Electricity
Def. Electrons in motion.
electrons are more easily moved in metals
materials which allow the movement of electrons are called CONDUCTORS
examples: gold, silver, copper, aluminum...
INSULATORS are materials which don't allow electrons to move (easily)
examples: rubber,wood,glass, dry air some plastics...

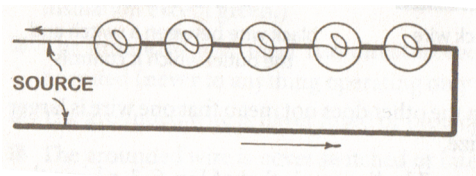
In order to get electrons in motion, we require a force, or ELECTRO MOTIVE FORCE (emf)
Examples of emf:
Static Electricity - produced by dissimiliar materials moving together
Chemical reactions - it is what powers us!
Thermo-Electricity - some materials produce an electron flow at areas of heat contrast
Solar or Photo-Electricity - some materials produce an electron flow when illuminated
Electro-magnetic Induction - a coil of conductor moving through a magnetic field
Piezio- Electricity - compressing some materials produces a flow of electrons

Most of the electricity we use is produced by electro-magnetic induction. Steam, wind or water are used to spin a turbine on which is an electro-magnet. Around this magnet are a series of coils. As the magnet rotates past a coil, it produces emf. The power produced in this method is called AC or ALTERNATING CURRENT - more on this later....
Another type of electricity we commonly use is a battery. A battery is a system with a chemical imbalance. When two sides of a battery are connected, electrons move from one side to the other to create a balance. In this type of system, electrons move in one direction only and it is called DIRECT CURRENT or DC.

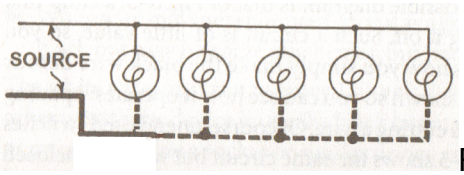
To use electricity, we need a CIRCUIT.
def: A closed circular path for electron movement.
Typically this path would consist of a conductor covered by an insulator (to keep the electrons on the path) a emf source.

Of course, if we have electricity, we'd like to use it too. An item in the circuit which uses electricity, is called a load. There are two basic types of loads: RESISTANCE and REACTANCE
example: resistance = toaster, heating coils, incandescent light bulbs
Reactance: motors, relays

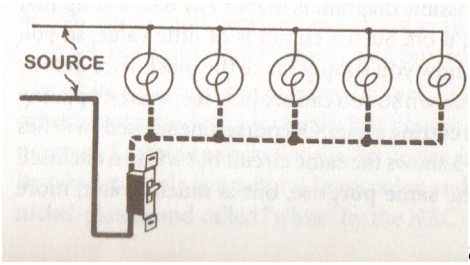
There are three types of electrical circuits:



Series, in which the entire electron flow goes through the entire circuit.



Parallel, in which the electron flow splits and is distributed through the circuit.



and Combination in which a switch is wired in series to control the entire circuit, and the load is wired in parallel.

A ground is a low resistance path for electrons to follow in the case of a short circuit.
a short circuit is an electrical emergency in which circuit components may become displaced resulting in an un-planned pathway for electrons.

Rule: Electricity always follows the path of least resistance.

4 Basic measurements may be made on any electric circuit.

1) VOLT - The difference in potential of electrical flow between two points in a circuit.(? How many more free electrons there are at one point than another?) Voltage is equal to emf. Symbol for voltage in equations is commonly E. Our standard value for voltage in the Hz is 120V. Also thought of as a unit of pressure. Pressure needed for a current of 1 amp though 1 ohm of resistance. Named after Alessandro Volta (1745-1827), inventor of the voltaic pile :) - this is the forerunner of today's batteries.
2) AMPERE - the rate of flow of current through a conductor - or - how many electron pass a given point at a time? Symbol is I (for intensity of current flow). Used to describe a circuit's electrical capacity. The standard for the Hz circuits is 20a. House circuits are commonly 15a. Is a unit of Quantity. The quantity of electricity which will deposit 0.00118 gram/second silver - when flowing through a neutral silver nitrate solution. Named after Andre Marie Ampere (1775-1836) a French Mathematician and

physicist, considered the Father of electrodydamics. One ampere is the movement of 6.28 billion billion electrons per second.

3) OHM - Everything offers some resistance to electron flow. This is the measurement of resistance. Symbol is : R. Named after Georg Simon Ohm (1785-1854), a German physicist.
4) WATT - The rate of doing work. Symbol is P. Can be thought of as use or consumtion of electricity - electrons are not consumed, their power is. Named after Sir James Watt. a scottish inventor and engineer.

Electric Math

THE POWER FORMULA. Expresses the relationship between wattage (P), amperage (I), and Voltage (E). It states that the rate of doing work is equal to the product of current flow and potential. P=I*E - Also called the West Virginia formula...Watts=Volts*Amps.

OHM'S LAW
Expresses the relationship between Amperage, Voltage and Resistance. It states that Amperage will equal

this should be aprox end of week #2...

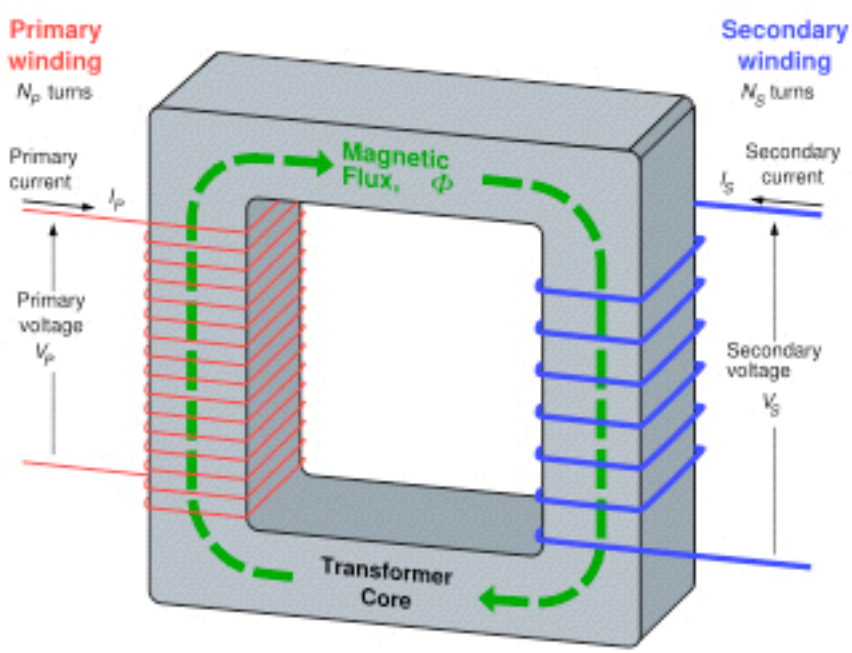
Next topics: AC/DC revisited,
transformers, OHM's Law, Worldwide delivery Standards
Electrical Distribution
Electrical Services.

More Electricity.

Tesla vs Edison.

AC vs DC

Tesla wins , AC prevails as the main type of power generated. By using



TRANSFORMERS voltage can be stepped up or down. Ohm's Law demonstrates that as Voltage increases, Resistance decreases which allows for long distance transmission of electricity with minimal loss.

AC power reverses direction - in our case 60 complete cycles / second or 60 hz.
in generation, since the electro-magnet is passing a coil, the amount of current fluctuates and can be illustrated by drawing a sine wave.
The power turn on then off in 60 complete cycles each second.

To offset the problem of no power over a portion of the cycle, polyphase distribution was introduced allowing for significant improvement.

because the current is fluctuating, electrical components - like lamp filaments vibrate.

Power is distributed differently in different parts of the world. Generally, North and South America use 120v as a std while Europe, Africa and Asia use 220v
Japan actually uses two, competing systems.

Power is distributed and delivered to the user in some different configurations or ELECTRIC SERVICES

2 WIRE SYSTEM - 1 hot, 1 neutral. 110v potential between them.
This system is no longer used as a delivery standard in the US. It is not very efficent.

3 WIRE SYSTEM -2 hots, 1 neutral. 110v between any hot and neutral, hots are out of phase so potential between two hots is 240v This is the normal delivery for household power. Allows for flexibility in used providing both 110v power and 220v power for heavier use such as electric hot water heaters, stoves, dryers and furnaces.

4 WIRE SYSTEM - 3 hots 1 neutral. 110v between any hot and the neutral, hots are 120 degrees out of phase so potential between any 2 hots is 208V. This is normal distribution for industrial use. Allows for polyphase delivery as well as 110v power. Polyphase power is important for heavy duty motor etc.

Hershel Zohn Theatre power delivery:
Power from supply enters "little theater vault" behind Jacobs
via the tunnels, It enters the building behind the green room and goes through the first interior control panel. The first control box contains a meter, a gage to show voltage, and the main switch. The main switch cut off all non-continuos, and non- emergency power to the entire building. Continuos power feeds some circuits in the building providing egress and emergency power kicks in anytime regular power is disrupted. The

main purpose of the emergency lighting is to get the audience out in the case of an emergency - and is required by code for an audience.

From the main switch, power branches to :
General building supply - outlets etc.
HVAC supply - for those big motors that move air around for heating and cooling
Building - general lighting - office lights, costume shop and dressing rooms etc.
Stage Lighting Supply - power to dimmerbanks
House/ Auditorium Supply - power to house system - which is separate from stage lighting.

MEASURING ELECTRICITY

Electrical use is measured in Kilowatt hours. Residential power is charged differently from commercial power and the price may vary widely depending on the amount used and time of day used - on peak or off peak.
From $0.10057/kWH to $0.19320/ kWH
Big power users are charged differently : Customer charge($25), Demand Charge($16.65) and per kWH from $0.18022/kWH to $0.04866/kWH
Every 2.0-3.0kW of lighting load requires an additional 1kW of cooling. Therefore, theoretically, every 1kW reduction in lighting results in 1.3-1.5kW drop in total energy requirements.

WIRE
Typical wiring is copper. During the 60's and 70's - low cost housing began to be made with Aluminum wire. Aluminum is a fine conductor - but reacted with then std fittings. Arcing and fires occur...Now fittings for aluminum wiring are widely available and must have that information imprinted upon them.
Stranded wire has a higher carrying capacity than solid conductors. Stranded wire is also used in our theatre cables because it allows the cables to be more flexible. Wire capacity is determined by the the size of the conductor, solid or stranded and material. The size of the cable is termed it's gage.
Most common non-electrician use of cable would be an extension cord. Extension cords are useful as temporary devices, but they should never be used to permanently carry power from a receptacle to lamps or other equipment.

You might notice wire insulation is often colored. These colors have std uses:

White = neutral (grounded)
Black = hot
Red = hot
blue = hot
white coded black = hot
green = ground
bare copper = ground

Most of the wiring we are concerned about in the theatre will be the temporary wiring for shows. The receptacles we plug into are HARD WIRED and considered permanent circuits. Connecting to these circuits, we uses connectors - the ends on a regular extension cord are an example and they are called EDISON connectors. All Edison connectors used in a theatre for power distribution must have 3 prongs - hot neutral and ground. Additionally, regular edison plugs are made to handle a maximum of 15 amps. Code for most Edison plugs in a theatre are to have the neutral pin set sideways - this allows larger items - up to 20 amps to be plugged in. This type of plugging system is in used at the Atkinson Recital Hall. A benefit is that any regular extension cord can be used to cable circuits.
We use a stage two pin and ground plug. It is rugged, designed for 20amps, fairly in expensive, and widely used. In this system, the ground is the center pin and one pin is offset further away (the hot).
One other system is a twist lock system - the ground is a center pin - the cable is joined and twisted to “lock” the connection.
Important to note that these are for temporary circuits only. Using temporary connectors long term will lead to arcing, circuit failure and/ or fire.
Cable is designated by #of connectors, gage and jacket or insulation.
our cable then is 3/12/so s being stranded and o being oil resistant.
We often use “circuit accessories” like cables to extend our reach, twofers to plug two items into one circuit and adapters to change from one plugging system to another. Each time something like this is added into a circuit, another possibility for failure is inserted along with it.

TRANSFORMERS
A transformer is just a piece of iron with a pair of wires coiled around it - one with many more turns in the coil than the other. The coils of wire are not physically connected. The iron core is immersed in an insulating oil bath which does not conduct electricity well.

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Michael Faraday...