9

INDUSTRIAL ARTS: AUTOMOTIVE (SERVICING AUTOMOTIVE BATTERY)

Learner's Material

Department of Education
Republic of the Philippines

Technology & Livelihood Education – Grade 9
Industrial Arts: Automotive - (Servicing Automotive Battery)
Learner's Material
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SERVICING AUTOMOTIVE BATTERY

Servicing Automotive Battery

Content Standard	Performance Standard
The learner demonstrates understanding of the principles in servicing the automotive battery	The learner independently performs servicing automotive battery

I. INTRODUCTION

This module contains information and suggested learning activities on Servicing Automotive Batteries. It includes instructions and procedure on how to test automotive battery, remove and replace batteries, service and charge batteries and jump start vehicle.

Completion of this module will help you understand the succeeding module on Test and Repair Wiring and Lighting System.

This module consists of four learning outcomes. Each learning outcome contains learning activities with instruction sheets. Before you follow the instruction, read the information sheets and answer the self-check and activities provided to assess your competence by your teacher. He or she will check if you have acquired the knowledge necessary to perform the skill portion of the particular learning outcome.

OPERATION AND SAFE HANDLING OF DIFFERENT TYPES OF BATTERY

- Identify main components of batteries
- Classify types of batteries
- Observe safe handling of batteries
- Identify hazards associated with batteries

PRE/DIAGNOSTIC ASSESSMENT

Direction: To determine prior learning, select the correct answer by writing the letter on the blank provided on each number.

_____1. The battery is an electro-chemical device, this means the battery
a. makes chemicals by electronic means.
b. uses chemicals to provide electricity.
c. has non-chemical plates.
d. does not use an electrolyte.

_____2. The battery performs the following EXCEPT
a. supplies current to crank the engine.
b. supplies current when the charging system cannot handle the load.
c. supplies current to the ignition system with the engine is off.

d. supplies current to the ECM while the engine is off.

_____3. When working around the battery, be sure to:
a. disconnect the negative terminal first.
b. disconnect the positive terminal first.
c. never disconnect the terminals.
d. a and b.

_____4. A type of battery which do not have removable caps.
a. maintenance free battery
b. battery with caps
c. 3A battery
d. b and c

_____5. This type of hydrometer is similar to ball type coolant hydrometer.
a. ball hydrometer
b. flat hydrometer
c. barometer
d. a and b

_____6. A type of hydrometer in which the state of charge marks on the float stem to show the electrolyte specific gravity.
a. ball type hydrometer
b. float hydrometer
c. a and b
d. none of the above

_____7. The indication if the battery is fully charge when using ball hydrometer.
a. all balls float
b. no balls float
c. a and b
d. none of the above

_____8. The more fully charge the battery is, the higher the float indicating the state of charge of:
a. float hydrometer
b. ball hydrometer
c. a and b
d. all of the above

_____ 9. The more balls float, the higher the state of charge is
a. ball hydrometer
b. float hydrometer
c. a and b
d. none of the above

_____10. When disconnecting the battery, the correct tools to use are:
a. box wrench
b. open wrench
c. battery pliers
d. a and c

INFORMATION SHEET 1
BATTERY CONSTRUCTION AND OPERATION

DESCRIPTION

An automotive battery is a type of rechargeable battery that supplies electric energy to an automobile. Usually this refers to an SLI battery (*starting, lighting, ignition*) to power the starter motor, the lights, and the ignition system of a vehicle's engine. An automotive battery may also be a traction battery used as the main power source of an electric vehicle.

Automotive SLI batteries are usually lead-acid type, and are made of six galvanic cells in series to provide a 12 volt system. Each cell provides 2.1 volts for a total of 12.6 volt at full charge. Heavy vehicles, like highway trucks or tractors, often equipped with diesel engines, may have two batteries in series for a 24-volt system, or may have parallel strings of batteries.

Lead-acid batteries are made of positive plates of lead peroxide (PbO_2), and negative plates of sponge lead (Pb) and which are submerged in electrolyte solution of 30-35% sulfuric acid (H_2SO_4) and 60-65% water (H_2O). This composition causes a chemical reaction that releases electrons which flow through conductors to produce electricity. When the battery discharges, the acid of the electrolyte reacts with the materials of the plates, changing their surface to lead sulfate. When the battery is recharged, the chemical reaction is reversed: the lead sulfate converted into lead oxide and lead.

Recycling automotive batteries reduce resources required to manufacture new batteries. It also prevent improper disposal of toxic waste.

TYPES OF BATTERY

The following are two types of automotive batteries. The “Low Maintenance” battery on the left has removable caps so the battery’s state of charge can be checked; adding distilled water if needed. The "Maintenance Free" battery (lead acid or alkaline) is sealed and does not require adding with distilled water. Its electrolyte level does not change because they do not produce much gas.

Fig. 1. Two types of Automotive Battery. The low maintenance battery (left) and the maintenance free battery (right). (www. google. com.ph.)

BATTERY CONSTRUCTION

The battery case is a molded plastic that provides enclosure to the battery parts. Inside the battery are number of plates molded to plate straps to form plate groups. The negative plate group and positive plate group with porous separator in between them. The porous separator prevents the positive and negative plates from touching one another. It also allows electrolyte to circulate between them. When these two plate groups are assembled together, it forms an element. The elements fit into compartments or partitions in the battery case. When this elements are immersed in a battery solution called electrolyte (water and sulfuric acid), it can form into a voltaic cell of two volts.

Heavy lead connectors are attached to the cell terminals that connect the cells in series. The battery voltage is determined by the number of cells. A twelve-volt battery has six cells and a six-volt battery has three cells. A plastic cover forms the top of the battery case or box.

Some batteries have openings in their cover with filler plugs or vent caps that are removable for adding water. Maintenance-free batteries do not have removable caps.

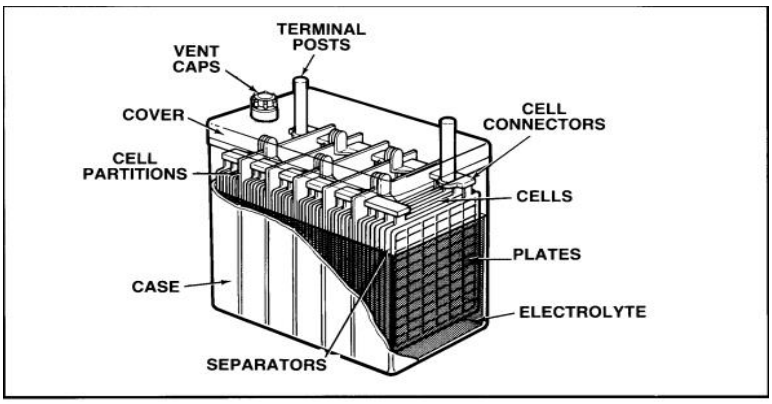


Fig. 2. Parts of Automotive Battery. *(Toyota Motor Sales, U.S.A. ,Inc.)*

PARTS OF THE BATTERY:

1. Vent caps – are plugs that covers the vent holes and remove when checking the battery solution or electrolyte.
2. Terminal posts – are positive and negative terminals where the battery cables are connected.
3. Cell connectors – are terminals connecting the battery cells in series.
4. Cells – are composed of positive and negative plates.
5. Plates – are positive (PbO2) and negative (Pb) plates connected together by separate plate straps.
6. Electrolyte – is a solution of sulfuric acid diluted with distilled water.
7. Separators – prevents the positive and negative plates from touching one another.
8. Case – is a molded plastic that provides enclosure to the battery parts.
9. Cell partition – where the two plates groups are assembled together.
10. Cover – acts as a covering of the battery parts.

WORKING SAFELY ON BATTERIES

Observe the following safety measures when working with batteries.

The sulfuric acid in the electrolyte is very corrosive. It can damage clothes. It can cause serious burns on human skin. If you get battery acid on your skin, flush it at once with water. Wear eye protector when testing or charging a battery. If the battery acid (electrolyte) gets into your eyes, flush them with water at once. It

can cause blindness if it gets into the eyes. Go to the school physician or nearest hospital for medical attention.

1. When disconnecting a battery, always disconnect the negative or ground terminal/ cable first.

2. If the battery has vent caps, make sure the vent holes are open before charging. Cover the vent holes with a damp cloth. Discard the cloth after the battery is charged.

3. Never lean over a charging battery, gasses or fumes emitted and inhaled are hazardous to your health.

4.Do not charge a frozen maintenance-free battery because when the charge indicator dot shows light yellow or clear the battery could explode.

5. Lift the case straight up. Tipping it to one side may allow the electrolyte to leak out.

6. To carry the battery case, put both hands under the case.

7. Do not overtighten the battery hold-down clamp through bolt and nut. This may lead the battery clamp to compress the battery and may cause damage to it.

SELF – CHECK 1

BATTERY CONSTRUCTION AND OPERATION

Direction: Select the correct answer to each question and write the letter on the blank provided for.

_____1. The battery is an electro-chemical device, this means the battery
a. makes chemicals by electronic means.
b. uses chemicals to provide electricity.
c. has non-chemical plates.
d. does not use an electrolyte.

_____2. The battery performs the following EXCEPT:
a. supplies current to crank the engine
b. supplies current when the charging system cannot handle the electrical load
c. supplies current to the ignition system with the engine is off.
d. supplies current to the ECM while the engine is off

_____3. When working around the battery be sure to:
a. disconnect the negative first
b. disconnect the positive first
c. never disconnect the terminals
d. a and b

_____4. A type of battery which do not have removable caps.

a. maintenance free battery
b. low maintenance battery
c. 3A battery
d. b and c

_____ 5. This type of hydrometer is similar to ball type coolant hydrometer.

a. ball hydrometer
b. flat hydrometer
c. barometer
d. a and b

TESTING OF AN AUTOMOTIVE BATTERY

- Select appropriate test equipment
- Test different types of battery
- Analyze test results
- Compare battery test result based on manufacturer's specification
- Observe safety at all times while doing battery test
- Report findings of test results

PRE/DIAGNOSTIC ASSESSMENT 2

Directions: This checklist determines your initial level of knowledge and mastery about testing the battery. Accomplish the following checklist.

SELF-RATING COMPETENCY CHECKLIST IN TESTING THE BATTERY

COMPETENCY	I cannot do this yet	I am learning how to do this.	I can do this but I need to learn more and improve.	I can do this very well
	Pre	Pre	Pre	Pre
➢ Uses the hydrometer				
➢ Reads the discharge state of the battery				
➢ Adds distilled water to the battery				
➢ Uses the tools or materials and equipment appropriately				
➢ Observes safety measures in testing the battery				

INFORMATION SHEET 2

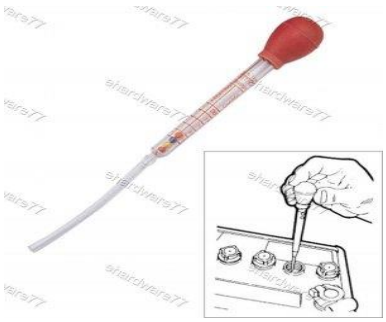
TESTING THE BATTERY

WAYS OF TESTING THE BATTERY

Batteries are tested through different ways: the state of charge, the condition of the cell and the capacity of the battery's performance. In a low maintenance or vent-cap battery, the state of charge is determined by a hydrometer. The hydrometer is like a syringe. It is made of glass tubing with rubber squeezer at the top-end and a short rubber hose at the front-end. Inside the glass tubing is a float with corresponding reading scale. When the hydrometer is inserted in the vent hole of the battery and the rubber squezzer is pressed, it draws battery solution. The float moves to determine the specific gravity or the state of charge of the battery.

The cell of the battery can be checked by using the cell tester. It determines wether the cells are in good or bad condition. Inside the tester is the color coded indicator that when the pointed portion of the tester is pressed to the cell connectors, the pointer moves according to the condition of the cells.

The battery capacity test or performance test determines the overall ability of the battery to provide and maintain minimum electrical power. The battery capacity test can be done by using a capacity tester connected to the battery. The tester has control knob to adjust the load in order for the battery to give its output capacity. In this way, serviceability of the battery is determined.



TWO TYPES OF HYDROMETER

1. Ball hydrometer

The **Ball hydrometer** is similar to the ball type coolant hydrometer. To perform a ball hydrometer test, insert the rubber tube into the vent hole of the battery, then squeeze and release the bulb. Electrolyte will be drawn into the tube. If all balls float, the battery is fully charged. If none, the battery is discharged. The more balls that floats, the higher the battery state of charge.

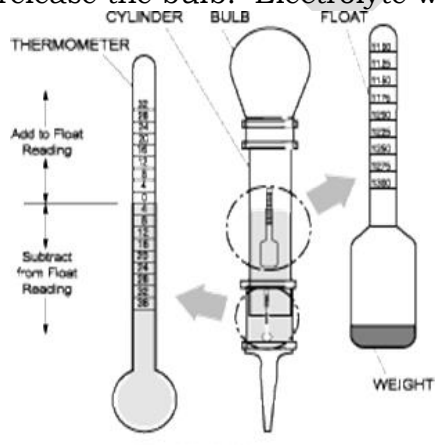


Fig. 3. Ball Hydrometer

(http://www.ecrater.com)

2. Float hydrometer

The **Float hydrometer** is used in the same way as the ball hydrometer. It will float as the electrolyte is drawn from the battery. Marks on the float stem

show the electrolyte specific gravity. This indicates the battery state of charge. The more fully charged the battery, the higher the float.

Fig. 4. Float Hydrometer
http://www.freeasestudyguides.com/battery-specific-gravity-test.html&h

As a precaution, make sure no electrolyte drips on the car because it will damage the car body and paint. It should not also touch your body because it will irritate your skin and damage your clothes.

The following table shows the relationship between specific gravity and state of charge.

SPECIFIC GRAVITY	STATE OF CHARGE
1.265 -1.299	**Fully charged battery**
1.235 -1.265	**Three – fourths charged**
1.205 -1.235	**One-half charged**
1.170 -1.205	**One-fourth charged**
1.140-1.170	**Barely Operative**
1.110-1.140	**Completely discharged**

The table below provides relationship between the specific gravity and temperature at freezing point. The temperature affects battery efficiency.

SPECIFIC GRAVITY	STATE OF CHARGE Freezing Point in Degrees F
1.100	+18 [-8.2]
1.160	+ 1 [-7.2]
1.200	-17 [-27.3]
1.220	-31 [-35]
1.260	-75 [-59.4]
1.300	-95 [-70.5]

ACTIVITY SHEET 2

TESTING AUTOMOTIVE BATTERY

SUPPLIES AND MATERIALS

- Laboratory gown or Apron
- Safety goggles
- Gloves
- Distilled water

TOOLS

- Float type hydrometer
- Battery cell tester
- Multi-tester or Load tester

EQUIPMENT

- Charged and discharged battery

A. HYDROMETER TEST

PROCEDURE:

Your teacher will discuss with you the proper procedure through the aid of pictures and actual battery.

1. Remove all battery vent caps.
2. Check the electrolyte level, it must be high enough to draw the correct amount of battery solution (electrolyte) into the hydrometer.
3. Squeeze the suction rubber bulb and insert the pick-up tube into the battery hole just enough to draw the electrolyte solution.
4. Slowly release the suction rubber bulb. Draw in enough solution until the float is freely suspended in the hydrometer glass barrel. Hold the hydrometer in vertical position.
5. Read the electrolyte level on eye level as shown in the figure below.
6. List the test result.

NOTE:

- Please see table of interpretation on the specific gravity and state of charge on page 8.

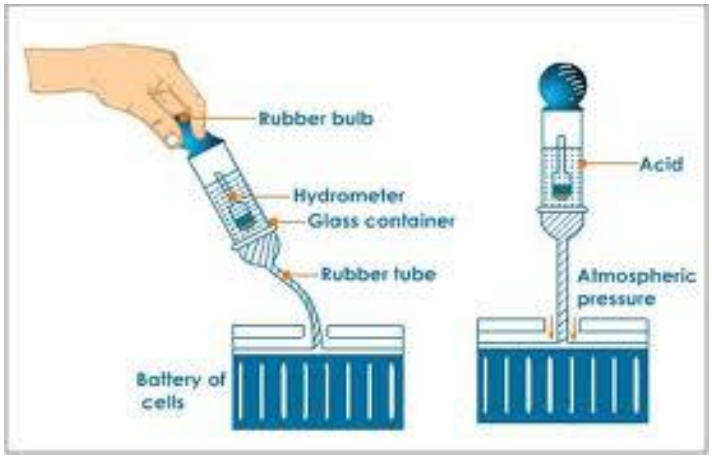


Fig. 5a.Drawing electrolyte from the battery

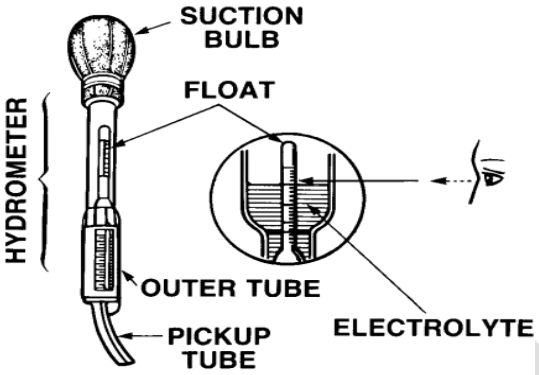


Fig. 5b. Checking specific gravity of electrolyte using float hydrometer.
(Toyota Motor Sales, U.S.A)

B. BATTERY CELL TEST

PROCEDURE:

1. Disconnect the negative and positive terminals of the battery.
2. Remove the battery from the vehicle and place it on the bench.

   Note: The battery can also be tested on the vehicle but safety precautions must be observed.

3. Cover the battery vent plugs with a damp cloth.
4. Place the battery cell tester on the cell connector of the battery.

   Note: This test can be performed in a low-maintenance battery.

5. Read the cell tester indicator if the battery cell being tested is good (usually green color) or bad (usually red color).
6. Replace the battery if cells are defective.

C. BATTERY LOAD TEST

1. Connect a battery or starter tester as shown below.
2. With the load control knob in the off position, set the voltmeter selector switch to the range closest to 12 volts.

3. Adjust the control knob clockwise until the ammeter reads three times the battery's ampere hour rating.

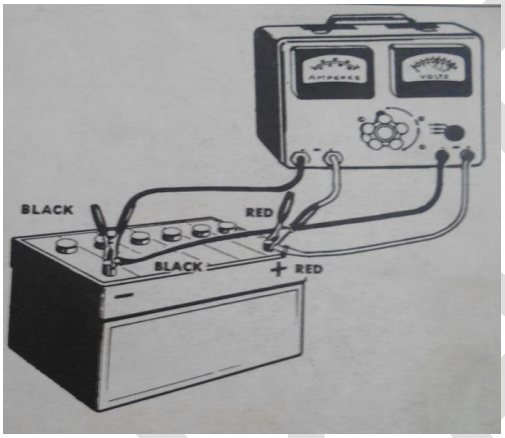
4. Hold the load constant for 15 seconds, read the voltmeter scale and reduce the load by turning the knob to off.

   Note: a similar test can be made using a voltmeter across the battery while cranking the engine with the starter motor to provide a load.

   Safety precaution: Ignition should be isolated.

5. A voltmeter reading of not less than 9.5 volts for a 12-volt battery indicates that the battery's output capacity is good and that the battery can be placed back in the service.

6. If the reading is below 9.5 volts for a 12-volt battery, a possible defective condition is indicated.



Petersen's **MINI-TRUCK REPAIR MANUAL . Petersen Publishing Co. 849 Sunset Blvd. LA, Cal., USA C1976 p. 1-4**

Fig. 6. Battery capacity/load test

SELF- CHECK 2

TESTING THE BATTERY

Direction: This checklist determines your level of knowledge and mastery about testing the battery. Accomplish the following checklist.

SELF-RATING COMPETENCY CHECKLIST IN TESTING THE BATTERY

COMPETENCY	I cannot do this yet	I am learning how to do this.	I can do this but I need to learn more and improve.	I can do this very well
	Post	Post	Post	Post
Uses the hydrometer				

Reads the discharge state of the battery				
Adds distilled water to the battery				
Uses the tools, materials and equipment appropriately				
Observes safety measures in testing the battery				

SUMMATIVE ASSESSMENT

A. WRITTEN TEST

Direction: Answer the following questions by writing the letter of the best answer in your activity notebook.

1. It is a lead-acid type of rechargeable battery .
   a. automotive battery
   b. button battery
   c. chip battery
   d. flashlight battery

2. When the battery's negative and positive plates are assembled together, it becomes:
   a. element
   b. plate group
   c. connectors
   d. partitions

3. The negative plate of the battery is made of :
   a. electrolyte (H_2SO_4)
   b. porous lead (Pb)
   c. non-porous lead (PbO_2)
   d. water (H_2O)

4. When an automotive battery lacks water, add:
   a. distilled water
   b. electrolyte
   c. mineral water
   d. oxygenated water

5. In order for the battery electrolyte not to leak out of the battery case, it must be:
   a. asphalted
   b. pasted
   c. sealed
   d. Welded

6. Why is there a need to wear goggles when testing or charging a battery?
   a. for visual acuity
   b. for visual clarity
   c. for visual condition
   d. for visual protection

7. In hydrometer testing of the battery, a specific gravity of 1.265-1.299 indicates that the battery is:
   a. fully charged
   b. three-fourth charged
   c. half-charged
   d. completely discharged

8. When reading a hydrometer, it must be at:
   a. chin level
   c. mouth level

b. eye level
d. nose level

9. When testing a battery with hydrometer, remove first the battery:
   a. cables
   b. clamps
   c. terminals
   d. vent caps

10. The battery capacity determines the battery:
   a. input load condition
   b. internal condition
   c. external load condition
   d. output load condition

B. PERFORMANCE ASSESSMENT

Direction: Below is the performance assessment that serves as your guide in evaluating the following skills that you need to perform. Please be guided with the tasks and its corresponding score and performance level.

Name : _____ **Year & Section:** _____

Course: _____ **Time Allotment:** _____

Module Title: _____ **Grading Period** _____

Unit of Competency SERVICE AUTOMOTIVE BATTERY	Tasks	Date	Time		Score	Performance Level
			Begun	Finished		
LO1 Explain the operation and safe handling of different types of battery	1. Identify components of battery 2. Classify types of battery 3. Proper handling of batteries					
LO2 Demonstrate testing of an automotive battery	Test an automotive battery					

Average: _____ _____

L E V E L O F P E R F O R M A N C E

RATING SCALE:	**Total Score**	**Numerical Rating**	**Descriptive Rating**
	21 – 25	**91 - 100**	**Outstanding**
	16 – 20	**86 - 90**	**Very Good**

11 – 15	**81 - 85**	**Good**
06 - 10	**76 - 80**	**Fair**
01 - 05	**71 - 75**	**Needs Improvement**

WHAT IS YOUR SCORE? _____