

Lesson #1: Introduction to Basic Circuitry

A Teachers Guide

Outlook: The point of this exercise is to introduce circuits using very intuitive recently developed educational tools. You can lead into this from any concurrent lesson you already have: i.e, electricity, energy, atoms, properties of elements on the periodic table, etc. The Little Bits electronic kits provide an excellent hands-on approach for beginning students to understand how circuits work by inserting various switches and powering an object from the power source. The lesson culminates in a Sensor Circuit activity conducted with the ManyLabs software (see below).

Purpose: *To learn how circuits work, their application, and how to build one.*

Student Learning Outcomes: At the end of these lessons, students will:

1. Be able to explain how electricity is transmitted from source to application.
2. Understand and be able to build a simple circuit.
3. Learn how to apply these concepts to work with sensors to collect data in experiments.

Topics Covered: History of electricity, electrical energy, voltage, current, resistance, circuits

CST:

Grade 7 7c-e

Grade 9-12: Physics 5a

Time Needed: This will vary greatly, depending on the details you cover, whether it's middle school or high school level understanding, and class schedules.

For middle school: approximately 2 weeks (three 45-minute classes + one 60-minute lab per week)

For high school: approximately 1 week (block schedule + homework)

Materials:

Little Bits Starter kits and parts

Computer

ManyLabs software, worksheets, Manylabs arduino uno set up with knob, button, light sensor, LED, tilt sensor, and screw terminal (optional)

Procedures:

Start off with defining a circuit by either asking students to come up with a definition (i.e., warm up question) or researching in text book/internet.

Lesson 1a: Using Little Bits to Explore Circuits

Allow students to explore manipulating a circuit with the Little Bits parts and have them make the basic power-switch-LED circuit, and progressively add on more input and output variables to create a more complex circuit.

<https://community.littlebits.cc/lessons/101-lesson-learning-input-and-output-the-littlebits-way>

The above site allows for about 1 hour of exploration for different circuits.

Example: “manipulating the bargraph bit”, by joining the power bit, button bit and bargraph bit together. What happens when you press the button? What bit(s) would you need to add/change and where would you put it/them in order to change the number of bars lit up at any given time?

Results:

1. Circuit 1: Power + Button + Bargraph
 - a. What happens when you press the button?

Bargraph fully lights up all at once.

- b. What bit(s) would you need to add/replace and where would you put it/them in order to change the number of bars lit up at any given time?

Either by inserting dimmer in place of, or after the button, the pressure sensor in place of, or after the button.

2. Circuit 2: Power + Button + LED

- a. What happens when you press the button?

The LED lights up.

- b. If you wanted to turn the LED on or off, what part(s) would you need to add/replace?

Depending on interpretation, the button turns it on and when you don't press the button, it is off. However, to turn the LED on and off, you can use the pulse bit. Easier yet, use the pressure sensor bit and it'll turn the LED on or off.

- c. How would you light up a Blue LED in this circuit? Which part(s) would you need to add/replace?

Since the LED bit is green, you'd have to replace the LED with the RGB LED bit.

3. Circuit 3: Power + Button + RGB LED

- a. What happens when you press the button?

The LED lights up, and depending on what the settings are on the small screws, you'll see a different color.

- b. What would you have to add/replace to make a flashing light?

Adding the pulse bit after the button or in place of the button works

- c. What would you have to add/replace light up a Yellow LED?

Either replacing RBG LED with yellow LED, adjusting the screws on the blue dial on the RGB LED to get it as close to yellow as possible, or place a blue filter over the LED so it absorbs the blue light.

4. Circuit 4: Power + Button + Vibration Motor

- a. What happens when you press the button?

The motor vibrates at a specific rate.

- b. What would you add/replace to create less vibration?

Adding a dimmer switch will lessen the vibration, or even the pressure sensor would do so.

c. How many different combinations of circuits can you create to lessen vibration? Give one example.

With the starter kit only, there are two: 1) adding the dimmer switch after button or in place of button, and 2) adding pressure sensor after button or in place of button.

e.g.: power + pressure sensor + vibration motor

5. Circuit 5: Power + Dimmer + Bargraph

a. What happens when you connect the circuit?

Depending on the setting of the dimmer switch, the bargraph lights up a certain number of bars.

b. Which way would you turn the dimmer to light up more bars? Fewer bars?

Clockwise will increase the number of bars, counterclockwise will decrease the number of bars

c. What part would you add/replace to create a flashing LED every second?

Adding a pulse bit after dimmer or in place of dimmer would do this.

6. Circuit 6: Power + Dimmer + LED

a. What happens when you complete the circuit?

Again, depending on the setting of the dimmer switch, the LED would light up a certain brightness.

b. What do you have to do for the LED to dim?

Turn the dimmer counterclockwise.

c. What part would you add/replace to turn the LED off/on and where would you put it in the circuit?

Adding a button from the starter's kit, or the pressure sensor either after the dimmer or in place of the dimmer, but definitely before the LED.

7. Circuit 7: Power + Pressure + Bargraph

- a. What happens when you press the pressure sensor?

Depending on how hard you press, the bargraph will light up a certain number of bars.

- b. If you want to light a maximum of 3 lights, what would you need to add?

You could put the dimmer switch before the pressure sensor, set it so to a maximum of 3 bars so that when you pressed hardest on the pressure sensor, 3 bars would light up.

- c. How would you get the bargraph to flash every second?

Add the pulse bit and adjust it to flash every second.

8. Circuit 8: Power + Pulse + Bargraph

- a. What do you see when you complete this circuit?

The bargraph blinks to whatever the pulse is set to.

- b. Is it possible to change the speed of flashing LEDs? How so?

By adjusting the speed screw on the pulse bit, you can increase by turning clockwise, and decrease by turning counterclockwise.

- c. How could you only light up 2 bars on the graph? What would you need to add?

Adding the dimmer switch before the pulse bit and set it so that the bargraph only lights up 2 bars.

- d. How can you vary the number of flashing LED bars lit up by using pressure?

Adding the pressure sensor does this.

9. Circuit 9: Power + Pulse + Bargraph + Button + LED

- a. What do you see when you complete this circuit?

When you press the button, the LED flashes at the same rate as the bargraph. Let go of the button, and only the bargraph blinks.

- b. Is it possible to dim the LED? How so?

Add a dimmer switch after button or in place of the button.

- c. How do you vary the number of bars that light up?

Insert the dimmer switch before the bargraph.

- d. How do you get the LED to flash?

Press the button and hold, without changing anything in the circuit.

10. Circuit 10: Power + Pulse + Dimmer + Bargraph + Vibration Motor

- a. What do you see when you complete this circuit?

Depending on the setting of the speed for the pulse bit, the bargraph will have a certain number of bars lit up, and the vibration motor will periodically vibrate.

- b. Is it possible to maintain 5 flashing bargraph lights while changing the vibration speed? How so?

Switch the position of the dimmer to after the bargraph.

- c. What would happen if you replace the Pulse sensor with a Pressure sensor?

Then you can vary the number of lights on the bargraph, and intensity of the vibration motor.

11. Circuit 11: Power + Dimmer + Vibration Motor + Button + Bargraph

- a. What do you see when you complete this circuit?

Depending on the setting of the dimmer, the vibration motor will operate at a certain frequency, and without pressing the button, nothing happens with the bargraph.

- b. What happens when you adjust the dimmer?

You can vary the speed of the vibration motor and the number of bars

2	Y						Y					
3			Y						Y			
4	Y			Y	Y							
5		Y		Y	Y							Y
6		Y	Y		Y				Y			Y
7		Y	Y	Y		Y		Y				Y

Conclusion:

1. What happened when you connected the Little Bits together and lit up the bargraph?

All the bars on the graph lit up instantaneously. (1 point)

2. What bit(s) will you need to add and where will you add it/them to change the output of the bargraph to light up only 2 bars rather than all 5?

You can add the “pressure sensor” bit after the button and the number of bars lit up would change based on the amount of pressure you apply to this new bit. Or you could add a dimmer switch, knob, or other potentiometer right after the button to vary the current enough to let the bars light up one after the other, slowly. (10 points)

3. On the ManyLabs exercise, what does connecting the blue dots represent?

The connections represent the actual pathway of the circuit (5 points)

4. What do the boxes with >30, <30, >50 and <50 mean?

These are maximum and minimum input values for each of the sensors they are attached to, meaning they will only operate up to or over the value (5 points)

5. What does it mean when you insert the “and”, “or”, or “not” button?

Each is a logic statement will include or exclude the sensors needed to operate the LED (5 points)

6. How difficult was the circuit at the very end? Explain the complexity.

Answers may vary but generally this sensor was more complex than the others

because of the order of connecting logic statements.

Resources:

The following sites are background information on basic electronics, to incorporate into the laboratory exercise on the computer.

<http://littlebits.cc>

<https://www.manylabs.org>

<http://www.adafruit.com/products/745>

http://www.youtube.com/results?search_query=basic+electronics&search_type=&aq=f

http://www.teachersdomain.org/resource/phy03.sci.phys.mfe.lp_electric/

<http://www.howstuffworks.com/electricity.htm>

<http://www.consumersenergy.com/uploadedfiles/kids/circuits%20and%20flow%20of%20electricity.pdf>

<http://teresacoppens.hubpages.com/hub/What-is-Electricity-Lesson-Plan-for-High-School-Students>

