NAVSEA
SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS

#SeaworthySTEM

Hues in Harmony

An Exploration of COLOR

Grades 6-8

Student Activity Workbook

Name: _____

Date: _____

Seaworthy STEM™ in a Box Series

In collaboration with NAVAIR!

NAVSEA SCIENCE, TECHNOLOGY, ENGINEERING & MATHEMATICS

NAVAL STEM SCIENCE · TECHNOLOGY · ENGINEERING · MATHEMATICS

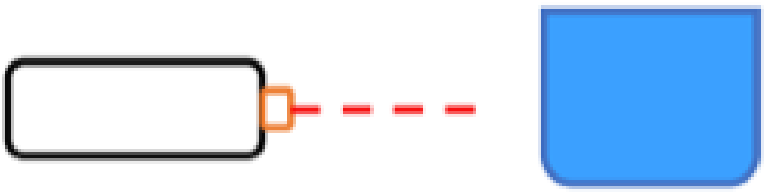
Office of Naval Research ONR Science & Technology

NAWC Aircraft Division NAVAL AIR WARFARE CENTER

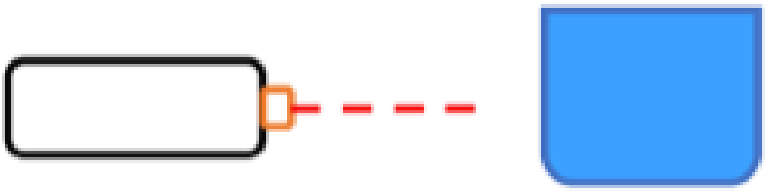
Optical Communications Research Sheet

Directions: Answer the questions below to expand your optical knowledge.

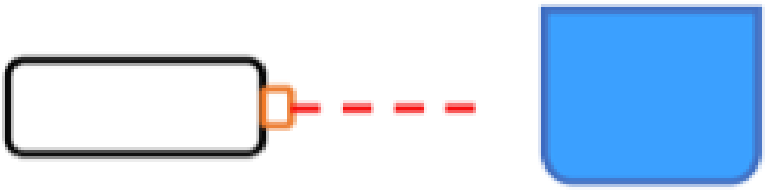
1 What happens to light during **Absorption**? Diagram and Explain below.



2 What happens to light during **Reflection**? Diagram and Explain below.



3 What happens to light during **Scattering**? Diagram and Explain below.



Using your research tools fill in the following:

4 Electromagnetic waves have a characteristic _____ and _____ .

5 Visible light is an electromagnetic wave with a wavelength between _____ - _____ nm.

6 Create a story for a younger student explaining what Optical Communication is. Use the information below as part of your story:

Optical communication is:

- One of the many technologies that make use of light.
- Used by fiber optic cables that serve as the information highways for the internet.
- Optical communication can also be conducted through air or water without a fiber optic cable.
- Doing this requires:
    - A transmitter such as a laser to send the light.
    - A receiver to collect and process the light to understand the information it is transmitting

Electronics Research Sheet

Directions: Read the following article and answer the questions below to expand your electrical knowledge.

Electronics and their POWER!

A voltage source, such as a battery, is used to push electrons through a material. This flow of electrons is referred to as an electrical current. Different materials allow or resist the flow of electrons. This property is referred to as the resistance of the material. Materials with little resistance are called conductors. An example is the copper wire found in a cable. Materials with high resistance are called insulators. An example is the rubber or plastic sheath around a wire. To better understand electricity, let us pretend we are talking about water. Imagine water moving through a pipe. Voltage is like water pressure. Current is the amount of water in the pipe. Resistance is anything making it harder for the water to flow, like a smaller pipe size or sand within the pipe.

The following units and symbols are used to describe electrical parameters:

- Voltage: V (measured in Volts or V)
- Current: I (measured in Amperes or amps or A)
- Resistance: R (measured in Ohms or Ω).

Breadboards provide a platform, making them a convenient way to build circuits and prototype projects on. They provide electrical connections between components without needing to solder or crimp components together. Voltage sources, such as batteries, have polarity so they have a positive and negative end. The negative is usually the reference to measure other voltages and is referred to as ground.

A circuit is formed when electricity flows out of the positive terminal through the load and back to the negative or ground terminal. A circuit is a closed loop of electrical flow. Connecting both ends of a voltage source without a load is called a short circuit. Don't do this! It is dangerous! Resistors are electronic components that have a specific nominal resistance. They come in different shapes and sizes. The colored stripes across the resistor tell you the nominal resistance value.

Resistors resist or limit the flow of electrical current.

- Photo = light, resistor = resistance

The resistance of the photoresistor changes based on the amount of light it receives.

- More light = less resistance.

Like photoresistors, potentiometers have a changing (variable) resistance. The resistance changes based on the position of the wiper (being the knob you turn). They can create a lot of resistance, very little resistance, or anything between. Transformers manipulate the voltage flowing through parts of a circuit. They are made of two coils of wire, which can increase or decrease a signal.

Questions:

1. What is an example of a voltage source?

2. What is electrical current?

3. What will different materials do to the flow of electrons and what is it called?

4. Compare conductors and insulators. Use examples.

5. Compare and contrast electricity and water.

6. What is a breadboard and what is it used for?

7. What is a circuit and how are they made?

8. What is a resistor and why is it important?

9. What is a photoresistor and why is it important?

10. What is a potentiometer and why is it important?

11. What is a transformer and why is it important?

Section One: Light Demonstrations

Part A: M&M's Inquiry Demonstration

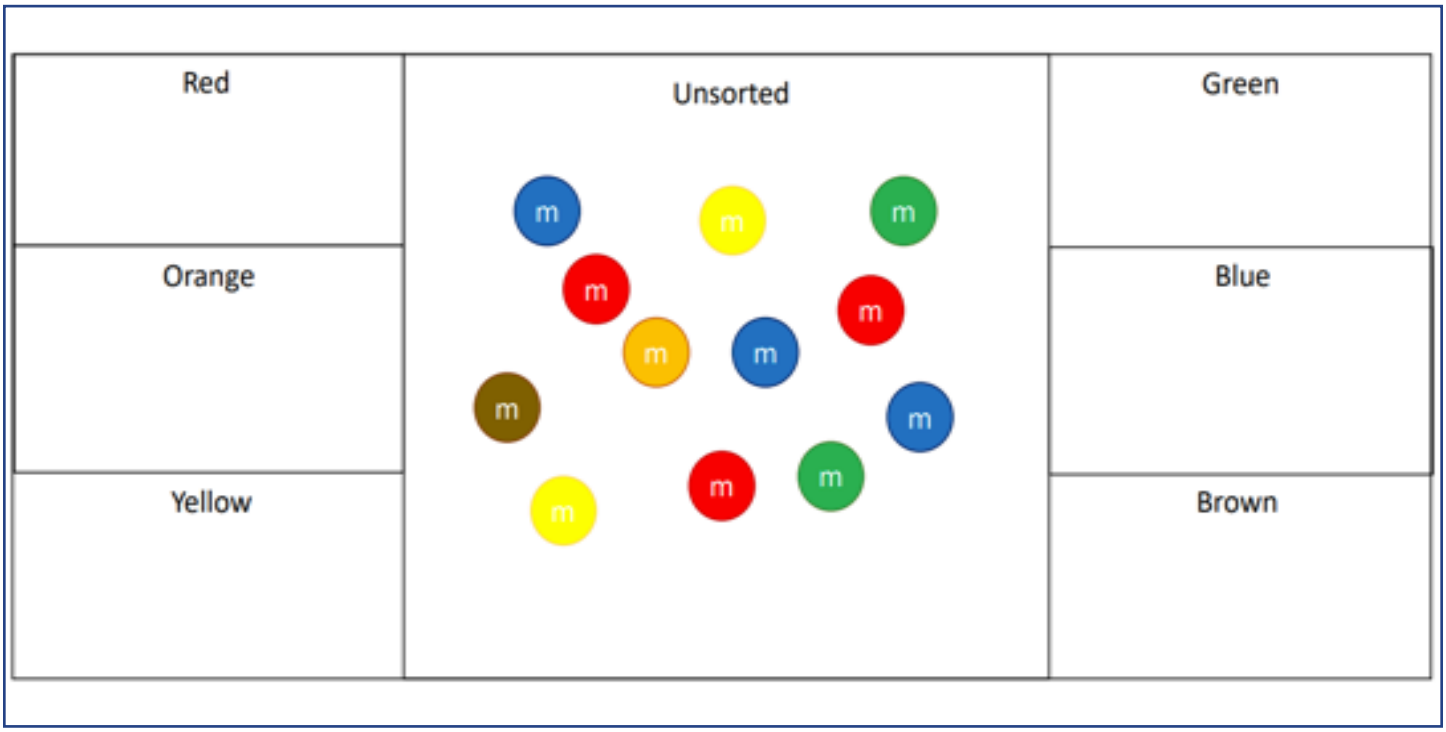
Materials:

- ☑ Small Pack of M&M's per student (or group)
- ☑ 1 set of Green, Blue, Red Filtered Lenses per group (or shared by class)

Procedure:

1. Look through the diffraction lenses to see how white light can be broken up into its base components.
2. Choose a pair of red, blue, or green filtered lenses and put them on.
3. Open up a pack of M&Ms and place them in the center of the activity sheet.
4. Sort the M&Ms into their respective color box.
5. Take off the glasses to see how you did

You can cover up the picture of the M&M's, it is there to show you an example!



Part B: Gummy Bear Inquiry Demonstration

Materials:

- ☑ Small Pack of Gummy Bears per student (or group)
- ☑ One finger LED per student (or group)

Procedure:

1. Collect the materials from the teacher for the demonstration, perform the procedure and fill in the following data table.

Gummy Bear	Which LED would show best from behind the gummy bear?	Why?
Red		
Green		
Blue		
	Which LED (ON) shows best from behind the gummy bear?	Why?
Red		
Green		
Blue		

Section Two: Building the Circuit System (Transmitter & Receiver)

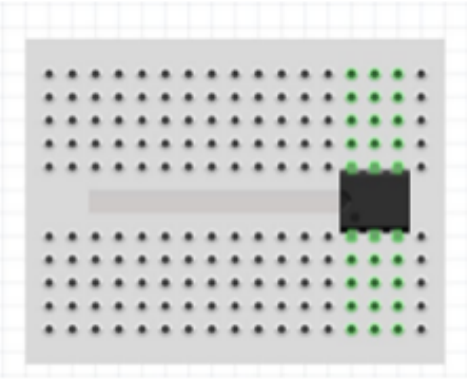
Part A: Transmitter

Materials:

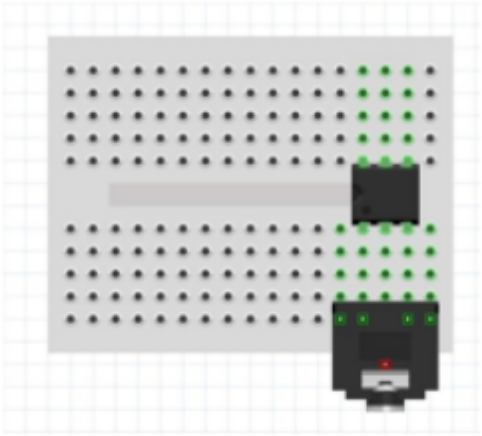
- ☑ 3 slot AA battery holder
- ☑ Mini breadboard
- ☑ 3 AA batteries
- ☑ 10 male-to-male breadboard jumper wires (less are needed, but its good to have a couple extra in each kit)
- ☑ 3.5mm mono audio plug to alligator clip cable (not always needed, but can be used)
- ☑ Aluminum laser mount
- ☑ 3.5mm audio jack to alligator clip cable
- ☑ 600:600 Ohm audio transformer
- ☑ 5mW laser diode
- ☑ 10k Ohm potentiometer

Procedure:

1. Place your transformer (here represented by an IC chip) so that it bridges the gap between the top and bottom sections of the breadboard. You will need to determine which is the primary side of the transformer. It may be labeled with a “P”. This side should be facing the upper portion of the breadboard.



2. Connect your audio jack to the outer bottom pins of the transformer. The positive (white) wire should be on the left and the negative (black) wire should be on the right. Remember that any components that are in the same column are electrically connected!



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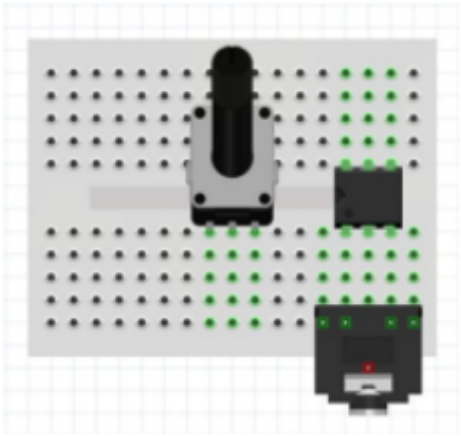
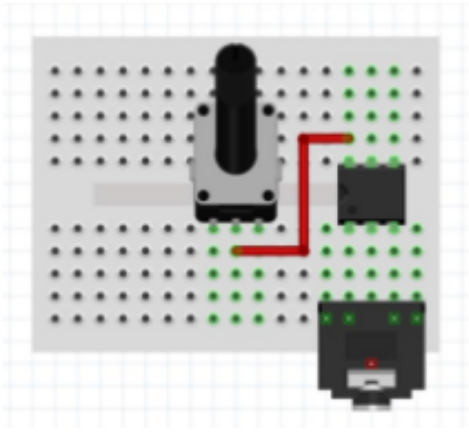
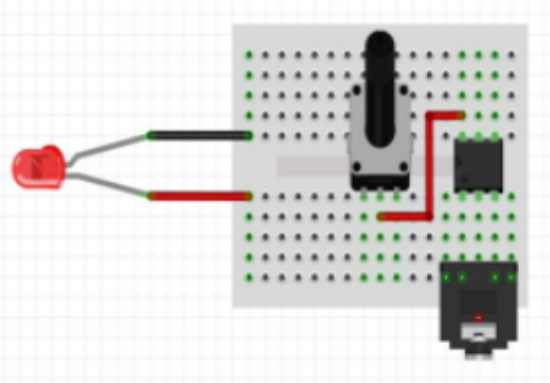


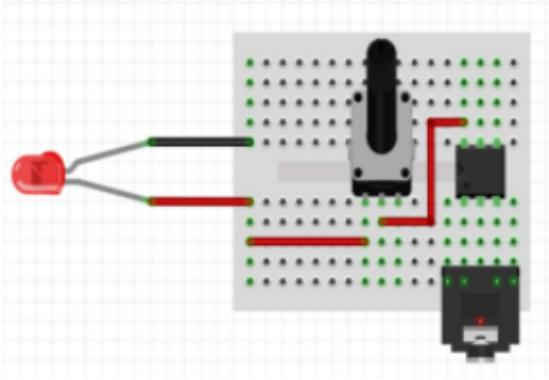
4 Place the potentiometer in the center of the breadboard.
Connect the upper left pin of the transformer to the center (wiper) pin of the potentiometer.



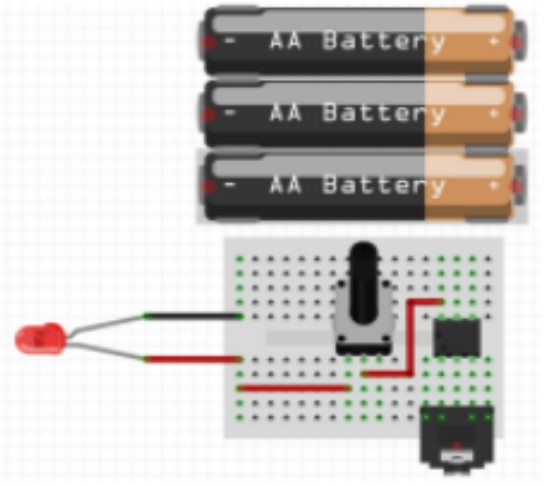
5 Connect your red laser (here represented by the red LED) to the breadboard. Ensure that the ground (black) wire is connected to the upper portion of the breadboard on the leftmost side, and the positive (red) wire is connected to the lower portion of the breadboard.



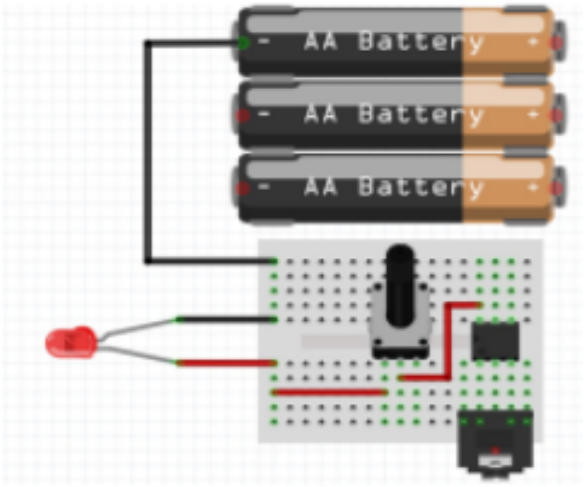
6 Connect the leftmost pin on the potentiometer to the positive (red) wire of the laser.



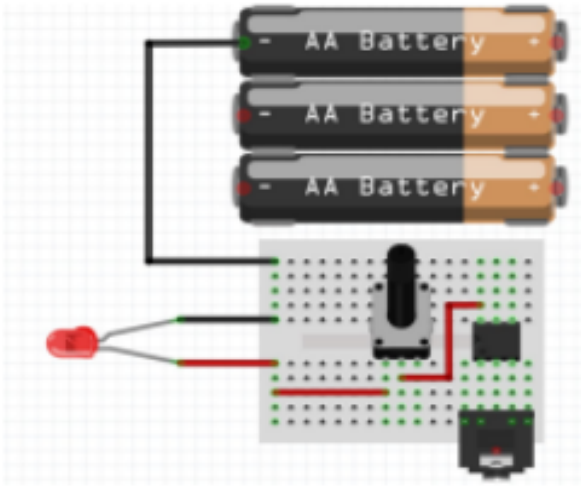
7 Place your 3 AA batteries in the holder above the breadboard. We will soon power the circuit.



8 Connect the negative (black) wire of the batteries to the ground (black) wire of the laser.



9 Connect the positive(red) wire of the battery to the center pin on the upper half of the transformer. Your circuit is now powered up. Press the button on the battery holder to turn it on. **BE CAREFUL TO NEVER POINT A LASER IN YOUR EYES OR THE EYES OF ANYONE ELSE!!!**



Section Two: Building the Circuit System (Transmitter & Receiver)

Part B: Receiver

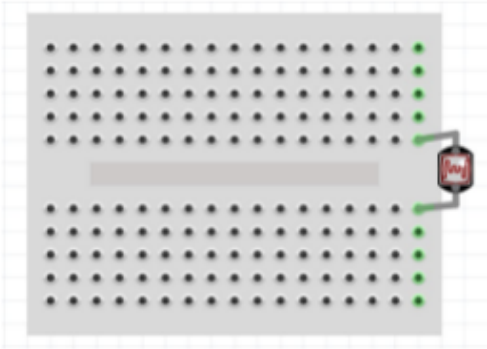
Materials:

- ☑ 3 slot AA battery holder
- ☑ Mini breadboard
- ☑ Photoresistor

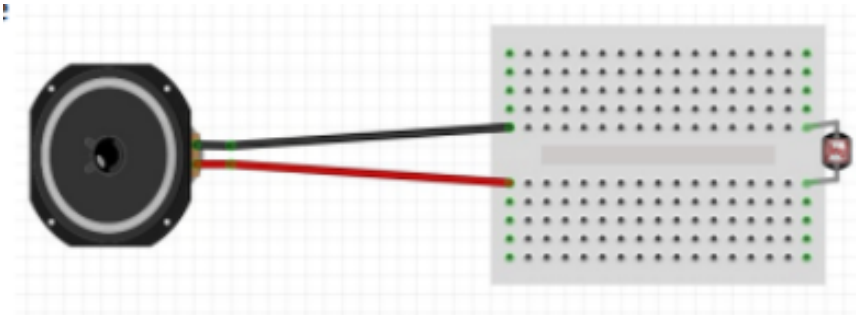
- ☑ 3 AA batteries
- ☑ 10 male-to-male breadboard jumper wires
- ☑ 10k Ohm resistor
- ☑ 4 Ohm 3 Watt speaker
- ☑ Adafruit STEMMA Audio Amp- PAM8302
- ☑ STEMMA JST 2mm 3-pin to Male header cable
- ☑ 2mm flat head screwdriver

Procedure:

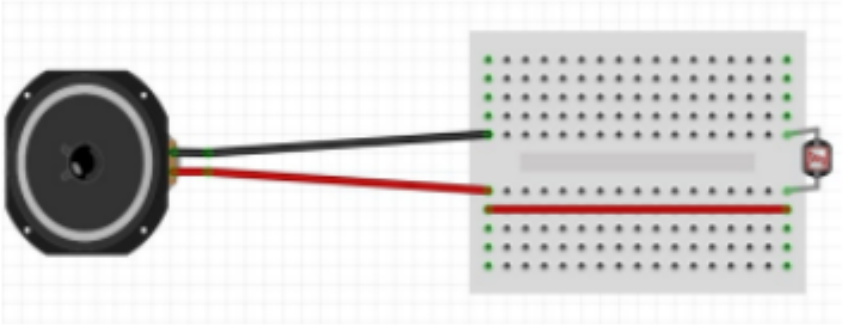
1. Use the photoresistor to bridge the gap between the two sides of the breadboard.



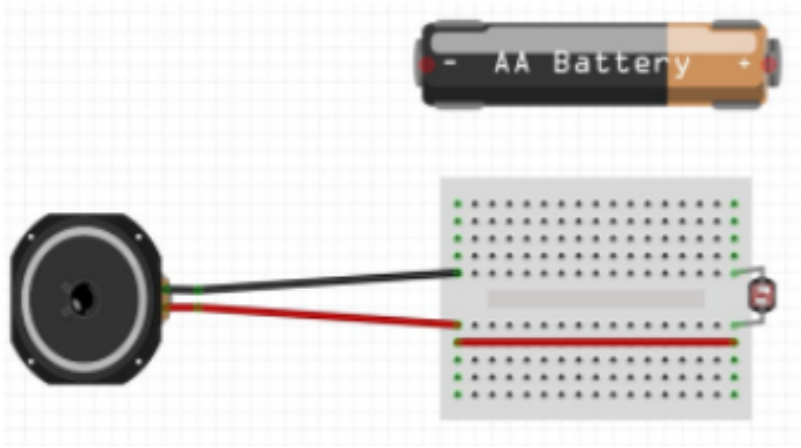
2. Plug the speaker in on the opposite side of the board, bridging the gap between the two sides of the breadboard. The positive (red) wire should be on the bottom half of the breadboard.



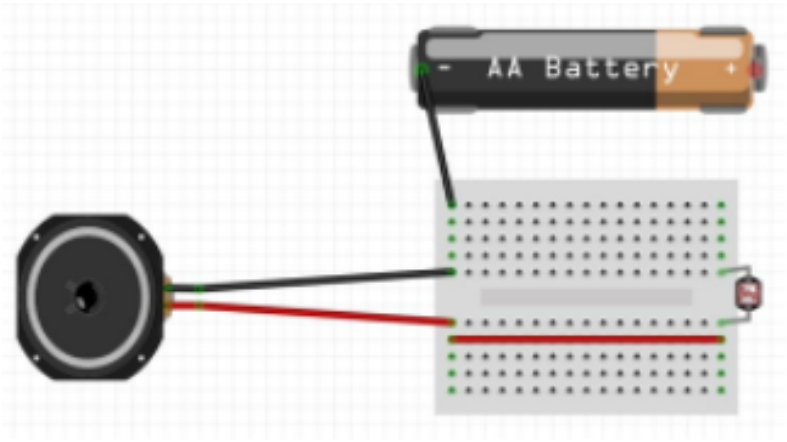
3. Connect the output of the photoresistor (bottom leg) to the input (red wire) of the speaker. Remember, anything in the same column on the breadboard as your wire will be electrically connected!



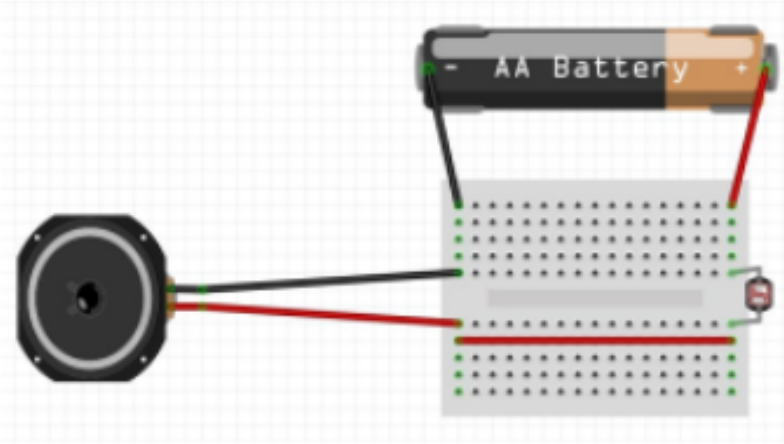
4 Position AA battery and holder above the top of the breadboard. The negative side of the battery should be facing the speaker, and the positive should be facing the photoresistor.



5 Connect the negative (black) side of the battery to the ground (black) wire of the speaker.

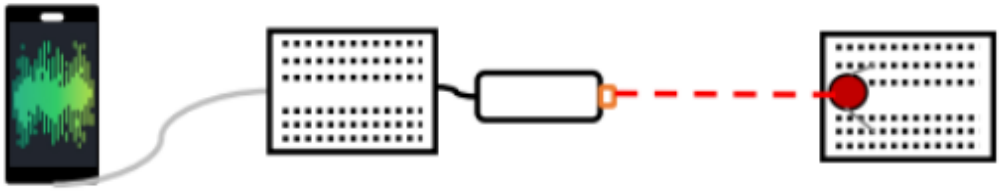


6. Connect the positive (red) side of the battery to the input (upper leg) of the photoresistor. Your circuit is now powered up and you should be able to hear quiet crackling from the speaker.



Section Three: COLOR Activity Testing

Part A: Testing Transmitter- Laser Power

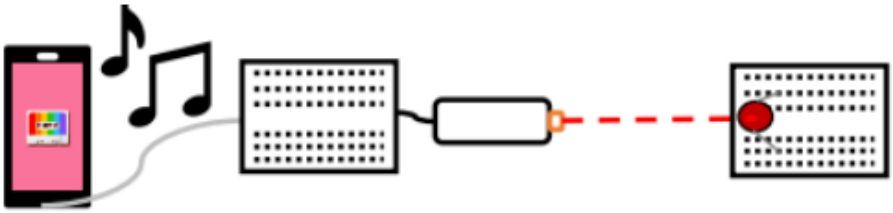


Directions: Collect the materials from the teacher for the demonstration, perform the procedure and answer the questions as you work.

1. Connect phone to 3.5 mm audio jack.
2. Transmit audio in 10-20Hz range using tone generator app
3. Adjust potentiometer and verify that laser output power changes. Why does this happen?

4. Illuminate the photoresistor with the laser.
5. Try changing the audio tone frequency.
6. Does the audio coming out of the speaker change when you change the frequency?

Part B: Testing Transmitter- Tone Frequency



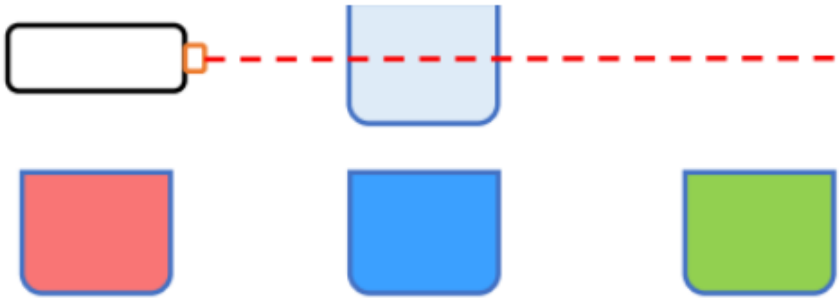
Directions: Collect the materials from the teacher for the demonstration, perform the procedure and answer the questions as you work.

1. Send music from the smartphone instead of the audio tone.
2. Illuminate photoresistor with laser.
3. Can you find a volume/laser power setting that optimizes the audio quality of the music from the speaker?

Part C: Testing Water Colors- Laser Power & Scattering Agent

Directions: Collect the materials from the teacher for the demonstration, perform the procedure and answer the questions as you work.

1. Place a clear water cell between the transmitter and receiver, then align the laser to hit the center of the photoresistor.
2. Which color of water do you think the light will transmit through best? Record the word best under the photo below and explain.



3 Try adding different colored dyes to the water one at a time to test how well they transmit light.

4 Use 20 drops food coloring per ½ cup water.

5 Was your prediction about which color would have the best transmission correct? Record why or why not under the color below and discuss what happened.

6 Your experiment should show that the red laser light transmits best through the red water. When you attempt to transmit the red laser light through the blue or green water, the red light from that laser tends to be absorbed.

7 What color of light would work best for transmitting light through blue or green water? Explain.

8 Add ½ to 1 tsp per ½ cup water of scattering agent (antacid) to clean water.

9 What happens to the laser beam and sound?

10 Why do you think this happens?

11 How could you use lasers if you were an Environmental Engineer knowing what you know now?

Notes

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Hues in Harmony Engineering Notebook

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