RED HAT CO.LAB BOOK CURRICULUM + INSTRUCTION GUIDE

OVERVIEW

CO.LAB is an activation of Open Source Stories, inspiring people everywhere to embrace open source in their own work and communities. Learn more about our stories and activations at redhat.com/opensourcestories

This curriculum is designed to be delivered in a day-and-a-half class (total of 8 hours).

MATERIALS TO PURCHASE

Use	Item	Quantity
Book pages	Coin Cell Battery	14 batteries
	Chibitronics White LED	40 LED stickers
	1/4“ Conductive Adhesive Copper Tape	31.5 ft
	1” Conductive Adhesive Copper Tape	6 ft
	LilyPad Arduino SimpleSnap	13 Arduinos
	LilyPad Snap LED White	2 Snap LEDs
	LilyPad Vibe Board	6 Vibe Boards
	LilyPad Buzzer	5 Buzzers
	Silver Snaps, Size: #2/0 (5/16")	26 Snaps
	Conductive Fabric	488 square inches
	1” Mounting Squares	14 squares
	1” Conductive Adhesive Copper Tape	27 ft
	Page Book Tape - 2" white, 15 yard roll	1 roll
	Binding Book Tape 2" red, 15 yard roll	1 roll
	8x10 Backer Board	28 Backer Boards
	Printed materials	All Printed pages
	Small baskets to hold table supplies	3

	Catalog size envelopes to hold activity kits w/ labels	27
Book binding	Binding Book Tape for pages: white	One 2”x 15 yard roll
	Binding Book Tape for outside: red	One 2”x 15 yard roll
	Power Plugs	2
	Soldering iron	1
	Extra soldering tips	Depends on your soldering skills
	Brass sponge (for cleaning tips and tinning)	1
	Heat shrink 3/32”-3/64” (2mm-1mm)	
	Heat gun	1
	Lead free solder	
	JST wire connectors	
	Wire- 2 colors (one for positive and one for negative)	
	Wire strippers	
	Tweasers	
	Extension cord	

PRE-CLASS CHECKLIST

1. Order parts (link to Github file that includes the parts list); see MATERIALS TO PURCHASE list.
2. Print a copy of the book.
3. Pre load software on Lilypad Arduino (30 minutes) and label the outside of the Arduino bag in case it gets lost from the activity envelope.
    a. TOOLS: board = Lilypad Arduino
    b. Processors: ATmega328P
    c. PORT: your USB port (example: / dev/tty/USB0)
    d. SKETCH: upload

    Specifically, you’ll need:

    - 6 vibe boards (link)
    - 3 beeps (link)
    - 1 song (link)
    - 1 keypad chime (link)
    - 2 LEDs (link)
4. Cut materials according to the directions below:

    a. Cut copper tape into 27” inches long pieces x14
    b. Cut conductive fabric into 2x7” strips x13
5. Cut and bag LED’s
    a. 1 LED x1
    b. 2 LED x1
    c. 3 LED x11
    d. 4 LED x1
6. Make copper tape buttons x 14 (link to cut file). Watch the demo (link) for instructions.
7. Make conductive fabric buttons x13 (link to cut file). Watch the demo (link) for instructions.
8. Kit parts according to table groups, activity #1 and activity #2 kits for individual students.
    a. TABLE GROUPS: consider putting these into baskets; one basket per table
        - 3 Scissors
        - 3 ⅛” Hole punch
        - Pencils
        - Colored pencils
        - Scotch tape
        - Snaps

    b. ACTIVITY #1 KIT: Label each envelope with the Avery labels (link)
        - 1 base page
        - 27” copper tape
        - 1 coin cell battery
        - Copper tape button
        - LED (specific # of LED’s listed on envelope label)
    c. ACTIVITY #2 KIT: Label each envelope with the Avery labels (link)
        - 1 Base page
        - 2x7 sheet of conductive fabric
        - 1 Lilypad Arduino (x5 are pre programmed for buzzer pages)
            - Page 11, 33, 47 - program simple beep noise
            - Page 49- program phone song (i.e. twinkle twinkle)
            - Page 61- program keypad chime noise
        - 1 mounting square
        - Conductive fabric button
        - Special hardware (specifics listed on envelope label)
            - Vibe Board
            - Buzzer
            - White Snap LED

9. Organize binding equipment
    - Page Book Binding Tape - x1 2" white, 15 yard roll
    - Cover Book Binding Tape x1 2" red, 15 yard roll
    - Overlay sheet x27

- Power Plugs x2
- Soldering iron x3
- Extra soldering tips
- Brass sponge
- Heat shrink
- Heat gun
- Lead Free Solder
- JST wire connectors x27
- Wire
- Wire strippers
- Extension cord
- Red dot sticker

10. Print example circuits: NOTE: INCLUDE PHOTOS HERE
    a. Functioning circuit w/ no button
    b. Example circuits with insulators
    c. Functioning circuit w/ button
    d. Circuit with microcontroller

LEARNING OBJECTIVES

Students understand basic circuitry:

- A circuit starts and stops at the power source with electricity flowing through components
- Components are directional
- Circuit layout
- Cause and Effect: Inputs and outputs

COMMON CORE LEARNING STANDARD GOALS

CCSS.ELA-LITERACY.RST.6-8.2

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-LITERACY.RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

CCSS.ELA-LITERACY.RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

LESSON

Opener:

To start, if students are talking, make eye contact with each of them to quiet kids down. If that doesn't work say "if you can hear me clap once, wait for clap, if you can hear me clap twice, wait for clap, etc..."

We have a book to illustrate with electronics. The pictures are already drawn, but you all get to electrify them!

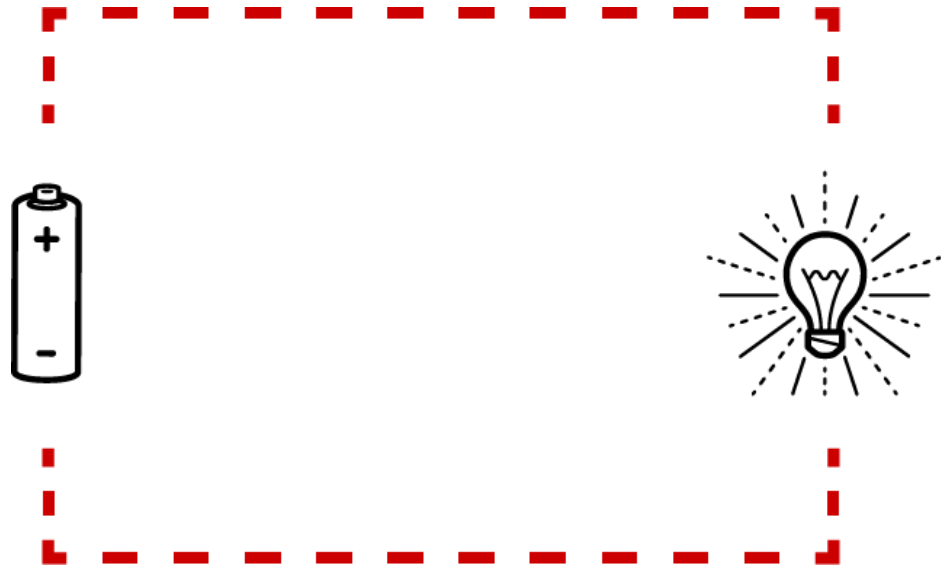
Today we will learn how to build a circuit. You'll be able to turn on LEDs, produce sounds and vibrations with different sensors. What building a circuit really means is that you'll be able to control how electrons flow. Have you heard of electrons? (Response) Have you heard of atoms? (Response) Atoms are tiny particles that make up everything in the universe. Electrons flow around the atoms and give that item an electrical charge. So in a way, learning to control electrons through a circuit allows you to control a tiny piece of the universe. Who wants to control the universe!?

Lesson in Circuit Building:

Electricity:

Electricity flows along a path. You get to make that path today. We're going to use copper tape in the first lesson as our path today because copper tape is made of very thin copper which is metal and electrons like flowing along metal the best.

Your goal today is to make a path from the battery, through the LEDs, and back to the battery again. You can think of it like doing a connect the dots.



Equipment / Materials:

These are the components we will be working with for our first lesson. Battery, LED stickers, copper tape. We're also going to use paper and binder clips for structural purposes.

Negative and Positive sides to a component:

Some components have a negative side and a positive side. We call these components directional because they have to go a particular direction in your circuit, they are like a one way street. They can only go one way and the direction matters. Batteries and LEDs are directional. The negative side of the LED needs to line up with the negative side of the battery and the positive side needs to line up with the positive side of the battery.

It is important that you don't cross positive and negative paths – or let your paths touch. If your paths touch, the electricity won't know which one way street to go down, and will start going the wrong direction and your LEDs won't light up.

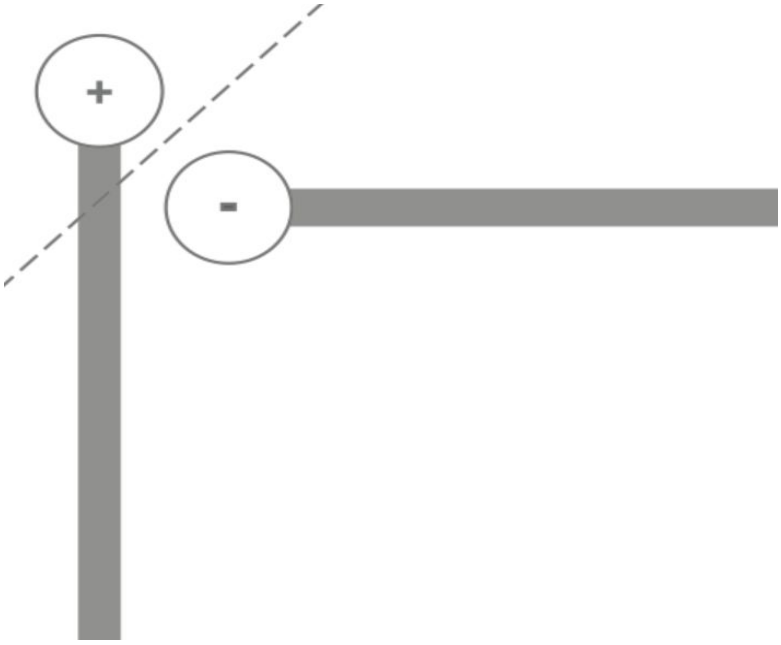
(Show an example circuit. Then reverse an LED. Then correct it again. Reverse the battery. Then correct it again.)

Activity 1 Part 1:

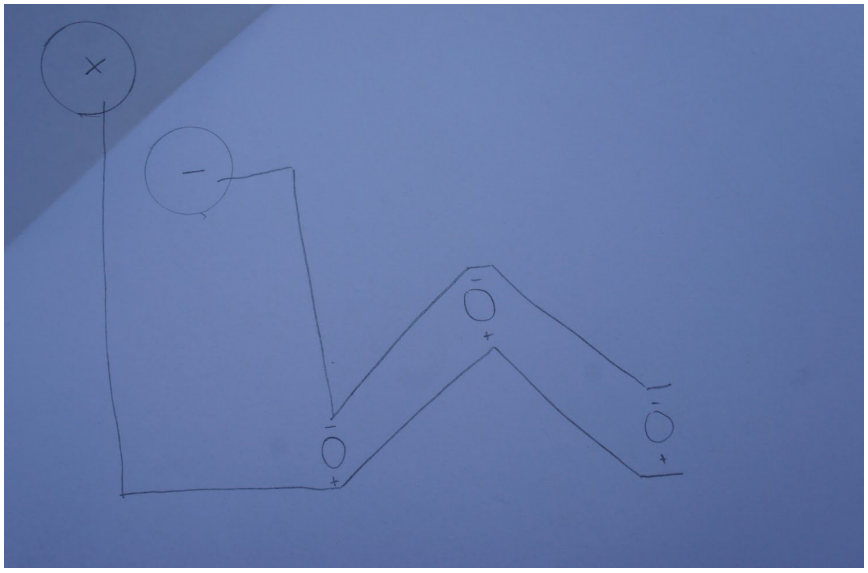
Activity 1 will have two parts. First we're going to create a basic circuit with a battery and an LED. Then after we have made working circuits we are going to add in a button to your circuit. So part one will be building the circuit and part two will be adding a button.

We're going to draw out your circuits with a pencil first. Start with the battery. Trace a circle around the battery at the top left of your paper about an inch away from the edge. Then you're going to fold the corner of the paper down. When I do that, look how my copper tape folds over the top of my battery to make a connection. If I have a battery that is sandwiched between the paper, my copper tape wraps around to the negative side and the positive side without letting the tape touch and cross each other.

Draw a line out from your battery circle to the right. Draw a line down from the folded area. Those two lines are the start of your negative and positive lines.



Draw where you're going to put 1, 2 or 3 LEDs in your picture. Draw a line for where you're going to put the copper tape. Then connect the LEDs with lines back to your battery. You can fold your picture where you want the LED to use it as a measuring guide. Some pictures make sense with just one LED, but others might make sense with more.



Check with your mentor once you have your circuit drawn.

A couple more things before you stick your tape down:

First, making connection with the copper tape:

The components must make contact with the copper tape. If they are too far off, the electrons won't be able to reach the component. If they're too close to the other side, the electrons will get confused which direction to go on your one way street.

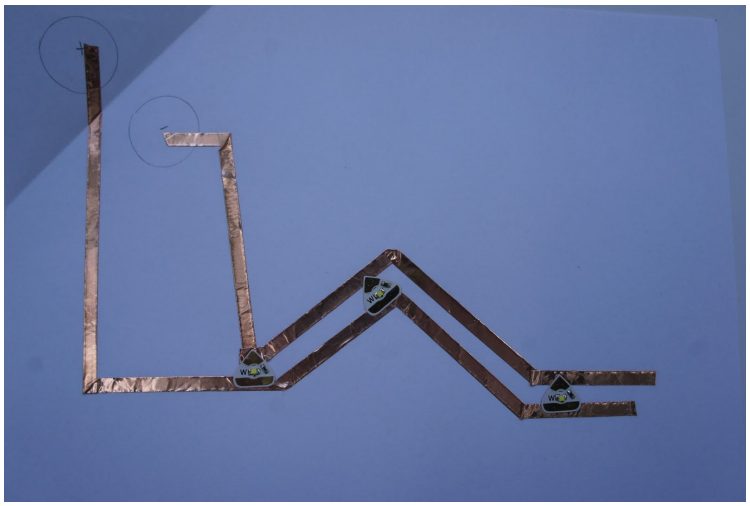
Next, folding copper tape:

Copper tape can be tricky to fold. To fold the copper tape, fold it back on itself it a straight line so now the sticky side is face up. Then fold it up or down at an angle so the sticky side is down again.

What questions do you have? Ok, let's stick down your copper tape!

Next stick down your LEDs. Make sure to press them against the copper tape hard! Use your nail to go back and forth over the LEDs.

Your whole circuit might look something like this. Next, put your battery on your copper tape, fold over the corner and clip it with a binder clip. Mentors: double check that the batteries work here.



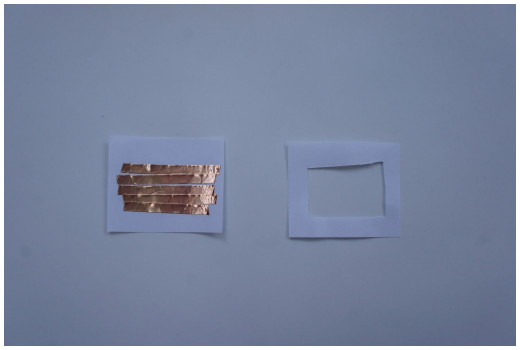
Activity 1 Part 2:

Now we're going to create a circuit with a button that turns on LEDs when pressed.

To do this we're going to cut off a bit of copper tape in your circuit so your path doesn't connect. Then we're going to construct a bridge on another piece of paper so your copper tape will connect again when someone presses it together.

If students have time to make their own buttons, follow the instructions or demo(link). These can be made ahead of time if needed.

To create a button, take small piece of paper and cut a square out of it. Fill that square with 1" copper tape. Then cut a second square with a smaller square cut out of the middle. "Frame" the copper tape by placing your cut out paper frame on top of the copper tape. Tape the sides down. Demonstrate the button being pressed.)



We are going to add a button into your circuit. Look at your illustration, where does a button make sense? Your button may be larger, or it may be smaller. Use your pencil again to draw a path to the button.

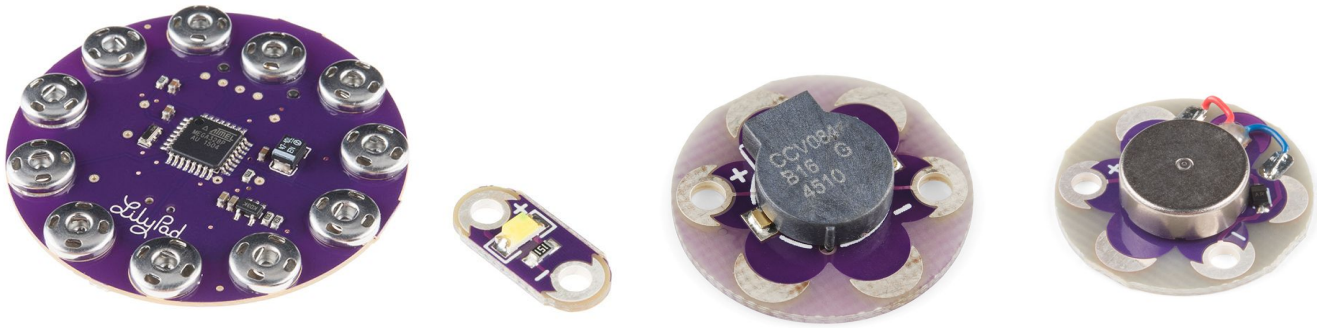
What questions do you have?

Activity 2:

For activity two we are going to get a little more fancy and use some sensors and some computing power to do more exciting things!

Materials:

For activity two, we're going to create a circuit with a microcontroller and a sensor:



Components:

These are the components we will be working with for our second lesson. Lilypad arduino microcontroller, LEDs, Buzzer (Buzzer) and Vibe Board (vibration motor). We're still going to use paper and now tape for structural purposes.

Negative and Positive sides to a component – plus data!

We learned that some components have a negative side and a positive side, where the negative side of the LED needs to line up with the negative side of the battery and the positive side needs to line up with the positive side of the battery. But now that we have some sensors, those sensors also need a data path. The data path is like a cell phone for the sensor and the microcontroller to talk to each other. So the for example the light sensor will use the data path to tell the microcontroller "Hi! I'm seeing light right now!" or it will say "Hi! I'm in the dark right now!"

Ok, so what the heck is a microcontroller? A microcontroller is like a teeny tiny computer that doesn't have a lot of power, so it can't do things your normal computer can, but it can send electronics to and from components at different times. A microcontroller is programmed with software that tells the hardware what to do. So when our light sensor calls the microcontroller on the data path and says "Hi! I'm seeing light right now!" the microcontroller says to the software, "Hey the the light sensor sees light, what should I do about that?" The software says "If the light sensor

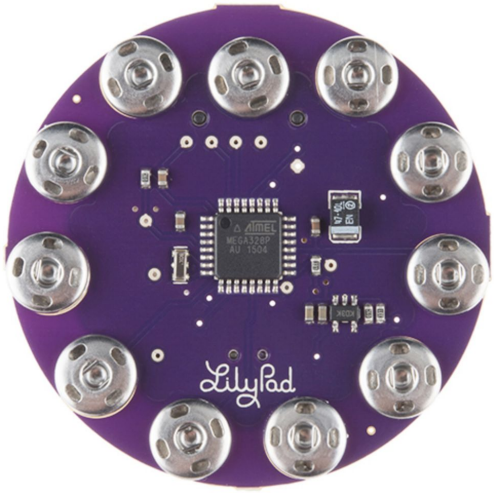
sees light, then turn on the LEDs" and the microcontroller, who is very agreeable, says "Ok!" And sends electrons to the LEDs to turn them on. We've already written software for you today. So you just need to think about creating your circuit. If anyone has extra time at the end, there might be time to change some of the software, if you want it changed.

Other components:

LEDs – We still have LEDs but they look a little different now. They still have a positive and negative side.

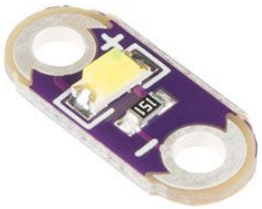
Buzzer – The buzzer plays very electronic noises. It will only play electronic noises because we are using a very tiny computer that doesn't have much power. The buzzer needs a positive path, negative path, and a data path.

Vibe board – If you or your parents have a cell phone that vibrates, this is how it works. The vibe board needs a positive path and a negative path. When electricity has a path to the board, it will turn on and vibrate back and forth.



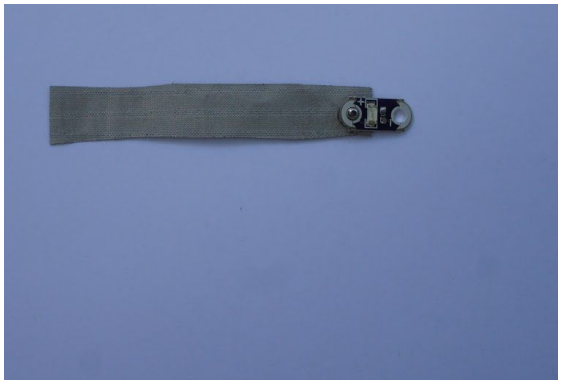
Pin outs:

You will notice on there are numbers all around the Lilypad microcontroller. These numbers are called Pin Outs. You can think of them as channels or a phone number that is one digit long to connect the microcontroller to the electronics component that it wants to talk to. So if the LED and the microcontroller wanted to talk, we would tell the software they are going to talk on Pin 9.



Negative and Positive sides to a component – plus data!

We learned that some components have a negative side and a positive side, where the negative side of the LED needs to line up with the negative side of the battery and the positive side needs to line up with the positive side of the battery. You would create a path between the positive pin and pin 5.



For activity two we are going to use conductive fabric. Conductive fabric has little metal fibers in the fabric which make it conductive. We're going to cut stips of the fabric, hole punch it, and use Snaps to attach it to the components.

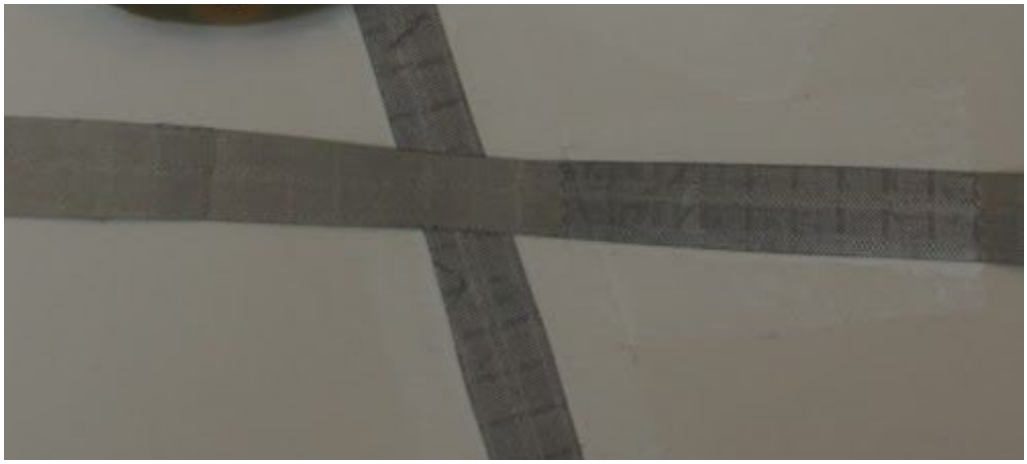
Attaching snaps:

To attach the snaps you will first use the hole punch to punch a hole in one end of the fabric. You can connect that

end to the microcontroller with a snap. Then punch a hole in the other end of the fabric and connect your electronic component with a snap on that side. To attach the fabric to itself, you can just use scotch tape.

Insulators:

This time, it's going to be harder to not cross our negative path with our positive path and we might have to do it. So we're going to need to use insulators.

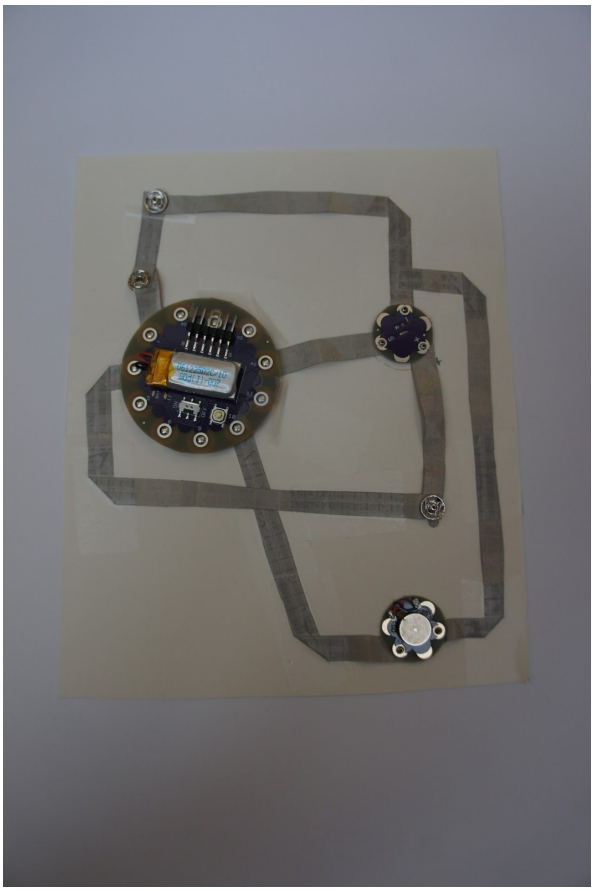


What are insulators? Tape / paper / anything without metal in it

(Show an example circuit without insulators. Ask where the paths cross. Then add an insulator.)

```
// Which pin the buzzer is attached to
int buzzerPin = 5;

// Delay in milliseconds
int delayTime = 500;

// Notes and their frequencies
const int C = 1046;
const int D = 1175;
const int E = 1319;
const int F = 1397;
const int G = 1568;
const int A = 1760;
const int B = 1976;
const int C1 = 2093;
const int D1 = 2349;

void setup()
{
    // Set the buzzer pin as an OUTPUT
    pinMode(buzzerPin, OUTPUT);
}

void loop()
{
  // Use the tone() function to play each note in a scale
  tone(buzzerPin, C);
  delay(delayTime);
  tone(buzzerPin, C);
  delay(delayTime);
  tone(buzzerPin, G);
  delay(delayTime);
}
```

This is what the software looks like. The software is loaded onto the Microcontroller. In this example the software tells the buzzer to play notes if it is plugged into pin 5 on the microcontroller. There is a delay time which means it pauses just slightly in between notes. The next part tells the microcontroller what the notes are called and what frequency they are played at. We can see down in the loop then that the notes C, C, and G get played.



PIN GUIDE

Inputs:

Button: Make it the same way we did lesson 1, no pin necessary

O**utputs:**

Vibe board: Use pin 10

LEDs: Use pin 9

Buzzer: Use pin 5

Your circuit might look like this when it's finished. Let's walk through where each pin is going. Notice the negative pin on the Lilypad arduino microcontroller goes to the light sensor and then down to the negative side of the Vibe Board.

Remember the light sensor has a positive pin and a data pin, so the positive pin goes into the positive pin on the microcontroller. In this circuit, the data pin on the light sensor goes into pin A2, and the positive pin on the Vibe Board goes into pin 10 because the Vibe Board doesn't have it's own data pin. I have a guide for which sensors use which pins based on the software written. It's sort of like a matching game, match the number or + and - symbol with the sensor and the microcontroller. (Read Guide)

You'll notice you all have different pages of the book. If you read the page you have, you might get some ideas about which electronics you should use. Pick out one input and one output to use. Trace out where you will place your microcontroller. Trace where your components are going, then draw lines of where your conductive fabric needs to go.

When you've checked with your mentor, you can start cutting strips of conductive fabric and punching holes in the end and snapping or taping things in place.

Once you have things snapped into place, you'll want to tape the microcontoller and sensors down with the double stick foam tape.

What questions do you have?

CONSIDER PUTTING BINDING INFORMATION HERE

BINDING

Cut the plug end

Using wire strippers, strip the end about an inch and a half back to reveal the two wires on the inside. Strip each of those wires. Note: it is really easy to do a bad job of this. If you find you have cut more of one of the copper wires, cut further down and continue.

Repeat this for the second power cord.

VIDEO

Strip the JST connectors - ½ inch.

PHOTO

Closure

You all were able to create circuits today with sensors, microcontrollers, LEDs and buttons! We also went over which components were directional, about power ground and data lines. You learned how to use different construction materials including binder clips to hold batteries, and snaps with conductive fabric. We have a take home kit for each of you that uses the same concepts of circuit building in this class and includes the materials you'll need to build a circuit with LEDs and one with a tilt sensor.

We're talking about electricity, but we're not using enough power today for you to get hurt. We're only using 3 volts. However, the power in the outlets in your house is nothing to play with, that power is 120 volts and is incredibly dangerous. So please don't stick any of your components in your outlets at home – only use the provided batteries so you don't get hurt.

Questions and Troubleshooting

Why can't we use copper tape with the Lilypad? Because we need the snap to make a strong enough connection to the microcontroller. The easiest way to use the snaps is with the conductive fabric because it is less rigid than the tape.

If a component is not working:

- Ensure the circuit path is correct
- Ensure the component is not the wrong direction, if directional
- Do a continuity test with a multimeter
- Press stickers / copper tape on harder / make sure fabric and snaps are connected

If a sensor is behaving strangely:

- Ensure the circuit path is correct
- Check that the software is going into the correct pin
- Check the data over the serial port, possibly toggle the serial values up and down in the code

Mentor Questions and Troubleshooting

Mentors please help check the girls' drawings for activities 1 & 2 and help with circuit layout if needed.

Why can't we use copper tape with the Lilypad arduino?

Because we need the snap to make a strong enough connection to the microcontroller. Technically it would work, until the tape lost a connection either by becoming misaligned or the adhesive wearing out. The easiest way to use the snaps is with the conductive fabric because it is less rigid than the tape.

What does LED stand for? Light Emitting Diode

Lilypad Arduino:

Battery switch on Arduino should be in off position unless testing.

Snaps should be secured before taping down the microcontroller

If a component is not working:

- Ensure the circuit path is correct
- Ensure there are no overlapping or touching pieces of tape or fabric
- Ensure the component is not the wrong direction, if directional
- Do a continuity test with a multimeter
- Press stickers / copper tape on harder / make sure fabric and snaps are connected
- Use new snaps if the snaps seem loose

If a sensor is behaving strangely:

- Ensure the circuit path is correct
- Check that the software is going into the correct pin
- Check the data over the serial port, possibly toggle the serial values up and down in the code
- Try swapping out a new sensor to see if the behavior changes

Pre-written code already loaded onto Lilypad Arduino:

*Page 11, 33, 47 - program simple beep noise

*Page 49- program phone song (i.e. twinkle twinkle)

*Page 61- program keypad chime noise

If girls need help with puzzles or circuit build, steer them in this direction:

P3, Activity #2, LED
Electronics: Lilypad Arduino, Conductive fabric, Snap LED
Instructions: Make the lamp or a star light up when you press a button

P5, Activity #1, LED
Electronics: Copper tape, 3 LEDs
Instructions: Make light shine from under the door when you press a button

P7, Activity #1, LED
Electronics: Copper tape, 3 LEDs
Instructions: Make the light bulb light up when you press the button on the end of the chain.

P9, Activity #2, LED
Electronics: Lilypad Arduino, Conductive Fabric, Snaps, 1 Snap LED
Instructions: Make the lightbulb light up when you press a button

P 11, Activity #2, Buzzer- beep
Electronics: Lilypad Arduino, LilyPad Buzzer, Conductive Fabric, Snaps, Buzzer
Instructions: Make the walkie talkie beep when you press the side button
Puzzle: Morse Code Puzzle

P 13, Activity #1, LED
Electronics: , Copper tape, 3 LEDs
Instructions: Make the flashlight shine when you press the flashlight button

P 15, Activity #1, LED
Electronics: , Copper tape, 3 LEDs
Instructions: Make light shine from the projector and onto the letter A when you press a button
Puzzle:

__ __ _ _ _ _- _ _ _ - _ _ _ _ _

20 9 20 1 14 19 20 23 15 23 9 14 19

ANSWER: TITANS TWO WINS

P 17, Activity #1, LED

Electronics:, Copper tape, 3 LEDs

Instructions: Make the scoreboard light up when you press a button on the outlet

P 19

Electronics: None

Puzzle: Using the two winning dates with first letter of corresponding country

ANSWER: Submarine

P 21, Activity #2, Vibe Board

Electronics: LilyPad Arduino, Vibe Board, Conductive Fabric, Snaps

Instructions: Make the globe shake when you press a button

Puzzle: In the third word another word

Clue: In Body

Possible answers: Brain, Beans, Bears, Rains, Manes, (ETC)

Correct answer: BRAIN

P 23, Activity #2, Vibe Board

Electronics: , LilyPad Arduino, Vibe Board, Conductive Fabric, Snaps

Instructions: Make the skeleton shake when you press a button

P 24, Activity #1, LED

Electronics: , Copper tape, 3 LEDs

Instructions: Make light shine from the flashlight when you press the flashlight button

Puzzle: WHAT MAKES MORE AS YOU TAKE THEM?

Clue: FOLLOW

Answer: FOOTSTEPS

P 27, Activity #1, LED

Electronics: , Copper tape, 3 LEDs

Instructions: Make light shine from the flashlight when you press the flashlight button

P 29

Electronics: None

Puzzle: Fill in missing pieces of article

Answer: Riddle, Darkest Corner, Turning off the light, a beeping sound, rumor, hospital, rumored vault, treasure

P 31, Activity #1, LED

Electronics: , Copper tape, 4 LEDs

Instructions: Make the eyes light up when you press a button

P 33, Activity #2, Buzzer-beep

Electronics: LilyPad Arduino, LilyPad Buzzer, Conductive Fabric, Snaps

Instructions: Make a beep noise when you press a button

P 35, Activity #1, LED

Electronics: , Copper tape, 3 LEDs

Instructions: Make the crack between the bricks light up when you press a button

Puzzle: Written on paper: We are a group of eight. We protect the King in every battle. We are considered weak, but if we move ahead, we never turn back. Who are we?

Clue: game

Answer: Chess

P 37, Activity #2, Vibe Board

Electronics: , LilyPad Arduino, Vibe Board, Conductive Fabric, Snaps

Instructions: Make the P shake when you press a button on the pawn

P 39, Activity #2, Vibe Board

Electronics: LilyPad Arduino, Vibe Board, Conductive Fabric, Snaps

Instructions: Make the P shake when you press a button

P 41

Electronics: None
Puzzle: Crossword/visual logic
Answer: LOOK ABOVE YOU

P 43, Activity #1, LED
Electronics: Copper tape, 3 LEDs
Instructions: Make the flashlight shine when you press the flashlight button
Puzzle: Rebus puzzle- Backwards 1 then a square then backwards 2.
Answer: Back to Square One

P 45, Activity #2, Vibe Board
Electronics: LilyPad Arduino, Vibe Board, Conductive Fabric, Snaps
Instructions: Make the phone shake when you press a button

P 47, Activity #2, Buzzer-beep
Electronics: LilyPad Arduino, Buzzer, Conductive Fabric, Snaps
Instructions: Make the phone been when you press the “ON” button

P 49, Activity #2, Buzzer-song/twinkle
Electronics: LilyPad Arduino, Buzzer, Conductive Fabric, Snaps
Instructions: Make phone sing when you press the “ON” button
Puzzle: Using the phone’s buttons, 3275 spells out DARK. The song indicates the word STAR.

P 53
Electronics: Copper tape, 3 LEDs
Instructions: Make the star light up when you press a button
Puzzle: Visual Puzzle where you have to make a star out of a bunch of triangles.

P 55, Activity #2, Vibe Board
Electronics: LilyPad Arduino, Vibe Board, Conductive Fabric, Snaps
Instructions: Make the P shake when you press a button

P 57, Activity #1, LED

Electronics:Copper tape, 1 LED

Puzzle: Visual puzzle.

ANSWER: I am surrounded by enemies

Instructions: Make a bulb on the chandelier light up when you press a button

P 59

Electronics: None

Puzzle:The ages of a mother and daughter add up to 66. The mother's age is the daughter's age reversed. How old are they? Clue: Over the hill, under a quarter.

ANSWER: 51 and 15

P 61, Activity #2, Buzzer-chime

Electronics: LilyPad Arduino, Buzzer, Conductive Fabric, Snaps

Instructions: Make the keypad chime when you press a button on the number "5"

P 63, Activity #1, LED

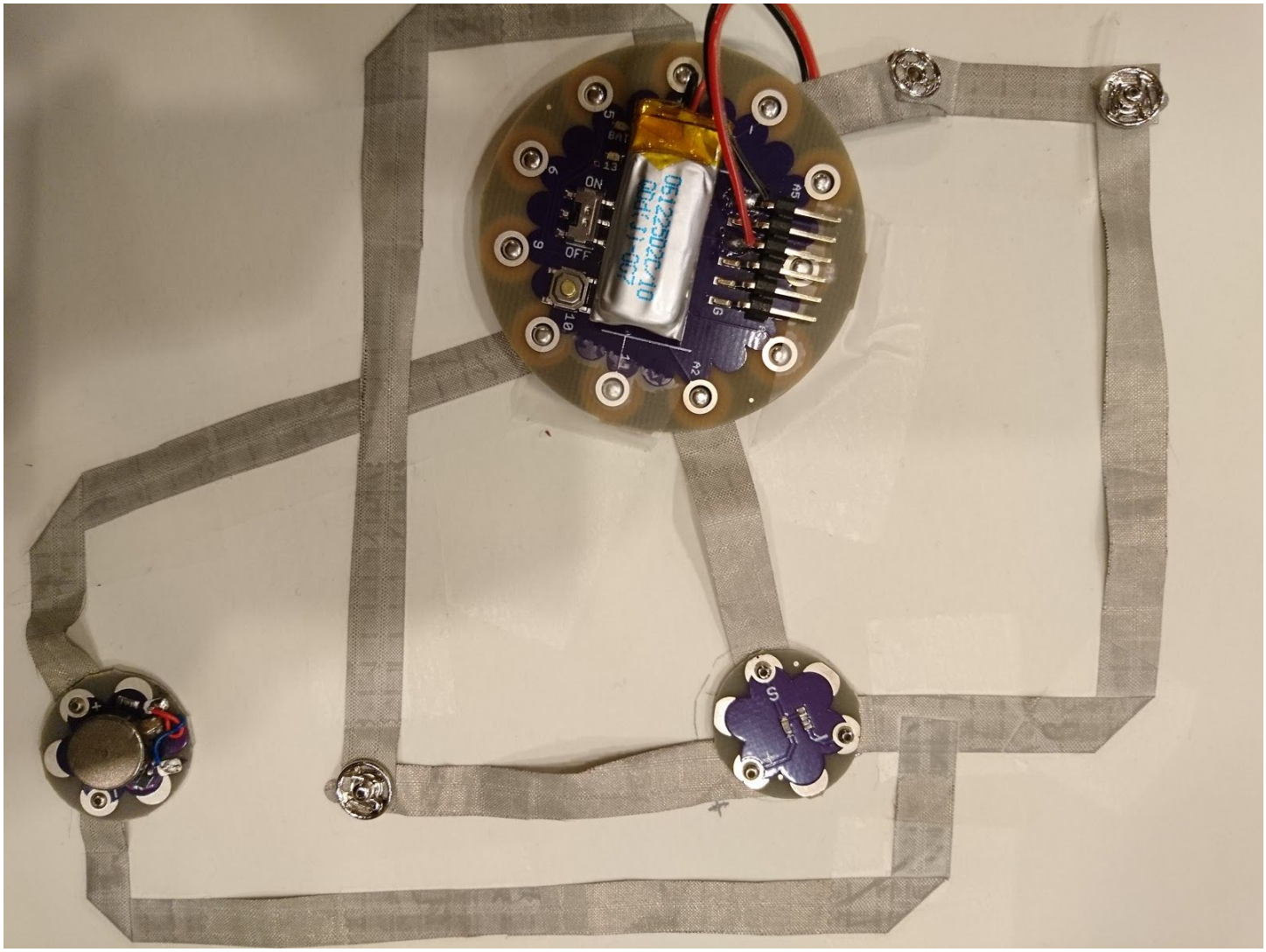
Electronics: Copper tape, 3 LEDs

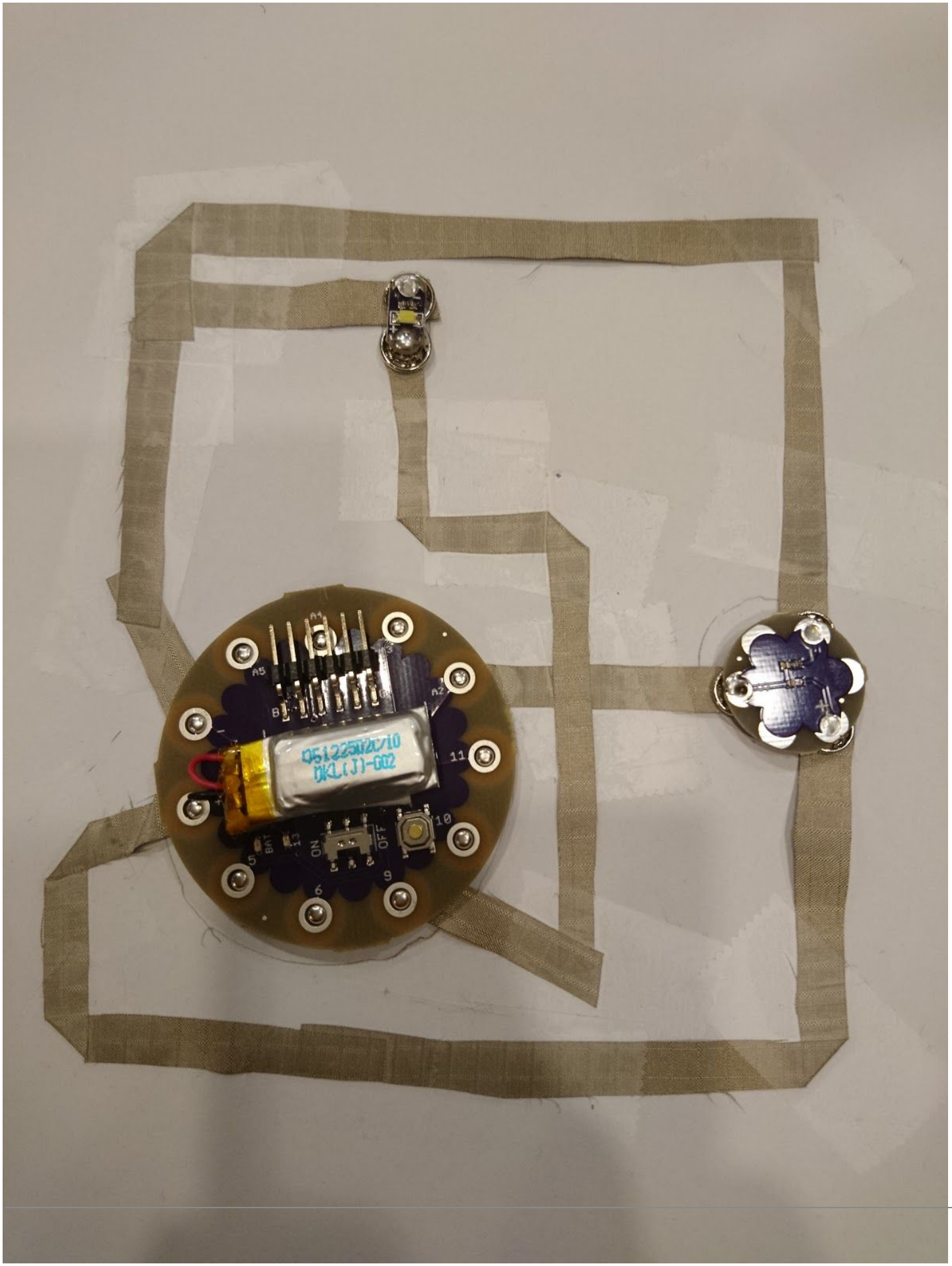
Instructions: Make the silver coins light up when you press a button

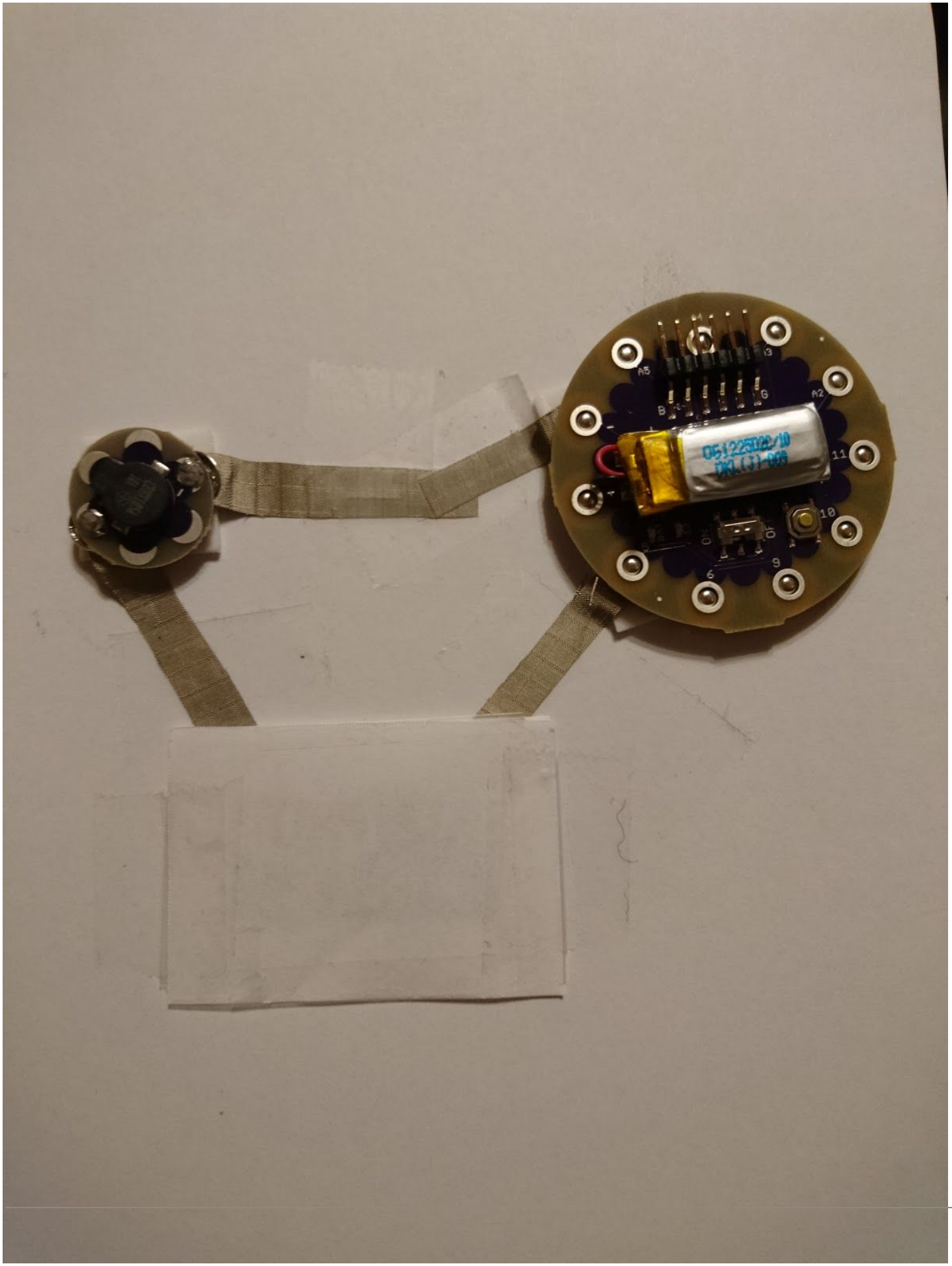
P 67, Activity #1, LED

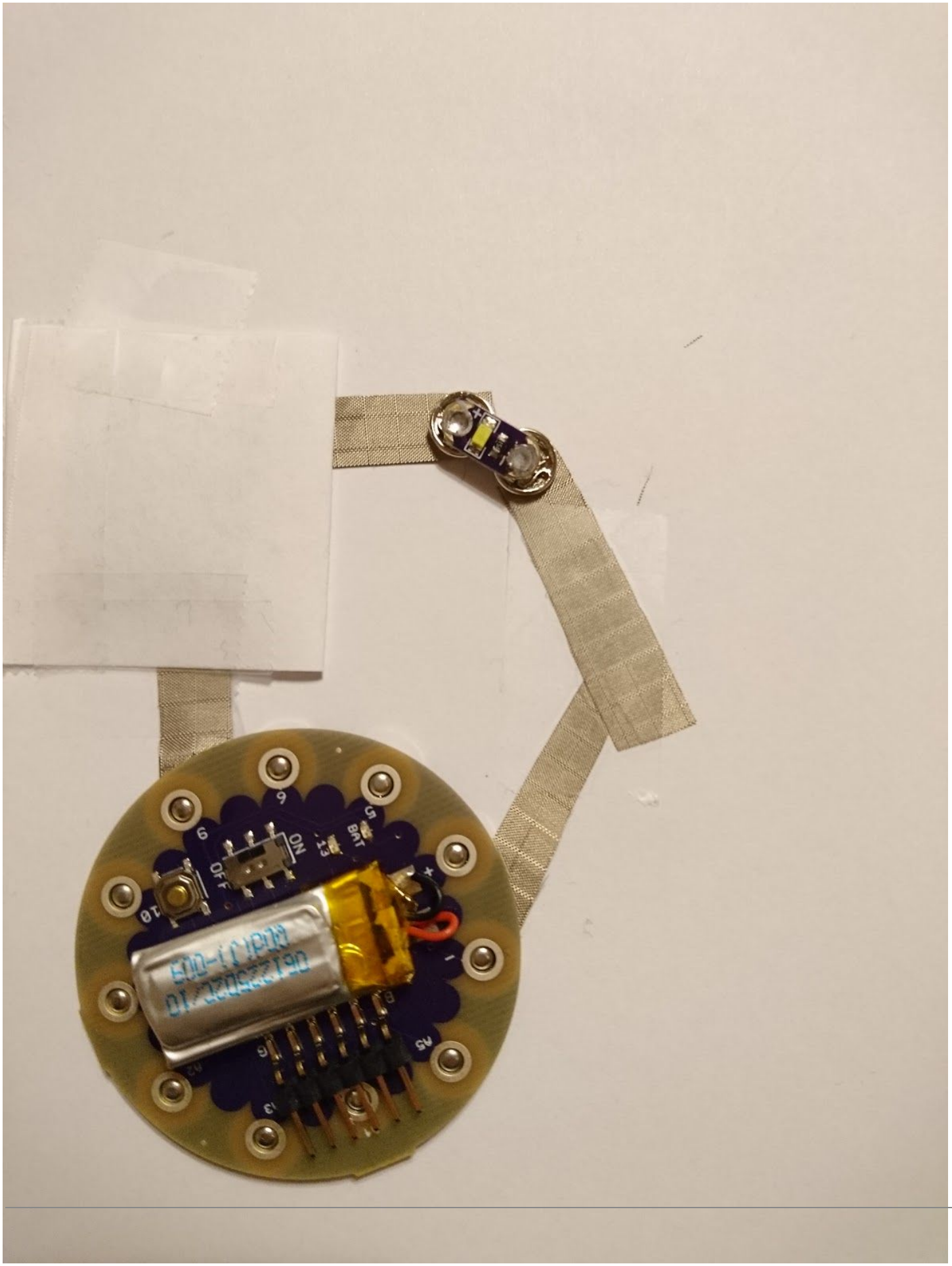
Electronics: Copper tape, 2 LEDs

Instructions: Make the lightbulbs light up when you press a button


ON
OFF


A5
A2
11
10
9
6
5
BAT
ON
OFF


A5
A3
A2
11
10
9


ON
OFF
BAT

HOW TO BIND THE BOOK

1. Plug in the soldering iron
2. Cut the wires per page (versus all at once); most copper tape pages will take approximately 4” of wire; the activity #2 pages will vary in wire length, depending on where the arduino is placed on the page.
3. Cut wires per page and strip them ¼” on one end and ½” on the other end.
4. It will make your life easier if all your ground (negative) wires are one color, and your positive wires are another color.

Our team Tasks

Cut wires per page and strip them ¼” on one end and ½” on the other end.