Battery Tester: Forsythe Robotics

FTC uses Nickel Metal Hydride batteries (NiMH). Over time, they can wear out!

What makes a battery good?

- Internal resistance (R_{INT}): Goal= <0.1 Ω (Ohm). This means that the electricity flows through the battery rapidly and can power all your electronic components without power loss or brownout.
- You can test your internal resistance cheaply with a few tools and some math. This is how!

What you need:

- A 25W/10Ω resistor (<8$) and some 2.5 mm copper wires (this is our R_L below). Optional: REV battery battery adapter (<$5), alligator clips (<$1).
- Multimeter- these are a good tool for any shop to have (as little as $14).

What we need to measure:

- Measure our Open Circuit Voltage (V_{OC}) and Loaded Voltage (V_L)
    1. Make sure your battery is fully charged before you start!
    2. Set the Multimeter to the lowest DC voltage that is above your expected range (20=ideal for our purposes).
    3. Connect black and red probes directly to the battery (yellow XT30 connector)- record value. This is your Open Circuit Voltage (V_{OC}).
    4. Connect copper wires to the resistor (2.5 mm copper wire with both ends stripped works fine). Upgrade: You can take a REV battery adaptor and solder the ends to your resistor. This is worth it if you are testing a lot of batteries!
    5. Connect other ends of copper wires into the battery (yellow XT30 port) or just plug it in if you are using a battery adapter.
    6. Use probes to contact either end of the resistor directly or with alligator clips- record value. This is your Loaded Voltage (V_L)

        *Only do this for < 1 minute. It will heat up the resistor!

Now we need to do some math!

*The equations we are using here are **Ohm's Law** and **Kirchhoff's Voltage Law**.

Subtract the loaded circuit voltage you measured (V_L) from the open circuit voltage you measured (V_{OC}). That is the voltage drop across the internal resistor of the battery (V_{Int}).

$$\mathbf{V_{OC} - V_L = V_{Int}}$$

Divide the loaded circuit voltage you measured (V_L) by the value of the external resistor you used (R_L). We used a 10 Ω external resistor, so we will divide by 10. This will tell us the current (I).

$$\mathbf{V_L / R_L = I}$$

Finally, calculate the internal resistance of the battery (R_{Int}) by dividing the voltage across the internal resistor (V_{Int}) by the current (I).

$$\mathbf{V_{Int} / I = R_{Int}}$$

R_{Int} *<0.1* (🙂) 0.1-0.2 (😐) *>0.2* (🙁)

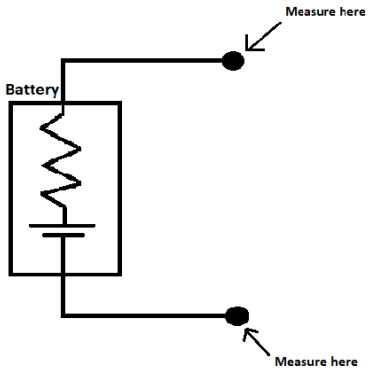
Sources:

https://learn.sparkfun.com/tutorials/measuring-internal-resistance-of-batteries/all

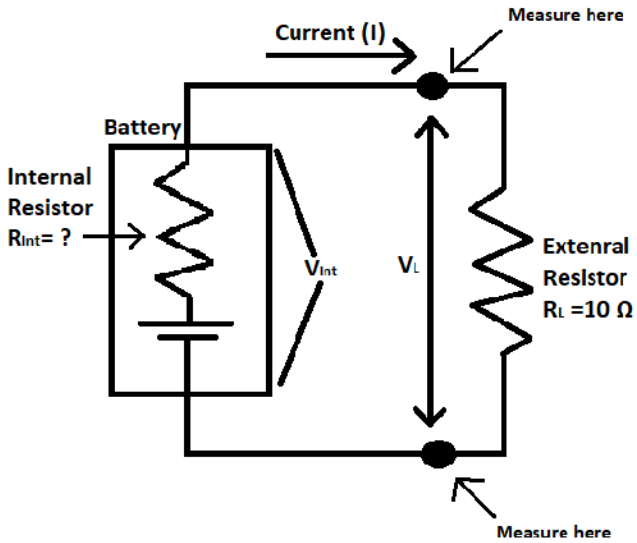
https://www.youtube.com/watch?v=CrJTt5-N4qU&t=403s

What's going on here?

When we measure the open circuit voltage, there is no circuit and no current. Because there is no current flowing through the battery, the internal resistance of the battery is 0. This means we are measuring the ideal voltage source of the battery (V_{OC}).



When we connect the battery to the external load of our resistor (R_L), we now have a circuit with a current moving around it (I). The current is moving through the external resistor AND the internal resistor of the battery. Using the values we know, we can calculate the internal resistance of the battery (R_{Int}).



Battery Tester Worksheet:

Battery Name/ID: _____

Goal Internal Resistance (R_{Int})= < 0.1 Ω

Open Circuit Voltage (V_{OC})= _____

Loaded Voltage (V_L)= _____

External Resistor (R_L) = 10

$V_{OC} - V_L = V_{Int}$ _____

$V_L / 10 = I$ _____

$V_{Int}/I = R_{Int}$ _____

This battery is:

🙂 <0.1 Ω

😐 0.1-0.2 Ω

🙁 >0.2 Ω