

**AUTOMOTIVE INDUSTRY TRAINING
RETAIL, SERVICE AND REPAIR
AUR05**

Learning & Assessment Resource

AURE218676A

TEST, SERVICE AND CHARGE BATTERIES



State Training Services

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Pre Requisite Units of Competence

Nil

Overview

This unit covers the competence to service, remove, replace and charge automotive batteries.

The unit includes identification and confirmation of work requirement, preparation for work, servicing, testing and charging of batteries, jump-starting of vehicle/equipment and completion of work finalisation processes, including clean-up and documentation.

All work and work practices must be undertaken to regulatory and legislative requirements. It is applicable in both a learning and assessment pathway and an assessment only pathway.

This competence is performed in the context that all materials and equipment needed to carry out this function have been provided, including learning materials, learning programs and learning resources.

Elements of Competence

To achieve competency in this unit you must demonstrate your ability to:

1. Prepare for work;
2. Service batteries;
3. Charge batteries;
4. Test batteries;
5. Jump-start vehicle; and
6. Clean up work area and maintain equipment.

1.0 Battery Tutorial

You have most likely heard the term K.I.S.S. (Keep It Simple, Stupid). This resource is going to attempt to explain how lead acid batteries work and what they need without providing you with a large amount of needless technical data. Some battery manufacturer's data will vary somewhat so for this reason some of the information will be generic.

The commercial use of the lead acid battery is over 100 years old. The same chemical principal is being used to create energy that our Great, Great, Grandparents may have used.

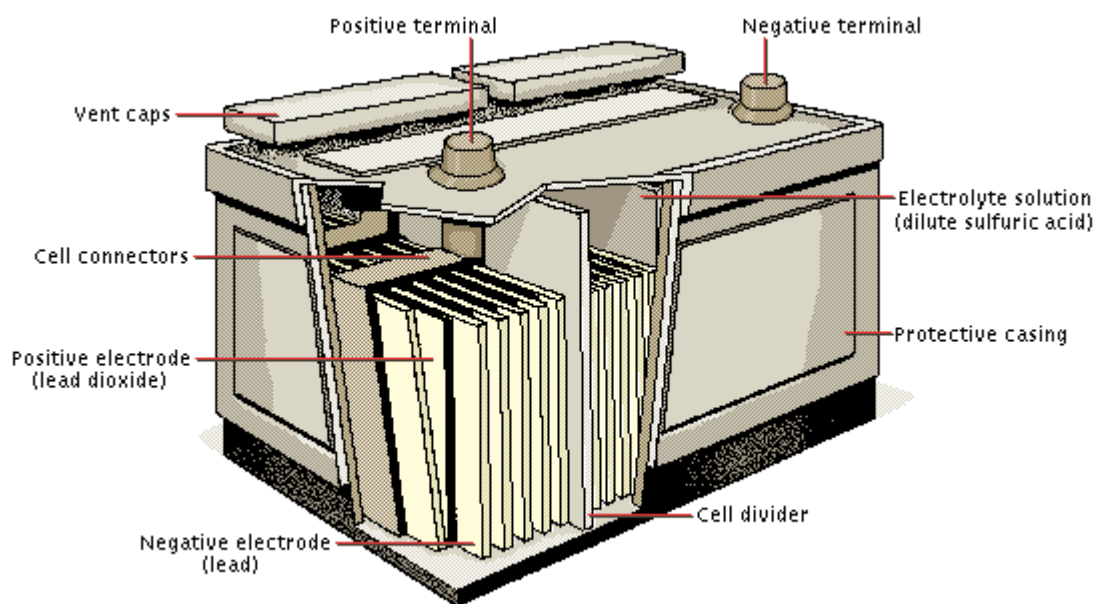


Figure 1

A battery is like a piggy bank. If you keep taking out and putting nothing back you soon will have nothing.

Present day battery power requirements are huge. Look at today's vehicle and all the electrical devices that must be supplied. Electronics require a source of reliable power. Poor battery condition can cause expensive electronic component failure. Did you know that the average car has 5 kgs of wire in the electrical system? Look at recreational vehicles, caravans and boats with all the electrical gadgets that require power. They only used to have a single 12-volt house battery. Today it is standard to have 2 or more house batteries powering inverters up to 4000 watts.

Average battery life has become shorter as energy requirements have increased. Life span depends on usage; 6 months to 48 months, yet only 30% of all batteries actually reach the 48-month mark.

2.0 The Basics

Lead-acid batteries, invented in 1859 by French physicist Gaston Planté, are the oldest type of rechargeable battery. Despite having the second lowest energy-to-weight ratio (next to the nickel-iron battery) and a correspondingly low energy-to-volume ratio, their ability to supply high surge

currents means that the cells maintain a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in cars, to provide the high current required by automobile starter motors.

2.1 Plates

The principle of the lead acid cell can be demonstrated with simple sheet lead plates for the two electrodes. However such a construction would only produce around an amp for roughly postcard sized plates, and it would not produce such a current for more than a few minutes.

Gaston Planté realised that a plate construction was required that gave a much larger effective surface area. Planté's method of producing the plates has been largely unchanged and is still used in stationary applications.

The Faure pasted-plate construction is typical of automotive batteries. Each plate consists of a rectangular lead grid alloyed with antimony or calcium to improve the mechanical characteristics. The holes of the grid are filled with a mixture of red lead and 33% dilute sulfuric acid. (Different manufacturers have modified the mixture). The paste is pressed into the holes in the plates which are slightly tapered on both sides to assist in retention of the paste. This porous paste allows the acid to react with the lead inside the plate, increasing the surface area many fold. At this stage the positive and negative plates are similar; however expanders and additives vary their internal chemistry to assist in operation when in use. Once dry, the plates are then stacked together with suitable separators and inserted in the battery container. An odd number of plates are usually used, with one more negative plate than positive. Each alternate plate is connected together. After the acid has been added to the cell, the cell is given its first forming charge. The positive plates gradually turn the chocolate brown colour of lead dioxide, and the negative turn the slate gray of 'spongy' lead. Such a cell is ready to be used.

One of the problems with the plates in a lead-acid battery is that the plates change size as the battery charges and discharges, the plates increasing in size as the active material absorbs sulfate from the acid during discharge, and decreasing as they give up the sulfate during charging. This causes the plates to gradually shed the paste during their life. It is important that there is plenty of room underneath the plates to catch this shed material. If this material reaches the plates a shorted cell will occur.

2.2 Separators

Separators are used between the positive and negative plates of a lead acid battery to prevent short circuit through physical contact, mostly through dendrites ('treeing'), but also through shedding of the active material.

Separators obstruct the flow of ions between the plates and increase the internal resistance of the cell.

Various materials have been used to make separators:

- wood
- rubber
- glass fiber mat

-
- cellulose
 - sintered PVC
 - microporous PVC/polyethylene.

An effective separator must possess a number of mechanical properties; applicable considerations include permeability, porosity, pore size distribution, specific surface area, mechanical design and strength, electrical resistance, ionic conductivity, and chemical compatibility with the electrolyte. In service, the separator must have good resistance to acid and oxidation. The area of the separator must be a little larger than the area of the plates to prevent material shorting between the plates. The separators must remain stable over the operating temperature range of the battery.

(The Basics sourced from Wikipedia 2008)

3.0 Safety

Safety must be a prime consideration when anyone is working around and with batteries. Remove all jewelry. After all you don't want to melt your watchband while you are wearing the watch. The hydrogen gas that batteries make when charging is very explosive. Batteries have been known to explode and drench people in sulfuric acid. This is a good time to use safety goggles because sulphuric acid eats up clothing and you may want to select Polyester clothing to wear, as it is naturally acid resistant. When doing electrical work on vehicles it is best to disconnect the ground cable. Just remember you are messing with corrosive acid, explosive gases and 100's amps of electrical current.

3.1 Battery types, Deep Cycle and Starting

Basically there are two types of batteries; starting (cranking), and deep cycle (marine/golf cart). The starting battery (SLI starting lights ignition) is designed to deliver quick bursts of energy (such as starting engines) and have a greater plate count. The plates will also be thinner and have somewhat different material composition. The deep cycle battery has less instant energy but greater long-term energy delivery. Deep cycle batteries have thicker plates and can survive a number of discharge cycles. Starting batteries should not be used for deep cycle applications. The so-called Dual Purpose Battery is only a compromise between the two (2) types of batteries.

3.2 Wet Cell, Gel-Cell and Absorbed Glass Mat (AGM)

Wet Cell (flooded), Gel Cell, and Absorbed Glass Mat (AGM) are various versions of the lead acid battery. The wet cell comes in 2 styles; serviceable, and maintenance free. Both are filled with electrolyte and I prefer one that I can add water to and check the specific gravity of the electrolyte with a hydrometer. The Gel Cell and the AGM batteries are specialty batteries that typically cost twice as much as a premium wet cell. However they store very well and do not tend to sulfate or degrade as easily or as easily as wet cell. There is little chance of a hydrogen gas explosion or corrosion when using these batteries; these are the safest lead acid batteries you can use. Gel Cell and some AGM batteries may require a special charging rate. I personally feel that careful consideration should be given to the AGM battery technology for applications such as Marine, RV, Solar, Audio, Power Sports and Stand-By Power just to name a few. If you don't use or operate your equipment daily; this can lead premature battery failure; or depend on top-notch battery performance then spend the extra money. Gel Cell batteries still are being sold but the AGM batteries are replacing them in most applications. There is a little confusion about AGM batteries

because different manufactures call them different names; some of the popular ones are sealed regulated valve, dry cell, non spillable, and sealed lead acid batteries. In most cases AGM batteries will give greater life span and greater cycle life than a wet cell battery. Special Note about Gel Batteries: It is very common for individuals to use the term Gel Cell when referring to sealed, maintenance free batteries, much like one would use Kleenex when referring to facial tissue or "Xerox machine" when referring to a copy machine. Be very careful when specifying a battery charger, many times we are told by customer they are requiring a charger for a Gel Cell battery and in fact the battery is not a Gel Cell.

AGM: The Absorbed Glass Matt construction (Figure 1) allows the electrolyte to be suspended in close proximity with the plates active material. In theory, this enhances both the discharge and recharge efficiency. Actually, the AGM batteries are a variant of Sealed VRLA batteries. Popular usage high performance engine starting, power sports, deep cycle, solar and storage battery. The AGM batteries we sell are typically good deep cycle batteries and they deliver best life performance if recharged before the battery drops below the 50 percent discharge rate. If these AGM batteries are discharged to a rate of 100 percent the cycle life will be 300 plus cycles and this is true of most AGM batteries rated as deep cycle batteries.

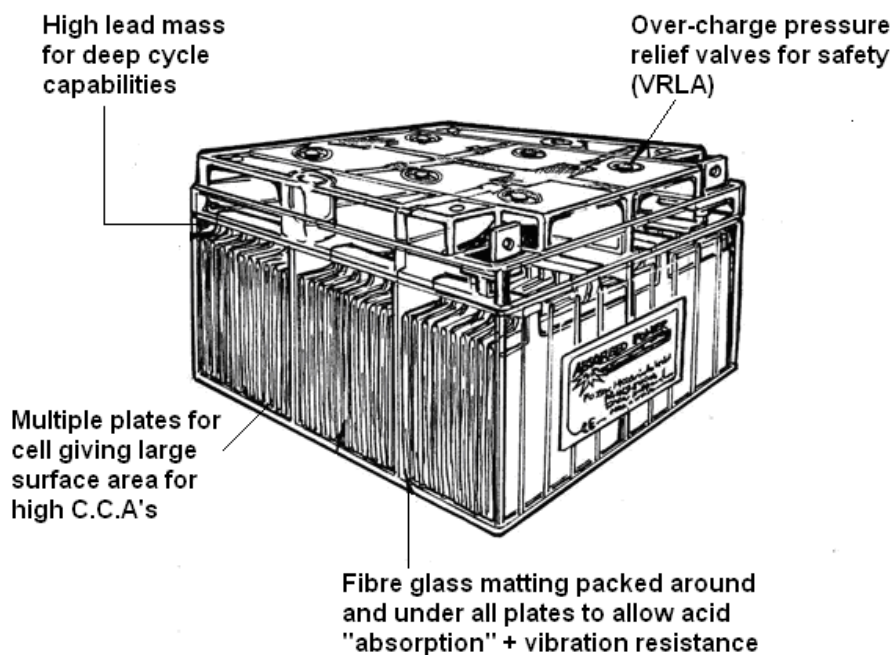


Figure 2

GEL: The gel cell is similar to the AGM style because the electrolyte is suspended, but different because technically the AGM battery is still considered to be a wet cell. The electrolyte in a GEL cell has a silica additive that causes it to set up or stiffen. The recharge voltages on this type of cell are lower than the other styles of lead acid battery. This is probably the most sensitive cell in terms of adverse reactions to over-voltage charging. Gel Batteries are best used in VERY DEEP cycle application and may last a bit longer in hot weather applications. If the incorrect battery charger is used on a Gel Cell battery poor performance and premature failure is certain.

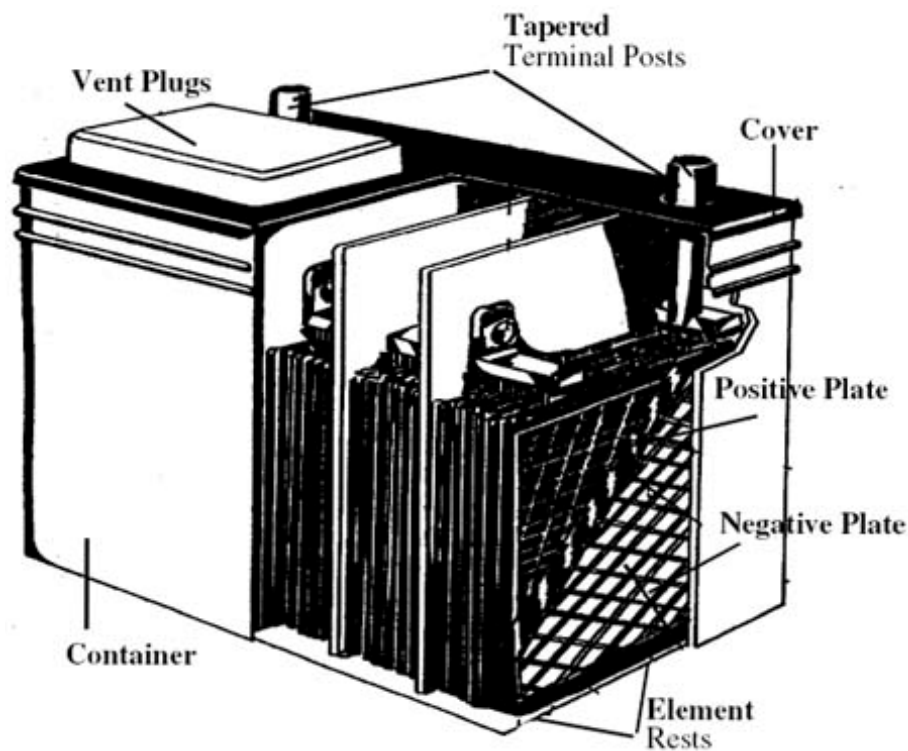


Figure 3

3.3 CCA, CA, AH and RC

CCA, CA, AH and RC what are these all about? Well, these are the standards that most battery companies use to rate the output and capacity of a battery.

Cold cranking amps (CCA) is a measurement of the number of amps a battery can deliver at 0 ° F for 30 seconds and not drop below 7.2 volts. So a high CCA battery rating is good especially in cold weather.

CA is cranking amps measured at 32 degrees F. This rating is also called marine cranking amps (MCA). Hot cranking amps (HCA) is seldom used any longer but is measured at 80 ° F.

Reserve Capacity (RC) is a very important rating. This is the number of minutes a fully charged battery at 80 ° F will discharge 25 amps until the battery drops below 10.5 volts.

An amp hour (AH) is a rating usually found on deep cycle batteries. If a battery is rated at 100 amp hours it should deliver 5 amps for 20 hours, 20 amps for 5 hours, etc.

4.0 Battery Maintenance

Battery Maintenance is an important issue. The battery should be cleaned using a baking soda and water mix; a couple of table spoons to ½ litre of water. Cable connection needs to be clean and tightened. Many battery problems are caused by dirty and loose connections. A serviceable battery needs to have the fluid level checked. Use only mineral free water. Distilled water is best. Don't overfill battery cells especially in warmer weather. The natural fluid expansion in hot weather will push excess electrolytes from the battery. To prevent corrosion of cables on top post batteries use a small bead of silicon sealer at the base of the post and place a felt battery washer over it. Coat

the washer with high temperature grease or petroleum jelly (Vaseline), then place cable on the post and tighten. Coat the exposed cable end with the grease. Most people don't know that just the gases from the battery condensing on metal parts cause most corrosion.

4.1 Battery Testing

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

1. Visual Inspection;
2. State of Charge;
 - a. Specific Gravity;
 - b. Open Circuit Voltage;
3. Capacity or Heavy Load Test.

Note: This does not include the electronic battery tester which has a different test procedure and will be discussed later in this resource.

4.2 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.
- Check for a loose battery hold-down or loose cable connections. Clean and tighten, as needed.
- Check the electrolyte fluid level (Figure 5). 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 overfill.

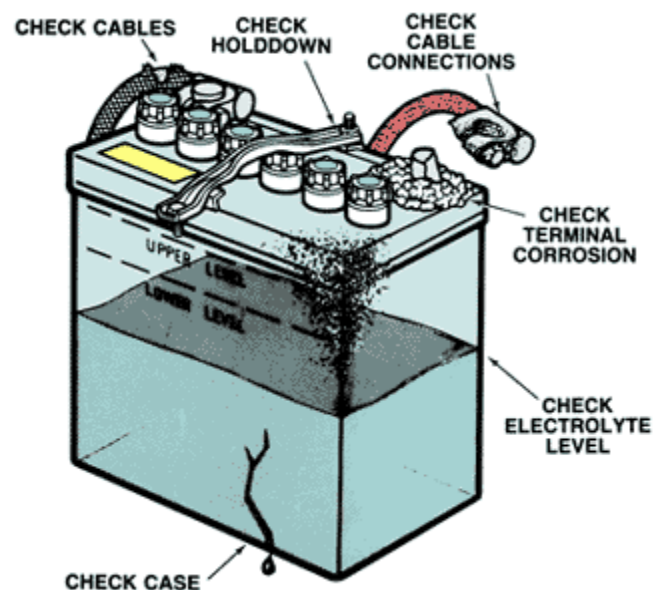


Figure 4

- Check for cloudy or discoloured electrolyte caused by overcharging or vibration. This could cause high self discharge. Correct the cause and replace the battery.



Figure 5

4.3 State Of Charge

The state of charge of a battery can be easily check in one of two ways:

- Specific Gravity Test; and
- Open Circuit Voltage Test.

4.3.1 Specific Gravity

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 seventy."

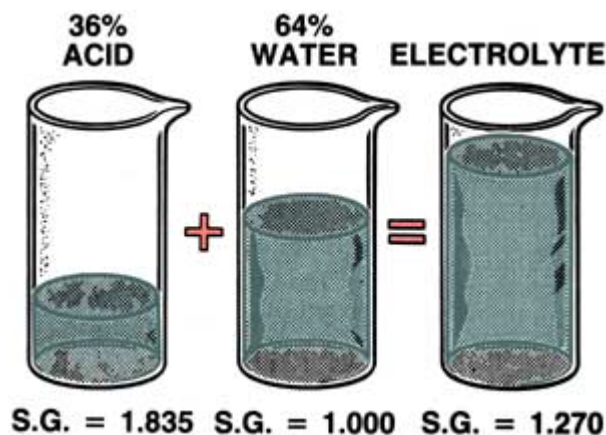


Figure 6

4.3.2 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 (Figure 7). 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.

Cell Readings	Percent Charged
1.270	100 %
1.230	75%
1.190	50%
1.145	25%
1.100	0%

Figure 7

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.

4.3.3 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 that 0.050. In the example below, the highest SG reading is cell #1 while the lowest SG reading is cell #5; the difference is 0.070 which requires battery replacement. Cell #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

Many factors contribute to cell variation; for example, if water was just added to that cell, the cell is then diluted with water resulting is a lower specific gravity reading. Recharging the battery would correct this false reading. In some cases if a battery that has cell variation slightly over the specification and is only about 50% charge, charging the battery at a slow rate of charge (5A) may reduce the cell variation, thus saving the battery.

4.3.4 Specific Gravity Test Procedure (Hydrometer)

- Wear suitable eye protection;
- Remove vent caps or covers from the battery cells;
- Squeeze the hydrometer suction bulb (Figure 8) and insert the pickup tube into the cell closest to the battery's positive (+) terminal;

- Slowly release the bulb to draw in only enough electrolyte 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; and
- Record your readings and repeat the procedure for the remaining cells.

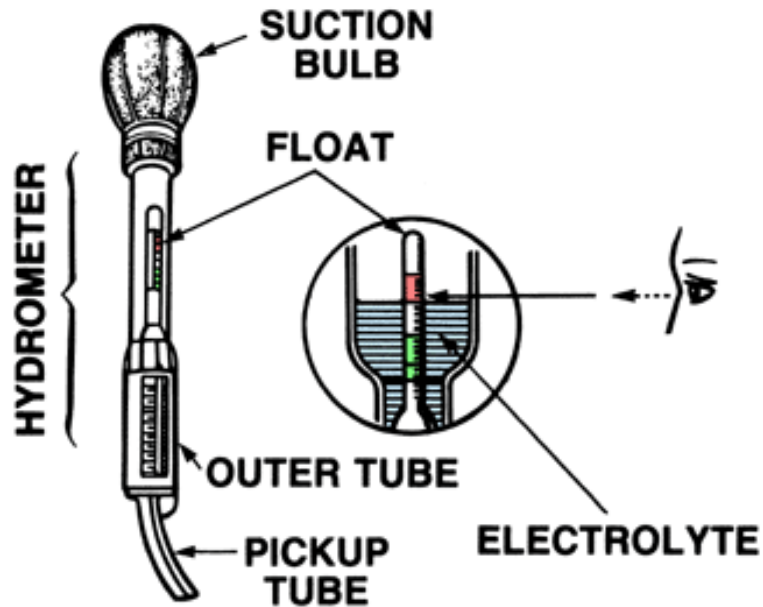


Figure 8

4.3.5 Adjusted Specific Gravity Readings

Temperature correction is needed because specific gravity changes with temperature. Cold thickens the electrolyte and raises the specific gravity. Heat thins the electrolyte and lowers the specific gravity. Hydrometers are calibrated at 26.7°C (80°F). Electrolyte temperatures above or below 26.7°C (80°F) must be adjusted. For every 5.5°C (10°F) increment below 26.7°C (80°F), subtract 0.004 to the hydrometer readings, and for each 5.5°C (10°F) increment above 26.7°C (80°F), add 0.004 to the readings. See the examples below.

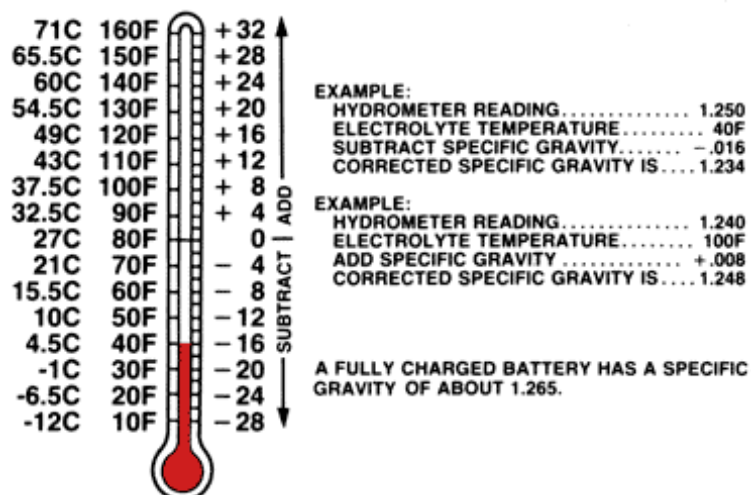


Figure 9

4.4 Specific Gravity Test Procedure (AC Delco Battery with built-in Hydrometer)

- Wear suitable eye protection.
- Observe the built-in hydrometer.

Green Dot is visible: the battery is sufficiently charged for further testing (Heavy Load Test).

Dark Green Dot is visible: the battery needs to be recharged before further testing.

Light or Yellow Dot is visible: replace the battery

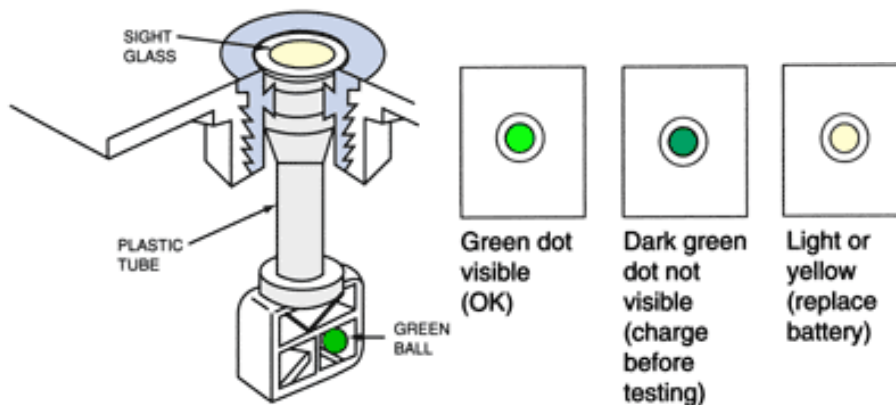


Figure 10

4.5 Open Circuit Voltage

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

- Turn on the headlamps' high beam for several minutes to remove any surface charge; and
- 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.

Note: 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. (Remember: a reading of 12.4 volts or higher

% of charge
12.6v = 100%
12.4v = 75%
12.2v = 50%
12.0v = 25%
11.9v = 0%

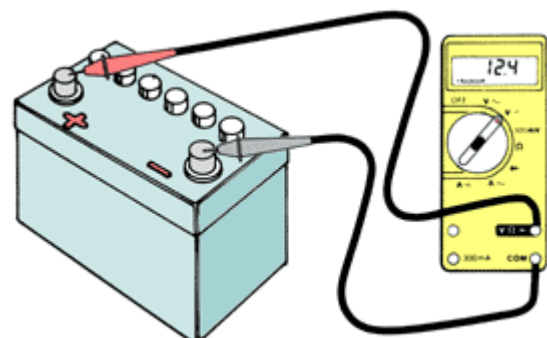


Figure 11

load test the battery, 12.3 volts or less, recharge the battery.)

4.5.1 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 Volt, Amp Tester (VAT) (Figure 12) is used. (Note: the battery must be at least 75% charged before a heavy test can be performed.)

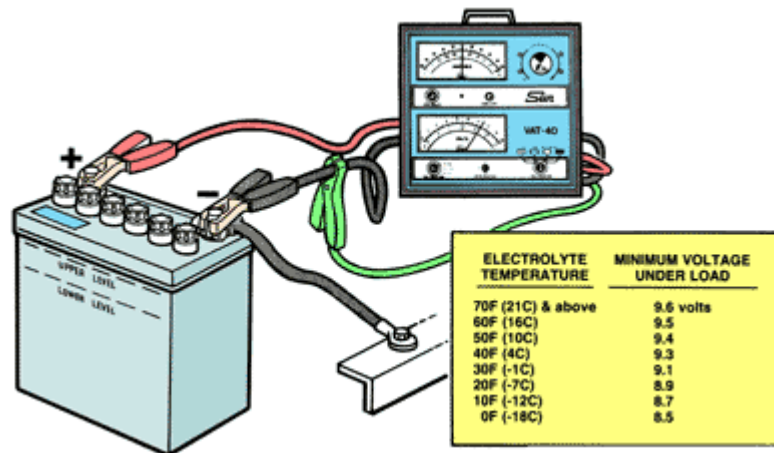


Figure 12

4.6 Capacity Rating

The capacity rating is located on the battery label (Figure 13). 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.



Figure 13

4.7 Heavy Load Test Procedure

- Install the load tester as shown in an earlier slide.
- 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.
- Maintain the load for no more than 15 seconds, and note the voltmeter reading.
- If the voltmeter reading during the test is:

9.6 volts or higher, the battery is good.

9.5 volts or below, the battery is defective and needs replacement.

Note: Results will vary with temperature. Low temperatures will reduce the voltage reading, so the electrolyte should be at 21°C (70°F) or above. If not, use the following conversion table:

Voltage	Temperature
9.6	21°C (70°F) or above
9.5	16° C (60°F)
9.4	10° C (50°F)
9.3	4° C (40°F)
9.1	-1° C (30°F)
8.9	-7° C (20°F)
8.7	-12° C (10°F)
8.5	-18° C (0°F)

4.8 Current Drains

Parasitic drains are the small current drains required to operate various electrical systems, such as the clock, computer memory, or alarms, that continue to work when the car is parked and the ignition is off. All vehicles today have parasitic drains and over time will drain all batteries if not driven or charged periodically. The problem is when the parasitic drain becomes excessive, usually over 35 milliamps.

Unwanted battery drain can also be the reason why a battery keeps discharging. Unwanted battery drain can be a result of excessive parasitic drain, or if the top of the battery is wet or has excessive corrosion, it could create a path between the two battery posts, causing a current drain; usually 0.5 volt potential or higher will result in a battery discharge. This is called Case Drain.

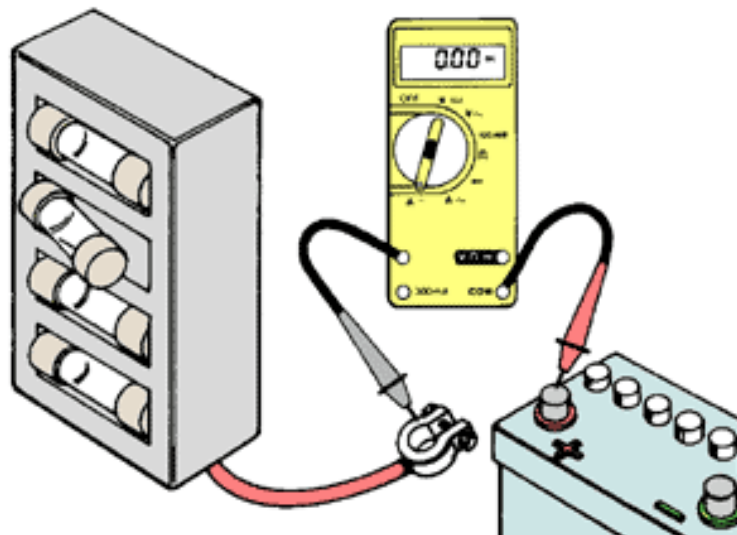


Figure 14

4.9 Parasitic Drain

Check for excessive battery drain or parasitic loads using an ammeter. Make sure all electrical loads are off in the car, doors closed, and the key is out of the ignition switch. Disconnect one of the battery cables from the battery, placing an ammeter in series between the battery post and cable clamp (Figure 15). The current draw reading should be less than 35 milliamps. A reading higher than this (or manufacturer specifications) would indicate excessive battery drain. Something is "on", allowing current to flow running down the battery. Vehicles today typically will draw less than .020 amps (20 milliamps) of current to maintain electronic memories and circuits.

Note: If the battery is disconnected parasitic drains may temporarily increase. Circuits in the engine and body computers are activated and will run until internal timers run out. This reactivation period could be anywhere from a few seconds to almost 30 minutes. Whenever possible avoid disconnecting the battery while performing this test. It is possible to place one lead of the ammeter on the battery post and the other on the battery clamp, while at the same time lifting the battery clamp off the battery post. On side terminal batteries, connect the voltmeter with alligator clips and let sit until the timers run out.

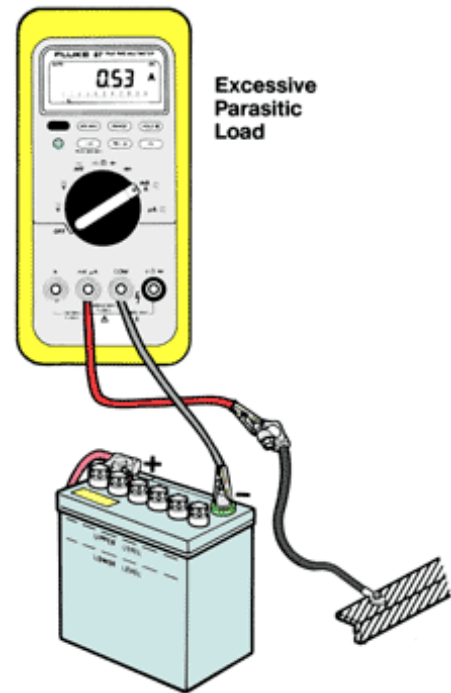


Figure 15

4.10 Battery Discharge / Case Drain

Check for battery discharge (case drain) across the top of the battery using a digital voltmeter. Connect the negative (black) test lead to the battery's negative terminal post, and connect the positive (red) test lead to the top of the battery case (Figure 16). If the meter reads more than 0.5 volt, clean the case top using a solution of baking soda and water. Remove excess water from top of battery.

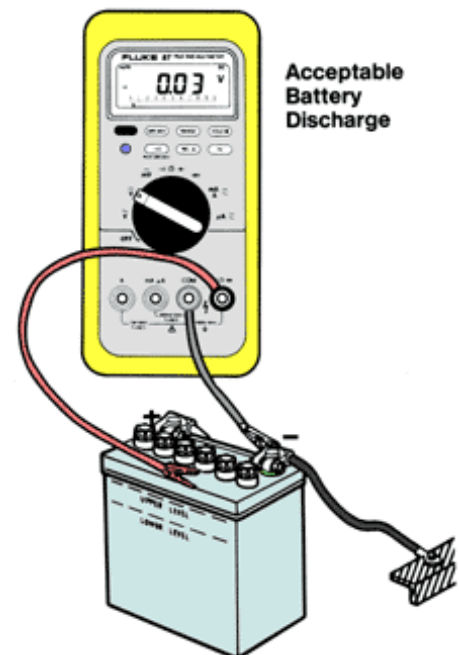


Figure 16

4.11 Battery Clamp - Post Resistance

Resistance between the battery terminal post and the clamp can account for the battery not being completely recharged and is often a problem. Although it may visually look all right, oxidation of the metal or slight corrosion can cause excessive resistance at the connection, thus creating a voltage drop and lowering current flow to the starter. Battery post and clamps should be cleaned at each battery inspection. To check for excessive resistance, perform a voltage drop between the battery terminal post and the clamp (shown below – Figure 17) while cranking the engine. The voltage drop reading

should be 0.0 volts. Any voltmeter reading higher than "zero" volts requires cleaning the connection and rechecking.



Figure 17

5.0 Battery Tester

Digital battery load test equipment (Figure 18) is safe and simple to use while providing an accurate diagnosis in seconds. Battery testers are based on the measurement of battery conductance rather than a load test. They can even test a discharged battery to determine its condition.

5.1 Conductance Test

Conductance is a measurement of the battery's ability to produce current. To measure conductance, the tester creates a small signal that is sent through the battery, then measures a portion of the AC current response. Conductance is a measure of the plate surface available in the battery which determines how much power the battery can supply. As a battery ages, the plate surface can sulphate or shed active material, which adversely affects its ability to perform. In addition, conductance can be used to detect cell defects, shorts, and open circuits, which will reduce the ability of the battery to deliver current.



Figure 18

6.0 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. 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.

A slow charge is 5 or 10 amps while a fast charge is generally 15 amps or higher. A slow charge is always preferred.

6.1 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 19

6.2 General Rules for Charging a Battery

- Always leave the vent caps in place during charging;
- 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; and
 - Periodically check the battery for excessive heat by placing your hand on the side of the battery. If it is hot 52° C (125°F) to the touch, interrupt the charging (turn off) until the battery cools and lower charge rate.

6.3 Charging Procedure - Automatic Charger

1. Determine the type of battery... "sealed" or "accessible". If "sealed," the battery must be charged using a slow rate. (A "sealed" battery does not allow access to the cells or the addition of water or measuring specific gravity.) If "accessible," the battery may be charged at either the slow or fast rates.
2. Ensure the charger is disconnected from the power source and/or the charger is turned off.
3. Connect the charger to the battery: positive cable to the positive terminal or negative cable to the negative terminal. (Insure a good connection by rocking back and forth.)
4. Plug in the charger. If there is a setting switch for "regular" or "deep cycle" batteries, use regular setting for regular (accessible) batteries and sealed/gel electrolyte batteries. Use deep cycle setting for standard deep cycle batteries and maintenance free batteries. Always refer to battery charger instruction manual before using battery charger.
5. Periodically check the battery for excessive heat by placing your hand on the side of the battery. If it is hot 52° C (125°F) to the touch, interrupt the charging (turn off) until the battery cools.
6. During the charge cycle, the charger senses the battery's state of charge and will input amps at the appropriate rate. As the battery approaches a full state of charge, the input amperage will decrease.
7. After charging is complete, verify the charger is turned off and disconnected from the power source before removing charger cables.

6.4 Charging Procedure - Manual Charger

1. Determine the type of battery... "sealed" or "accessible". If "sealed," the battery must be charged using a slow rate. (A "sealed" battery does not allow access to the cells for the addition of water or measuring specific gravity.) If "accessible," the battery may be charged at either the slow or fast rates.

2. Insure the charger is disconnected from the power source and/or the charger is turned off.
3. Connect the charger to the battery: positive cable to the positive terminal or negative cable to the negative terminal. (Insure a good connection by rocking clamp back and forth.)
4. Plug-in the charger, set -the charge rate, and turn on the charger.
5. 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.
6. After charging is complete, insure charger is turned off and disconnected from the power source before removing charger cables.

6.5 Charging Rates - Manual Charger

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, 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.

Note: If you are wondering where to get the RC rating of a battery that only has a CCA rating on it, refer to your battery manufacturer for such information. It should be readily available from their product application book. If not, place battery on a low charge rate and check electrolyte specific gravity every 30 minutes until charged.

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							

6.6 Charging Rate - Optima Gel Cell Battery

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

Note: Always use a voltage regulated battery charger with limits set to the above ratings. 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.

6.7 Battery Terminal Cleaning

Over a period of time, sulphuric 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 (Figure 20). Battery terminals and cables 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.

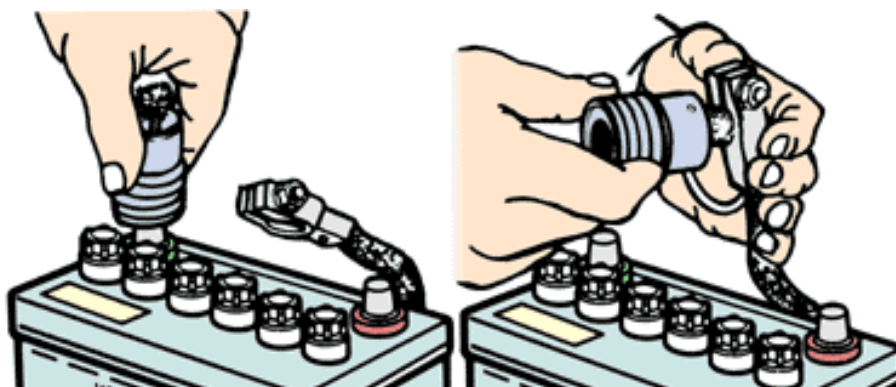


Figure 20

7.0 Battery Jumping with Booster Cables

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 (Figure 21). 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.

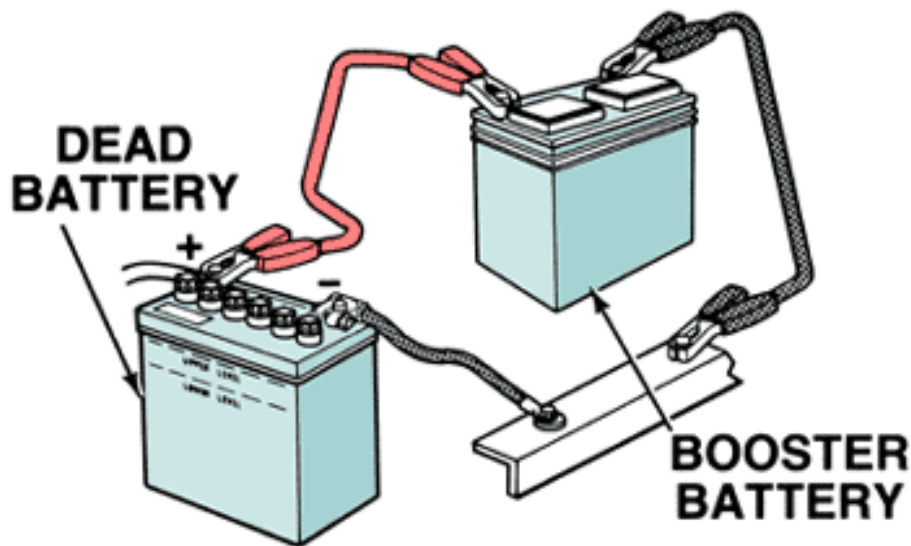


Figure 21

7.1 Battery Jumping with Booster Pack

The portable booster pack is a lead-acid gel cell type battery (Figure 22). Typically capacity ranges from 250 - 1000 CCA ratings. Both consumer and professional versions are available. It contains an accessory plug and has a test button to verify its' own state of charge. Booster battery packs have proven to be a safe and effective in jump starting vehicles. To use: Connect the red booster pack cable to the positive terminal of the battery and the other cable end to a good ground on the engine away from the dead battery.



Figure 22

8.0 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.

9.0 General Safety and Cleanliness

9.1 Personal Protective Equipment

1. All personnel (including visitors and observers) must wear the appropriate protective equipment, and implement work practices that eliminate any hazards or, if this is not feasible, greatly reduce the possibility of injury due to a hazard.
2. It is stressed that the use of Personal Protective Equipment is a last resort in achieving safe working conditions. An understanding of work environment and of the safe work practices required is necessary before choosing or resorting to PPE.
3. Eye protection must be worn in all workshop areas if work is being carried out. Suitable eye protection includes safety glasses (or overglasses) or a full-face visor.
4. Fully enclosed footwear must be worn by all personnel (including visitors and observers) using or entering Workshop facilities.

9.2 Workshop Safety Facilities and Procedures

The following safety facilities, equipment and procedures shall be provided:

1. First aid kits must be readily available.
2. A safety noticeboard should be placed in the workshop, preferably near the entrance/exit door. This safety noticeboard should contain the following information:
 - Emergency evacuation procedures.
 - Emergency contact names and phone numbers; e.g. qualified first aid officer, fire warden, medical suite, nearest hospital, etc.
 - Location of the nearest First Aid Kit.
 - Protective clothing and equipment that **MUST** be worn in the workshop.
 - All relevant organisational safety documentation.
 - Relevant operating procedures for equipment within the Workshop.
3. Relevant operating instructions, inspection and maintenance reports for each item of equipment should be placed adjacent or attached to the equipment.
4. Adequate ventilation for the type of work being performed must be provided in all Workshops and Workshop Areas. This is especially applicable where dust, other particle fragments or solder fumes are generated.
5. Soldering and de-soldering equipment must be fitted with appropriate fume extractors.

Workshops that have electromechanical tools (e.g. saws, drills, lathes, grinders, etc.) are required to have the following additional safety equipment and procedures:

-
- All belt driven machinery must have guards in place when in use.
 - All personnel working in the area must wear appropriate footwear.
 - All visitors or observers must wear appropriate personal protective equipment (e.g. safety glasses, ear muffs, etc.) if work is being carried out.
 - Visitors and observers must not interfere in the operations being performed.
7. Workshops where soldering, painting or spray painting are performed are required to have the following additional safety equipment and procedures:
- Adequate ventilation to remove all fumes or
 - Appropriate respirators

9.3 Housekeeping

1. The Workshop shall be kept neat and tidy. Good housekeeping can significantly reduce the risk of an accident and injury.
2. Technicians are normally responsible for cleaning up their own mess after they have finished using the Workshop.

A handy checklist is detailed below. It is not an exhaustive list but it does provide a very good starting point that could be customised for your workplace:

- Area waste bins are not overflowing.
- Waste bins are used for appropriate materials only.
- All equipment and spare parts not in use are stored in designated cabinets.
- Equipment stored on shelving, and racking is clean, neat and tidy (no overhangs).
- All equipment stored on shelving is clean and tidy.
- All benches tidy when not in use.
- Folder/catalogues and manuals stored neatly on shelves.
- All equipment is within calibration and tagged appropriately.
- Hair is covered, sleeves covering arm, no jewellery other than small sleepers.
- Laptop computers locked in cupboard in the storage room.
- Communal tools stored in designated areas.
- All fire/emergency exits are unimpeded.
- Safety clothing/equipment worn and used correctly for appropriate tasks.
- Fire extinguishers and hoses visible and accessible.
- All fire extinguishers in test (Tested 6 monthly).
- Floors are clear of equipment or spare parts not in use. Clear of waste and spills.
- Danger tags available for use.

10.0 Competency Based Training and Assessment Tools

- Are you ready for assessment? Yes No
- Do you understand the assessment process? Yes No
- Have you considered the Recognition of Prior Learning (RPL) process? Yes No
- Do you understand the term evidence and how it is to be collected? Yes No

If you have answered YES to these four questions you are ready to proceed to the assessment phase of this unit of competence. If you have answered NO you need to discuss your progress with a qualified assessor.

Introduction

Competency Based Training is always concerned with what a participant will be able to do at the end of training. What the inputs are or how the participant got there will vary, however it is critical that the participant achieves the listed competencies and that a quality assessment be undertaken by a competent trainer/assessor.

Assessment Coversheet

Participant Name			
Participant Email		Telephone Number	

Receipt of Assessment

Receiver's Signature		Date	
Signature of assessor		Result	

I certify that this assessment is my own work based on my personal study and /or research and that I have acknowledged all materials and resources used in the preparation of this assessment whether they are books, articles, reports, lecture notes and any other kind of document, electronic or personal communications. I also certify that the assessment has not previously been submitted for assessment in any award or course and that I have not copied in part or whole or otherwise plagiarised the work of other students and/or persons. I can produce another hard/soft copy of this assessment within 24 hours if requested.

Participant Signature		Date	
-----------------------	--	------	--

This assignment/assessment will not be marked unless the the above declaration is signed

Please copy this page and attach it to each submission for assessment

Observation Report/Third Party Assessment

To be administered by an Assessor and/or a Workplace Supervisor

Purpose of the task

The purpose of the observations is to assess your competency in testing, servicing and charging of vehicle batteries.

Instructions for the observation component

You will be required to participate in servicing sessions whilst being observed by an assessor who is qualified in this unit of competency. You may use an assessor from your preferred registered training organisation, or alternatively, you may source your own assessor (this person must use the observation checklist and provided a certified copy of their qualifications).

You will need to be observed in a **minimum of three (3)** service sessions:

- These sessions can be conducted by a workplace supervisor but must be completed by an suitably qualified assessor from a Registered Training Organisation on at least one occasion if you are submitting this assessment for recognition towards a nationally recognised qualification.

You will be assessed on the following required skills and attributes:

- Customer service
- Oral communication and interpersonal skills
- OHS skills
- Workshop practice skills

Please refer to the observation checklist for specific observation requirements under the above skills groups. Competency will need to be demonstrated over a period of time reflecting the scope of the role, as reflected by all components of this unit.

Where assessment is part of a structured learning experience, the evidence collected must relate to a number of performances assessed at different points in time and separated by further learning and practice with a decision of competence only taken at the point when the assessor has complete confidence in the ability of the person.

Where assessment is for the purpose of recognition (RCC/RPL), the evidence provided will need to show that it represents competency demonstrated over a period of time and is current.

Evidence must show the ability to transfer skills to different environments.

Observation Report/Third Party Assessment

To be administered by an Assessor or a Workplace Supervisor

Candidate Name:	
RTO Assessor Name:	
Unit/s of Competency:	
Name of Workplace:	
Date of Assessment:	

During the Observation Assessment, did the candidate:	PC	S	NS
Determine the job requirements including method, process and equipment from the work instructions	1.1	<input type="checkbox"/>	<input type="checkbox"/>
Read and interpret the job specifications	1.2	<input type="checkbox"/>	<input type="checkbox"/>
Observe the OH&S requirements, including personal safety needs throughout the work	1.3	<input type="checkbox"/>	<input type="checkbox"/>
Identify and check the equipment and tooling for safe and effective operation	1.4	<input type="checkbox"/>	<input type="checkbox"/>
Determine the procedures to minimise task time	1.5	<input type="checkbox"/>	<input type="checkbox"/>
Correctly interpret information accessed from manufacturer/ component supplier specifications	2.1	<input type="checkbox"/>	<input type="checkbox"/>
Identify, select and prepare in accordance with site procedures material, components, tooling and equipment to complete work	2.2	<input type="checkbox"/>	<input type="checkbox"/>
Check and top up electrolyte levels in accordance with site procedures	2.3	<input type="checkbox"/>	<input type="checkbox"/>
Clean batteries and terminals in accordance with site procedures	2.4	<input type="checkbox"/>	<input type="checkbox"/>
Remove and replace batteries are safely and according to site procedures	2.5	<input type="checkbox"/>	<input type="checkbox"/>
Correctly interpret information for charging accessed from manufacturer/component supplier specifications	3.1	<input type="checkbox"/>	<input type="checkbox"/>
Identify, select and prepare components, tooling and equipment to complete work are in accordance with site procedures	3.2	<input type="checkbox"/>	<input type="checkbox"/>

Check and top up electrolyte levels in accordance with site procedures	3.3	<input type="checkbox"/>	<input type="checkbox"/>
Charge batteries in accordance with site procedures and component manufacturer/component supplier recommendations	3.4	<input type="checkbox"/>	<input type="checkbox"/>
Access information for battery testing from product and vehicle manufacturer/component supplier specifications and correctly interpreted	4.1	<input type="checkbox"/>	<input type="checkbox"/>
Identify, select and prepare components, tooling and equipment in accordance with site procedures	4.2	<input type="checkbox"/>	<input type="checkbox"/>
Perform and analyse battery tests and results in accordance with site procedures and product/manufacturer /component supplier specifications	4.3	<input type="checkbox"/>	<input type="checkbox"/>
Conduct battery testing procedures in accordance with legislation, industry and enterprise policies/procedures guidelines	4.4	<input type="checkbox"/>	<input type="checkbox"/>
Access and correctly interpret information from manufacturer/component supplier specifications	5.1	<input type="checkbox"/>	<input type="checkbox"/>
Connect/disconnect leads in correct sequence and polarity	5.2	<input type="checkbox"/>	<input type="checkbox"/>
Conduct work tasks without causing damage to component or system	5.3	<input type="checkbox"/>	<input type="checkbox"/>
Complete workplace documents in accordance with enterprise procedures	5.4	<input type="checkbox"/>	<input type="checkbox"/>
Collect and store material that can be reused	6.1	<input type="checkbox"/>	<input type="checkbox"/>
Remove waste and scrap following workplace procedures	6.2	<input type="checkbox"/>	<input type="checkbox"/>
Clean and inspect equipment and work area for serviceable condition in accordance with workplace procedures	6.3	<input type="checkbox"/>	<input type="checkbox"/>
Identify and tag unserviceable equipment in accordance with workplace requirements	6.4	<input type="checkbox"/>	<input type="checkbox"/>
Complete operator maintenance in accordance with manufacturer/component supplier specifications and site procedures	6.5	<input type="checkbox"/>	<input type="checkbox"/>

Maintain tooling and equipment in accordance with workplace procedures	6.6	<input type="checkbox"/>	<input type="checkbox"/>
--	-----	--------------------------	--------------------------

Legend

S	NS	NS = Not Satisfactory. The participant requires more training, instruction and/or experience prior to re assessment
		S = Satisfactory
		NOTE : Always indicate an outcome

Feedback Comments:

Result for Assessment:	<input type="checkbox"/> Satisfactory (S)	<input type="checkbox"/> Not Satisfactory (NS)
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Candidate Signature:		Date:	
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RTO Assessor Signature:		Date:	
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Portfolio of Evidence

To be completed by the candidate and submitted to the RTO Assessor

Candidate Name:	
------------------------	--

RTO Assessor Name:	
Unit/s of Competency:	
Name of Workplace:	
Date of Assessment:	

This assessment covers components of the elements required for competency in:

- Element 1* Prepare for work
- Element 2* Service batteries
- Element 3* Charge batteries
- Element 4* Test batteries
- Element 5* Jump-start vehicle
- Element 6* Clean up work area and maintain equipment

Purpose of the task

As you work through the steps in assessing competence, you must collect documentation or work samples that “prove” what you do.

Indicative examples of the type of evidence you should collect at different stages of your program are listed below. There may be other pieces of evidence that you could collect. You are encouraged to discuss any other options with your assessor.

Instructions

You are required to provide evidence of:

- Gather information about the OH&S and environmental regulations/requirements, equipment, material and personal safety requirements;
- Create a list of some of the common automotive terminology;
- Develop a brief about each different type and application of batteries;
- about different testing, servicing and battery replacement procedures;
- List the steps for the testing, servicing and battery replacement procedures;
- Provide written information for the procedures for the disposal of batteries and acids;
- List the process for jump-starting and battery charging procedures;
- List your site reporting procedures;
- Discuss your work organisation and planning processes; and

- Detail your housekeeping procedures.

Legend

S	NS	NS = Not Satisfactory. The participant requires more training, instruction and/or experience prior to re assessment
		S = Satisfactory
		NOTE : Always indicate an outcome

Feedback Comments:	

Result for Assessment:	<input type="checkbox"/> Satisfactory (S) <input type="checkbox"/> Not Satisfactory (NS)
Candidate Signature:	<div style="border-bottom: 1px solid black; width: 100%;"></div>
RTO Assessor Signature:	<div style="border-bottom: 1px solid black; width: 100%;"></div>
Date:	<div style="border-bottom: 1px solid black; width: 50%;"></div>
Date:	<div style="border-bottom: 1px solid black; width: 50%;"></div>

Sources of Acknowledgement

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