least one-half volt higher than it should. Depending on the sensor and the operating conditions of the vehicle, this could be critical.

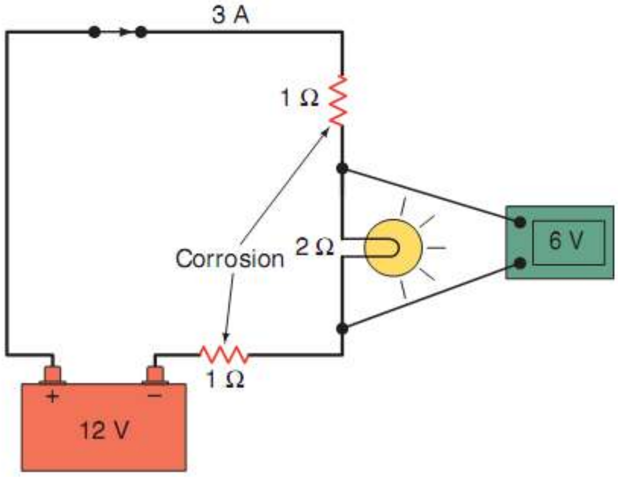


Figure 2-45 A simple light circuit with unwanted resistance. Notice the reduced voltage drop across the lamp and the reduced circuit current.

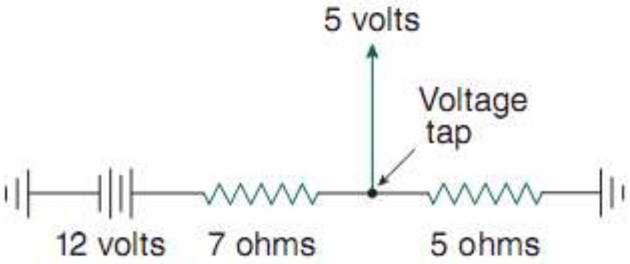


Figure 2-46 A voltage divider circuit.

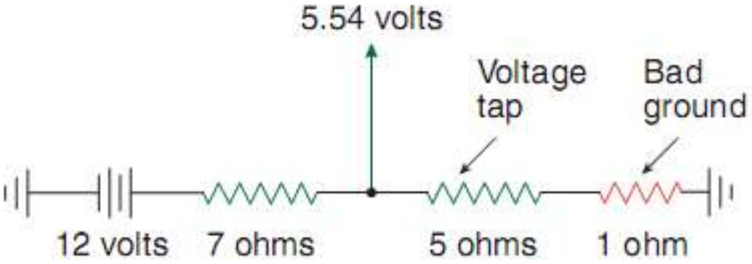


Figure 2-47 A voltage divider circuit with a bad ground.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Sort answer

1. Explain the following electrical problem
   - i. Open circuits
   - ii. Short circuits
   - iii. High-resistance circuits

Note: **Satisfactory rating - 60 %** **Unsatisfactory - below 60%**

Answer Sheet

Score = ___________

Rating: ____________

Name ____ **ID NO_** ___________________

Operation Sheet 5	Testing for an Open Circuit

Upon completion of this job sheet, you should be able to test a circuit and locate the open.

ASE Correlation

This job sheet is related to the ASE Electrical/Electronic System Certification Exam's content area: General Electrical System Diagnosis; task: Find shorts, grounds, opens, and high-resistance problems in electrical/electronic circuits and determine needed repairs.

Tools and Materials

A vehicle
DVOM
Test light
Wiring diagram for the vehicle

Describe the vehicle being worked on:

Year____________________ Make________________ Model_______________

VIN________________________________Engine type and size____________________

Procedure

1. What is the customer's complaint? ____
____
_____

2. Can the complaint be verified? □ Yes □ No
(If no, consult your instructor.)
3. Are there any other related symptoms? □ Yes □ No
If yes, describe the symptom.______________________________________
____
4. Following the wiring diagram, use a voltmeter or test light to trace the circuit.
5. Describe the location of the open.____
____
____
____
____

Instructor's Response ____
____
____
____
____

Operation Sheet 6	Testing for a Short to Ground

Upon completion of this job sheet, you should be able to test a circuit and locate the short to ground.

ASE Correlation

This job sheet is related to the ASE Electrical/Electronic System Certification Exam's content area: General Electrical System Diagnosis; task: Find shorts, grounds, opens, and high-resistance problems in electrical/electronic circuits and determine needed repairs.

Tools and Materials

A vehicle
DVOM
Test light
Circuit breaker fitted with alligator clips
Gauss gauge
Wiring diagram for the vehicle

Describe the vehicle being worked on.

Year__________________ Make________________ Model __________________

VIN ______________________ Engine type and size ___________________________

Procedure

1. Which circuit is affected by the short to ground?
2. Are there any other related symptoms? ☐ Yes ☐ No

If yes, describe the symptom(s).

____

2. Pull the fuse or circuit protection for the affected circuit from the fuse box.

4. With ignition switch in the RUN position, connect the test light across the fuse terminals in the fuse box. Does the test light illuminate? ☐ Yes ☐ No

5. What does this test indicate?

____

____

____

6. With the test light connected across fuse terminals of the fuse box, disconnect components and connectors in the affected circuit that are identified in the wiring diagram.

7. Did the test light go out when a component was disconnected? ☐ Yes ☐ No

8. What can be concluded thus far? ____

____

____

9. Connect the test circuit breaker across the fuse terminals of the fuse box and use the Gauss gauge to find the location of the short to ground.

9. Describe the location of the short to ground. _______________________________

____

____

Instructor's Response ____

____

____

Operation Sheet 7	**Testing Switches**

Upon completion of this job sheet, you should be able to test a switch and properly determine needed repairs.

ASE Correlation

This job sheet is related to the ASE Electrical/Electronic System Certification Exam's content area: General Electrical System Diagnosis; task: Check continuity and resistance in electrical/electronic circuits and components with an ohmmeter and determine needed repairs. Check electrical/electronic circuits with jumper wires and determine needed repairs.

Tools and Materials

A vehicle
DVOM
Test light
Jumper wires
Wiring diagram for the vehicle

Describe the vehicle being worked on:

Year______________________________ Make ______________Model __________
VIN_____________________ Engine type and size ______________________

Procedure

1. Locate the brake light switch (or other switch as directed by your instructor).
2. Disconnect the switch from the wire harness.
3. Use an ohmmeter to measure the resistance of the switch with the brake pedal released. Record your results. ____

____

3. With the ohmmeter still connected across the switch terminal, press the brake pedal and record the ohmmeter reading:

____

4. Based on your results, is the switch operating properly? □ Yes □ No
Why? ____

____

5. With the electrical connector to the switch still unplugged, connect a jumper wire across the battery feed and brake light circuits.
6. Do the brake lights come on? □ Yes □ No
What is the faulty component if the brake lights did not come on with the switch connected and the brakes depressed, but they do come on when jumped across the terminals?____

____

____

7. Instructor's Response ____

____

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LAP Test 5	**Practical Demonstration**

Name: _____________________________ Date: ________________
Time started: ________________________ Time finished: ________________
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2:00 hour.

Task1. Checking and Find out shorts, grounds, opens, and high-resistance problems in electrical/electronic circuits and determine needed repairs.

Information Sheet-3	Carry-out repair options

Basic repairing procedures of electrical problem

Whenever an electrical problem gives you fits, take a deep breath and think of the basic electrical building block: the series circuit. No matter how complicated a system is, you can always simplify it to smaller series of circuits. Then, inspect each circuit for voltage drop. See figure 2-48

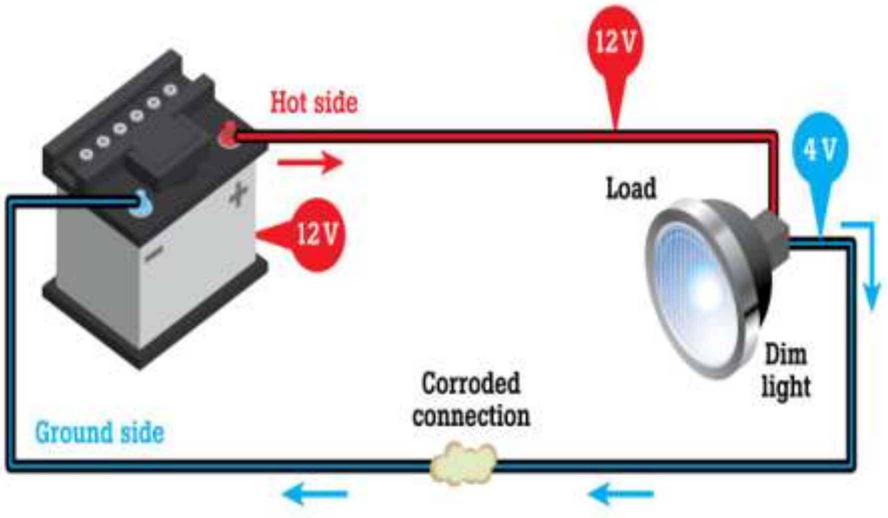

Figure2- 48 a corroded connection electrical circuit

In an electrical circuit, electrical pressure (voltage or volts) pushes electrical volume (current or amps) through the circuit, operating a load. The load may be a computer, a motor, a lamp, a relay or other device. Electrical pressure (voltage) is used up operating the load. Therefore, voltage falls to about zero on the ground side, but current keeps flowing toward the battery. Because the voltage in a healthy ground circuit should be about zero, some technicians call it ground zero. Ground-side voltage drop hurts load performance and causes a voltage reading at the ground side of the load.

Resistance—Restriction

Excessive resistance on an electrical circuit can cause a restriction in current flow. Bad connections and broken or undersized wires act like a pipe with a kink, restricting current flow. Restricting current flow anywhere hot side or ground side hurts the performance of the load. The effect on the load is hard to predict because it varies with the severity of the restriction. For example, the motor in a restricted circuit may stop working or just run slower than normal.

A restricted circuit can cause an a/c compressor clutch to slip and prematurely burn out. A computer on a restricted circuit may shut off or work erratically. When corrosion, loose connections or other types of resistance restrict a circuit, volts and amps both drop. If volts drop, amps drop too. That is why when you find a voltage drop in a connection or cable, you know the connection or cable is restricted. See figure 2-49

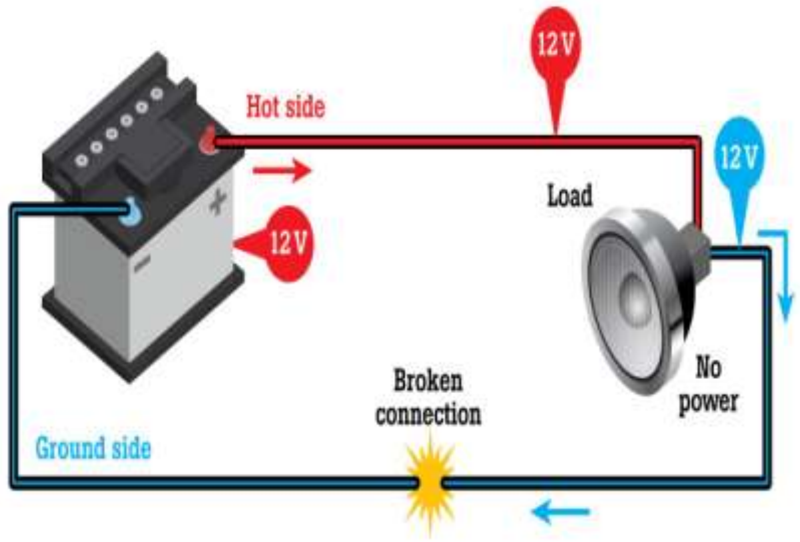

Figure2- 49 a broken connection electrical circuit

Look at the circuits in our drawings and remember two critical points:

1. A free-flowing ground side is as important as a free-flowing hot side.
2. A ground-side restriction is the only thing that causes voltage readings greater than 0 to 0.1V in any ground circuit.

A broken ground wire totally blocks current flow, shuts off the load and causes the ground side of the load to read system voltage.

Voltage drop tests

Electrical voltage drop varies according to current flow. Unless you operate the circuit so current flows through it, you cannot measure voltage drop. Because a digital multimeter's battery cannot supply the current that normally flows through most circuits, digital multimeter tests usually cannot detect restrictions as accurately as a voltage drop test.

Open-circuit problems such as broken or disconnected wires or connections stop current flow. After you fix an open circuit, switch the circuit on again and check for lingering voltage drop. Until you get current flowing and check the circuit again, you cannot know if the entire circuit is healthy.

Although resistance-free connections, wires and cables would be ideal, most of them will contain at least some voltage drop. If your manuals do not list voltage drop values, use the following as maximum limits:

- 0.00V across a connection
- 0.20V across a wire or cable
- 0.30V across a switch
- 0.10V at a ground

Because most computer circuits operate in the milliamp range, they do not tolerate voltage drop as well as other circuits does. Note that a milliamp is one-thousandth (0.001) amp. The recommended working limit is 0.10V-drop across low-current wires and switches. Testing low-current circuits also requires a high-impedance (10-megohm) digital multimeter. A low-impedance digital multimeter may load a low-current circuit so much that it gives an incorrect reading or no reading at all. Most professional-grade digital multimeters have 10-megohm input impedance. Using a digital multimeter is the fastest way to accurately measure voltage drop. If the digital multimeter you own does not have auto-ranging capability, use a low-voltage (0 to 1V) scale for voltage drop testing. Remember that test lights are not accurate enough to diagnose electrical voltage drop and can damage most computer circuits.

Quick ground tests

Because ground circuit voltage drop can cause most of the symptoms listed earlier, consider adopting this new work habit: test grounds first. Before you do a tune-up, check out electrical problems, or test a starting, charging, ABS, or air conditioning system, routinely test the engine and body grounds. Connect your digital multimeter between the engine and negative battery terminal. Safely disarm the ignition and crank the engine for a few seconds, or if your multimeter has a data recording function it will capture the reading in as little as 100 milliseconds.

If the voltage drop is excessive, repair the engine ground circuit and retest. Note that on some ignition systems without a distributor, the simplest way to prevent the engine from starting during the ground test is to pull the fuel pump fuse. Next, connect the digital multimeter between the negative battery terminal and the vehicle's firewall. Then start the engine and switch on the major electrical accessories. If there is too much voltage drop, then fix the body ground and retest.

Once the engine and body grounds are within limits, proceed with your diagnosis. Do not be surprised if fixing these grounds solves the car's problems. The fact that a vehicle passes the body ground test does not mean you can safely ground your digital multimeter wherever you want to. Some technicians have run in circles for hours because their digital multimeters were not well grounded. For safe electrical service, make yourself a 20- or 30-foot jumper wire with an alligator clip on each end, allowing you to test an electrical fuel pump, lighting system or ABS computer in the rear of the vehicle by grounding your digital multimeter to the battery with the jumper wire.

Computer ground kinks

Because computer circuits operate on such low current, the standard ground tests may not reveal a marginal ground on an on-board computer. Before you condemn any on-board computer, check its grounds first. Operate the computer system and back-probe each computer ground terminal. If you measure anything greater than 0.10V, trace that ground circuit and locate the problem.

Sometimes computer grounds are connected to a spot where they are easily disturbed or prone to corrosion, such as a thermostat-housing bolt. Computer connector terminals can also corrode. Removing the connector and spraying the terminals with electrical cleaner may be all it takes to eliminate the voltage drop.

Experience shows that as little as 0.30V on a computer ground terminal can cause trouble. Before pinpointing that with an electronic test light, remember that a traditional test light pulls too much current and can damage the computer. Poor computer and/or sensor grounds can cause higher-than-normal sensor voltages and false trouble codes. In many cases, the bad ground prevents the computer or sensor from pulling a voltage signal down to or near ground zero. Accessing the computer to check grounds may be a hassle, however, mistakenly replacing expensive sensors and computers is a bigger hassle.

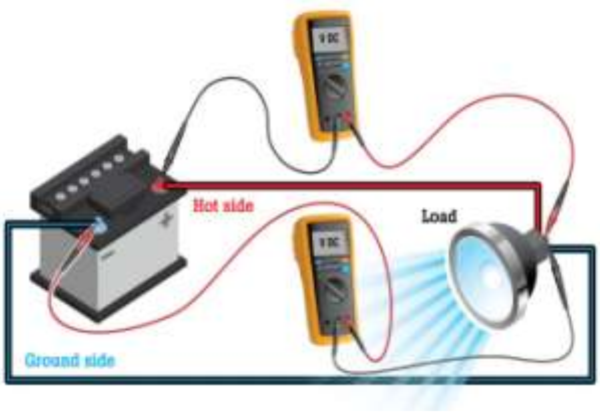

Figure2- 50 electrical circuit

Connect a digital multimeter across any part of a circuit to directly read the voltage drop across that wire, cable, switch or connection. In this example, one digital multimeter would display the voltage loss between the battery and the load, the other would show the voltage loss from the ground side of the load to the battery.

Testing procedure

The process of checking a lighting system circuit is broadly presented in Figure 2-51.

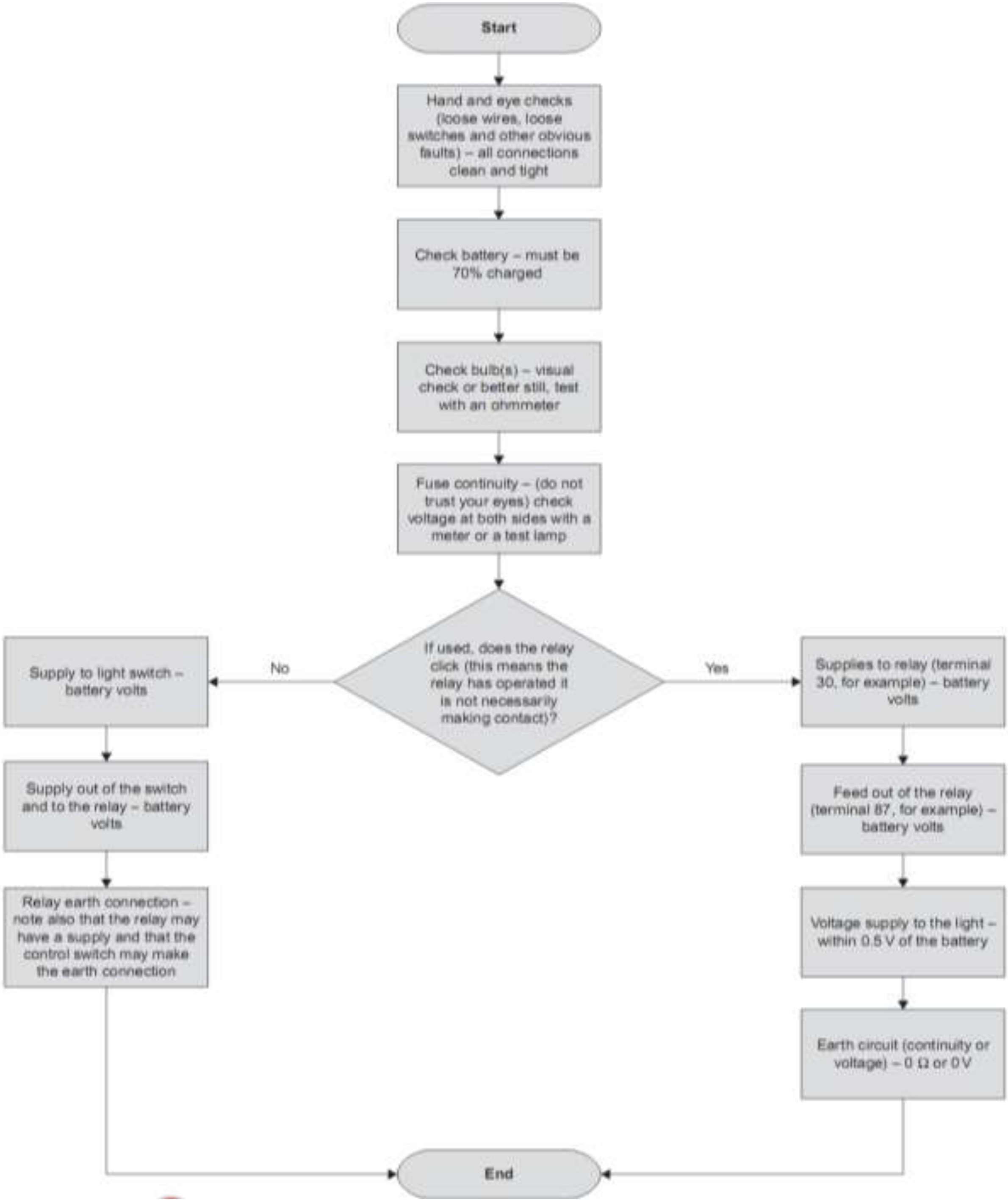

Figure 2-51 Lighting system diagnostics chart

Figure2-52 shows a simplified dim dip lighting circuit with meters connected for testing. A simple principle to keep in mind is that the circuit should be able to supply all the available battery voltage to the consumers (bulbs, etc.). A loss of 5% may be acceptable

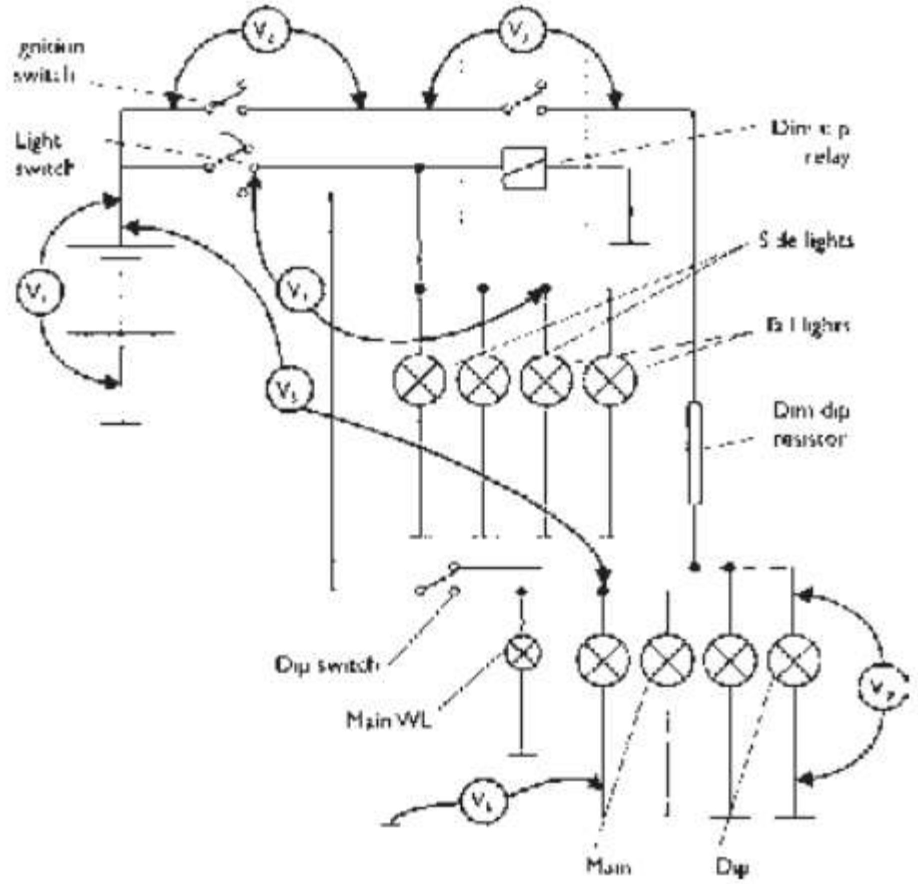

Figure 2-52 Lighting circuit under test

With all the switches in the ‘on’ position appropriate to where the meters are connected, the following readings should be obtained:

- V_1 12.6 V (if less, check battery condition);
- V_2 0–0.2 V (if more, the ignition switch contacts have a high resistance);
- V_3 0–0.2 V (if more, the dim dip relay contacts have a high resistance);
- V_4 0–0.2 V (if more, there is a high resistance in the circuit between the output of the light switch and the junction for the tail lights);
- V_7 12–12.6V if on normal dip or approximately 6 V if on dim dip (if less, then there is a high resistance in the circuit – check other readings, etc., to narrow down the fault).

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Sort answer

1. Bravely explain the basic procedure of electrical problem repairing
2. Write and sketch the process of checking a lighting system circuit

Note: **Satisfactory rating - 60 %** **Unsatisfactory - below 60%**

Answer Sheet

Score = ___________
Rating: ____________

Name ____ **ID NO_** ___________________

Information Sheet-4	Carry-out post-repair testing

BASIC LIGHTING SYSTEM DIAGNOSIS

Light problems can be solved by simply replacing bulbs. A bulb can be quickly checked with a powered test light or an ohmmeter. Connect the test light across two of the bulb's terminals (Figure 20–53). If there is continuity, the bulb is good.

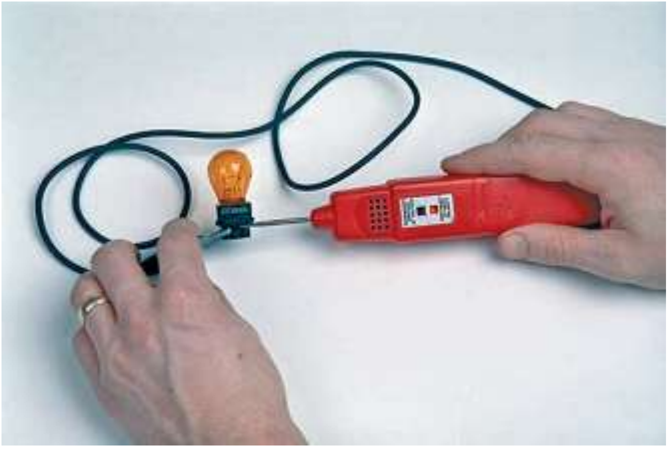

Figure 20–53 A bulb can be quickly checked with a continuity tester.

ELECTRICAL TROUBLE- SHOOTING GUIDE

When troubleshooting any electrical component, remember the following hints to find the problem faster and more easily.

1. For a device to work, it must have two things: power and ground.
2. If there is no power to a device, an open power side (blown fuse, etc.) is indicated.
3. If there is power on both sides of a device, an open ground is indicated.
4. If a fuse blows immediately, a grounded power-side wire is indicated.
5. Most electrical faults result from heat or movement.
6. Most non-computer-controlled devices operate by opening and closing the power side of the circuit (power-side switch).
7. Most computer-controlled devices operate by opening and closing the ground side of the circuit (ground-side switch).

When a burnt-out bulb is not the problem, corroded or loose wiring is the next most common problem. All wiring connections should be clean and tight; light assemblies need to be securely mounted to provide a good ground. Table 2–2 is a basic troubleshooting guide for lighting problems.

Lamp Replacement

When replacing a bulb, make sure it is the correct replacement bulb. Using the wrong bulb can cause problems, such as an incorrect blink rate. Inspect the bulb socket. Often moisture gets into a bulb socket and causes corrosion at the electrical contacts in the socket. At times, the corrosion can be removed with sandpaper. Other times, the socket or light assembly should be replaced.

Light bulbs are contained in an assembly and access to the bulb is gained by reaching around the rear of the assembly and removing the socket. Other assemblies require the removal of the light's out-side lens. With the lens removed, the bulb is removed from the front. While doing this, inspect the lens and gasket for damage and replace any damaged parts. If the lens is not sealed, dirt and moisture can enter the assembly and cause problems in the future.

On some light fixtures, the light assembly must be removed and the bulb and socket are removed from the rear of the assembly. Do not remove the lens from the assembly. It is a sealed unit and dust and other contaminants can cause serious damage to the reflector. Also, never attempt to clean the reflector. Wiping its surface can seriously reduce the light's brightness.

Bulbs are held in their sockets in a number of ways. Some bulbs are simply pushed into and pulled out of their sockets (Figure 2–54), and some are screwed in and out. Some bulbs must be depressed and turned counter clockwise to remove them.

Figure 2–54 Many light bulbs are pulled out or pushed into their sockets.

TABLE 2–2 GENERAL LIGHTING TROUBLESHOOTING GUIDE		
No_	**Concern**	**Most Probable Cause**
1.	One light does not work	➢ Bad bulb ➢ Open in that circuit
2.	One light is dim	➢ High resistance in the power ➢ or ground circuit
3.	All lights in a circuit do not work	➢ Open in the power or ground circuit ➢ Blown fuse ➢ Bad (control) switch
4.	All lights in a circuit are dim	➢ High resistance in the power ➢ or ground circuit
5.	One low-beam headlamp does not work	➢ Bad bulb ➢ High resistance in the power ➢ or ground circuit
6.	Flickering lights	➢ Loose electrical connection ➢ A circuit breaker that is kicking out because of a short
7.	One low-beam headlamp does not work	➢ Bad bulb ➢ High resistance in the power ➢ or ground circuit
8.	Both low beams do not work	➢ Open in the power or ground circuit ➢ Bad (control) switch ➢ Blown fuse ➢ Bad bulbs due to overcharging
9.	One high-beam headlamp does not work	➢ Bad bulb ➢ High resistance in the power ➢ or ground circuit
10	Both high beams do not work	➢ Open in the power or ground circuit ➢ Bad (control) switch ➢ Blown fuse ➢ Bad bulbs due to overcharging
11	Slow turn signal operation	➢ Bad flasher unit ➢ High resistance in the power ➢ or ground circuit ➢ Incorrect bulb
12	Turn signal on one side does not work	➢ Bad bulb ➢ High resistance in the power ➢ or ground circuit

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Sort answer

1. Quickly checking bulb by ______________
2. Who can electrical component troubleshooting to find the problem faster and more easily?
3. Write in table the possibility cause of concern

No_	Concern	Most Probable Cause
1.	One light does not work	
2.	One light is dim	
3.	All lights in a circuit do not work	
4.	One low-beam headlamp does not work	
5.	One low-beam headlamp does not work	
6.	Both low beams do not work	
7.	One high-beam headlamp does not work	
8.	Both high beams do not work	
9.	Slow turn signal operation	
10.	Turn signal on one side does not work	

Note: **Satisfactory rating - 60 %** **Unsatisfactory - below 60%**

Answer Sheet

Score = ____________
Rating: _____________

Name ____ **ID NO_** ____________________

List of Reference Materials

1- AUTOMOTIVE TECHNOLOGY A SYSTEMS APPROACH 5th Edition Jack Erjavec, © 2010 Delmar, Cengage Learning (website at www.cengage.com.)
2- Classroom Manual for Automotive Electricity And Electronics Fifth Edition Barry Hollembeak © 2011 Delmar, Cengage Learning
3- AUTOMOTIVE TECHNOLOGY Principles, Diagnosis, and Service FOURTH EDITION by James D. Halderman, publishing as Pearson Education, in 2012
4- Automobile Mechanical and Electrical Systems First published 2011, Copyright © 2011 Tom Denton. Published by Elsevier Ltd. All rights reserved
5- Bob Goodman and Rodney G. Brown (3M). "Electrical Taping Skills: A Lost Art?", *EC&M*, p.2
6- https://www.pfjones.co.uk/PCT/FD3166.pdf
7- Kovacic, Michael, and Karl Cunningham. "Effective Electrical Safety Program Training in Multi-Lingual/Cultural Environments." *IEEE Transactions on Industry Applications*(2019).
8- http://www.mhi.org/fundamentals/material-handling
9- Classroom Manual for Automotive Electricity And Electronics Fifth Edition Barry Hollembeak © 2011 Delmar, Cengage Learning