Electrical Circuits Concepts Review Sheet

Like charges repel, opposite charges attract.
Matter is made up of both types of charges.
Electrons can be added or subtracted from matter to give it a net charge (not protons).
One Coulomb of charge is 6 billion billion electrons.

The important quantities in electricity (four of them):

1) Voltage—electrical "push" measured in Volts (Joules/C)
2) Current—(positive) electrical charge flow measured in Amps (C/sec)
3) Resistance—electrical opposition to flow measured in Ohms
4) Power—the **rate** at which electrical energy is delivered to a load measured in Watts

Voltage "push" causes flow. Usually, the more flow through a load like a bulb, the brighter it is (the more power it delivers).
When thinking about circuits, visualize the source like a pump, the current like flowing water, and the wires like pipes.
Long, thin resistors have high resistance, short, fat resistors have low resistance.
Electricity comes in AC (wall outlets) and DC (batteries and power supplies).
Electrical circuits use up energy, not charge

Three types of circuits:
• Open Circuit (no current)—can result from an open switch or blown fuse
• Short Circuit (very high current—dangerous)
• Complete Circuit (Normal Circuit)—contains a source, wires, and a load in a complete "loop" from one terminal of the source to the other

Three ways to burn out a fuse or throw a breaker:
• Ground short—direct path to ground
• Bridge short—direct path from terminal to terminal
• Too demanding a load—draws too much current

Bulbs (resistors) in parallel and series:
Series
• one bulb goes out, they all go out (Christmas lights)
• many bulbs get dimmer
• resistance increases as bulbs are added, power decreases

Parallel
• one bulb goes out, the others stay on (household wiring)
• many bulbs, each one stays the same brightness
• resistance decreases as bulbs are added, power increases

Kirchhoff's Laws

All **voltage** gained in a single path around a circuit (a loop) must be lost
All **current** into a junction must flow out of the junction

Meters

• Ammeters are low resistance meters that must be wired in series (current must go through the meter) in order to measure Amps
• Voltmeters are high resistance meters that must be wired in parallel (across) a circuit element in order to measure voltage (potential) difference

Ohm's Law

$I = V/R$ means the current (I) in a circuit element is determined by the size of the push (V) divided by the resistance to the push (R)

Power

$P = IV$ means the power produced or used by a circuit element is determined by the current through the element (I) multiplied by how hard it's being pushed (V)
Alternate forms of the power relationship:

$P = I^2R$ means if you double the current in a resistor the power quadruples
$P = V^2/R$ means if you double the voltage across a resistor the power quadruples

Batteries

• Ideal batteries are considered to provide constant voltage regardless of the current they are producing (real batteries lose a little voltage as the current increases due to internal resistance)
• Batteries are used in series to increase voltage
• Batteries are used in parallel to keep terminal voltage more constant (reduce internal resistance) and increase battery lifetime (supply more charge)
• Batteries are rated in Ampere-hours (A typical car battery is rated about 50 A-hr, meaning it can deliver a 50 amp current for one hour, or a 1 amp current for 50 hours (etc.) without being recharged)