Today's Lecture

- Ampere-Hour Rating
- Battery Life Factors
- Conductors, Insulators & Semiconductors
- Ammeters & Voltmeters
- Applications
- Reading Assignment (for next week)
  - Chapter #3: 3.1 – 3.15

Battery Specifications

Batteries are rated by :

- Voltage (V)
- Ampere-Hours (Ah)

Specifications:
Voltage : 6V
Capacity:11Ah

Ampere-Hour Rating & Battery Life

The ampere-hour (Ah) rating provides an indication of how long a battery of fixed voltage will be able to supply a particular current.

$$\textit{Battery}\ \text{Life (hours)} = \frac{\textit{Ampere - Hour}\,(\textit{Ah})\ \text{Rating}}{\textit{Amperes}\ \text{Drawn (A)}}$$

Battery Life Exercise

How long will a 9V battery with an ampere-hour rating of 480 mAh provide a current of 20 mA?

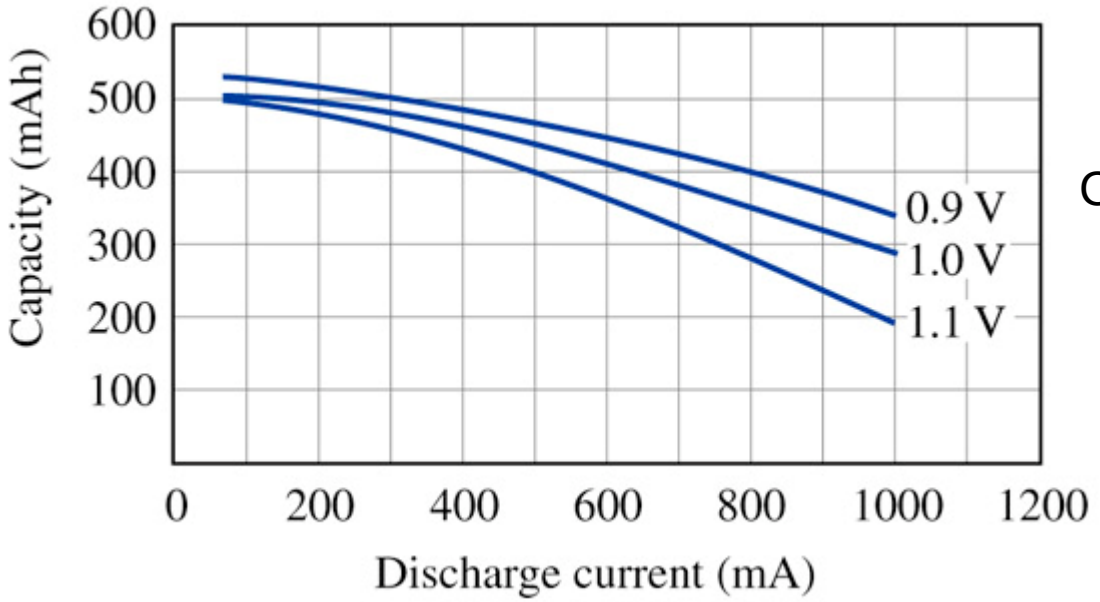
$$\text{Life (hours)} = \frac{480\,\text{mAh}}{20\text{mA}} = \frac{480}{20}\text{h} = 24\,\text{h}$$

Breakout Exercise #1

If a 12 volt flashlight battery with a capacity of 300 mAh is needed (to be used) for 45 minutes, what is the maximum amount of current the flash-light should be allowed to draw from the battery?

Battery Life Factor : Constant-Current Demand

The capacity of a battery (in ampere-hours) will decrease with an increase in current demand.



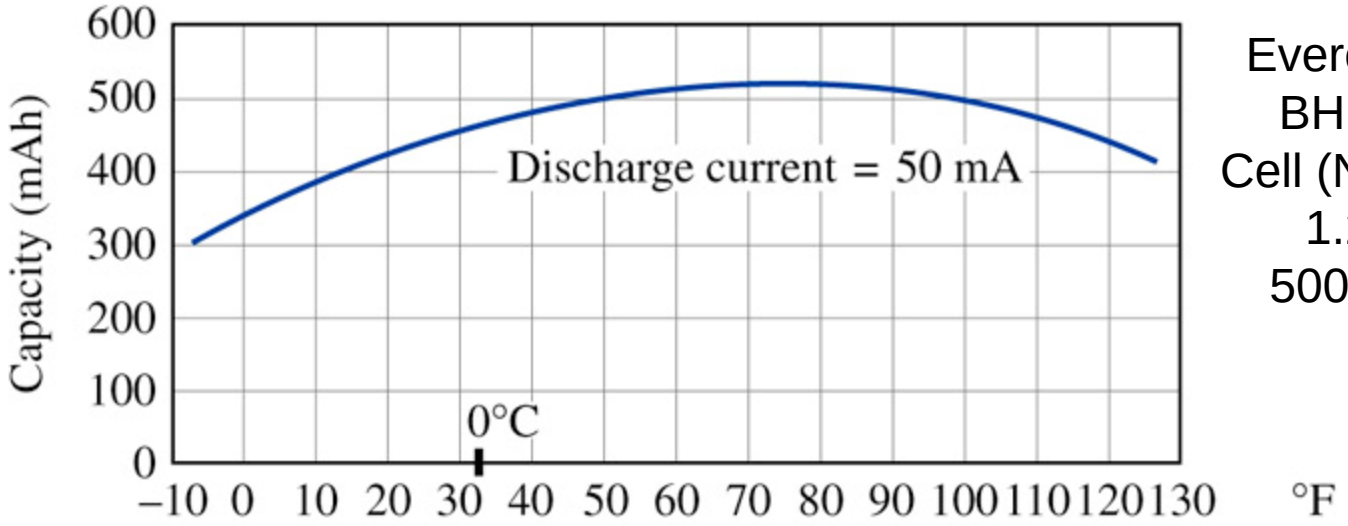
Eveready®
BH 500
Cell (Ni-Cad)
1.2V,
500mAh

$$\textit{Battery}\ \text{Life (hours)} \approx \frac{\textit{Ampere - Hour}\,(\textit{Ah})\ \text{Rating}}{\textit{Amperes}\ \text{Drawn (A)}}$$

Good for comparison, but not an absolute

Battery Life Factor : Temperature

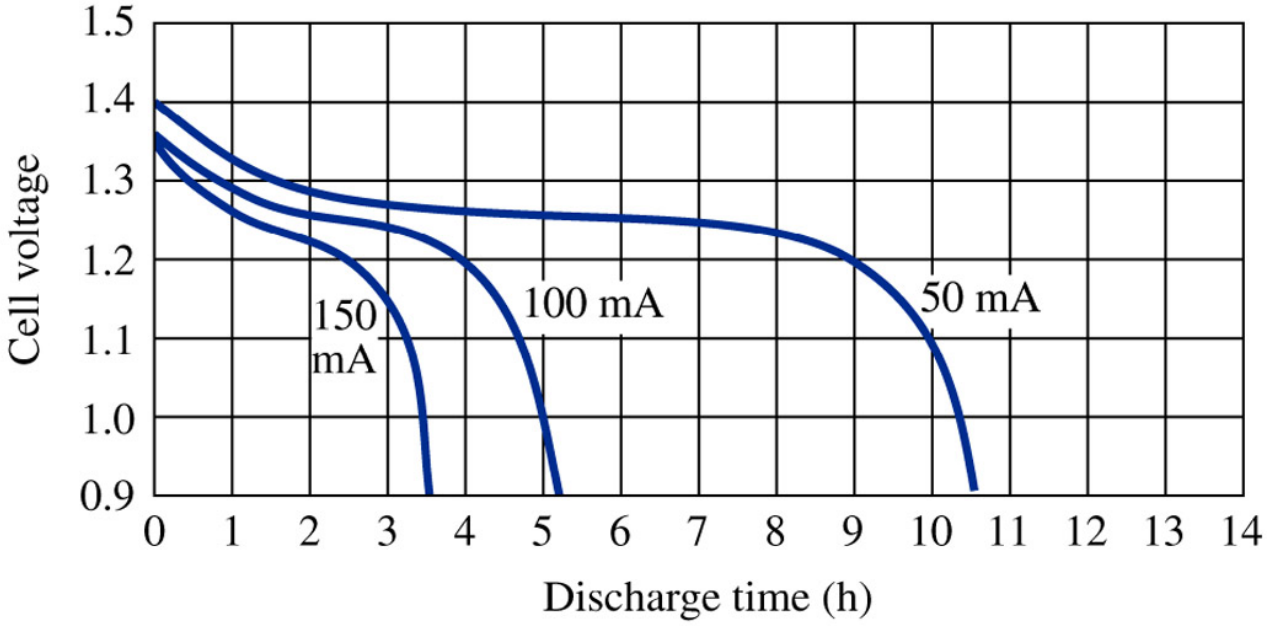
The capacity of a battery (in ampere-hours) will decrease from its room-temperature level with very cold and very warm temperatures



Eveready®
BH 500
Cell (Ni-Cad)
1.2V,
500mAh

Battery Life Factor : Duration

The terminal voltage of a battery will eventually drop if the duration of continuous discharge is too long.



Eveready®
BH 500
Cell (Ni-Cad)
1.2V,
500mAh

Conductors

- Conductors are those materials that permit a generous flow of electrons with very little external force (voltage applied).

- Good Conductors typically have only one electron in the valence (most distant from the nucleus) ring.

Material	***Relative Conductivity***
Silver	105.00 %
Copper	100.00 %
Gold	70.50 %
Aluminum	61.00 %
Tungsten	31.20 %
Nickel	22.10 %
Iron	14.00 %
Constantan	3.52 %
Nichrome	1.73 %
Calorite	1.44 %

Insulators

- Insulators are those materials that require a large applied potential (voltage) to establish a measurable current level.
- Insulators are those materials that have very few free electrons.

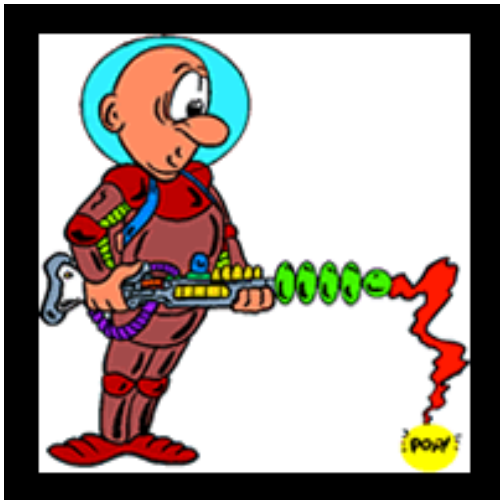
Material	***Breakdown Strength (kV/cm)***
Air	30
Porcelain	70
Oils	140
Bakelite	150
Rubber	270
Paper	500
Teflon	600
Glass	900
Mica	2000

Tidbit – Stun Guns

$$Voltage = \text{Break Down Strength}_{AIR}\ (\frac{V}{CM}) \times \text{Distance (CM)}$$

$$\text{Voltage} = \left[\frac{30\ \text{kV}}{\text{cm}}\right] \times 0.75\ \text{in} \times \left[\frac{2.54\text{cm}}{\text{in}}\right]$$

$$\text{Voltage} = 57{,}150\ \text{volts}$$

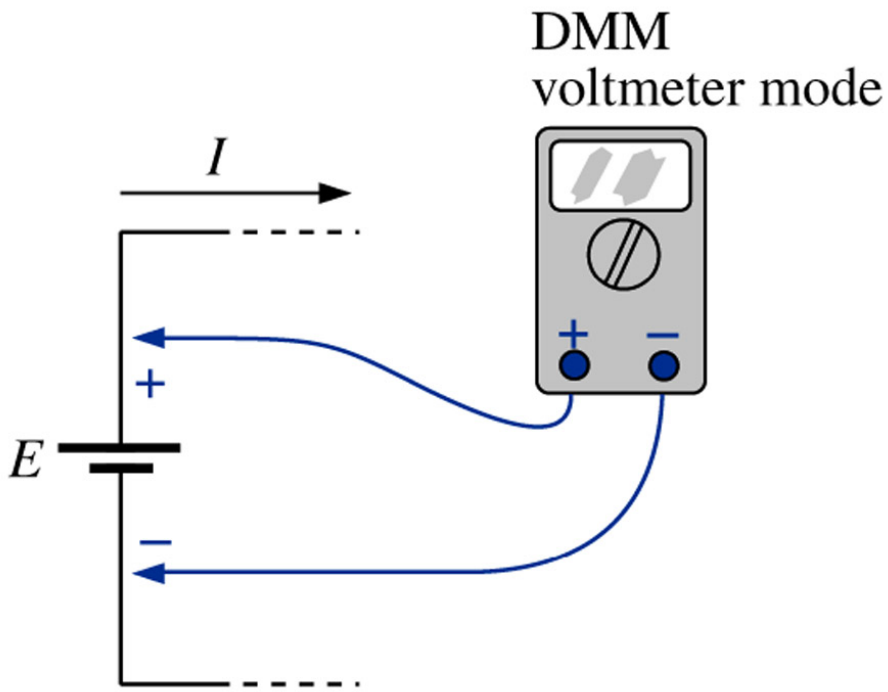


Semi-Conductors

- Semiconductors are a specific group of elements that exhibit characteristics between those of insulators and those of conductors.
- Semiconductor materials typically have four electrons in the outermost valence ring.
- Semiconductors are photoconductive. Photons from incident light can increase the carrier density of the material.
- Semiconductors have a negative temperature coefficient whereas the resistance decreases as the temperature increases.
- More on semiconductors in future courses.

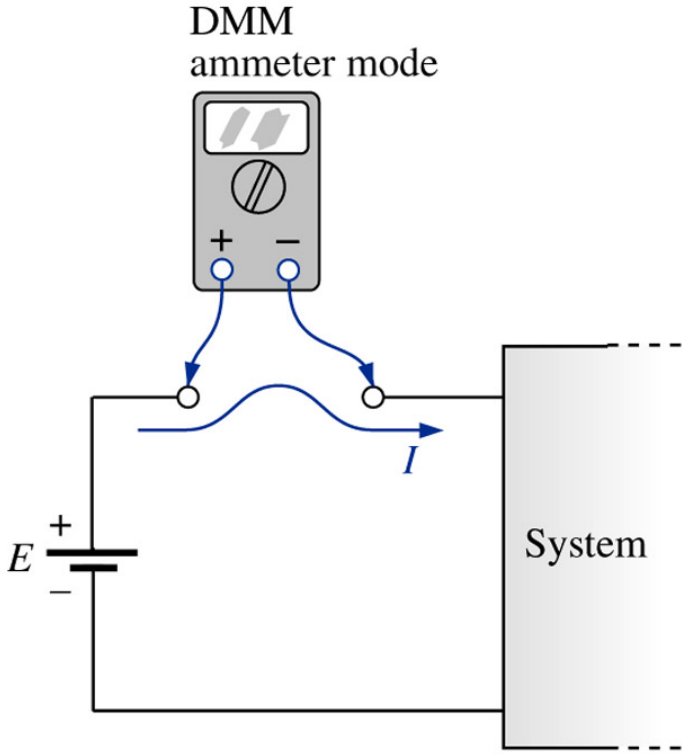
Voltmeter

- Used to measure voltage in an operating circuit.
- Voltage measurements are non-intrusive (ie. no changes need to be made to the circuit to make the measurement)



Ammeter

- Used to measure current in an operating circuit.
- Current measurements are intrusive (ie. changes need to be made to the circuit to make the measurement)

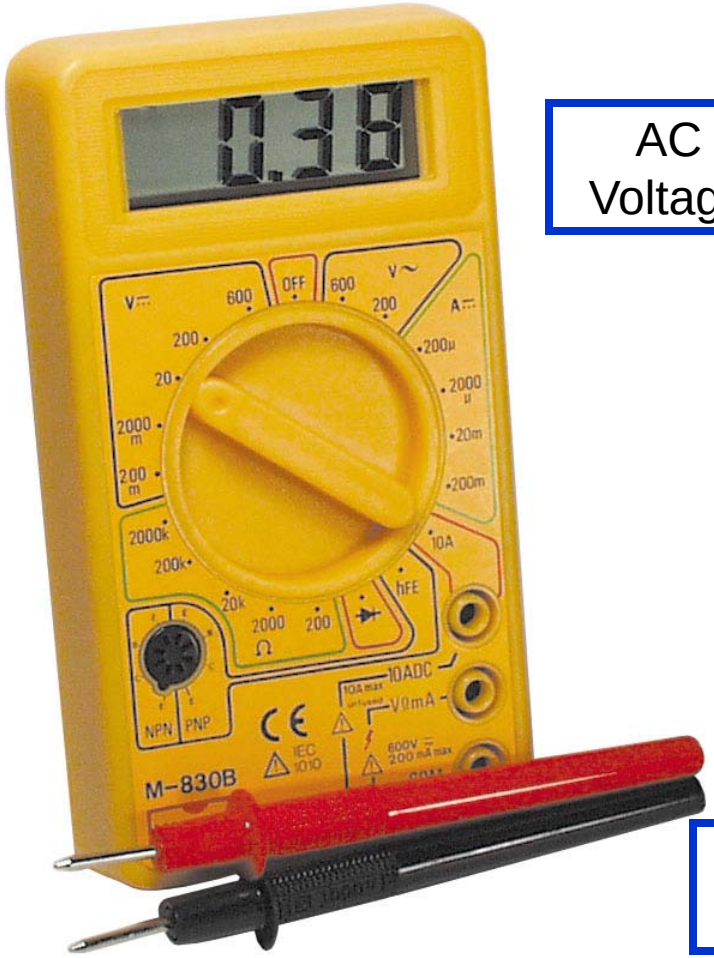


Multi-Meters….

Digital (DMM)

Analog

Basic Digital Multi-Meter (DMM)



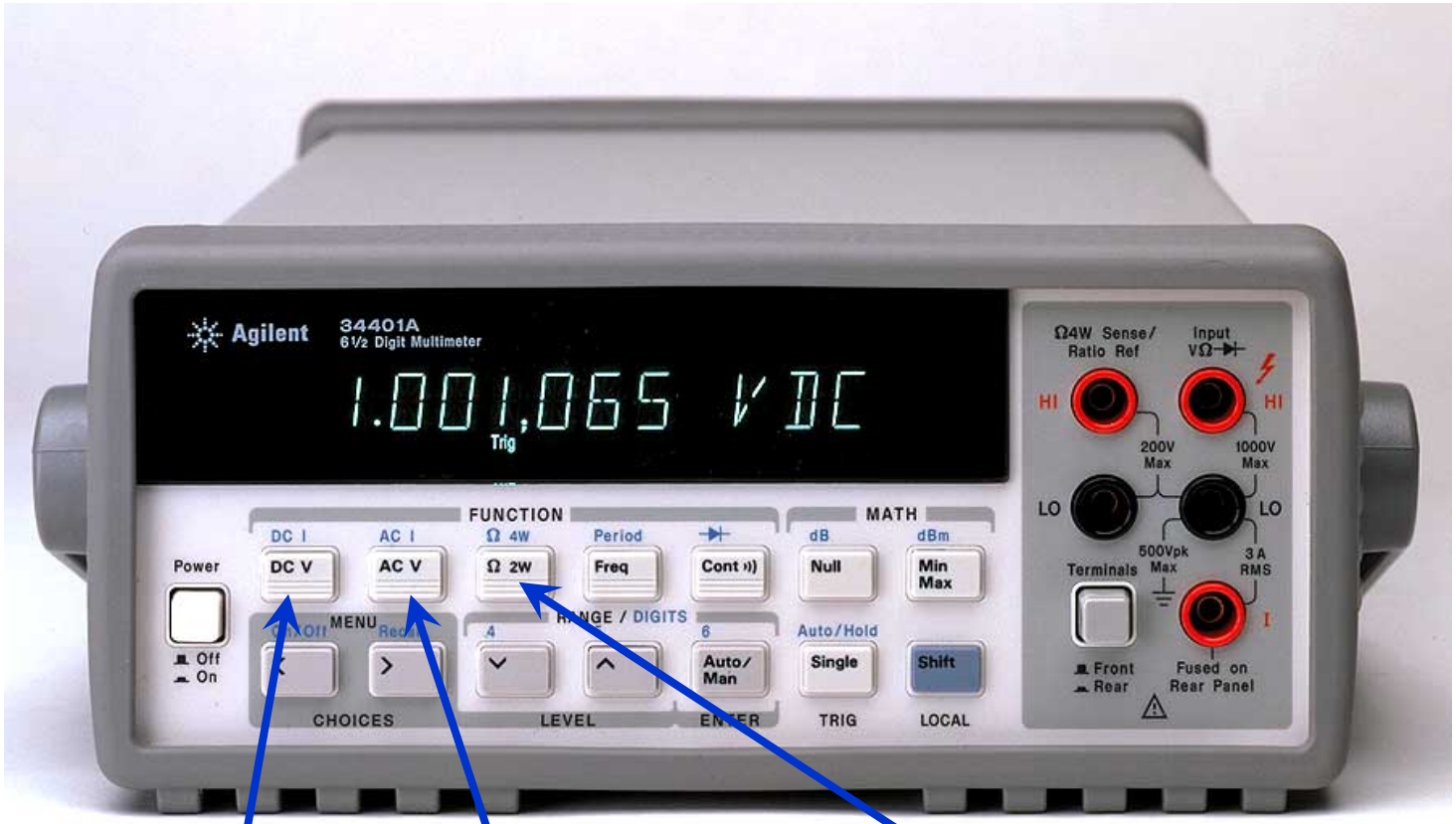
DC Voltage

AC Voltage

Resistance

DC Current

Professional Digital Multi-Meter

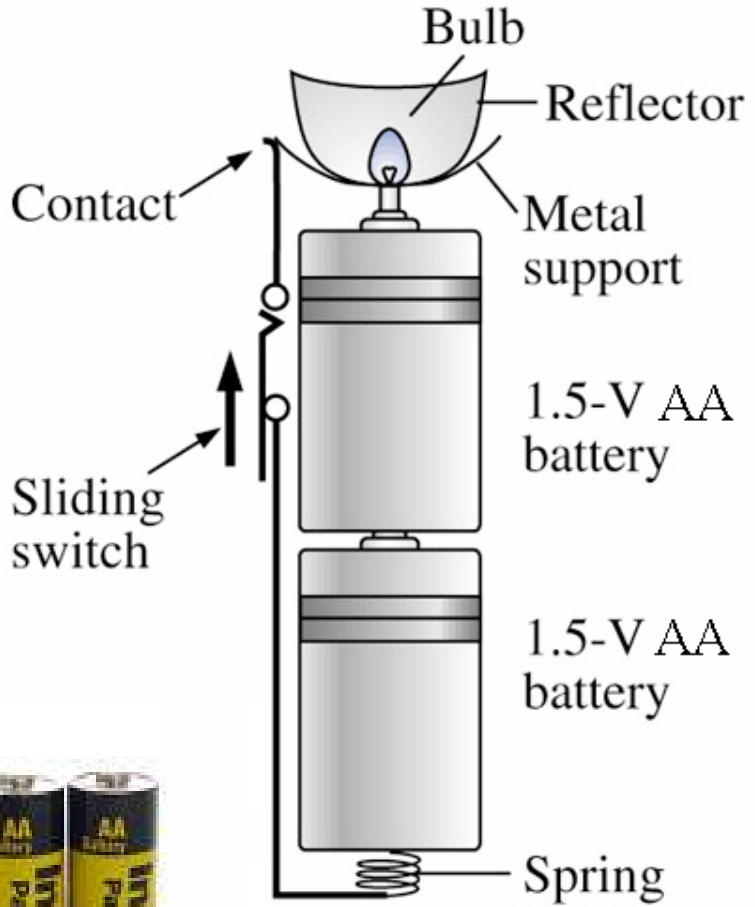


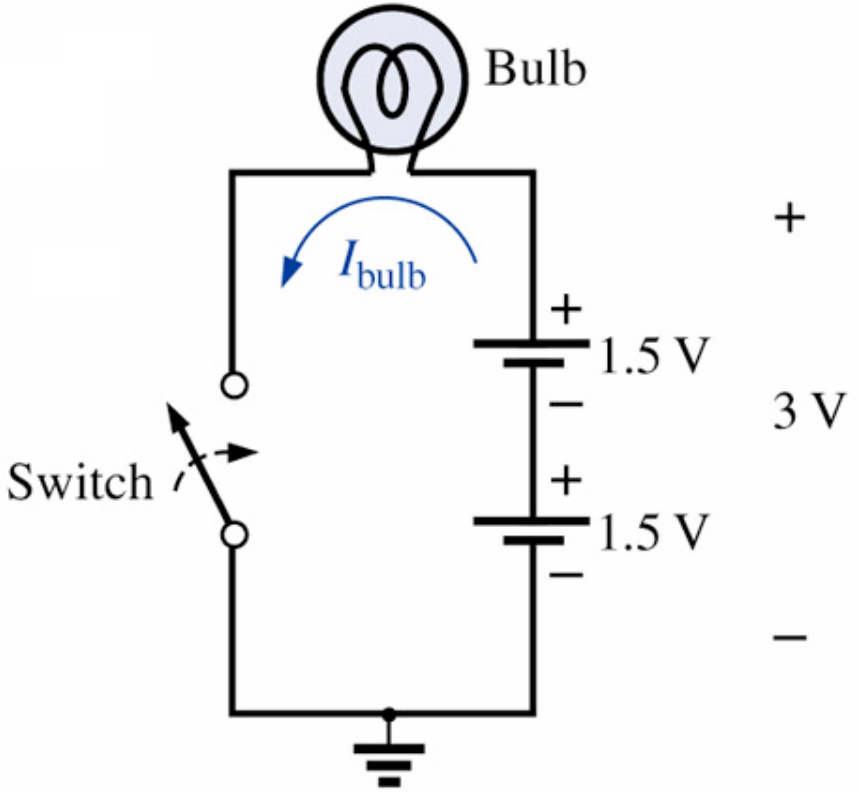
DC Voltage & Current

AC Voltage & Current

Resistance

Application : Flash Light



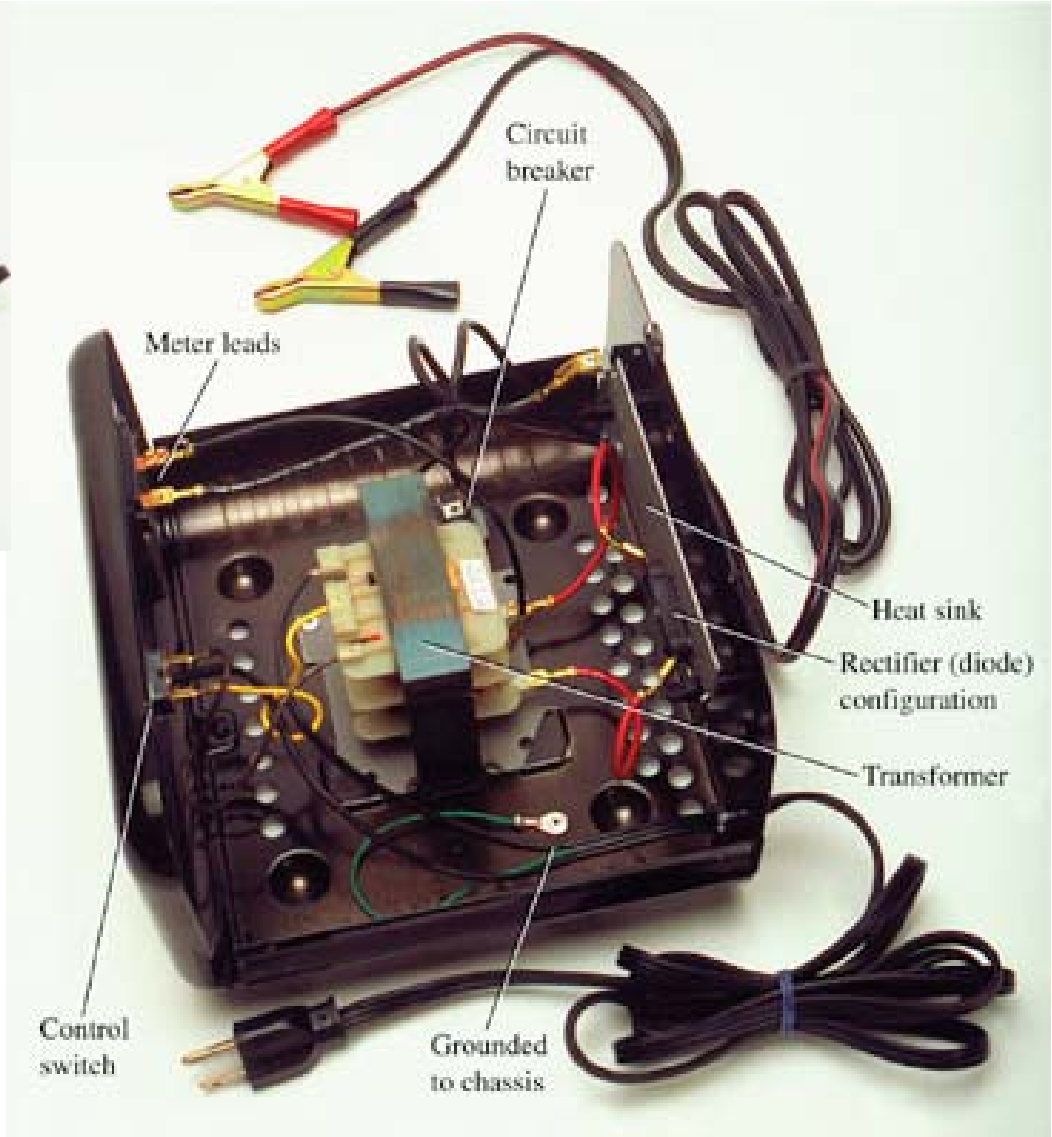


Breakout Exercise #2

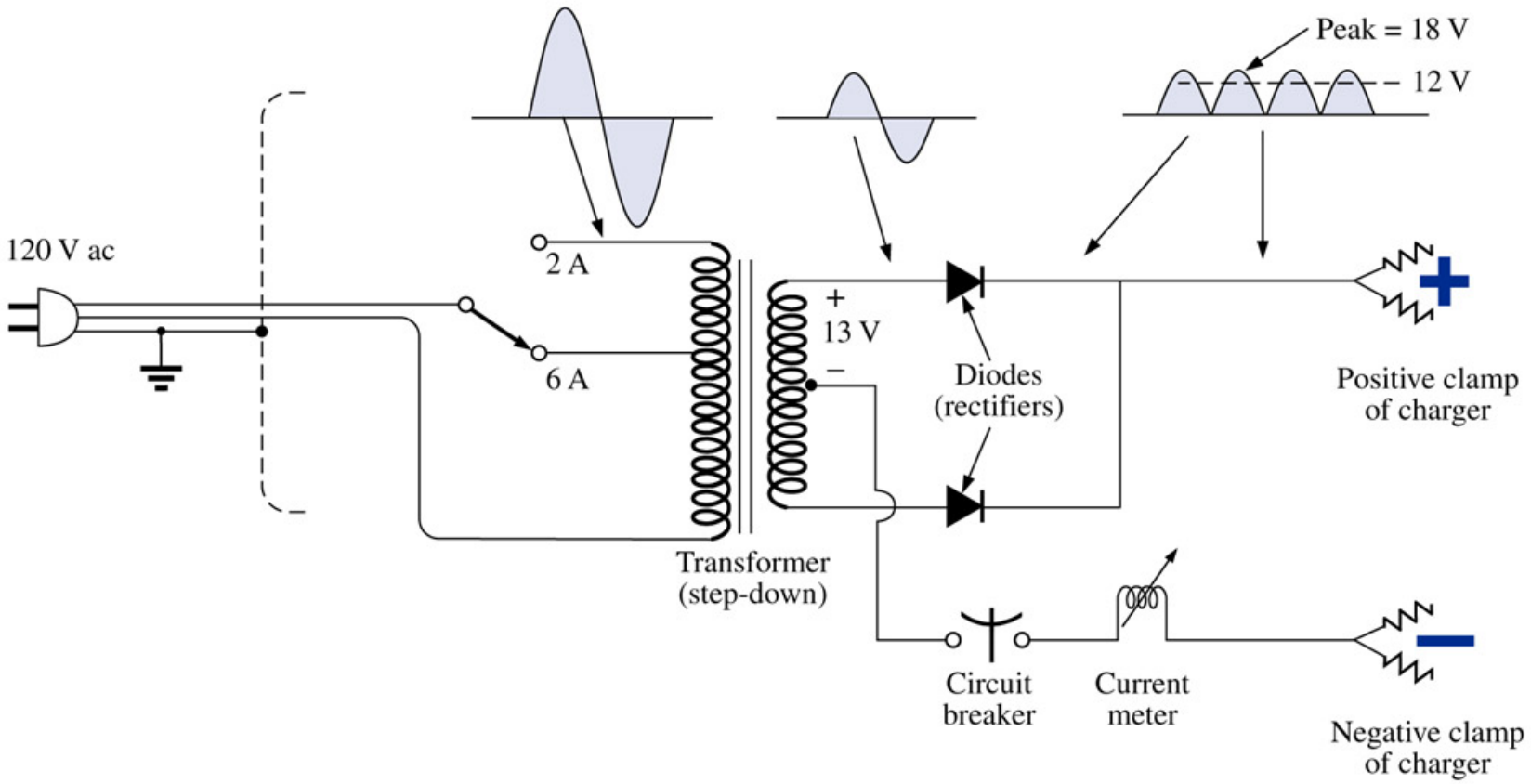
A Mini-Mag Light can be purchased with an incandescent bulb or a LED array. The incandescent bulb draws 350 mAmps and the LED array draws 180 mAmps. For these two bulb types, calculate the usage time (battery life) for the four batteries listed below.

Battery Type (all AA)	Capacity (mAh)	Incandescent Bulb	LED Array
Nickel-Metal Hydride	1550		
Nickel Cadmium	1000		
Lithium	3000		
Alkaline	2780		

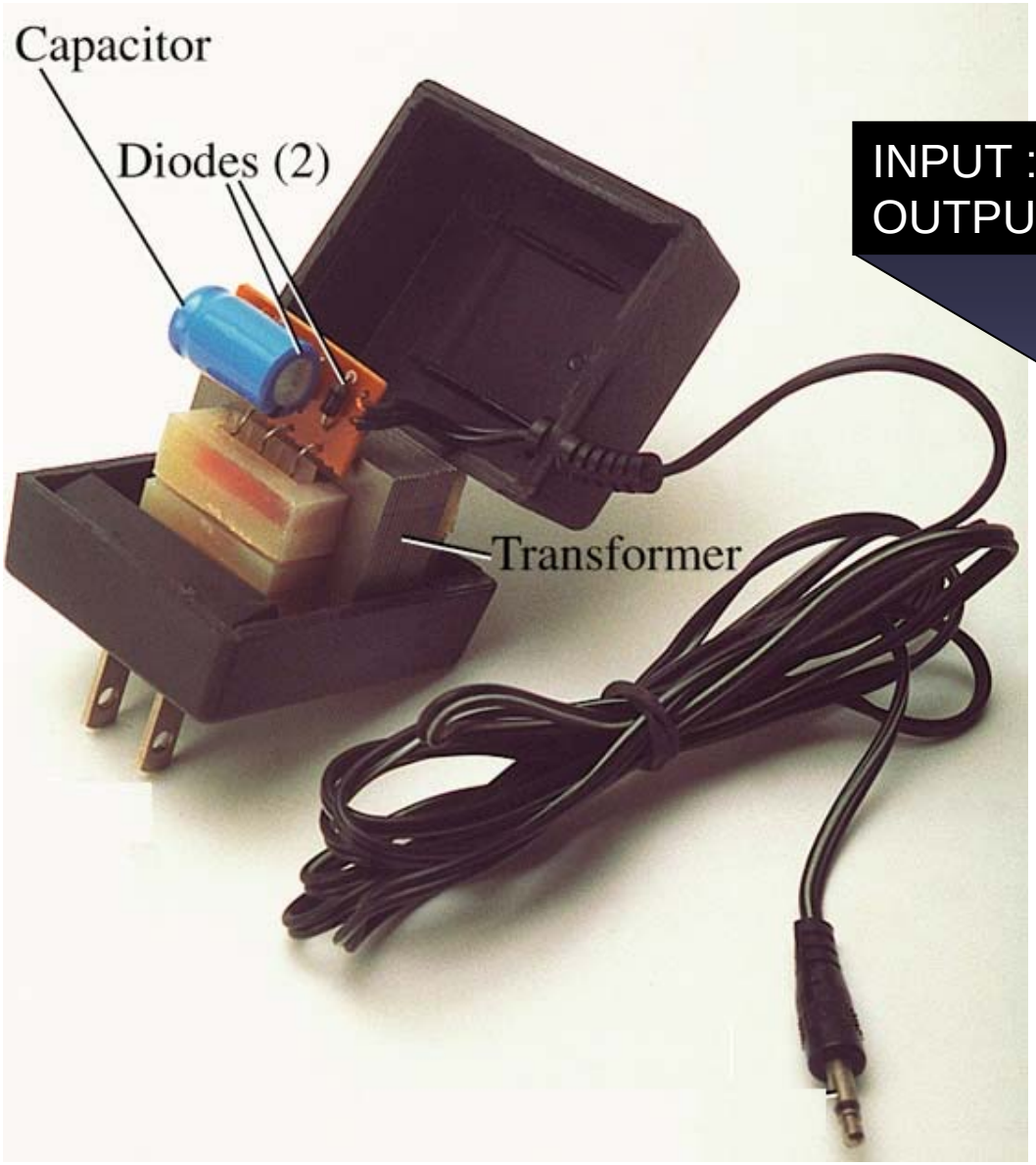
Application : Battery Charger



Battery Charger Schematic



"Wall-Wart"


Capacitor
Diodes (2)
Transformer


INPUT : 120VAC 60Hz 16W
OUTPUT : 12VDC 1A