RECHARGEABLE BATTERIES

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The Easy Guide to Rechargeable Batteries:
In an effort to take away the science from what is in fact quite complex technology we will start off by likening the rechargeable battery to a bucket! Sounds crazy? Well maybe, but read on and you will see…..
A rechargeable battery is just a storage device, it stores electrical charge, once that energy is used up it can be refilled again and so on. Just like a bucket can be filled with water again and again. However, to make the example a bit more realistic, the bucket has a hole in it, so as we are filling it up water is leaking out all the time, and so as we slowly pour water into the bucket it will leak away, meaning that we may need to pour 12 litres of water into a 10 litre bucket before it reaches the brim. In the same way, it takes more energy to charge a battery than it will actually store. Remember the hole in the bucket? Well once its full, the hole is still there and so the bucket will slowly empty, in the same way a rechargeable battery will slowly lose its charge.

So what do all the numbers mean?
The first figure that you will be given is the "Capacity, expressed in either "mAh" meaning milli-Ampere hours, or "Ah" meaning Amp-hours (1 Ah = 1000 mAh). This is basically the amount of current the battery will give multiplied by the number of hours that it will give it for, so obviously a bigger number means that the battery will last longer. So from the following table you can see how many hours a 2700mAh battery would in theory last.

Rated current for device	Equation	Theoretical battery life
100mA	2700/100	27 hours
270mA	2700/270	10 hours
2700mA	2700/2700	1 hour

This all seems very simple, however it doesn't quite work this way. The battery is less efficient when larger currents are being drawn from it

Rated current for device	Equation	Actual battery life
100mA	2700/100	30 hours
270mA	2700/270	10 hours
2700mA	2700/2700	50 mins

So our "2700mAh" battery will last longer than expected if it is used in a device which takes little current, but with a device using a lot of current it will not last as long as expected. Generally battery manufacturers will give the capacity based on "0.2C discharge" This means at a discharge of 2/10 its rated capacity i.e. 540mA for a 2700mAh battery, There are some cheap batteries where the manufacturer gives the capacity based on a much slower rate of discharge, and so the capacity seems very good, like with the example above, at a discharge current of 100mA the battery would seem to have the capacity of 3000mAh. You should avoid companies that claim very high capacities – such as 18650 lithium-polymer cells with capacities over 3,500mAh as these are fake & generally will have very low actual capacities. For the 18650 lithium polymer example, Panasonic are regarded as the world leaders in the development of this type of rechargeable battery, so if they cannot produce a battery with a capacity greater than 3500mAh you can be totally sure that no-one else can.

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What about the Voltage?

All batteries are tied by the laws of physics, so regardless of the manufacturer, the voltages will always fall into one of the following main categories:

For NiMH batteries – 1.2V per cell For sealed lead-acid batteries – 2.0V per cell For lithium-ferrite batteries – 3.3V per cell For lithium polymer batteries – 3.7V per cell* * There are some manufacturers who are producing 3.8V lithium polymer cells, generally labelled "LiHV"

To obtain batteries with higher voltages the manufacturers simply connect several cells in series, for instance a 12V lead-acid battery contains six 2.0V cells. It therefore follows that battery voltages must always be some multiple of the cell voltages, for instance lithium polymer batteries can only be 3.7V, 7.4V, 11.1V, 14.8V etc etc.

What about the Power Output?

One other thing that is important to consider when choosing the right type of battery for a particular application, is its discharge capability I.e. how quickly the stored charge within the battery can be delivered, or what the maximum current that it can supply. Lead acid batteries are the oldest technology that is still in common usage & as you would expect, are the worst at providing high currents, however they are excellent for lower power applications & are generally the cheapest option. NiMH batteries are better at providing good levels of power, for example AA size NiMH batteries will generally far outperform alkaline batteries in devices such as digital cameras, radio transmitters etc. Lithium-polymer batteries are by far the best at providing high power outputs & can supply very high currents, hence their popularity in high power applications such as powering brushless motors in model aircraft. Lithium-ferrite batteries sit between NiMH & lithium polymer in terms of performance.

What does the "C" rating mean?

Most manufacturers will use a C rating to express the maximum charge & discharge for a battery. C simply relates to the battery capacity, so from our earlier example of a 2700mAh battery, we can take C as meaning 2700mA, or 2.7A. Hence if the manufacturer states that the battery can be charged at up to 2C this means that the maximum charge current should be no more than 5400mA or 5.4A. Similarly f the maximum discharge is quoted as 20C it means that the maximum current that the battery can supply is 54000mA or 54A. Although this is just the maximum, the actual current that comes from the battery is just what is being demanded of it by whatever it is connected to. For example, if this example battery is connected to a motor requiring 20 Amps at full power, it would have no problem powering it & in fact would
only be working at just under 40% of its capability, so the battery would not be getting pushed too hard. If on the other hand, the motor needed 100A for full power, then this battery could not supply that & so you would not get full power from the motor. If this was in a model aircraft it would result in very poor performance.
Quite often the discharge rating of a battery max be expressed as 20C/40C with our example it would mean that the battery is capable of supplying 54 Amps continuously, but up to 108 Amps for short bursts, typically just a couple of seconds. Going back to our example of the motor that required 100A for full power, the 20C/40C battery would possibly be OK here, as long as the full power was only for short bursts, such as a model stunt aircraft. However, as the battery is working much harder, it may have a reduced life expectancy..

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What about recharging the battery?
Each different battery type is charged in different ways & it is essential that you use the correct charger, otherwise the battery can be damaged & in extreme cases it can be seriously dangerous. We will cover the complexities of battery chargers in a later post.

Which is the best type of rechargeable battery?

This all depends on the application (& budget) as there are pros & cons to each type.
Sealed lead-acid batteries. Pros:- Inexpensive, reliable, easy to charge, low self-discharge (ideal for standby applications). Cons:- Large, heavy, low output current.
NiMH batteries. Pros:- Lighter & more compact than lead-acid, medium cost, reasonable output current, hold their voltage well under load, many different sizes available. Cons:- Can be damaged by over discharge,
Lithium-ferrite (LiFe) batteries Pros:- Light weight, very compact, useful range of voltages. Cons:- Require specialised charging, relatively expensive.
Liyjium-polymer (Lipo) batteries Pros:- High charge density + lots of power in small & light package, possibility for high current outputs, many different sizes available Cons:- Require specialised charger, need careful handling & storage, expensive, destroyed by over-discharge, relatively short life expectancy - Can only be recharged <100 times whereas the NiMH type can be recharged 500+ times.