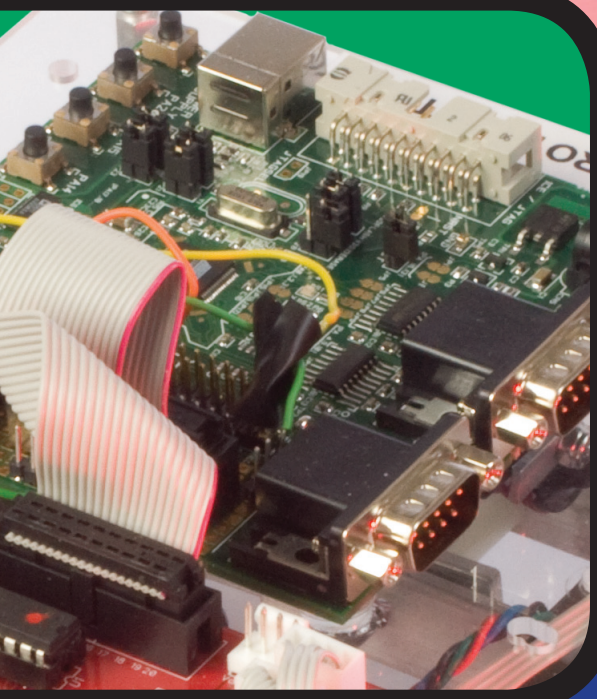
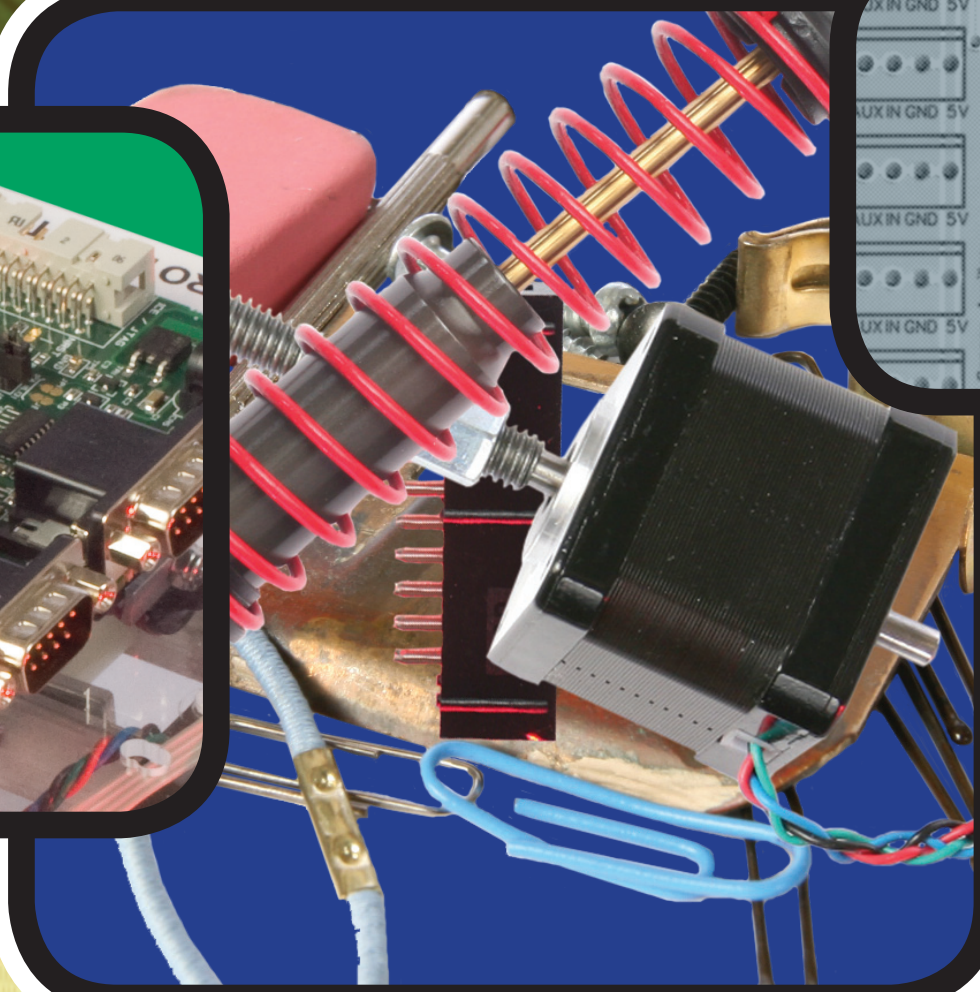
REVIEWED & RECOMMENDED
National 4-H Curriculum

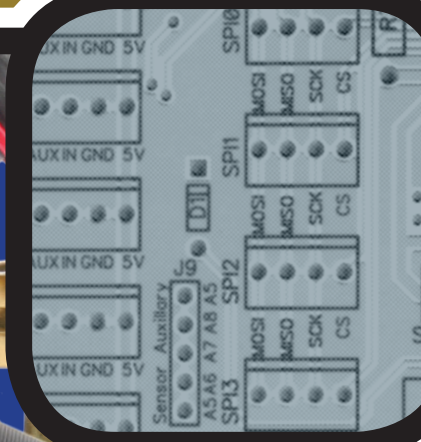
NATIONAL 4-H CURRICULUM
Product Number 08433

JUNK DRAWER ROBOTICS

LEVEL 3: MECHATRONICS







4-H ROBOTICS: ENGINEERING FOR TODAY AND TOMORROW

18 USC 707

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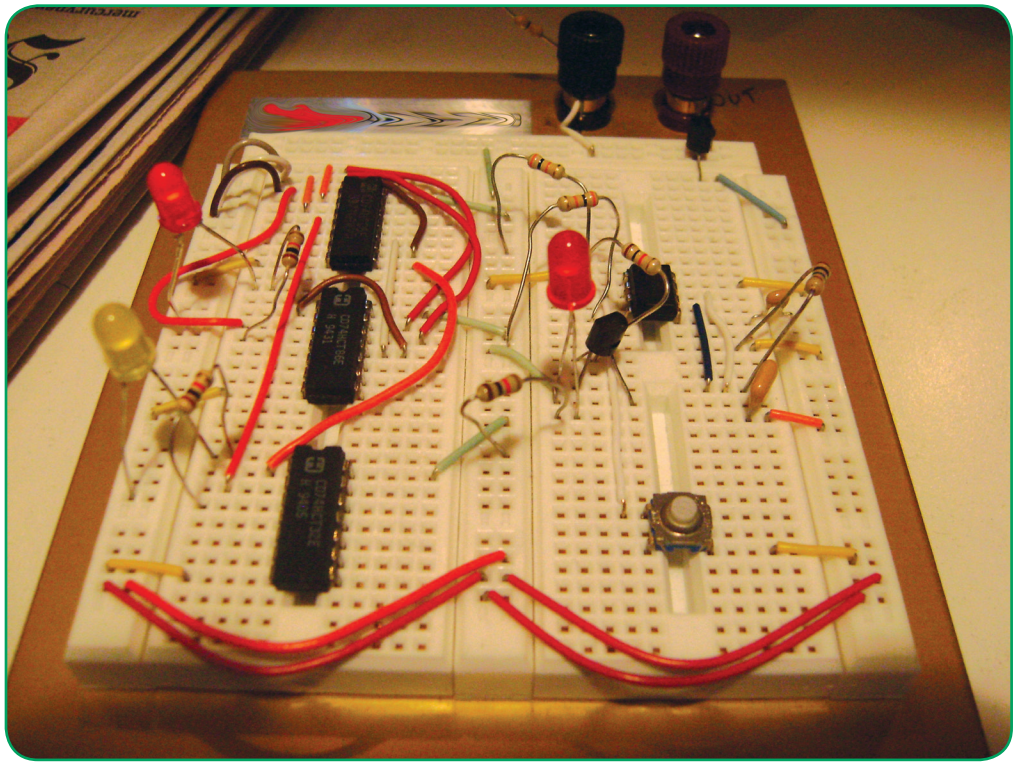
4-H Robotics: Engineering for Today and Tomorrow

Junk Drawer Robotics

Level 3

Mechatronics

Presenter's Activity Guide



Junk Drawer Robotics Level 3
Mechatronics

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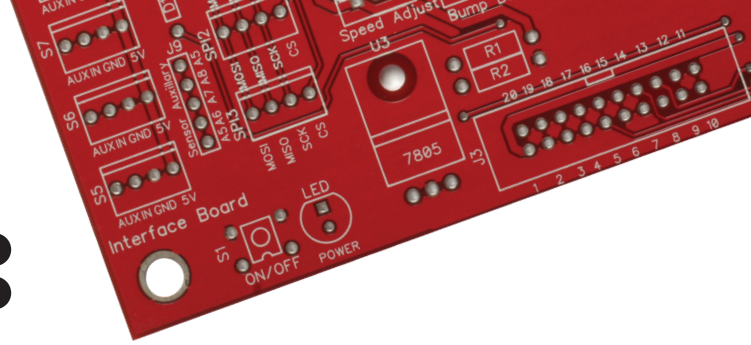


Module 1: Circuit Training

Overview of Activities in this Module

To Learn

Activity A – Series/Parallel
Activity B – Off and On
Activity C – Direction of Flow

To Do

Activity D – Forward and Reverse Design Team

To Make

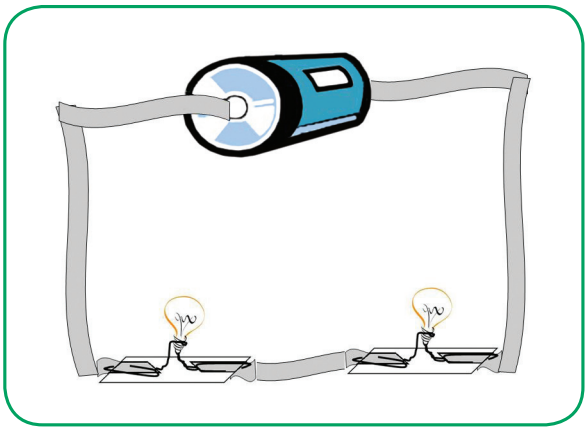
Activity E – Forward and Reverse Build Team

Note to Leader

Circuit — In a circuit, an electrical flow or path is needed from the + (plus) battery contact through the item (bulb, motor, light, hair dryer, etc.) and back to the – (negative) contact of the battery. When there is a complete path, the electricity will flow through the circuit and the light will glow, the motor will turn, and the hairdryer will get hot.

Switches — Switches are used in a circuit to control the flow by opening or breaking the flow, which turns off the item. When the light switch is flipped off, the circuit is opened. No electricity will flow, and the light goes off. This switch allows control over the electrical flow and the light.

Series circuit — In a series circuit, one wire (conductor) goes from the power source (battery, transformer, etc.) to the item and back, as in Example A. In this example, the two lights have one conductor going into and out of each light (one loop). This construction saves wire, but if one light burns out, the circuit will open and the other light will go out.



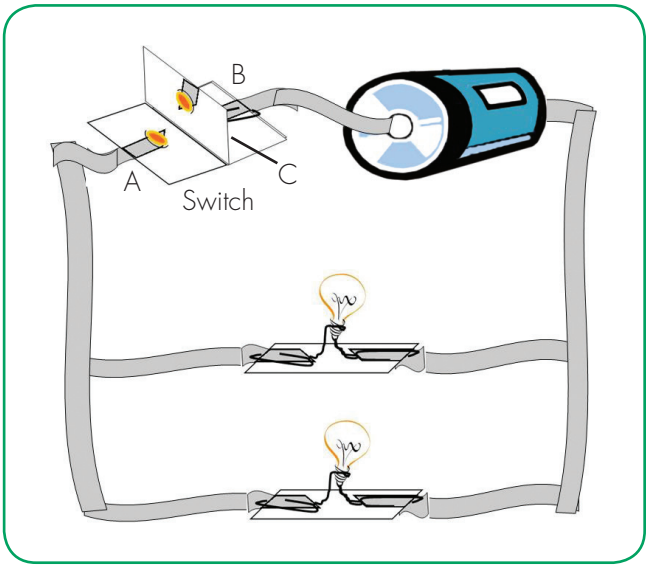
Example A

Parallel circuits — In a parallel circuit, two wires (conductors) go to each item, as in Example B. In this example, each of the two light bulbs has an individual path (multiple loops) for the flow of electricity. Even if one light burns out, the other retains its electrical flow and remains lit.

There are combinations of series/parallel circuits for multiple items. Multiple **batteries** also can be connected in either a series or parallel circuit. Batteries connected in series will add voltages. However, if a group of batteries is connected together in a series and create too high a voltage, the light bulbs will burn out.

As stated before, an electrical switch is used to control the on/off flow of electricity in a circuit. The switch can either be on (flow) or off (no flow). The opening and closing of the switch can control the lights, motors, or other electrical items in the circuit. Electronic components like transistors also are used for switching and control of lights, motors, and other circuits. By using electronic circuits, a whole array of options for programming, sensor data, and control can be automated for the robot.

In this module, we will begin to look at simple electrical circuits and physical switches to control them. A simple switch can be made from a few metal parts (conductors) and some insulating parts (wood, plastic, air). A knife switch is one example with contact A, contact B, and a lever C, as shown. The contacts A and B are wired into the circuit. The lever C is moved to touch both contacts to allow the electricity to flow, and pulled up to stop the flow. In this module you will assist the participants in exploring series and parallel circuits, switches, and in designing and creating their own switches using craft sticks, aluminum foil, paper brads, and paper clips.



Example B

What you will need for Module 1: Circuit Training

- Robotics Notebook for each youth
- Trunk of Junk, see page 8
- Tool Box
- Activity Supplies
  - Copies of handout/poster of electrical circuits on page 18
  - Copies of handout/poster of electrical switches on page 20
  - Wire or aluminum foil and craft sticks with holes
  - Paper brads, paper clips, rubber bands
  - Masking, clear, or electrical tape
  - Holiday mini and holiday LED lights
  - 1.5-volt batteries – AA, C, or D size
  - Toy electric motor (1.5 volt to 6 volt will work)
  - A wheel, gear, propeller, or cardboard disk to fit on the toy motor
  - Backing or base for holding circuit elements being designed; can use pegboard, cardboard, or plastic canvas for this base
  - Drill and bits

Note: See See the 4-H Robotics website at *www.4-H.org/curriculum/robotics* for more information about electrical circuits and suggestions for making foil connections using craft sticks, lamp holders, switches, and battery holders.

Timeline for Module 1: Circuit Training

Activity A – Series/Parallel
- Activity will take approximately 20 minutes.
- Divide youth into groups of two or three.

Activity B – Off and On
- Activity will take approximately 20 minutes.
- Divide youth into groups of two or three.

Activity C – Direction of Flow
- Activity will take approximately 20 minutes.
- Divide youth into groups of three or four.

Activity D – Forward and Reverse Design Team
- Activity will take approximately 20 minutes.
- Divide youth into groups of two or three.

Activity E – Forward and Reverse Build Team
- Activity will take approximately 40 minutes.
- Use the same groups from Activity D, Forward and Reverse Design Team.

Performance Tasks For Youth

You will learn about the differences between series and parallel electric circuits.

You will create an on/off switch for a basic circuit.

You will experiment with circuits and control the direction of electrical flow.

You will plan and design a double pole double throw (DPDT) switch to change the circuit's polarity.

You will use your DPDT design and build a working switch that you can attach to a simple circuit.

Focus for Module 1: Circuit Training

Big Ideas
- An electrical circuit is a closed path through which an electric charge can flow. It typically consists of a power source (battery), conductors (wire), a load (bulb), and a control (on/off switch).
- The interaction between the "sense," "think," and "act" components of what a robot does is accomplished using electric signals.

NSE Standards
- Constancy, change, and measurement
- Light, heat, electricity, and magnetism
- Abilities of technological design
- Understanding about science and technology

STL
- Relationships and connections
- Engineering design
- Energy and power technologies

SET Abilities
- Build/construct
- Compare/contrast
- Draw/design

Life Skills
- Communication
- Critical thinking
- Keeping records
- Planning/organizing

Success Indicators

Youth will build simple operating electric circuits using parallel and series designs.

Youth will be able to turn off and on a circuit they created to power a light and/or motor.

Youth will change the direction of electrical flow in a circuit.

Youth will plan, design, and share what they've learned about a double pole double throw switch.

Youth will create a DPDT switch that will reverse a motor's rotation.

Activity A – Series/Parallel

Performance Task For Youth

You will learn about the differences between series and parallel electric circuits.

Success Indicators

Youth will build simple operating electric circuits using parallel and series designs.

List of Materials Needed

- Robotics Notebook
- Activity Supplies
  - Craft sticks, brass brads, wire or aluminum foil, paper clips, tape, rubber bands, three holiday mini lights, and batteries
  - A base to attach circuit elements made of pegboard, cardboard, or plastic canvas

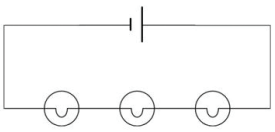
    Note: See the 4-H Robotics website at *www.4-H.org/curriculum/robotics* for more information about electrical circuits and suggestions for making foil connections using craft sticks, lamp holders, switches, and battery holders.
  - Copies of handout/poster of electrical circuits on page 18

Activity Timeline and Getting Ready

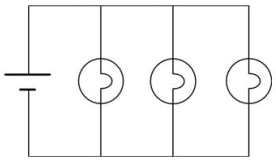
- Activity will take approximately 20 minutes.
- Divide youth into teams of two or three.
- Prepare two identical packets per team, including a base or backing material about 6 inches square, three small holiday mini lights, two craft sticks (with holes), and one battery.
- Provide other materials, such as brads, paper clips, aluminum foil, or rubber bands as needed, or allow teams to select materials from the supply area.
- Share handout or refer to the Robotics Notebook for information on types of circuits. A series circuit consists of a one-loop circuit with each item connected to the next, providing one path for the electrical flow. A parallel circuit consists of a multiloop circuit in which each item can make its own path (loop) for electrical flow.

Experiencing

1. Ask the youth to build a three light series circuit using one of the prepared packets. For this exercise, none of the bulb wires should be directly connected to another, and the whole circuit should be attached to a cardboard or plastic canvas. This will require the use of two aluminum foil-covered craft sticks, paper brads, paper clips, etc., to make the connections. When finished, test the circuit with the battery. Save this circuit setup for later use.



2. Ask youth to build a second three light circuit with the second prepared packet, but this time as a parallel circuit. Once again, none of the bulb wires should be directly connected to another, and they should be attached to a cardboard or plastic canvas base. This will require the use of two aluminum foil-covered craft sticks, paper brads, paper clips, etc., to make the connections. When finished, test the circuit with the battery. Save this circuit setup for later use.



3. Ask each team to compare the designs of their two circuits with the other groups' creations — how they are alike and how they are different. Students should record their observations in the Robotics Notebook.
4. Ask participants to modify one of their circuits to create a hybrid with both series and parallel sections in the same circuit.

Sharing and Processing

As the facilitator, help guide youth as they question, share, and compare their observations. Have participants record their experience in their Robotics Notebook, including notes about new discoveries and knowledge. If necessary, use more targeted questions to prompt particular points.

- How are the lights affected by circuit type? Brightness/dimness?
- When one light goes out, what happens to the others? (Note: When one light goes out in a series circuit, all the lights go out. In a parallel circuit, even if one light goes out, the others stay on.)
- Which circuit do you think would be better for building a robot? Why?

Generalizing and Applying

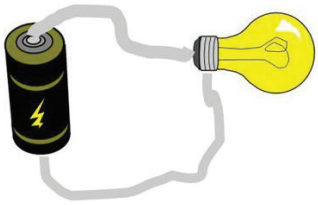
- Where have you seen or used series circuits? (Series: In some older holiday decoration lights, when one bulb goes out, they all go out.)
- When have you seen or used parallel circuits? (Parallel: In stadium lights, when some burn out, the rest stay lit.)
- Share other types of circuits you've seen. Are they similar or different to the one you've created?
- Youth can apply what they have learned in Activity B.

Note: Have the participants save these two bases and circuits for use in Activity B, Off and On, and Activity C, Direction of Flow.

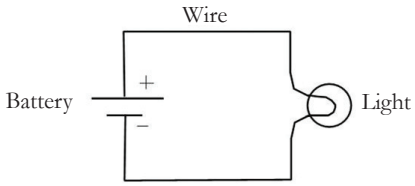
Electrical Circuits

There are many ways to create an electrical circuit for the flow of electricity (electrons) to do things like buzz a buzzer, make a motor turn, or light a lamp bulb.

A simple electrical circuit can be made from a battery, wires (connectors), and a light bulb (lamp).



This circuit can be drawn using symbols: These drawings are called schematics.

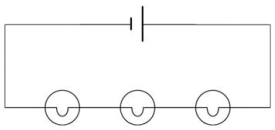


Conductors and Insulators:

Most metals are good conductors of electricity. Copper and aluminum are some of the best and easily used conductors. Not all conductors are wire shaped; sometimes a metal frame or other part of a structure is used as part of a designed circuit. But be careful. If you don't want certain metal items as part of a circuit, you'll also need insulators to block the electrical flow in areas that you don't want electrons to go. Some good insulators are made of wood, rubber, or plastic. These insulators can be placed between, around, or covering a conductor to help direct where the electrical current will flow.

Make your own conductors: Use craft sticks with holes and cover (wrap) them with aluminum foil to create electrical connectors. Then use brads, paper clips, and mini lamp sockets to complete the circuits. Use masking tape and rubber bands to hold the connections and battery in place.

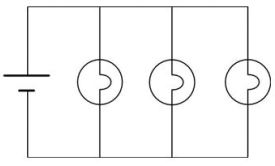
SERIES Circuit



A series circuit is one continuous loop from the battery, conductors, the bulbs, and then back to the battery. To set up the series circuit, make a single path with the foil-covered craft sticks to the lamps and battery. Use brads and paper clips at the connections.

PARALLEL Circuit

A second way to set up a circuit is to have multiple paths or loops for the electrical flow from the battery. In a parallel circuit, each of the three lamps will have its own direct link to and from the battery. Make a parallel circuit with multiple loop connections with the foil-covered craft sticks, lamps, and battery. Use brads and paper clips at the connections.



Test both circuits with a battery. Compare what happens with the lights as you remove one light at a time. Also, note the brightness of the lights in each circuit: Are lights brighter in one circuit but not the other? What happens if you light one, two, or three of the lights in a series circuit?

Activity B – Off and On

Performance Task For Youth

You will create an on/off switch for a basic circuit.

Success Indicators

Youth will be able to turn off and on a circuit they created to power a light and/or motor.

List of Materials Needed

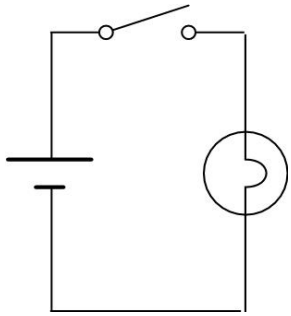
- Robotics Notebook
- Activity Supplies
  - Copies of handout/poster of electrical circuits on page 18
  - Copies of handout/poster of electrical switches on page 20
  - Craft sticks (with holes), brass brads, wire or aluminum foil, paper clips, tape, light bulbs, and batteries
  - A base for building circuit design of pegboard, cardboard, or needlepoint board
  - Or, the circuits made from Activity A – Series/Parallel

Activity Timeline and Getting Ready

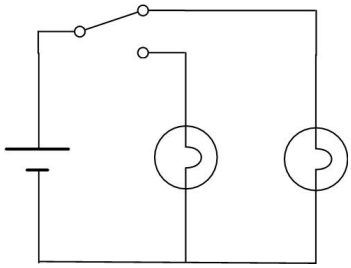
- Activity will take approximately 20 minutes.
- Divide youth into teams of two or three.
- Provide each group with the materials they can use to create an on/off switch.

Experiencing

1. Challenge youth to experiment with different designs of switches and types of material.
   a. Challenge 1: Make a single pole single throw (SPST) switch to control all the lights in the series circuit made in Activity A.



   b. Challenge 2: Make a single pole single throw (SPST) switch to control just one of the lights in the parallel circuit from Activity A.
   c. Challenge 3: Make a single pole double throw (SPDT) switch to turn on/off two different lights, one at a time.

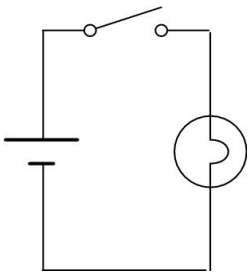


Electrical Switches

The electrical flow in a circuit may need to have a control to turn it on and off. The use of a switch or switches can provide ease of control while retaining good contacts at the connections. There are a number of different types of switches that can be made in a circuit.

Single Pole Single Throw (On/Off) Switch (SPST):

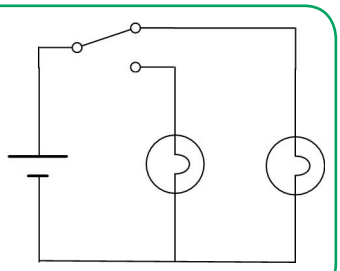
The simplest switch is a single pole single throw switch; it will open and close one circuit. Craft sticks with holes, aluminum foil, paper clips, and brass brads can be used to make an on/off switch (on – closed circuit; off – open circuit). Hint: Only cover part of the craft stick with foil.



Single Pole Double Throw Switch (SPDT):

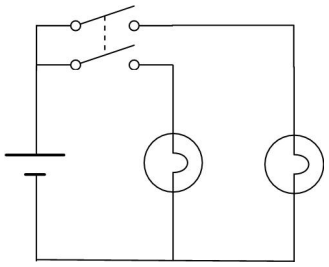
This type of switch can control two different circuits, one at a time. One circuit can be opened as a second circuit is closed.

Challenge: Try using a craft stick, one paper clip, and three brads to create a SPDT switch.



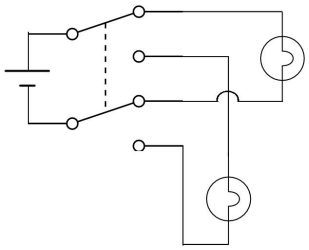
Double Pole Single Throw Switch (DPST):

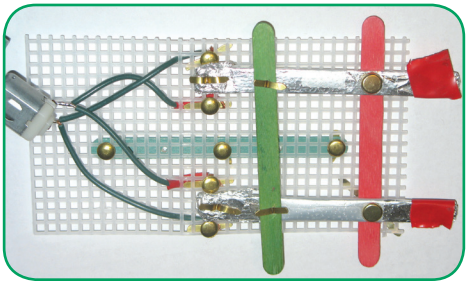
This switch can operate two circuits at the same time, opening and closing them together. It is like two single pole switches next to each other.

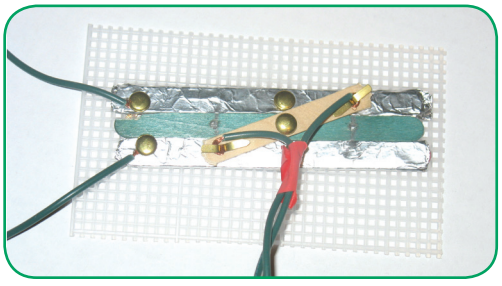


Double Pole Double Throw Switch (DPDT):

This type of switch can control a number of circuit directions, including reversing the electrical flow to change the direction of motor rotation. Below are some sample designs for DPDT switches. What design can you create for a DPDT switch?



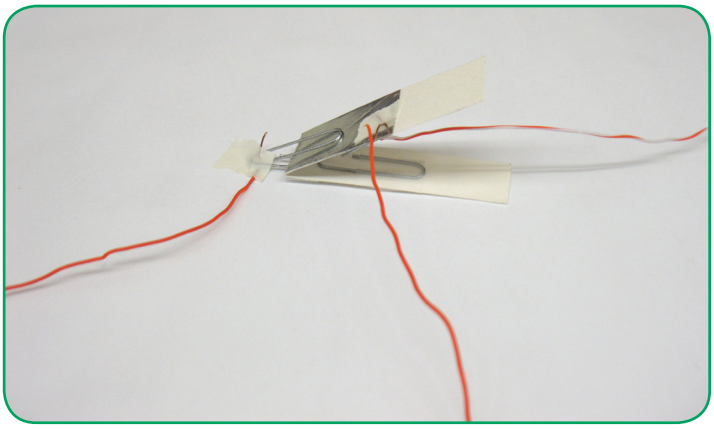


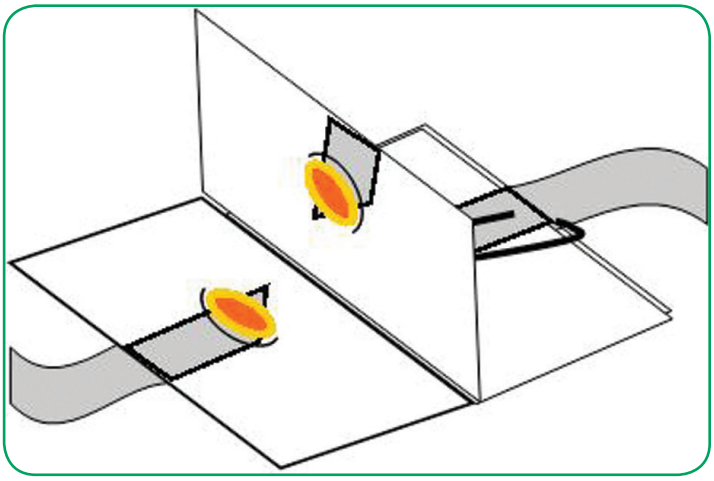


Sharing and Processing

As the faciliator, help guide youth as they question, share, and compare their observations. Have participants record their experience in their Robotics Notebook, including notes about new discoveries and knowledge. If necessary, use more targeted questions to prompt particular points.

- Which type of switch is the easiest to make? The hardest? Why?
- How could different designs of switches be beneficial to the circuit?
- Is there a way to turn the light on and off without touching the switch? (thermal, sound, motion, light)





Generalizing and Applying

- Where do you use switches?
- Where could you use a switch in a robot?
- Youth can apply what they have learned in Activity C.