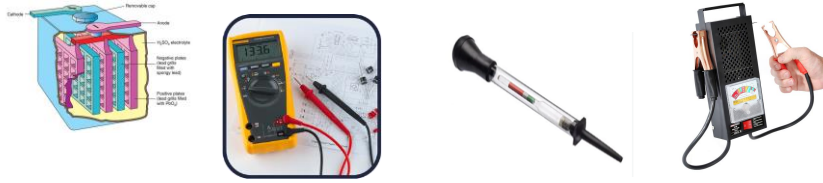


Farm Machinery and Equipment Operation

Level – II



**Based on March 2022, Version II Occupational
standard**

Module Title: - Test, Service and Charge Batteries

LG Code: AGR AMO2 M01 LO (1-4) LG (1-4)

TTLM Code: AGR AMO2 TTLM 0523 v1

May, 2023

Addis Ababa, Ethiopia.

Table of Contents

Introduction to the Module	2
LO #1- Prepare to undertake battery inspection	3
Instruction sheet	3
Information Sheet 1	4
Self-check 1	23
Operation Sheet -1	24
LAP TEST-1	25
LO #2- Conduct inspection.....	26
Instruction sheet	26
Information Sheet 2	27
Self-check 2	50
Operation sheet 2	52
LAP TEST-2	55
LO #3- Carry out service and maintenance.....	56
Instruction sheet	56
Information Sheet 3	58
Self-check 3	74
Operation sheet 3	75
LAP TEST-3	78
LO #4- Cleanup work area and maintain Equipment.....	79
Instruction sheet	79
Information Sheet 4	80
Self-check 4	84
Reference Materials	86
AKNOWLEDGEMENT	88

Introduction to the Module

This module covers knowledge, skills and attitude required to test, service and charge batteries. Safety required and proper materials needed, their safety of processing; storing and using a battery properly also it includes methods used in elongating the life of new batteries.

Page 2 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

LG #1

LO #1- Prepare to undertake battery inspection

Instruction sheet

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

- Identifying and confirming OHS and environmental requirements.
- Using personal protection equipment needs throughout the work.
- Sourcing safe operating procedures and information.
- Identifying and preparing sourced tools and equipment's.

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify and confirm OHS and environmental requirements.
- Use personal protection equipment needs throughout the work.
- Source safe operating procedures and information.
- Identify and prepare sourced tools and equipment's.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets1
4. Accomplish the Self-checks 1
5. Perform Operation Sheets 1
6. Do the “LAP test”1

Page 3 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

Information Sheet 1

Terms and definitions

It's important to identify and know terms and definition before going into the module deeply. These terms are important terms for knowing the use and meaning of materials we are going to use.

Battery: is an electrochemical device for storing energy in chemical form so that it can be released as electricity for cranking the engine and powering the electrical load.

Battery Acid: is the electrolyte used in a battery; a mixture of sulfuric acid and water.

Battery Charger: is equipment used to charge battery capacity given in ampere hours.

Cell tester: is a testing device used to measure the voltage of each cell of battery.

Circuit: is the complete path of an electric current including current source.

Corrosion: is a process of combining one metal with oxygen producing an undesirable product.

Electrolyte: is the liquid mixture of about 40% sulfuric acid and 60% water in a fully charged.

Hydrometer: is a testing device used to measure the specific gravity of battery electrolyte.

Load tester: is an instrument used to measure the capacity or load of a battery.

Multi-tester- a device used to measure two or more instruments.

Plate Strap: is a part of a battery which is composed of both negative and positive accessories

Polarity: is the quality of an electric component or circuit that determines the direction of current.

Side Terminal: is the positive or negative terminal found in a maintenance free battery type.

Volt meter: is an instrument used to measure the electromotive force or voltage of a battery.

Page 4 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

1.1. Identifying and confirming OHS and environmental requirements

An OHS is a process to manage health and safety issues in the workplace. It prevents injury, illness and property damage and decreases the associated human and financial costs. An effective OHS Program creates a positive health and safety culture. It is a multidisciplinary practice dealing with all aspects of health and safety in the workplace, with a strong focus on preventing workplace hazards. The enjoyment of these standards is a basic human right that should be afforded to each and every worker, regardless of the nature of their work. With OHS standards in place, workers are able to carry out their responsibilities in a safe and secure working environment, free from hazards. OHS professionals seek to remove or mitigate things in the workplace that could cause harm to workers. “Harm” can mean a physical injury or exposure to something that leads to the development of an illness or disease. Occupational safety, health and environment means actions or working conditions which are safe from any cause resulting in danger to life, physique, mentality or health arising out of or related to working. The term ‘**OHS and environment**’ is related by the term **EHS** which is defined as environmental health and safety as defines ‘the place in which any stand of tree is growing’ or ‘The locality in which there is a population of trees of a given species possessing distinct genetic characteristics and evolved under the local environment, site or origin of seed from trees with such characteristics is known as the provenance. EHS is the set that studies and implements the practical aspects of protecting the environment and maintaining healthy and safety at occupation. In simple terms it is what organizations must do to make sure that their activities do not cause harm to any one. According to WHO (1995), occupational safety and health can be defined as a multidisciplinary activity aiming at:

- Protection and promotion of the health of workers by eliminating occupational factors and conditions hazardous to health and safety at work.

Page 5 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

- Enhancement of physical, mental and social well-being of workers and support for the development and maintenance of their working capacity, as well as professional and social development at work.
- Development and promotion of sustainable work environments and work organizations.

The ILO/WHO definition of occupational health is “The promotion and maintenance of the highest degree of physical, mental social well- being of workers in all occupation” and the WHO considers occupational health service to be responsible for the total of worker and, if possible, his or her family. OHS addresses an enormous range of hazards, including

- Fire
- Machinery, tools, and equipment
- Noise
- Radiation
- Chemicals
- Temperature extremes
- Repetitive stress injuries
- Heavy lifting
- Slipping or falling

1.1.2 Environmental regulatory and requirements

Environmental regulation requirements dealt with the proclamations and laws set for the enforcement of OHS, at different sectors. According to world health organization (WHO) (1995), occupational safety and health can be defined as a multidisciplinary activity aiming at:

- Protection and promotion of the health of workers by eliminating occupational factors and conditions hazardous to health and safety at work

Page 6 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

- Enhancement of physical, mental and social well-being of workers and support for the development and maintenance of their working capacity, as well as professional and social development at work.
- Development and promotion of sustainable work environments and work organizations
According to labor proclamation No. 377/2003, the Ministry of Labor and Social Affairs of Ethiopia is the organ charged with the responsibility to inspect labor administration, labor conditions, occupational health and safety.

Labor regulation

Talking about labor Law in Ethiopia means to basically review the history of the last 40-50 years. Present-day labor law, as a specialized law designed to protect employees' welfare, only came into existence as a result of the modern industrial development and with the rise of the status of the employee as wage earner. Until recently, the main source of labor law, the Labor Proclamation, Proclamation No. 42/1993, was developed in the post-socialist time, marking the overcoming of the centralized state-economy towards a market oriented, pluralistic society. Ethiopia was criticized for several years by the ILO Committee of Experts, which noted serious discrepancies between the national legislation and the Freedom of Association and Protection of the Right to Organize Convention, 1948 (No. 87). It was partly in response to the observations made by the House of People's Representatives adopted Labor Proclamation No. 377/2003, Occupational Health and Safety 16 effective since 26 February 2004.

1.2 . Using personal protection equipment needs throughout the work

It is the companies' responsibility for the provision of personal protective equipment for their employees, suitable and appropriate to the work being conducted. Each employee is to have individual equipment; PPE is not to be shared among employees. Companies must also be able to demonstrate that the employees have been trained in proper inspection, maintenance, and safe use of the PPE.

Page 7 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

i. Footwear:- Safety shoes are required where the potential for serious injury to the foot may result from an employee's daily job duties. Foot injuries may occur in areas where there are rolling or falling objects, objects piercing the sole, or where feet are exposed to electrical hazards, such as a static-discharge or electric-shock hazard, that remains after the employer takes other necessary protective measures. Individuals working around or servicing electrical equipment are to wear electric shock resistant footwear. It is recommended that all companies wear slip resistant footwear due to the varying conditions in all workplaces.



Figure 1.1 safety shoese

ii. Eyewear / Face Protection:- Safety glasses allow air in and around the eye area. Eye protection goggles fit tight against the face, offering protection against dust and splashes. Correspondingly, face guard provides further protection and can also be worn over spectacles or goggles. All eyewear and face protection are to meet required standards.



Figure 1.2 Eyewear / Face Protection

Page 8 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

iii. Hand Protection:- Hand protection is designed to guard against a wide range of hazards, including: cuts and abrasions; extreme temperatures; skin irritation and dermatitis; and. contact with toxic or corrosive substances. All hand protection is required to meet required standards.



Figure 1.3 Hand Protection

iv. Head Protection: - Head protection is designed to protect you if there is a risk that you could be struck by falling objects and/or strike your head against a fixed object (e.g. where there is restricted headroom). Companies are required to provide their employees with head protection appropriate to the nature of the work being conducted. Contractors working in areas of low head room or where overhead work is being conducted are required to wear approved bump caps or hard hats.



Figure 1.4 Head Protection

Page 9 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

v. Safety Clothing:- Companies in areas with vehicular traffic are required to wear high visibility clothing. All persons involved in ground maintenance will be required to wear such clothing during the course of performing their work.



Figure 1.5 Safety Clothing

vi. Hearing Protection:- Hearing protectors are wearable devices that can lower the intensity of sound that enters your ears. Employees must use hearing protection appropriate to the nature of the work being conducted. Hearing protection applies to both indoor and outdoor work. Personal Sound Transmission Devices (i.e. music playing devices such as smart phones) or any other personal devices that may impair hearing are prohibited.



Figure 1.6 Hearing Protection

Page 10 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

vii. Respiratory Protection:- Companies are required to provide their employees with respiratory protection appropriate to the nature of the work and the environmental conditions. Respiratory protection is to be approved and meet the applicable standards. Companies are required to ensure all employees required to wear a respirator have been fit tested by a certified safety professional and are clean shaven. Generally Companies are required to provide their employees with specialized personal protective equipment appropriate to the nature of the work being conducted. The contractor is responsible to train all their employees required to use and wear any specialized PPE.



Figure 1.7 Respiratory Protection

Work Area /workplace environment

- First Aid / Emergency Equipment

Under no circumstances are first-aid equipment, fire extinguishers, fire blankets, stretchers, eyewash fountains, deluge showers, and other emergency equipment, to be moved, relocated or blocked unless absolutely necessary and alternate equipment is provided in the interim. Companies are to provide first aid supplies and ensure the appropriate number of trained first aid responders is located on-site in accordance with applicable local, state, provincial and federal regulations. Enterprise are required to provide their own safety equipment appropriate to the work being conducted on-site. All emergency equipment,

✓ fire extinguishers,

Page 11 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

- ✓ first aid kits,
- ✓ eye wash stations,

Emergency equipment must meet at a minimum all applicable standards. Emergency equipment not meeting the required minimum standard will not be allowed on site. Enterprises are responsible to determine the correct quantity of emergency response equipment to be located on-site and are to ensure that the equipment is replaced as used. If a contractor is required to use emergency equipment, the contractor is obligated to provide a complete report detailing the circumstances for the use and corrective actions taken to prevent any further incidents.

1.3 Sourcing safe operating procedures and information

Lead-acid batteries contain sulfuric acid and only trained and authorized personnel should handle them. When talking about lead-acid batteries, people usually call sulfuric acid "battery acid" or the "electrolyte". An electrolyte is a general term used to describe a non-metallic substance like acids such as sulfuric acid or salts that can conduct electricity when dissolved in water.

- Use extreme care to avoid spilling or splashing the sulfuric acid solution. It can destroy clothing and burn the eyes and skin.
- Always wear splash-proof goggles and protective clothing (gloves and aprons). A face shield (with safety goggles) may also be necessary.

Batteries can weigh about 14 to 27 kg (30 to 60 lb) so practice safe lifting and carrying procedures to prevent back injuries. Use a battery carrier to lift a battery, or place hands at opposite corners. Only work with or charge batteries if you have been trained to do so. Use extreme care to avoid spilling or splashing the sulfuric acid solution. It can destroy clothing and burn the eyes and skin. Always wear splash-proof goggles and protective clothing (gloves and aprons). A face shield (with safety goggles) may also be necessary. Batteries can weigh about 14 to 27 kg (30 to 60 lb) so practice safe lifting and carrying procedures to prevent back injuries. Use a battery carrier to lift a battery, or place hands at opposite corners. Only work with or charge batteries if you have been trained to do so.

Page 12 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1 May, 2023
----------------------	--	--	---------------------------------------

What is material safety data sheet?

A Material Safety Data Sheet (MSDS) is a document that contains information on the potential hazards (health, fire, reactivity and environmental) and how to work safely with the chemical product. It is an essential starting point for the development of a complete health and safety program. It also contains information on the use, storage, handling and emergency procedures all related to the hazards of the material. The MSDS contains much more information about the material than the label. MSDSs are prepared by the supplier or manufacturer of the material. It is intended to tell what the hazards of the product are, how to use the product safely, what to expect if the recommendations are not followed, what to do if accidents occur, how to recognize symptoms of overexposure, and what to do if such incidents occur.

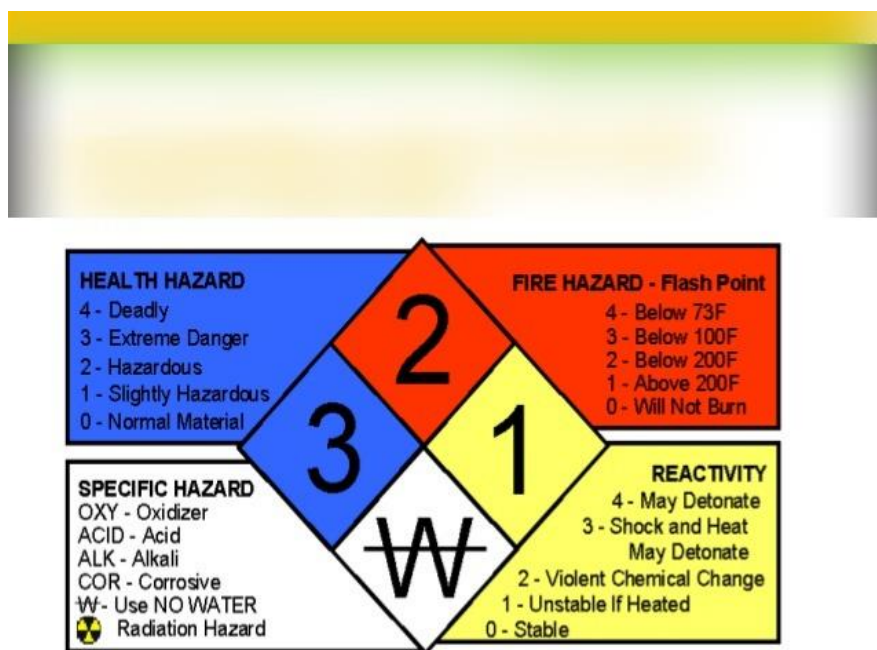


Figure 1.8 Material safety data sheet

Page 13 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

1.3.1 Emergency and safe operating procedures

Battery acid contact

Battery acid is composed of sulfuric acid. Sulfuric acid is very corrosive to human tissues. If battery acid is splashed into eyes or on skin do the following:

- **If the eyes are splashed with acid,**
 - ✓ Use an emergency eyewash/shower station if solution is splashed into the eyes.
 - ✓ Immediately flush the contaminated eye(s) with clean, lukewarm, gently flowing water for at least 30 minutes, while holding the eyelid(s) open.
 - ✓ If irritation persists, repeat flushing. Neutral saline solution may be used as soon as it is available.
 - ✓ DO NOT INTERRUPT FLUSHING. If necessary, keep the emergency vehicles waiting.
 - ✓ Take care not to rinse contaminated water into the unaffected eye or onto the face. Those assisting should avoid direct contact.
 - ✓ Wear chemical protective gloves, if necessary.
 - ✓ Call for assistance.
 - ✓ Quickly transport the victim to an emergency care facility.
- **If the skin is splashed with acid,**
 - ✓ As quickly as possible, flush the contaminated area with lukewarm, gently flowing water for at least 30 minutes. If irritation persists, repeat flushing. DO NOT INTERRUPT FLUSHING. If necessary, keep emergency vehicle waiting.
 - ✓ Those assisting should avoid direct contact with contaminated areas. Wear chemical protective gloves, if necessary.
 - ✓ Under running water, remove contaminated clothing, shoes and leather goods (e.g., watchbands, belts). Remember, acid will collect in the waistband of underwear and tops of socks. If the acid has moved to those areas or the act of washing causes the acid water to move into those areas

Page 14 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

then the undergarments should also be removed. Discard contaminated clothing, shoes and leather goods.

- ✓ Transport the victim to an emergency care facility immediately

- **Handling batteries and battery acid**

- ✓ Rinse off your gloves well before removing them. Then rinse the apron to remove any battery acid that may have contaminated it.
- ✓ Wash yourself with soap and water immediately after servicing a battery.
- ✓ Neutralize spilled or splashed sulfuric acid solution with a baking soda (sodium bicarbonate) solution, and rinse the spill area with clean water.
- ✓ Keep tools and other metallic objects (including jewellery) away from the tops of batteries.

- **Using booster cables** Sparks created from booster or jumper cables can ignite a flammable mixture of hydrogen in air causing an explosion.

Before using jumper cables:

- ✓ Wear eye protection.
- ✓ Make sure that the two vehicles are not touching each other.
- ✓ Turn off the ignition switches of both vehicles. Extinguish all cigarettes, cigars, and other sources of flame or ignition. Remember, explosive mixtures of hydrogen are always present in the cells of batteries.
- ✓ Remove the filler caps from both batteries to vent the dangerous hydrogen gas. This is not necessary if the vehicles are equipped with maintenance-free batteries.
- ✓ Do not charge or jump a frozen battery.
- ✓ Check vehicle/equipment service manual for specific requirements.

WARNING: When connecting or disconnecting jumper cables, use extreme care in handling the clamps.

Page 15 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

- ✓ Do not allow cables to touch each other, nor to touch the frame or body of either vehicle.
This will prevent sparks that can cause an explosion.
- ✓ Avoid contact with the revolving cooling fans when disconnecting the cables.
- ✓ After removing the booster cables, replace the filler caps on both batteries.

1.4 Identifying and preparing sourced tools and equipment's


Tools to remove and replace vehicle batteries include crescent wrenches, an adjustable wrench, vise pliers or a socket wrench that can accommodate a 10mm cable nut. Battery specialty tools are used to service automotive batteries. Car battery tools include brushes and cleaners to clean terminals, carriers to make it easier to transport batteries, and hold-down bolts to secure batteries, as well as kits and a variety of other tools to service and replace automotive batteries.

This tools and equipment's are used for inspecting, testing and servicing batteries.

a) Tools: is a device or implement, especially one held in the hand, used to carry out a particular function.

Hand tools used for car battery maintenance



Table 1.1: Hand tools used for car battery maintenance

No	Name	Picture
1	Vise pliers	






2	Socket wrench	
3	Battery Brush.	
4	Battery Carrier.	



5	Battery Carrying Strap.	
6	Battery Filler.	 <p>2 QT. BATTERY FILLER W54274</p> <p>SPRING LOADED Filler valve</p> <p>2 QUART Durable plastic body</p> <p>SECURE FIT Twist cap</p> <p>ERGONOMIC Handle</p>




7	Battery Pole Brush.	
9	Battery Terminal Puller.	
10	Battery Terminal Spreader and Cleaner	

b) Equipment: is most commonly refers to a set of tools or other objects commonly used to achieve a particular objective.



Equipment's used to undertake battery inspections are listed below:

- i. Voltmeter
- ii. Special battery tester
- iii. Acid resistant metal
- iv. Ammeter
- vi. Peak load tester
- v. Hydrometer

Table 1.2 Equipment's used to undertake battery inspections

No	Name	Picture
1	Voltmeter	



2	Special battery tester	
3	Acid resistant metal	
4	Ammeter	



5	Peak load tester	
6	Hydrometer	

Self-check 1	Written test
--------------	--------------

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Test I: Choose the best answer (25point).

1. From the following which one is correct when adding water to battery?(3)

- A. Add cold water
- B. Add distilled water
- C. Add 25% water
- D. None of the above

2. What supplies power to the ignition and the starting system

- A. Starter motor
- B. Battery
- C. Alternator
- D. None of the above

3. A mixture of sulfuric acid and water is called:

- A. Battery liquid
- B. Battery activator
- C. Electrical charge
- D. Electrolyte

Test II: Short Answer Questions

1. Define battery.(4 pts)
2. What is safety(2pts)
3. What criteria should fulfill the tree to be a good mother tree for seed collection? (3 pts)
4. What equipments are used for test battery test?(5 pts)
5. Define provenance. (5pts)

Note: Satisfactory rating - 25 points and Unsatisfactory - below 25 points.

Page 23 of 90	Ministry of Labor and Skills Author/Copyright	Agricultural Machinery And Equipment Operation Level-II	Version -1
			May, 2023

Operation Sheet -1

Perform methods of testing specific gravity. (2hours)

A. Tools and equipments

- Hydrometer
- Heavy load tester
- PPE

B. Procedures/Steps/Techniques

1. Wear suitable eye protection.
2. Observe the built-in hydrometer.
3. Green Dot is visible: the battery is sufficiently charged for further testing (Heavy Load Test).
4. Dark Green Dot is visible: the battery needs to be recharged before further testing.
5. Light or Yellow Dot is visible: replace the battery

LAP TEST-1	Performance Test
-------------------	-------------------------

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 3 hours.

Step1: Method of testing specific gravity

LG #2

LO #2- Conduct inspection

Instruction sheet

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

- Implementing methods of inspection
- Operating principles and layout of battery storage systems
- Comparing inspection results
- Documenting inspection results
- Making inspection reports

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Implement methods of inspection
- Operate principles and layout of battery storage systems
- Compare inspection results
- Document inspection results
- Make inspection reports

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets1
4. Accomplish the Self-checks 2
5. Perform Operation Sheets 2
6. Do the “LAP test”2

Information Sheet 2

2.1 Implementing methods of inspection

Inspection methods range from taking a voltage reading, to measuring the internal resistance by a pulse or AC impedance method, to coulomb counting, and to taking a snapshot of the chemical battery with Electrochemical Impedance Spectroscopy (EIS).

Battery service/inspection

Battery services are routinely performed. These services include:-

1. Testing
2. Charging
3. Cleaning
4. Jumping a dead battery.
5. Adding water.

2.1.1 Battery testing

Battery testing has changed in recent years; although the three areas are basically the same, the equipment has improved.

- ✓ Visual inspection
- ✓ State of charge
 - Specific gravity
 - Open circuit voltage
- ✓ Capacity or load tester
- **Visual inspection**

Battery service should begin with a thorough visual inspection. This inspection may reveal simple, easily corrected problems.

- ✓ Check for cracks in the battery case and broken terminals. Either may allow electrolyte leakage, which requires battery replacement.
- ✓ Check for cracked or broken cables or connections. Replace, as needed.
- ✓ Check for corrosion on terminals and dirt or acid on the case top. Clean the terminals and case top with a mixture of water and baking soda. A battery wire brush tool is needed for heavy corrosion on the terminals.

Page 27 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

- ✓ Check for a loose battery hold-down or loose cable connections. Clean and tighten, as needed.
- ✓ Check the electrolyte fluid level. The level can be viewed through the translucent plastic case or by removing the vent caps and looking directly into each cell. The proper level is 1/2" above the separators (about 1/8" below the fill ring shown below). Add distilled water if necessary. Do not over fill.
- ✓ Check for cloudy or discolored electrolyte caused by overcharging or vibration. This could cause high self-discharge. Correct the cause and replace the battery.

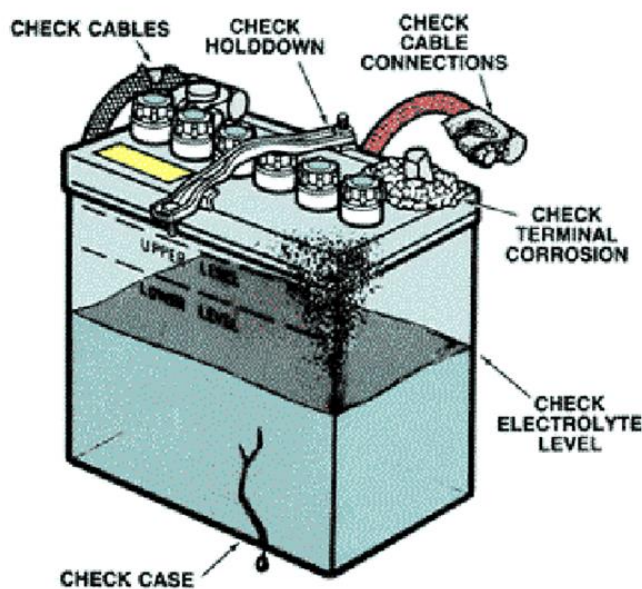


Figure 2.1 battery visual inspection

- **State of charge**

State of charge of battery can be checked in one or two of ways

- Specific gravity test
- Open circuit voltage test

Specific gravity:- means exact weight. A "Hydrometer" or a "Refractometer" compares the exact weight of electrolyte with that of water. Strong electrolyte in a charged battery is heavier than weak electrolyte in a discharged battery. By weight, the electrolyte in a fully charged battery is about 36% acid and 64% water. The specific gravity of water is 1.000. The acid is 1.835 times heavier than water, so its specific gravity is 1.835. The electrolyte mixture of water and acid has a specific gravity of 1.270, usually stated as "twelve and seven."

Page 28 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---

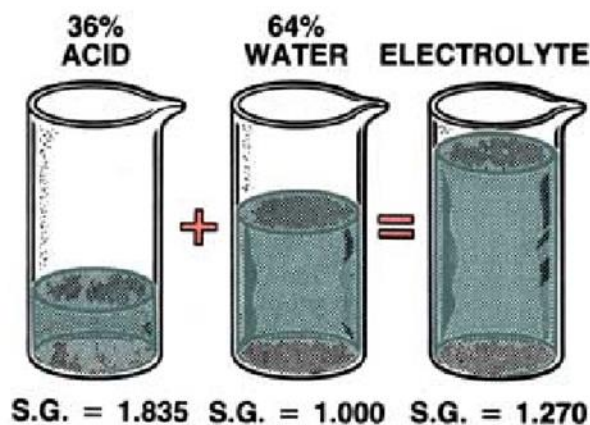


Figure 2.2 battery specific gravity

By measuring the specific gravity of the electrolyte, you can tell if the battery is fully charged, requires charging, or must be replaced. It can tell you if the battery is sufficiently charged for a capacity (heavy-load) test. The battery must be at least 75% charged to perform a heavy load test. (The heavy load test will be discussed later). In other words, each cell must have a specific gravity of 1.230 or higher to proceed.

Specific gravity test procedure

- Wear suitable eye protection
- Remove vent caps or covers from the battery cells.
- Squeeze the hydrometer bulb and insert the pickup tube into the cell closest to the battery's positive (+) terminal.
- Slowly release the bulb to draw in only enough electrolytes to cause the float to rise. Do not remove the tube from the cell.
- Read the specific gravity indicated on the float. Be sure the float is drifting free, not in contact with the sides of top of the barrel. Bend down to read the hydrometer at eye level. Disregard the slight curvature of liquid on the float.
- Record your readings and repeat the procedure for the remaining cells.

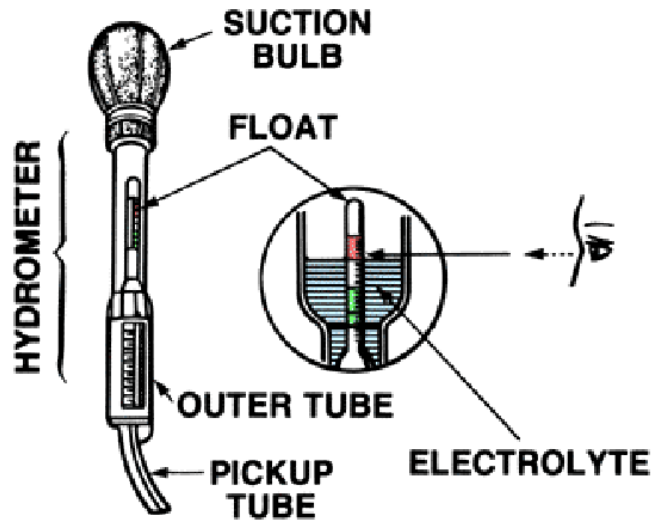


Figure2.3 hydrometer

<https://www.youtube.com/watch?v=5iRvcJMGRhM&pp=ygUuY2FyIGJhdHRlcnkgc3BIY2lmaWMgZ2Fydml0eSB0ZXN0aW5nIHByb2NiZHVyZQ%3D%3D>

Open circuit voltage

A digital voltmeter must be used to check the battery's open-circuit voltage. Analog meters are not accurate and cannot be used.

- Turn on the headlamps' high beam for several minutes to remove any surface charge.
- Turn headlamps off, and connect the digital voltmeter across the battery terminals.
- Read the voltmeter. A fully charged battery will have an open-circuit voltage of 12.6 volts.

On the other hand, a totally dead battery will have an open-circuit voltage of less than 12.0 volts. If the battery is 12.4v or higher, proceed to heavy load test. If the battery is less than 12.4v, the battery must be fully recharged before testing. Be sure to remove the surface charge completely; this is the number one mistake technicians make. If need be, place a load tester on the battery and load the battery for 10 seconds at approximately 200 amps. Allow a few minutes for the battery to recover then measure the open circuit voltage. This should remove the surface charge and allow an accurate open circuit voltage measurement.

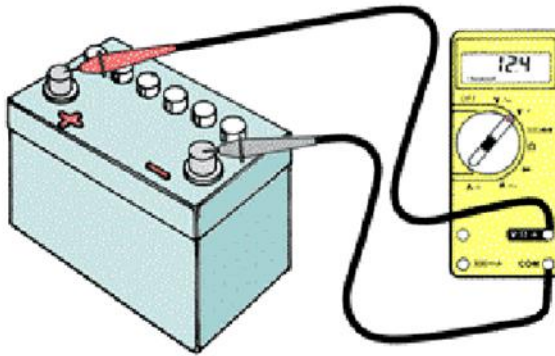


Figure:2.4 open circuit voltage test

<https://www.youtube.com/watch?v=M5H7UY55rrw&pp=ygUi3BlbiBjaXJjdWl0IHZvbHRhZ2UgdGVzdCBiYXR0ZXJ5IA%3D%3D>

- **Heavy load test**

While a State of Charge test determines the battery's state of charge, it does not measure the battery's ability to deliver adequate cranking power. A capacity or heavy-load test measures the battery's ability to deliver current. A battery load tester such as a Sun VAT-40 is used. (Note: the battery must be at least 75% charged before a heavy test can be performed.)

Heavy load test procedure

1. Install the load tester as shown in the figure blow.
2. Load the battery by turning the Load Increase control until the ammeter reads 3 times the amp hour (AH) rating or one-half the cold-cranking ampere (CCA) rating.
3. Maintain the load for no more than 15 seconds, and note the voltmeter reading.

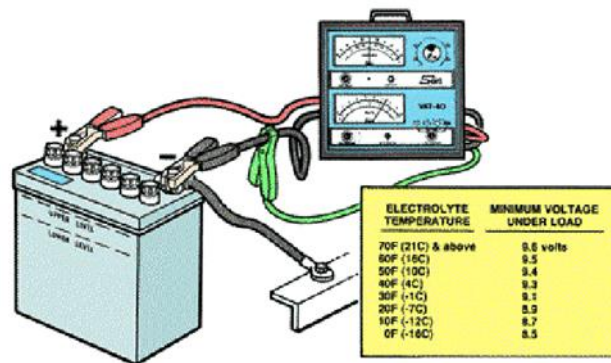


Figure: 2.5 heavy load tester

2.1.2 Battery charging

All battery chargers operate on the same principle: an electric current is applied to the battery to reverse the chemical action in the cells. Never connect or disconnect leads with the charger turned ON. Follow the battery charger manufacturer's instructions. DO NOT attempt to charge a battery with frozen electrolyte. When using a battery charger, always disconnect the battery ground cable first. This will minimize the possibility of damage to the alternator or electronic components in the vehicle. The battery can be considered fully charged when all cells are gassing freely and when there is no change in specific gravity readings for more than one hour.

- **Battery charger types**

Battery chargers are available in two classifications: Manual and Automatic.

- ✓ **Automatic chargers** (typically the type consumers' purchase) pulse and cycle the charge current and voltage rates. This automatic cycling rate protects the battery from damage and allows the charge rate to taper over time.
- ✓ **Manual chargers** (shown below), also known as wheel chargers, are preferred by automotive professionals. These charges do not cycle, but rather provide a constant non tapering charge. The constant charge rate allows the technician to accurately calculate the charge time to prevent overcharging of the battery.



Figure: 2.6 automatic and manual charger

✓ **General rules for charging a battery**

- Always follow the battery charger manufacturer's instructions.
- Always charge batteries in a well-ventilated area, and wear eye protection and protective clothing, such as a rubber apron and rubber gloves.
- Always keep sparks or flames away from the battery. (Do not smoke near a battery)
Recharge the battery at the same rate at which it was discharged. If the discharge was slow, then charge at a slow rate; if the discharge was rapid, then charge at a higher rate. (When in doubt always use a slow charge.)
- Never charge a battery that is connected to a vehicle. Disconnect the battery and charge. Excessive voltage can damage electrical circuits on the vehicle.
- Recheck specific gravity readings periodically, determine if further charging is still required.
- Periodically check the battery for excessive heat by placing your hand on the side of the battery. If it is hot (125°F) to the touch, interrupt the charging (turn off) until the battery cools and lower charge rate.

2.1.3. Battery terminal cleaning

Over a period of time, sulfuric acid will corrode battery terminals, clamps, and hold-down. This corrosion adds resistance and lowers current flow to and from the battery. Corrosion can be easily cleaned with a mild solution of baking soda and water. Battery terminals and cables

Page 33 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

are routinely removed, cleaned, and reinstalled. A battery brush, which has both an external and internal brushes, is ideal for cleaning the terminal posts and the inside of clamp.



Figure 2.7: battery terminal cleaning

2.1.4. Jumping a dead battery with booster cable

Jump starting a dead battery with a booster battery or battery in a car can be dangerous, so the proper sequence of connections will prevent sparks.

- First, connect the two positive terminals, one from the good battery and the other to the dead battery.
- Next connect one end of the jumper cable to the negative terminal of the booster (Good) battery.
- Finally connect the other end to a good ground on the engine away from the dead battery. If a spark occurs, it won't be near the battery, thus reducing the chance for explosion. If the jump starting from another vehicle, start the vehicle, running the engine at 1500 RPM for a few minutes. While the engine is running, start the dead vehicle. Never jump start a frozen battery.

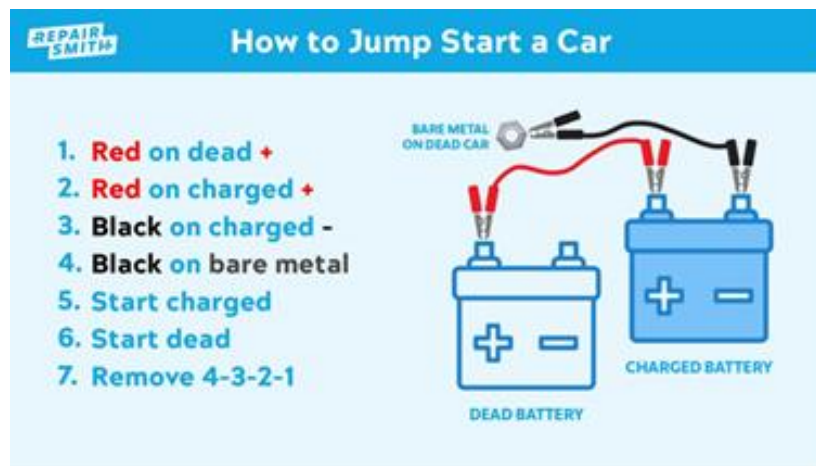


Figure 2.8 : Jumping dead battery

Page 34 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
---------------	--	--	-------------------------------

2.1.5. Adding water

Under the rare occurrence of adding water to a battery, use only distilled water. Minerals and chemicals that are commonly found in regular drinking water will react with the plate material and shorten battery life. Under normal conditions the addition of water should not be required. However, the addition of water may be necessary when the battery has been overcharged, for overcharging results in excessive evaporation of water from the electrolyte. The water level should be no higher than 1/8 inch below the bottom of the vent well. To avoid permanent damage, make sure the electrolyte level never drops below the top of the plates. Also, avoid over filling, this may result in electrolyte overflow from the battery.

Water adding procedure

Here is the step-by-step guide on how to properly water your car battery:

- Start by wearing the appropriate safety gear.
- Disconnect the battery. Remove the vent cap and clean the surface around the battery terminals. This will prevent dirt from getting inside the battery.
- Open the battery cap and inspect the fluid level. The battery terminals in each cell should be fully immersed in the liquid.
- Observe the electrolyte solution and check if the battery water level is low, normal, or maximum capacity.
- If the levels are low, pour just enough distilled water to cover the lead plates. Make sure you use your battery charger and charge it before filling it with clean water.
- For older batteries, never fill them up to maximum battery capacity. These are very quick to overflow, causing further damage and corrosion.
- Once done, close the vent cap and the battery cap, and seal them shut.
- If you see any overflow, clean it with a rag.
- If you feel like you accidentally overfilled the battery and expect a boilover, let the battery be. Check back after every two days to see for any signs of an overflow and water loss. If yes, wipe it off.

Note: Remember that this procedure only applies to flooded lead acid batteries. You cannot add battery water to an AGM battery since these types of batteries tend to be maintenance-free.

2.2 Operating principles and layout of battery storage systems

An automotive battery or car battery is a rechargeable battery that is used to start a motor vehicle. Its main purpose is to provide an electric current to the electric-powered starting motor, which in turn starts the chemically-powered internal combustion engine that actually propels the vehicle. Once the engine is running, power for the car's electrical systems is still supplied by the battery, with the alternator charging the battery as demands increase or decrease.

2.2.1 Classification of cells and batteries

Electrochemical cells and batteries are identified as primary (no rechargeable) or secondary (rechargeable), depending on their capability of being electrically recharged. Within this classification, other classifications are used to identify particular structures or designs. The classification used in this TTLM for the different types of electrochemical cells and batteries is described in this section.

1. Primary Cells or Batteries

These batteries are not capable of being easily or effectively recharged electrically and, hence, are discharged once and discarded. Many primary cells in which the electrolyte is contained by an absorbent or separator material (there is no free or liquid electrolyte) are termed “dry cells.” The primary battery is a convenient, usually inexpensive, lightweight source of packaged power for portable electronic and electric devices, lighting, photographic equipment, toys, memory backup, and a host of other applications, giving freedom from utility power. The general advantages of primary batteries are good shelf life, high energy density at low to moderate discharge rates, little, if any, maintenance, and ease of use. Although large highcapacity primary batteries are used in military applications, signaling, standby power, and so on, the vast majority of primary batteries are the familiar single cell cylindrical and flat button batteries or multicell batteries using these component cells.

2. Secondary or Rechargeable Cells or Batteries

These batteries can be recharged electrically, after discharge, to their original condition by passing current through them in the opposite direction to that of the discharge current. They are storage devices for electric energy and are known also as “storage batteries” or “accumulators.” The applications of secondary batteries fall into two main categories:

i. Those applications in which the secondary battery is used as an energy-storage device, generally being electrically connected to and charged by a prime energy source and delivering its energy to the load on demand. Examples are automotive and aircraft systems, emergency no-fail and standby (UPS) power sources, hybrid electric vehicles and stationary energy storage (SES) systems for electric utility load leveling.

ii. Those applications in which the secondary battery is used or discharged essentially as a primary battery, but recharged after use rather than being discarded. Secondary batteries are used in this manner as, for example, in portable consumer electronics, power tools, electric vehicles, etc., for cost savings (as they can be recharged rather than replaced), and in applications requiring power drains beyond the capability of primary batteries. Secondary batteries are characterized (in addition to their ability to be recharged) by high power density, high discharge rate, flat discharge curves, and good low-temperature performance. Their energy densities are generally lower than those of primary batteries. Their charge retention also is poorer than that of most primary batteries, although the capacity of the secondary battery that is lost on standing can be restored by recharging. Some batteries, known as “mechanically rechargeable types,” are “recharged” by replacement of the discharged or depleted electrode, usually the metal anode, with a fresh one. Some of the metal/air batteries (Chap. 38) are representative of this type of battery

2.2.2 operating principle of battery

Since the vehicle’s electrical power is stored in a battery or battery pack, special handling procedures must be followed when working with or near batteries. The principle of how a battery works is based on a scientific principle that states. When two dissimilar metals are placed in an acid, electrons flow between the metals if a circuit is connected between them. A battery consists of one or more electrochemical cells. Each cell contains two metal electrodes and at least one electrolyte solution (a solution containing ions that can conduct electricity). The

Page 37 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

battery operates through electrochemical reactions called oxidation and reduction. These reactions involve the exchange of electrons between chemical species. If a chemical species loses one or more electrons, this is called oxidation. The opposite process, the gain of electrons, is called reduction. The automobile battery, or lead storage battery, consists of six electrochemical cells connected in series. The anode of each cell is lead, while the cathode is lead dioxide. Lead dioxide is represented as: PbO_2 , The electrodes are immersed in a sulfuric acid solution. Sulfuric acid is represented as: H_2SO_4 .

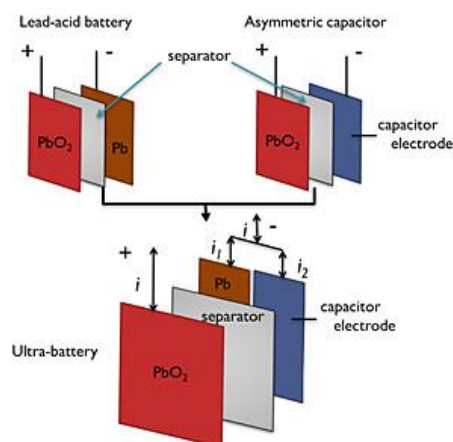


Figure 2.9 : operating principle of car battery

- $\text{Pb(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + 2\text{H}^+ + 2\text{e}^-$ (anode)
- $2\text{e}^- + 2\text{H}^+ + \text{PbO}_2(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O(l)}$ (Cathod)
- $\text{Pb(s)} + \text{PbO}_2(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow 2\text{PbSO}_4 + 2\text{H}_2\text{O(l)}$ (overall reaction)

When this reaction takes place, both electrodes become coated with solid lead (II) sulfate, and the sulfuric acid is used up. After the automobile has been started, the alternator or generator takes over the job of producing electricity (for spark plugs, lights, and so on) and also recharges the battery. The alternator reverses both the flow of electrons into the battery and the original redox reactions, and regenerates the lead and lead dioxide:

2.2.3 Battery storage systems

There are many different types and designs of batteries available. Batteries differ in size, from small single cells to large battery packs, comprised of many cells. They also have different ratings (not always dependent on size) and service lives. The primary difference between batteries is the chemicals used in the cells. During charging, the automobile battery acts like a second type of electrochemical cell, and electrolytic cell, which uses electricity to produce a desired redox reaction.

i. Charged

ii. Discharging

iii. Discharged

iv. Charging

i. A fully charged battery contains:

- ✓ Negative plate of sponge lead (Pb)
- ✓ positive plate of lead dioxide (PbO₂)
- ✓ Electrolyte of sulphuric acid (H₂SO₄)

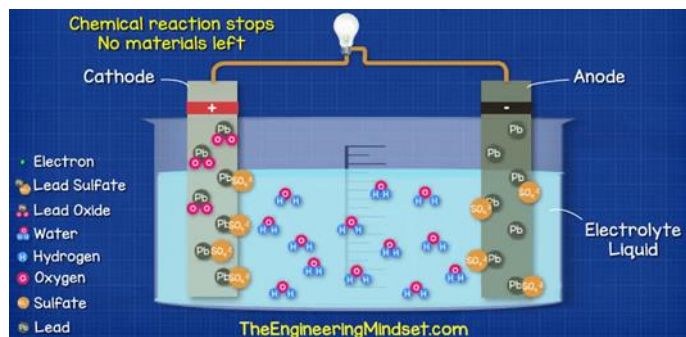


Figure 2.10 a fully charged battery chemical reaction

ii. Discharging

Discharging system - A car battery discharge quickly if something called the alternator on your charging system fails to push out enough voltage, ideally between 13.5 - 14.5 volts. In this case, the battery will continue to drain even while the car is running.

Reason for discharge or drain

Your standard lead acid battery will naturally drain at 0.1V per month – even sitting on a shelf. That may not sound a lot, but if we consider that a fully charged battery is at 12.72V and a chemically discharged battery, at which point you'd struggle to start the car, is at 11.8V, in just eight months of non-use, the battery could appear flat. And that is without any drains on the battery.

- Self-discharge
- Continual power draws, when parked
- Opening the doors / trunk
- Leaving your key close to your car
- You're taking too many short drives
- Parasitic drain
- Alternator fault
- Cold weather
- Sulphation
- Your battery needs replacing

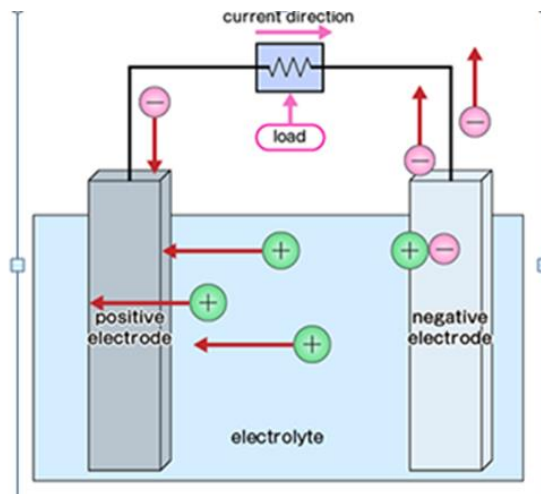


Figure 2.11 discharging battery chemical reaction

iii. Discharged

When someone says that their car battery is dead, this usually refers to the idea that it is discharged. This means that the voltage of the battery is below a functional amount. Car batteries tend to run 12 or more volts, and if the battery falls below that amount, you could have a dead battery.

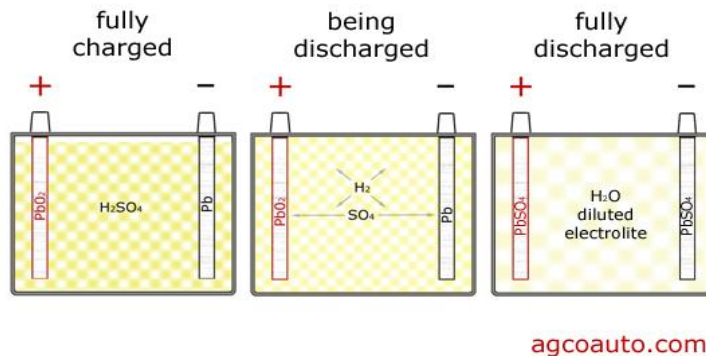


Figure 2.12 different battery stage chemical reaction

2.3 Comparing inspection results

Batteries cannot serve as per capacity and sometimes permanently damage before completing economic lifetime due to the lack of proper maintenance. But if batteries are properly designed and maintained, batteries will improve the system's performance and lead to economic savings over its lifetime.

2.3.1 Specific gravity readings

By measuring the specific gravity of the electrolyte, you can tell if the battery is fully charged, requires charging, or must be replaced. It can tell you if the battery is sufficiently charged for a capacity (heavy-load) test. The battery must be at least 75% charged to perform a heavy load test. (The heavy load test will be discussed later). In other words, each cell must have a specific gravity of 1.230 or higher to proceed.

Table 2. 4 specific gravity testing results

CELL READINGS	PERCENT CHARGED
1.270	100 %
1.230	75%
1.190	50%
1.145	25%
1.100	0%

2.3.2 Open circuit voltage readings

If 12.4v, the battery must be fully recharged before testing. Be sure to remove the surface charge completely; this is the number one mistake technicians make. If need be, place a load tester on the battery and load the battery for 10 seconds at approximately 200 amps. Allow a few minutes for the battery to recover then measure the open circuit voltage. This should remove the surface charge and allow an accurate open circuit voltage measurement.

% of charge

12.6v = 100%

12.4v = 75%

12.2v = 50%

12.0v = 25%

11.9v = 0%

If the battery is less than 75% charged, it must be fully recharged before proceeding. If the battery is 75% or higher proceed to a heavy load test. A battery not sufficiently charged will fail because it is discharged.

i. Specific gravity - excessive cell variation readings

Variation in specific gravity among cells cannot vary more than 0.050. The variance is the difference between the lowest cell and the highest cell. A battery must be condemned for excessive cell variation if more than 0.050. In the example below, the highest SG reading is cell #1 (shown in green) while the lowest SG reading is cell #5 (shown in blue); the difference is 0.070 which requires battery replacement. From below readings cell number 5 is failing.

Cell #1	Cell #2	Cell #3	Cell #4	Cell #5	Cell #6
1.260	1.230	1.240	1.220	1.190	1.250

2.3.3 Heavy load test results

The capacity rating is located on the battery label. Ratings can be expressed in CCA (Cold Cranking Amps), AH (Amp-Hour), or JIS (Japanese Industrial Standard.) JIS uses a six digit code (not shown). A conversion table is offered below that can be printed. If no rating is found on the battery, then use the OEM battery rating found in most repair manuals.

Results will vary with temperature. Low temperatures will reduce the voltage reading, so the electrolyte should be at 70°F or above. If not, use the following conversion table:

Table 2.5: Load testing result

Voltage	Temperature
9.6	70°F or above
9.5	60°F
9.4	50°F
9.3	40°F
9.1	30°F
8.9	20°F
8.7	10°F
8.5	0°F

2.3.4 Charging rates readings

The table below is used to calculate the charge rate and time of batteries of various strengths and states of charge using a manual (wheel type) charger.

Example: A battery with an RC (Reserve Capacity) rating of 80 RC and the state of charge is only 25% (specific gravity), first select the correct RC rating in the yellow column, 80 RC in our example. Now, select the charge rate (either 5 or 10 amps) under the state of charge column, 10 amps in our example. Where the two reading intersect (10 amps under 25% and 80 RC) will provide the amount of time in minutes (180) to charge the battery.

Table 2.6: Charging rate readings

STATE OF CHARGE	75%		50%		25%		0%	
CHARGE RATE (AMPS)	5	10	5	10	5	10	5	10
50 RC	75	35	150	75	225	180	300	150
60 RC	90	45	180	90	270	135	360	180
70 RC	105	50	210	105	315	155	420	210
80 RC	120	60	240	120	360	180	480	240
90 RC	135	65	270	135	405	200	540	270
100 RC	150	75	300	150	450	225	600	300
110 RC	165	80	330	165	495	240	660	330
120 RC	180	90	360	180	540	270	720	360
BATTERY RESERVE (RC) CAPACITY RATING IN MINUTES	CHARGE TIME IN MINUTES							

2.3.5 Charging rates

A Gel Cell Battery requires a shorter charge time. Optima recommends use of a voltage regulated charger set to the limits below

- Voltage: 13.8 to 15.0 volts
- Current: 10 amps maximum
- Time: 8 hours maximum

Overcharging can cause the safety valves to open and battery gasses to escape, causing premature failure. These gasses are flammable! You cannot replace water in sealed batteries that have been overcharged. Any battery that becomes very hot or makes a hissing sound while recharging should be disconnected immediately.

2.4 Documenting inspection results

An inspection report form is a document that collects an inspector's details and assessments about a certain subject or area. This form is also frequently used by businesses and organisations throughout the inspection period of their offices, workstation, enterprises, or any other property that needs to be appraised over time. This can be for **products inspections**, **property inspections** or **building inspections**. Furthermore, inspection report forms will detail the resolutions and corrective action plans to be considered to resolve the inspector's concerns and issues.

- ✓ Don't rush it. ...
- ✓ Know your report writing template. ...
- ✓ Cater each report to the property. ...
- ✓ Stick to the facts. ...
- ✓ Be concise and understandable. ...
- ✓ Take LOTS of photos. ...
- ✓ Manage your risk

2.4.1 Property Inspection Report Form

The Property Inspection Report Form will deal with the information about the client and location. This identifies who generated the report and the precise location of the inspection. This includes the precise date, time, and weather conditions at the time the inspection was performed. The building/house/property is described in-depth, including the kind and style of residence, building type, flooring, walls, roof structure, and roof covering. The orientation of the dwelling is also included. Buyers have the freedom to select their own Property Inspector through the help of this inspection. You must guarantee that the Property Inspector has reasonable access to the property and that any help or information requested on behalf of the buyer is delivered. Suppose you advise a vendor not to accept the buyer's choice of Property Inspector or do not allow them access to inspect after a sale and purchase agreement has been entered into. In that case, you may be advising a vendor to breach the sale and purchase agreement, which may result in a finding of unsatisfactory conduct. A basic property inspection checklist template/form will cover insulation and ventilation, heating and cooling machines, all locking components, including shingles and flashing, doors, stairs and railings, floors, ceilings, and related structures, including passages,

Page 46 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

balconies, and external areas. It also contains electrical components like breakers and fuses, as well as plumbing components like indoor pipes. It may, however, exclude possible concerns like vermin, which may necessitate independent examinations.

Why we use an inspection report form

Inspectors are trained professionals familiar with inspections, evaluations, analyses, and the quality requirements of a certain regulatory body. For developing an inspection report form, they perform duties such as: These specialists must employ inspection report forms to document their ratings and judgments since they rely on facts and correct statements, as well as their observations.

- Certain things regarding the property or subject must be checked to ensure that they are functioning properly.
- They must also ensure that some areas are suitable for living and that they carry out their responsibilities.
- These professionals are known as inspectors, and their job is to ensure that everything is in working order.

Inspection report forms come in various formats; however, choosing an inspection report form in word format provides numerous advantages to the firm or organization that will use the form. The following are some of the most prevalent advantages of employing inspection report forms in standardized form. It is simple to update and modify: Inspection report forms in standard format can be easily modified. The margins, format styles, and other settings and the form's contents and entry fields can be altered depending on the information to be collected and presented. It is the most fundamental format: Documents in a standardized format is simple to prepare since the document-maker only needs to utilize a basic word-processing programmer or software application. This means that an organization can easily construct an inspection report form by installing the appropriate application and program on the device to be utilized.



Table 2.7: Inspection report form

DuPont® ZODIAQ® <small>QUARTZ SURFACES</small>		Quality Inspection Report <small>Fax completed form to DuPont 1-800-417-1266</small>	
Name _____		Distributor/Marketer Name _____	
Address _____		Manufacturer Name _____	
Telephone Number _____		Installer Name _____	
(Work) _____		Dealer Name _____	
(Home) _____		Date Installed _____	
Inspected by _____ Date _____			
Description of complaint: 			
Manufacturing Requirements:		Yes	No
1 Does the material used in the installation meet the Zodiac® product non-conformity standards as described in the Zodiac® Product Non-Conformity Identification document?			
2 Does the material used in the installation match the color criteria outlined in the Zodiac® warranty?			
3 Do all inside corners of one piece L, U, etc. have a minimum of a 1/4" (6 mm) radius?			
4 Do all top and bottom edges of straightedge profiles have a minimum of 1/16" radius (1.5 mm) or chamfer?			
5 Do all outside corners have a minimum 1/8" (3 mm) radius?			
Cutout Requirements:		Yes	No
6 Are cooktop and sink cutout corners radiused with a minimum allowable radius of 3/16" (5 mm)?			
7 If a square cutout is used, has the inspector assured that the cut does not extend past the cutout perimeter?			
8 If cutouts (electrical outlets) extend past the cutout perimeter are they filled with adhesive?			
9 Is there at least 1/8" (3 mm) clearance space on all sides to allow for cooktop/sink expansion?			
10 Are cutouts supported within 3" (7.5 cm), of the cutout edge?			
11 Are stainless steel or lavatory undermount sinks supported with clips or cradles?			
12 Are all non stainless steels sinks supported with cradles?			
Installation General Requirements:		Yes	No
13 Is this an interior installation?			
14 Are tops of cabinets flat and true to within 1/8" (3 mm) over a 118" (3 m) length?			
15 Is the maximum visible gap ≤ 1/8" of clearance between Zodiac® countertops and the walls?			
16 Are tops properly adhered using flexible adhesive to support material?			
17 If inserts are used are they insert and glue type?			
Installation Support Requirements:		Yes	No
18 For structures with <26" (66 cm) depth, is there continuous perimeter support?			
19 For structures with >26" (66 cm) depth, is there continuous perimeter support and additional front to back support every 36"?			
20 For structures with support on three (3) sides is there proper support?			
21 For overhangs exceeding 12" (30 cm) for 2 cm product, and 15" (38 cm) for 3 cm product is there proper support?			
22 For half walls, knee walls, pony wall overhangs is there proper support?			
23 Has only acceptable support material (MDF, plywood, structural steel, or wood) been used?			
Installation Seam Requirements:		Yes	No
24 Are all field seams color matched using a DuPont approved adhesive?			
25 Are all field seams filled through the entire seam thickness?			
26 Are all field seams supported minimally on both sides in the front and the back of the seam?			

2.5 Making inspection reports

Making inspection report is providing the recorded report to a responsible party about the inspected, done and going to be done. The inspection report helps in defining and tracking hazards for a Corrective Action Plan and to ensure client and employee safety through a critical examination of the workplace. These are all intended to assess the risk from a moral, physical, and financial perspective. Inspection reports are widely used in engineering, construction, auto vehicle firms, land, manufacturing, and construction. Do you need a variety of inspection reports for your business? Then don't worry, we've got you covered.

Working platforms, excavations and cofferdams and caissons.

- The competent person will inspect the platform, the excavation or the cofferdam or caisson and complete the report form whenever requested to do so by the senior company representative on site. This will be at the intervals specified in the regulations.
- Findings will be reported to the senior company representative on site and the report form will be given to him.
- The senior company representative on site will instigate any remedial action highlighted in the report.
- The report will be kept on site and a copy sent to the chief executive.
- Any major hazard found during the examination must be reported to the chief executive immediately by telephone.

Self-check 2	Written test
--------------	--------------

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Part: 1 Choose the correct answer(25%)

- The electrolyte of a fully charged battery is usually contain
 - 64% water and 36% acid
 - 70% acid and 30 % water
 - 36% water and 64% acid
 - 50 % acid and 50 % water
- Which one of the followings equipment's are used for battery testing?
 - Hydrometer
 - Acid resistant material
 - Voltmeter
 - All
- Which one of the followings are not characteristics of battery
 - Self- discharge
 - Cold cracking ampere
 - Accumulator capacity
 - Un rechargeable
- Which one of the following is most commonly refers to a set of tools or other objects commonly used to achieve a particular objective.
 - Tool
 - Battery
 - Equipment
 - All
- To check for the battery drain you would connect ammeter between
 - Battery and alternator
 - Battery terminal and ground cable
 - Battery and (-) terminal
 - None

Part 2- Write true if the statement is correct and false if it is incorrect.

- If the battery is fully charged, it should read 12.6 volts or higher while testing with voltmeter.
- While testing battery terminals we need to turn of the engine ignition.
- A hydrometer is used to test the state of charge of a battery cell.
- Some battery manufacturers rate their batteries in watt-hours

Note: Satisfactory rating - 25 points and Unsatisfactory - below 25 points.

You can ask you teacher for the copy of the correct answers.

Page 50 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
---------------	---	--	-------------------------------

Part 3- List down the correct answers for the following questions

1. List down the main components of car batteries.
2. List down the characteristics of car batteries.
3. What types of testes are made on car batteries list them down?
4. List the reason for discharge of battery.

Note: Satisfactory rating - 30 points Unsatisfactory - below 25 points. You can your teacher for the copy of the correct answers.

Operation sheet 2

Operation sheet 2.1

Perform Battery terminal testing (3 hours)

Operation Title: Testing battery terminal

Purpose: To check of poor electrical connection between the terminals and the battery cables.

A. Conditions or situations for the operations:

- Safe working area.
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

B. Equipment, Tools and Materials:

- Multi-meter
- Battery
- Vehicle

C. Steps in doing the task

- Connects the negative voltmeter lead to the battery cable end.
- Touch the positive lead to the battery terminal
- The ignition or injection system disabled so that the engine will not start
- Crank the engine while watching the voltmeter reading.

Operation sheet 2.2

Perform Testing Battery Drain (2hours)

- **Purpose:** To checks for abnormal current draw with the ignition off

A. Conditions or situations for the operations:

- Safe working area.
- Properly operated tools and equipment.
- Appropriate working cloths fit with the body.

B. Equipment Tools and Materials:

- Voltmeter
- Battery with vehicle Battery

C. Steps in doing the task

- Set up an ammeter, as shown in figure
- Pull the fuse if the vehicle has a dash clock
- Close all doors and trunk (if applicable).
- Rread the ammeter

Operation sheet 2.3

Perform Battery cell voltage test (3hours)

Operation Title: Testing Battery Cell voltage

Purpose: to know if the battery is discharged or defective

A. Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

B. Equipment Tools and Materials:

• Hand tools

- ✓ Voltmeter special cadmium (acid resistant metal) tip

Steps in doing the task:

1. Insert the tips into each cell.
2. Starting at one end of the battery and work your way to the other.
3. Test each cell carefully.

LAP TEST-2	Performance Test
-------------------	-------------------------

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 5 hours.

Task 1- Battery Specific Gravity testing

Task 2- Testing Battery Drain

Task 3- Battery cell voltage test

LG #3	LO #3- Carry out service and maintenance
--------------	---

Instruction sheet

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

- Technical and tool requirements for servicing and maintenance
- Implementing methods for conduct of service and maintenance
- Performing Battery pole or terminal cleaning and refilling
- Replacing Battery electrolyte and Performing top up
- Type and methods of battery charging and boosting
- Performing Battery charging and boosting operation
- Battery clamp adjustments during service and maintenance
- Comparing Battery test results
- Making reports

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Technical and tool requirements for servicing and maintenance
- Implement methods for conduct of service and maintenance
- Perform Battery pole or terminal cleaning and refilling
- Replace Battery electrolyte and Performing top up
- Perform methods of battery charge and boost
- Perform battery charge and boosting operation
- Adjust Battery clamp during service and maintenance
- Compare Battery test results
- Make reports

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets3
4. Accomplish the Self-checks 3
5. Perform Operation Sheets 3
6. Do the “LAP test”3

Information Sheet 3




3.1 Technical and tool requirements for servicing and maintenance

Most batteries in today's vehicles fancy themselves "maintenance free," but that's not entirely true. This just means you won't be concerning yourself with pulling terminals or pouring electrolyte. Actually, these batteries require attention to stay in good shape. And using the right techniques and tools for battery maintenance plays a major role in the longevity and safety of what's just under the hood. Older and neglected batteries can leak acid, emit ignitable gasses and explode unexpectedly. Dead batteries can leave you stranded. But once you know what to look for, it's easy to keep them maintained.

- i. **Safety Equipment:** Always wear gloves and goggles when performing any maintenance or inspection. Visible leaks, a rotten egg smell or bulging sides mean the battery needs to be replaced outright, and a battery swap is one of the easier DIY tasks. Remember
- ii. **Battery Post Wrench:** A solid connection between the battery post and cable clamp is essential. It must be not only tight but clean. You'll need to disconnect the clamps to service it, and you don't want to strip the nut in the process. Make sure to buy the right size wrench for your terminal connectors.always disconnect the Negative cable first to avoid shock.
- iii. **Battery Terminal Brush:** This deceptively simple 2-in-1 tool cleans both terminals and clamps alike and is a real must-have in any toolbox. The bluish white crust that builds up around the terminal posts can interfere with battery power. Disconnect the cables, and clean terminals and clamps separately.
- iv. **Battery Cleaner:** This spray neutralizes any acid or surface gasses and removes corrosion at the same time. Simply spray it on, wait according to the directions, and then wipe it off. Voila! Clean battery!
- v. **Terminal Spreader:** When you're done, you might notice the clamp is too tight to sit down on the terminal. In order to get it snugly at the base, use a terminal spreader to widen the clamp so it fits all the way down before tightening.

- vi. **Battery Protectant:** Once everything is back together (remember to install the Positive cable first to avoid getting shocked) and tight, grab a can of protectant and spray the surface of the battery, applying a light coat over the terminal connections. This spray keeps things clean longer and discourages future buildup so you don't have to do this as often.

Table 3.1 Tools for servicing battery

No	Name of tools	Picture
1	Battery protectant	
2	Battery post wrench	
3	Battery Terminal Brush	

4	Battery cleaner	
5	Battery terminal spreader	

Before using any tool

Wear protective equipment when handling batteries including gloves, eyewear and hardhat. Gloves and protective eye gear are to guard against battery acid while a hard hat is important during the lifting process in case a battery swings or falls. 6. Batteries can be dangerous when mishandled.

- Check the battery's state of charge. ...
- Ensure the battery top is clean, dry, free of dirt and grime. ...
- Inspect the terminals, screws, clamps and cables for breakage, damage or loose connections.

3.2 Implementing methods for conduct of service and maintenance

i. Change every four years: It's recommended that each car battery is replaced after four years and to ensure your vehicle runs properly it's important that you don't forget to do this. There's nothing worse than losing power mid-journey, so don't try to extend the life of your battery for longer than you should. Here's some useful advice on how to replace your car battery.

ii. Check the acid level: As part of your car battery maintenance you should check the acid level of your battery around every six months. Be on the lookout for acid stratification, which happens when batteries dwell at a charge below 80 per cent, never receive a full charge or have shallow discharges. If you have a stratified battery, electrolytes will concentrate at the bottom and leave the top starved. Your battery is particularly at risk if your car is primarily driven short distances with power-robbing accessories in use.

iii. Add water carefully: If you notice that electrolyte levels are low (the plates will be exposed), top them up with distilled water. Be careful when doing this and only fill the cells to cover the plates. A funnel or sports bottle is often best for adding water as they allow you to control the flow. Once you've topped up the water levels, use a battery charger to recharge the battery.

vi. Conduct battery load test: For comprehensive car battery maintenance, every month you'll want to conduct a battery load test, which can be done by a mechanic. This car battery service is to ensure that the device can charge properly, even in freezing temperatures.

V. Clean battery: Dirt and debris can be bad news for your battery if it gets into the cells. It can also cause corrosion on nearby metal, so it's important as part of your car battery maintenance, to clean the top of the battery and around the terminals. Ammonia-based window cleaners are often recommended but a combination of baking soda and water will help to get rid of any 'crust' when applied via a wire brush. Baking soda and water is particularly useful for cleaning corrosion. However, as a rule of thumb you want to think of the brush as damp, as opposed to wet. You also need to make sure you fully wipe the battery down so no baking soda residue is left, as this can cause corrosion. It's important that when cleaning the battery, no fluid is let in through the battery ports.

vi. Keep cables Tied: It's important that your cables don't move, so be sure to keep them tied tightly. This will help to keep everything properly secure.

vii. Check the car is recently on function: If you leave your car too long without driving it, your battery will drain down. It's recommended that you drive your vehicle at least every three days.

viii. Keep the battery warm: The cold weather is bad news for your battery so it's important to try to keep it warm during winter. An engine or battery heater is often advised to help cars stay up and running in the cold. They not only make it easier to start the battery but help to minimize power consumed.

ix. Don't over charge: If you change your battery manually, it's important not to over-charge it as this can lead to damage. Check on the battery every half an hour to see how it's progressing.

3.3 Performing Battery pole or terminal cleaning and refilling

This simple process involves battery acid, so you must be taking the proper procedures needed to protect yourself. This includes wearing the proper rubber gloves and eye protection. Here is what you need to clean your battery:

- Baking soda
- Petroleum jelly
- Anti-corrosion pads
- Stiff-bristle brush, wire brush, or professional tool
- Water
- Protective gear
- Shop towels

a. Steps to clean battery

i. Disconnect Your Battery Cables

First and foremost, ensure your car is completely off and disconnect your battery cables. Always begin with the negative cable first, marked by the (-) sign, and is usually black. Next, remove the positive cable, which is marked by (+) and is usually red. If the corrosion is extreme enough, you may need to wiggle the connectors loose even after any bolts are loosened.

ii. Inspect Your Battery and Cables

While you're here, it's important to take a good look at your battery and cables. If you notice any other type of buildup, whether it's from dirt or other grime, this may be causing your trouble as

Page 62 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

well. If you notice that your battery is swollen, cracked, or bloated, be sure to schedule service right away to have it replaced. Inspect the cables to ensure they are free of any fraying, cracks, or anything else that may contribute to a bad connection and have these replaced as needed.

iii. Clean Away Corrosion and Rinse

Using around a teaspoon of baking soda, or more as necessary, coat your battery terminals and other affected areas. Pour a small amount of water on each terminal then use your brush to scrub the corrosion away. While a steel wire brush will work the best, an old toothbrush can work with enough elbow grease. Alternatively, you can also combine the water and baking soda in a cup to create a cleaning solution. Dip your brush in it and scrub away! You can repeat the same cleaning process to clear away any corrosion found on the end of your battery cables. Either way you go about cleaning the terminals, you'll notice the baking soda react with the corrosion, neutralizing the acidic nature and making it safe to handle. Once the corrosion has been removed, rinse it away with clean water.

iv. Thoroughly Dry Battery

Once the battery has been rinsed, let it dry. You can either use shop towels or an air compressor to speed things up. You want to make sure it is completely dry before reconnecting.

v. Apply Preventative Measures

Once everything is dry, you can use cost-friendly anticorrosive pads, also known as battery terminal protectors, to help prevent this problem from repeating itself. You can also apply a generous layer of petroleum jelly to the terminals which can help improve the conduction between the cable and battery. The jelly will also work to reduce corrosion in the future.

vi. Reconnect Battery Cables

Once the preventive measures are in place, you can reconnect your battery. You will be reconnecting the battery in reverse order of how you disconnected them, with the positive (+) being connected first and the negative (-) end being connected after. If you feel like you should add more petroleum jelly or other extra preventive measures at this time.

d. Car charging system

At times, a dead car battery might not indicate a problem with the battery, but rather your car's charging system. If the battery warning icon comes on while you're driving, this is likely a sign that there's a malfunction within your charging system. You should have to check your alternator, serpentine belt, battery cable and terminals, and alternator belt are all functioning correctly.

e. Corrosion on battery terminals

Finally, a dead car battery could be indicative of corrosion on your battery terminals. These are the posts that connect your battery to the rest of the charging system. At times, corrosion which looks like white, ashy deposits builds up between the terminal posts and the battery cables and can cause a reduction in the flow of power in your vehicle. You can use a wire brush and baking soda to remove corrosion from your battery. However, if it keeps occurring, this might suggest that either your battery cables or terminals need to be replaced.

3.5 Type and methods of battery charging and boosting

Charging a battery reverses the chemical process that occurred during discharge. The Sulphation and hydrogen ions basically switch places. The electrical energy used to charge a battery is converted back to chemical energy and stored inside the battery. The storage battery can be recharged in to its original state by a battery charger, which delivers a direct current and a proper voltage. The battery charger has a control switch and an ammeter, which is used to adjust the charging rate.

Since most commercially available electricity is alternating current (AC) the charger consists of a transformer to reduce the voltage to a usable value and a rectifier to change the alternating current to direct current. The battery charger has a control switch and an ammeter so the charging rate can be adjusted. The battery chargers are categorized as slow charger and fast charger. A battery in good condition may occasionally fail to crank the engine fast enough to make it start.

- All battery chargers operate on the same principle:

Page 65 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

- ✓ An electric current is applied to the battery to reverse the chemical action in the cells.
- ✓ Never connect or disconnect leads with the charger turned ON.
- ✓ Follow the battery charger manufacturer's instructions.
- ✓ And, do not attempt to charge a battery with frozen electrolyte.



Figure 3.1: battery charger

3.5.1 Method of charging

There are three basic types of batteries connection.

- a. Series Connection
- b. Parallel Connection
- c. Series-Parallel Connection

a. Series Connection of Batteries

If we connect the positive (+) terminal of battery to negative (-) and negative to positive terminal as shown in the below fig, then the batteries configuration would be in series. In series connection of batteries, current is same in each wire or section while voltage is different i.e. voltages are additive e.g.

$$V_T = V_1 + V_2 + V_3 + V_4 + \dots V_n$$

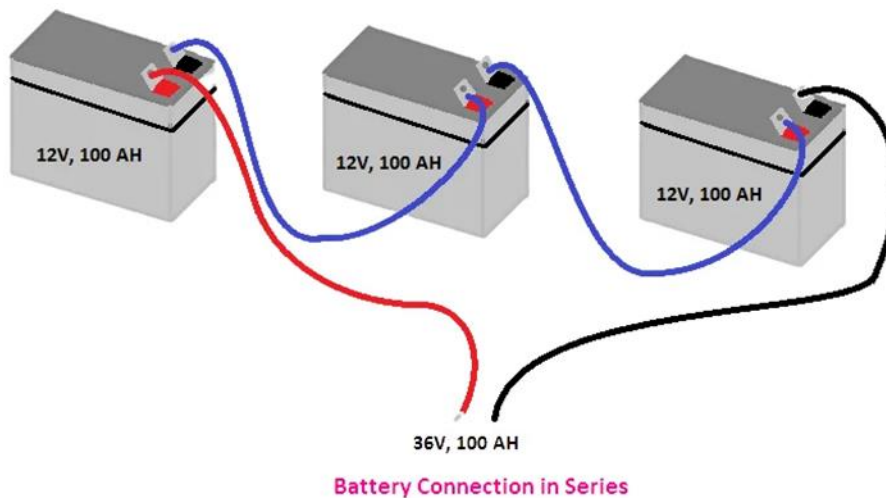


Figure 3.2 Series Connection of Batteries

b. Parallel Connection of Batteries

- i. If we connect the positive terminal (+) of battery to positive and negative (-) to negative terminal, then the batteries configuration would be in parallel.
- ii. In parallel connection, voltage will be same in each wire or section, while current will be different i.e. current is additive.

$$I_T = I_1 + I_2 + I_3 + \dots I_n$$

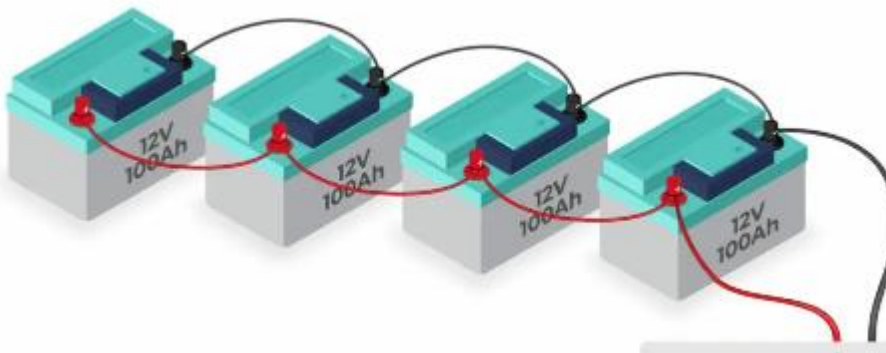


Figure 3.3 Parallel Connection of Batteries

c. Series-Parallel Connection of Batteries

If we connect two pairs of two batteries in series and then connect these series connected batteries in parallel, then this configuration of batteries would be called series-parallel connection of batteries. In other words, It is series, nor parallel circuit, but known as series-parallel circuit. Some of the components are in series and other are in parallel or complex circuit of series and parallel connected devices and batteries.

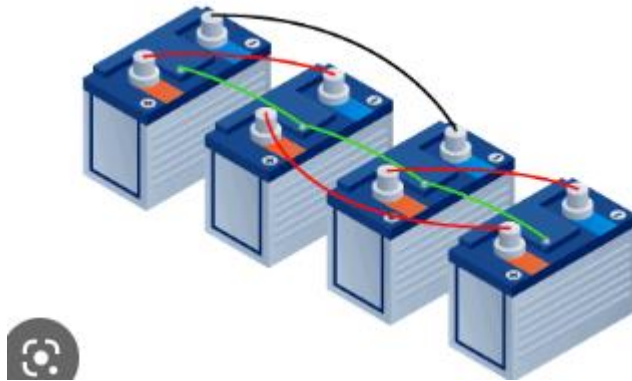


Figure 3.4 Series-Parallel Connections of Batteries

<https://www.youtube.com/watch?v=gffnkJQxRAg&pp=ygUbcGFyYWxsZWwgYW5kIHNLcmllcyBiYXR0ZXJ5>

3.6 Perform battery charge and boosting operation

Car battery charging means activation of chemicals in the battery, car batteries run on chemical and electrical energy. There is an electrical circuit connected to the outside of the battery that charges the battery and allows electrons to flow. There are also chemical substances within the battery that form chemical reactions with each other and the electrons. Electrons act as the subatomic particle that activates the battery, allowing it to power up the car's engine.

The battery charging are categorized as slow and fast charging

i. Fast charging

Fast charging is usually constant voltage with a high capacity in which their common charging rates are 80-100 amperes from 6 volt battery and 40-50 amperes for 12 volt battery. Twenty to thirty minutes of charging time will normally charge the battery. So that the starting motor will

Page 68 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

crank the engine and the battery will not be over heated. Fast chargers do not fully charge a battery in the time allotted for charging. Batteries are 40-60 percent charged when the temperature reaches 1100F. Some fast chargers have controls for finishing the charging cycle at low rate so the battery can be brought up to a full charge.

i. Slow charging

Slow battery chargers operate at low rate and take a longer time to charge a battery. The charging rate is one ampere for each positive plate in a cell. Batteries of different size can be charged at the same time. But the charging rate is determined by the smallest battery. Batteries are safely charged at a high rate if the temperature is below 1250F. During slow charging the maximum charging current should be less than 1/10th of the battery capacity. It's recommended that you let the vehicle charge overnight with this setting. If the battery was completely dead, it may take up to 24 hours to charge fully.

3.6.1 Charging current and time

Determination of the allowable charging amperage and time is very essential if the battery chargers have no a test device. Determination of charging amperage determination the state of the battery from the specific gravity, using the below graph, then calculate the correct charging amperage using the following formula. The charging time for quick charging is usually from half to one hour.

$$\text{Correct charging amperage (A)} = \frac{\text{State of discharge Capacity (Ah)}}{1 + \text{Charging Time}}$$

Example

1. Calculate the suitable charging current in Amps and the needed charging time in hrs for a 12V,120 Ah battery.

Battery Charging Current:

- i. First of all, we will calculate charging current for 120 Ah batteries. As we know that charging current should be 10% of the Ah rating of battery.
- ii. Therefore,
- iii. Charging current for 120Ah Battery = 120 Ah x (10 ÷ 100) = 12 Amperes.

Page 69 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

iv. But due to some losses, we may take 12-14 Amperes for batteries charging purpose instead of 12 Amps.

2. Suppose we took 13 Amp for charging purpose, then, charging time for 120Ah battery = $120 \div 13 = 9.23$ Hrs.

i. But this was an ideal case...

ii. Practically, it has been noted that 40% of losses occurs in case of battery charging.

iii. Then $120 \times (40 \div 100) = 48$ (120Ah x 40% of losses)

iv. Therefore, $120 + 48 = 168$ Ah (120 Ah + Losses)

v. Now Charging Time of battery = Ah \div Charging Current

a. $= 168 \div 13 = 12.92$ or 13 hrs.

vi. Therefore, a 120Ah battery would take 13 Hours to fully charge in case of the required 13A charging current.

3.6.2 Perform battery boosting operation/Jumping

A jump start, also called a boost, is a procedure of starting a motor vehicle (most commonly cars or trucks) that has a discharged or depleted battery. A temporary connection is made to the battery of another vehicle, or to some other external power source.

A jump start, also called a boost, is a procedure of starting a motor vehicle (most commonly cars or trucks) that has a discharged or depleted battery. A temporary connection is made to the battery of another vehicle, or to some other external power source. The external supply of electricity recharges the disabled vehicle's battery and provides some of the power needed to crank the engine. Once the vehicle has been started, its normal charging system will recharge, so the auxiliary source can be removed. If the vehicle charging system is functional, leaving the engine running will restore the charge of the battery, although it is usually recommended to drive the vehicle for a few minutes after starting to speed up the recharging process.

A. Jump Starting Safety Tips

- i. When jump starting, make sure you are not smoking.
- ii. Make sure the vehicle is in park.
- iii. Do not let the cables dangle from the car.
- iv. Do not use poor- and low-quality cables. Use high-quality ones.

Page 70 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
---------------	--	--	-------------------------------

- v. Keep a wire brush handy for proper cable-to-terminal connection in case cleaning battery terminals is appropriate.

B. Steps to Jump Car Battery

- i. Connect red to dead + (positive battery terminal)
- ii. Connect red to donor + (positive battery terminal)
- iii. Connect black to donor – (negative battery terminal)
- iv. Connect black to dead, bare metal
- v. Start donor vehicle
- vi. Start dead vehicle
- vii. Disconnect in reverse (steps 4,3,2,1)

Two types of jump starts

1. Jump start using another battery
2. Jump start using battery charger

1. Jump start using another battery

Turn off the ignition on both cars. First, clamp one end of the positive cable to the dead battery's positive clamp. Now have a helper connect the other end of that cable to the other battery's positive clamp. Next, connect the negative cable to the negative terminal on the good battery.

<https://www.youtube.com/watch?v=iI1o2hNy2hE&pp=ygUVanVtcCBzdGFydCBvZiBiYXR0ZXJ5>

2. Follow these steps if you're using a portable battery charger on your car battery:

- Turn off both the vehicle and the battery charger. Turn off your car's engine. ...
- Connect the battery to the charger. ...
- Set the charger. ...
- Charge the battery. ...
- Turn off the charger, and start the engine.

<https://www.youtube.com/watch?v=TnMCoPzMYj4&pp=ygUoSG93IHRvIGp1bXAgaYmF0dGVyeSB3aXRoIGJhdHRlcnkY2hhcmdlcg%3D%3D>

3.7. Battery clamp adjustments during service and maintenance

Battery clamps are attached to the side of a battery/inverter and have either a negative or positive charge. Clamps are placed around battery terminals to transfer power securely. Their handles are usually made from an insulated vinyl construction that prevents the user from being shocked.

• Tools and Materials Needed:

- ✓ Clean wipes
- ✓ Rubber band
- ✓ Wire brush
- ✓ Plastic bag
- ✓ Wrench set
- ✓ Battery terminal cleaner

Step 1 - Clean the Inside Parts

- ✓ You have to clean all the inside parts of the car that are near the battery. This will allow you to see all of the parts you're working with more clearly.
- ✓ Use a clean wipe to make sure that there aren't any impurities while you're working in the area. Cleaning is very important for this kind of work.

Step 2 - Remove the Positive Cable

- ✓ Use a wrench to loosen the pin situated on the positive cable connector.
- ✓ Remove the positive cable connector from its positive battery terminal.
- ✓ Always be extremely careful when you work with wires.

Step 3 - Secure a Plastic Bag over the Cable

- ✓ Put the plastic bag over the positive battery cable connector.
- ✓ Secure the plastic bag with the rubber band. This will be a temporary measure.
- ✓ You will have to remove the bag later on in the procedure so be sure to keep this in mind when you're securing it.

Page 72 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

- ✓ That is, make sure the rubber band isn't too tight that you won't be able to remove it

Step 4 - Remove the Negative Cable

- ✓ In this step, you'll be removing the negative cable. This part should be easy because it's similar to the procedure in Step 2.
- ✓ Use a wrench to loosen the pin situated on the negative cable connector.
- ✓ Carefully remove the negative cable connector from its negative battery terminal.

Step 5 - Clean the Battery Terminals

- ✓ All battery terminals should be cleaned with a battery terminal cleaner.
- ✓ Also clean the connectors on the battery cables thoroughly with a wire brush. This is very important.
- ✓ It's safer to clean everything before you start working with wires and battery terminals.

Step 6 - Connect the Negative Cable to the Negative Terminal

- ✓ Take hold of the negative battery cable connector.
- ✓ Place the negative cable connector in the negative terminal on the battery.
- ✓ Adjust it with the wrench, but be careful with the wires - they are delicate and you could easily damage them.

Step 7 - Connect the Positive Cable to the Positive Terminal

- ✓ • Now you have to remove the plastic bag from the positive battery cable (You had secured the plastic bag in Step 3).
- ✓ Place the positive cable on the positive battery terminal and adjust it carefully (as in the previous step).
- ✓ You have officially finished the adjustment process and you can now drive wherever you want to and verify your battery cable whenever you want to.

Self-check 3	Written test
--------------	--------------

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Part: 1 Choose the correct answer(25)

- Which one of the followings are types of jump start?
 - Jump start using battery
 - Jump start from dead battery to dead battery
 - Jump start with battery charger
 - A and C
- Which one of the followings is correct about slow charging?
 - It takes longer time
 - operate at low rate
 - Battaries are charged safely
 - All
- Which one of the followings are not characteristics of battery
 - Self- discharge
 - Accumulator capacity
 - Irreplaceable
 - Un rechargeable
- Which one of the following is most commonly refers to a set of tools or other objects commonly used to achieve a particular objective.
 - Tool
 - Equipment
 - Battery
 - All
- To check for the battery drain you would connect ammeter between
 - Battery and alternator
 - Battery terminal and ground cable
 - Battery and (-) terminal
 - None

Part 2- Write true if the statement is correct and false if it is incorrect.

- If the battery is fully charged, it should read 12.6 volts or higher while testing with voltmeter.
- While testing battery terminals we need to turn of the engine ignition.
- A hydrometer is used to test the state of charge of a battery cell.
- Some batties are unrechargeable

Note: Satisfactory rating - 25 points and Unsatisfactory - below 25 points.

You can ask you teacher for the copy of the correct answers.

Page 74 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
---------------	---	--	-------------------------------

Operation sheet 3

Operation sheet 3.1

Perform Preparation of electrolyte (3hours)

A. Conditions or Situations for the Operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body

B. Equipment's, Tools and Materials

- H₂SO₄, distill water,
- Hydrometer,
- serviceable battery,
- wire brush,
- plier,
- backing soda plastic container,
- plastic stick etc.

C. Procedure:-

- Prepare plastic container
- Added distilled water in plastic container
- Add sulfuric acid on water as a droplet
- Steer with plastic stick
- After 12 hour added electrolyte inside battery case [each cell]
- Warning must be done first :
- Wearing proper clothes, eye glass, glove
- Make working area hazard free
- Read and interpret manual which guide you how to use tools and equipment's

Operation 3.2

Perform Preparing of battery for charging (1hour)

PURPOSE: For the purpose of Checking the electrolyte level and fill it if necessary.

A. Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment
- Appropriate working cloths fit with the body
- Appropriate working cloths fit with the body

B. Equipment tools and materials:

- Hydrometer
- Serviceable battery
- Wire brush
- Plier backing soda etc

C. Procedure

- Clean and wash dirt from the battery terminals.
- Inspect the case
- Cell covers
- Sealing compounds and vent plugs and make repairs if damaged.
- Check the electrolyte level and fill it if necessary.

• PRE-CAUTIONS:

- ✓ wearing proper clothes, eye glass, glove
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment's

Operation sheet 3.3

Perform Battery Charging (Slow Charging) (2hours)

Operation Title: Battery Charging (Slow Charging)

A. Conditions or situations for the operations:

- Safe working area
- Properly operated tools and equipment's
- Appropriate working cloths fit with the body

B. Equipment Tools and Materials:

- Battery charger
- Batter

C. Steps in doing the task

- Remove all vent plugs.
- Check electrolyte and add distilled water if the level is low.
- Connect the battery to the charger. Connect the positive charger cable to the positive battery terminal post and the negative cable to the negative terminal post.
- If more than one battery are to be charged, connect the batteries in series up to the capacity of the charger.
- Switch on the charger and adjust the charging rate.
- Check specific gravity of the electrolyte by means of hydrometer after every two hours until there is no further rise in specific gravity.
- When the battery shows no further rise in specific gravity (should not be less than 1.280) for more than one hour, it will be considered as fully charged.
- Watch the battery temperature, as there is possibility of overheating in this method.
- If the battery boils or overheats, remove it from the line.
- **PRE-CAUTIONS**
 - ✓ Wearing proper clothes, eye glass, glove

Page 77 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
---------------	--	--	-------------------------------

LAP TEST-3	Performance Test
-------------------	-------------------------

Instructions: Given necessary templates, workshop, tools and materials you are required to perform the following tasks within 3 hours.

Step1: Prepare electrolyte

Step2: Charging Battery

Step3: Perform slow charge based on the circuit

LG #4	LO #4- Cleanup work area and maintain Equipment
--------------	--

Instruction sheet	
<p>This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:</p> <ul style="list-style-type: none"> • Collecting and storing reused materials • Removing waste and scrap • Cleaning and inspecting Equipment and work area • Tagging unserviceable equipment and identifying faults <p>This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:</p> <ul style="list-style-type: none"> • Collecte and store reused materials • Remove waste and scrap • Clean and inspect Equipment and work area • Tag unserviceable equipment and identify faults 	
Learning Instructions:	
<ol style="list-style-type: none"> 1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets1 4. Accomplish the Self-checks 2 5. Perform Operation Sheets 2 6. Do the “LAP test”2 	

Information Sheet 4

4.1 Collecting and storing reused materials

Waste batteries can always be recycled or taken to household hazardous waste collection points . To prevent fires from lithium-ion batteries, tape battery terminals and/or place batteries in separate plastic bags and never put these batteries in household garbage or recycling bins. Store used batteries in a cool and dry area. Batteries should not be stored in extreme heat, near flammable materials or in locations where there is moisture or humidity.

4.1.1 Storing re-used materials

Storing is carried out to segregate the waste into different streams to fulfill one or more of the objectives listed above.

- Store maintenance items and equipment may include:
 - ✓ Counting items back into store Storing equipment, etc into designated areas
 - ✓ Replenishing consumables that have been used
 - ✓ Requisitioning additional materials, equipment and items needed.

Accordingly the waste should be divided into the following streams:

- (a) Dry Recyclables
- (b) Construction and demolition waste
- (c) Biodegradable waste
- (d) Bulky waste (white goods)
- (e) Hazardous waste
- (f) Mixed MSW (often referred to as comingled waste)

4.2. Removing waste and scrap

- Dispose of waste may include:
 - ✓ Flushing cleaning chemicals from areas
 - ✓ Capturing waste created as part of the cleaning process
 - ✓ Alignment with enterprise policies and procedures
 - ✓ Compliance with local legislation and regulations
 - ✓ Observing environmental sensitivity issues

4.3. Cleaning and inspecting Equipment and work area

- The selected cleaning process may include:
 - ✓ Sweeping, including manual, walk-behind and ride-on.
 - ✓ Vacuuming, including wet and dry.
 - ✓ Hosing down, including pressure and high-pressure washing.
 - ✓ Air blowing
 - ✓ Scrubbing, washing, wiping, spot cleaning, rinsing and pre-spraying
 - ✓ Stripping, re-sealing and polishing
 - ✓ Blasting, including sand, water, steam, powder and dry ice
 - ✓ Specific removal procedures for items such as graffiti, gum, grease and oil
 - ✓ Mopping, including wet and dry High level cleaning
 - ✓ Wet and dry area cleaning.
 - ✓ Wet and dry area cleaning.
- Clean, check and store cleaning equipment and chemicals may include:
 - ✓ Cleaning equipment that has been used.
 - ✓ Cleaning personal protective equipment and clothing that has been used, as appropriate.
 - ✓ Conduct safety checks on equipment Undertaking basic preventative maintenance. and basic repairs on equipment.
 - ✓ Storing equipment in accordance with enterprise requirements
 - ✓ Storing chemicals in accordance with legislated requirements of the host country and enterprise requirements
 - ✓ Replenishing consumables.

- After cleaning return area to operational condition may :
 - ✓ Replacing items that were moved back into original position
 - ✓ Replacing items into designated positions as identified by work orders
 - ✓ Cooperating with other staff to establish a suitable operational area at the start of shift/trade
 - ✓ Removing barriers and signage
 - ✓ Opening the site/area for staff and public access, as appropriate
 - ✓ Notifying relevant supervisors of operational readiness of area.

4.4 Tagging unserviceable equipment and identifying faults

The tag is to indicate the reason for the equipment being isolated, who the tag was completed by and the date it was completed. The workplace should have 'Out of Service' and 'Danger Do Not Operate' tags available in an accessible location, when required.

4.4.1 Isolation and Tag out Procedure

The purpose of this procedure is to ensure:

- All unsafe plant, machinery and equipment ('equipment') is identified and removed from service
- All plant and equipment undergoing maintenance, inspection, cleaning or repair is isolated from relevant energy sources (for example, electrical, hydraulic, chemical or mechanical energy sources) and tagged.

4.4.2 Isolation of static and portable non-electrical equipment

- Unsafe non-electrical equipment must be isolated from energy sources, for example by using some of the following methods:
 - ✓ installing mechanical stops or retaining pins capable of being padlocked
 - ✓ physically blocking the system against movement
 - ✓ bleeding residual gases, liquids and vapours from systems
 - ✓ relieving pressure for hydraulic or pneumatic systems
 - ✓ pressure, hydraulic or pneumatic systems must be relieved of pressure if appropriate, or parts be blocked that could move due to loss of pressure.

- Unsafe electrical equipment must be isolated from energy sources, for example by using some of the following methods:
 - ✓ removal of fuses
 - ✓ isolation of the drive motor at the source
 - ✓ isolation of the control panel
 - ✓ complete removal of power cable/plug from plant and equipment
 - ✓ locking out the power supply board.

4.4.3 Tag out

For equipment that has been isolated, a tag indicating that the item is “Out of Service” should then be placed onto all on/off switches and power leads. The “Out of Service” tag must be left on faulty items until the fault has been rectified or the tag is replaced with a ‘Danger – Do Not Operate’ tag and/or lock by a contractor or other person authorized to rectify the fault. The tag is to indicate the reason for the equipment being isolated, which the tag was completed by and the date it was completed. The workplace should have ‘Out of Service’ and ‘Danger Do Not Operate’ tags available in an accessible location, when required. Equipment must only be returned to service when the defect or condition which necessitated its removal for service has been repaired or corrected. Tags and isolation devices are to be removed and the equipment must only be re-connected and activated according to specific requirements for the equipment.

Self-check 4	Written test
---------------------	---------------------

Name..... ID..... Date.....

Directions: Answer all the questions listed below.

Part: 1 Choose the correct answer(25)

- Which one of the following is included in disposal of waste?
 - Flushing cleaning chemicals from areas
 - Apturing waste created as part of the cleaning process
 - Alignment with enterprise policies and procedures
 - All
- Waste should be divided into the following?
 - Dry Recyclables
 - Construction and demolition waste
 - Biodegradable waste
 - All
- Which one of the followings are not characteristics of west?
 - Recyclables
 - Un used at all
 - Degradable
 - A and C
- Store maintenance items and equipment may include
 - Counting items back into store Storing equipment
 - Replenishing consumables that have been used
 - Requisitioning additional materials, equipment and items needed
 - All

Part 2- Write true if the statement is correct and false if it is incorrect.

1. If the battery is fully charged, it should read 12.6 volts or higher while testing with voltmeter.
2. While testing battery terminals we need to turn of the engine ignition.
3. A hydrometer is used to test the state of charge of a battery cell.
4. Some battery manufacturers rate their batteries in watt-hours

Note: Satisfactory rating - 25 points and Unsatisfactory - below 25 points.

You can ask you teacher for the copy of the correct answers.

Page 85 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1 September, 2022
----------------------	--	---	---------------------------------------

Reference Materials

Books:

- Tom Denton. (2011). Automotive mechanical and electrical system (1st Edition) (Access date 01/05/2023)
- Meggar.(2009) Battery testing guide (3rd Edition) (Access date 02/05/2023)

Web addresses:

- [http://www.tx.nrcs.usda.gov/technical/pmc/docs/ecs580\(August29/2022\).](http://www.tx.nrcs.usda.gov/technical/pmc/docs/ecs580(August29/2022).) (access date 30/05/2023)
- <https://www.google.com/search?q=Tagging+unserviceable+equipment+and+identifying+faults&oq=Tagging+unserviceable+equipment+and+identifying+faults&aqs=chrome..69i57.6392j0j15&sourceid=chrome&ie=UTF-8> (access date 30/05/2023)
- <https://www.google.com/search?q=collecting+and+storing+reused+materials+pdf&oq=Collecting+and+storing+reused+materials&aqs=chrome..69i57j33i160j33i15i22i29i30.6280j0j15&sourceid=chrome&ie=UTF-8>(access date 01/05/2023)
- <https://mohua.gov.in/upload/uploadfiles/files/chap8.pdf> (access date 03/05/2023)
- <https://www.wur.nl/en/research-institutes/food-biobased-research/research-in-the-spotlight/waste-a-valuable-resource-for-performance-materials/recycled-materials-properties-and-standards.htm> (access date 04/05/2023)
- https://www.1800gotjunk.com/us_en/what-we-take/scrap_metal (access date 04/05/2023)

Videos link address

- <https://www.youtube.com/watch?v=S3FB8GY2ZyQ&pp=ygUXaG93IHRvIHRlc3QgY1IgQnR0ZXJpZXM%3D> (access date 29/04/2023)
- <https://www.youtube.com/watch?v=Ait054e0Yo&pp=ygUaYmF0dGVyeSBjaGFyZ2luZyBwcm9jZWRR1cmU%3D> (access date 29/04/2023)



- <https://www.youtube.com/watch?v=gffnkJQxRAg&pp=ygUZc2VyaWVzIGJhdHRlcnkgY29ubmVjdGlvbG%3D%3D> (access date 30/04/2023)
- <https://www.youtube.com/watch?v=9n0oo2hHZv8&pp=ygUicGFyYWxsZWwg2VyaWVzIGJhdHRlcnkgY29ubmVjdGlvbG%3D%3D> (access date 30/04/2023)
- <https://www.youtube.com/watch?v=sTkWmUEqQHk&pp=ygUZYMf0dGVyeSBqdW1waW5nIHByb2NlZHVyZQ%3D%3D> (access date 01/05/2023)
- <https://www.youtube.com/watch?v=ahLNvQapnyk&pp=ygUZYMf0dGVyeSB0ZXJtaW5hbCBjbGVhbmluZW%3D%3D> (access date 02/05/2023)
- <https://www.youtube.com/watch?v=5rsECklzqwU&pp=ygUkc2lkZSBwb3N0IGJhdHRlcnkgdGVybWluYWwgZXh0ZW5kZXI> (access date 03/05/2023)
- <https://www.youtube.com/watch?v=tsJUuLu1cw0&pp=ygUeYmF0dGVyeSBsb2FkIHRLc3RlciBob3cgdG8gdXNI> (access date 04/05/2023)

ACKNOWLEDGEMENT

Ministry of Labor and Skills and Ministry wishes to extend thanks and appreciation to the many representatives of TVET instructors and respective experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Page 88 of 90	Ministry of Labor and Skills Author/Copyright	Natural Resources Conservation and Development Level – I	Version -1
			September, 2022

The experts who developed the learning guide

No	Name	Qualification	Educational background	Region	Phone number	E-mail
1	Degaga Kumera	Bsc	Agricultural Engineering	Alage	+251992573882	dagaagakumarra@gmail.com
2	Gemeda Tsegaye	Bsc	Agricultural Mechanization Engineering	Agarfa	+251955231495	gideonaron81@gmail.com
3	Firomsa Tasfaye	Bsc	Agricultural Engineering	Holota	+251932498778	fromsatesfaye@gmail.com
4	Wabi Abdisa	Msc	Agricultural and bioprocessing engineering	Alage	+251911818926	Wabia180@gmail.com
5	Destawu Alemu	BSc	Agricultural and bioprocessing engineering	Agarfa	+251988417848	destawalex@gmail.com
6	Gashawu Abebe	BSc	Agricultural Mechanization Engineering	Alage	+251910032109	abebegashawu@gmail.com
7	Abayine Awake	BSc	Agricultural Mechanization Engineering	Alage	+251920075051	Abayaweke28@gmail.com
8	Epherem Sertse	BSc	Agricultural Mechanization Engineering	Alage	+251966002891	efremsertse30@gmail.com