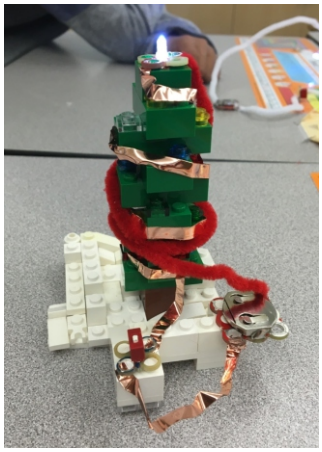
# Circuit Crafts

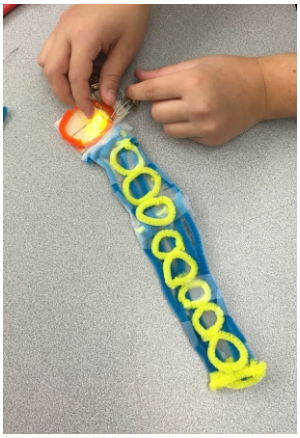
Standards based, hands-on projects that provide students agency to explore Computer Science concepts through projects that are easy to implement, open-ended, age-appropriate and low cost.

**Next Generation Science Standards (NGSS) Standards K-5 covered**
2-PS1 Matter and its Interactions
2-PS2 Analyze data from testing
4 Energy
4- PS2&3 Observe and Apply
K-2 Engineering Design
3-5 ETS1 Engineering Design

**K12 CS Framework Items covered**
K–2.Computing Systems.Devices
K–2.Computing Systems.Hardware and Software
K–2.Algorithms and Programming.Control
K–2.Algorithms and Programming.Algorithms
K– 2.Algorithms and Programming.Modularity
K–2.Data and Analysis.Collection
K–2.Data and Analysis.Storage
https://k12cs.org/

## Sample Student Projects


Lego Xmas Tree

Pipe-cleaner Menorah



Candle/ornament

Holiday Headband


## Why Circuit Crafts for K-2 Computer Science instruction?

In the 21st century, even young children need early exposure to computer science – not necessarily to programming or even to computers, but rather to the scientific concepts and problem-solving approaches that underpin our computerized world. With standards just emerging for this arena, elementary schools and teachers have few resources available for teaching students the basics about engineering.

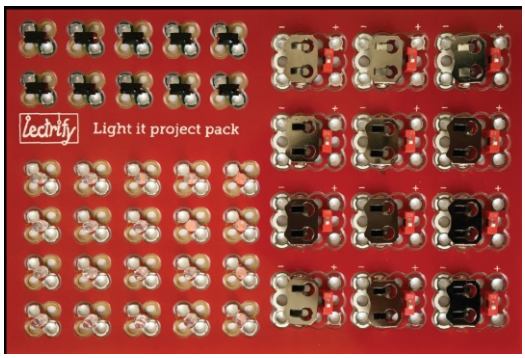
Lectrify offers a range of open-ended circuit-based products for STEM instruction and exploration. Our line of products help teachers and parents bridge from hands-on "analog" learning appropriate at younger ages with the more abstract "digital" learning students will master as they get older. With inexpensive, easy-to-use products that build upon one another as students learn, Lectrify helps prepare students to understand computational thinking – a crucial precursor to other STEM skills like programming and coding.

# Getting Started

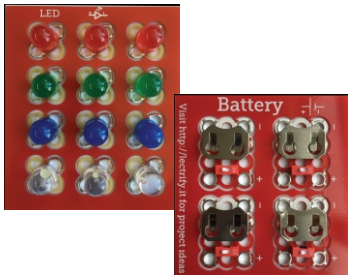
## Prepare the Electronics

Circuit Crafts require only the most basic electronic components: A battery and a light. In the Lectrify kits, these can be found in the Light it Project Pack, Light it Board, or Add-on packs for as little as $2.50/student.


Light It boards

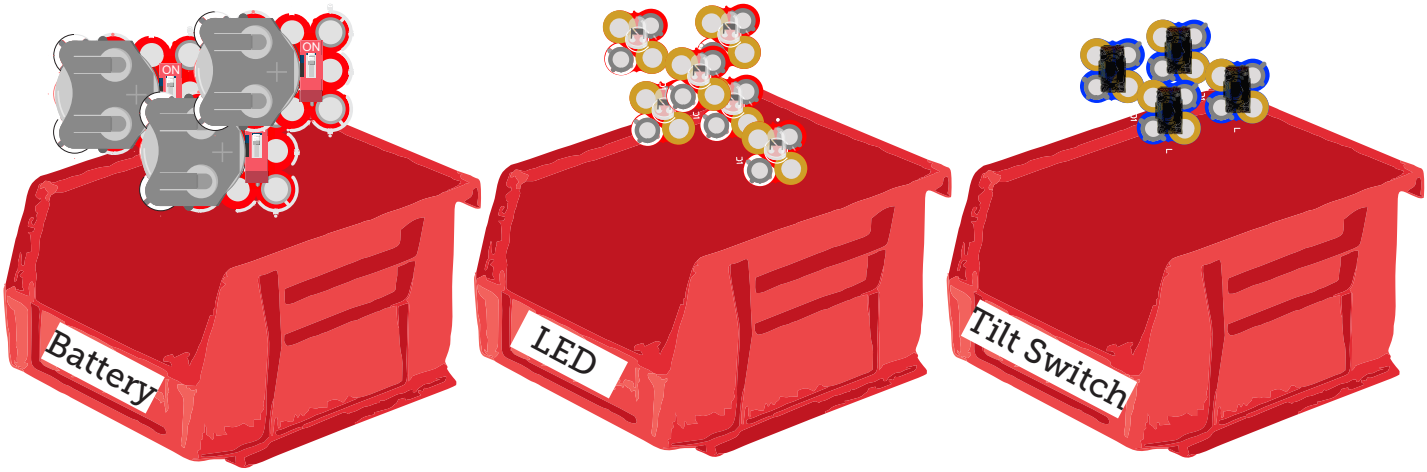



Light It project pack




Extension Pack boards

For K-2 instruction we recommend removing the components from the boards and placing them in labeled bins. This makes them more accessible to students as familiar craft materials.




## Gather Craft Materials

Many common craft materials conduct electricity. Provided are examples of conductive craft material.

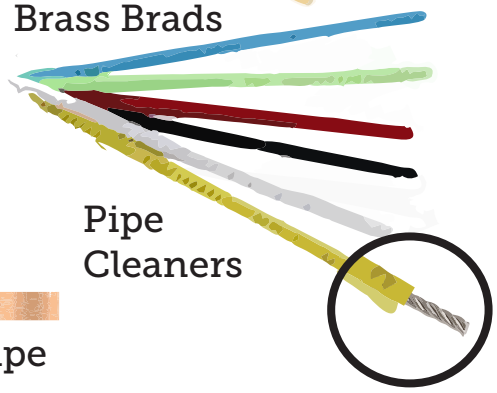
Students should be given a combination of conductive and non-materials to build with. This provides them agency to discover basic principles of conductivity through trial and error as they build with various materials.

Paper Clips

Brass Brads

Aluminum Foil

Copper Tape



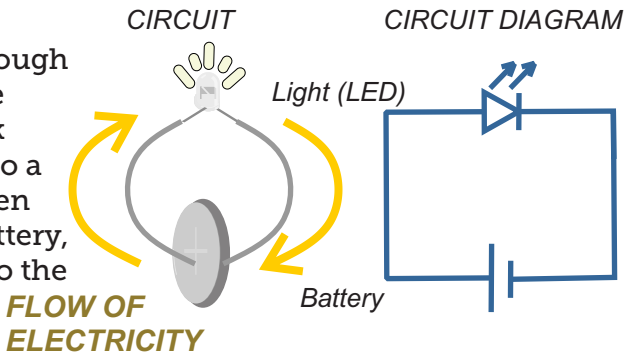
Pipe Cleaners

Remove fuzz to expose wires

# Project Design Ideas

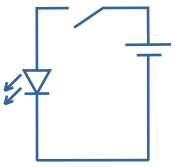
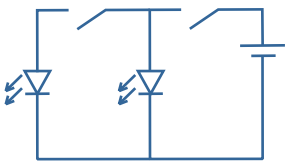
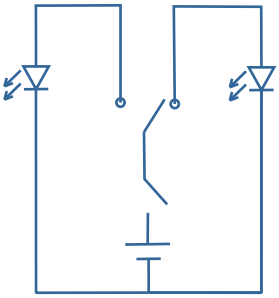
**Start by exploring: what is a circuit?**

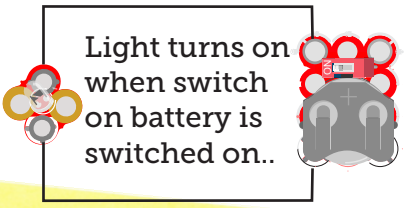
A circuit is a closed path through which electricity flows. The simplest circuit we can work with is a battery connected to a light. The light turns on when electricity flows from the battery, through the light and back to the battery.




In a circuit diagram, a battery is shown as two parallel lines and an LED as a triangle and line with arrows representing the light. NOTE: An LED has polarity, a negative and positive side. Always make sure the positive side of the battery is connected to the positive side of the LED. On Lectrify circuits red is positive and white is negative.

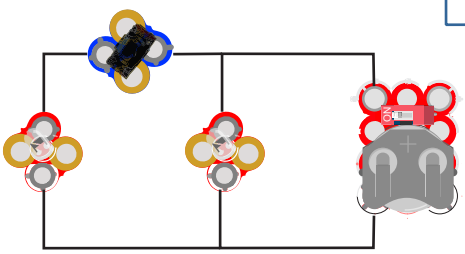
Once students have been introduced to a basic circuit, provide them components and craft materials to build their own. The scope and complexity of a student's project can be calibrated to fit ability and time. Below is a sample rubric with project examples.

| | Foundational | Proficient | Extending |
|---|---|---|---|
| Description | Students build a simple circuit to light an LED within their creation. Students explore conductivity and electricity. | Simple AND/OR logic is added to circuit to enable user to control outcome through simple actions. | Through the use of switches, students demonstrate conditional logic through circuit. |
| Components | Single LED<br>Battery | 2 LEDs<br>2 or more switches<br>Battery | Multiple LEDs<br>Novel switches<br>Battery |
| Craft Materials | Single material (e.g. Paperclip, pipe cleaner, etc.) | Multiple materials (e.g. Paperclip, pipe cleaner, etc.) | Novel materials discovered by students. |
| Example |  Simple Circuit with 1 Switch | 2 Switches in series<br>2 LEDs in parallel  |  This circuit uses a Single Pole Double Throw switch where a single switch controls two lights. |

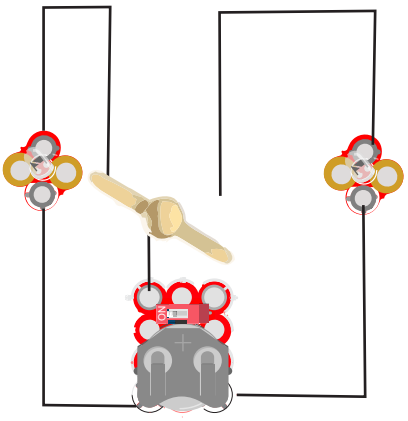


Light turns on when switch on battery is switched on..

Troubleshooting Tips:
- Always make sure circuit is a closed path.
- Check LED polarity (red to red, white to white)



First light turns on when switch on battery is switched on. Second light turns on when tilt switch is tilted AND the battery switch is on.

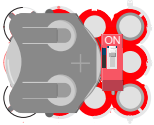


# Teaching notes

## The switch is an important building block

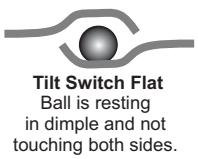
In a circuit diagram, a switch is drawn as a "door" that opens and closes the circuit. Switches come in many different shapes and forms and can be found in every device with electricity.

**BATTERY WITH ON/OF SWITCH**



The lectrify kits come with two switches. The battery has an On/Off switch. The tilt switch has a metal ball bearing in it that closes the circuit when the switch is tilted.

**TILT SWITCH**

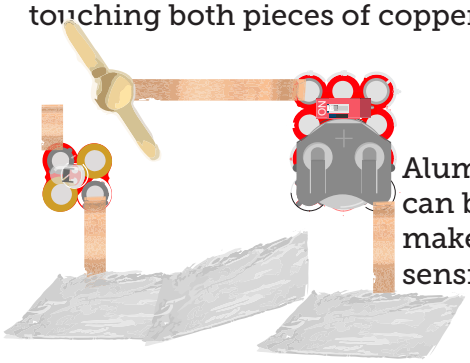


**Tilt Switch Flat**
Ball is resting in dimple and not touching both sides.

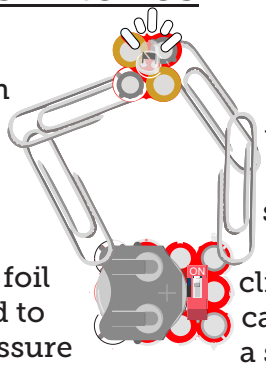
**Tilt Switch Tilted**
Ball rolls down and touches both sides.

## Get creative with your switches

In this circuit, the brad can function as the switch closing the circuit when touching both pieces of copper tape.



Aluminum foil can be used to make a pressure sensitive switch

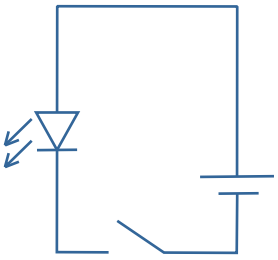


This paperclip bracelet does not look like it has a switch but the air gap between the clips when it is loose can be thought of as a switch. Tight= On, Loose=Off

**Prompt**

Ask students to look around the room and see how many switches they can see from their seats

## Advanced: Explore how switches enable logic



In a simple circuit, the switch is the part of the circuit we control and is our INPUT, and the light is the OUTPUT, (what the circuit does). Even a simple circuit allows us to collect data as in the following table.

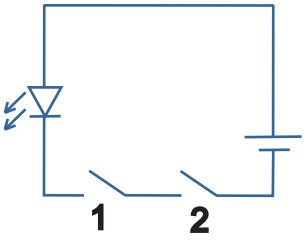
| INPUT (Switch) | OUTPUT (Light) |
|---|---|
| OFF | OFF |
| ON | ON |

We shorten ON/OFF to I/O

| INPUT (Switch) | OUTPUT (Light) |
|---|---|
| O | O |
| I | I |

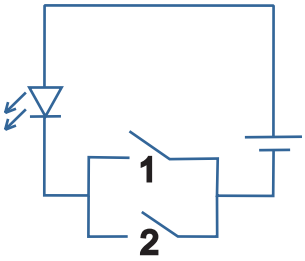
When we use two switches, we now have two inputs and this allows us to explore the most common logic circuits in computers: AND and OR. An AND circuit is done when we put two switches in series and the OR when they are done in parallel.

2 Switches in series




| INPUT | | OUTPUT |
|---|---|---|
| Switch 1 | Switch 2 | Light |
| O | O | O |
| I | O | O |
| O | I | O |
| I | I | I |

2 Switches in parallel




| INPUT | | OUTPUT |
|---|---|---|
| Switch 1 | Switch 2 | Light |
| O | O | O |
| I | O | I |
| O | I | I |
| I | I | I |

When the switches are in series, both switches must be on for the light to turn on. We call this an AND circuit because both Switch 1 AND Switch 2 need to be on for the light to turn on.

When the switches are in parallel, we observe that the light turns on when Switch 1 OR Switch 2 or both switches are on. This is called an OR circuit.

AND and OR are building blocks for many programming ideas and important circuits to learn.