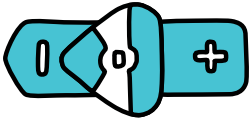
Paper Circuits | Level 1

Launchpad Sketchbook



Getting Started with Paper Circuits
by Jie Qi

and you:

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A digital version of this book is available to download for free at:
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CONTENTS

HOW TO USE THIS BOOK

Welcome to the Launchpad Sketchbook: Getting Started with Paper Circuits!

This book will show you step-by-step how to build your own paper circuits. You will be crafting your circuits right onto the pages of this book.

Start with the COMPONENTS & MATERIALS section to learn some core concepts and get familiar with all the parts in your kit. We've put key words in **bold**. You can look these up in the GLOSSARY (p. 113) to learn more. Be sure to check out the BATTERY SAFETY section (p. 107) to learn how to use and dispose of your batteries safely.

Then go through the PAPER CIRCUIT ACTIVITIES. Each chapter introduces new concepts that build on previous chapters. Once you've built your template circuit, be sure to try the drawing activity. Half the fun of making paper circuits is bringing your unique stories to life with light!

The *YOUR TURN* section (p. 125) gives you blank templates for designing and building your own circuits from scratch.

The PAPER CIRCUIT ACTIVITIES also come with online companion videos. You can find them at this link:
go.chibitronics.com/LVideo

If you run into problems, check out the HELP & DEBUGGING section on page 97 for answers to common questions. It's okay if your circuit doesn't work at first. In fact, debugging is a natural part of the learning and making process!

If you ever feel stuck, want to ask a question, or created something that you would like to share with us, please contact us at:
help@chibitronics.com

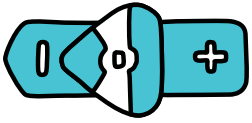
We're here to help and excited to hear from you!

For a free PDF download of this book, as well as other language translations, go to this link:
go.chibitronics.com/LBook

Happy making :)

—Jie & Chibitronics Team

Components & Materials

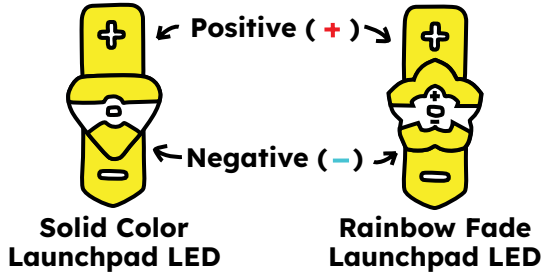


COMPONENTS & MATERIALS

Launchpad LEDs

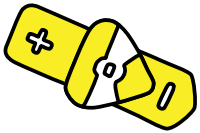
LEDs, which stand for **light emitting diodes**, shine when powered by **electricity**. All LEDs have a **positive** "+" side and a **negative** "-" side. This is called the **polarity**.

The beginner-friendly **Launchpad LEDs** in your kit have large metal **pads** made for easy connections, one with "+" to indicate the positive side and one with "-" to indicate the negative side.



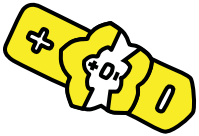
Throughout this book, we will use the color red to show positive or "+" parts of the circuit and blue to show negative or "-" parts of the circuit.

The Launchpad LEDs in your kit shine in different colors and effects.



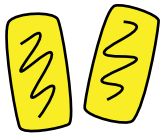
Solid Color Launchpad LEDs have a triangular center and shine a single color. The color of the LED center shows the color it will shine.

These LEDs are also marked with the first letter of the color: “R” for red, “Y” for yellow, “G” for green, “B” for blue, and “W” for white.



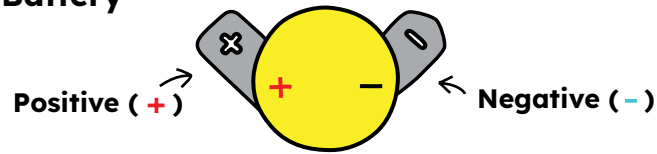
Rainbow Fade Launchpad LEDs, which have a flower-shaped center, are special LEDs that gently fade through different colors!

You can connect Launchpad LEDs to circuits by touching **conductive** materials to the pads. Conductive means that electricity can flow through. You can also place the Launchpad LED on top of conductive materials and tape them in place using **nonconductive** tape, like clear or masking tape.



We’ve included sheets of clear yellow rectangular stickers in your kit to use as nonconductive tape.

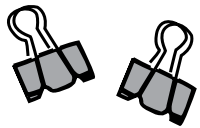
Battery



A battery provides power to your circuit. Batteries also come in many shapes and sizes. Like the Launchpad LED, the **Launchpad Battery** in your kit has two metal pads: one marked “+” for positive and the other marked “-” for negative. Touching conductive material to the battery’s metal pads creates an electrical connection.

Note: *Store the Launchpad Battery in its ziplock pouch, one battery per pouch, when not in use. This avoids accidental connections that can drain the batteries. Check out the BATTERY SAFETY section on page 107 for more important information.*

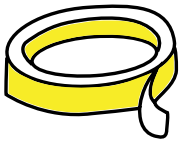
Binder Clip



The **binder clips** in your kit are handy for holding the Launchpad Battery in place and connecting it to your circuit.

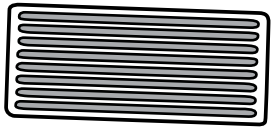
Conductive Tapes

Conductive tapes allow electricity to flow just like wires. They come in many forms like shiny metal **copper tape** and **conductive fabric tape**, which feels like ribbon. They also come in different shapes and sizes like rolls, **strips**, or sticker **patches**.

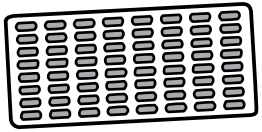


Copper Foil Tape

Conductive Fabric Tape



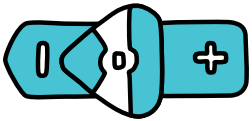
Fabric Tape Strips



Fabric Tape Patches

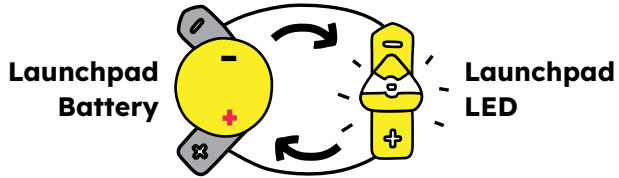
The conductive fabric tape in your kit comes in a roll and as strips on a sticker sheet. It is soft yet also very sturdy. Just like regular ribbon, you will need scissors to cut it. You can stick pieces of conductive fabric tape together to create an electrical connection because its adhesive is conductive too.

Paper Circuit Activities



1. SIMPLE CIRCUIT

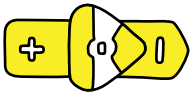
Let's start by lighting up an LED! We will use conductive tape to connect the Launchpad battery to a Launchpad LED. This is called a **simple circuit**. The + pad of the LED connects to the + pad of the battery and the - pad of the LED to the - pad of the battery. This loop is called a **complete circuit**.

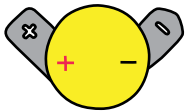


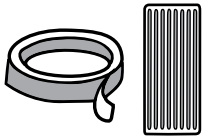
A complete circuit allows **electrons** in the circuit to flow from the battery, through the LED, and back into the battery. This round-trip flow of electrons through the circuit, called **current**, is the **electricity** that powers your light and makes it turn on.

Electrons are lazy, and always take the path of least resistance. Since electrons prefer to take a "shortcut" through the tape, rather than do work lighting an LED, an accidental connection from + to - will quickly drain the battery, and the LED will not light. This condition is called a **short circuit**.

YOU WILL NEED:

 x 1 Solid Color Launchpad LED (triangular center)

 x 1 Launchpad Battery

 Conductive Tape or Tape Strips

 x 2 Binder Clips

 Scissors

DIRECTIONS:

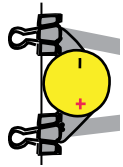
1. Turn to the template on the next page. Place the Launchpad LED over the footprint. Make sure that the + and - match the footprint.

2. Stick conductive tape over the blue - line, taping over the - pad of the Launchpad LED. Cut any extra tape with scissors.

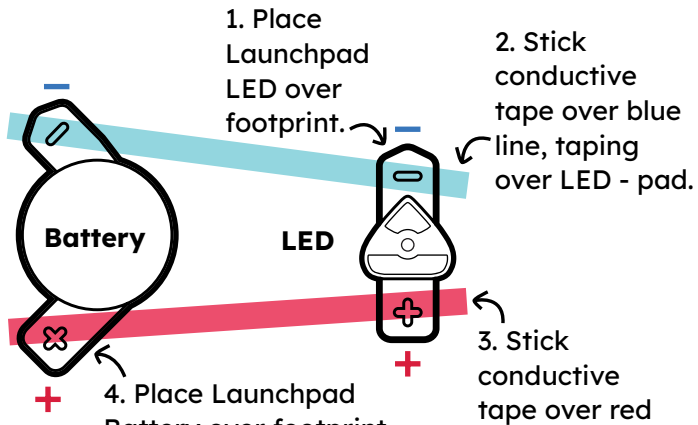
3. Stick conductive tape over the red + line, taping over the + pad of the Launchpad LED. This will hold the LED in place. Cut any extra tape with scissors.

4. Place the Launchpad Battery over the battery footprint. Make sure that the + and - battery pads line up with the footprint's pads.

5. Binder clip the pads of the battery to the page, over the conductive tapes. This will hold the battery in place and turn on your light!



1. SIMPLE CIRCUIT TEMPLATE



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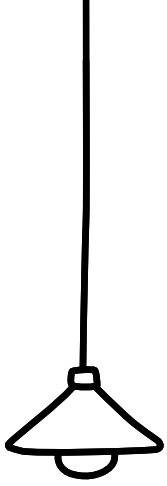
6. With the LED on, flip to the next page and complete the scene with your own drawing!

Note: *Is your LED not lighting up? No worries! Check out the HELP & DEBUGGING section on page 97 for common issues and tips on how to troubleshoot circuits.*



You've turned on the light! What does it illuminate?

REUSING LAUNCHPAD LEDs

In the previous SIMPLE CIRCUIT activity we taped the Launchpad LED down by sticking conductive tape over the pads. This type of connection is quick and also makes a secure circuit connection between the LED pad and conductive tape.

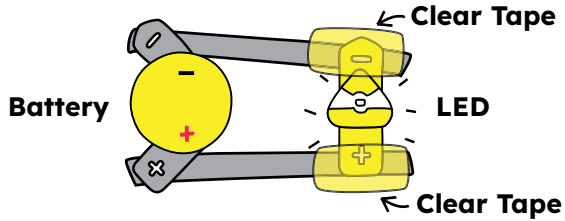
For easier reuse, you can connect Launchpad LEDs by first sticking down the conductive tape, putting the LEDs on top, and holding them in place with clear tape. Let's give this a try!

YOU WILL NEED:

x 2 Clear Yellow Stickers (or any common nonconductive tape)

DIRECTIONS:

1. Turn to the Simple Circuit Template on page 18.
2. Gently peel up the ends of the conductive tapes holding the Launchpad LED in place and remove the LED from underneath the tape.
3. Stick the conductive tape ends back down over the red and blue lines, where they were before.
4. Place the Launchpad LED over the footprint again, but this time on top of the conductive tapes rather than below them. If you press down on the LED + and - pads, the LED will light up!
5. Secure your Launchpad LED in place by sticking a clear yellow sticker over the Launchpad LED + pad and another sticker over the - pad. Press firmly to ensure a strong circuit connection.

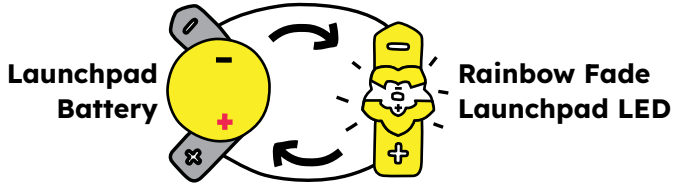


Now that you don't need to untape your Launchpad LEDs from under the conductive tape, they are easier to move and reuse in other projects!

In the rest of this book, we will use this type of reusable Launchpad LED connection so that your LEDs will be easier to move between circuits. However, feel free to use whichever type of connection (conductive tape on top or below the LED) you prefer!

2. RAINBOW FADE LED

Now let's try lighting up the **Rainbow Fade Launchpad LED**! Unlike the solid-color Launchpad LEDs, this special LED has a tiny computer inside that makes it automatically fade through different colors of the rainbow.



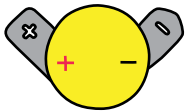
Just like with solid color Launchpad LEDs, to turn on the Rainbow Fade Launchpad LED simply create a complete circuit by connecting the + battery pad to the + pad of the LED and the - battery pad to the - pad of the LED.

Whenever you see a circuit template that shows the footprint for a solid color Launchpad LED, you can also use a Rainbow Fade Launchpad LED instead. Just make sure you match the + and - LED pads to the footprint!

YOU WILL NEED:

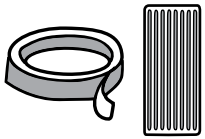
x 1

Rainbow Fade Launchpad LED (flower-shaped center)



x 1

Launchpad Battery



Conductive Tape or Tape Strips

x 2

Binder Clips

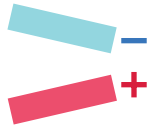
x 2

Clear Yellow Stickers or Common Nonconductive Tape

Scissors

DIRECTIONS:

1. Turn to the template on the next page. Stick conductive tape over the blue - line and the red + line. Cut any extra tape with scissors.

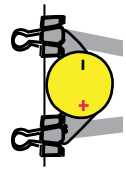


2. Place the Rainbow Fade Launchpad LED (with a flower shaped center) over the footprint. Make sure that the + and - pads match the footprint.

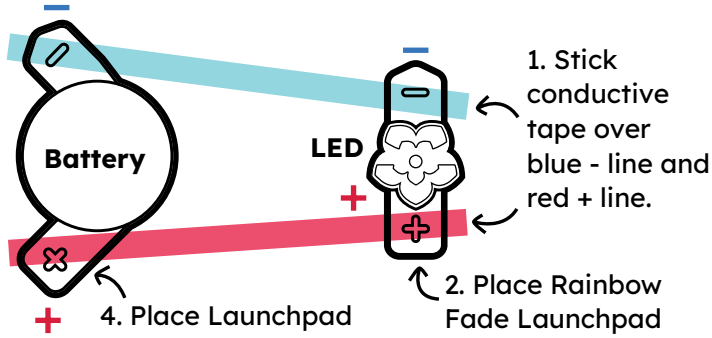
3. Tape the Launchpad LED in place using clear, nonconductive tape.

4. Place the Launchpad Battery over the battery footprint. Make sure that the + and - battery pads line up with the footprint's pads.

5. Binder clip the pads of the battery to the page, over the conductive tapes. This will hold the battery in place and turn on your light!



2. RAINBOW FADE CIRCUIT TEMPLATE



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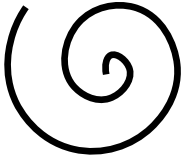
6. With the LED on, flip to the next page and complete the scene with your own drawing!

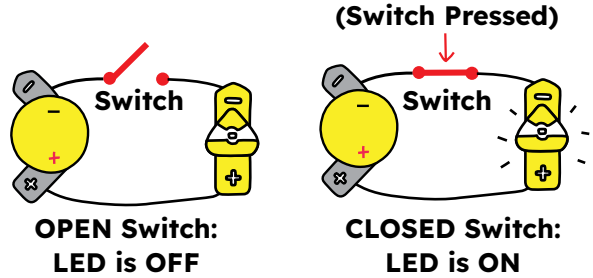
✨ ***Note:*** *This template is the same as the Simple Circuit Template on page 18 except for the shape of the Launchpad LED. You can use solid color and Rainbow Fade Launchpad LEDs interchangeably as long as the + and - pads of the LEDs match the circuit template footprints!*



What's this magical spiral?

3. CUT-AND-FOLD SWITCH

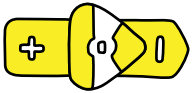
Now that your light is shining, let's try using a switch to make it interactive! A **switch** is made up of two parts: a **switch gap** in your circuit and the **switch contact**, a piece of conductive material that can connect and disconnect the gap, turning the circuit on and off.

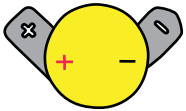


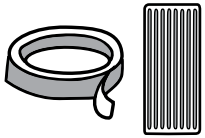
When the switch is **closed**, and the gap is connected, the light turns ON because the loop is complete and electrons are able to flow through your circuit. When the switch is **open**, and the gap is disconnected, electrons cannot find a closed loop. So they will stop flowing, and the light will turn OFF.

In this activity you will make a simple Cut-and-Fold Switch by cutting a flap at the edge of the paper.

YOU WILL NEED:


x 1 Launchpad LED


x 1 Launchpad Battery


Conductive Tape or Tape Strips


x 2 Binder Clips

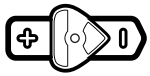

x 2 Clear Yellow Stickers or Nonconductive Tape


Scissors

DIRECTIONS:

1. Stick conductive tape over the blue - line and the red + lines. Cut any extra tape with scissors.

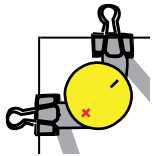
2. Place the Launchpad LED over the footprint. Make sure that the + and - pads match the footprint.



3. Tape the Launchpad LED in place using clear, nonconductive tape.

4. Place the Launchpad Battery over the battery footprint. Make sure the + and - battery pads line up with the footprint's pads.

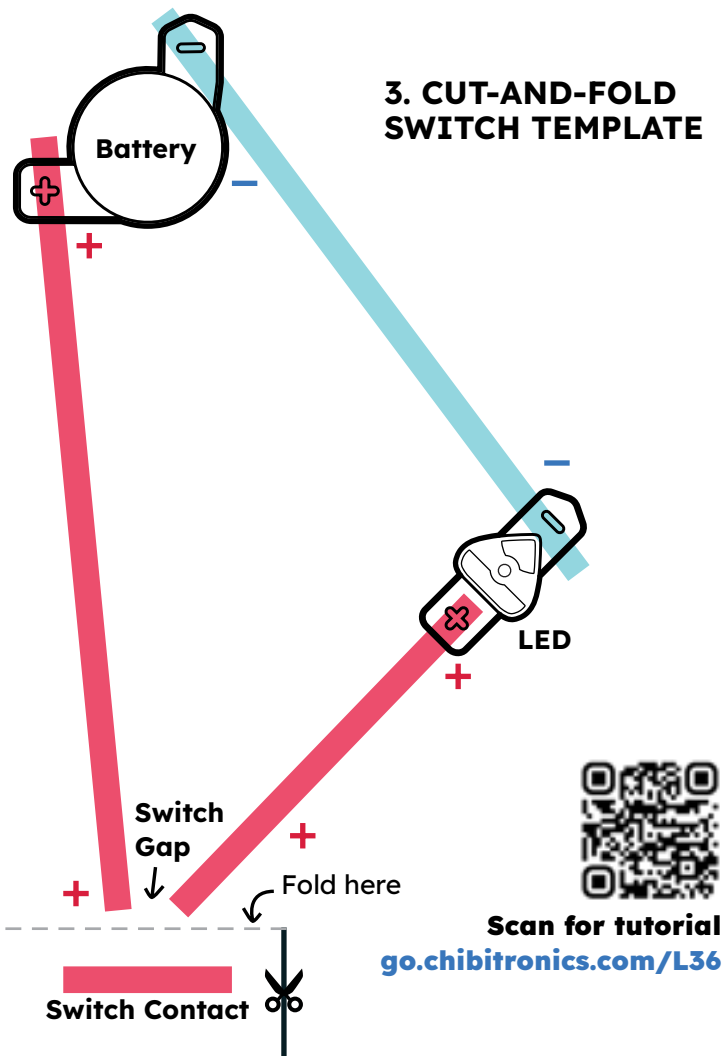
5. Binder clip the pads of the battery to the page, over the conductive tapes, to hold the battery in place.



6. Cut along the bold black line to create your Switch Flap.

Cut here

Switch Flap



3. CUT-AND-FOLD SWITCH TEMPLATE

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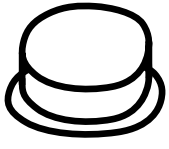
7. Fold the Switch Flap up along the dotted line. Now when you press the flap, you close the switch and your light turns on!

8. Flip to the next page and complete the scene with your own drawing!

Note: *Is your tape strip not long enough? No worries! Extend the length by sticking multiple pieces of conductive fabric tape together. Make sure the pieces overlap to ensure a strong circuit connection.*

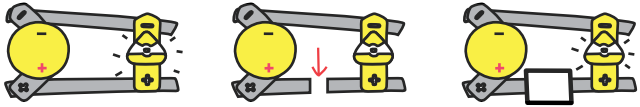


What happens when you press the button?

4. FLAP SWITCH

You can add a switch anywhere in your circuit, as long it interrupts the flow of electricity between your battery and your light!

In the previous Cut-and-Fold Switch activity, the switch is on the positive connection between the battery and LED. You can also put it on the negative connection between the battery and LED.



1. Start with complete circuit

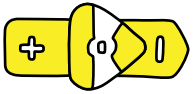
2. Cut gap in circuit, making switch gap

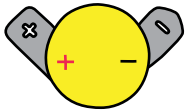
3. Make switch contact with flap of paper and conductive tape

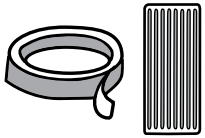
To add a switch, start with a complete circuit and cut a gap in one of the connections, creating a gap for your switch. Then, tape or glue a flap of paper alongside the gap, so it can be folded over the gap. Finally, add conductive tape to the flap so it acts as the switch contact, closing the switch when you fold the flap over the gap.

We call this type of switch a Flap Switch. Let's give it a try in the next activity!

YOU WILL NEED:

 x 1 Launchpad LED

 x 1 Launchpad Battery

 Conductive Tape or Tape Strips

 x 2 Binder Clips

 x 4 Clear Yellow Stickers or Nonconductive Tape

 Scissors

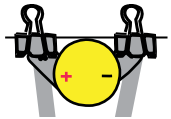
DIRECTIONS:

1. Stick conductive tape over the blue - line and the red + lines.

2. Place the Launchpad LED over the footprint. Make sure that the + and - match the footprint.

3. Tape the Launchpad LED in place using clear, nonconductive tape.

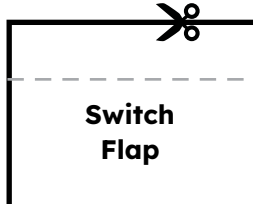
4. Place the Launchpad Battery over the matching battery footprint and binder clip the battery in place.



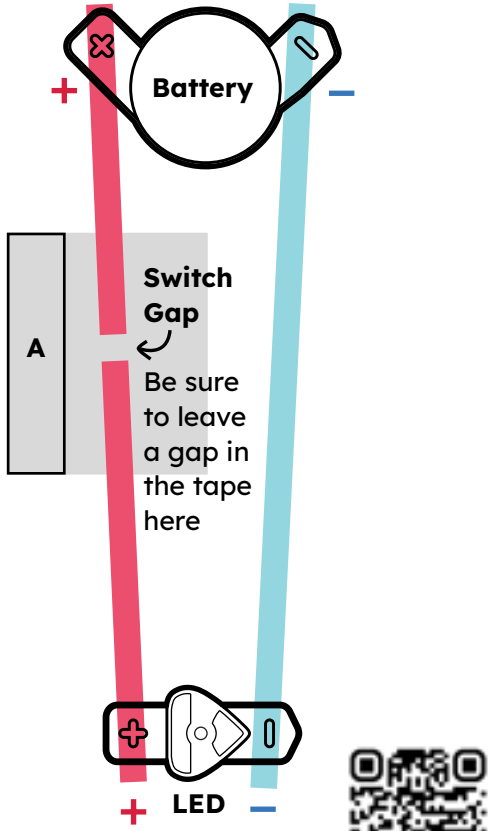
5. Cut off the corner of this page along the bold line and fold at the dotted line. This is your Switch Flap.

6. Place the Switch Flap over the gray rectangular footprint so that the letter A's align and the conductive tapes can touch.

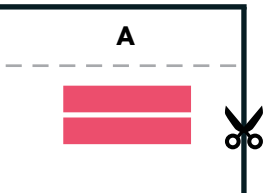
7. Tape the Switch Flap down on the left side using clear, nonconductive tape.



4. FLAP SWITCH TEMPLATE



Cut out flap here



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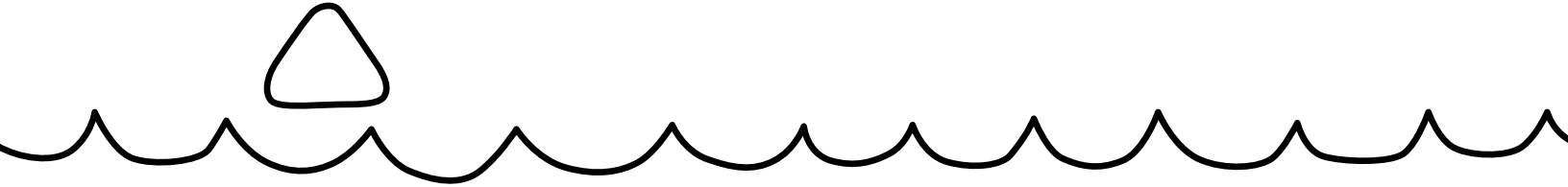
8. Bend the right side of the Switch Flap up, so that it springs up. When you press the flap, the switch closes and turns on the light!

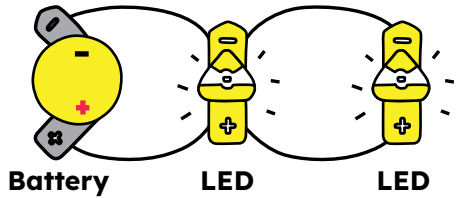
9. Flip to the next page and complete the scene with your own drawing!



What glows beneath the waves when you press the triangle button?

5. PARALLEL CIRCUIT

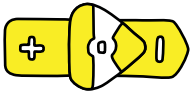
Now let's try adding more lights to your circuit using a **parallel circuit**! Here, we connect all the + pads of the Launchpad LEDs to the + pad of the Launchpad battery, and connect all the - pads of the LEDs and battery. This is called connecting the LEDs **in parallel**.

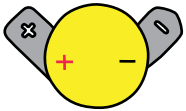


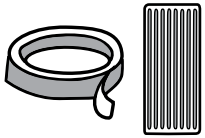
This creates multiple loops for electricity to flow, turning on all of the LEDs at the same time with only one Launchpad Battery.

You can try adding as many Launchpad LEDs in parallel as you would like. However, the battery will drain more quickly as you add since it's working harder to power more lights. Eventually if you add too many LEDs, you will notice all the LEDs get dimmer. This is because there isn't enough energy in the battery to fully power them all anymore.

YOU WILL NEED:


x 2 Launchpad LEDs


x 1 Launchpad Battery


Conductive Tape or Tape Strips


x 2 Binder Clips

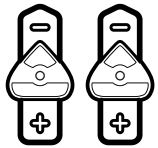

x 4 Clear Yellow Stickers or Nonconductive Tape


Scissors

DIRECTIONS:

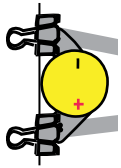
1. Stick conductive tape over the blue - line and the red + line.

2. Place the two Launchpad LEDs over the matching footprints. Make sure the + and - pads match the footprints.



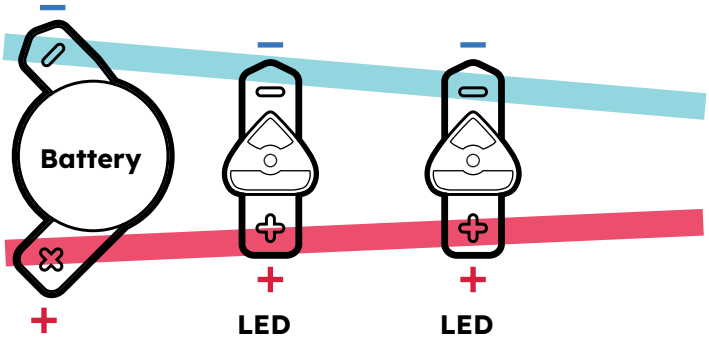
3. Tape the Launchpad LEDs in place using clear, nonconductive tape.

4. Place the Launchpad Battery over the matching footprint and binder clip the battery in place. With the battery connected, now both lights will turn on!



5. With the LEDs on, flip to the next page and complete the scene with your own drawing!

5. PARALLEL CIRCUIT TEMPLATE



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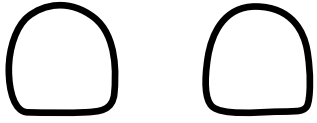
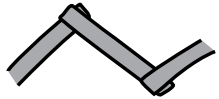


You woke up the creature! Who is it?

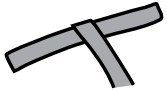
6. ZIGZAG CIRCUIT

So far we have only been using straight conductive tape lines in our circuit. In this next activity we will try turning corners with the conductive tape!

The first way to turn corners is to overlap different pieces of conductive tape and stick them together. This is also useful for making branches, or extending the length of your conductive tape.



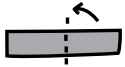
Turning Corners



Branching

Extending Length

The second way to turn corners with conductive tape is to use this folding technique:



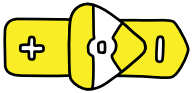
1. Fold the tape back, exposing the sticky side

2. Flip and turn the tape in the new direction, creating a corner

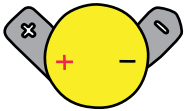
3. Flatten the corner and you're done!

Folding the conductive tape instead of using multiple pieces keeps it in one continuous piece, which creates a stronger circuit connection. Try these out in the next activity!

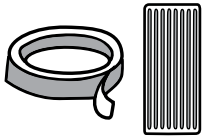
YOU WILL NEED:



x 3 Launchpad LEDs



x 1 Launchpad Battery



Conductive Tape or Tape Strips

x 2 Binder Clips

x 6 Clear Yellow Stickers or Nonconductive Tape

Scissors

DIRECTIONS:

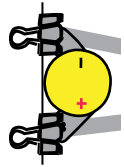
1. Stick conductive tape over the blue - line. At the turns, be sure to either use the fold technique or overlap multiple pieces of tape to ensure a strong circuit connection.

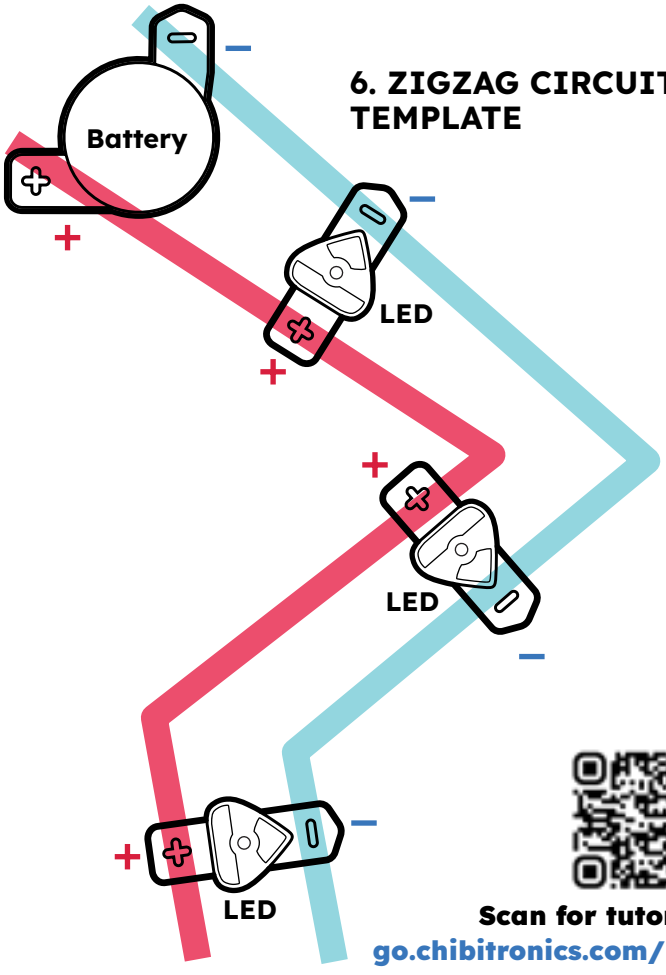
2. Stick conductive tape over the red + line. Again, at the turns be sure to either use the fold technique or overlap multiple pieces of tape to ensure a strong circuit connection.

3. Place the three Launchpad LEDs over the matching footprints. Make sure that the + and - pads match the footprints.

4. Tape the Launchpad LEDs in place using clear, nonconductive tape.

5. Place the Launchpad Battery over the matching footprint and binder clip the battery in place. With the battery connected, now all three lights will turn on!





6. ZIGZAG CIRCUIT TEMPLATE

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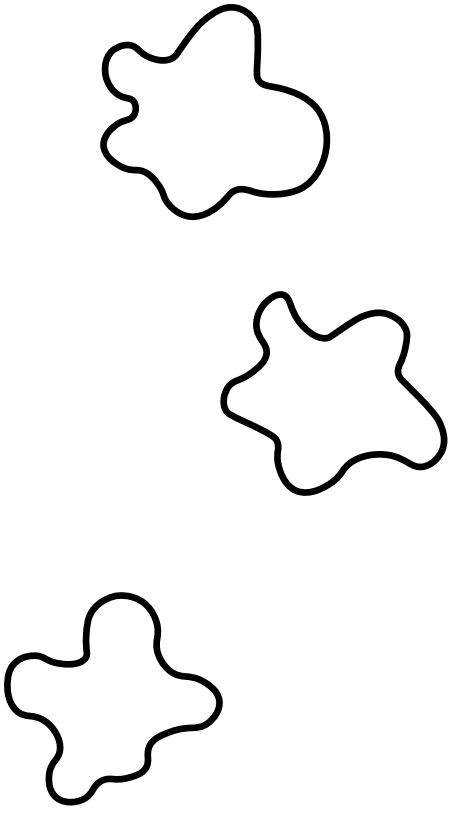
5. With the LEDs on, flip to the next page and complete the scene with your own drawing!

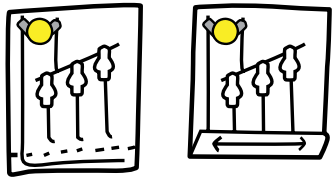


The puddles are glowing! What are they?

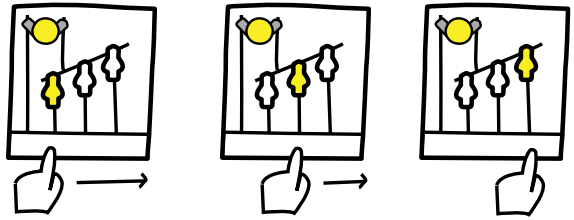
7. SEQUENCE SWITCH

Now that you've tried switches and lighting up multiple LEDs with parallel circuits, let's combine these to create more complex interactive effects!

In the **Sequence Switch**, multiple branches of LEDs and switches connect along a single switch contact.

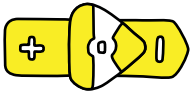


When you press and slide your finger across the switch contact at the bottom, the LEDs will come on in sequence as each switch below closes.

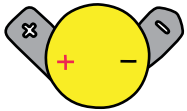


In the next activity, the Launchpad LEDs go up as you press and slide your finger to the right!

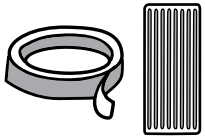
YOU WILL NEED:



x 3 Launchpad LEDs



x 1 Launchpad Battery



Conductive Tape or
Tape Strips

x 2 Binder Clips

x 6 Clear Yellow Stickers or
Nonconductive Tape

Scissors

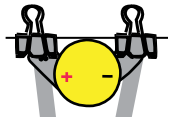
DIRECTIONS:

1. Stick conductive tape over the blue - lines and the red + lines.

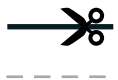
2. Place the three Launchpad LEDs over the matching footprints. Make sure the + and - pads match the footprints.

3. Tape the Launchpad LEDs in place using clear, nonconductive tape.

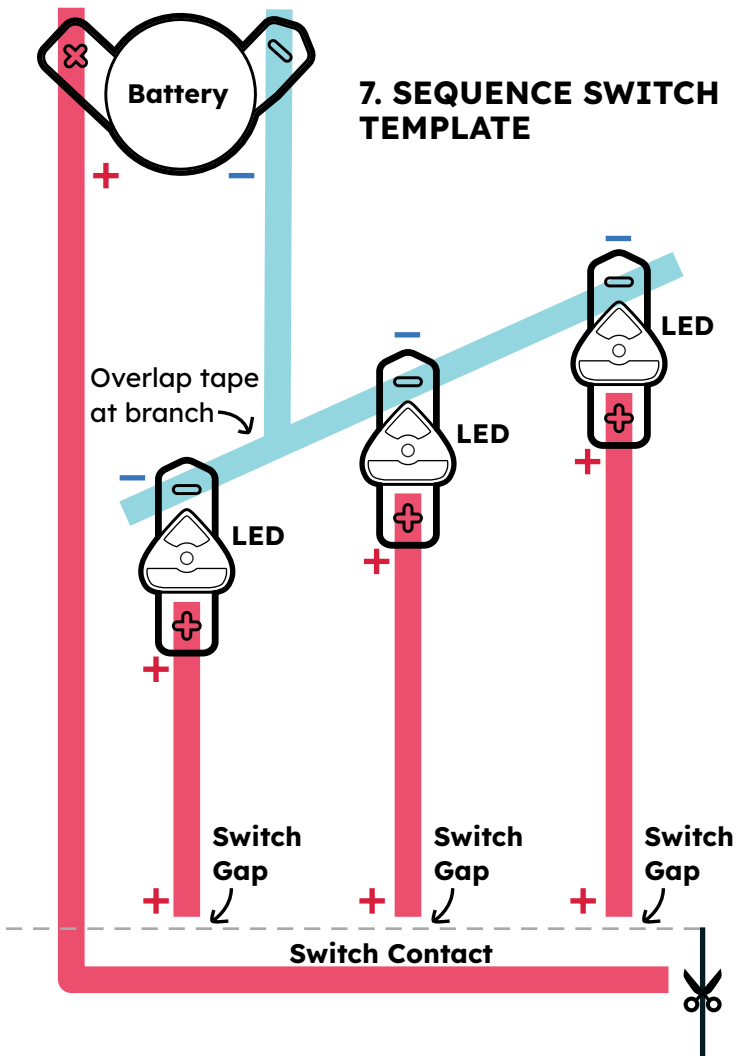
4. Place the Launchpad Battery over the matching footprint and binder clip the battery in place.



5. Cut along the bold black line and fold the Switch Flap up along the dotted line so that the vertical + tapes can touch the switch contact at the bottom of the page.



6. When you press and slide your finger across the switch, the lights come on in sequence!



7. SEQUENCE SWITCH TEMPLATE

7. Flip to the next page and complete the scene with your own drawing!

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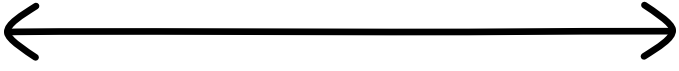


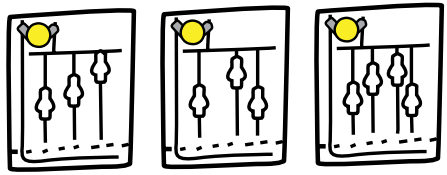
What goes up when you slide your finger across?

8. BRANCH SWITCH

In the previous Sequence Switch activity, the LEDs are arranged in a straight line. You can also make a sequence switch where the LEDs are arranged in any way you would like!

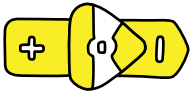
The **Branch Switch** is a type of sequence switch where LEDs go on branches that extend between the battery connection at the top of the page and the switch gap at the bottom of the page.

LEDs can go anywhere on the vertical branch, and the branches can be arranged anywhere left and right. You can easily add more LEDs by adding more vertical branches. Here are some examples of different branch switch designs:

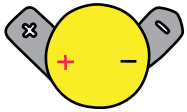


This switch makes it easy to create custom and irregular light arrangements in your sequence switches. Let's give it a try!

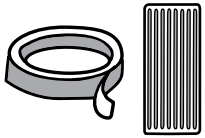
YOU WILL NEED:



x 3 Launchpad LEDs



x 1 Launchpad Battery



Conductive Tape or Tape Strips

x 2 Binder Clips

x 6 Clear Yellow Stickers or Nonconductive Tape

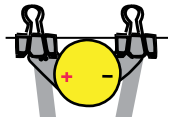
Scissors

DIRECTIONS:

1. Stick conductive tape over the blue - lines and the red + lines. Be sure to leave a gap in the conductive tape beneath the LEDs.

2. Place the three Launchpad LEDs over the matching footprints.

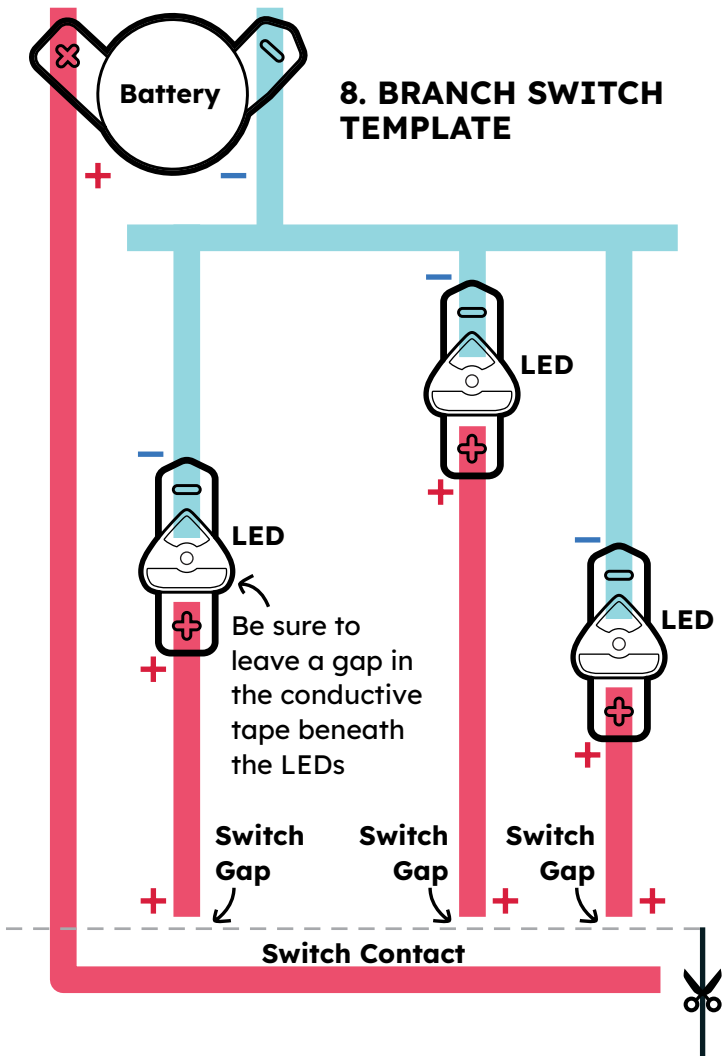
3. Tape the Launchpad LEDs in place using clear, nonconductive tape.



4. Place the Launchpad Battery over the matching footprint and binder clip the battery in place.

5. Cut along the bold black line and fold the Switch Flap up along the dotted line so that the vertical + tapes can touch the switch contact at the bottom of the page.

6. When you press and slide your finger across the switch, the lights come on in sequence!



8. BRANCH SWITCH TEMPLATE

7. Flip to the next page and complete the scene with your own drawing!

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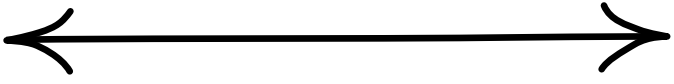
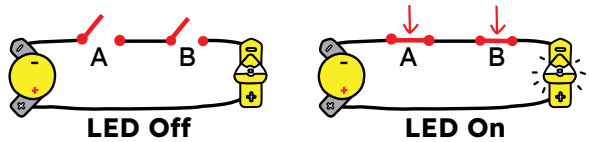


What jumps up and down as you slide your finger across the page?

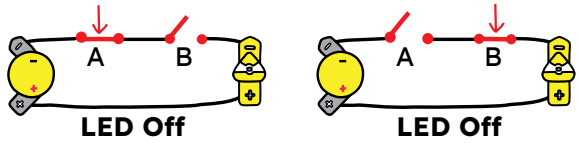
9. AND SWITCH

You can also use switches to create simple **logic circuit** interactions. In a logic circuit, the flow of electricity represents yes and no. ON means “yes” or “true” and OFF means “no” or “false.”

If you put multiple switches one after the other **in series** in a single loop, you have to press all the switches at the same time to turn on your light. This is called a logical **AND** because you have to press *Switch A **and** Switch B* to make a complete circuit:

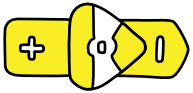


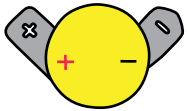
If you press only one of the switches, then there is still an open gap in your circuit, so the electrons won’t flow and your light will be off.

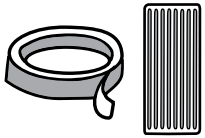


Let’s give the **AND switch** it a try!

YOU WILL NEED:

 x 1 Launchpad LED

 x 1 Launchpad Battery

 Conductive Tape or Tape Strips

 x 2 Binder Clips

 x 2 Clear Yellow Stickers or Nonconductive Tape

 Scissors

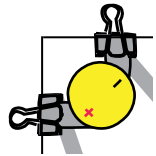
DIRECTIONS:

1. Stick conductive tape over the blue - line and the red + lines.

2. Place the Launchpad LED over the footprint. Make sure the + and - match the footprint.

3. Tape the Launchpad LED in place using clear, nonconductive tape.

4. Place the Launchpad Battery over the matching footprint and binder clip the battery in place.

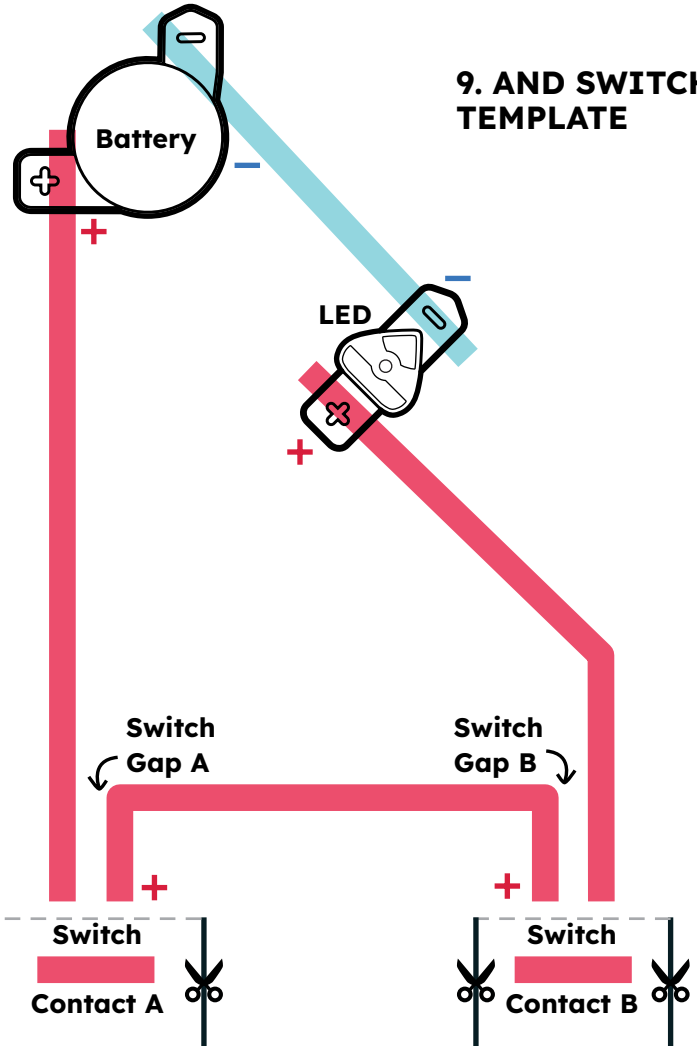


5. Cut along the bold black lines to create your Switch Flaps A and B.

6. Fold the Switch Flaps up along the dotted lines so that the vertical + tapes can touch the switch contacts.

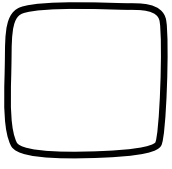
7. Now when you press both Switch A *AND* Switch B, the light turns on!

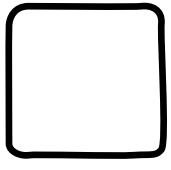
9. AND SWITCH TEMPLATE



6. Flip to the next page and complete the scene with your own drawing!

Scan for tutorial
go.chibitronics.com/L85

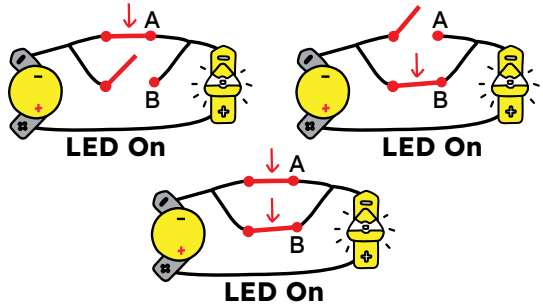




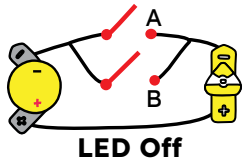
What happens only when you press on both square buttons?

10. OR SWITCH

You can also connect multiple switches **in parallel** using different branches so that pressing any one of them will turn on your circuit. This is called a logical **OR** because you can press *Switch A* ***or*** *Switch B* to make a complete circuit and turn on your light:

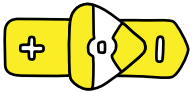


In an **OR switch**, the light is off only when none of the switches are pressed:

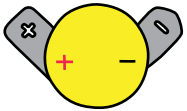


Now let's try making an OR switch!

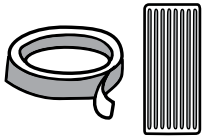
YOU WILL NEED:



x 1 Launchpad LED



x 1 Launchpad Battery



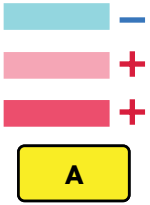
Conductive Tape or Tape Strips

x 2 Binder Clips

x 3 Clear Yellow Stickers or Nonconductive Tape

Scissors

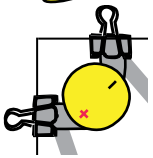
DIRECTIONS:



1. Stick conductive tape over the blue - line, pink + lines, and red + lines. Be sure to put a clear yellow sticker between the pink and red tapes cross, marked “A”, so that the two conductive tapes don’t touch.

2. Place the Launchpad LED over the footprint. Make sure the + and - match the footprint.

3. Tape the Launchpad LED in place using clear, nonconductive tape.

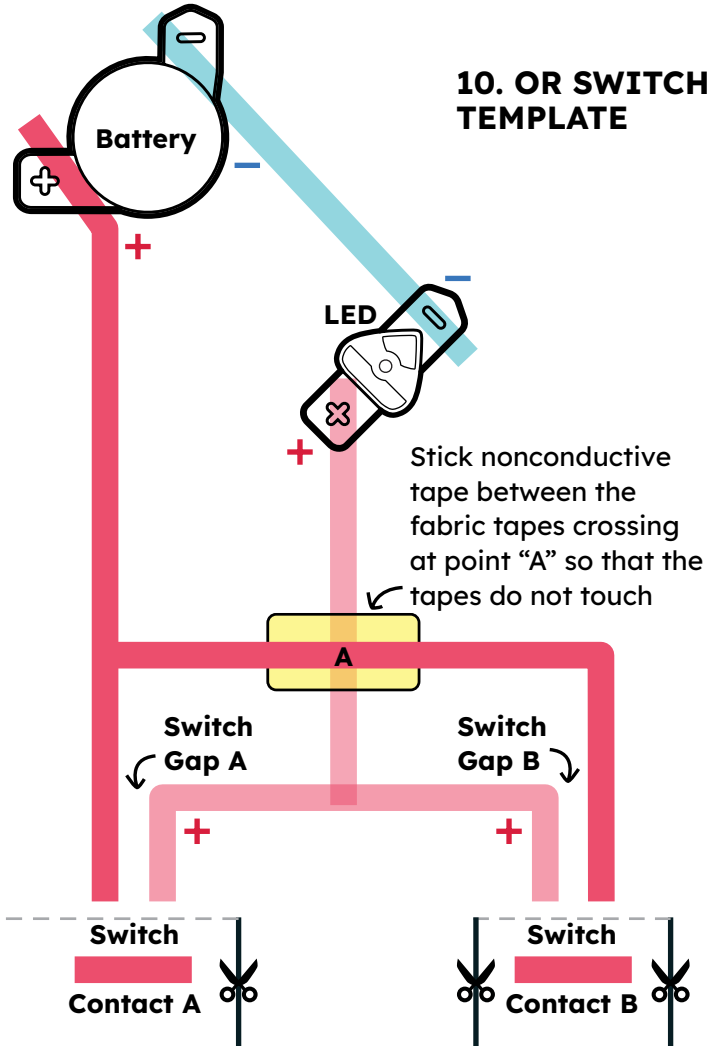


4. Place the Launchpad Battery over the matching footprint and binder clip the battery in place.

5. Cut along the bold black lines to create your Switch Flaps A and B.

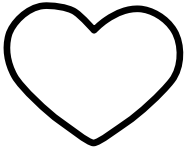
6. Fold the Switch Flaps up along the dotted lines so that the vertical + tapes can touch the switch contacts.

10. OR SWITCH TEMPLATE



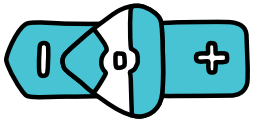
7. Now when you press either Switch A *OR* Switch B, the light turns on. Flip to the next page and complete the scene with your own drawing!

Scan for tutorial
go.chibitronics.com/L93



What happens when you press either of the heart buttons?

Help & Debugging

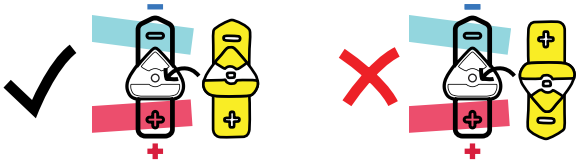


HELP & DEBUGGING

Is your light not turning on? That's okay! Let's debug it. **Debug** means to look closely at the project, find the problems—also known as **bugs**—and then fix them so that your project works the way you would like it to.

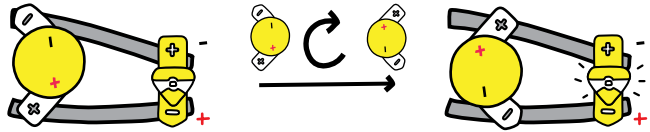
Don't worry when things don't work the first time. Figuring out what went wrong is part of the learning and creative process! Use this guide to carefully review your circuit for common bugs.

1. Is the LED connected backwards?
Make sure that the positive and negative pads of your Launchpad LED match the + and - of the LED footprint on your template.



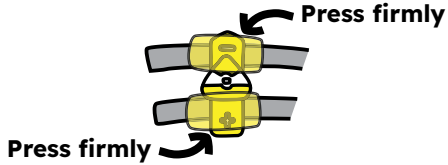
If the + and - pads of your LED are connected in reverse from the + and - pads of your battery, the LED won't shine because the current can't flow.

A quick way to test whether your LED is backwards is to unclip the Launchpad Battery, rotate the battery so that the connection is reversed, and then press down on the battery's + and - pads to make contact with the conductive tape.



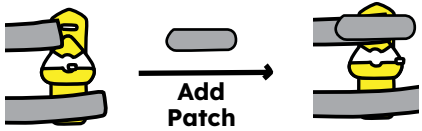
This way you can test your LED without having to untape the light!

2. Is the LED connected securely?
If the Launchpad LED polarity is correct, try pressing on the metal pads of the LED to make sure they are firmly contacting the conductive tape.



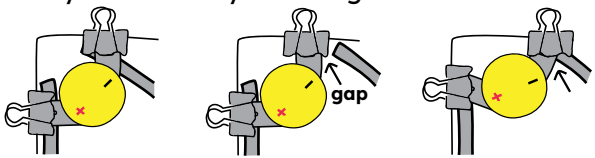
If you're using nonconductive tape to hold the Launchpad LED in place, press firmly on the nonconductive tape to ensure a strong connection.

If using conductive tape on top of the Launchpad LED, make sure there's plenty of overlap between the conductive tape and the LED pads. If the overlapping area is too small, then power cannot flow to the LED.

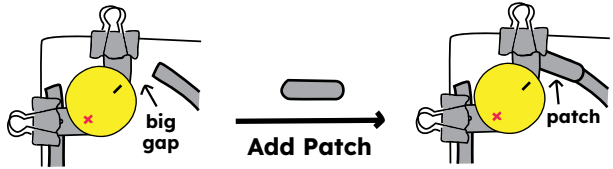


To fix this, add a conductive fabric patch or cut a small piece of conductive fabric tape to increase the overlap and strengthen the circuit connection.

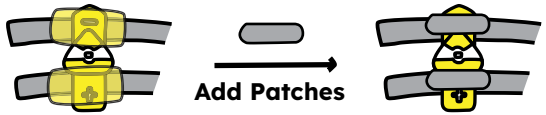
3. Is the battery connected securely?
Just like with LEDs, there needs to be plenty of overlap between the pads of the Launchpad battery and the conductive tape in your circuit. If you notice a gap, try moving the battery and reclipping the binder clips so that the pads of the battery are securely touching the conductive tape.



If there is a big gap between the battery and conductive tape, use more conductive tape to extend your circuit so that it reaches the battery.



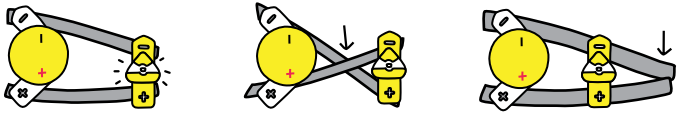
4. Is the LED flickering instead of staying on?
If an LED is flickering on and off, or only turns on when you hold it down, this often means that the connection between the pads and conductive tape is not secure enough.



Fix this by sticking a conductive fabric patch or small piece of conductive tape directly connecting the Launchpad LED pads and the conductive tape of the circuit.

If you're using nonconductive tape to hold the Launchpad LED in place, make sure to remove the nonconductive tape first.

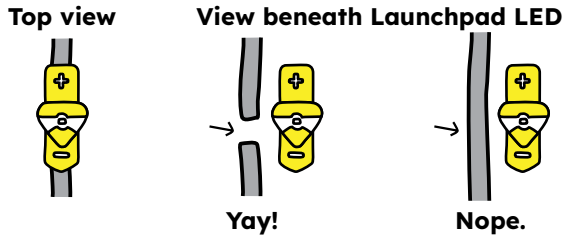
5. Is there a short circuit?
If the tapes that go to the positive and negative pads of the battery touch, even the tiniest bit, then this is a short circuit and your light will not turn on.



Yay! Nope. Nope.

Look through your circuit to make sure that there are no accidental short circuit connections.

6. Is there a gap in the conductive tape where the Launchpad LED is?
Make sure that the conductive tape has a gap between the positive and negative pads of the LED.



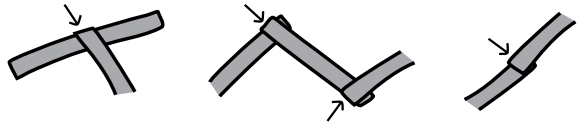
Top view View beneath Launchpad LED

Yay! Nope.

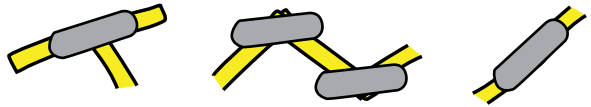
Otherwise if the tape is continuous, it will act as a short circuit that is underneath the LED instead!

7. Are the connections between different pieces of conductive tape secure?

Try pressing down on all the joints where multiple pieces of conductive tape are stuck together, for example at a turn, a branch, or if you had to extend a piece of tape with a patch.

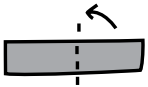


If you notice that the light only comes on when you press on a spot where two tapes come together, and turns off again when you let go, that means the connection isn't strong.



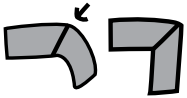
Strengthen the connection by sticking a conductive fabric patch or small piece of conductive fabric tape across it. This is especially important if you are using copper tape, since the adhesive is not as conductive. With copper tape, we recommend reinforcing all joints with some conductive fabric tape or a fabric patch.

To reduce chances of weak connections at turns and corners, instead of sticking multiple pieces of conductive tape together we recommend using the following folding technique instead:



1. Fold the tape back, exposing the sticky side

2. Flip and turn the tape in the new direction, creating a corner



3. Flatten the corner and you're done!

8. Is the tape wrinkly or bumpy?
The Launchpad LEDs connect best to tape that is flat, not wrinkled. Smooth out any wrinkles or bumps by re-sticking your tape down. If you are using copper tape, flatten wrinkled foil by rubbing it flat with a pencil eraser.

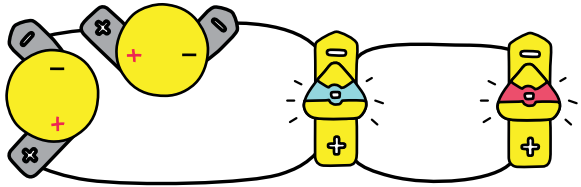
9. Is the battery out of power?
If all the connections in your circuit look correct but the light is still not turning on, the battery may be out of power. Try testing your circuit with a fresh battery. You can also put the battery in a circuit that you know works properly to test if the battery has power.

12. Are only the red and yellow Launchpad LEDs coming on but not the blue or white ones?

This could mean that your battery doesn't have enough power to turn on all the colors at once. This is because different colors require different amounts of energy. Low power colors like red and yellow often draw power away from high power colors like blue and white.

To resolve the issue, try replacing the blue and white LEDs with red and yellow ones. Alternatively, replace the red and yellow LEDs with blue and white ones. If you want to have all the colors turn on, you can try boosting the power by putting in a fresh battery.

Another way to boost power in your circuit is by adding a second battery. Connect the batteries one after the other, like this:



The positive pad of one battery goes to the negative pad of the other battery. This is called connecting the batteries **in series**.

Once you have the two batteries connected in series, you can treat them like one large battery with the negative pad on one battery and the positive pad on the other battery.

Because there are now twice as many batteries, your circuit will have double the power of a circuit with only a single battery.

14. Is your circuit still not working?

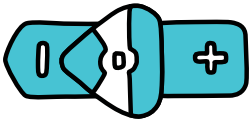
No worries! Send a note describing the issue with pictures of your circuit to:
help@chibitronics.com

We're here to help and excited to debug with you!

For additional debugging resources:

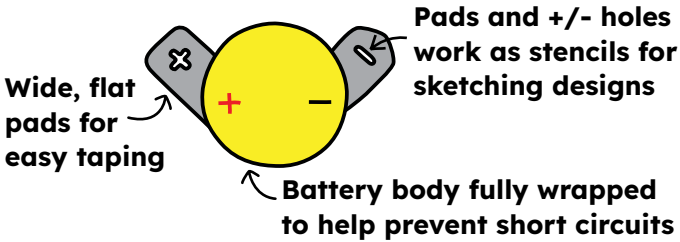
Explore our online debugging page which has more tips and tutorial videos for debugging:
go.chibitronics.com/LDebug

Battery Safety



BATTERY SAFETY

Our Launchpad Batteries are designed to be safe and easy to use for learning and creating with paper circuits.



They are enhanced versions of standard CR2032 lithium metal coin cell batteries. Here are some technical features of the Launchpad Battery:

Property	Feature
Voltage	3 **Volts**
Rechargeable?	No
Safe Usage Temperature	-4°F to 160°F (-20°C to 60°C)
Energy Capacity	230 mAh (**milliampere hour**)

While these batteries are user-friendly, they do contain coin cell batteries, so we remind you to please use, store, and dispose of them responsibly!

The following are some important safety and disposal guidelines. Please follow the instructions provided.

Battery Safety and Disposal Guidelines

1. Please do not disassemble the Launchpad Battery. The yellow plastic wrap helps cover the metal battery contacts in order to prevent accidental short circuits.
2. Keep the ziplock pouch that your Launchpad Battery came in for storing the battery when it's not in use. Store only one battery per pouch.
3. When storing batteries, keep batteries away from metal containers, conductive tape, other batteries, and any exposed metal parts. This is to prevent accidental connections that could drain your battery.
4. Do not allow young children (ages 7 or younger) to play with batteries or handle them unsupervised by an adult.

5. Let older kids and siblings know about the risks of batteries, and to keep batteries away from younger kids as well as pets.

6. Store spare and used batteries out of sight and reach of young children.

7. Do not try to recharge the Launchpad Battery, as they are not rechargeable. Attempting to recharge may cause leakage, overheating, or rupture.

8. Do not expose batteries to extreme temperatures like fire or freezing temperatures, which can damage batteries and reduce battery life.

9. Keep batteries away from water, damp areas, and high humidity to prevent accidental connections and corrosion.

10. When a battery is drained or out of power, immediately dispose of them by taping over the + and - ends and placing them in a secure container until they can be recycled or discarded at a local designated safe battery drop-off location. Do not dispose of used batteries in regular household garbage or incinerate them.

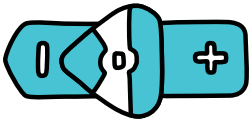
11. Batteries can be extremely dangerous if swallowed or inserted into the nose or ears. If you suspect that this might have happened, seek medical attention immediately and do not induce vomiting.

12. When traveling, be sure to keep spare batteries in individual protective pouches or cases to avoid accidental short circuits. Follow current airline regulations for carrying batteries in hand luggage rather than checked luggage.

For more information, please visit:
go.chibitronics.com/LBattery

Stay safe, and happy making!

Glossary & Index



GLOSSARY & INDEX

For an online, interactive version of this Glossary, please go to this link: go.chibitronics.com/LGlossary

AND: Logic situation where both conditions have to be true in order to get a "yes" result. (p. 81)

AND switch: Type of logic switch design where multiple switches are connected in series, so you have to press all the switches in the loop in order to turn on the circuit. (p. 81)

binder clip: Common clip used for temporarily holding the Launchpad Battery in place in the circuit. Use one binder clip per Launchpad Battery pad. (p. 11)

branch switch: Type of **sequence switch** where LEDs are arranged in branches that extend between the battery connection at the top of the page and row of switch contacts at the bottom of the page (p. 73)

bug: In circuits, this means a problem or mistake that causes your project (such as your circuit) to not work the way you want it to. (p. 98)

closed: In a switch this means when the switch gap is connected by a conductive material, turning the circuit on. (p. 33)

complete circuit: When the parts of a circuit, such as a battery and LEDs, are connected in a closed loop so that electricity can flow and turn on the components. (p. 15)

conductive: This kind of material allows electricity to flow through it. Examples include metal and conductive fabric tape. (p. 10)

conductive fabric tape (or fabric tape): Type of conductive tape made from fabric embedded with metal particles. This tape is soft and sturdy, can be folded repeatedly without breaking, and requires scissors to cut. The adhesive on conductive fabric tape is conductive enough to create electrical connections simply by taping two pieces together. (p. 12)

conductive fabric tape patches (or fabric patches): Form of conductive fabric tape that

comes in small pieces on a sticker sheet. These patches are handy for fixing weak electrical connections or bridging gaps in circuits. They are also useful for connecting multiple pieces of conductive copper tape together or making hinges that need to fold repeatedly in copper tape circuits. (p. 12)

conductive fabric tape strips: Form of conductive fabric tape that comes as pre-cut sticker strips in a sheet. These strips are handy for making smaller circuits and easier to peel from the paper backing than standard conductive fabric tape in roll form. (p. 12)

conductive tape: Any tape that is made out of a conductive material so that electricity can flow through it. (p. 12)

copper foil tape (or copper tape): Type of conductive tape made from thin copper metal foil. This tape is soft enough to tear by hand and you can **solder** to it. The adhesive on copper foil tape is not as conductive as the adhesive on conductive fabric tapes. (p. 12)

current: The flow of electrons. (p. 15)

debug: Process of looking closely at a project (for example your circuit) when it isn't working as you expect, figuring out what the issue is, and fixing it so that the project works the way you would like it to. (p. 98)

electricity: The type of energy that powers circuits. (p. 9 and p. 15)

electron: A tiny particle, too small to see, in circuits that can flow through components and conductive materials carrying energy. The energy of this flow makes up electricity. (p. 15)

flap switch: A type of switch made by placing a flap of paper over a gap in the circuit and adding conductive tape to the gap so that the switch closes when you press the flap. (p. 41)

in parallel: When circuit components are connected side by side like rungs on a ladder. For LEDs, it means that all the + sides are connected and all the - sides are all connected. For switches, it means that all the left sides of the switch gaps are connected and all the right sides of the switch gaps are connected. (p. 49 and 89)

in series: When circuit components are connected one after the other in a single loop, like beads on a string. For switches, this means connecting the right side of one switch gap to the left side of the next switch gap. For LEDs, this means connecting the + of one LED to the - of the next LED. (p. 81 and 106)

Launchpad Battery: Special type of battery made by Chibitronics that has large positive and negative pads for easily taping with conductive tape. The body of a Launchpad Battery is completely wrapped to protect from short circuits, making them safer than standard coin batteries. (p. 11)

Launchpad LED: Special type of LED made by Chibitronics that is reusable and has large positive and negative pads for easily taping with conductive tape. Launchpad LEDs are made up of a rigid circuit board base, an LED, and a **resistor**. (p. 9)

LED (or light emitting diode): An electronic component that lights up when powered by electricity. (p. 9)

LED sticker: Special type of LED made by Chibitronics that comes in the form of a sticker, so you can connect it to your circuit by sticking it down. LED stickers are made up of an LED and a **resistor**, a flexible circuit board base, and conductive adhesive. They come in many shapes, colors, and animating effects, including pink, orange, Rainbow Fade, and Blinking (p. 132)

logic circuit: Type of circuit where the flow of electricity represents “yes” and “no.” ON means “yes/true” and OFF means “no/false” (p. 81)

milliampere hour (mAh): Unit used for measuring how much energy a battery can store and supply, and for how long it can keep powering the circuit. (p. 108)

negative (marked with “-” or blue color): In batteries it is the side that electricity flows into and in LEDs it is the side that electricity flows out of. (p. 9)

nonconductive: This kind of material does not allow electricity to flow through it. Examples include clear tape, masking tape, and printer paper. (p. 10)

open: For a switch this means when the switch gap is not connected by a conductive material, turning the circuit off. (p. 33)

OR: Logic situation where either condition can be true in order to get a "yes" result. (p. 89)

OR switch: Type of logic switch design where multiple switches are connected in parallel branches, so you can press any of the switches (for example Switch A or Switch B) to turn on the circuit. (p. 89)

pad: Metal tab connectors on Launchpad components, such as Launchpad LEDs and Launchpad Batteries. The pads are marked + for positive or - for negative (p. 9)

parallel circuit: Type of circuit where multiple LEDs are connected to one battery with all the + pads connected and all the - pads connected. There are other ways to create parallel circuits, but this is what we mean in paper circuits. (p. 49)

polarity: Tells the direction that electricity must flow through electrical components. Batteries and LEDs have polarity while conductive tape and switches do not. (p. 9)

positive (marked with "+" or red color): In batteries it is the side that electricity flows out of and in LEDs it is the side the electricity flows into. (p. 9)

Rainbow Fade Launchpad LED: Launchpad LED with a flower-shaped center that gently fades through different colors. (p. 10 and p. 25)

resistor: Circuit component that protects circuits by preventing too much power from flowing through. (p. 118 and 119)

sequence switch: Type of switch that lights up LEDs in a sequence when you slide your finger across the switch contacts (p. 65 and 73)

short circuit: When electricity flows directly from the positive to the negative side of a battery, skipping the LED or other component that it is supposed to power. This quickly drains the battery of power and happens when the positive and negative sides of the battery are accidentally connected directly by a conductive material. (p. 15)

simple circuit: A circuit with one battery and one LED. There are other types of simple circuits with different electrical components, but this is what we mean in paper circuits. (p. 15)

solder: Advanced method of connecting two metal parts by melting a third metal between them (p. 116)

solid color Launchpad LED: Launchpad LED with triangular center that shines a single color. (p. 10)

switch: Circuit component that controls when a circuit is on or off by opening and closing a connection in the circuit loop. When the switch is **closed**, the loop is complete and electricity can flow, turning the circuit on. When the switch is **open**, the loop is incomplete and electricity cannot flow, turning the circuit off. (p. 33)

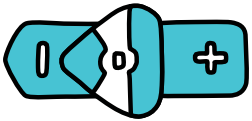
switch contact: A conductive material that can move to either connect or disconnect the switch gap. (p.33)

switch gap: An opening in the circuit that can be left open or connected with a conductive material. (p. 33)

volt (or V): Unit used for measuring voltage. (p. 108)

voltage: The amount of energy that a battery has for powering the flow of electricity. It is the amount of “push” that the battery can give to move electrons through the circuit. The higher the voltage, the more power a battery has. (p. 108)

Your Turn!



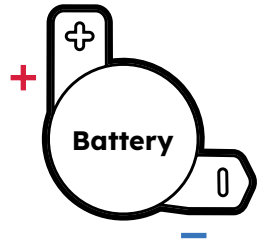
YOUR TURN!

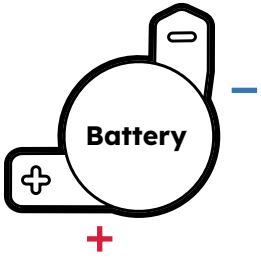
Use the blank templates in this section to start designing and building your own circuits from scratch! Remember, the main three rules to making a working circuit are:

1. Connect the + pads of the Launchpad LEDs and Launchpad Battery
2. Connect the - pads of the Launchpad LEDs and Launchpad Battery
3. Avoid accidentally connecting the + and - pads of the battery directly to prevent a short circuit, which will drain your battery.

If you run into issues with your circuit (which is common when designing circuits from scratch!), refer to the DEBUGGING section on page 97.

For a free PDF download of these blank templates, go to:
go.chibitronics.com/LBlank




Battery
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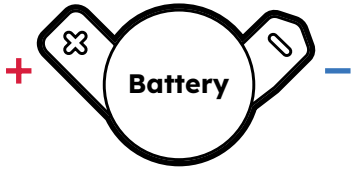
+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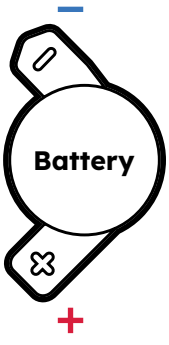
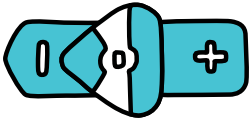


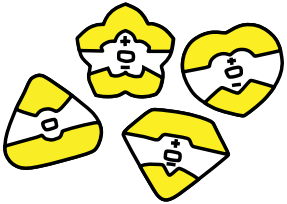
What's Next?



WHAT'S NEXT?

Congratulations on completing your Launchpad Sketchbook! Looking to explore more with paper circuits or dive deeper? Here are some ideas:

Create with STEAM: LED Stickers Kit

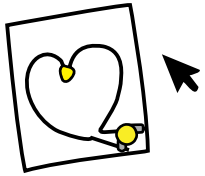


If you had fun with the guided paper circuit activities in this book, you will love the Create with STEAM: LED Sticker Kit!

This kit teaches you how to use **LED stickers**: thin, flexible, and peelable LEDs that stick to make a circuit connection. They are more compact than Launchpad LEDs and come in more colors and animating effects, perfect for enhancing your paper circuit crafts!

Scan to learn more:
go.chibitronics.com/L132

Circuit Sketcher Design Tool



Are you ready to take your creativity beyond the sketchbook and design your own circuits? Give our Circuit Sketcher design software a try!

Our design tool lets you virtually build and simulate circuits in your web browser so that you can make sure your circuit design works just right. Then you can print out your design as a circuit template just like the ones in this book, but created by you!

You can also share your digital Circuit Sketcher designs and template creations for others to create with your designs too!

Scan to learn more:
go.chibitronics.com/L133

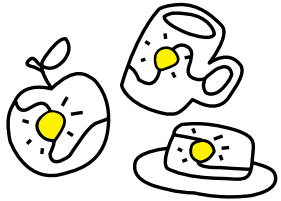
Love to Code Kit

Take your paper circuit projects to the next level by adding code—now your creations can interact and respond in more complex ways thanks to programming! Dive into our Love to Code kit for a fun introduction to coding with paper circuits.

You'll learn how to make more advanced interactive art, meet friendly characters, and follow along with their creative journeys as you build your own coding skills!

Scan to learn more:
go.chibitronics.com/L134

Chibitronics Projects Library



Explore our extensive online resources library packed with paper circuit tutorials and activities for all interests, subjects, and skill levels!

From beginner projects to advanced creative coding creations—like simple holiday cards to light-up costumes and solar-powered paper cities—check it out and see what amazing paper circuit projects you can create next!

Scan to learn more:
go.chibitronics.com/L135

Stay in Touch and Join our Community!

We're always working on new resources, products, and creative ideas for paper circuits. Want the latest updates? Sign up for our newsletter:

Scan to learn more:
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You can also connect with us on our social media channels, where we showcase amazing projects from our creative team as well as the Chibitronics community.

Find us @chibitronics:

Share your own creations using **#chibitronics**—you might see your work featured next!

We hope you have enjoyed learning and creating with us :)

– Jie & Chibitronics Team

About the Author

Jie Qi is the cofounder and CEO of Chibitronics, a company that produces creative learning toolkits. She holds a degree in mechanical engineering from Columbia University and a Ph.D. in media arts and sciences from the MIT Media Lab. Her dream is to empower creators of all backgrounds to fall in love with the magic of making expressive and personally meaningful technologies.

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Thanks to my friends and family for your unending support. To May, Michael, Dad, Mom, and Kevin: thank you for your infinite love and light. And to Kai: our newest and brightest spark.

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