Circuits!!!!****

Voltage, Resistance, Current, and Heat

There is a lot to learn about electronic circuits. We can't learn it all at once, and it is pretty hard to learn anything without actually building circuits. But we can't do anything until we understand some basic concepts.

You should read this chapter, but don't try to memorize it and don't worry if you don't understand it completely. Everything in this chapter will be repeated ... over and over... and over.

OK, let's get started.

Any path that begins and ends at the same place can be called a circuit. There are circuit courts, racing circuits, and rides at the carnival, which all start and end in the same place and are all examples of circuits. These are all examples of circuits, but they are not electron circuits:)

When you see the word, "terminal," you can just think of it as a "connector."

Let's imagine that you create a continuous path for an electron current to flow out of the (+) positive terminal of a battery through a dc motor and then back to the (-) negative terminal of the battery. You would do this by connecting everything together with two pieces of wire. One of the wires goes from the (+) positive terminal of the battery to a terminal on the motor. The other wire goes from the other terminal on the motor back to the (-) negative terminal of the battery. What you have created is an electronic circuit.

The instant you connect the second wire from the motor to the battery, an electron current will flow from the (+) positive terminal of the battery, through the dc motor and back to the (-) negative terminal of the battery. The flow of the electron current does two things, which we can directly observe: the motor shaft turns and heat is generated. The motor will heat up, the battery will heat up.

A circuit can be said to be in one of three conditions. A circuit can be 1) shorted, 2) opened or 3) closed.

A shorted circuit exists when the positive and negative terminals of a power supply (battery) are directly connected to each other by a short piece of wire!!!!

We aren't going to create any shorted circuits, because if you connect the + and - terminals of a battery, all of the electrons will attempt to flow through the shorted path. The battery will immediately expend (use up) all of its energy, and both the wire and the battery will become very hot.

An open circuit is the exact opposite of a shorted circuit. In a shorted circuit, all of the current flows in the blink of an eye. In an open circuit, current cannot flow at all. It doesn't matter how long you look at an open circuit, nothing is going to happen until you close it--->:) A little joke and a true fact. What causes an open circuit is any opening(discontinuity) in the path of the circuit. If you cut a wire, that creates an opening in the path.

if you forget to hook up one of the wires to the motor, what you will have is as an open circuit.

When we "switch" a light off, what we are actually doing is creating an open circuit at the switch, which prevents electrons from flowing through the light bulb.

When electrons are free to flow along a closed path (through a wire), a closed circuit is said to exist. When we switch a light on, we create a closed path, and we create a closed circuit.

We never work on closed circuits. We always work on open circuits. When we are all done doing whatever it is that we are doing, the last thing that we do is create a closed circuit.

Every circuit can be described by the source voltage, the total amount of resistance, the amount of current flowing and the amount of heat that gets created. This is true for all circuits.

Let's say that again with some real conviction:)

Every closed circuit uses a voltage source, to create an electron current, which always flows in the presence of resistance, and always creates some heat!!!!

There is a very special relationship between, current, voltage, resistance.

This relationship is so important that we call it a law. The law is called Ohm's Law!!!!!!!!!!!!!!!!!!!!!!!!!

Georg Ohm found that if one knows the rate at which **Current** is flowing in a circuit and one knows the **Voltage** at the source of that flow, then one can always calculate the **Resistance** in the circuit. And if we know the Voltage and the Resistance, we can calculate the amount of Current. AND if we

know the Resistance and the Current, we can calculate the Voltage. Heat is more complicated and depends on all kinds of other things and has been described by all kinds of laws. We need to know that heat is always produced, but right now we aren't going to worry about exactly how much, exactly where or why people think it happens. That sort of stuff is what we call "beyond the scope of this book-->:)" A little joke, a little fact. Don't worry about it.

What were we talking about?

OHM's LAW !!

Georg Ohm discovered that the relationship between the resistance, voltage and current flowing in a closed circuit can be stated as the simplest of all linear equations.

Because there are three variables, the relationship can be stated in three ways.

1. **Voltage = Current X Resistance** !!!!!!

In this form the relationship is stated "voltage equals the current multiplied by the resistance,"

which can also be rearranged:

2. Current = Voltage / Resistance

Current equals the Voltage divided by the Resistance

and rearranged again to read:

3. Resistance = Voltage / Current

There is only one relationship, but it can be stated in three ways. The important thing is that if have values for two of the variables, you can always calculate the third.

This discovery was so important that to honor **Georg Ohm**, the unit for resistance was given the name, **Ohm**. Georg has his own law and his own unit. For a scientist this is like being in heaven. And there is also a symbol that is used to this indicate Ohm's unit of resistance... the symbol is omega, **Ω**, the last letter of the Greek alphabet. On a Macintosh using an iso9000 keyboard, if you want to type an Ω, you hold down the Alt key on your keyboard and type the last letter of the English alphabet, z. Only the Lord knows how to do it in Windows 7-->:) See if you can figure it out.

Question:

Who is the volt named after?

Answer:

The symbol for volts is just **V**. The volt is named after General Motor's first electric car, the Volt:) That is a joke... it doesn't contain a fact.

Question:

Who else was the **V**olt **not** named after?

The Volt was also not named after Voltaire, a French philosopher-->:)

Alessandro Giuseppe Antonio Anastasio Volta!!!!!

The **V**olt is named to honor **Alessandro Giuseppe Antonio Anastasio Volta**, who found that the leg of a dead frog would still move if you hooked it up to a battery. But before Volta could hook a dead frog's leg to a battery, Volta had to invent the battery!!!! A true fact... almost. A Volt is a unit of electrical potential.

How did Ohm discover his law?

By using various voltage sources to give himself shocks and then comparing the size of the voltage source and resistors to the shocks he was receiving... no joke.

Don't do it, with modern batteries you could really hurt yourself. But at the time, batteries were rather pathetic and good old **Georg** was pretty safe.

The unit for current is called an Ampere(abbreviated Amp or A) to honor **André-Marie Ampère**.

Ohm, Volta and Ampere are three scientists, who changed the world.

So, Volts(V) =Amps(A) X Ohms(Ω.) When Ohm described his law, he represented current by the capital i, I. So, Ohm's law is also written: V=I*R, which you will see if you read about Ohm's Law.

One Volt will cause one Amp of current to fbw in a circuit that has one Ohm of resistance.

1=1*1.

How much current will flow from a 9V battery through a circuit with a 9 Ω resistor?

answer: 9=9*Amps

Amps = 9/9

Amps=1.

Whenever you have a current of 1 A , your voltage will equal your resistance (different units but the same value)!!!!

Those are pretty nice units. We will be discussing some other units, that are not quite so nice. In all of science, there is no Law that is more clear or has more beautiful units than Ohm's Law, with the possible exception of one of Newton's Laws of motion, which is slightly beyond the scope of this book:) Maybe we will talk about it. Maybe not. You will just have to keep reading to find out---->:)

In the Lab section we will use Ohm's law in a variety of ways to build all kinds of circuits.