Power, E.M.F., and Internal Resistance

Power

- Power is defined as the rate at which energy is used by or supplied to the circuit.
- Power is dissipated in resistors (as heat)

$$P = \frac{W}{t}$$

$W = qV$ and $q = It$

$$W = ItV \quad \text{or} \quad \frac{W}{t} = IV$$

$$\boxed{P = IV}$$

$$V = IR$$

$$\boxed{P = I^2 R}$$

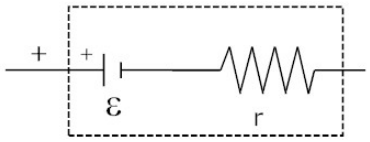
E.M.F.
(Electromotive Force)

- Emf is the work per unit charge made available by an electrical source.
- The amount of energy that would be available if it were not for resistance.
- Units: Volts

Internal Resistance

- All sources of emf have resistance.
- This resistance reduces the amount of potential energy available to the circuit.
- This resistance is internal to the emf source and cannot be eliminated.

Internal Resistance of a Cell



$$V = \varepsilon - Ir$$

Terminal Potential Difference

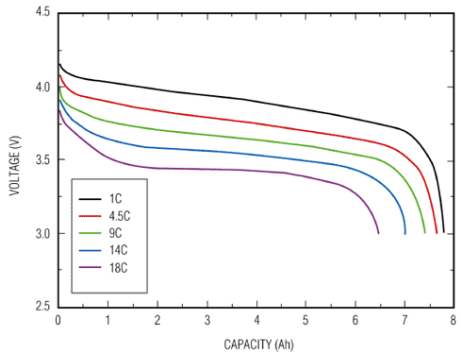
- The potential difference of a cell at its terminals
- The potential difference after the loss due to the internal resistance

Primary vs Secondary Cells

- Primary Cell
  - A cell that can only be used once (until it runs out) and then is thrown away
- Secondary Cell
  - A cell that can be recharged (the chemical reaction inside the battery is reversible) and can be used again

Capacity of a Cell

- The amount of charge a cell can deliver to an external circuit in its lifetime
- The bigger the current, the faster the cell discharges
- There is a drop in voltage at the beginning and then the terminal voltage remains almost constant until the capacity of the cell is exhausted



- electronics.stackexchange.com/questions/18612/how-to-measure-capacity-of-a-lithium-ion-battery
- C is the discharge rate needed to discharge in 1 hour
- The small decrease in voltage is partially caused by an increase in internal resistance

- Capacity is measured in amp-hours (Ah)
- A 200 Ah cell can provide
  - 200A of current for 1 hour
  - 20A of current for 10 hours
  - 2A of current for 100 hours
  - Or any other situation that produces 200