A creative and innovative way for young engineers to explore programming

NATIONAL PEER REVIEWED
01914

#3 BUILD A POWER PARK:

LIGHTS ON IN THE NEIGHBORHOOD

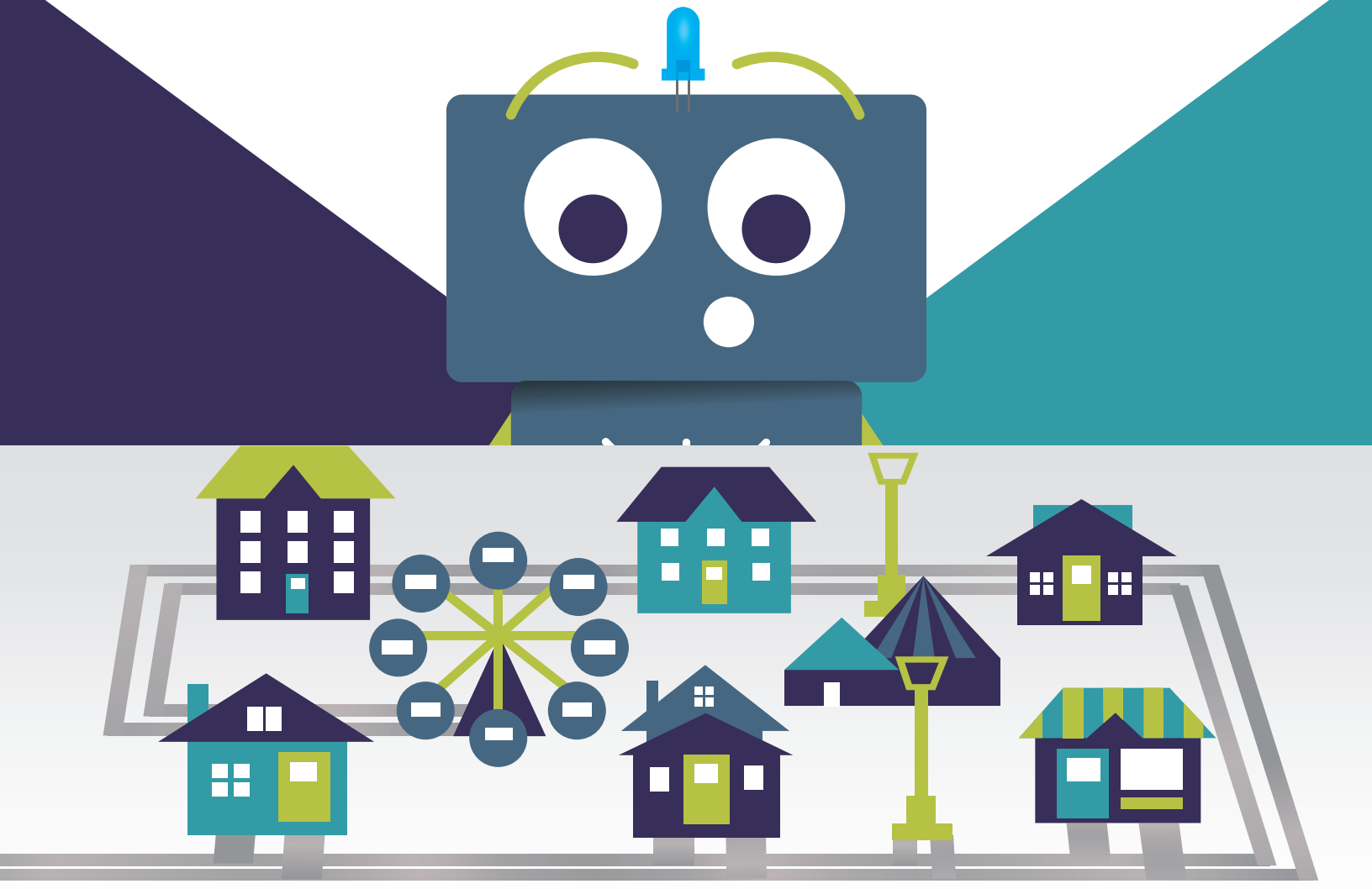
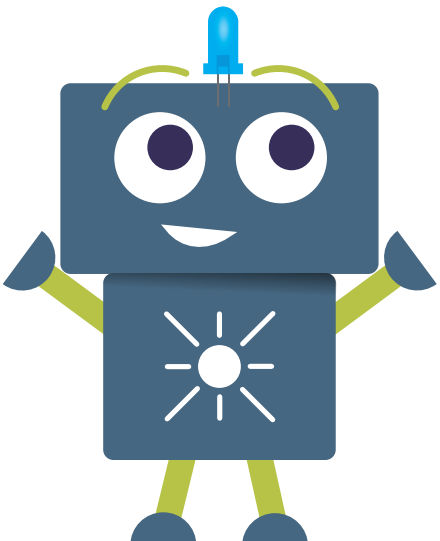
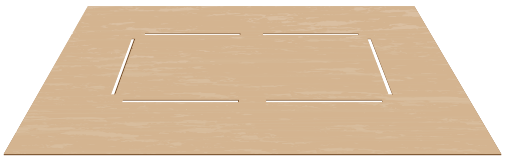


TABLE OF CONTENTS

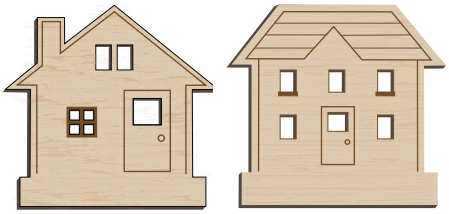


MATERIALS

The materials listed on the following pages include everything you need to complete the activities in this book. Many of these materials are available for purchase through the National 4-H Supply Service e-commerce website, shop4-H.org

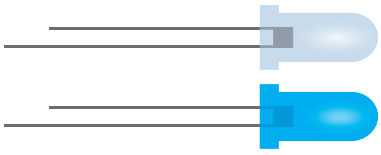


8.5 x 11 inch Base Piece

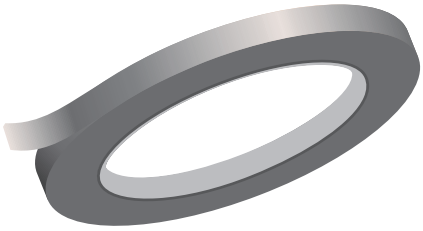


8 Building Pieces

1 Streetlight Piece

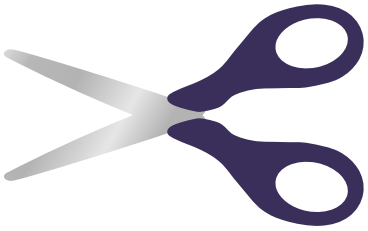


Assorted LEDs

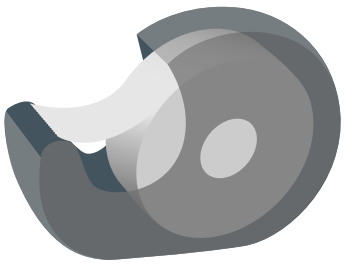


Conductive Tape

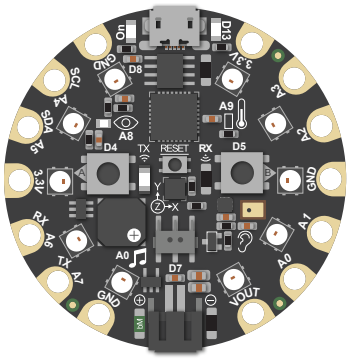
RGB LED



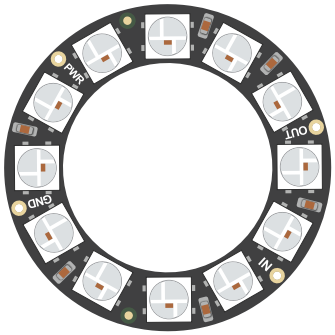
Scissors



Clear Tape



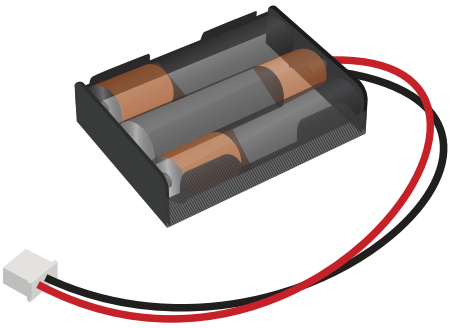
Adafruit CircuitPlayground Express



NeoPixel Ring

1 Micro USB Data Cable

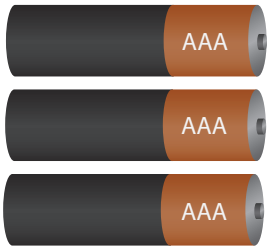
Alligator Clip to Jumper Wires



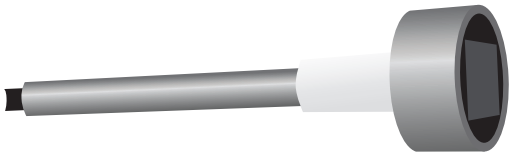
AAA Battery Holder with JST Connector

Alligator Clip Wires

Female Jumper Wires



3 AAA Batteries



Solar Path Light

FOR THE FACILITATOR

This interactive workbook has over 25 hours of hands-on activities that introduce coding, microcontrollers, and sensors to circuitry projects while challenging young designers to solve problems and think creatively and critically. This book can ignite a young person's curiosity and imagination. It encourages playing, tinkering, and exploring new ideas and possibilities.

Short tutorials and background information accompany investigations and challenges. The activities build on each other and allow youth to learn by doing. Challenges provide opportunities for solving problems with multiple possible solutions. Some of the activities are short and may take less than an hour, but others are more complex and offer opportunities to explore and create. **Estimates of time to complete activities do not include time for fully investigating challenge activities or for divergent or outside the box thinking.** The final project introduces more advanced programming skills and requires youth to synthesize and apply previously learned concepts. Young people can work on the activities individually, with partners, or in a guided instructional setting to solve puzzles, meet challenges, and create fun light-up projects.

As a facilitator of these projects, encourage youth to use their troubleshooting and problem-solving skills to learn from every situation, even when there is a "power outage." This book offers opportunities for collaboration and redesign to encourage empowered learners and promote creative design.

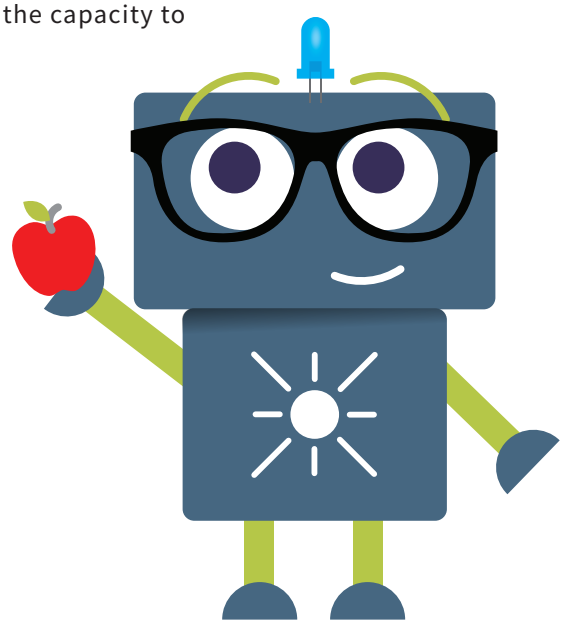
This curriculum was written for youth in Grades 6 and higher, based on experience. Each book in the Power Park series was written using the International Society for Technology in Education (ISTE) Standards for Students, Next Generation Science Standards (NGSS), and Common Core State Standards (CCSS) for Mathematical Practice as guidance.

STANDARDS EXPLICITLY ADDRESSED:

ISTE Standards For Students:

Innovative Designer

- Students develop, test and refine prototypes as part of a cyclical design process.
- Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.



NGSS Science and Engineering Practices

- Asking questions *(for science)* and defining problems *(for engineering)*
- Planning and carrying out investigations
- Using mathematics and computational thinking
- Constructing explanations *(for science)* and designing solutions *(for engineering)*
- Obtaining, evaluating, and communicating information

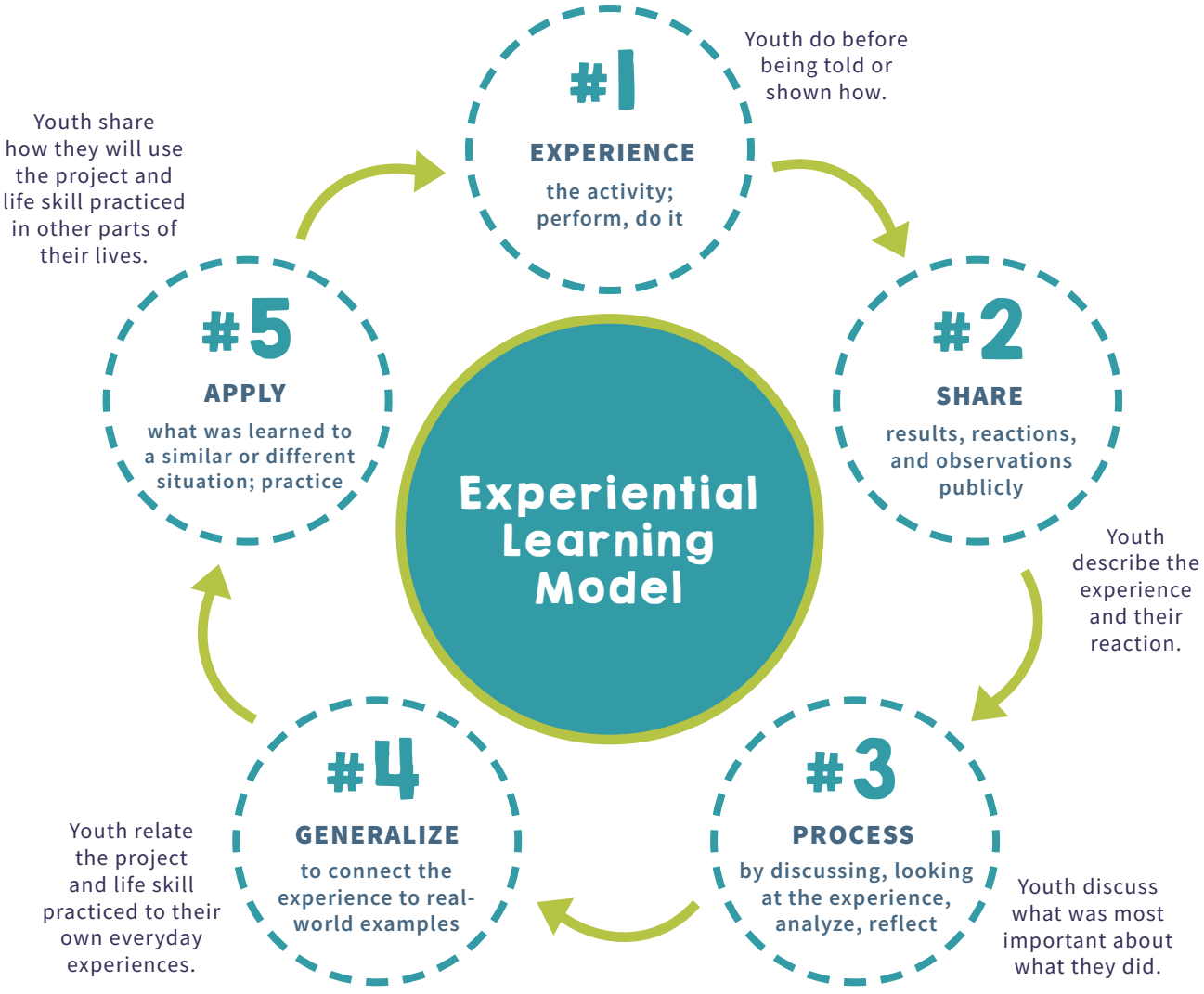
CCSS for Mathematical Practices

- **MP1:** Make sense of problems and persevere in solving them.
- **MP2:** Reason abstractly and quantitatively
- **MP6:** Attend to precision

EXPERIENTIAL LEARNING

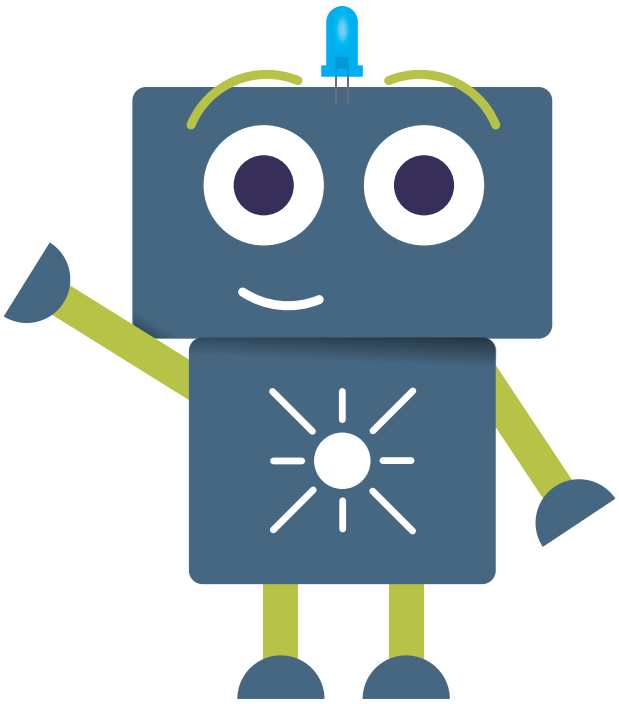
The **Experiential Learning Model of Instruction** provides learners an opportunity to become familiar with the content (**Experience**), explore a deeper meaning of the content (**Share and Process**), connect the learning to other examples or opportunities (**Generalize**), and apply it in real world situations.

The facilitator will guide youth through this process by helping them to focus on the activities, provide support and feedback for the learning, and debrief with them about their learning experience: what went well, what they could have done differently, what they could do next. This debriefing process fits hand-in-glove with the engineering design process used throughout the curriculum.



Pfeiffer, J.W., & Jones, J.E., "Reference Guide to Handbooks and Annuals"

WELCOME TO THE PARK



USING THIS BOOK

Welcome to the Power Park! I'm the friendly neighborhood robot.

This is an interactive workbook designed to give you a hands-on learning experience. You must do the activities to fully understand the concepts as you follow along.

Use the pages of this book for writing, taping, cutting, drawing, creating, and more!

- Describe your explorations.
- Record your thoughts and questions.
- Document images of your results.
- Challenge what you've learned.
- Create your own projects!

Pay attention to what the green boxes say!

Jot down notes and thoughts in the gray dotted boxes.

Find interesting challenges in the blue boxes!

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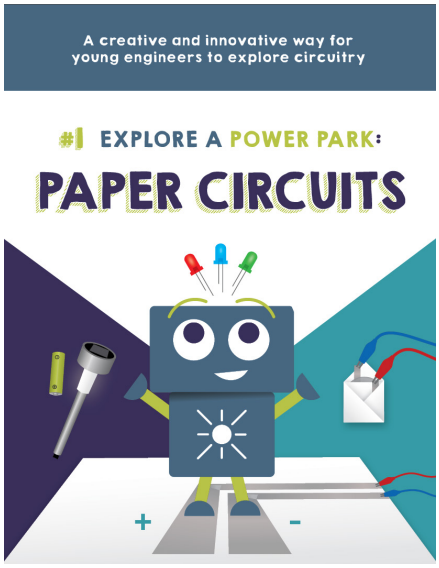
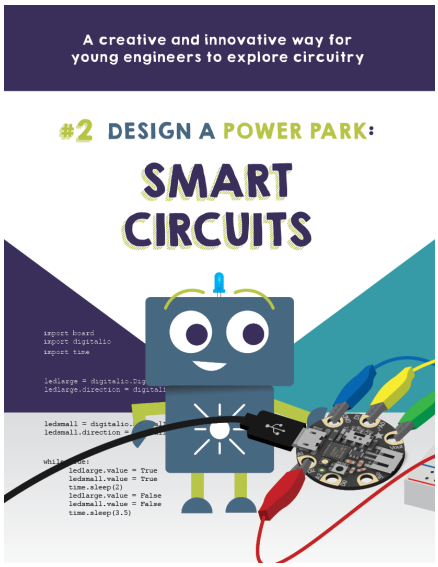
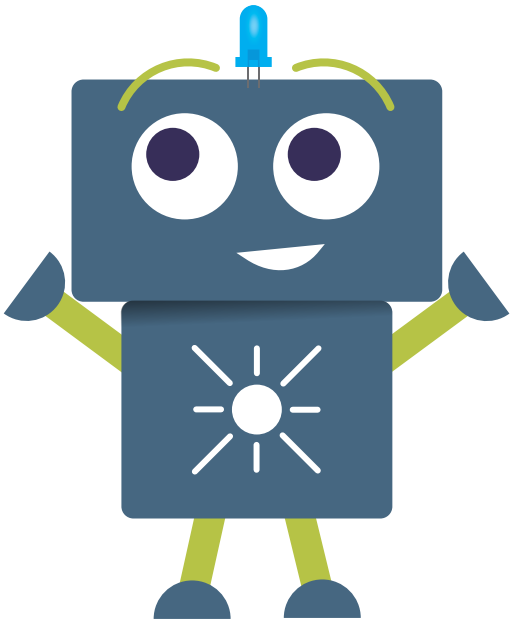
ABOUT THE POWER PARK SERIES

This series of three **Power Park** books provides opportunities to explore electrical circuits, power systems, sensors, coding, and microcontrollers. ***Explore a Power Park: Paper Circuits*** is an interactive notebook for investigating conductive tape circuits and alternative power sources. ***Design a Power Park: Smart Circuits*** introduces coding, microcontrollers, and sensors to circuitry projects. ***Build a Power Park: Lights On in the Neighborhood*** adds controls to a three-dimensional neighborhood concluding with a design challenge. These books invite you to create, explore, investigate, and tinker as you use science and engineering design to meet a series of challenges.







THE NEIGHBORHOOD MODEL

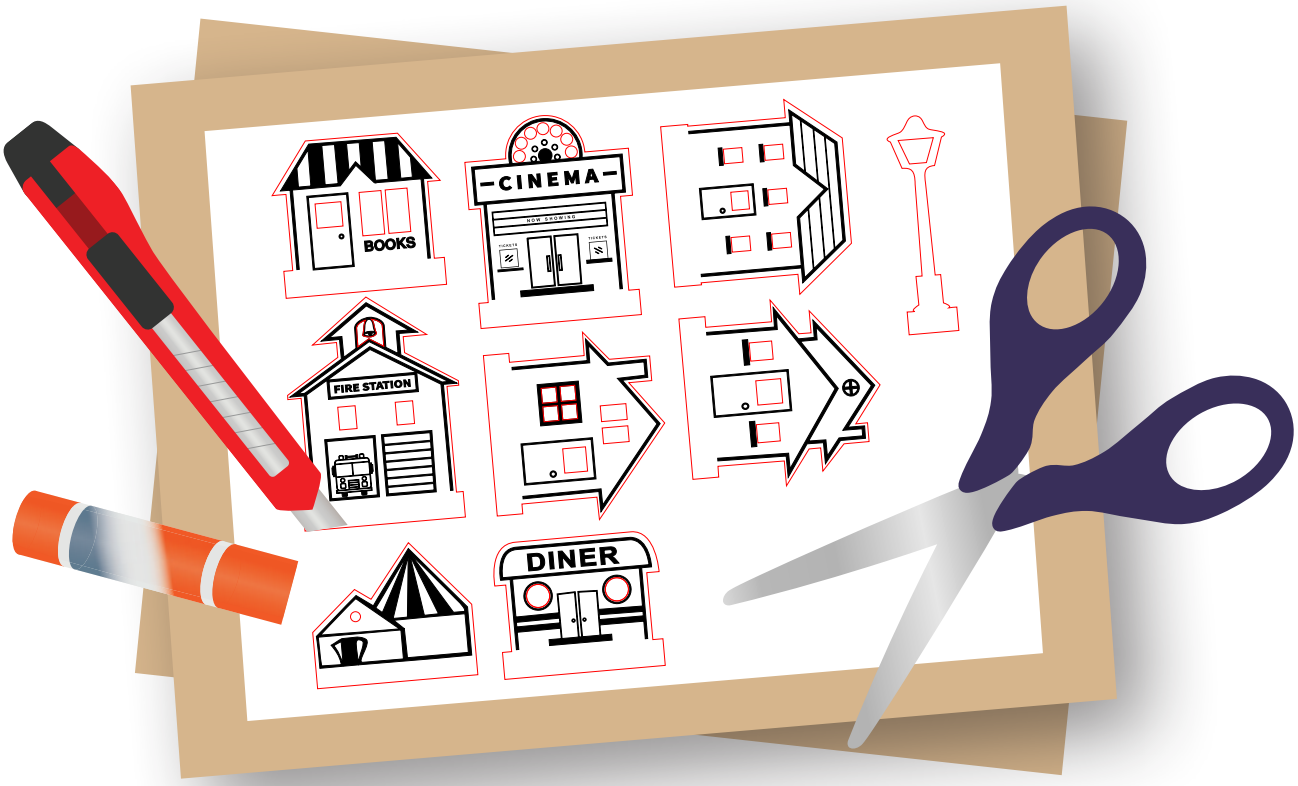
We've designed an accompanying neighborhood model kit for you to use with the activities in this workbook.

To get started, visit our website to find template files and instructions for setting up your own neighborhood model:

credc.mste.illinois.edu/power-park

The template files contain all the neighborhood pieces needed for activities in this book: 8 buildings, 1 streetlight, and 1 base. The base has 6 building slots and 1 streetlight slot.

The buildings include 2 houses, 1 apartment building, 1 bookstore, 1 diner, 1 cinema, 1 fire station, and 1 circus.



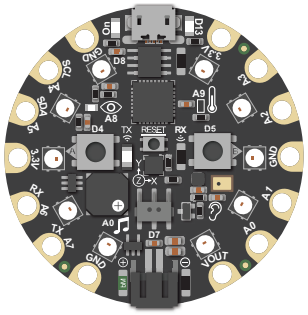
#1

A Smart Neighborhood

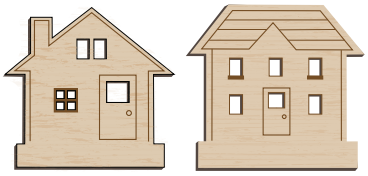
MATERIALS NEEDED

8.5 x 11 inch Base Piece

Assorted LEDs



Circuit Playground Express



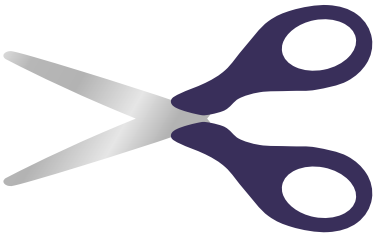
Building Pieces

Alligator Clip Wires

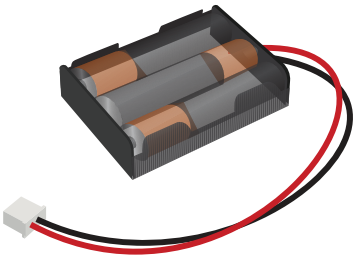
Micro USB Data Cable

Alligator Clip to Jumper Wires

Conductive Tape



Scissors



Battery Holder with JST Connector and 3 AAA batteries

RGB LED

POWER UP THE NEIGHBORHOOD

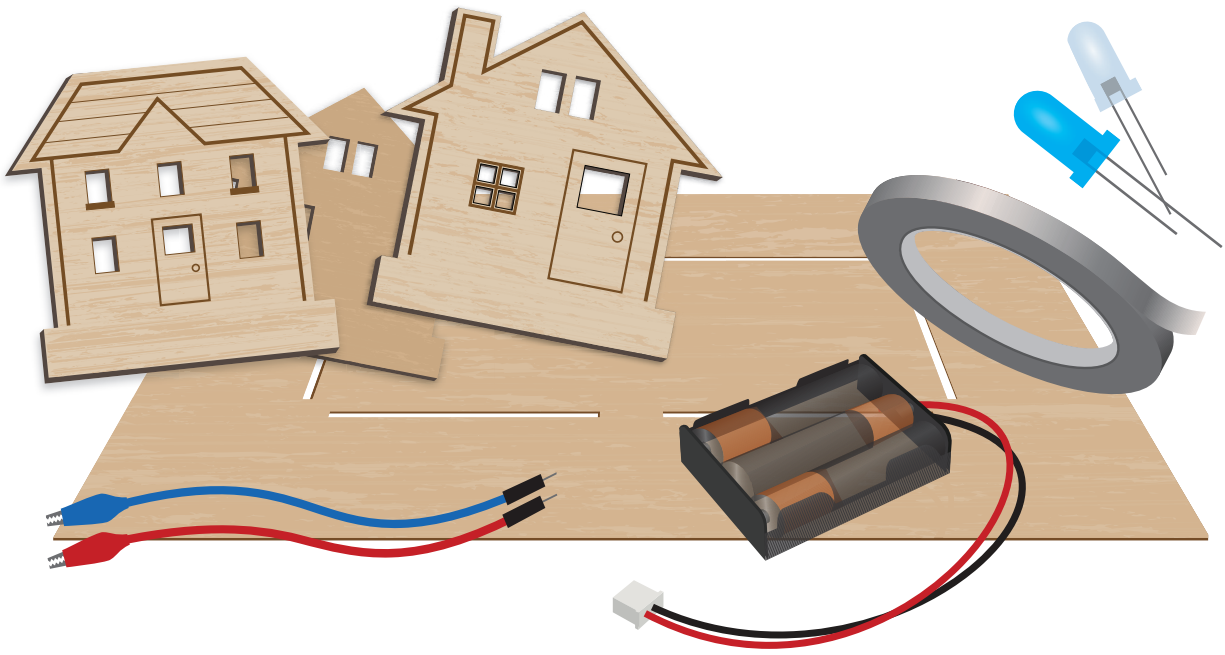
Estimated time to complete: ***1 hour 30 mins - 2 hours***

Build and power a three-dimensional model neighborhood. Use conductive tape to deliver power to lights in the neighborhood buildings.

CREATE THE NEIGHBORHOOD CIRCUIT

The neighborhood includes buildings and a base. The basic kit includes a street light and six buildings. There's a diner, a cinema, a bookstore, an apartment building, and some houses.

Grab a building, some conductive tape, and an LED to get started building the neighborhood circuit!



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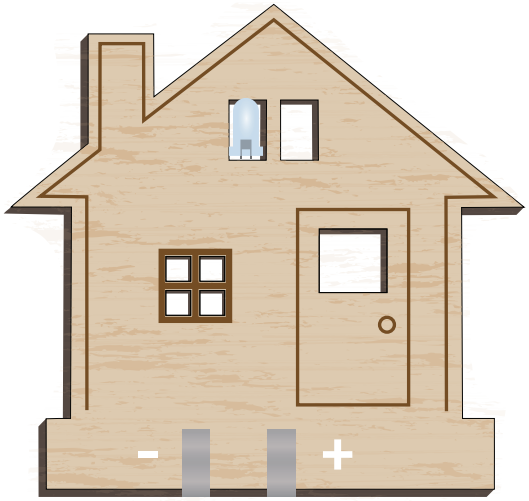
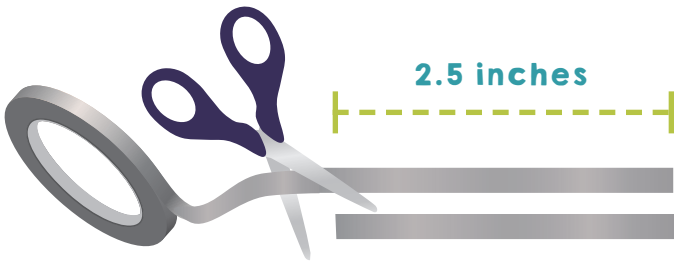
A CIRCUIT IN A BUILDING

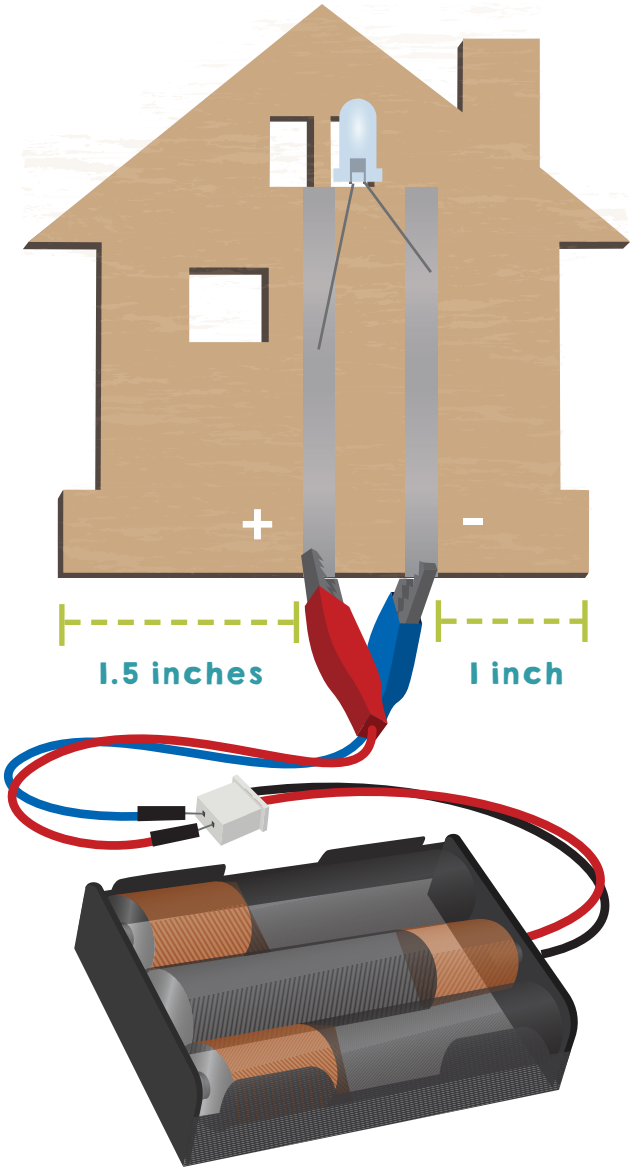


1. Place an LED on the back of a building so that it peeks through a window.
2. Cut two pieces of conductive tape (about 2.5” long).



3. Measure one inch from the right as you look at the back of the building. Place one piece of tape on the back of the building with an end near the shorter leg of the LED and so that the other end wraps around the bottom and up the front so it crosses at the one inch mark.
4. Place the other piece of tape with one end near the longer leg of the LED so that it wraps around the bottom and up the front and so it crosses 1 1/2 inches from the left as you look at the back of the building.
5. Bend the legs of the LED so that each leg touches the appropriate strip of conductive tape.

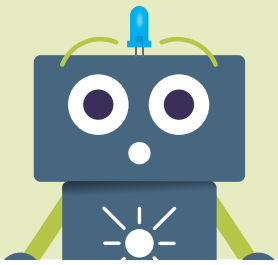
   Using small pieces of conductive tape, tape the LED legs to the long conductive tape strips to hold the LED legs down and make for a better connection.



ADD BATTERY POWER

6. Power the LED on the house using the battery pack. Use alligator-to-jumper clips to connect to the JST connector on the battery pack.

   Clip the positive battery lead to the positive base tape, and the negative battery lead to the negative base tape.

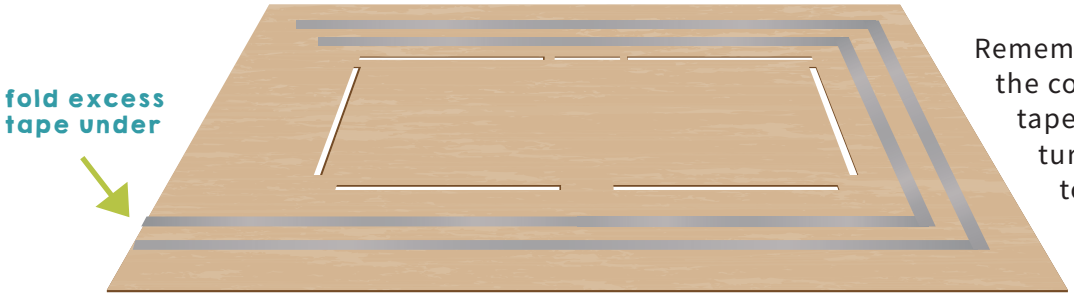


REMINDER:

The long leg of the LED is positive (the anode) and the short one is negative (the cathode)!

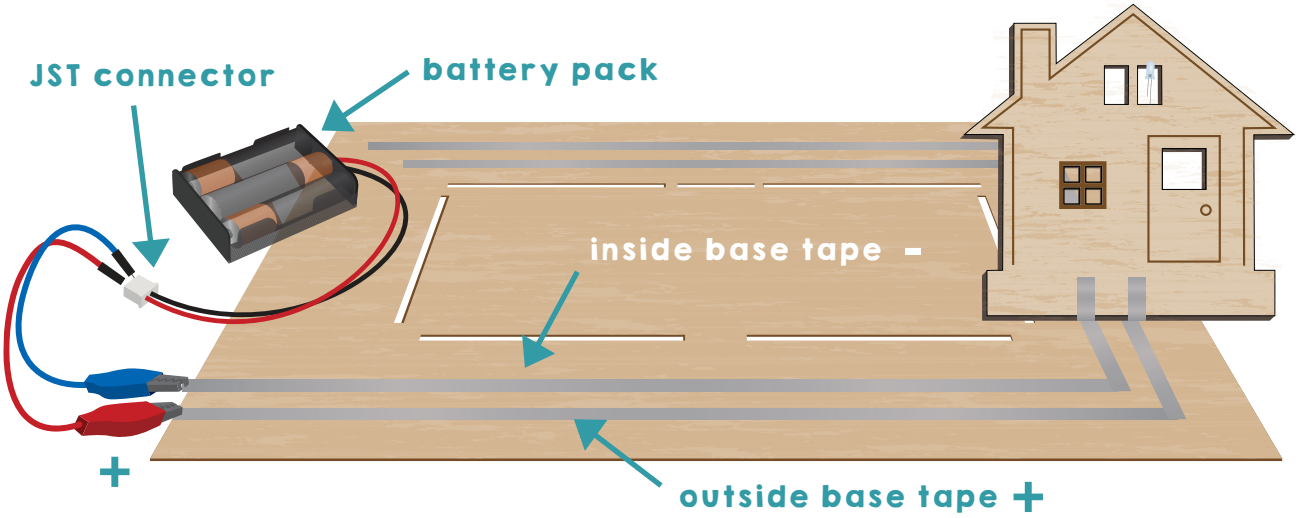
THE DELIVERY SYSTEM: ADD BATTERY POWER TO THE NEIGHBORHOOD

Begin by cutting 2 pieces of conductive tape about 26 inches long. Place two parallel strips of tape along the outside edge of the 8.5 x 11 base so that the tape goes off the edge of the cardboard base, as shown below.



Remember to fold the conductive tape when turning corners to improve conductivity!

The parallel strips of conductive tape start our neighborhood power delivery system. To bring power to the neighborhood, we also need a power source connected to the positive and negative traces.



Power the neighborhood you created using the battery pack. Touch the bottom of your house to the taped base to test the connection. If the correct leads are touching, the LED lights!

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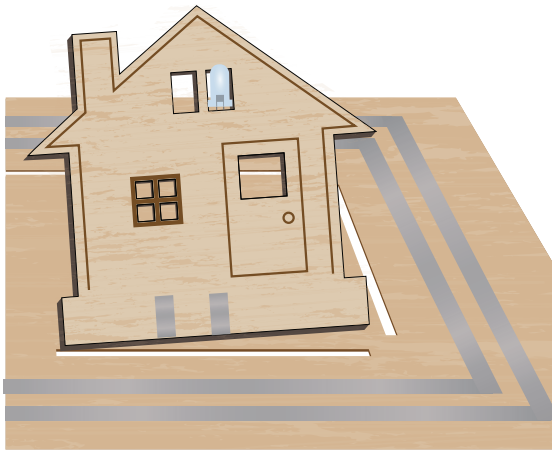
Does the LED come on? If not, what else could you try?

HINT: ***Polarity*** *of the LED matters! Current can only flow through the LED in one direction. Be sure you've taped the negative (shorter) LED leg to the tape trace on the right as you are looking at the back of the building.*



BRING POWER TO A BUILDING SITE

We want to connect each building to the neighborhood power delivery system. To do this, we must bring power to each slot in the base.

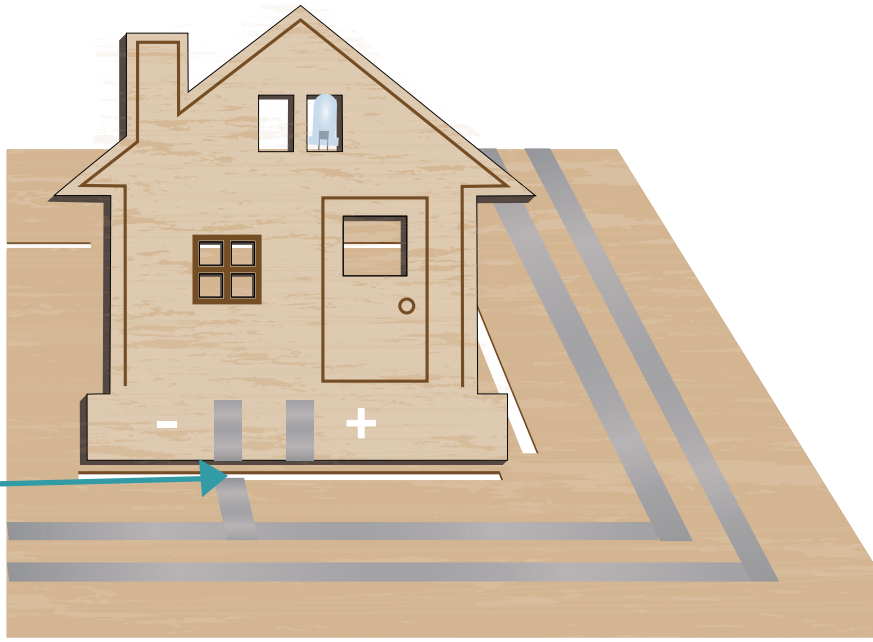
1. Put the building you taped into one of the slots on your base. The tapes on this building are used as a guide for new tape.

NEGATIVE TAPE

2. Cut a 1.5 - 2 inch piece of conductive tape.

3. Place this new piece of tape so that it lines up with the negative tape on the house and connects with the negative base tape.

4. Press firmly to tape down the new piece of tape, tuck into the slot and wrap the extra on to the bottom of the base.

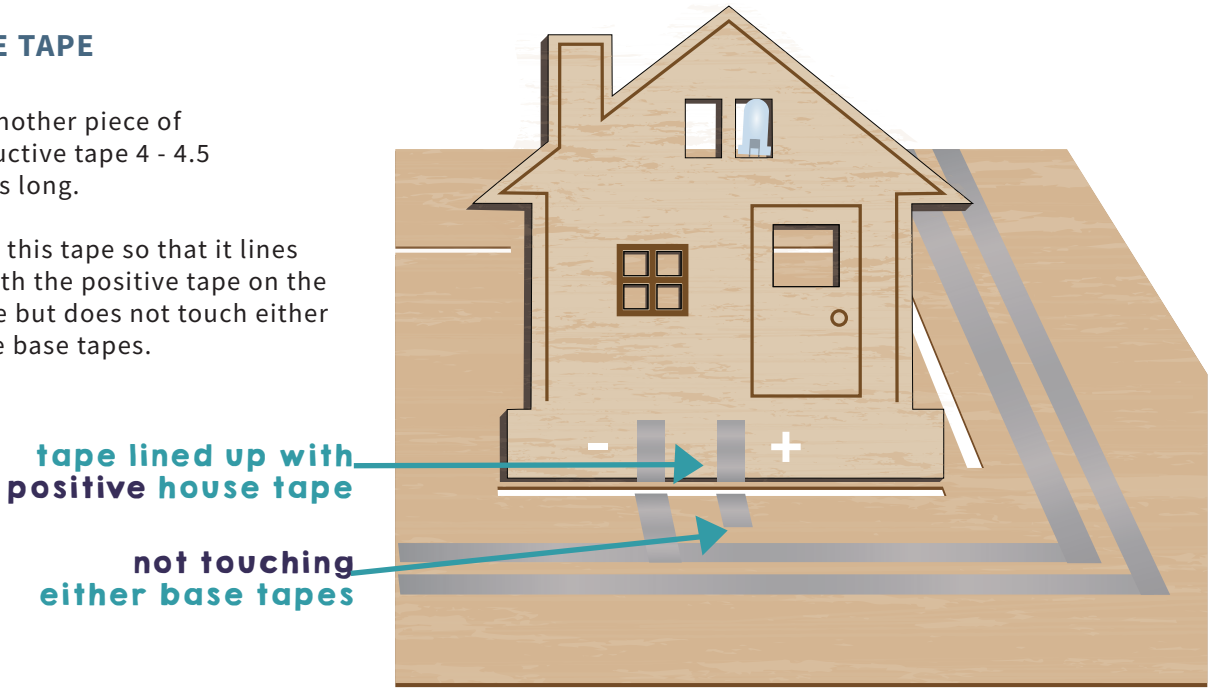


5. Place the house into the slot to ensure the pieces of tape touch to make a connection.

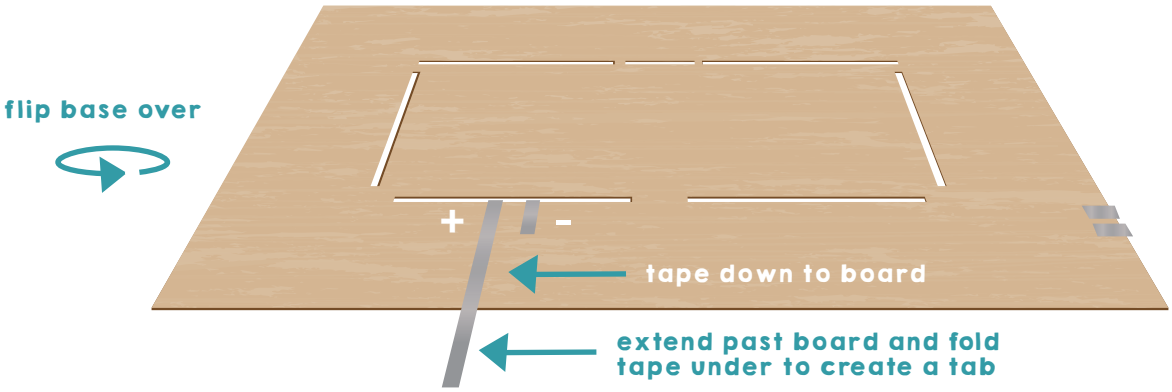
POSITIVE TAPE

6. Cut another piece of conductive tape 4 - 4.5 inches long.

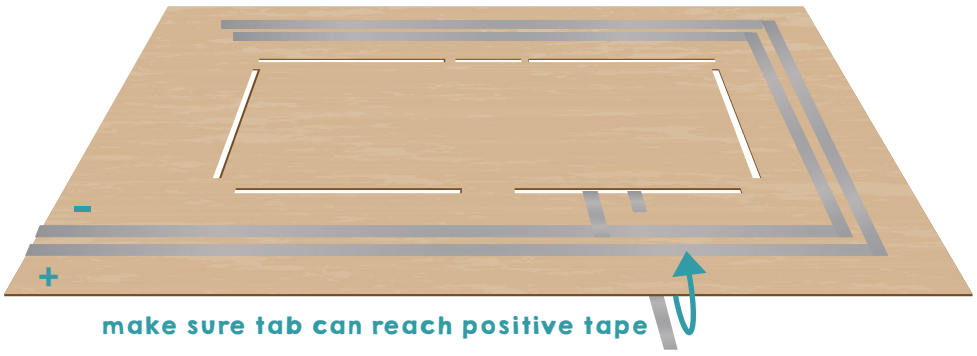
7. Place this tape so that it lines up with the positive tape on the house but does not touch either of the base tapes.



8. Tuck the tape into the slot and tape to the back of the base board so that it extends past the edge.



9. Fold sticky-side to sticky-side so there is a tab on the edge of the base board that is long enough to touch the outer positive base tape.



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10. Use a small piece of conductive tape to attach the tab to the positive base tape.

11. Place the house into the slot. Use the battery pack to power up your neighborhood circuit. Does your house light up now?

12. Attach an LED to a second building and create a connection to the neighborhood delivery system at another base slot.

CHALLENGE

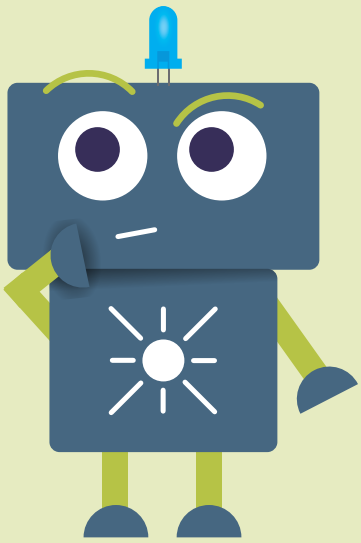
Attach an LED to each of the buildings and connect them to the base. Use only white LEDs for right now. See the whole neighborhood light up!

Can your battery light all of the LEDs?

CHALLENGE

Paint or decorate your buildings or design your own buidlings! Use the building templates online as a guide to design your own Power Park structure. The buildings used in this guide all have bases that are about 3.25” long.

TROUBLESHOOTING TIPS



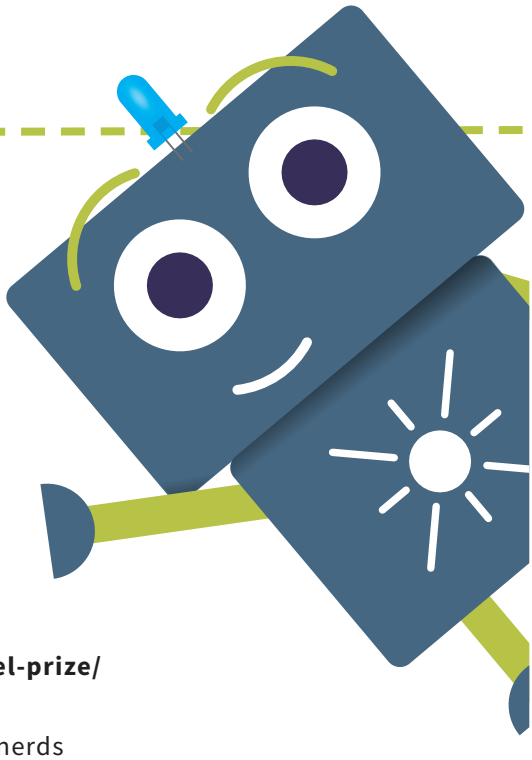
If your building doesn’t light, wiggle it in the base. If the slot is getting too wide, the tape on the building might not be touching the tape on the base.

If it still doesn’t light, take the building out and see if it lights when it is touching the base tapes directly:

- If it lights now, then you know that it’s not getting a good connection while in the base. If it’s too loose, try folding a small piece of paper and wedging it in the slot with the building.
- If it still doesn’t light, then the tapes connecting the base tapes to the building slots do not provide good connections. Where these two tapes meet, press firmly with your fingernail to ensure a good connection. You can also add a small patch of additional conductive tape where they meet.

Did you need to troubleshoot something? What did you try?

LEARN MORE



LEDS

The Light Emitting Diode - Electronics Tutorials
https://www.electronics-tutorials.ws/diode/diode_8.html

MAKE presents: The LED – Collin Cunningham video
https://www.youtube.com/watch?v=P3PDLsJQcGI

Why a Blue LED is Worth a Nobel Prize – Popular Science
https://www.popsci.com/article/technology/why-blue-led-worth-nobel-prize/

LED Tutorial – Learn the Basics – BaldEngineer: Electronics Stuff for Enginerds
https://www.baldengineer.com/led-basics.html

RGB LED - Collin's Lab Notes – Collin Cunningham video
https://www.youtube.com/watch?v=-QxBqPXKBmc

CIRCUIT PLAYGROUND EXPRESS

Adafruit Circuit Playground Express - Adafruit Explore and Learn
https://learn.adafruit.com/adafruit-circuit-playground-express

Welcome to CircuitPython – Adafruit Learning System
https://learn.adafruit.com/welcome-to-circuitpython

Adabot Operation Game - Adafruit Learning System
https://learn.adafruit.com/adabot-operation-game/overview

Dear Diary Alarm - Adafruit Learning System
https://learn.adafruit.com/dear-diary-alarm/overview

LIGHT & COLOR

Only some humans can see this type of light – Physics Girl

https://www.youtube.com/watch?v=CSu0cV3fqi8&t=38s

Light and Color – Bill Nye the Science Guy

https://www.youtube.com/watch?v=g5BHxozBPuA

Light and Color – CK-12 Interactive Physics for High School

https://flexbooks.ck12.org/cbook/ck-12-physics-flexbook-2.0/section/13.3/primary/lesson/color-ms-ps/

MU

Code with Mu: a simple Python editor for beginner programmers - Mu Home

https://codewith.mu/en/

Plotting Data with Mu – Mu Tutorials

https://codewith.mu/en/tutorials/1.0/plotter

Make It Plot – Adafruit Explore & Learn

https://learn.adafruit.com/make-it-graph-plot

MUSICAL NOTES AS FREQUENCIES

Note Frequencies – Seventh String

https://www.seventhstring.com/resources/notefrequencies.html

Physics of Music – Notes – Michigan Tech Department of Physics

http://pages.mtu.edu/~suits/notefreqs.html

CAPACITIVE TOUCH

Introduction to Capacitive Touch Sensing – All About Circuits

https://www.allaboutcircuits.com/technical-articles/introduction-to-capacitive-touch-sensing/

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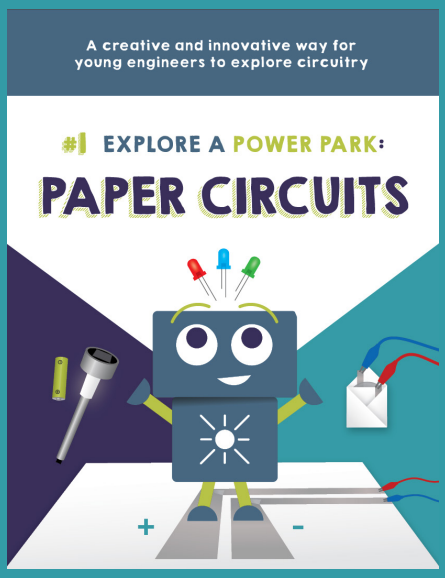

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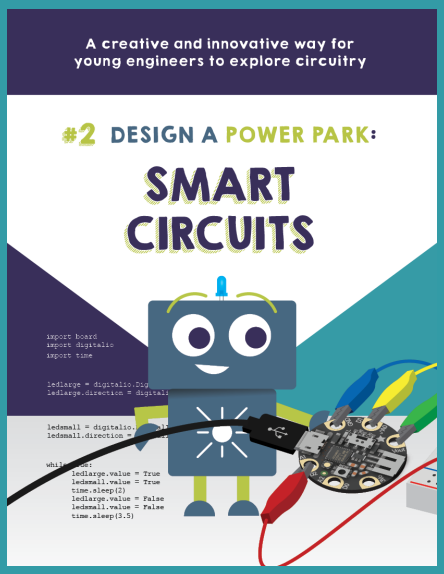

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ILLINOIS

This guide was created as a part of the education and outreach initiative associated with the Cyber Resilient Energy Delivery Consortium (CREDC) project and is based upon work supported by the Department of Energy and the Department of Homeland Security under Award Number DE-OE0000780.

Additional support was provided by the 4-H Computing Connections (CS4H) project funded by the University of Illinois Extension and Outreach Initiative.