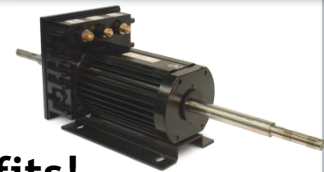




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*Welcome to the MCI*LEARN Series

Your Webinar Will Begin Shortly

Today's Topic:

Basic Electrical: Going with the flow

If you do not have an audio connection, dial 877-739-5904 and enter the Audio PIN number given to you on your screen



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Learning Objective

When finished with this course the mechanic should have a better understanding of the following:

- Electrical Circuitry
- Fundamentals/Laws
 - Ohm's Law
 - Power Circle
- “Some” Electrical Components
- Batteries

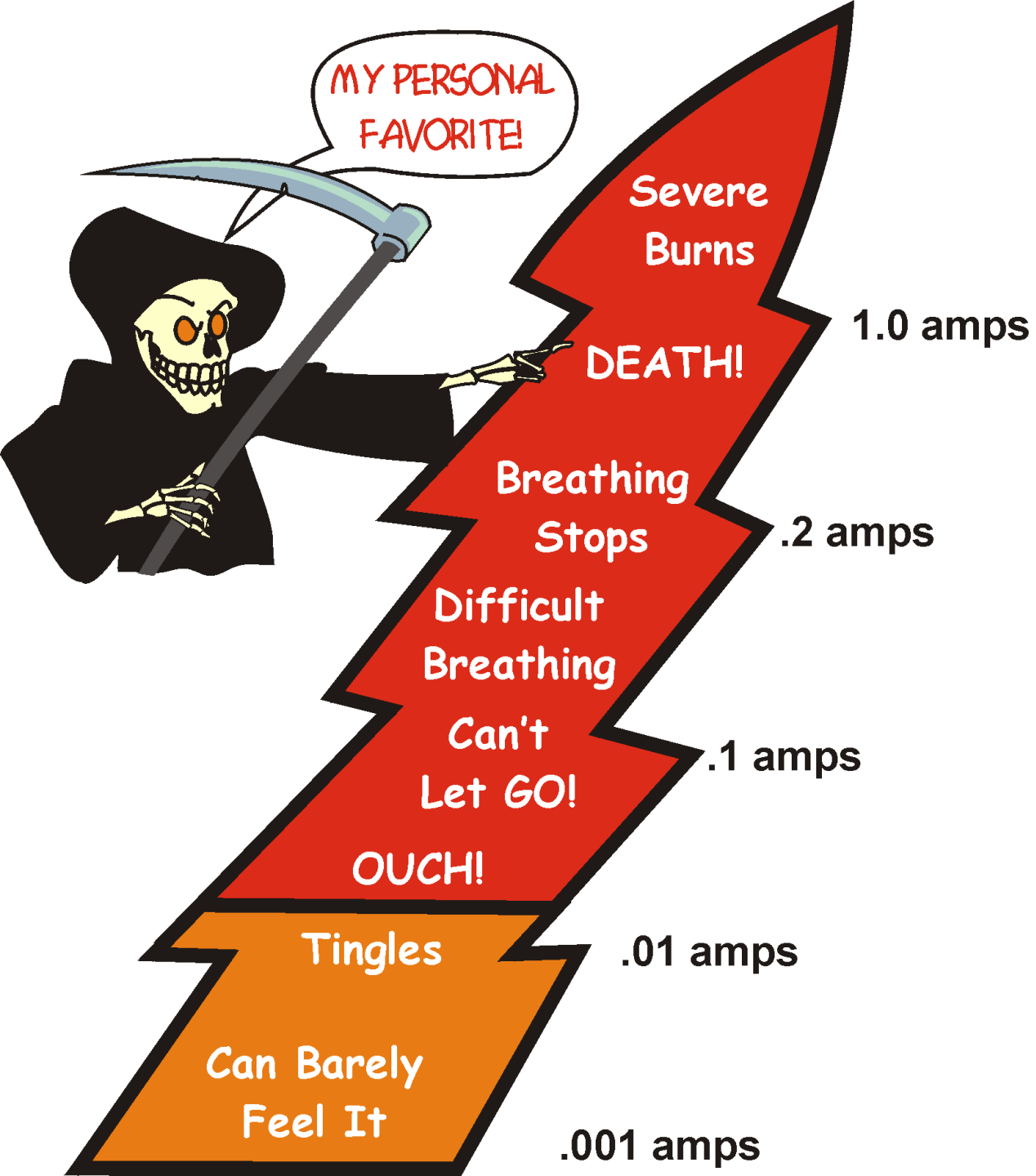


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Safety Message

- Always use personal protection devices
 - Safety glasses, ear protection, etc
- Always observe all safety precautions listed Maintenance Manual including but not limited to:
 - Ensure coach is on a level surface
 - Ensure parking brake is applied
 - Chock wheels
 - Always use jack stands
 - Shut off batteries
 - Utilize Lock Out/Tag Out procedures





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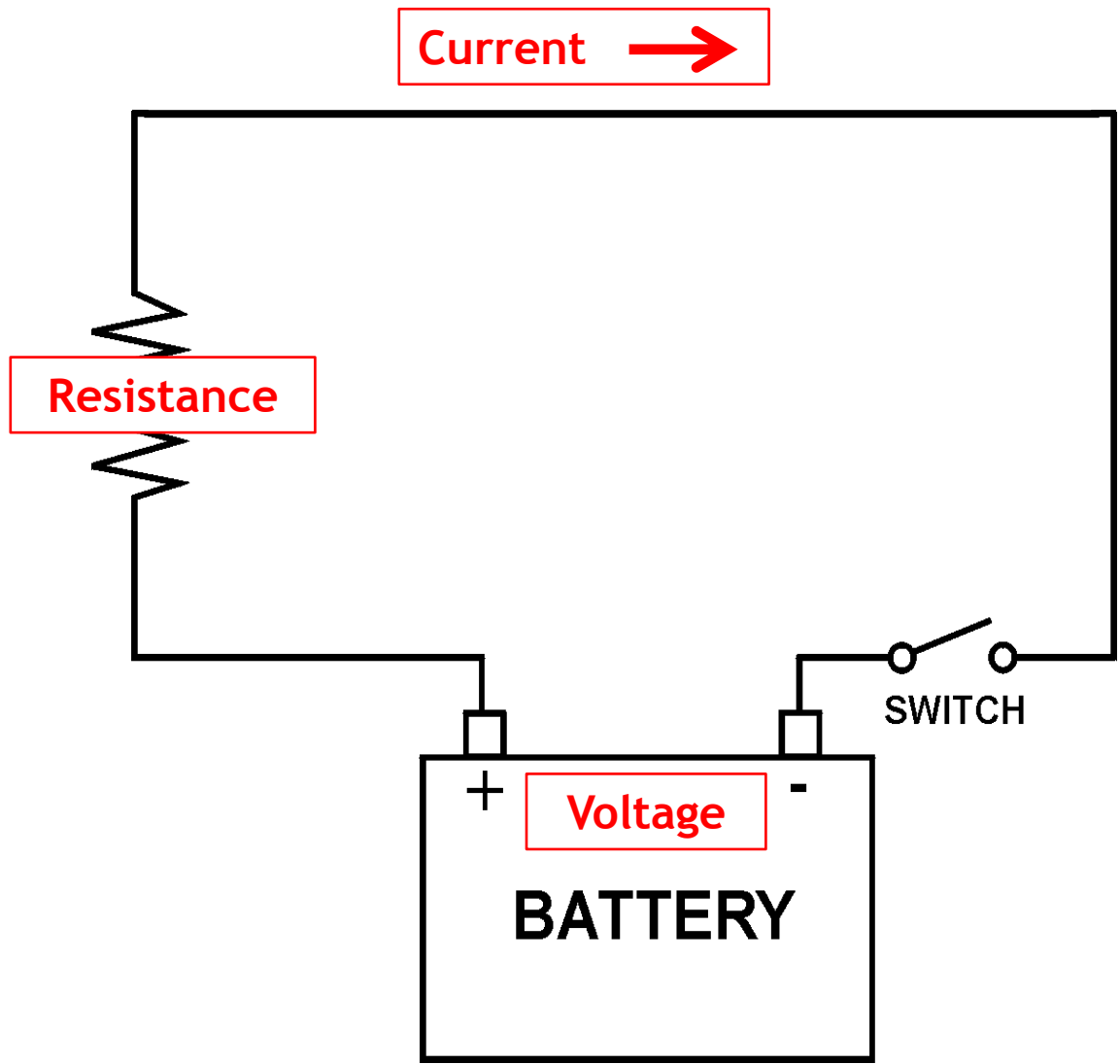
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Fundamentals



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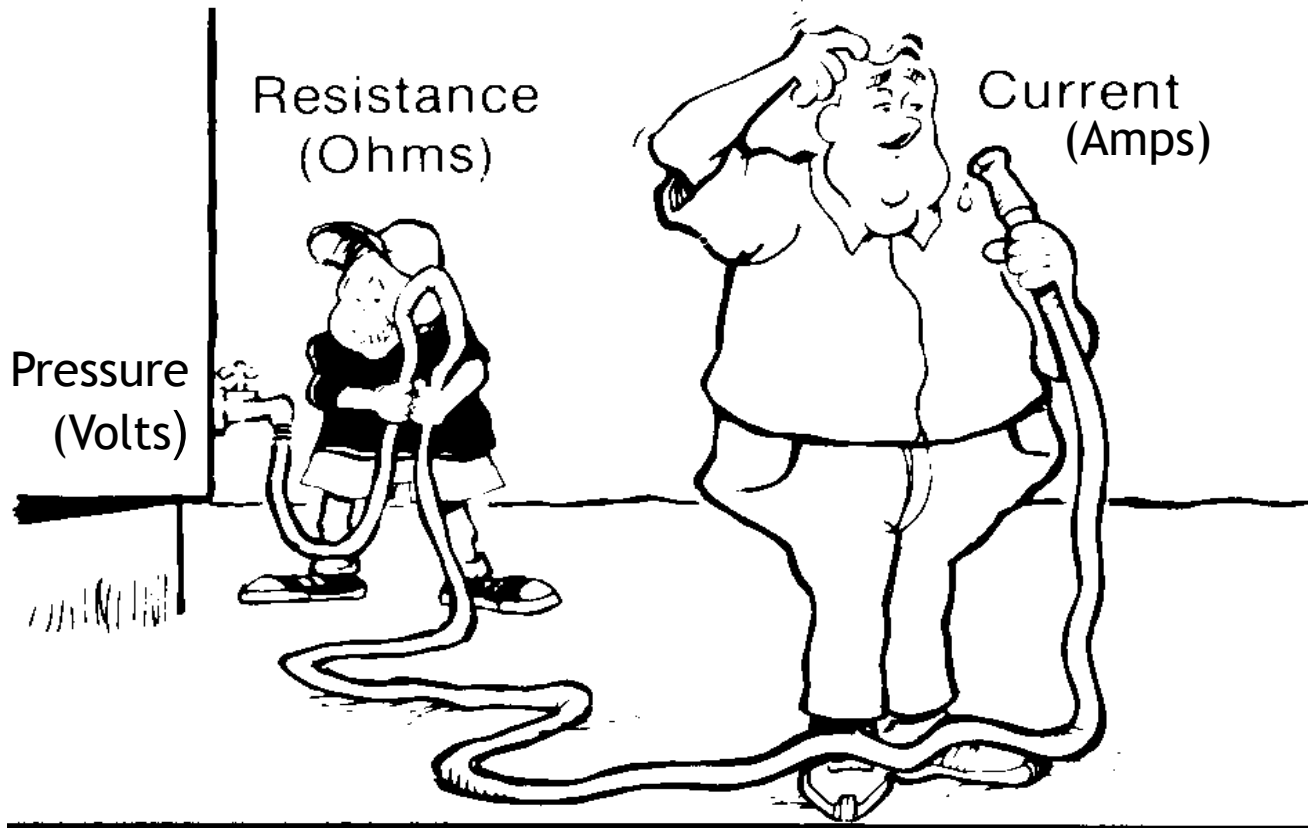
An Electrical Circuit





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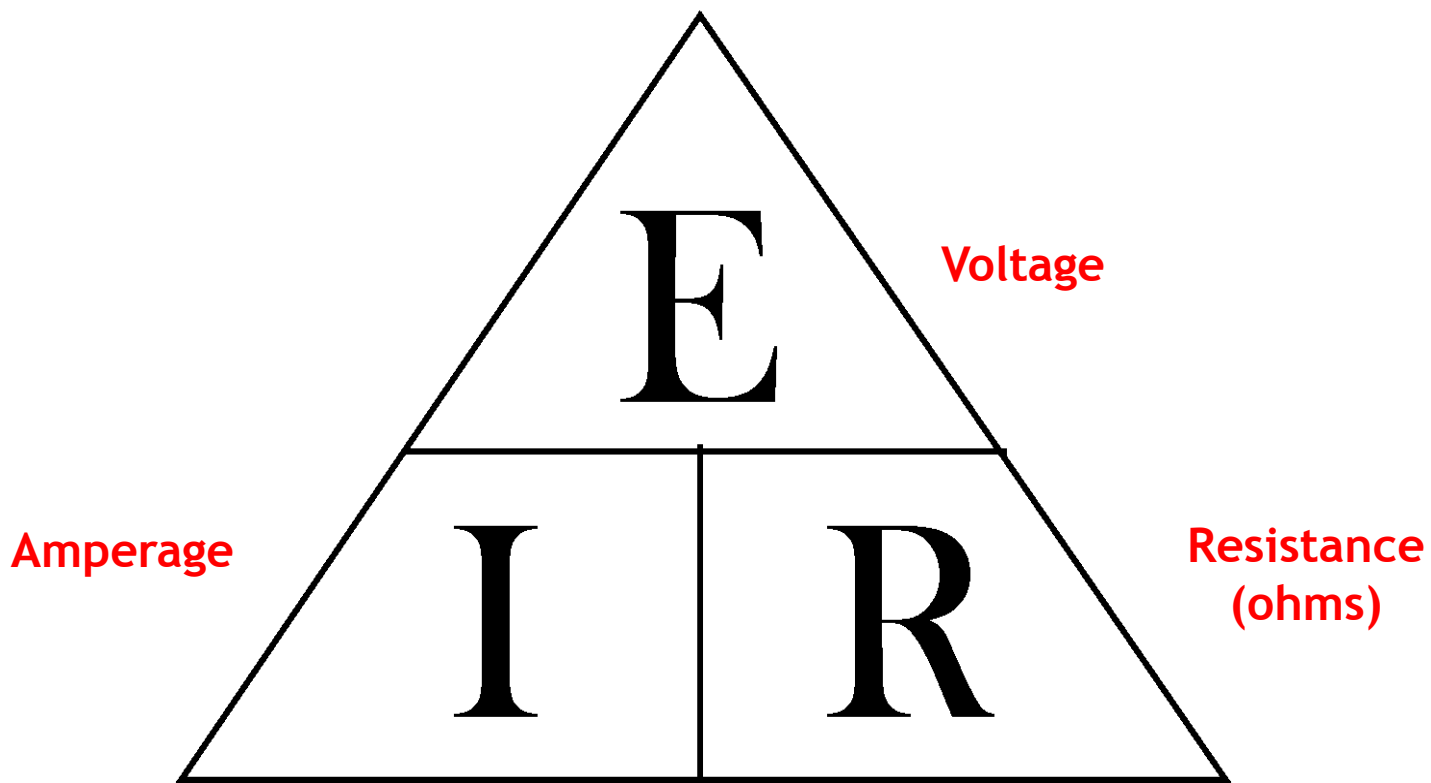
Fundamentals of Electricity





Ohm's Law Chart

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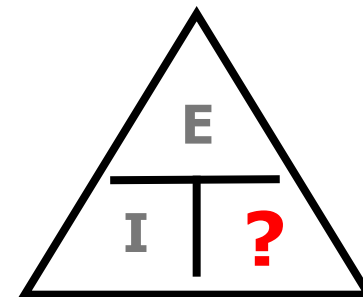
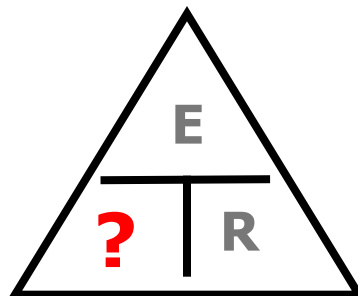
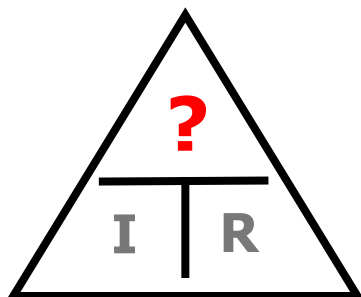




Ohm's Law at Work

The change in **ONE** property, has a direct effect upon the operation of the remaining properties

$$\begin{aligned} E &= I \times R & (E=IR) \\ I &= E \div R & (I=E/R) \\ R &= E \div I & (R=E/I) \end{aligned}$$





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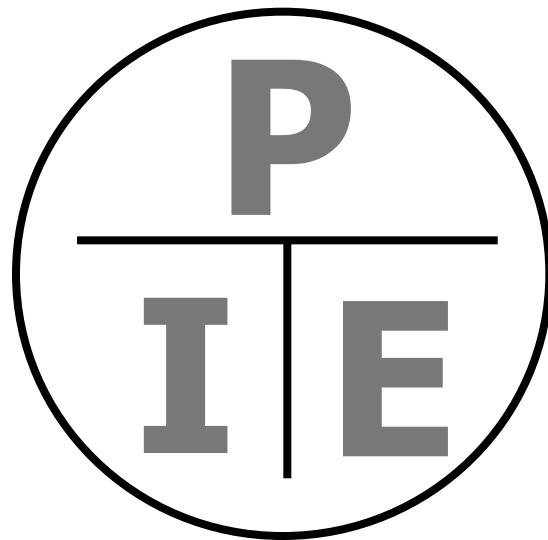
Power Circle

- **1 WATT** of work is performed by (P)
- **1 VOLT** of electrical pressure on (E)
- **1 AMP** of current (I)

A 12 Volt, 4 AMP circuit is performing 48 WATTS of work

How much work is performed in a 24 Volt 6 AMP application ?

144 WATTS





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Series Circuits Laws

- Circuit Resistance is the SUM of ALL resistances in the Circuit
 - $R1 + R2 (+Rx + Rx) = \text{Effective Circuit Resistance}$
- Circuit Current flow is the same in ALL parts of the Circuit
- Source Voltage is equal to the SUM of ALL Voltage drops in the Circuit
 - $VD1 + VD2 (+VDx + VDx) = \text{SOURCE VOLTAGE}$



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Voltage Drop

- Applied voltage is consumed through the circuit
 - All voltage is used in the circuit: Zero at Ground
 - Voltage Drop occurs at EACH resistance
- Voltage Drop is proportional to the individual resistance values of the circuit
 - Equal resistances ‘drop’ equal voltages
 - Higher resistances ‘drop’ higher voltages



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Measuring Voltage Drop

At various point of the Circuit:

A = ?

B = ?

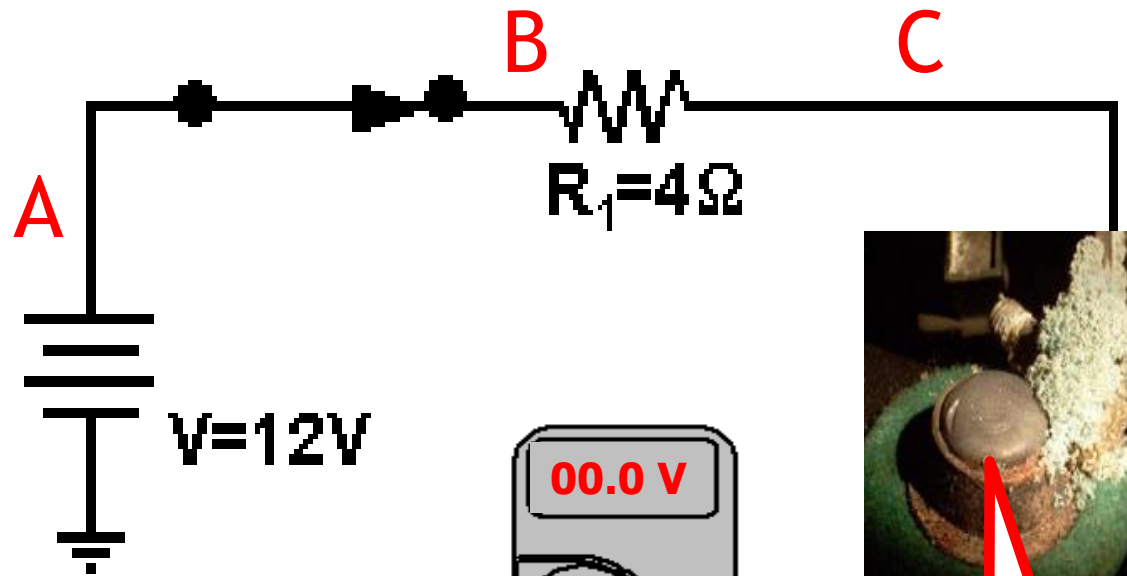
C = ?

D = ?

B to C = ?

C to D = ?

Total Current: **2 Amps**





Wire Gauge and Current Limits

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AWG gauge	Diameter Inches	Diameter mm	Ohms per 1000 ft	Ohms per km	Maximum amps for chassis wiring	Maximum amps for power transmission
0000	0.46	11.68	0.05	0.16	380	302
000	0.41	10.40	0.06	0.20	328	239
00	0.36	9.27	0.08	0.26	283	190
0	0.32	8.25	0.10	0.32	245	150
2	0.26	6.54	0.16	0.51	181	94
4	0.20	5.19	0.25	0.82	135	60
6	0.16	4.11	0.40	1.30	101	37
8	0.13	3.26	0.63	2.06	73	24
10	0.10	2.59	1.00	3.28	55	15
12	0.08	2.05	1.59	5.21	41	9.3
14	0.06	1.63	2.53	8.28	32	5.9
16	0.05	1.29	4.02	13.17	22	3.7
18	0.04	1.02	6.39	20.94	16	2.3
20	0.03	0.81	10.15	33.29	11	1.5
22	0.03	0.65	16.14	52.94	7	0.92
24	0.02	0.51	25.67	84.20	3.5	0.577

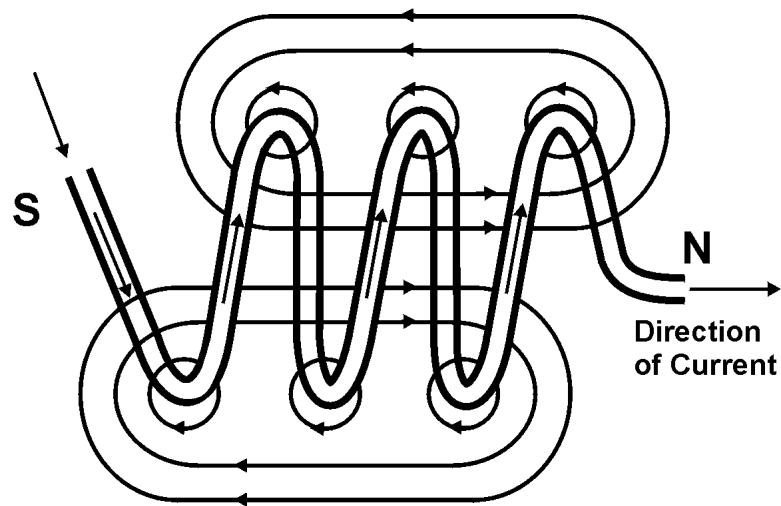
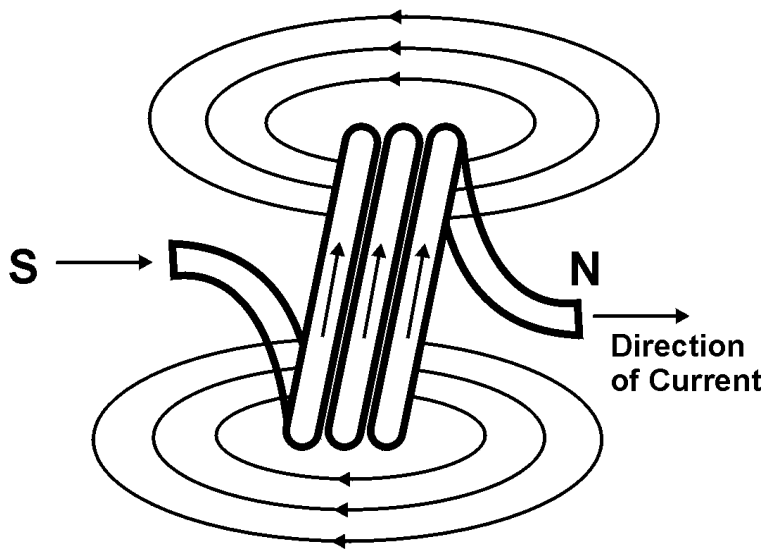
When the gauge of a conductor is decreased by three gauge numbers, it's cross-sectional area doubles. It's resistance is half as much.

Kiner's Rule of Thumb
2 Ω of resistance per 100 feet



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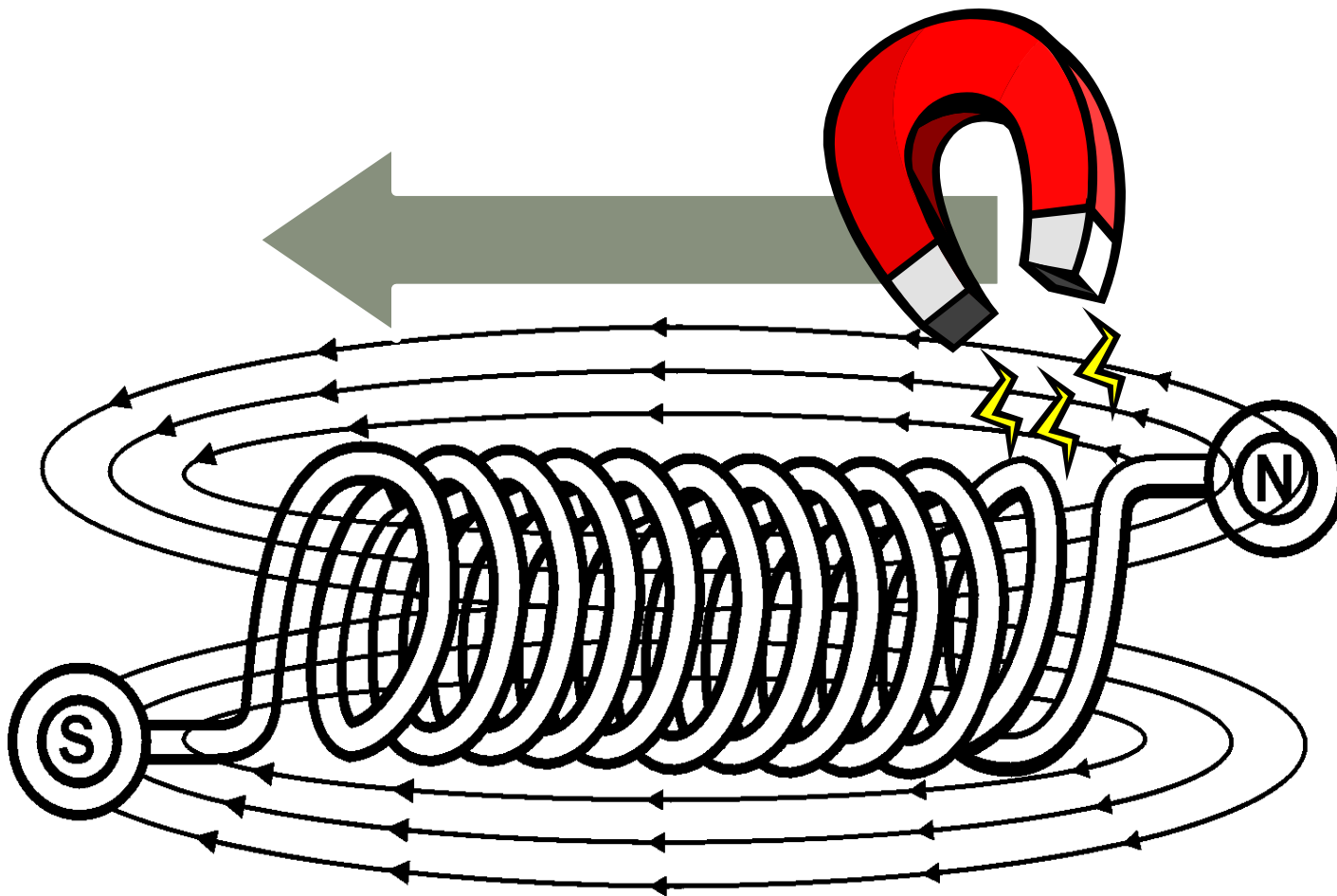
Fundamentals Of Electricity





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Use of Electromagnets

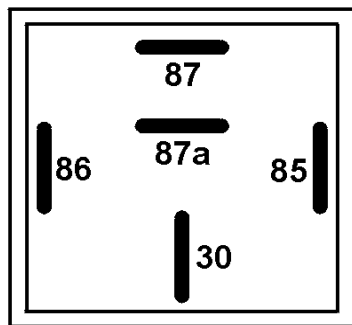
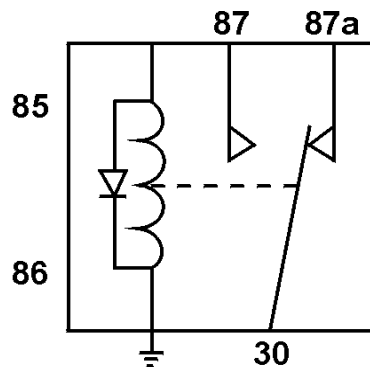




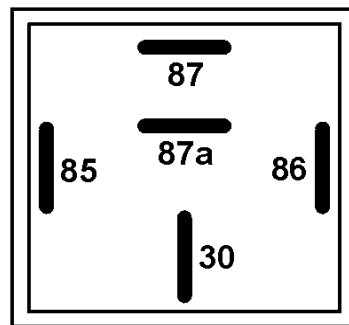
Basic Relay Terminals

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- 12 VOLT 40/30 AMP
- 24 VOLT 40/30 AMP
- 30 COMMON
- 85 COIL
- 86 COIL
- 87 NORMALLY OPEN
- 87a NORMALLY CLOSED



RELAY



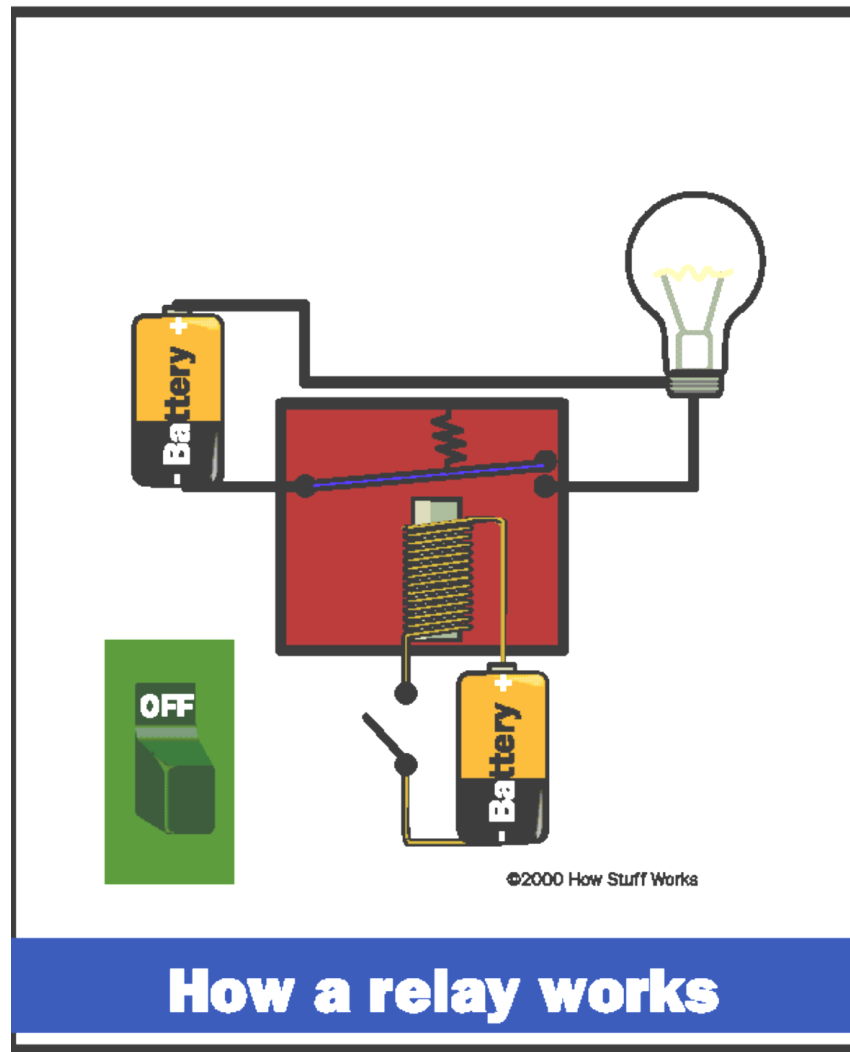
RELAY SOCKET

Relays



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How a Relay Works



How a relay works



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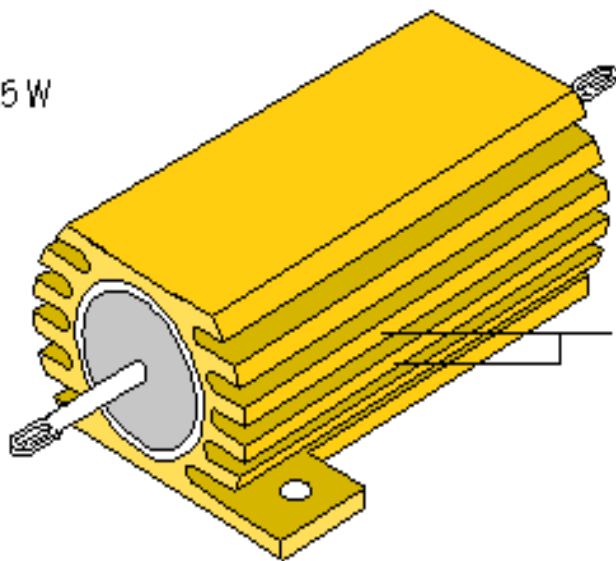
Resistors

0.25 W 

0.5 W 

1 W 

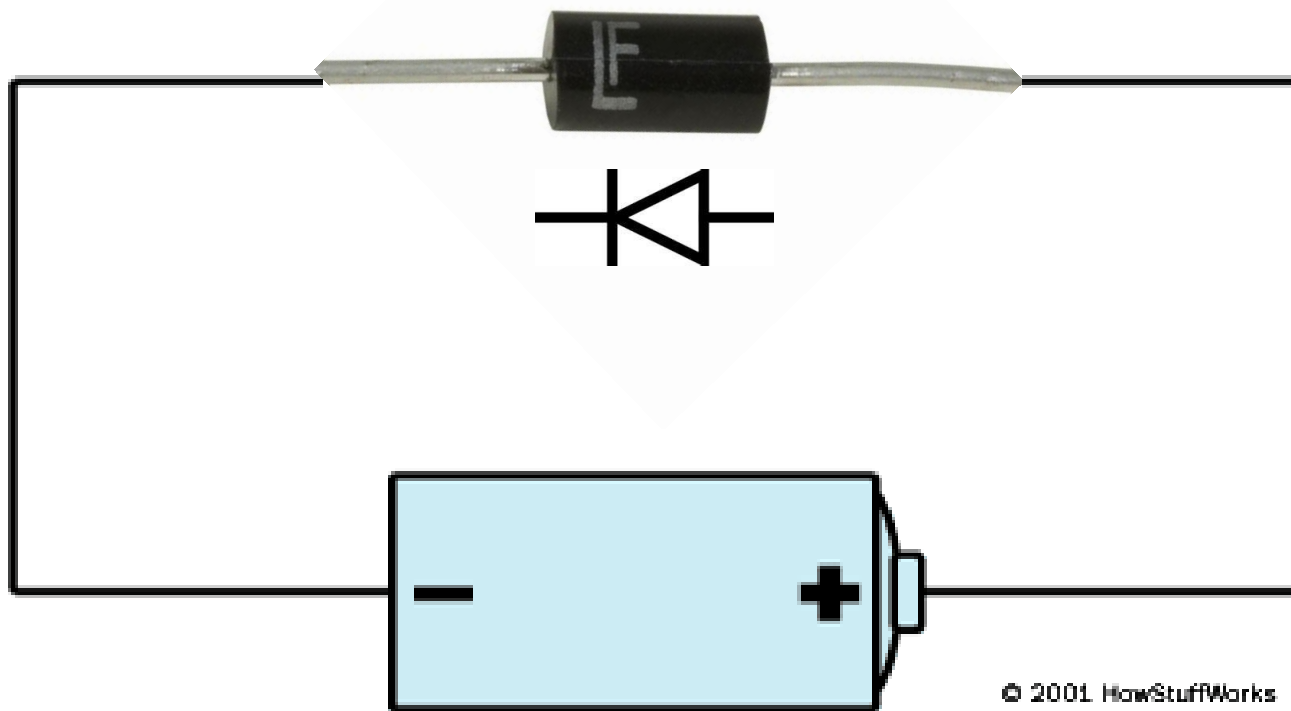
2 W 

25 W  aluminium fins



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How Diodes Work

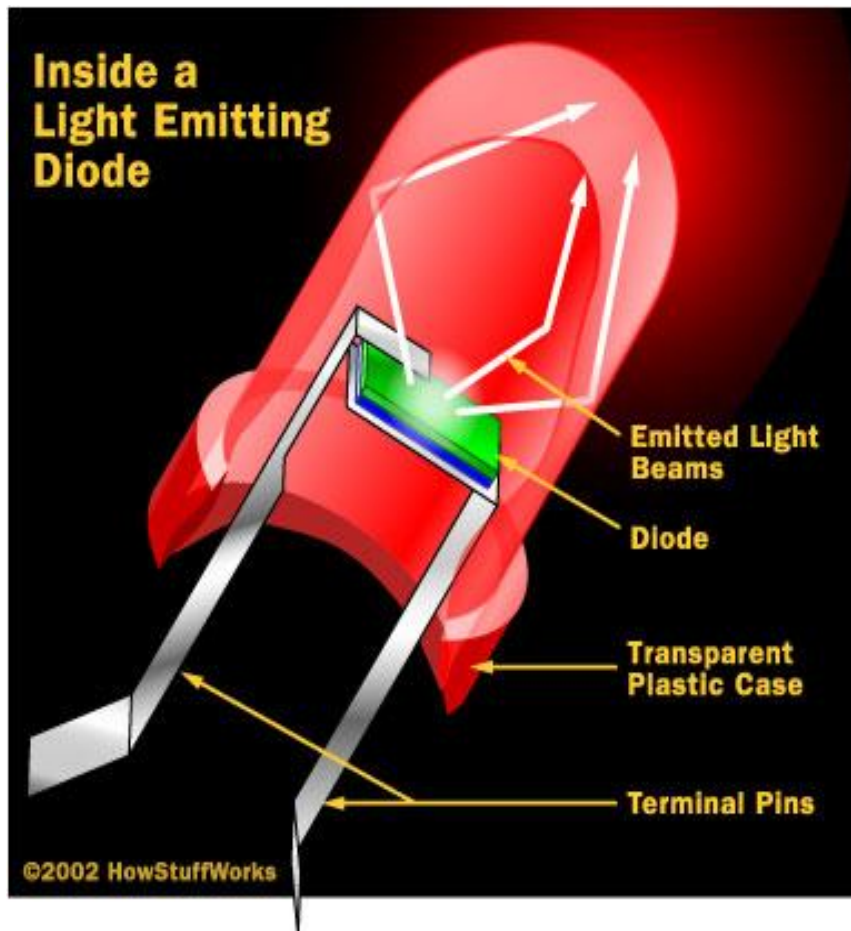


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Light Emitting Diodes





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Batteries



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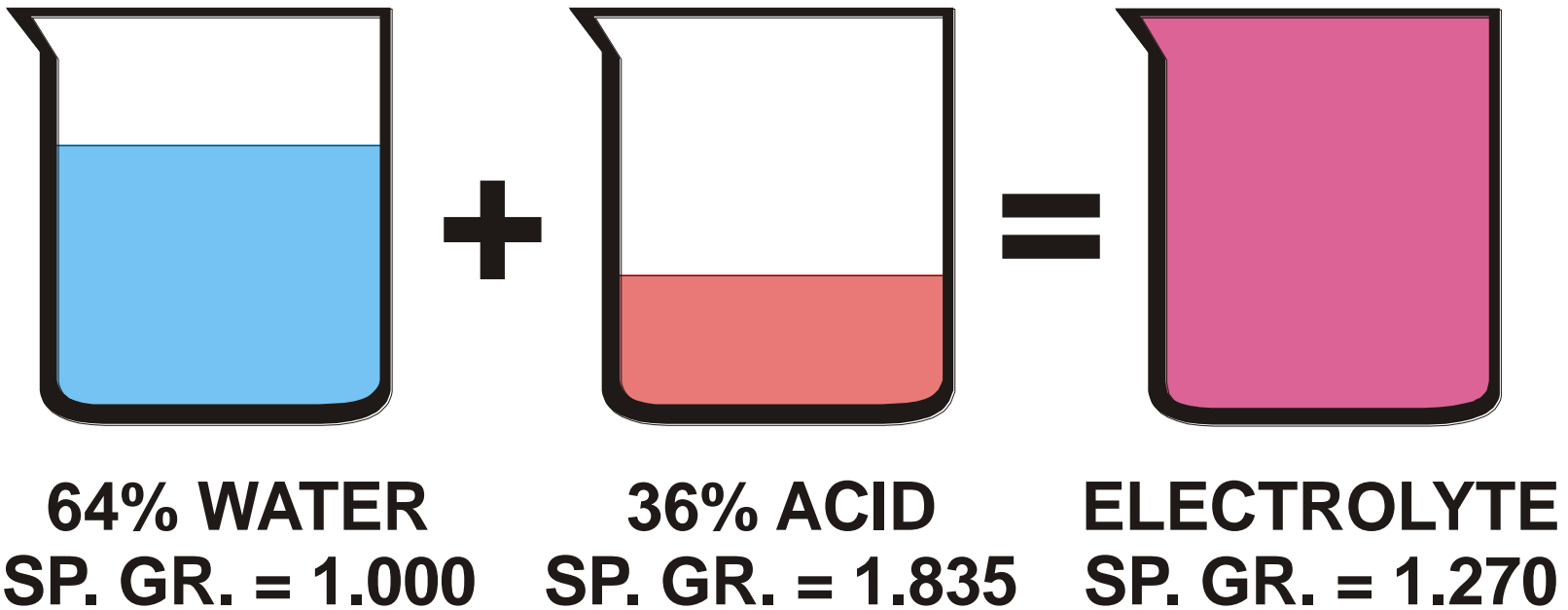
What is a Battery's Main Function?





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What is Electrolyte?





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How is Electrolyte Measured?

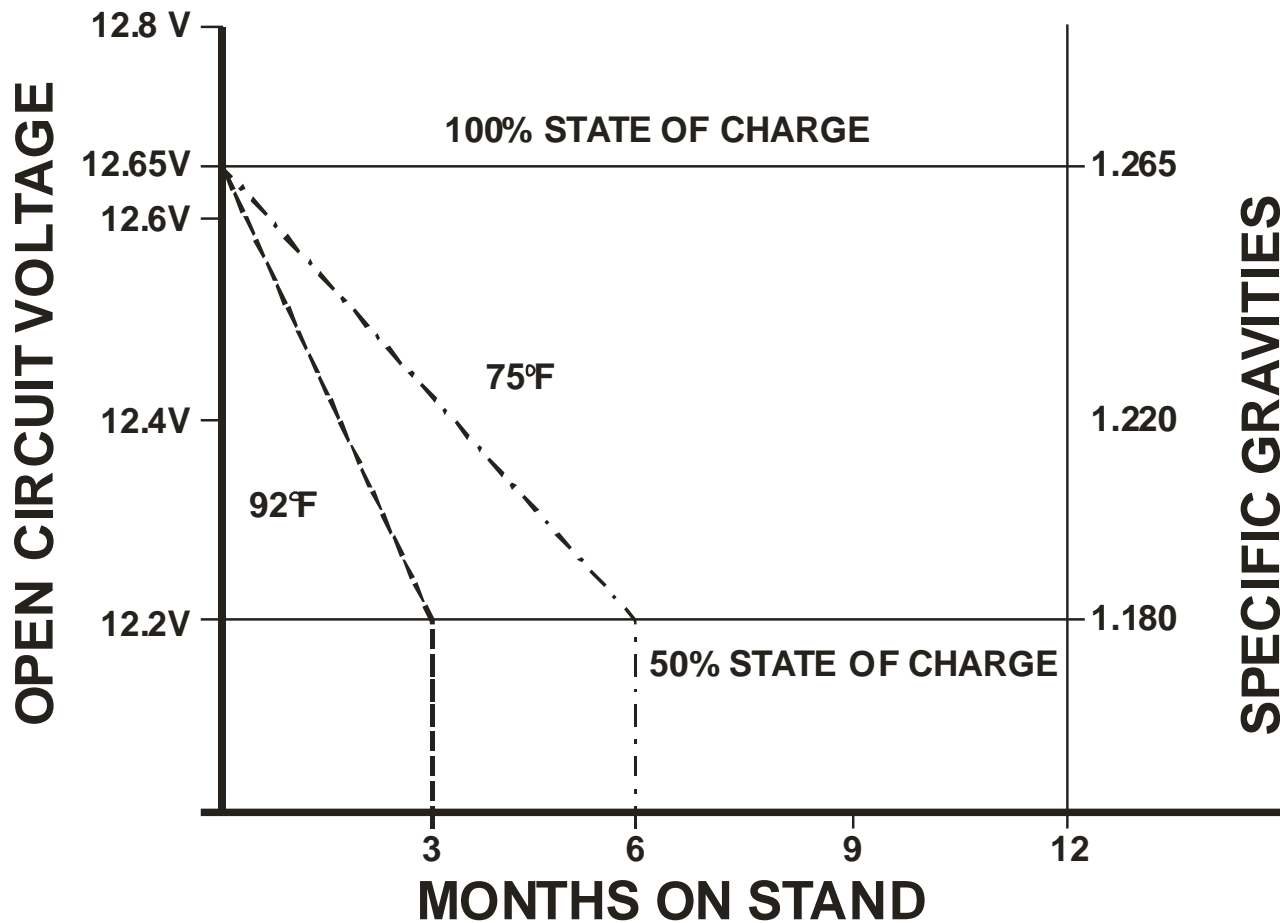
CHARGE LEVEL	SPECIFIC GRAVITY	VOLTAGE (12)
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
DISCHARGED	1.120	11.89



Effects on Batteries in Storage

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Effect of Storage Temperature On Self-Discharge- Typical Conventional Batteries





When Will Batteries Freeze?

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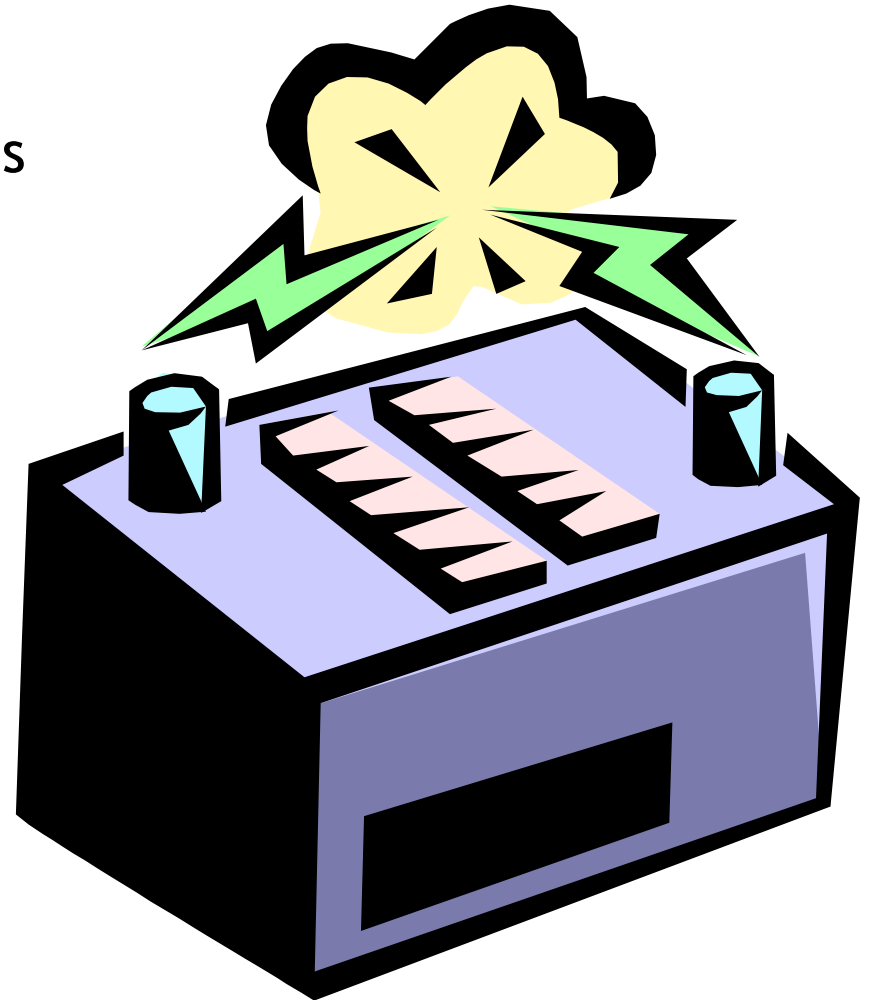
Value of Specific Gravity	Freezing Temp. Deg. F	Value of Specific Gravity	Freezing Temp. Deg. F
1.100	18	1.220	-31
1.120	13	1.240	-50
1.140	8	1.260	-75
1.160	1	1.280	-92
1.180	-6	1.300	-95
1.200	-17		



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Why Batteries Fail

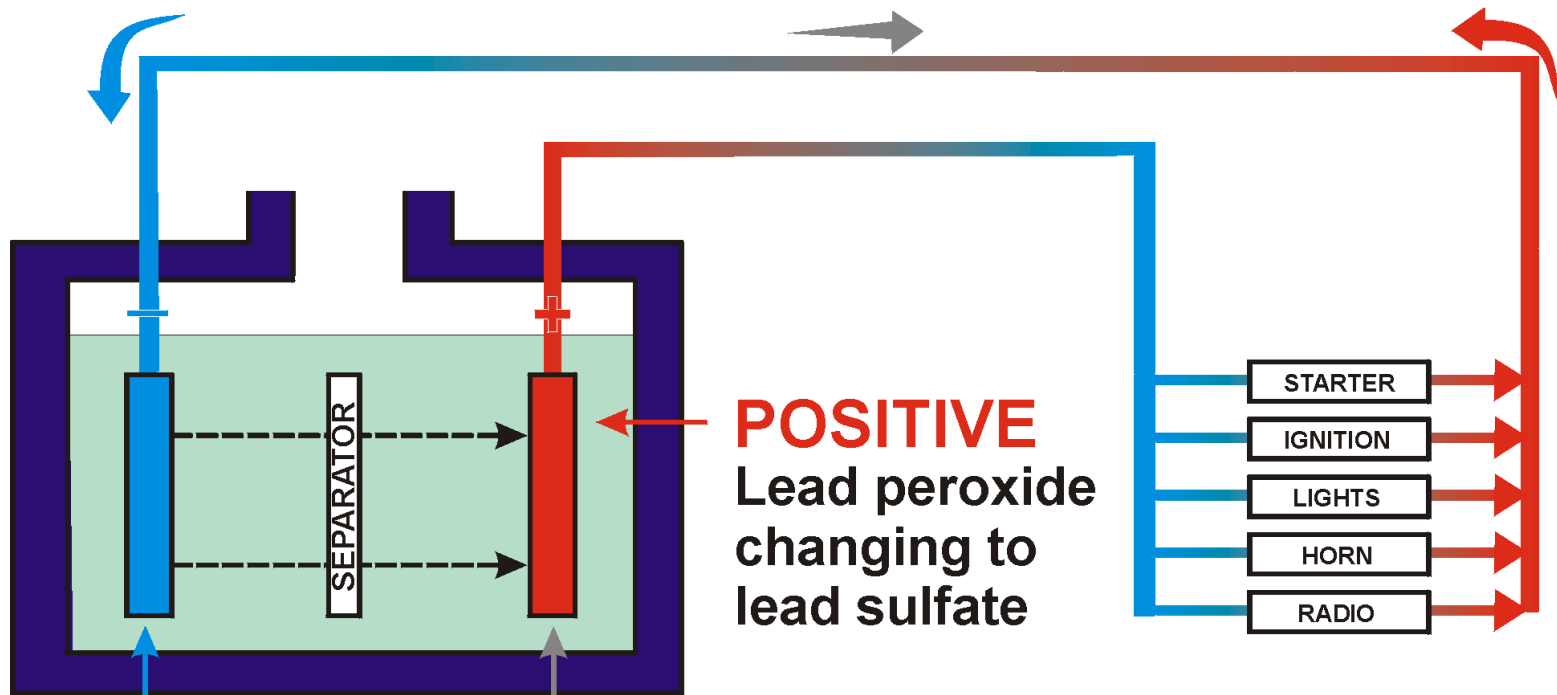
- All batteries eventually fail because of natural deterioration of the plates
- We can reduce early failure with proper maintenance
- Batteries are usually the fourth highest operating cost in most transit authorities





Discharge Process

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NEGATIVE
Spong lead changing to lead sulfate

POSITIVE
Lead peroxide changing to lead sulfate

ELECTROLYTE

The sulfate of sulfuric acid unites with active materials on plates leaving weaker acid solution. Hydrogen of acid and oxygen of lead peroxide combine to form water, diluting solution.



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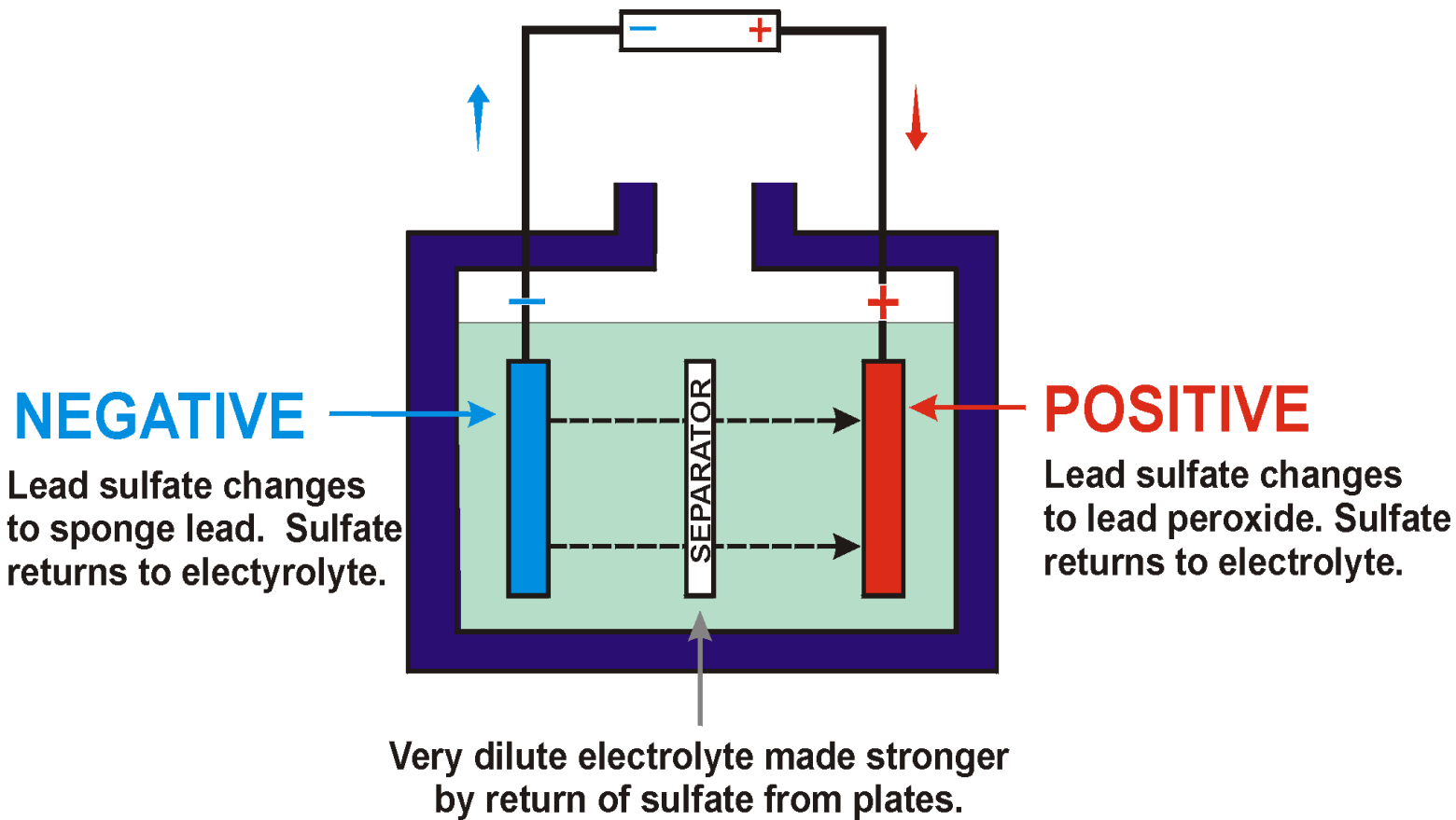
What Causes Batteries to Discharge

- Loads being accidentally left on
- Loads that are ON whenever the batteries are on, with coach not running
- Long periods at idle with all the accessories turned on
- Long periods of storage before putting batteries in service
- Dirty or moisture coated batteries resulting in surface discharge
- Numerous tries at starting the coach and not letting the coach run to recharge the batteries
- Faulty charging system



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Charging Process





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What Effects How Batteries Charge?

- Source voltage of the batteries. Low battery voltage hampers the charging system
- Dirty or corroded terminals at any terminal point
- How the batteries are connected, whether in series or parallel
- The temperature of the battery. Cold batteries are less chemically reactive than warm batteries. Temperatures over 125 degrees F will warp the plates
- The construction of the batteries, lead acid batteries boil at a lower voltage than maintenance free batteries



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How Batteries are Rated

Cold Cranking Amps

1. Is the maximum amperage produced at 0 or -20°F with 1.2 volts per cell available
2. 1.2 volts represents the minimum voltage required to crank the starter at 0.0°F

Reserve Capacity

1. Given in minutes
2. This figure is attained by taking a fully charged battery at 80°F and discharging it at a rate of 25 amps until the terminal voltage is equal to 1.75 volts per cell or total voltage is 10.5 volts



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Battery Load Test

Electrolyte Temp
Voltage

80 ° F

70 ° F

60 ° F

50 ° F

Minimum

9.7 Volts

9.6 Volts

9.5 Volts

9.4 Volts

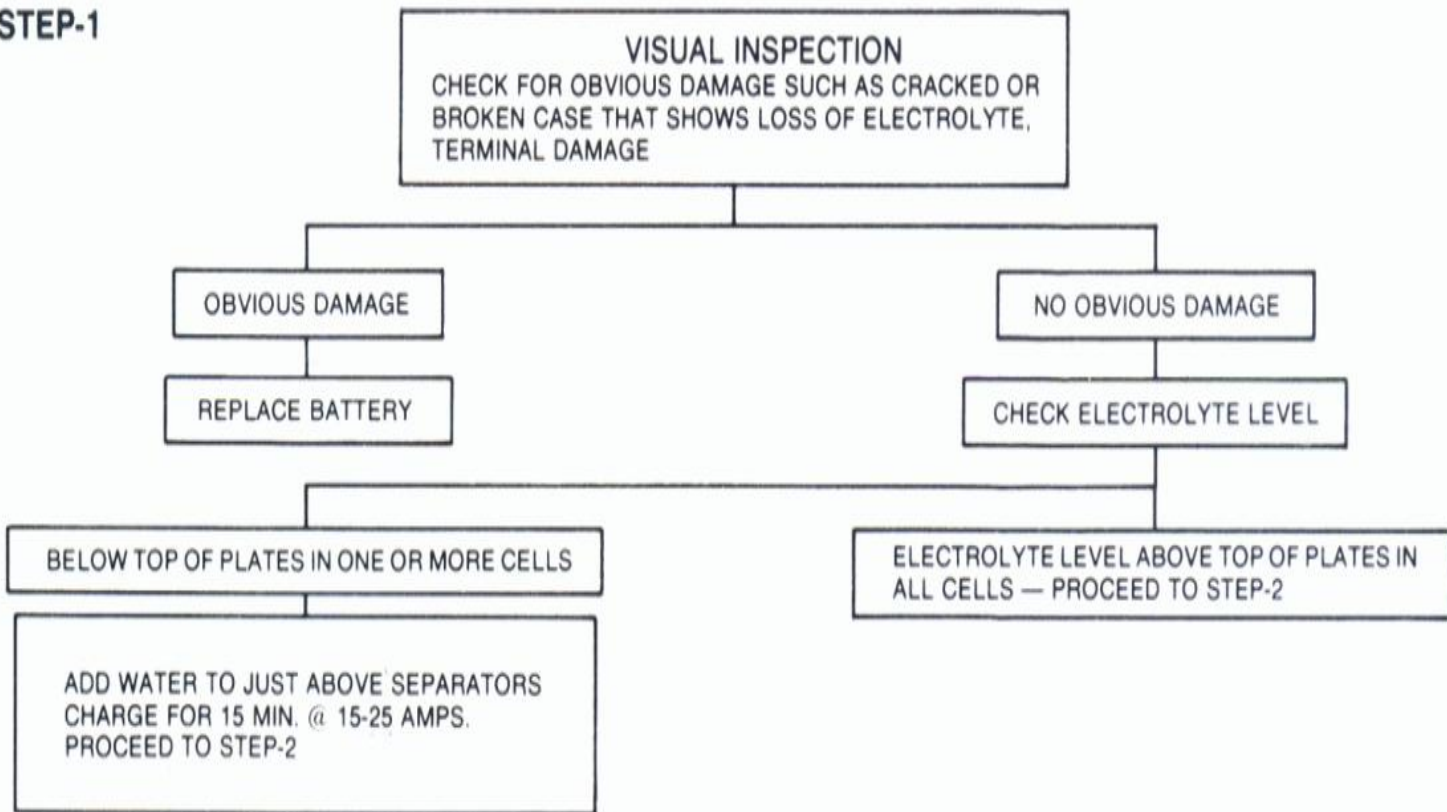




Battery Testing Chart

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STEP-1

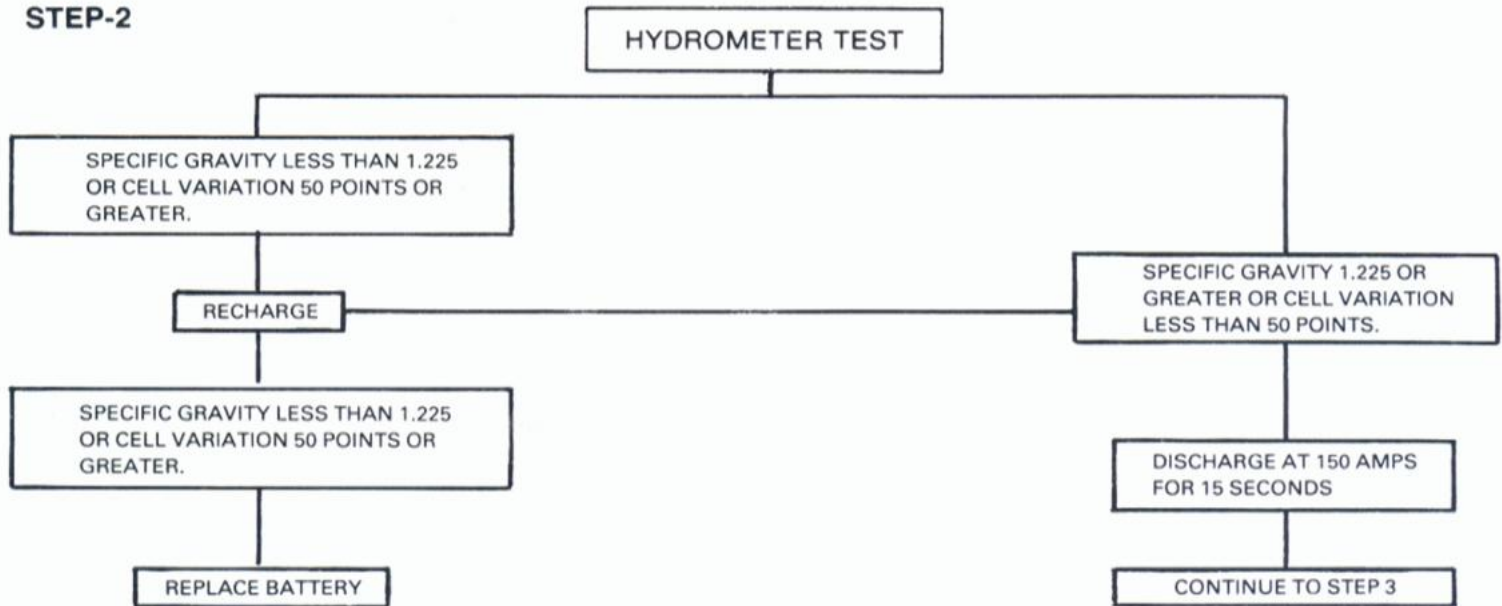




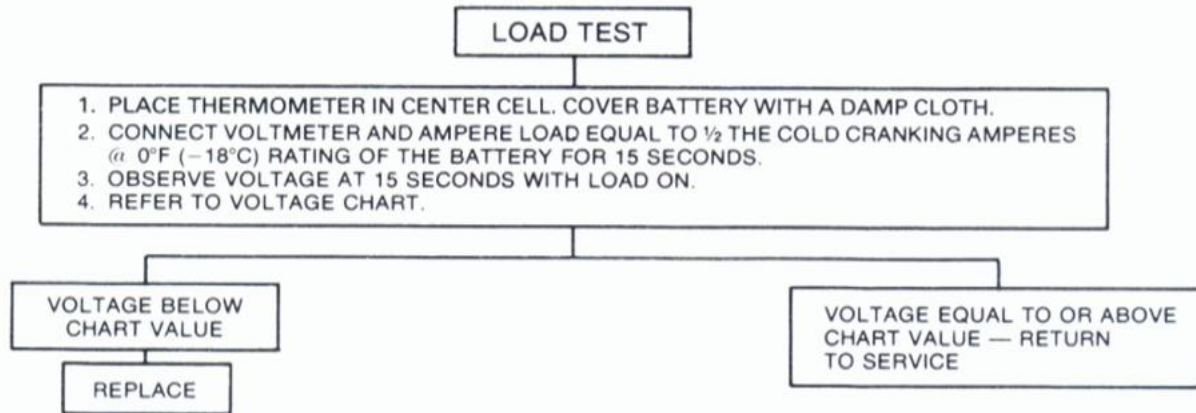
Battery Testing Chart Cont'd

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STEP-2



STEP-3





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Types of Battery Connections

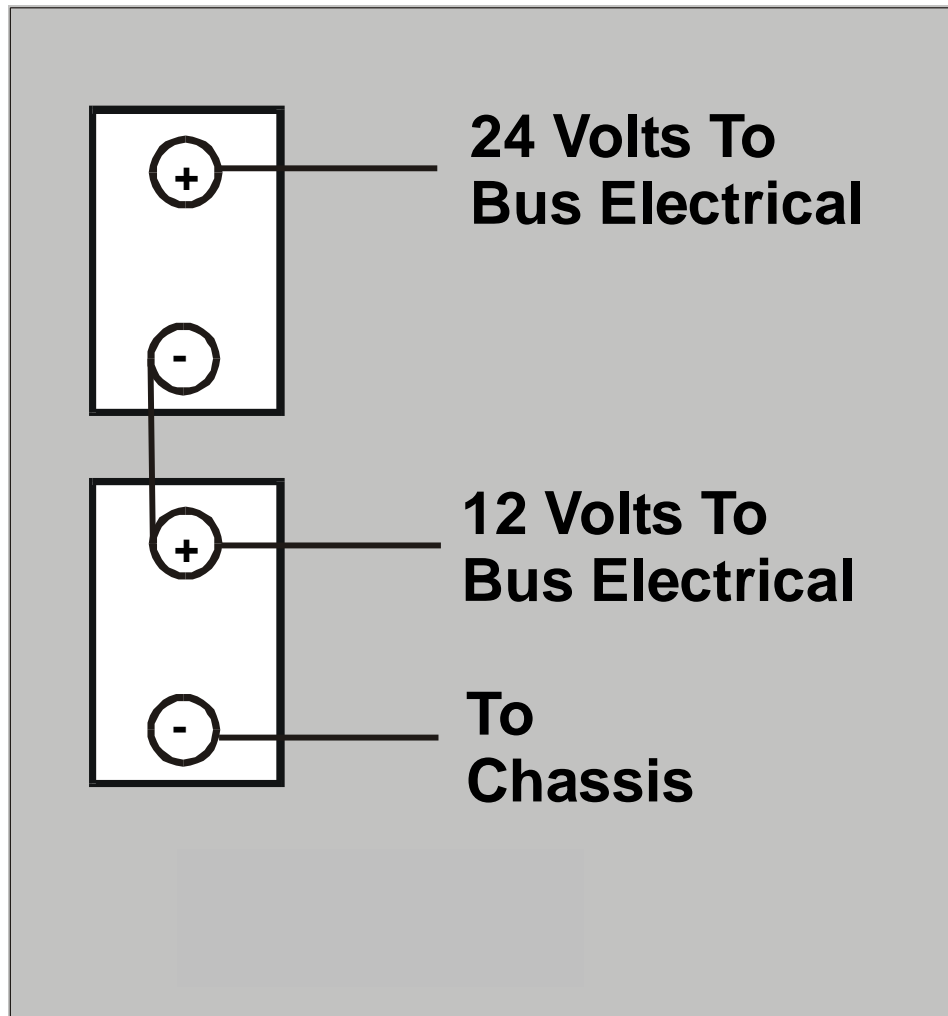
Buses typically use three different types of battery connections:

- Series Connection - positive to negative. Provides 12 volt and 24 volt tap
- Parallel Connection - positive to positive & negative to negative. Provides twelve volt tap
- Series/Parallel Connection - combination of above. Batteries are first tied in parallel, then in series



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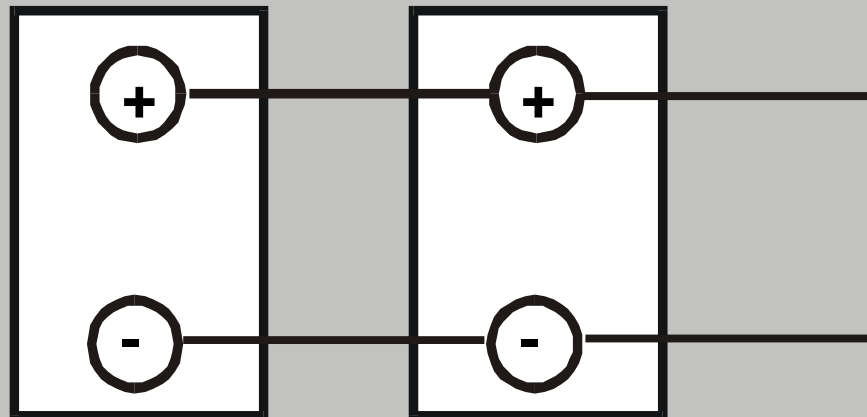
Series Connection





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Parallel Connection

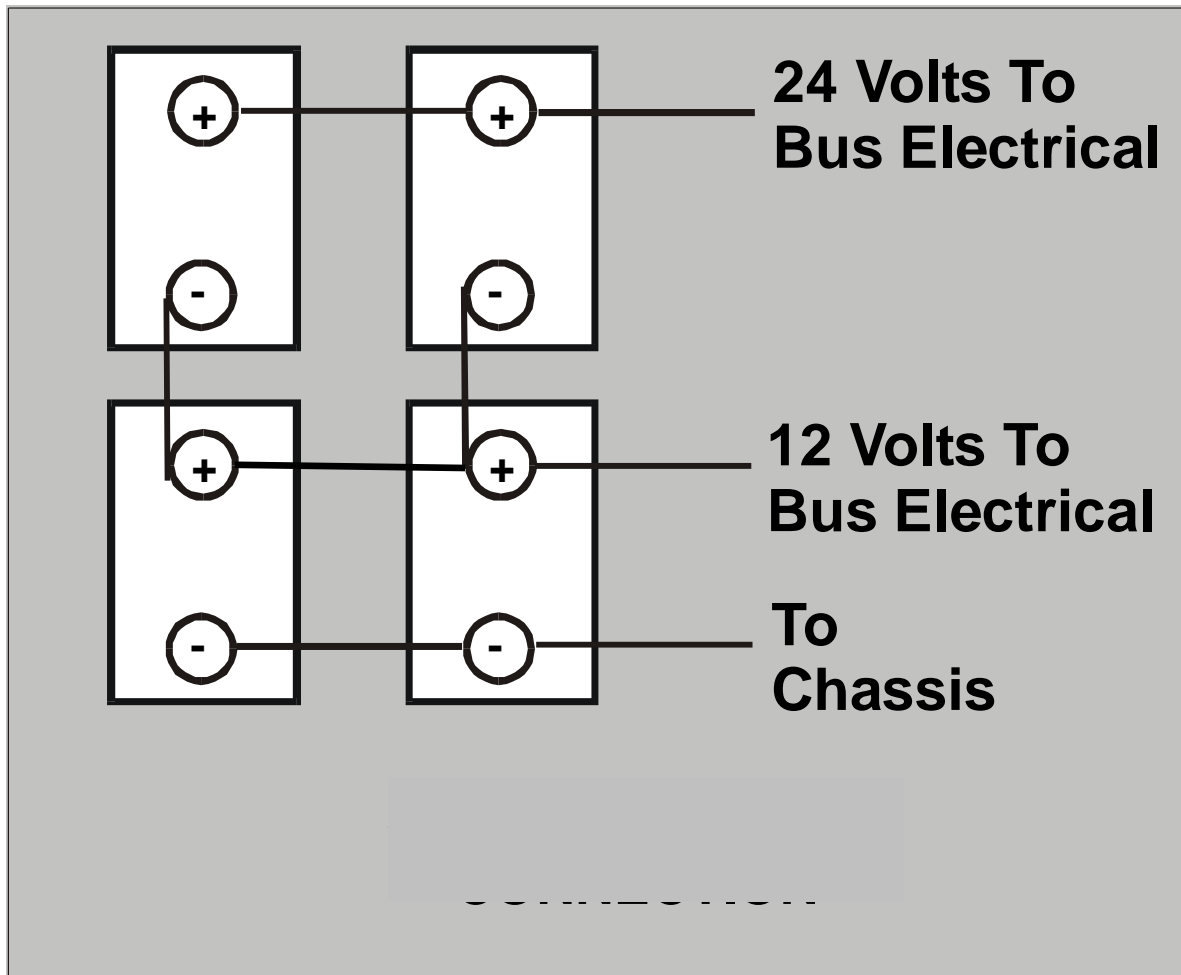


**12 Volts To
Bus Electrical
To
Chassis**



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Series - Parallel Connection





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Summary

- You now know.....
 - OHMS's Law
 - Electrical Circuitry
 - Components & Symbols
 - Batteries
 - Electricity can Kill... Be Careful!



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Questions and Answers

Click on the hand



to ask your question with your voice



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Thank you for your business

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