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## THE SNAP CIRCUITS® PROJECT MANUALS

The Snap Circuits® project manual includes lots of useful information in addition to the projects themselves, as listed below. The project manual summarizes much of the lesson in the Student Guide while adding troubleshooting information.

Much of the text in all chapters is color-coded green and blue so that instructors can easily adapt the course based on the skills and interests of the students. The orange boxes are more advanced material while the brown boxes are considered additional/background material, either can generally be omitted without a significant impact on the course.

### The Project Manual contains:

1. Parts List (partial, continued in second manual)
2. **How To Use It** - brief description of how to make connections and understand the circuit drawings.
3. **About Your Snap Circuits® Parts** - brief description of what each component does (partial, continued in second manual).
4. **DO's and DON'Ts of Building Circuits** - brief but important guidelines for building circuits (additional guidelines are in second manual).
5. **Basic & Advanced Troubleshooting** - systematic testing procedure for identifying damaged parts (continued in second manual).
6. Project Listing
7. Projects 1-101

## Preface

This booklet is an introduction to the exciting world of electronics. Following the "Learn by Doing®" concept, electronics will be easy to understand by using Snap Circuits® to actually build circuits as you learn about them. This booklet emphasizes the practical applications of electronics, without bogging down in mathematics.

Why learn about electronics? Electronics plays an important and increasing role in our everyday lives,

and so some basic knowledge of it is good for everyone. Learning about it teaches how to do scientific investigation, and the projects develop basic skills needed in today's world.

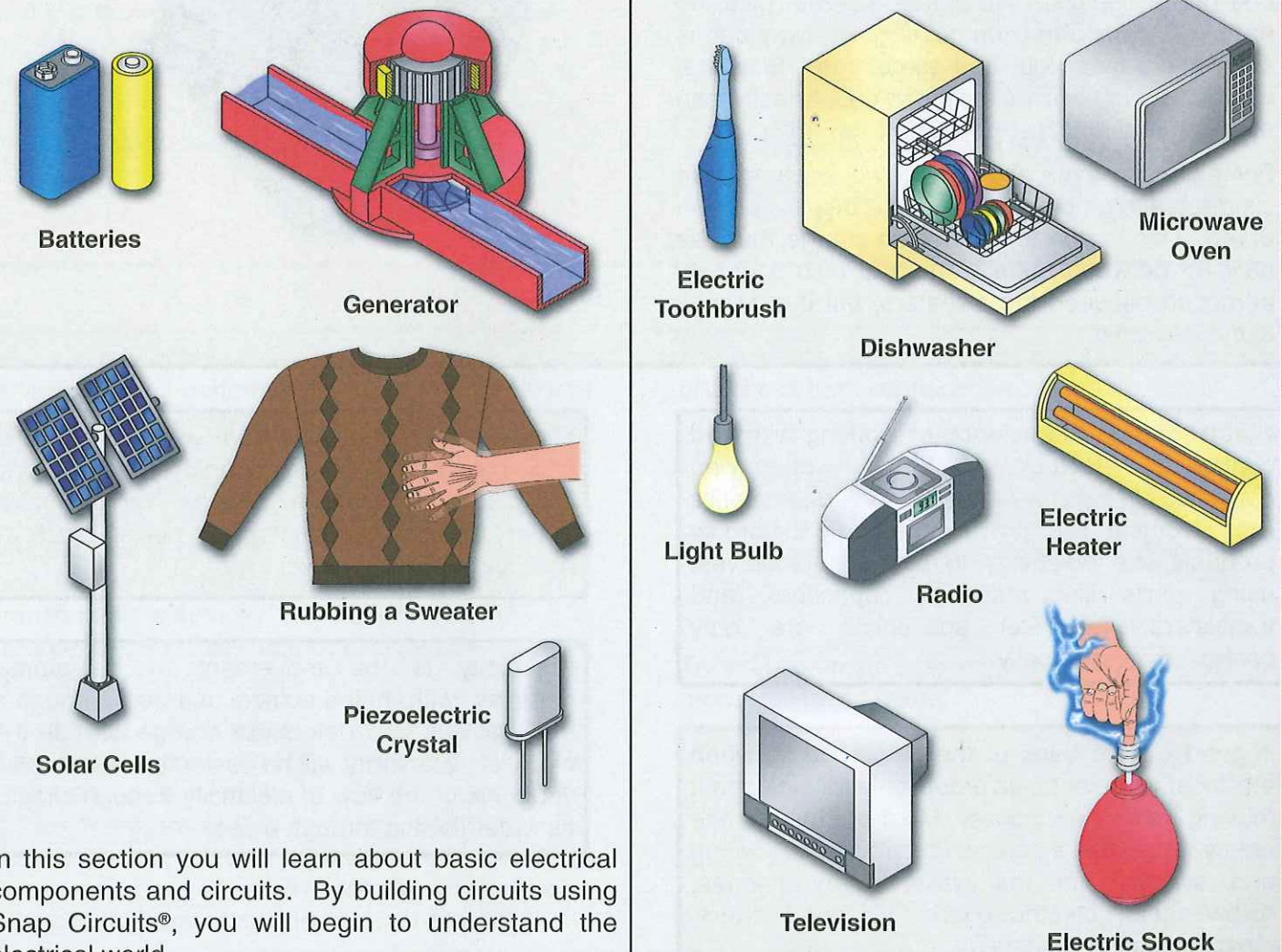
The first pages of the Snap Circuits® project manuals contain a brief description of the parts in Snap Circuits®, along with brief guidelines for building circuits.

## CHAPTER 1: BASIC COMPONENTS & CIRCUITS

Learn By Doing®

What is electricity? Nobody really knows. We only know how to produce it, understand its properties, and how to control it. It can be created by chemistry (batteries), magnetism (generators), light (solar cells), friction (rubbing a sweater), and pressure (piezoelectric crystals).

Electricity is energy that can be used to save us effort (electric toothbrushes and dishwashers), heat things (electric heaters and microwave ovens), make light (light bulbs), and send information (radio and television). But electricity can also be dangerous if abused (electric shock).



In this section you will learn about basic electrical components and circuits. By building circuits using Snap Circuits®, you will begin to understand the electrical world.

# 1-1 Electricity

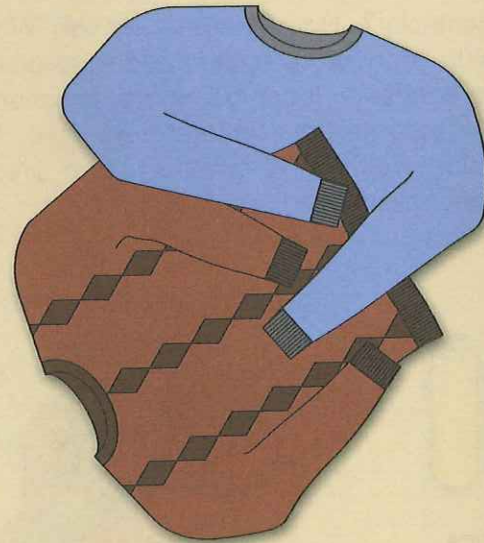
The name electricity came from the Greek name for amber, the material in which electrical effects were first observed. What do you think of electricity as being? **Electricity** is one of the fundamental forces of nature. At its most basic level, it is an attraction and repulsion between sub-atomic (very, very, very, very tiny) particles within a material.

This attraction/repulsion is referred to as an **electrical charge**; it is similar to and closely related to magnetism. These attractions/repulsions are extremely powerful but are so well balanced out at the sub-atomic level that they have almost no effect on our lives.

As an example, electrical attraction is about 1,000 times more powerful than gravity (gravity is what causes things to fall to the ground when you drop them). However electrical attraction is so completely balanced out that you don't notice it, while gravity effects are always apparent because they are not balanced out.

Gravity is actually the attraction between objects due to their weight (or technically, their mass). This effect is extremely small and can be ignored unless one of the objects is as big as a planet (like the earth). Gravity attraction never goes away and is seen every time you drop something. Electrical charge, though usually balanced out perfectly, can move around and change quickly.

For example, think about how two sweaters can cling to each other when you take them out of the dryer. This is due to an electric charge that has built up between them. There is also a gravity attraction between the sweaters, but it is always extremely small.



**Electronics** is the science of working with and controlling electricity. Many work-saving appliances like dishwashers, hairdryers, and drills are electrical but not electronic. Electronic products use electricity to control themselves, using parts like resistors, capacitors, and transistors. Electrical appliances are only controlled mechanically.

Most products you bring from your old house to your new house are electronic (such as TVs, computers, touch-tone phones, radios, most battery operated products), but not all (such as hairdryers, electric power tools).

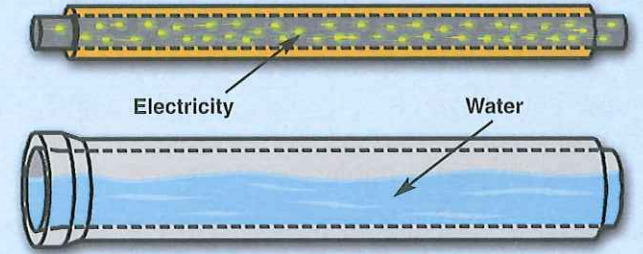
Electricity is the movement of sub-atomic particles (with their electrical charges) through a material due to an electrical charge outside the material. Electricity will be easier to understand if you think of the flow of electricity through circuits as water flowing through pipes.

A good way to think of the difference between electrical and electronic products is to think about moving into a new house. Most products in the empty house are electrical (such as all the wiring and switches in the walls, rotary phones, dishwashers, electric ovens, air conditioners, most types of thermostats).

# 1-2 Wires

**Wires** can be thought of as large, smooth pipes that allow water to pass through easily. Wires are made of metals, usually copper, that offer very low resistance to the flow of electricity.

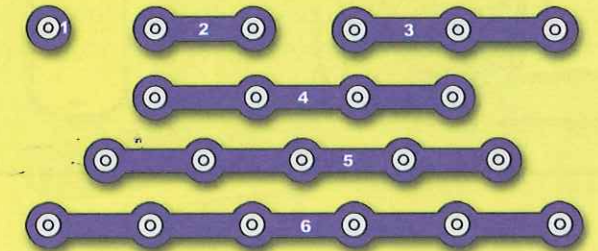
The **electric current** is a measure of how fast electricity is flowing in a wire, just as the water current describes how fast water is flowing in a pipe. It is expressed in **amperes** (A, named after Andre Ampere who studied the relationship between electricity and magnetism) or **milliamps** (mA, 1/1000 of an ampere).



With Snap Circuits the wires you will use have been shaped into snap wire strips, to make interconnection easy. These work the same as any other wires you might find in your house, since they are made of metal.

# Introducing New Parts

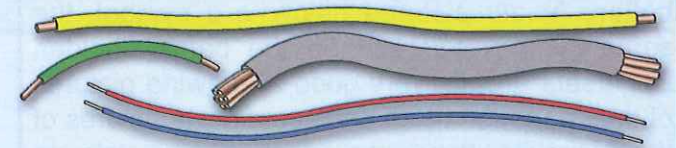
If you have the Snap Circuits® parts nearby then pull out the wires and look at them. They have numbers such as 2, 3, 4, 5, or 6 depending on the length of the wire connection. There is also a 1-snap wire that is used as a spacer or for interconnection between different layers.



Wires can generally be as long as desired without affecting circuit performance, just as using garden hoses of different lengths has little effect on the water pressure as you water your garden. However there are cases where the length and size of a pipe does matter, such as in the water lines for your entire city or in an oil refinery. Similarly, wire length and size are important for electric power lines transporting electricity from a power plant in a remote area to a city, and in circuits used in radio or satellite communication.

If you were to look inside an electronic device in your home (make sure it's not plugged in) you might see a lot of wires of different colors. The actual wires are all the same color of metal, but they have a protective covering over them. The colors are used to easily identify which wire is which during assembly and repair of the circuit.

The covering is also used to prevent different parts of a circuit from connecting accidentally.



Try to imagine the total length of wire used in all the products in your home!