

# HIMALAYAN MAKERS GUILD

## ACTIVITY 12 – SOLDERING A NIGHT-LIGHT CIRCUIT

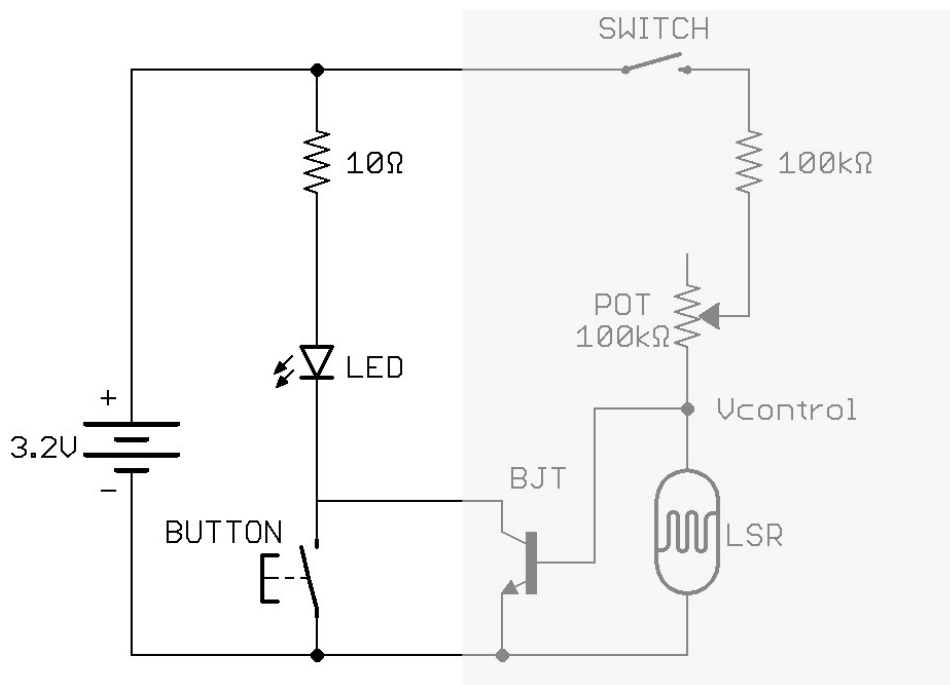
### LEARNING OUTCOMES

Students will,

1. Solder an LED light circuit onto a perforated circuit board.
2. Test an LED light circuit.

This lesson plan assumes free access to soldering equipment (part 2), a black-and-white printer, and a classroom with a whiteboard, blackboard, or chart-paper. For details on soldering equipment, see [Setting Up 10 Budget Soldering Stations](#).

Activity 12 will take at least **2 hours** to complete, and is split into two 1 hour parts. In that time, the students are expected to complete one half of the night-light circuit: the battery and LED light part, so the circuit will function as a flash-light (shown on the left below). It is unlikely that the students will complete the control-circuit half of the night-light (shown on the right below). Students who move quickly through the activity can continue on to add the control circuit. The focus of the first part of the activity is to layout the wires on the board; the second part focuses on soldering the wires and parts in place, then testing the circuit.



There are many different methods for soldering parts and wires to perforated circuit boards (perforated board, prototype board). The method presented here was chosen because it requires few solder-joints to be made for each wire, and the wires are positioned quite securely before soldering them to the parts making the joints easier for beginners. Using [strip board](#) would be an even simpler option, but is not explored in this activity.

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## OUTLINE

### Part 1 - Trace and Place Wires

1. 5m Review Night-Light Circuit
2. 5m Circuit Layout
3. 15m Wire Tracing and Placement - Explanation
4. 30m Wire Tracing and Placement - Hands On
5. 5m Reflection

### Part 2 - Solder in the Parts

1. 5m Review Night-Light Circuit
2. 5m Securing the Wires
3. 10m Inserting and Soldering the Parts Into the Board
4. 30m Soldering and Testing
5. 5m Reflection

## MATERIALS AND COSTS PER STUDENT

Item	Qty.	Cost per Student <sup>1</sup>	Supplier	Circuit Part <sup>2</sup>
Push Button	1	0.02	<a href="#">AliExpress</a>	LED Light Circuit and Battery
Resistors Assorted 2100pcs	2	0.01	<a href="#">AliExpress</a>	LED Light Circuit and Battery
100m solid wire, 2x twisted	0.01	0.06	Bangemudha, Kathmandu	LED Light Circuit and Battery
LED 5mm white	1	0.04	Bangemudha, Kathmandu	LED Light Circuit and Battery
Battery Lithium CR2025	1	0.19	Bangemudha, Kathmandu	LED Light Circuit and Battery
CR2025 coin cell battery holder	1	0.26	Himalayan Solution	LED Light Circuit and Battery
9x15cm circuit board (perforated board)	0.5	0.64	Himalayan Solution	LED Light Circuit and Battery
Solder wire, flux core, lead-tin, 0.8mm	0.01	0.04	Himalayan Solution	LED Light Circuit and Battery
LSR Light Sensitive Resistor	1	0.19	Bangemudha, Kathmandu	Control Circuit
Potentiometer, 100k	1	0.13	Himalayan Solution	Control Circuit
BJT NPN PN2222	1	0.06	Himalayan Solution	Control Circuit
Switch, slide, dpdt, 2.5mm pitch	1	0.14	<a href="#">AliExpress</a>	Control Circuit
<b>Total Cost per Student</b>		<b>\$1.79 CAD</b>		

1. Currency is CAD, 2017-06-10. Assuming one set of parts per student. ↵
2. Only the LED Light Circuit and Battery parts are absolutely necessary for the activity ↵

Many of the parts were purchased here in Kathmandu (Bangemudha neighborhood, Himalayan Solution shop). Parts bought in Bangemudha will likely cost twice as much if purchased online.

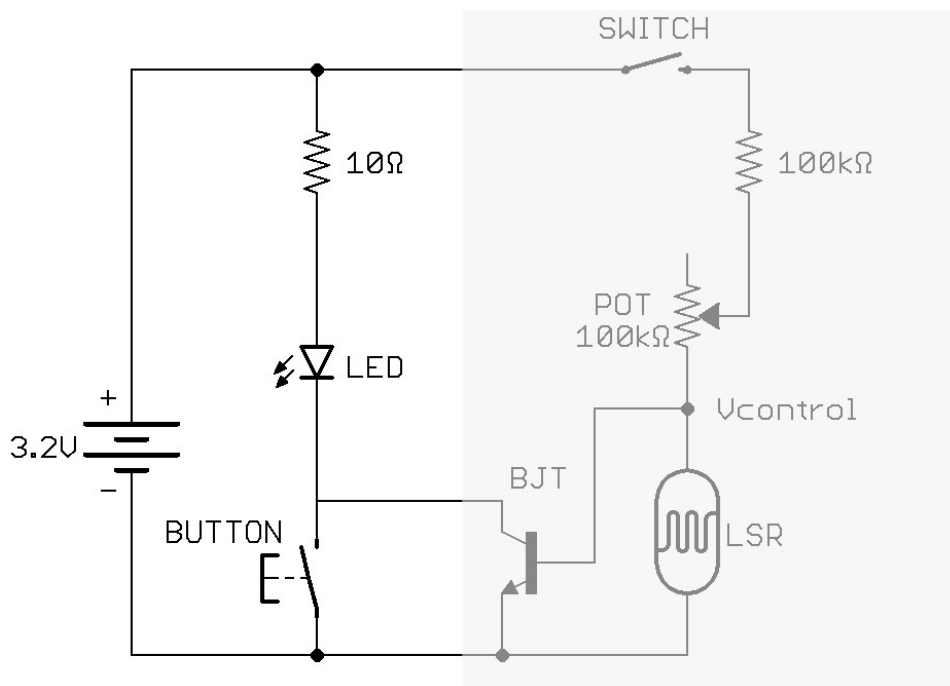
## LESSON PART 1 - TRACE AND PLACE WIRES

Before class: split perforated boards to the correct size (~9cm x 14cm), and smooth the rough edges; print student handouts.

**Bold text** indicates direction or notes for the instructor.

### 1. REVIEW NIGHT-LIGHT CIRCUIT

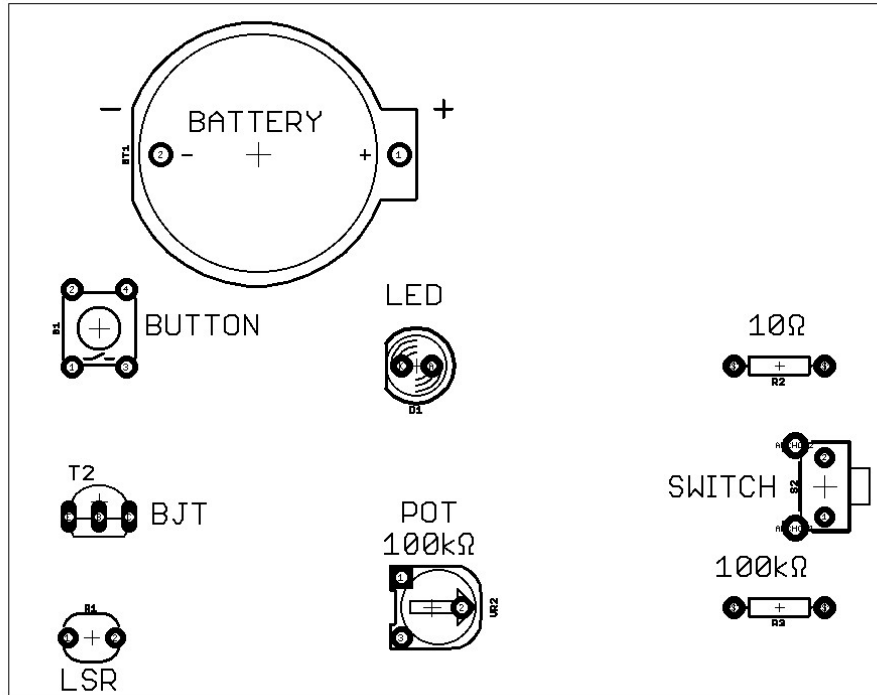
- **Review the circuit: 2 parts, the LED Circuit (left) and the Control Circuit (right).** See [Activity 9](#), [10](#), and [11](#) for details.



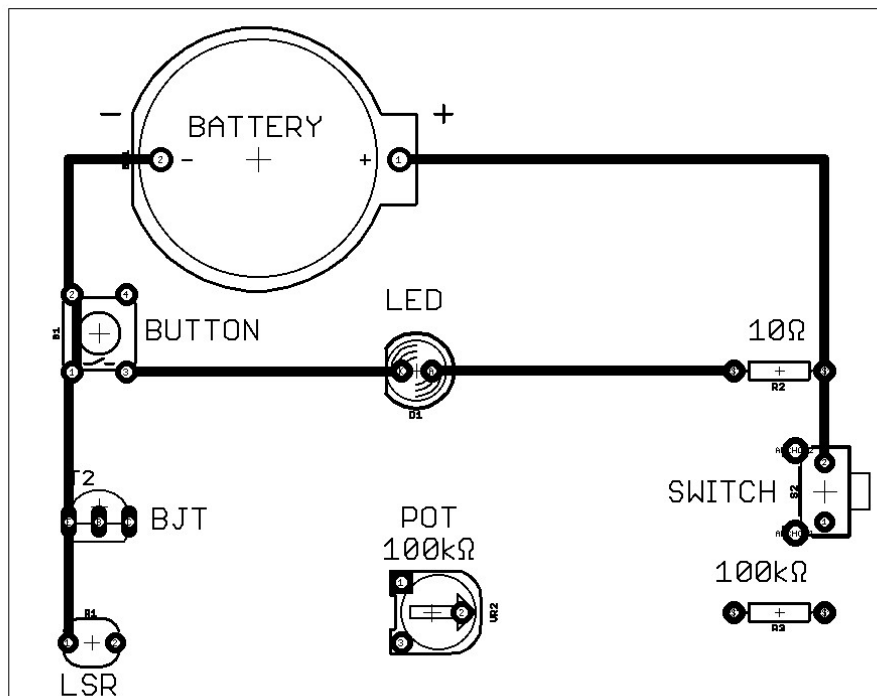
- **Introduce switches: button to turn on (flashlight), switch for night-light function.**
- What would we need to change if the night-light turns on before the room is really dark? A: bigger resistor in voltage divider.
- And what about if it doesn't turn on soon enough as it becomes dark? A: smaller resistor in voltage divider.
- Once we solder the circuit, this resistance is set. So, we can use a potentiometer (variable resistor) in the voltage divider to easily adjust of the sensitivity of the night-light.
- Today we're going to focus on putting the wires for the LED part of the circuit into our circuit board, then next activity we will solder the parts into the circuit and test the light.
- Why put a circuit onto a circuit board? It can be smaller and more reliable than building the circuit on a breadboard.
- The top of the circuit board is where the parts will sit, and the bottom (where there are metal plates) is where we will solder connections between the wires and parts.

### 2. CIRCUIT LAYOUT

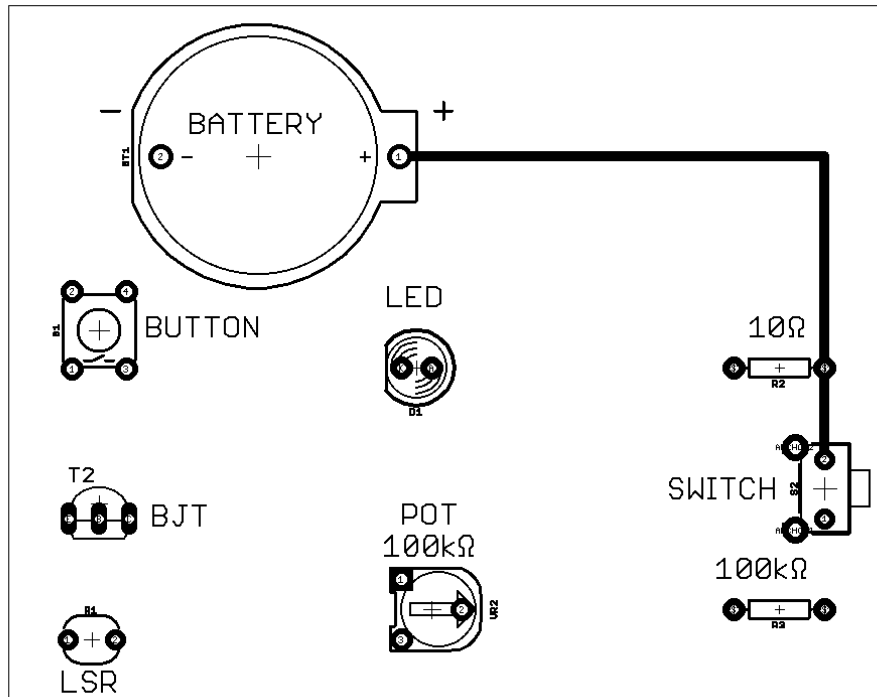
- Let's turn the circuit on its side, and draw out the parts as if they were on the circuit board, looking at the board from the top:



- We'll use four wires to connect the LED part of the circuit: battery+, battery-, the wire between the 10 ohm resistor and LED, and the wire between the LED and button.
- Battery- extends past the button to connect to the BJT and LSR
- Battery+ extends past the 10 ohm resistor to the switch.

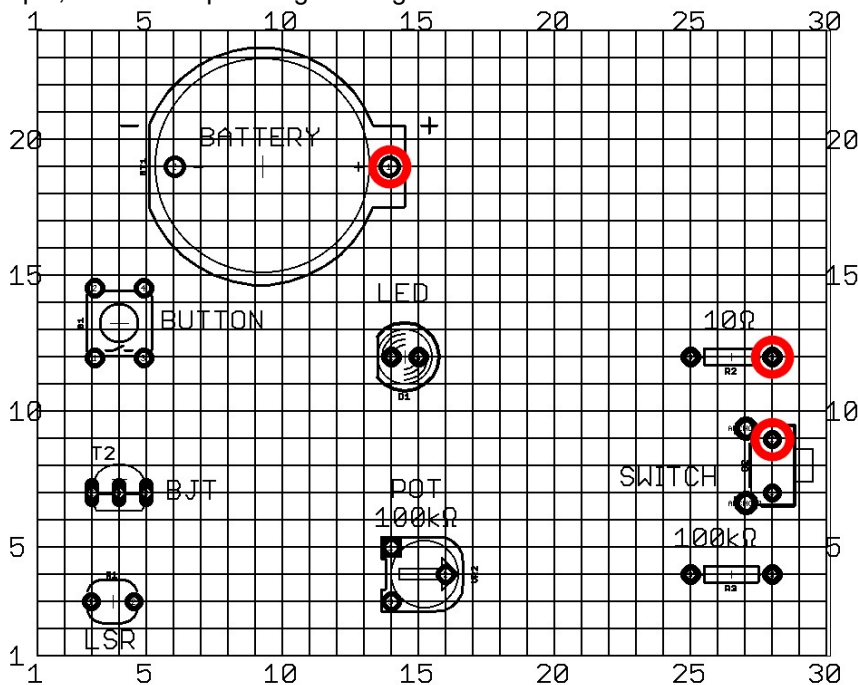


- Let's start by placing the battery+ wire into the board

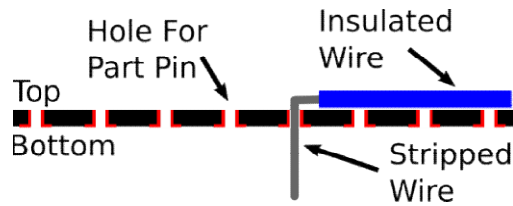


### 3. WIRE TRACING AND PLACEMENT - EXPLANATION

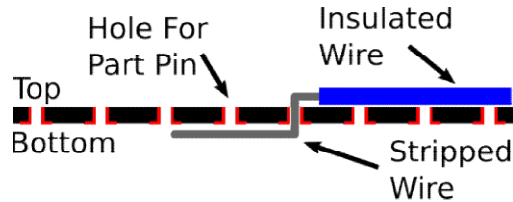
- This part can be a live demonstration, a detailed description using diagrams on the board, or a pre-recorded video
- On the top of the board, we use a marker to circle the holes where the battery+ pin, 10 ohm resistor pin, and switch pin will go through the board.



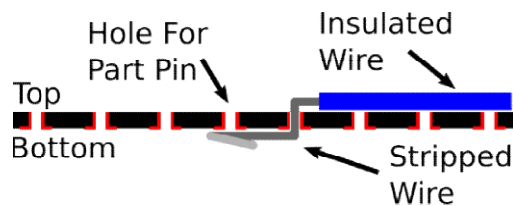
- From the top of the board, put a wire through the hole next to the hole for the battery pin.



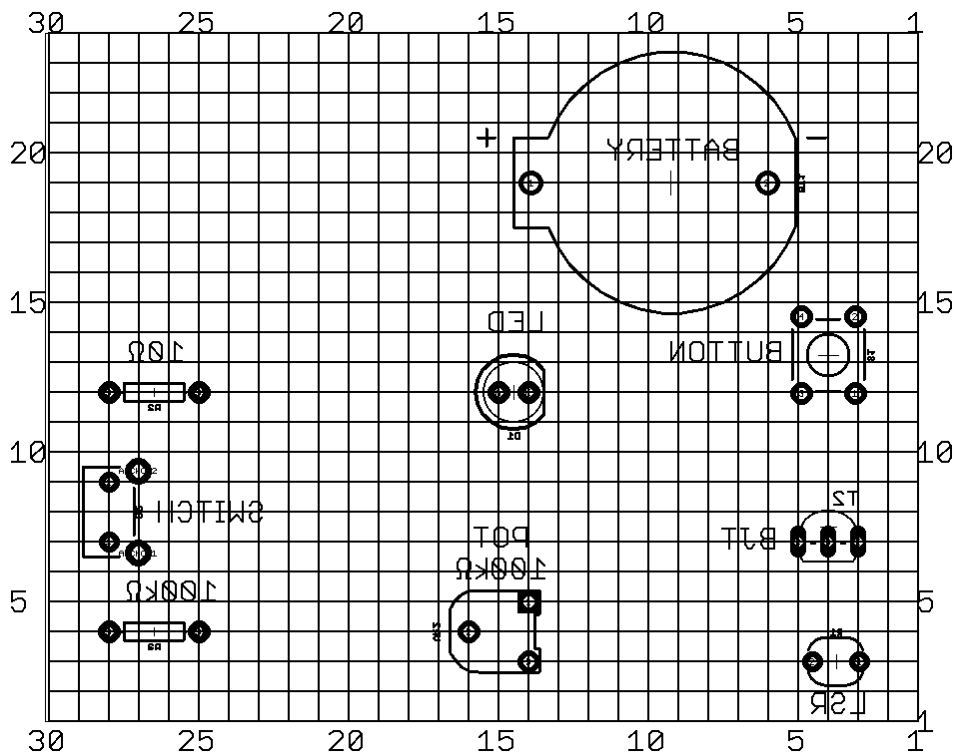
- Bend the wire towards the whole for the battery pin.



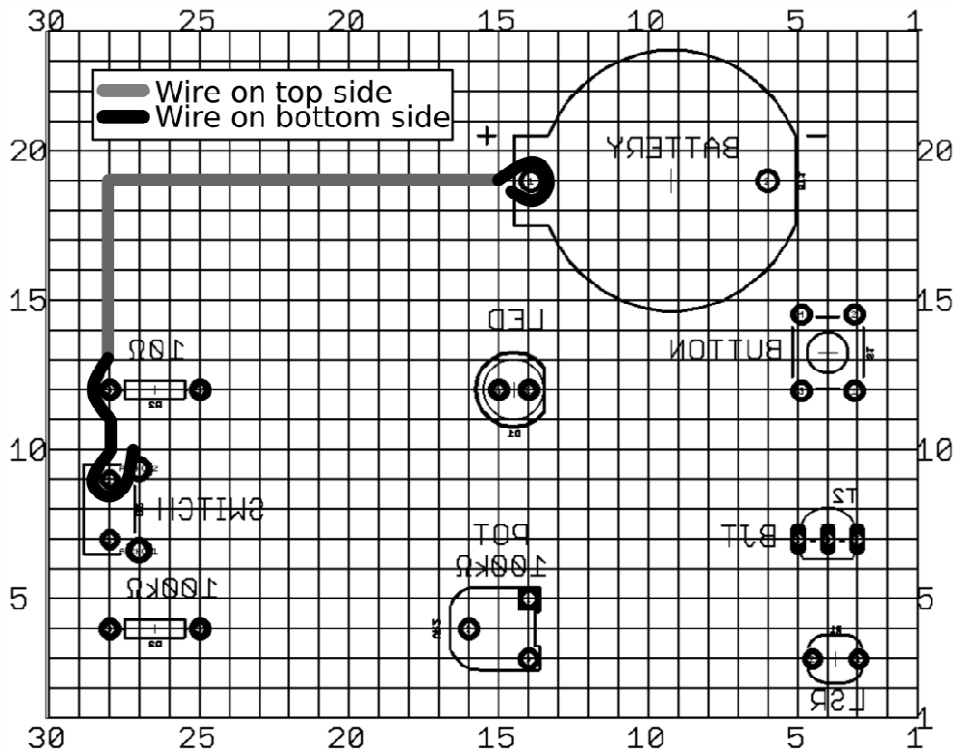
- Wrap the wire around the hole (put a pen-tip or small screwdriver tip into the hole to help wrap the wire). Trim off any extra wire with flush-cutters.



- Looking at the board from the bottom where the metal plates are, the parts will appear like this:

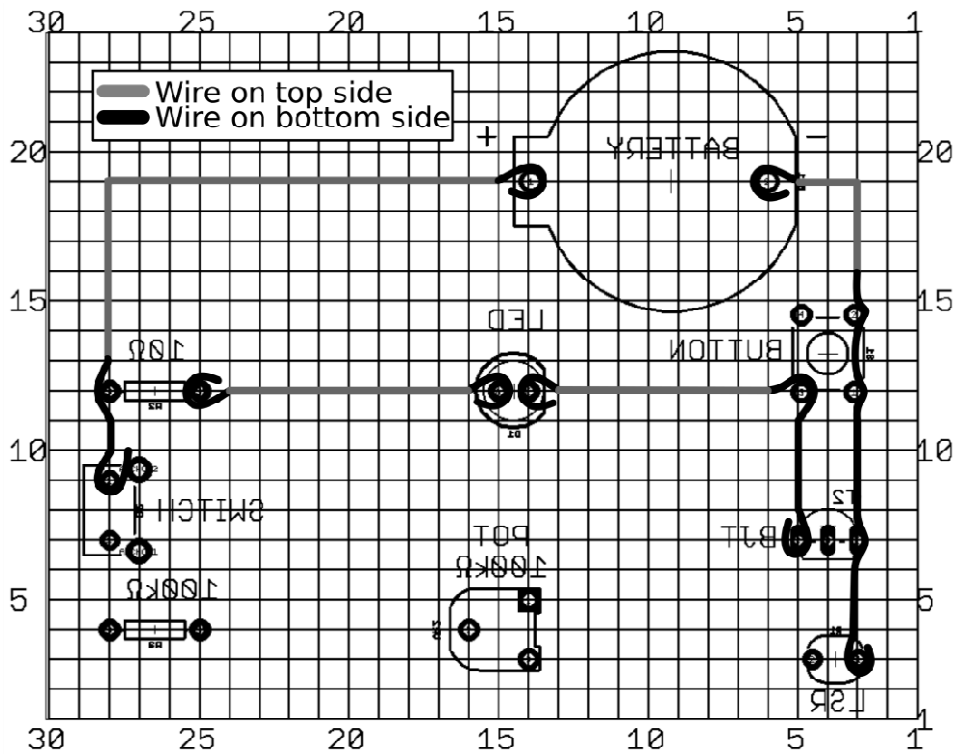


- After bending around the battery+ pin on one side, wrap it around the resistor pin and continue along the bottom of the board to the hole for the switch. This is what the wire will look like, viewing the board from the bottom:



**4. WIRE TRACING AND PLACEMENT - HANDS ON**

- Start the battery+ wire.
- Have an instructor check the first wire placement, then continue with the other 3 wires.
- **Distribute Part 1 (page 1 and 2) of the Student Handout, circuit boards, markers, wire, and wire strippers/cutters. Have the students write their name on their circuit board.**
- **Complete placement:**

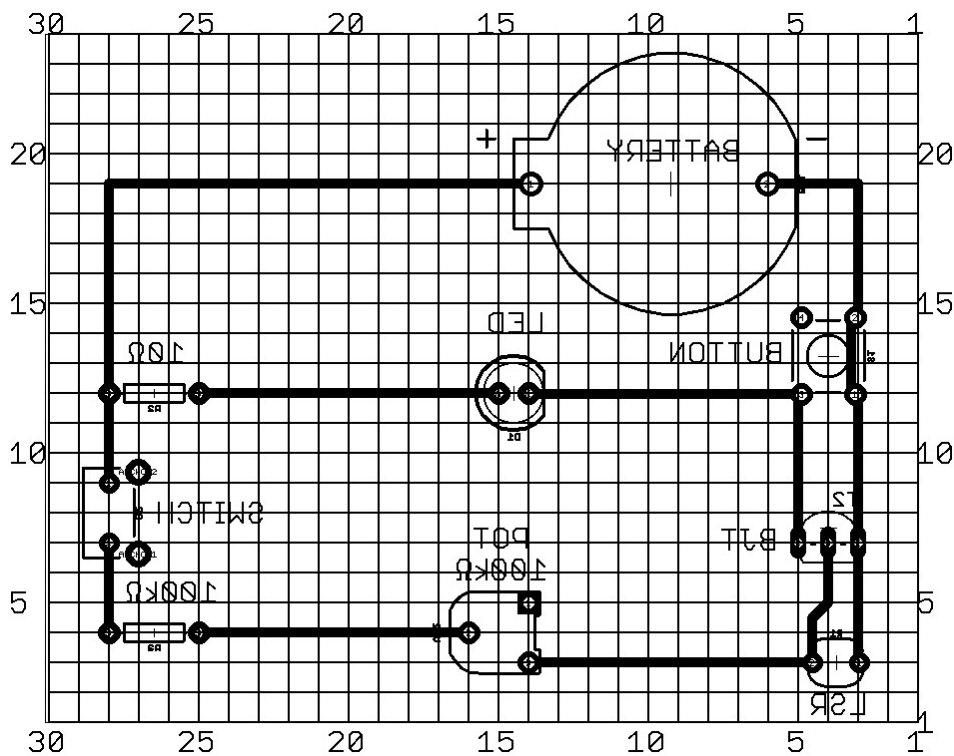


## 5. REFLECTION

- **have the students share and compare their wire placements**
- Did you run into any challenges, or find some useful tricks?
- In the next activity, we'll secure the wires with solder, solder in the parts, and test out the circuit!

## CHALLENGE AND EXPLORE - PART 1

- For students who finish placing all four wires, they can continue with placing the wires for the control part of the circuit. The completed circuit may look like this:

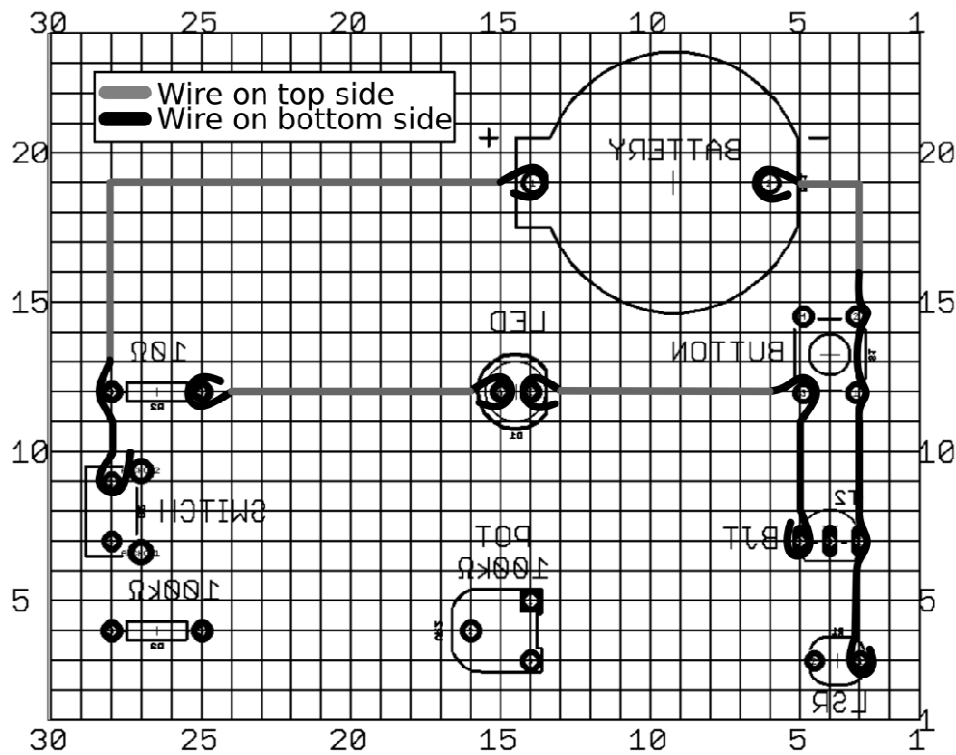


## LESSON PART 2 - SOLDER IN THE PARTS

### REVIEW NIGHT-LIGHT CIRCUIT

- Last activity, we focused on placing the wires onto the board for the Battery and LED Circuit of the Night Light.
- **Draw out the parts and wires, viewed from the bottom**

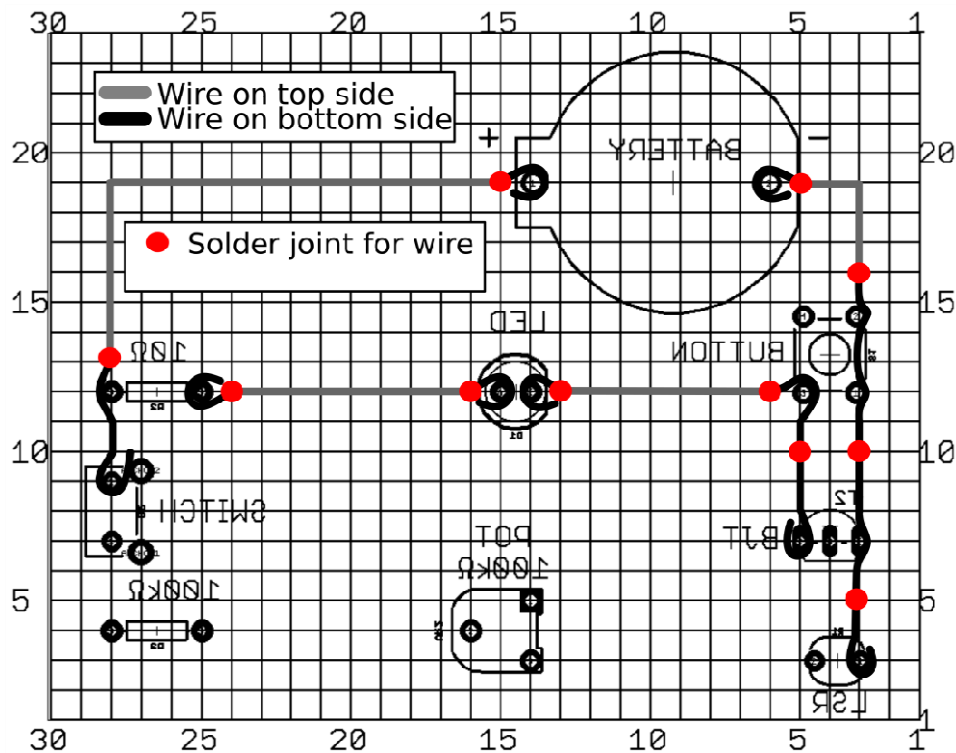




- We can now secure the wires with solder, solder the parts into the circuit board, and test the LED light
- Objectives of soldering the circuit onto the board: 1) make electrical connections, just like we do on a breadboard 2) securing the parts to the circuit board.

### SECURING THE WIRES

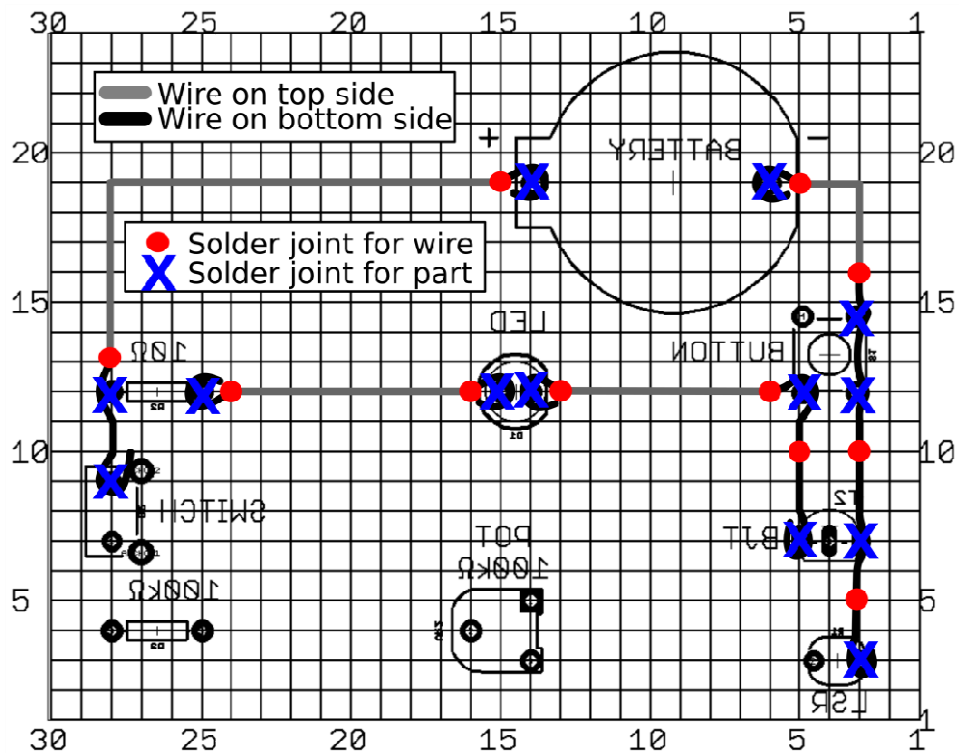
- Secure the wires to the board by soldering them where they come through the board, or if they run along the bottom of the board they can be soldered directly on top of a plate
- **mark where the wires are to be secured, making special note of the surface-solder joints at (3, 5), (3,10), and (5, 10).**



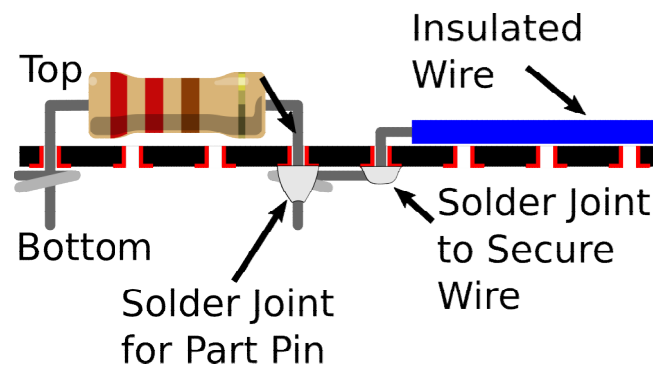
- Gently re-adjust the wires that wrap around the holes to make sure they're still lined up with the holes

### INSERTING AND SOLDERING THE PARTS INTO THE BOARD

- Place the parts into the board. Be careful to place the + side of the battery holder (flat edge), and the + side of the LED (long leg) in the right direction (pointing towards the 10 ohm resistor).
- It's a good idea to solder the parts with long legs in so that they stand ~1cm above the board. That way, if there's a mistake the part can then be easily be removed and resoldered. Bending the pins of the parts after putting them into the board can help hold the parts in place while soldering them.
- When soldering the parts, we want to connect three things: the metal plate on the board, the part pin, and the wire. For solder to flow over all three, we need to heat all three at the same time with the soldering iron tip before applying the solder wire!



- The joints will look similar to this:



- Review soldering safety: ventilation, safety glasses, keep the iron in the iron-stand, wash hands with soap after and don't touch your face.

### SOLDERING AND TESTING

- After soldering in the battery holder, 10 ohm resistor, LED, and button have been soldered in, it's time to test the circuit!
- First, we need to put the battery into the battery holder, with the + side facing up.
- Then, we need to know what to expect the circuit to do. We have a light, and we have a button. When the button is not pressed, the button should turn off. When it is pressed, the light should be on.
- If the circuit acts differently, try to see if you can find an error in the circuit. Ask your peers for help if you can't figure it out, or the instructor if you're unable to find a problem.
- **Distribute Part 2 (page 3 and 4) of the Student Handout, and the students' circuit boards from Part 1**

### REFLECTION

- Did the circuit work as expected? Can someone demonstrate their completed circuit?
- What were some challenges you faced, and how did you work through them?
- If you're interested in adding the control circuit, ask about a time when you could come to continue working on your circuit!

**CHALLENGE AND EXPLORE - PART 2**

- If students complete Part 2, they can continue with adding the Control Circuit to the board. They can start by placing the wires into the board as in Part 1, then secure them with solder, and finally solder in the parts in. The completed circuit may look like this:

