



# **VEHICLE SERVICING AND REPAIRING**

**NTQF Level II**

## **Learning Guide- #43**

**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 M012 LO1-LG-43

**TTLM Code:** EIS VSR2 TTLM 0919v1

**LO1: Prepare for work**

<b>Instruction Sheet</b>	<b>Prepare for work</b>
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This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- ✓ workplace instructions and job requirements
- ✓ Workplace Health and Safety (WHS) requirements
- ✓ Source and interpret procedures and information
- ✓ Analyse, Select and prepare installation options
- ✓ Identify tools and equipment.

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 –

- Workplace instructions are used to determine job requirements.
- Workplace Health and Safety (WHS) requirements are observed throughout the work.
- Procedures and information are sourced and interpreted.
- Installation options are analysed and those most appropriate to the circumstances are selected and prepared.
- Tools and equipment are identified for effective installation and testing procedures.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 2 to 32.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1” in page 4.
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**

**workplace instructions and job requirements**

**INSPECTION, MAINTENANCE AND ADJUSTMENT GENERAL INSTALLATION**

- ✚ Products should only be fitted by competent persons.
- ✚ Read the product fitting instructions carefully and check all components are included in the fitting kit before commencing installation.
- ✚ Check vehicle for corrosion and/or accident damage. Tow bars should not be fitted to any vehicle suffering from corrosion or accident damage or which is not in a roadworthy condition.
- ✚ Clean off all road dirt, under seal and sound deadening mastic where parts are to fit to ensure correct seating of all components.
- ✚ Bumper cut information is given as a guide only. Variations in models may occur therefore the fitter should always check that the bumper cut is necessary and of the correct size and shape before commencing with the cut.
- ✚ All drilling sward should be removed from the vehicle and all holes drilled in the vehicle should be treated with an appropriate rust inhibitor.
- ✚ Do not fully tighten bolts before tow bar is completely fitted unless instructed to do so in the fitting instruction, this will allow some variances to be overcome before final tightening of bolts.

**ELECTRICAL INSTALLATION, TEST/COMMISSIONING AND MAINTENANCE**

Failure to comply with the following instructions may cause damage to the towing vehicle's wiring loom and/or drawing electrics installation. Where displacement tap connectors e.g. Scotch, are the preferred method of connection, always use the correct colour coded tap connector for the size of cable to which it is to be connected. Automotive manufactured relays with integral cables should be connected using red tap

**Electrical maintenance jobs requirements**

- Clean and tighten battery cables and connections.
- Jump-start the car if your battery is low.
- Check all lights and replace bulbs.
- Remove and replace turn-signal flasher.
- Replace blown fuses.
- Check, remove, and replace alternator.
- Remove and replace spark plugs.
- Perform a compression test on the engine.
- Remove and replace distributor cap and rotor (if equipped).
- Remove and replace ignition or spark plug wires.
- Remove and replace the fuel system filter.

<b>Self-Check -1</b>	<b>Written Test</b>
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**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

**True or false**

1. Before fitting components checking all components available.
2. Workplace instruction is not necessary for new fit component.
3. Technician's make Possible to tightening bolt without instruction.
4. During maintain battery cables must be Clean and tighten the connections.
5. Vehicle Electrical failure to comply with the following instructions may cause damage to wiring loom and/or drawing electrics installation.

**Note: Satisfactory rating – 60%**

**Unsatisfactory - below 60%**

**Answer Sheet**

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

**Name** \_\_\_\_\_ **ID NO** \_\_\_\_\_

<b>Information Sheet-2</b>	<b>Workplace Health and Safety (WHS) requirements</b>
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**1. Workplace Health and Safety (WHS) requirements**

- Wear eye protection whenever you work on cars. Safety glasses, goggles, or a full-face shield can prevent eye injuries, infections, and possible blind.
- Remove watches, rings, neck or ankle chains, and all other jewellery from your body before you start work. These items can be caught by moving parts and cause serious injury.
- Do not wear loose clothing that can be caught in moving parts. Tuck in shirttails and roll up long sleeves or wear short-sleeved shirts or blouses when you work on a running engine.
- If you have long hair, tie it into a tight ponytail. Then pin the ponytail to the top of your head or stuff it down the back of your shirt or blouse.
- Work in well-ventilated areas. Never run the engine in a closed garage or other enclosed area. Carbon monoxide gas from the exhaust is poisonous and cannot be seen or detected by smell.
- Work on cars only when you're feeling fit and well. Never work on cars if you are tired, ill, or have taken drugs that can cause drowsiness or that can impair mental or physical functioning.
- Whenever possible, work with friends or partners. Difficulties and safety problems may arise with which you may need assistance.
- Perform all repairs and maintenance in accordance with the car manufacturer's recommendations, as printed in the manufacturer's service manual.
- The Car Care Book includes generalized procedures for common maintenance jobs, but it cannot anticipate all the variations that may be found on different makes and models of cars.
- Make sure you have the correct tools, parts, supplies, and materials before you begin work. Do not substitute or try to improvise with makeshift tools, parts, or supplies.
- Have a source of fresh clean water nearby to flush out eyes and minor wounds. It is also a good idea to have a first-aid kit handy whenever you work on cars.
- Whenever possible, avoid working on a running engine or one that is still hot. Serious burns can result from touching a hot exhaust system, cooling system, or other engine parts. If possible, allow the engine to cool down for several hours before you begin work.
- If you must work on a running engine, stay clear of all moving parts, including belts, pulleys, and fan blades. A spinning fan may be impossible to see. Serious injury or loss of limbs can result if you are caught in moving machinery.
- Work in well-lighted areas and use a safety droplight with a cage around the bulb. If a bare bulb breaks, the hot filament can ignite fuel or other flammable vapors and cause a fire.

- Position the car on a flat and level surface before you begin work. Never work on a car that is on an incline.
- Put the transmission in PARK (automatic transmission) or in a gear (manual transmissions) and set the parking brake firmly.
- Always place large wheel chocks or blocks both in front and in back of the wheels that remain on the ground to prevent the car from rolling, especially if you are going to raise the car.
- Raise and support the car properly and safely, according to the recommendations in the manufacturer's service manual.
- Never put any part of your body under a car that is supported only by a jack. A jack is only used to raise or lower the car. Always use safety stands, or jack stands, to safely support a car.
- Always disconnect the ground cable, typically the negative (–) battery terminal, when you work on the electrical system. This precaution will prevent sparks, fires, and damage to electrical parts.
- Have a fire extinguisher that will extinguish Classes A, B, and C fires.
- Do not use a heater with an open flame to heat the work area. Use an electric heater placed as far away as possible from the car and from any gasoline or other flammable liquids. Heat and other ignition sources can ignite fuel vapors, flammable liquids, and hydrogen gas produced by the battery.
- Collect oil, fuel, brake fluid, and other liquids only in approved metal or heavy plastic containers that can hold more liquid than you expect to drain. Do not use food or beverage containers that might be reused.

## 2.1. Personal protective clothing and equipment

Safety is not just a buzzword on a poster in the work area. Safe work habits can reduce accidents and injuries, ease the workload, and keep employees pain free.

- i. **SAFETY GLASSES** The most important personal protective equipment (PPE) a technician should wear all the time are safety glasses, which meet standard to showing in figure 1-1.



Figure1- 1 Safety glasses should be worn at all times when working on or around any vehicle or servicing any components.

- ii. **STEEL-TOED SHOES** Steel-toed safety shoes are also a good investment (See figure 1-2). If safety shoes are not available, then leather-topped shoes offer more protection than canvas or cloth covered shoes.



**Figure1- 2** Steel-toed shoes are a worthwhile investment to help prevent foot injury due to falling objects. Even these well-worn shoes can protect the feet of this service technician.

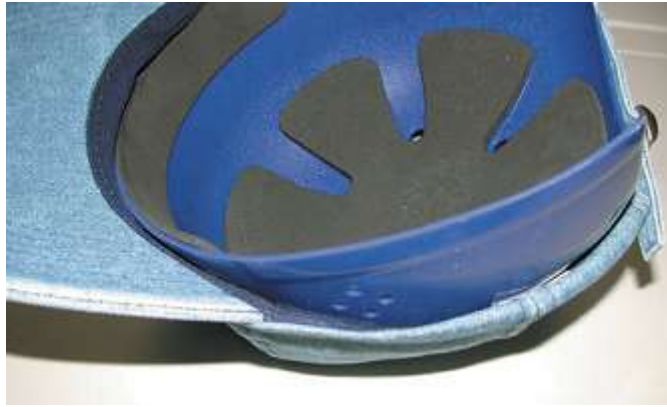
- iii. **GLOVES Wear** gloves to protect your hands from rough or sharp surfaces. Thin rubber gloves are recommended when working around automotive liquids such as engine oil, antifreeze, transmission fluid, or any other liquids that may be hazardous. Several types of gloves and their characteristics include:



**Figure1- 3** Protective gloves such as these vinyl gloves are available in several sizes. Select the size that allows the gloves to fit snugly. Vinyl gloves last a long time and often can be worn all day to help protect your hands from dirt and possible hazardous materials.

- iv. **BUMP CAP** Service technicians working under a vehicle should wear a bump cap to protect the head against under-vehicle objects and the pads of the lift. See figure 1-4





**Figure1- 4** One version of a bump cap is this padded plastic insert that is worn inside a regular cloth cap.

## **2.2. Safe use of tools and equipment (Use the tool only for its designed purpose.)**

- Read the Owner’s Manual and follow manufacturer’s safety instructions.
- Do appropriate PPE.
- If an extension cord is required, make sure it is for the correct wattage and has the proper plugs. Verify condition of the cord and plugs and check for rated use: indoor or outdoor.
- Ensure the power switch is “OFF” before plugging or unplugging tools.
- Never disconnect power by pulling on the cord – use the PLUG.
- Never carry a tool by the cord.
- Unplug the cord before making adjustments, changing/replacing parts/accessories.
- Inspect tool before each use. Replace tool if parts are worn or damaged. Remove from service and tag “Danger, Do Not Operate.”
- Do not use electric-powered tools in damp or wet locations.
- Keep the cord away from heat, oil/chemicals, sharp edges and ensure it doesn’t become a tripping hazard
- Remember there are specific practices also when drilling or penetrating areas which may contain energized conductors.
- Electrical, hydraulic and compressed air equipment can cause serious injury if incorrectly used.
- Dust and chips should be removed from machinery and equipment such as grinders and drilling tools after use to keep them clean.
- Tools should be cleaned after finishing a job, checked item by item, and stored in the tool box.

- Remove dirt and oil from special service tools (SST), testers, gages etc., and put them away neatly in the correct places.

### 2.3. Safe of material handling

Material handling is the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal. As a process, material handling incorporates a wide range of manual, semi-automated and automated equipment and systems that support logistics and make the supply chain work. Their application helps with

- Forecasting
- Resource allocation
- Production planning
- Flow and process management
- Inventory management and control
- Customer delivery
- After-sales support and service

A company's material handling system and processes are put in place to improve customer service, reduce inventory, shorten delivery time, and lower overall handling costs in manufacturing, distribution and transportation.

#### **What Are the Principles of Material Handling?**

When designing a material handling system, it is important to refer to best practices to ensure that all the equipment and processes—including manual, semi-automated and automated—in a facility work together as a unified, system. By analyzing the goals of the material handling process and aligning them to guidelines, such as the 10 Principles of Material Handling, a properly designed system will improve customer service, reduce inventory, shorten delivery time, and lower overall handling costs in manufacturing, distribution and transportation. These principles include:

1. **Planning:** Define the needs, strategic performance objectives and functional specification of the proposed system and supporting technologies at the outset of the design. The plan should be developed in a team approach, with input from consultants, suppliers and end users, as well as from management, engineering, information systems, finance and operations.
2. **Standardization:** All material handling methods, equipment, controls and software should be standardized and able to perform a range of tasks in a variety of operating conditions.

3. **Work:** Material handling processes should be simplified by reducing, combining, shortening or eliminating unnecessary movement that will impede productivity. Examples include using gravity to assist in material movement, and employing straight-line movement as much as possible.
4. **Ergonomics:** Work and working conditions should be adapted to support the abilities of a worker, reduce repetitive and strenuous manual labor, and emphasize safety.
5. **Unit load:** Because less effort and work is required to move several individual items together as a single load (as opposed to moving many items one at a time), unit loads—such as pallets, containers or totes of items—should be used.
6. **Space utilization:** To maximize efficient use of space within a facility, it is important to keep work areas organized and free of clutter, to maximize density in storage areas (without compromising accessibility and flexibility), and to utilize overhead space.
7. **System:** Material movement and storage should be coordinated throughout all processes, from receiving, inspection, storage, production, assembly, packaging, unitizing and order selection, to shipping, transportation and the handling of returns.
8. **Environment:** Energy use and potential environmental impact should be considered when designing the system, with reusability and recycling processes implemented when possible, as well as safe practices established for handling hazardous materials.
9. **Automation:** To improve operational efficiency, responsiveness, consistency and predictability, automated material handling technologies should be deployed when possible and where they make sense to do so.
10. **Life cycle cost:** For all equipment specified for the system, an analysis of life cycle costs should be conducted. Areas of consideration should include capital investment, installation, setup, programming, training, system testing, operation, maintenance and repair, reuse value and ultimate disposal.

#### 2.4. Use of fire-fighting equipment

There are four classes of fire extinguishers. Each class should be used on specific fires only.

**Class A** is designed for use on general combustibles, such as cloth, paper, and wood.

**Class B** is designed for use on flammable liquids and greases, including gasoline, oil, thinners, and solvents.

**Class C** is used only on electrical fires.

**Class D** is effective only on combustible metals such as powdered aluminum, sodium, or magnesium.

The class rating is clearly marked on the side of every fire extinguisher. Many extinguishers are good for multiple types of fires. (See figure 6).



**Figure1- 5** A typical fire extinguisher designed to be used on type class A, B, or C fires.

### Use of fire-fighting equipment

When using a fire extinguisher, remember the word **“PASS.”**

**P** Pull the safety pin.

**A** Aim the nozzle of the extinguisher at the base of the fire.

**S** Squeeze the lever to actuate the extinguisher.

**S** Sweep the nozzle from side to side. See Figure



**Figure1- 6** A CO<sub>2</sub> fire extinguisher being used on a fire set in an open steel drum during a demonstration at a fire department training center.

### Safety policies and procedure

When you know the set procedures to be followed, it is easier to look after yourself, your workshop and your workmates. You should know:

- Who does what during an emergency
- The fire procedure for your workplace
- About different types of fire extinguisher and their uses
- The procedure for reporting an accident.

If an accident does occur in your workplace the first bit of advice is: keep calm and don't panic! The Health and Safety at Work (HASAW) states that for companies above a certain size:

- first aid equipment must be available
- Employers should display simple first aid instructions
- Fully trained first aiders must be employed.

In your own workplace you should know about the above three points. A guide to how to react if you come across a serious accident is given in Table 1 .

**Table 1 Actions in the case of an accident**

No_	Action	Notes
1.	Assess the situation	Stay calm: a few seconds to think is important
2.	Remove the danger	If the person was working with a machine, turn it off. If someone is electrocuted, switch off the power before you hurt yourself. Even if you are unable to help with the injury you can stop it getting worse
3.	Get help	If you are not trained in first aid, get someone who is and/or phone for an ambulance
4.	Stay with the casualty	If you can do nothing else, the casualty can be helped if you stay with him. Also say that help is on its way and be ready to assist. You may need to guide the ambulance
5.	Report the accident	All accidents must be reported: by law, your company should have an accident book. This is a record so that steps can be taken to prevent the accident happening again. Also, if the injured person claims compensation, underhanded companies could deny the accident happened
6.	Learn first aid	If you are in a very small company, why not get trained now, before the accident?

## 2.5. Workplace First Aid and Eye Wash Stations

All shop areas must be equipped with a first aid kit and an eye wash station centrally located and kept stocked with emergency supplies.

### a. FIRST AID KIT

A first aid kit should include:

- ✚ Bandages (variety)
- ✚ Gauze pads
- ✚ Roll gauze
- ✚ Iodine swab sticks
- ✚ Antibiotic ointment
- ✚ Hydrocortisone cream
- ✚ Burn gel packets
- ✚ Eye wash solution
- ✚ Scissors
- ✚ Tweezers
- ✚ Gloves
- ✚ First aid guide

See figure 1-7 every shop should have a person trained in first aid. If there is an accident, call for help immediately.



**Figure1- 7** A first aid box should be centrally located in the shop and kept stocked with the recommended supplies.

- b. **EYE WASH STATION** An eye wash station should be centrally located and used whenever any liquid or chemical gets into the eyes. If such an emergency does occur, keep eyes in a constant stream of water and call for professional assistance. See figure1- 8.



**Figure1- 8** A typical eye wash station. Often a thorough flushing of the eyes with water is the best treatment in the event of eye contamination.

### 3. Hazard control, including control of hazardous materials and toxic substances

Working in a motor vehicle workshop is a dangerous occupation, if you do not take care. The most important thing is to be aware of the hazards and then it is easy to avoid the danger. The hazards in a workshop are from two particular Sources: you and your surroundings. Hazards due to you may be caused by:

**Carelessness** – particularly while moving vehicles

**Drinking or taking drugs** – badly affects your ability to react to dangerous situations

**Tiredness or sickness** – affects your ability to think and work safely

**Messing about** – most accidents are caused by people fooling about

**Not using safety equipment** – you have a duty to yourself and others to use safety equipment

**Inexperience** – or lack of supervision: if in doubt – ask.

The surroundings in which you work may have:

- bad ventilation
- poor lighting
- noise
- dangerous substances stored incorrectly
- broken or worn tools and equipment
- faulty machinery
- slippery floors
- untidy benches and floors
- unguarded machinery
- Unguarded pits.

### HAZARDOUS WASTE

**DEFINITION OF HAZARDOUS WASTE** Hazardous waste materials are chemicals, or components, that the shop no longer needs that pose a danger to the environment and people if they are disposed of in ordinary garbage cans or sewers. However, no material is considered hazardous waste until the shop has finished using it and is ready to dispose of it.

**PERSONAL PROTECTIVE EQUIPMENT (PPE)** When handling hazardous waste material, one must always wear the proper protective clothing and equipment detailed in

the right-to-know laws. This includes respirator equipment. All recommended procedures must be followed accurately. Personal injury may result from improper clothing, equipment, and procedures when handling hazardous materials.

**The Environmental Protection Agency (EPA)** publishes a list of hazardous materials that is included in the Code of Federal Regulations (CFR). The EPA considers waste hazardous if it is included on the EPA list of hazardous materials, or it has one or more of the following characteristics:

**Reactive:**-Any material that reacts violently with water or other chemicals is considered hazardous.

**Corrosive:**-If a material burns the skin, or dissolves metals and other materials, a technician should consider it hazardous. A pH scale is used, with the number 7 indicating neutral.

Pure water has a pH of 7. Lower numbers indicate an acidic solution and higher numbers indicate a caustic solution. If a material releases cyanide gas, hydrogen sulfide gas, or similar gases when exposed to low pH acid solutions, it is considered hazardous.

**Toxic:**-Materials are hazardous if they leak one or more of eight different heavy metals in concentrations greater than 100 times the primary drinking water standard.

**Ignitable:**- A liquid is hazardous if it has a flash point below 140°F (60°C), and a solid is hazardous if it ignites spontaneously.

**Radioactive:**-Any substance that emits measurable levels of radiation is radioactive. When individuals bring containers of a highly radioactive substance into the shop environment, qualified personnel with the appropriate equipment must test them.



<b>Self-Check -2</b>	<b>Written Test</b>
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**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

**Sort answer**

1. Write at list five points about workplace health and safety (WHS) requirements?
2. explain the following personal protective equipment
  - i. safety glasses
  - ii. steel-toed shoes
  - iii. gloves wear
3. define the meaning of material handling
4. write 10 principles of material handling explain them
5. What are four classes of fire extinguishers?
6. Explain the word “pass.”
7. write at list five points about first aid kit materials
8. what are particular sources of hazards in a workshop
9. write at list four cause hazards due to you
10. write the characteristics hazardous materials considers environmental protection agency (EPA)

**Note: Satisfactory rating - 60 %**

**Unsatisfactory - below 60%**

**Answer Sheet**

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

**Name** \_\_\_\_\_ **ID NO** \_\_\_\_\_

**Information Sheet-3****Identify tools and equipment****3.1. Multi-meters**

A multimeter is a must for diagnosing the individual components of an electrical system. Multimeters have different names, depending on what they measure and how they function. A volt-ohm-milliamp meter is referred to as a VOM or DVOM, if it is digital. A digital multimeter (DMM) can measure many more things than volts, ohms, and low current. Most multimeters (**Figure1-9**) measure direct current (dc) and alternating current (ac) amperes, volts, and ohms. More advanced multimeters may also measure diode continuity, frequency, temperature, engine speed, and dwell, and/or duty cycle?

Multimeters are available with either digital or analog displays. DMMs provide great accuracy by measuring volts, ohms, or amperes in tenths, hundredths, or thousandths of a unit. Several test ranges are usually provided for each of these functions. Some meters have multiple test ranges that must be manually selected; others are auto ranging.

Analog meters use a sweeping needle against a scale to display readings and are not as precise as digital meters. Analog meters have low input impedance and should not be used on sensitive electronic circuits or components. Digital meters have high impedance and can be used on electronic circuits as well as electrical circuits.



**Figure1- 9 Typical multifunctional, low-impedance multimeter.**

A digital meter is a necessary tool for any electrical diagnosis and troubleshooting. A digital multimeter, abbreviated DMM, is usually capable of measuring the following units of electricity.

- DC volts
- AC volts
- Ohms
- DC Amperes
- AC Amperes

**3.2. Insulation testers**

An insulation tester can be a stand-alone meter or an additional function of a DMM (Figure1-10). It is used to measure the insulation resistance on the powered down HV system when servicing a HEV. Isolation tests are only performed on systems that have the power removed.

To test for insulation leakage of the high-voltage system, begin by inserting the insulation test probe into the + terminal and the ground lead into the – terminal. Do not connect the leads to the volt-ohm terminals. Turn the knob to the “INSULATION” position. In this position, a battery level check is performed. Confirm that the battery level test has passed. Press the “RANGE” button to select the desired voltage range. If performing an isolation test on an HEV, this should be set to 500 volts. Next, connect the leads to the circuit you are testing. The meter will automatically detect if the circuit is powered. The meter display should indicate a series of dashed lines. If the meter displays >30 V, then there is voltage greater than 30 volts in the circuit and the test meter will not perform the insulation test. Push and hold the “TEST” button on the red insulation test lead. While the test is in progress, the applied voltage will be displayed in the lower right corner on the screen and the resistance in M ohms or G ohms will be displayed in the center of the screen. Leave the test leads attached to the circuit and release the “TEST” button. The meter will continue to display the resistance reading while the circuit is discharged through the meter.



Figure1- 10 An insulation meter is used on many HEVs to determine insulation leaks in the high-voltage system.

### 3.3. Crimping tools

Crimpers are tools used to make cold weld joints between two wires or a wire and a connector, such as lugs. Ideally, the electrical and mechanical properties of the weld joint are as strong as the parent materials.

Crimping tools are sized according to the wire gauges (using AWG - American Wire Gauge) they can accept. Some come with interchangeable die heads that allow for a wider range of wire sizes and connectors. See figure 1-11



Figure1- 11 crimper

## How to Use a Crimping Tool

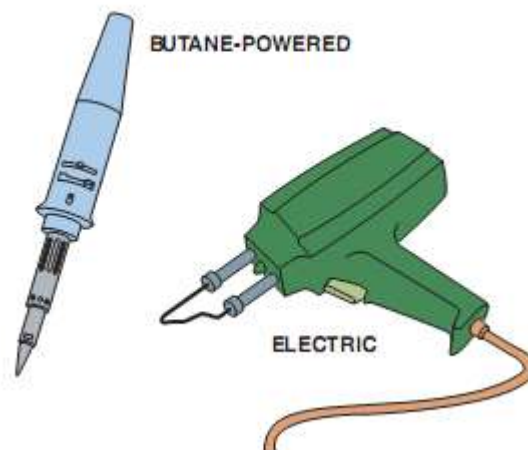
First you will need to strip the length of wire that you want to crimp. Then, attach the connector. For crimping tools with interchangeable dies, you will need to select the right die head for the connector by matching wire gauge ratings. For die less crimpers, you will need to match to the proper groove. Finally, apply pressure, take out the newly crimped connector, and give a few tugs to make sure you have a solid and secure connection.

## How to Select a Wire Crimper

The content we provide is meant to inform you and help support the proper selection and use of crimpers. As always, we recommend you consult a licensed and competent electrician to help you with the sizing and selection of parts for your particular application. Need more help? Call our technical support engineers for live, front-end support.

### 3.4. Soldering equipment( **SOLDERING GUNS**)

**Electric soldering gun:-** This type of soldering gun is usually powered by 110 volt AC and often has two power settings expressed in watts. A typical electric soldering gun will produce from 85 to 300 watts of heat at the tip, which is more than adequate for soldering. See figure 1-12



**Figure1- 12** An electric soldering gun used to make electrical repairs.

Soldering guns are sold by the wattage rating. The higher the wattage, the greater amount of heat created. Most solder guns used for automotive electrical work usually fall within the 60 to 160 watt range.

**Electric soldering pencil:** - This type of soldering iron is less expensive and creates less heat than an electric soldering gun. A typical electric soldering pencil (iron) creates 30 to 60 watts of heat and is suitable for soldering smaller wires and connections.

**Butane-powered soldering iron:-** A butane-powered soldering iron is portable and very useful for automotive service work because an electrical cord is not needed. Most butane- powered soldering irons produce about 60 watts of heat, which is enough for most automotive soldering.

In addition to a soldering iron, most service technicians who do electrical-related work should have the following:

- Wire cutters
- Wire strippers
- Wire crimpers
- Heat gun

### 3.5. Heat-gun or blower

Heat Guns (blower) are powerful heat blowers with lightweight ergonomic design, a soft grip handle and quiet operation for convenient long-term use. Interchangeable temperature keys lock in specific output ranges. See figure 1-13



Figure1- 13 heat gun

### 3.6. Wire and cabling of various colours and sizes

#### i. Wires

A wire in a wiring harness is made up of a conductor and an insulator. The metal core of the wire, typically made of copper, is the conductor.

The outer jacket (made of plastic or other material) coating the core is the insulator. Under normal circumstances, electrons move a few inches per second. Yet when an electrical potential is applied to one end of a wire, the effect is felt almost immediately at the other end of that wire. This is so because the electrons in the conductor affect one another, much like billiard balls in a line.

#### ii. Wire Types

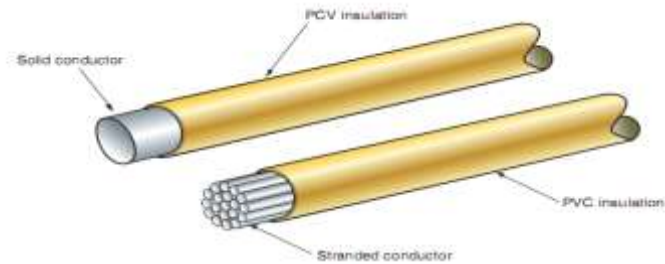
Automotive wiring or circuit conductors are used in one of three forms, as follows:

- a. Solid wires (single-strand)
- b. Stranded wires (multistrand)
- c. Printed circuitry

**a. Solid or single-strand wire** is used where current is low and flexibility is not required. In automotive electrical systems, it is used inside components such as

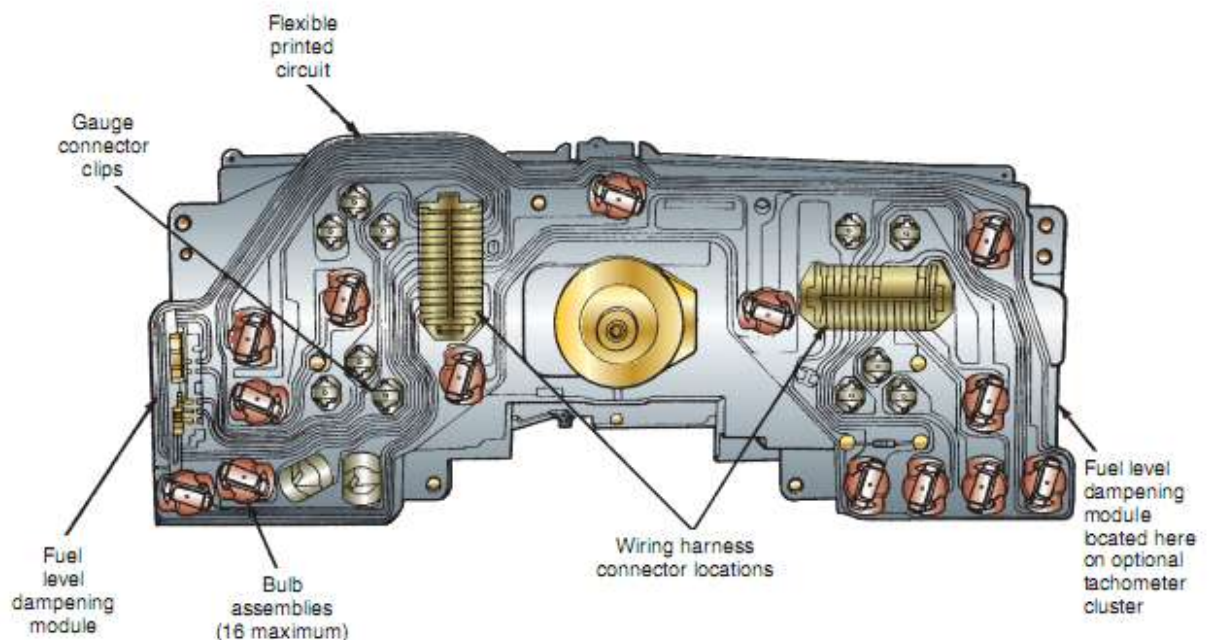
alternators, motors, relays, and other devices with only a thin coat of enamel or shellac for insulation.

- b. Stranded or multistrand wire** is made by braiding or twisting a number of solid wires together into a single conductor insulated with a covering of coloured plastic, as shown in Figure1-14. Most automotive electrical system wiring uses stranded wire, either as single conductors or grouped together in harnesses or looms. For more information about wire types, see the section on “Copper Wiring Repair” in Chapter 6 of the Shop Manual.



**Figure1- 14** Comparison between solid and stranded primary wire.

- c. Printed circuitry** is a thin film of copper or other conductor that has been etched or embedded on a flat insulating plate (Figure 1-15). A complete printed circuit consists of conductors, insulating material, and connectors for lamps and other components, and is called a printed circuit (PC) board. It is used in places where space for individual wires or harnesses is limited, such as behind instrument panels.



**Figure1- 15.** Printed circuits eliminate bulky wires behind the instrument panel.

### Wire Gauge Number or size

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The size of a wire determines how much current it can safely carry without overheating. The larger the wire diameter, the less resistance the wire offers to the flow of current and therefore, the greater the current carrying capacity. The wire or cable size is expressed in terms of standard gauge numbers. Size refers to the measure of the cross-sectional diameter of all the separate strands.

### Metric Wire System & American Wire Gauge (AWG) System

Wire size or gauge can be expressed either by **metric system** or by **American wire gauge (AWG) number system**. To show table 1

Table 1-1: Metric Wire System in mm<sup>2</sup> & American Wire Gauge (AWG)

Metric (mm <sup>2</sup> )	AWG Number (gauge)
0.22	24
0.5	20
0.8	18
1.0	16
2.0	14
3.0	12
5.0	10
8.0	8
13.0	6
19.0	4
32.0	2

#### 3.3.1 American Wire Gauge (AWG) System

Wiring is sized and purchased according to gauge size as assigned by the American wire gauge (AWG) system. AWG numbers can be confusing because as the gauge number increases, the size of the conductor wires decreases. Therefore, a 14-gauge wire is smaller than a 10-gauge wire. The greater the amount of current (in amperes), the larger the conducting wire (the smaller the gauge number) required. The wire used in **automotive wiring is usually between 10 and 18 gauge. Battery cables are between 2 and 6 gauges.**

#### 3.3.2 Metric Wire System



In the metric system, wire size is expressed as the cross-sectional area of the wire in square millimetre (mm<sup>2</sup>). This designation is the true measurement of area.

### Color coding of electrical wires

Automotive electric wires are color coded to make fault finding in the electrical circuit and for further distinction according to its purpose. Electric wires in automotive vehicles are additionally provided with color trailers or strips.

The first color mentioned is always the base color. For example, a Red wire with a white strip may be designated as RED/WHT, RO/WH, R/W, RED/W or RD/W. see table 1-2

Table 1-2 **Color coding of electrical wires**

Code	Color
BK	Black
BR	Brown
GY	Grey
O	Orange
P	Purple
PK	Pink
R	Red
T	Tan
W	White
Y	Yellow
DB	Dark blue
LB	Light blue
DG	Dark green
LG	Light green

### 3.7. Heat shrink sleeve and flexible conduit

Heat-shrink tubing (or, commonly, *heat shrink* or *heatshrink*) is a shrinkable plastic tube used to insulate wires, providing abrasion resistance and environmental protection for stranded and solid wire conductors, connections, joints and terminals in electrical work. It can also be used to repair the insulation on wires or to bundle them together, to protect wires or small parts from minor abrasion, and to create cable entry seals, offering environmental sealing protection. Heat-shrink tubing is ordinarily made of polyolefin, which shrinks radially (but not longitudinally) when heated, to between one-half and one-sixth of its diameter.

#### Use of Heat shrink

The unshrunk tubing is fitted on the wire before making the connection, then slid down to cover the joint after it is made. If the fit is tight, silicone lubricant can be applied without compromising the heat-shrink material.<sup>[1]</sup> The tubing is then shrunk to wrap tightly around the joint by heating in an oven or with a hot air gun or other source of hot gas flow.

Convenient but less consistent methods for shrinking the tube include a soldering iron held close to but not touching the tube, or the heat from a lighter. Uncontrolled heat can cause uneven shrinkage, physical damage and insulation failure, and these methods are not recommended by heatshrink suppliers.<sup>[1]</sup> If overheated, heat-shrink tubing can melt, scorch or catch fire like any other plastic. Heating causes the tubing to contract to between half and one sixth of its original diameter, depending on the material used, providing a snug fit over irregularly shaped joints. There is also longitudinal shrinking, usually unwanted and to a lesser extent than narrowing, of typically around 6%.<sup>[1]</sup> The tubing provides good electrical insulation, protection from dust, solvents and other foreign materials, and mechanical strain relief, and is mechanically held in place (unless incorrectly oversized or not properly shrunk) by its tight fit.

### 3.8. Terminals and connectors

To perform the function of connecting the wires from the voltage source to the load component reliably, terminal connections are used. Today's vehicles can have as many as 500 separate circuit connections. The terminals used to make these connections must be able to perform with very low voltage drop. Terminals are constructed of either brass or steel. Steel terminals usually have a tin or lead coating. A loose or corroded connection can cause an unwanted voltage drop those results in poor operation of the load component. For example, a connector used in a light circuit that has as little as 10% voltage drop (1.2 V) may result in a 30% loss of lighting efficiency.

Terminals can be either crimped or soldered to the conductor. the terminal makes the electrical connection, and it must be capable of withstanding the stress of normal vibration. the illustration (Figure 1-16) shows several different types of terminals used in the automotive electrical system. In addition, the following connectors are used on the automobile:



Figure1- 16 Examples of primary wire terminals and connectors used in automotive applications.

- 1. Molded connector:** these connectors usually have one to four wires that are molded into a one-piece component (Figure 1-17). Although the connector halves separate, the connector itself cannot be taken apart.



Figure1- 17 Molded connectors cannot be disassembled to replace damaged terminals or to test.

- 2. Multiple-wire, hard-shell connector:** these connectors usually have a hard, plastic shell that holds the connecting terminals of separate wires (Figure 1-18). The wire terminals can be removed from the shell to be repaired.

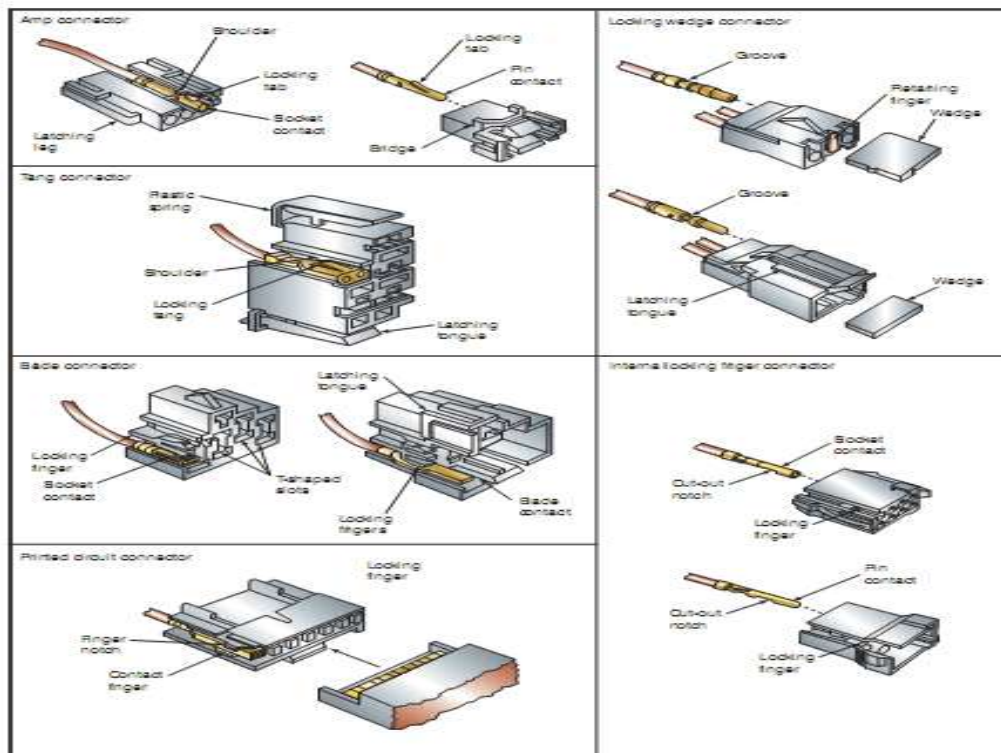


Figure1- 18 Multiple-wire hard-shell connectors

- 3. Bulkhead connectors:** these connectors are used when several wires must pass through the bulkhead (Figure 1-19).



Figure1- 19 Bulkhead connector

- 4. Weather-Pack Connectors:** these connectors have rubber seals on the terminal ends and on the covers of the connector half (Figure 1-20). they are used on computer circuits to protect the circuit from corrosion, which may result in a voltage drop.



Figure1- 20 Weather-pack connector is used to prevent connector corrosion

- 5. Metri-Pack Connectors:** these are like the weather-pack connectors but do not have the seal on the cover half (Figure 1-21).



Figure1- 21 Metri-pack connector.



**6. Heat Shrink Covered Butt Connectors:** Recommended for air bag applications by some manufacturers. Other manufacturers allow NO repairs to the circuitry, while still others require silver-soldered connections.

To reduce the number of connectors in the electrical system, a common connection can be used (Figure 2-21). Common connections are used to share a source of power or a common ground and are often called a splice. If there are several electrical components that are physically close to each other, a single common connection (splice) eliminates using a separate connector for each wire.

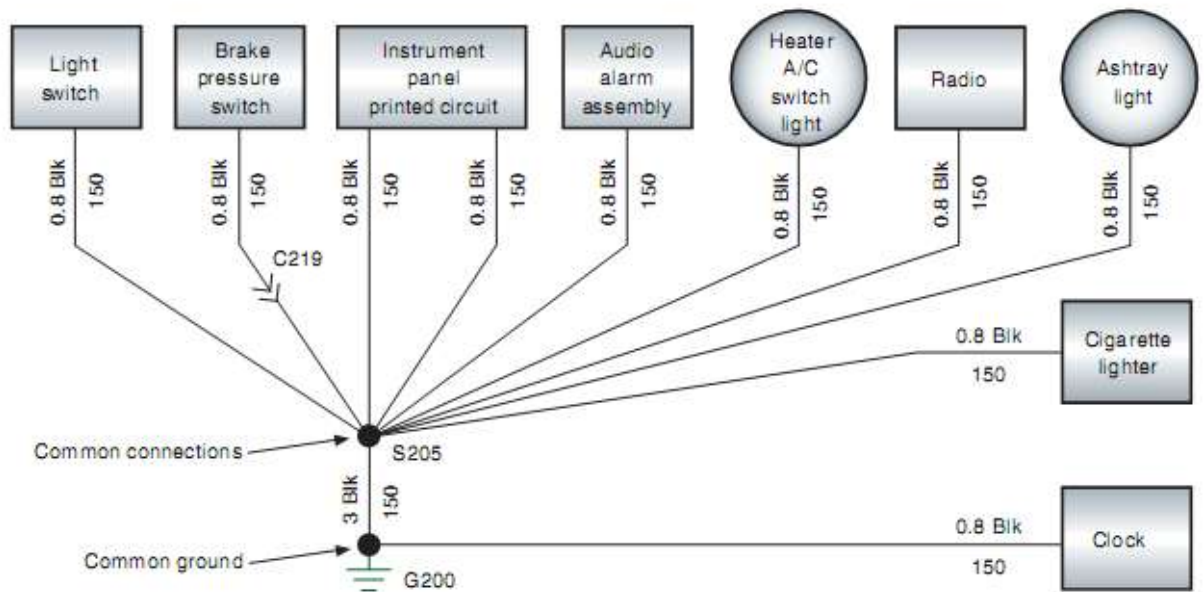


Figure1- 22 Common connections (splices) are used to reduce the amount of wire and connectors.

### 3.9. Electrical tape

Electrical tape (or insulating tape) is a type of pressure-sensitive tape used to insulate electrical wires and other materials that conduct electricity. It can be made of many plastics, but vinyl is most popular, as it stretches well and gives an effective and long lasting insulation. Electrical tape for class H insulation is made of fiberglass cloth.



Figure1- 23 Electrical tape

<b>Self-Check -3</b>	<b>Written Test</b>
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**Directions:** Answer all the questions listed below. Use the Answer sheet provided in the next page:

**Sort answer**

1. define digital and analog Multimeters
2. write the purpose of Insulation testers
3. How to Use a Crimping Tool
4. Automotive electrical work usually used Mostly solder guns \_\_\_\_\_ to \_\_\_\_\_ watt range.
5. Write Wire Automotive wiring Types and explain them
6. Wire size or gauge can be expressed either by \_\_\_\_\_ or by \_\_\_\_\_ number system.
7. What is the function of connectors
8. Write at list five type of connector used on the automobile
9. What are the purpose of Electrical tape

**Note: Satisfactory rating - 60 %**

**Unsatisfactory - below 60%**

**Answer Sheet**

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

**Name** \_\_\_\_\_ **ID NO** \_\_\_\_\_

## List of Reference Materials

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