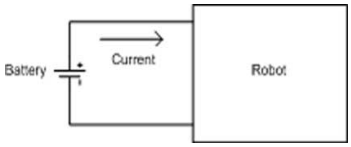
# Battery 

One of the things that all robots have in common are that they all need power. Plugging a mobile robot into your electrical outlet isn't very practical if you want it to move around, so you need a portable source of power. That's why most robots rely on batteries in order to get their power. The most common batteries convert chemical energy into electrical energy. The actual chemical reactions that occur inside the battery are out of the scope of this guide, but there are plenty of resources out there that you can go to if you're interested in that.

## Basic Info

Pretty much all batteries are rated using the amp-hour rating. But what does that really mean?Let's say you hook up your robot to your battery and turn it on. The robot will draw a certain amount of current from your battery.



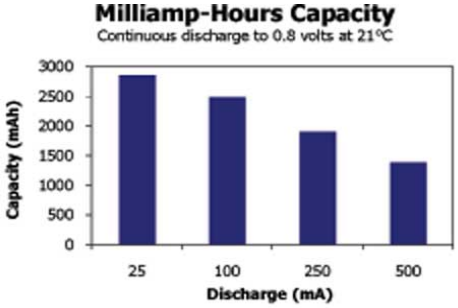

And the robot will keep drawing this current until your battery is dead.The amp-hour rating is basically the product (multiplication) of the current and the time it can provide that current:

Amp Hour Rating = Current X Time = I X t

So, for example, if you draw say…1amp from a battery for two hours, then it just provided you with 1amp X 2 hours = 2 Amp-hours (or 2000 milliamp-hours)

Now, let's go on to a practical example. So you take a new set of 2500 milliamp-hour alkaline batteries and pop them into your robot. You know that your robot draws 500 milliamps of current, so your robot should be able to run for five hours. (2500milliamp-hours/500milliamps = 5 hours) So you let your robot run, and after only one hour, your batteries are dead. What the heck happened? Did the manufacturer lie to you? Well, the answer is yes, and no. The battery really is 2500 milliamp-hours, but at a different current.

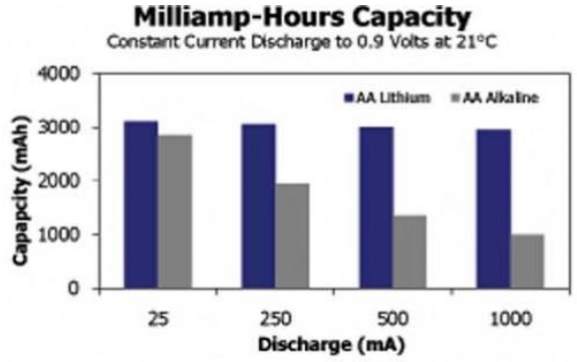
So, here's what you do. You go to the battery manufacturer's webpage, and you look for what's called the "product datasheet" for your batteries. (Here's an example of one: http://data.energizer.com/PDFs/E91.pdf) Not all manufacturers will give you this data, but the better datasheets will have the capacity of the battery as a function of how much current you draw from it. An example pulled from that datasheet I linked you to earlier is this:



So, if you draw 25 milliamps from the battery, you get almost 3000 milliamp hours from your batteries. That means that you can last for 120 hours! (3000 milliamp-hours/25 milliamps = 120 hours) But how about if we draw 500 milliamps from the batteries? According to that graph, we only get a little over 1000 milliamp-hours. That means that the batteries will run for only a little over two hours. What a rip!

The lesson? The capacity of your batteries depends on how much current you draw from them.

The good news? There are better batteries out there. Look at the same chart for energizer lithium batteries. (It can be found here: http://data.energizer.com/PDFs/l91.pdf) Notice the milliamp-hour capacity chart for the lithium batteries:




Milliamp-Hours Capacity for an Energizer AA Lithium Battery

Energizer was nice enough to put data for their lithium and alkaline batteries. Now, look at the performance of the lithium batteries. Like the alkaline batteries, the higher the current you draw from the lithium batteries, the lower their capacity. But compared to the alkaline batteries, their capacities are still much greater. You can get almost the same capacity from the lithium batteries no matter what current you draw from them. The drawback? Lithium batteries cost more than alkaline batteries. So, you must decide if the extra cost is worth the better discharge characteristics. If you're drawing 25 milliamps from your batteries, then chances are, you don't need to dish out the extra cash for the lithium batteries because the alkaline batteries will perform just as well as the lithium batteries at such a small current.

So, does that mean that you should buy lithium batteries if you are drawing a lot of current from your batteries? Not necessarily. You can actually add more batteries in parallel with each other like this:

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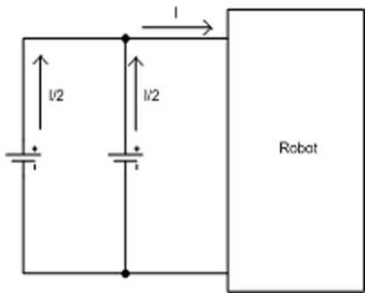


In this parallel configuration, you can get a certain current, and you will only draw half of that current from each battery. For example, if you are drawing 500 milliamps from the two batteries, you will only be drawing 250 milliamps from each individual battery. You can put even more batteries in parallel in order to decrease the amount of current you're drawing from each individual battery. Also, the net equivalent resistance of this battery pack is lower than a single battery! So for the same current drawn, if it is being split between several batteries, the potential drop will decrease. Battery will act more closer to an ideal voltage source.

The drawback? Of course, adding more batteries will increase the weight of your robot.Also, you must remember if you are using non-rechargeable batteries, then all the batteries you place in your robot should be either 1. brand new or 2. Almost equal voltages. Otherwise, one your batteries will end up trying to charge the other, which isnt possible because isnt rechargable, so it'll end up discharging through the resistance of your other battery which is small. You must decide whether or not the extra weight is worth the decreased current draw from your batteries. Remember, alkaline and lithium batteries aren't the only batteries out there. Feel free to do some research and look at the spec sheet for each one that you are considering in order to make a more informed decision.