Lesson Seven: Introduction to Breadboards
Center for Sensorimotor Neural Engineering
Lesson Plan Author: Phelana Pang

LESSON OVERVIEW

Activity Time: 50 minutes.

Lesson Plan Summary:
In this lesson, students will explore how breadboards work and create simple circuits.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- Breadboards are used to prototype circuits.

Essential Question:

- How can breadboards be used to create circuits?

Learning Objectives:
Students will know…

- Breadboards are made of rows of metal clips. Components can be inserted into certain positions in the breadboard to create a circuit.

Students will be able to…

- Use breadboards and create circuits.

Vocabulary:

- **Circuits**: circuit, battery/power, current, switch, open/closed, positive/negative terminals, resistor, LED, motor, diode.

Standards Alignment: This lesson addresses the following middle school Next Generation Science Standards (NGSS).

NGSS Cross-Cutting Concepts

- **Systems and System Models**
- **Cause and Effect**

NGSS Science & Engineering Practices

- **SEP:** Developing and Using Models

MATERIALS

Material	Description	Quantity
Student Handout 7.1: Introduction to Breadboards	Students label the parts of the breadboard and identify components	1 copy per student
Breadboards	Item #64, $5.00 from https://www.adafruit.com/product/64	1 per group/pair
AA battery packs	Item #12900, $1.50 from https://www.sparkfun.com/products/12900	1+ per student/pair
AA batteries		2+ per student/pair
LEDs	Item# 12062, $2.95 for 20 pack from https://www.sparkfun.com/products/12062	1+ per group/pair
330 ohm resistors	Item #11507, $0.95 for 20 pack from https://www.sparkfun.com/products/11507	1+ per group/pair
Push buttons	Item #9190, $0.50 from https://www.sparkfun.com/products/9190	1 per group/pair
Potentiometers	Item #9806, $0.95 from https://www.sparkfun.com/products/9806	1 per group/pair
Vibration motors	Item #8449, $4 from https://www.sparkfun.com/products/8449	1 per group/pair
Buzzers	$4.49 from https://www.amazon.com/Electric-Buzzer-DC-Physics-Circuits/dp/B0083LWHDQ	1 per group/pair

TEACHER PREPARATION

1. Teacher should go through *Student Handout 7.1* and create each circuit (can save the circuits as samples or take pictures as needed).

2. Preview the Introduction to Breadboard video by Science Buddies and see how much of it you want to show (entire video is 12:20 minutes, but you can show just up to 6:04).
    a. https://www.youtube.com/watch?v=6WReFkfrUIk

PROCEDURE

Engage: Circuit Review (5 minutes)

1. Review circuit concepts from lesson 6. Have students quickly recap the components they've used and how circuits need to be wired.

Explore and Explain: Introduction to Breadboards (35 minutes)

2. Introduce breadboards and how they are arranged.

3. Show the Introduction to Breadboard video by Science Buddies.
    a. https://www.youtube.com/watch?v=6WReFkfrUIk (up to 6:04).

4. Design the following circuits on a breadboard:
    a. Circuit 1: Battery, LED, resistor
    b. Circuit 2: circuit 1 + switch
    c. Circuit 3: circuit 2 with motor or multiple LEDs

Evaluate: Reflection (10 minutes)

5. Students can explain their understanding in their lab notebook using the reflection prompts at the bottom of the page of the handout.

STUDENT ASSESSMENT

Assessment Opportunities: Student knowledge, skills, and concepts for this lesson will be assessed in a number of ways.

- As students go through the exercises, check for understanding. Ask students to explain why components were placed in certain orientations.
- Check the responses to the reflection questions at the bottom of the handout.

Student Metacognition:

- Provide students opportunities to come up with questions, reflect on their initial ideas about what they know and understand, and write them down in their lab notebook. They can add new/changing ideas to their lab notebook.

Scoring Guide:

- *Teacher Resource 7.1* provides a scoring guide for *Student Handout 7.1*.

EXTENSION ACTIVITIES

Extension Activities:

- Students can use breadboards to create circuits in parallel and circuits in series with multiple LEDs, resistors, buttons, etc.
- Students can draw circuit diagrams for the circuits they design.

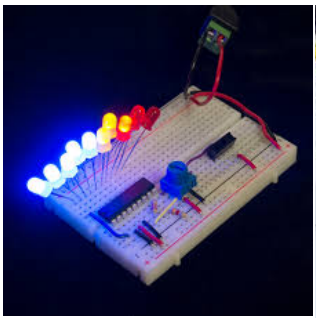
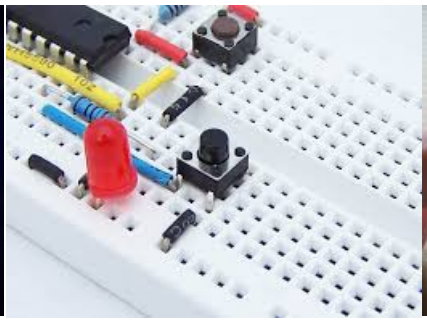
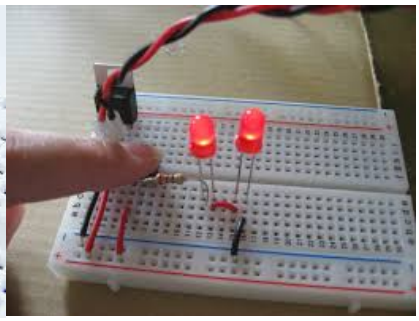
TEACHER BACKGROUND & RESOURCES

Background Information:

Breadboards allow for prototyping of circuits. It allows for “plug and play” of components without soldering. This is great for students to experiment with and gain understanding of the way circuits need to be designed in order for them to work.

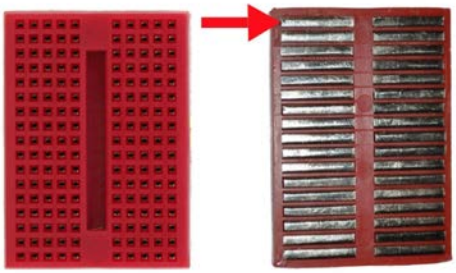
Student Handout 7.1: Introduction to Breadboards

Name:_____ Date:_____ Period:_____

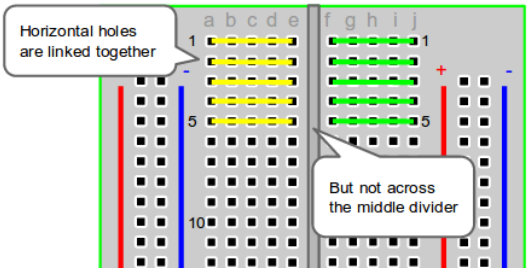




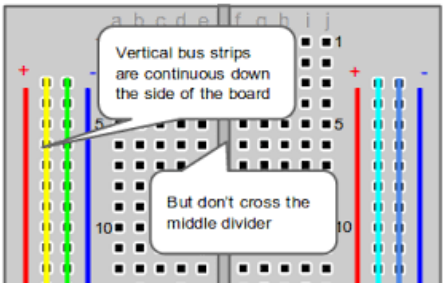
What is a breadboard?

A breadboard is a device that allows you to build basic to intricate circuits. Here is how it works…



If we open up a breadboard and look inside, this is what you will find (left). Metal rows, which means every row is connected. Each column is not!





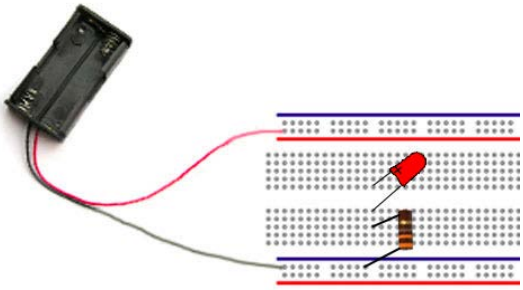
The two columns along the side are for powering the board. You will notice a (+) on one side and a (-) on the other. When connecting a battery pack, the red wire goes to (+) and the black wire goes to (-).

Connect any wire from the power columns to the board to power your circuit. You can watch this detailed how-to video for more explanation. The first six minutes are best! How to Use a Breadboard from Science Buddies TV: https://www.youtube.com/watch?v=6WReFkfrUIk.

You will often need a resistor to make sure your circuit works**.** A resistor is a component that reduces the voltage traveling through the circuit. This is important because different

pieces need different amounts of power even when they are in the same circuit! If you don't use a resistor, you can damage components, like burn out an LED, or your circuit simply just won't work! It can be hard to determine what resistor to use for your circuit. Each resistor reduces electricity by a certain amount. The best method is to do some research and find out what is best based on your project.

Do this: On the diagram to the right,



1. Label the battery pack, (+) column, LED, resistor, and (-) column.

2. Is the circuit open or closed? How do you know?

3. What might you add to the circuit to make it work? Draw it in and label.

TASK 1:

Let's try using it! You will need: two AA batteries, a battery holder, 1 LED, 330 ohm (Ω) resistor, and jumper wires

Step 1: Power your bread board by connecting the red wire to the **positive column** and the black wire to the **negative column**.

Step 2: Place your LED in the breadboard. Be sure to place the two leads into different **rows.**

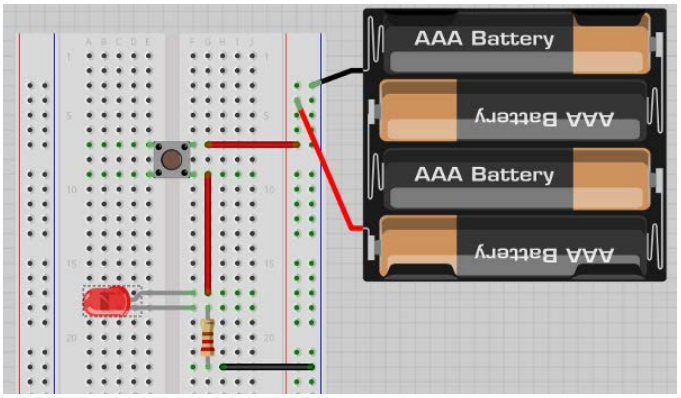
Step 3: Use a red wire to connect the **positive column** to the **positive lead** (the longer one!) of your LED.

Step 4: Connect one end of the resistor on the same row as the **negative lead** (the shorter one!) of your LED, and the other end in a different row (NOT the same row as the positive lead of the LED).

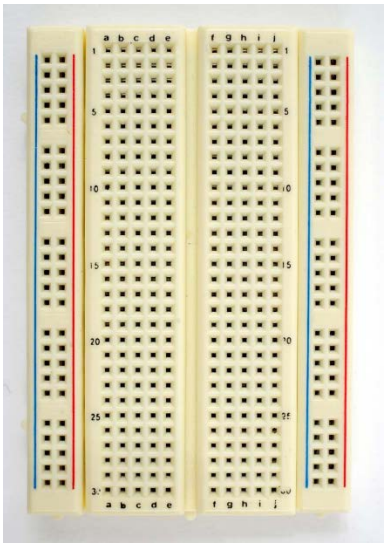
Step 5: Use a black wire to connect the resistor to the **negative column** of your bread board.

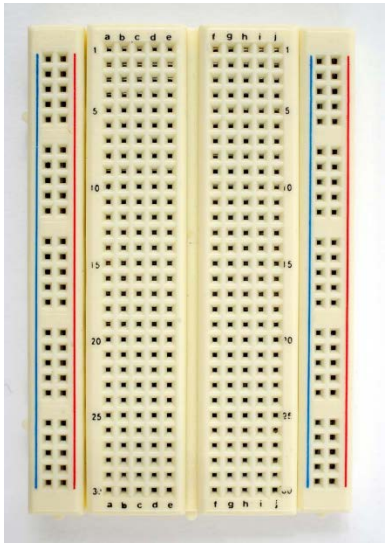
Congratulations! Your light should be on, you have successfully used a breadboard to complete a circuit!

TASK 2: Try building the circuit diagrammed below! Gather your supplies (LED, resistor, push button, battery pack - it's okay to use two batteries only), then build the circuit.



TASK 3: Instead of an LED, can you attach a motor to your circuit so that the button turns the motor on and off (a motor requires more current than an LED)? Or can you connect multiple LEDS to your breadboard (try in parallel and in series)? Draw your breadboard set-up(s) below and label.





TASK 4: Instead of a button, can you connect a potentiometer to your circuit? A potentiometer acts like a dimmer switch, changing the brightness of your light!

Here is a helpful guide: Dimmer Switch Step by Step Guide, available at: http://www.instructables.com/id/How-to-control-the-brightness-of-a-LED/

Reflection

1. How does a breadboard work? Explain its layout and how its construction makes it a helpful tool.

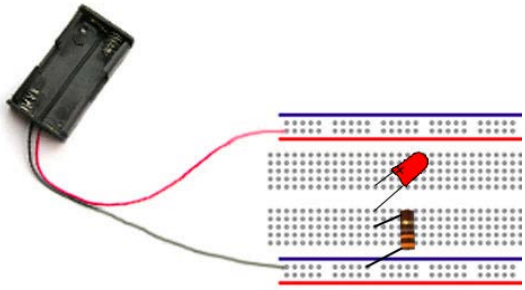
2. Explain the role of each of the following components:

Battery	
Wires	
Push Button	
LED	
Resistor	
Potentiometer	

Teacher Resource 7.1: Introduction to Breadboards Answer Key

Do this: On the diagram to the right,

1. label the battery pack, (+) column, LED, resistor, and (-) column.
2. Is the circuit open or closed? How do you know?



Open - no wire to connect LED to battery

3. What might you add to the circuit to make it work? Draw it in and label.

Insert one end of a wire anywhere along column of red wire from battery pack, and insert the other end of the wire in the same row as the positive end of the LED.

Reflection

1. How does a breadboard work? Explain its layout and how its construction makes it a helpful tool.

The breadboard is made of metal clips that are connected by rows. Components can be used to connect different rows. The columns on either side of the breadboard are not connected to the rows and can be used for battery and ground. This allows for testing circuits and different components without having to solder them in a permanent circuit.

2. Explain the role of each of the following components:

Battery	Source of voltage
Wires	Connects components
Push Button	Switch that closes circuit
LED	Light emitting diode - lights up in closed circuit, requires resistor
Resistor	Reduces current flowing through circuit
Potentiometer	Varies the amount of resistance flowing through a circuit