Building Electronic Circuits

OVERVIEW:

In this activity, students will follow directions in order to build their own circuit board. In addition, students will practice following safety rules in a laboratory setting.

CONCEPTS:

National Science Foundation Standards:

Standard B: Physical Science

(Transfer of Energy):

- Energy as a property of many substances and its association with heat, light, electricity, mechanical motion, sound, atomic, nuclei and the nature of a chemical.

Benchmark 4: The Physical Setting

E: Energy Transformations:

- Energy appears in different forms. Heat energy is the disorderly motion of molecules; chemical energy is in the arrangement of atoms; mechanical energy is in moving bodies or in elastically distorted shapes; gravitational energy is in the separation of mutually attracting masses.

OBJECTIVES:

Students will:

- Identify the basic components in a circuit.
- Build a circuit board
- Follow basic safety procedures in the laboratory

PROCEDURES:

- Allow 4 hours to present the background information and to complete the activity.
- Present the background information.
- Complete the activity (Part A.)
- Follow up activity with discussion questions (see Part B.) These questions may be used for assessment purposes

MATERIALS:

- Background information
- Transparency master: Circuit Board and Soldering
- Circuit boards
- Drills
- Soldering irons
- Solder wire, flux
- Goggles, 4 resistors (47K,10K,1M, 1K)
- 3 Capacitors (10u, .01u,.001u)
- 2 Potentiometers (1M, 5K)
- 2 transistors (3904NPN, 3906PNP)
- 1LED
- 1 Cadmium Sulfide Sensor

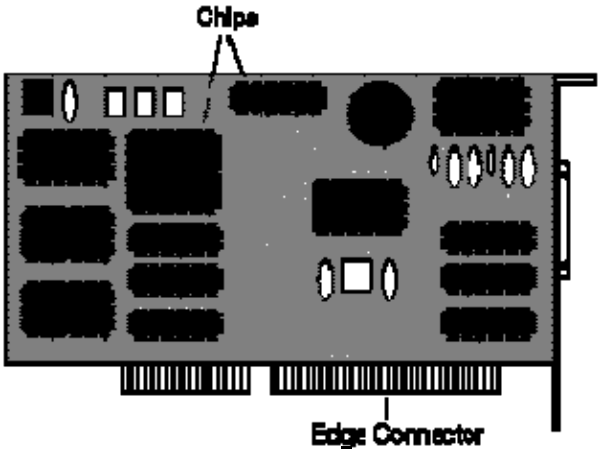
- 1 Piezoelectric buzzer
- 1 9V battery
- Needle nose pliers
- Wire cutters
- Clamps

BACKGROUND:

We will be discussing circuits and in particular a Printed Circuit Boards, also called PCB's. Electronics is based on and concerned with the controlled flow of electrons. An electronic component is any electronic building block with two or more connecting leads. Components are intended to be connected together, by soldering, to a printed circuit board. You will get the experience of making one for your self and seeing at the end if everything will work as expected.

A printed circuit board consists of "printed wires" attached to a sheet of insulator. The conductive "printed wires" are called "traces" or "tracks". Sometimes abbreviated PCB, a thin plate on which chips and other electronic components are placed. Computers consist of one or more boards, often called cards or adapters.

Circuit boards vary across the board. They can be single or double sided, single or multi-layered. Some may have through-hole or surface mounted components which may be passive or active. You can see this from the examples of circuit boards from various devices around the home, computer, phone, radio, television, etc. Below is an example of a circuit board.



Terms to know:

- **Insulators** – materials which prevent the flow of heat or electric charge
- **Conductors** – The opposite of insulators. They permit the flow of charge
- **Solder** – This is a fusible metal alloy, often of tin and lead, with a melting point or melting range below 450 degrees C (840 degrees F). It is melted to join metallic surfaces in a process called *soldering.*
- **Flux** – A copper wire that can be used to remove any soldering work done. It is a reducing agent designed to help remove impurities.

How to Solder and De-solder:

1. Connect the soldering iron to a power source, and lay it on its stand. After a few minutes of the iron heating, put it next to the wire that you want to solder, and count to 5.
2. Then bring in the solder wire right next to the base of the component. Since both the base and the wire are hot, this should melt the solder wire and as soon as this happens, pull out the wire first then the soldering iron.
3. Make sure that the soldering appears in the shape of a cone from the bottom up. If you get half a cone, you have used too little solder and if you have a hanging ball at the top, then you have used too much.
4. If you have too much or too little solder or have soldered you components in the wrong slots, using the flux wire, reheat the base again and the flux will almost automatically suck the solder up. If you have too much solder on the soldering iron, use a wet sponge to take it off.
5. Always wear safety goggles when drilling and soldering to avoid any items getting into your eyes**.**

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ACTIVITY:

Part A: Make a Circuit Board

Directions:

1. Pick a printed board and drill holes in all the little donut shapes that you can find. You can use the hand or the electric drill.
2. After you are done, take out your little components from the envelope in front of you and try and match it up to the illustrated handout.
3. Once you are done, take a component at a time as they follow from the top to the bottom on the list and fit them in the donut holes you just drilled as shown in the handout.
4. Leave out the battery connection until you have soldered all the other components.
5. Solder on all the other components and remember to check the handout for how each should go in.
6. Remember that if the copper lines are not touching before you solder, you should not solder them together because that will break the flow in the circuit you are creating and it will not work as you would expect.
7. Also, if you have soldered the copper line off, you can complete the circuit by folding over the wire to take the place of the missing line.
8. Once you have soldered in all the components, solder in the battery connection, then connect the battery and find out if your circuit is working and if not, go back to your connections and check them again. If your circuit is working, then using the cutter cut off the wires and your circuit is good to go.

Part B:
Ask the following questions and allow time for discussion.

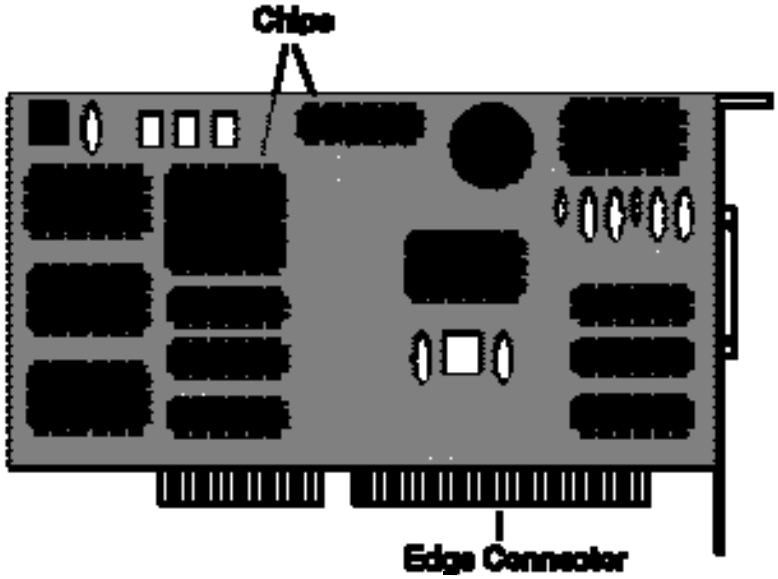
Share:
What was some of the equipment you observed in the laboratory? What was it used for? What is a circuit board?

Process:
What happens to the circuit board when we use too much solder?

Generalize:
What are the parts of a circuit board? What role does each play?

Apply:
Where are circuit boards used? What happens if a circuit board is not working properly in a computer or other technology? Why do we need to follow the rules in a laboratory?

Circuit Board



Soldering