


HIDDEN ALARM


Grades
3–5, 6–8


20–60
minutes

DESIGN CHALLENGE

Build an electrical circuit to power an alarm that can be switched on and off and that is small enough to hide.

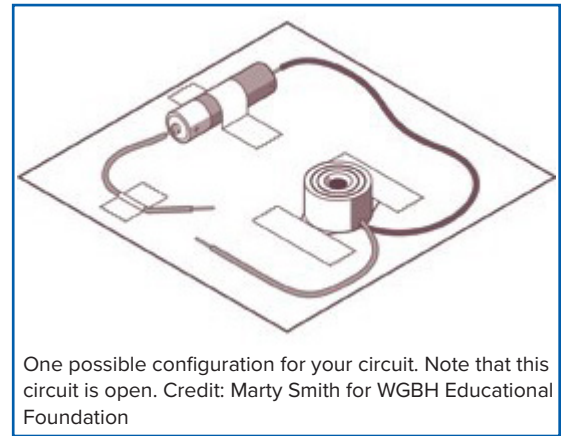
MATERIALS

Supplies and Equipment:

- Scissors (enough to share)
- Wire strippers (several to share, or 1 for prep)
- 1.5V electric buzzers with leads (1 per team)

Consumables:

- AA batteries (1 per team)
- Thin cardboard or chipboard
- 22 AWG electrical wire
- Aluminum foil (1 roll)
- Masking tape (several rolls to share)



One possible configuration for your circuit. Note that this circuit is open. Credit: Marty Smith for WGBH Educational Foundation

GETTING READY

Test batteries to make sure they work. Cut and strip various lengths of wire in advance. You may let participants do this step, but prepping wire in advance reduces time and waste.

INTRODUCTION

Smartphones, game consoles, and refrigerators are examples of electronic devices. All electronic devices rely on circuits to work. A circuit is a path that electricity flows through. Circuits can control a simple system, like turning on the refrigerator light when you open the door, or a complex task, such as a mathematical computation. The circuits in this activity have a power source (battery), buzzers, and wires that conduct electricity.

Switches control whether or not electricity can flow through a circuit. For a circuit to work it must be “closed”—that is, it must provide a complete path for electrical current to flow. A switch can “open” a circuit by physically disconnecting wires to turn a device off. Today you are going to create a circuit with a switch that makes the circuit open or closed. When it is closed, your circuit will set off a buzzer that is small enough to hide.

INSTRUCTIONS

Ask participants where there are switches or circuits in their home and what they control. Ask them if they can think of other places outside of their home where there are different kinds of switches.

Introduce the design challenge: make an electrical circuit with a switch that controls a hidden alarm. Then provide details:

- Use a battery, buzzer, and any other materials provided.
- Decide what will trigger the alarm: opening a door/window, sitting in a chair, something else?
- The alarm must be small so that it can be hidden.

Before building the alarm, participants will need to know how to construct a simple circuit. Build a simple circuit by connecting the battery to the buzzer. You will need to help participants with this step. Once they know how to build a circuit, the rest of the activity will be easier.

1. Cut two lengths of wire about 6".
2. Use the wire strippers to remove the insulation from the last half-inch of each end of the wire.
3. Use tape to connect one end of one wire to the positive end of the battery and the other end to the red wire on the buzzer.
4. Use tape to connect one end of another wire to the negative end of the battery and the other end to the black wire on the buzzer.
5. The buzzer should now be turned on. Disconnect the wires to turn it off.

WARNING: Never directly connect both ends of a battery. This creates a short circuit that can damage the battery or cause injury.

Encourage participants to experiment with making the circuit switchable. The easiest way to do this is to make a gap in the circuit that can be closed by touching two wires together.

1. Disconnect one wire in your simple circuit from the buzzer.
2. Connect a third wire to the buzzer.
3. Complete the circuit by touching the two loose wires together to turn on the buzzer. Move the wires apart to open the circuit and turn off the device.
4. Tear off a strip of aluminum foil. Touch the two loose wires to the foil. Does your circuit work?

Encourage participants to work in teams of 2–4 to design the hidden alarm.

Evaluate the success of each design.

- Did the circuit make the buzzer sound?
- Could the circuit be switched on and off?
- Was the circuit small enough to hide? (This is subjective. Where could it be hidden?)

ACTIVITY VARIATIONS

Make the activity more challenging by requiring the alarm to sound when a door is opened.

Extend the activity using any other electrical exhibits or parts you have on hand.

TROUBLESHOOTING

Make sure all connections are tight. Loose wires are a likely culprit for a circuit that isn't working.

Is the buzzer properly connected to the battery? The red wire on the buzzer should go to the positive (+) end of the battery; the black wire on the buzzer should connect to the negative (-) end of the battery.

RELEVANT TERMINOLOGY

Circuit: The complete path that an electric current follows, including the energy source. A battery is an example of an energy source.

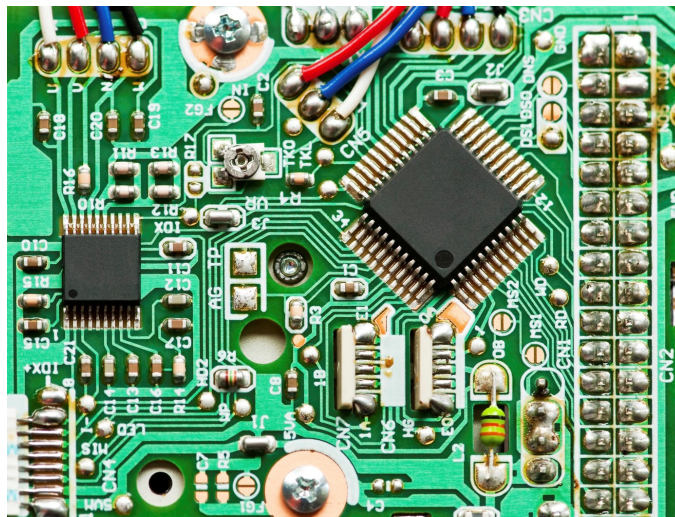
Conductor: A substance that transfers heat, electricity, or sound. Copper wire is an example of a conductor of electricity.

Current: The rate of flow for an electric charge, or how much electricity is flowing. A strong current means that a lot of electricity is flowing.

Electricity: A form of energy caused by the flow of electrons that occurs naturally and can be transferred through conductive materials like wires.

Electrons: Tiny pieces of electricity that are so small, you can't even see them with the most powerful microscopes. Electrons are part of atoms, and atoms are what everything in the world is made of.

Switch: A small device that starts or stops the flow of electricity when pressed or moved up or down.



Circuitry on a circuit board. Engineers find ways to make circuits smaller to build lighter electronic devices. Credit: NASA.

GUIDANCE FOR YOUNGER CHILDREN

QUESTIONS TO ASK AFTER THE ACTIVITY

- Where did you put the battery in your circuit design?
- How did you connect the wires?
- Were you able to make the buzzer sound when you wanted it to?
- How did you create a switch? Does it matter where in the circuit it is placed?
- How did you hide your circuit?
- Why would engineers want to design a way to hide a circuit?

ENGINEERING CONNECTIONS

Electrical engineers use circuits to enable us to use the power of electricity. We use electricity to power lights, run computer programs, power the TV, and keep the refrigerator working, among many other uses. As in the circuit you built today, a switch is a very important part of every electrical device. The switch is used to start or stop the flow of electricity, thereby allowing us to turn electrical devices on and off. When you turn a light off, the switch is opened, meaning that the wires are not connected, so electricity cannot flow through the circuit. However, close the switch and—eureka!—electricity can run through the circuit, and your light, TV, oven, or computer comes to life.

Some of the earliest electrical engineers include Thomas Edison, who invented the electric lightbulb, Guglielmo Marconi, who invented the radio, and Philo T. Farnsworth, who invented the television. These men paved the way for modern-day electrical engineers. Today, electrical engineers work on anything that makes or uses electricity, from the lights in your home, to the cars we drive, to the rockets we send into space.

SCIENCE CONNECTIONS

Electricity is a type of energy that can build up in one place or move from one place to another. When energy builds up in one place, it is called static electricity; the word *static* means something that doesn't move. You have probably experienced static electricity when you touch someone or something and get a shock. When electricity moves from one place to another, it is called current electricity. Current electricity is what powers all of our electrical devices. It is called current because the electricity flows like the current in a river.

Lightning is a powerful example of an electric current. First, it begins as static electricity as the energy builds up in one place (the clouds). When lightning strikes, that electricity flows as a current between the clouds and the ground. In fact, the amount of energy in one bolt of lightning is enough to power an entire house for a month! Circuits are used to carry current electricity from the power source to where you want to use it (the load).

GUIDANCE FOR OLDER YOUTH AND ADULTS

QUESTIONS TO ASK AFTER THE ACTIVITY

- How did you design your circuit? How did you create a switch?
- In your circuit, what action triggered your switch to close the circuit and sound the buzzer? What would you have to change to have it triggered by a different action, such as when a door is opened?
- Did your circuit overheat? How could you prevent a short circuit or prevent your circuit from overheating?

ENGINEERING CONNECTIONS

Electronics engineering is a specialized discipline within electrical engineering. Electronics engineers design and test circuits that use a variety of electrical components. Before building an electronic circuit, electronics engineers create schematics, which are drawings that identify the different components in the circuit as well as how they are connected to one another. Planning is a very important part of every engineer's job, because it saves time and resources in the long run and enables engineers to identify potential problems before they manufacture these very complex circuits.

Electronics engineering began with the improvement of the telegraph in the 19th century and the radio and telephone in the 20th century. Today, electronics engineers focus on more than just communication systems and are employed in a wide variety of industries. We live in a world that is powered by electronics and driven by the need to make those devices smaller, smarter, and faster. The companies that can accomplish this will be the most profitable and successful, but this cannot be accomplished without the expertise and creativity of engineers.

SCIENCE CONNECTIONS

Circuits transfer electricity from one place or component to another. To do so, they require certain materials called conductors. In these materials, which include copper, silver, and gold, the electrons are more loosely attached to the nucleus and can more easily "fly off" on their own. These materials transfer electricity better than others because these independent electrons, when they move, are the basis of current electricity. Current electricity is the flow of electrons.

To better understand current electricity, think of water that flows through a river from a reservoir to the ocean. The reservoir is like a battery, in that the energy that the river can have depends on how much water is stored in the reservoir. The electrons are like the water molecules in the river. The current is how much water is flowing past a certain point in a given amount of time. The wider and deeper the river, the more water it can carry. The same is true for wires. The bigger the wire, the more electrical current it can handle.

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ACKNOWLEDGMENTS

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