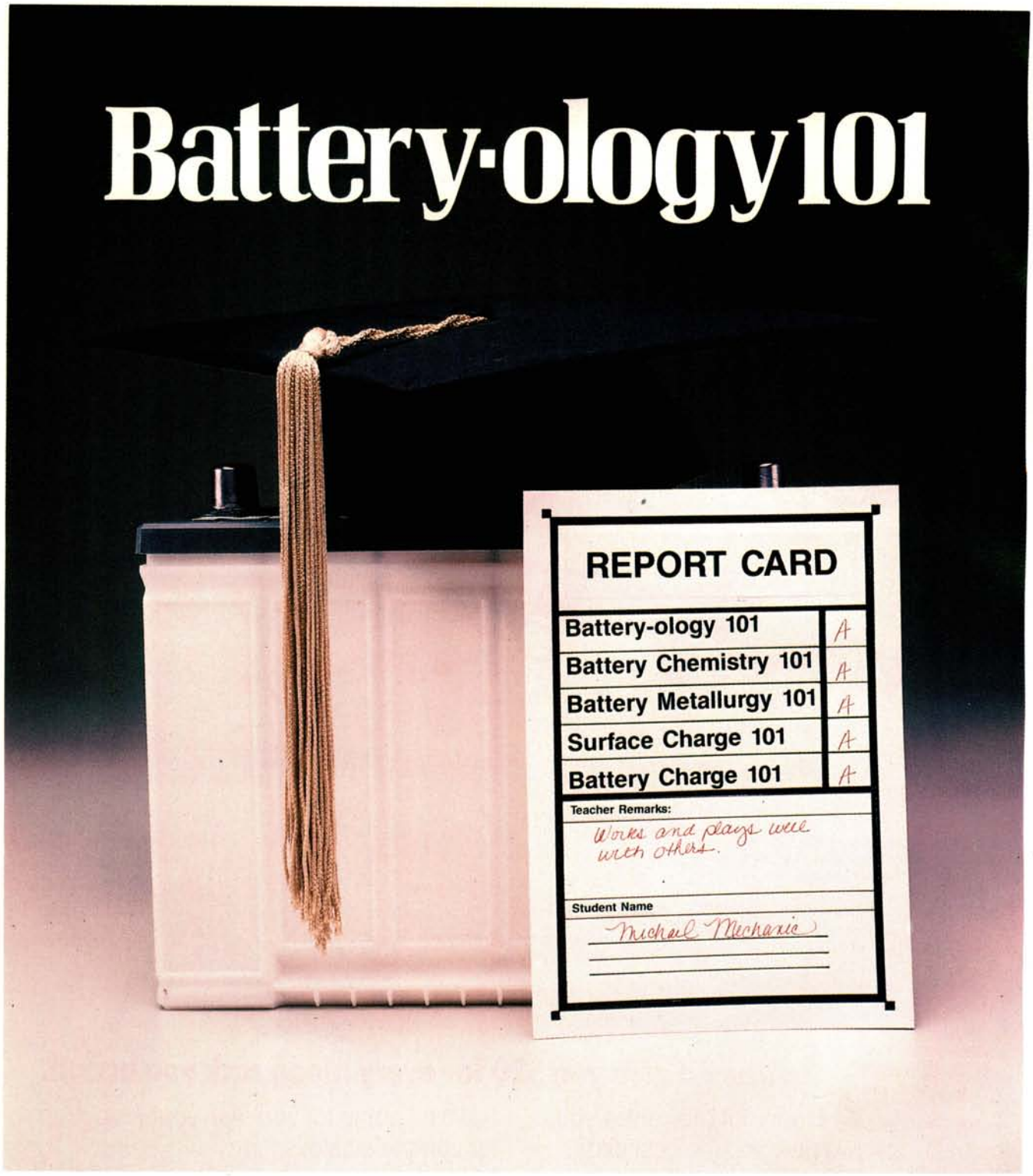
Battery-ology 101



Testing Batteries

Good morning class. Welcome to Battery-ology 101—Testing Maintenance-Free Batteries. This class is part one of a two part series on battery testing. Next month's class, Battery-ology 102, will deal with low-maintenance battery testing. But you'll have to pass the 101 course first.

Let me start by asking you a question.

Have you ever diagnosed a car with a dead battery?

Have you replaced that battery and thought you'd corrected the problem? Yawn. Just another dead battery. A new one will fix the problem every time.

But the customer comes back in a few days, hoppin' mad. He's waving your report card at you, and there's a big "F" under Battery-ology 101. He needed another jump start to get him going this morning.

It seems the battery wasn't the problem in the first place. Maybe a little time spent reviewing your battery testing skills is in order before you take your next battery test.

Battery manufacturers report that half of all batteries returned under warranty are not defective. They are simply discharged. After a proper recharging of the batteries, they work just fine. This means that half of the customers who purchase a new battery drive away from the service shop with the original problem still hiding in their car.

The problem may be nothing more serious than a loose alternator belt, or dirty battery connections. Other commonly overlooked problems include defective voltage regulators or alternators with low or no output. But that's another, separate course.

So why do these things happen, class? That's right. Either someone isn't taking the time to properly test the battery, or they're just not sure how to do it in the first place.

This class will show you how to quickly test maintenance-free batteries to recognize the difference between good batteries that are simply discharged, and bad ones that are worn out. Then you can focus your attention on why a good battery keeps going dead, instead of installing a new battery that ends up as dead as the old one in a few days.

It's easy when you know how to do it. But it takes some study and practice.

The heart of any battery is its lead grid. The grid is used to support the paste that forms the negative and positive plates. The lead grid by itself is too weak to support the paste. Calcium is added to both the negative and positive plate grids to strengthen them.

Maintenance-free batteries are usually sealed top batteries. That is, they do not have removable vents caps so water can be added as needed. These sealed top batteries use a special chemistry, usually calcium-calcium. This gives a sealed top battery some specific characteristics.

Benefits of this type of construction include low water loss, less gassing, and a longer shelf life than other chemistries. Since the calcium-calcium chemistry means little water loss, the battery top can be sealed.

On the down side, calcium-calcium batteries are more reluctant to take a charge in the first place, so charging voltage in cars equipped with maintenance-free batteries is slightly higher than with cars using batteries with removable caps.

A maintenance-free battery also has a lower reserve capacity than a comparable low-maintenance battery. If you lose an alternator belt, you won't get as far with your maintenance-free.

If a customer leaves his headlights on all day long and discharges a calcium-calcium battery too far, it may refuse to accept a charge at all. Then it will have to be replaced.

Battery chemistry depends on the electrolyte solution covering the plates in the battery. Electrolyte is a combination of distilled water and sulfuric acid.

As long as good battery plates are covered with electrolyte solution, the battery produces power at the proper levels. If the electrolyte level drops below the top of the plates, the portion of the plates exposed to air stops working. Exposed plate material hardens and becomes useless. This is called sulfation, and there is no cure for it.

Another side note about sealed top batteries with low electrolyte levels. They have higher than normal terminal post voltage readings. Sometimes, terminal post voltage will be 13.0 volts or more.

Why? Low water means higher acid content in the electrolyte solution. Water evaporates, but the acid in the remaining electrolyte does not. You end up with too much acid and not enough water in the electrolyte solution.

This extra acid causes a stronger chemical action at the plate surfaces still covered by electrolyte. The extra chemical action means more voltage at the posts. But this is one case where more is not necessarily better.

If water isn't added to the electrolyte solution to bring the post voltage back down to 12.6 volts, the battery will self-destruct. Unfortunately, since maintenance-free batteries are sealed, you can't add water. In this case, replacement of the battery is called for.

The opposite happens when the battery becomes discharged. As the battery discharges, more of the electrolyte solution is water, and less is acid. Battery energy decreases.

When testing batteries with removable vent caps, you can check specific gravity as an indication of battery state of charge. We'll talk more about specific gravity next month. But we have a sealed top battery now, class. What do we do?

The only alternative we have with a sealed top battery is to check state of charge with very precise measurements of battery post voltage, using a high accuracy DVOM. The DC accuracy of the DVOM must be at least ± 0.5 percent. A DVOM with an accuracy of ± 0.25 percent is better, and an accuracy of ± 0.1 percent is the best of all.

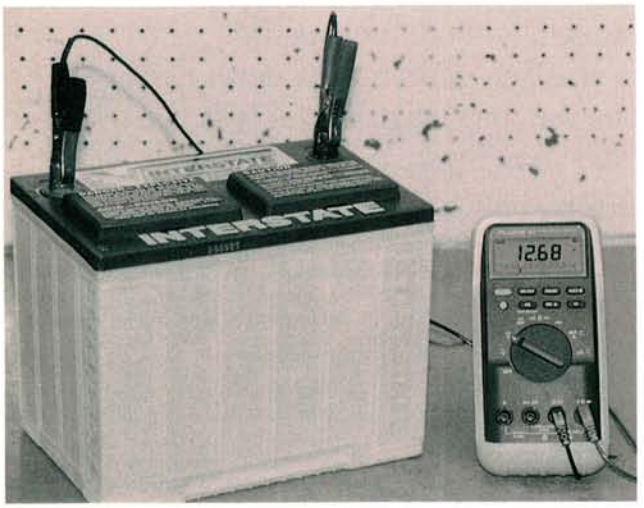
State Of Charge	VS.	Battery Terminal Post Voltage
100%		12.68v
75%		12.45v
50%		12.24v
25%		12.06v
0% (discharged)		11.89v

(Courtesy of Battery Council International)

Battery Math 101

A fully charged battery has a terminal post voltage of 12.68 volts. (You can't even get close to that kind of accuracy with your old analog voltmeter.)

If the battery is completely discharged, the voltage drops to only 11.89 volts. That's a difference of only 0.79 volt between a fully charged, and a completely discharged maintenance-free battery.



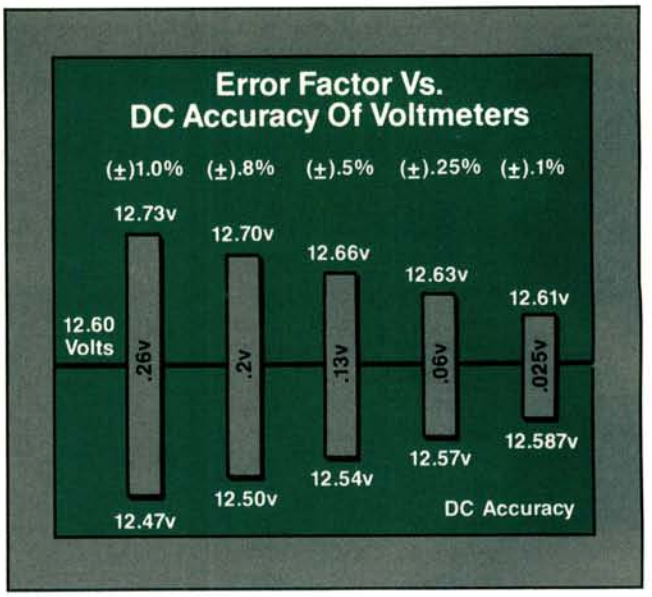
Checking Battery Terminal Post Voltage With A High Quality DVOM. Compare the reading to the "Voltage Vs. State Of Charge" chart. This test can be done either in or out of the car.

If you try to measure that 0.79 volt range using a voltmeter with a poor accuracy rating, the readings won't be accurate enough to tell you anything.

Here's an example: If you try measuring the voltage in a fully charged battery that has a post voltage of 12.6 and your DVOM has an accuracy of ± 1.0 percent, your readings can be as much as 0.13 volts above or below the actual reading. That's a total window of error of 0.26 volt.

If the DVOM is accurate to ± 0.1 percent, the most you can be off is only 0.025 volt above or below the actual post voltage on a battery with 12.6 volts. That's a lot better. This high degree of accuracy offers you the best chance of measuring the true state of charge in a maintenance-free battery.

You may be flunking the final exam in battery testing because your voltmeter isn't giving you accurate enough readings.



Surface Charge 101

Surface charge is created when a battery is discharged or charged. It is a temporary imbalance in battery chemistry.

There are two kinds of surface charge:

- **Negative Surface Charge** artificially lowers battery voltage to make the battery appear weaker than it really is. Negative surface charge is created when the battery is discharged as in starting the engine. Battery voltage will gradually rise again if the battery is simply allowed to rest after the load is removed.
- **Positive Surface Charge** artificially raises battery voltage to make the battery appear stronger than it really is. Positive surface charge is created on the battery plates after charging. Battery voltage will gradually drop to its true level of charge if the battery is simply allowed to rest.

Positive surface charge is the one that can affect battery performance when testing. It must be removed before testing. Ignoring positive surface charge may let a weak or bad battery squeak by during testing.

This is called cheating in some classrooms.

Removing Positive Surface Charge

Since the battery may have been charged during the 12-24 hour period before testing, it may have some positive surface charge. Here are two quick ways to dissipate positive surface charge before testing:

• **In the Car**. Turn on the headlights for two to three minutes. Then turn them off and let the battery catch its breath for about 10 minutes. This lets the battery chemistry settle down.

• **On the Bench**. Apply a 150 amp load to the battery for 10-15 seconds with a carbon pile load tester. Then allow the battery to rest for 10 minutes.

Letting a battery rest for 12-24 hours before testing is the only way to be sure that surface charge will completely dissipate. But anyone who works on cars for a living will tell you that this approach is anything but practical in a real world filled with impatient customers and delivery deadlines.

It's tough to guess just how much surface charge needs to be removed, and the "in the car" or "on the bench" methods are admittedly a scientific guess. But this is one of those rare times when a guess is better than doing nothing at all to eliminate the effects of surface charge before testing post voltage.

Battery Lab 101

Lesson: Testing Maintenance-Free Batteries

Testing maintenance-free batteries is done in four easy steps. Everyone in class must test maintenance-free batteries using the approved method in order to pass the final exam.

STEP ONE—Visual Inspection

Look the battery over. Check the battery case and connections. If the battery case is translucent, look to see if the electrolyte is low in any of the cells. A maintenance-free battery that is low on water should be replaced. (Those of you tempted to re-engineer battery cases by drilling holes to add water better think twice. It's just not worth the dangers of personal injury or product liability.) Before moving on to Step Two, remove the positive surface charge.

STEP TWO—Determine State of Charge

Use a DVOM with high DC accuracy to measure the terminal post voltage of the battery. Compare the DVOM reading to the chart "Terminal Post Voltage vs. State of Charge" as an indication of the battery's real state of charge.

Readings between 12.45 and 12.70 (75—100 percent of charge) mean the battery has enough charge to attempt the load test covered in our next step. Perform the load test on a battery in this condition.

Readings below 12.45 volts mean the battery is below 75 percent of full charge, and probably won't pass the load test at its present state of charge. Recharge the battery to full charge and remove the surface charge before attempting the load test.

STEP THREE—Perform the Load Test

You'll get your best load tests results when the battery is fully charged. Use a carbon pile load tester and a high accuracy DVOM to test terminal post voltage as follows:

• Connect the load tester and DVOM to the battery terminals. Apply a load equal to ½ the CCA (Cold Cranking Amperage) rating of the battery for 15 seconds. At the end of 15 seconds, note the reading on the DVOM. Then turn off the load tester.

• To determine if the battery passes the load test, compare the DVOM reading to the "Temperature vs. Voltage" chart. The battery's temperature is critical.

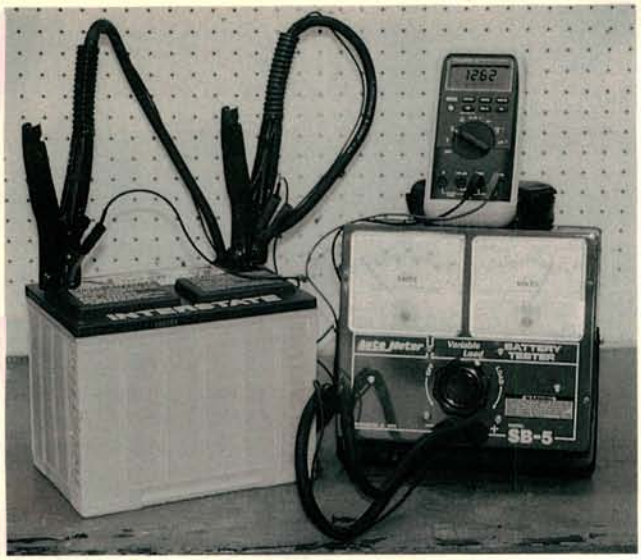
Battery Temperature	VS.	Battery Terminal Voltage
70°F		9.60v
60°F		9.50v
50°F		9.40v
40°F		9.30v
30°F		9.10v
20°F		8.90v
10°F		8.70v
0°F		8.50v

(Courtesy of Battery Council International)

Unfortunately, our sealed battery case causes us some problems here too. You can't use a thermometer to check the temperature of the electrolyte. On a very cold day, you can let the battery sit at room temperature until it warms. Or, in a pinch, place your hand on the battery case to see if it's very cold or very warm and "guesstimate" the battery temperature. Experience is the best teacher here.

• If the DVOM reading meets or exceeds the chart voltage at a given battery temperature, then the battery passes the load test. It can stay in service.

• If the DVOM reading drops below the chart reading for a given temperature, the battery flunks the load test. Stamp it "F" for failed and replace it, no questions asked.



The Load Test. A carbon pile and an accurate DVOM are connected to the battery terminals. A load test can be done in or out of the vehicle.

Pay close attention to the voltage readings on good batteries. If readings are exactly what the chart calls for, the battery is acceptable. But these batteries won't have a margin of reserve when the going gets tough. If readings are better than the minimum allowable voltage at a given temperature, you know the battery has a good reserve, and will have something extra to offer when winter cold, or summer heat push the battery to its limits.

Let's stop here for a minute and look back at Step Two. If the no-load voltage test in our second step said the battery was fully charged, but the load test tells you the battery is only marginal, you'd better beware of that battery. Batteries with good no-load voltage should test higher during the load test than batteries with borderline no-load voltage.

Batteries that tested at 75 percent of no-load voltage (12.45 volts) will probably test lower during the load test. That doesn't necessarily mean they're bad. They are simply being tested at 75 percent of their capacity.

Those of you dealing with side terminal batteries may be running into a special kind of problem. A common test practice with side terminal batteries is to screw two bolts into the terminal posts to connect the load tester.

Do not do this unless the bolts are pure lead. Metal alloy bolts commonly used for this purpose will make a bad electrical connection with the lead terminals since they are dissimilar metals. This bad electrical connection will cause a voltage drop and ruin the test since you won't be able to dial in a big enough load, no matter how far you crank up the carbon pile. Some techs have mistakenly assumed that since the load indicator on the ammeter is low, the battery is too weak to be tested.

Side Terminal Lead Adapters For Load Testing Batteries. Don't use bolts.

STEP FOUR—What to do if Battery Fails Load Test

If the battery flunks the load test, continue testing by leaving the DVOM connected to the battery terminals. Watch the rise in battery voltage over a 5-10 minute period after the load is removed. This rise in no-load voltage is called "bounce back" voltage. It will tell us if the battery is really bad.

- If the voltage bounces-back to 12.45 volts or higher, the battery is working but doesn't have enough power under load. Even though post voltage recovers, this battery fails the stamina test.
- If the voltage fails to bounce back to 12.45 volts, don't be fooled into thinking the battery is bad, especially if the no-load voltage was less than 100 percent. It may be a good battery that needs to be recharged. Charge the battery until post voltage reaches 12.68 volts, remove the surface charge, and run the load test again. If the battery fails a second load test, replace it.

Class Review

These simple procedures result in more effective testing of sealed top batteries. Short-cutting the job by stuffing a new battery in the car may get the customer on the road in a hurry. But if the old battery wasn't the real problem, you better hope the guy never gets his hands on your report card.

For additional information on battery testing, write: Bob Johnson, c/o Interstate Battery System of America, 9304 Forest Lane, Suite 200, Dallas, Texas 75243. Ask for their **Automotive Electrical Clinic Manual**. You can also contact your local Interstate Battery Distributor. The manual sells for $19.95.

—By Vince Fischelli