Activity 1: Light Emitting Diodes (LEDs)

Time Required: 45 minutes

Materials List
Group Size: 2
Each pair needs:
One each of the following:

- One Activity 1 bag containing:
    - Red LED
    - Yellow LED
    - Green LED
    - Blue LED
    - 1 KΩ Resistor (Brown, Black, Red)
- 9 V Battery
- 9 V Battery Snap (in bag with breadboard)
- Breadboard

To share between every two groups:

- Multimeter
- Pliers

Student Handouts

- Activity 1: Light Emitting Diodes (LEDs)

Learning Objectives
After this activity, students should be able to:

- Build a simple circuit using a solderless breadboard.
- Explain that engineers use solderless breadboard's to test circuit designs because these circuits may be changed quickly.
- Identify a battery, resistors, LEDs.
- Explain what a a) battery b) resistor c) LED does.
- Measure the voltage across a circuit element.

Introduction
During the next few classes, we are going to be introducing you to some of the components used to make your TV remote work. TV remotes use infrared light, a form of light that the human eye cannot see, to transmit a signal from the remote control to the TV. TV remotes are one example of a technology that engineers have designed that that uses infrared light. Today's activity will introduce you to some fundamental concepts in electrical engineering that you will use in building infrared transmitting and receiving circuits in the next few classes. In this activity, you will learn how to build a circuit that makes a light emitting diode (LED) turn on. You will also learn what a breadboard is and how electrical engineers use them to design circuits. Finally, you will learn how to measure voltage using a multimeter.

Vocabulary

Word	Definition
Battery	Source of electrical energy
Resistor	Limits energy flow and converts electrical energy into heat
LED	Light Emitting Diode – converts electrical energy into light
Breadboard	A solderless board for building electric circuits
Schematic	A diagram of a circuit used by electrical engineers
Multimeter	Device for measuring electrical quantities such as voltage
Infrared Light	A form of light that the human eye cannot see; invisible light

Procedure

Instructor Preparation: (Time = 10 minutes)

Check each multimeter and 9 V battery by turning the knob of the multimeter to the 20 V DC setting and touching the probes to the battery terminals. The multimeter should read more than 8.7 V. If the multimeter reads less than 8.7 V, try a second meter. If that still reads less than 8.7 V, try a new battery.

During the Activity:

1) Split students into groups of two.
2) Pass out electronic components. Tell the students not to connect the battery to anything until they are told to do so!
3) Walk around and help the students as they work through the activity.
    a. If the LEDs do not light up, change the polarity of the LED by switching the leads. Check to make sure the students' circuits are built correctly.
    b. If the battery leads are hard to get into the breadboards, try twisting the strands of the wires to form a firmer end of the wire.
4) At the end of the activity, ask the students to put the components back in their original bags.
5) Collect the components from the students. The batteries go back in the boxes to keep the contacts from touch something metal and short circuiting.

Processing and Activity Closure:

After the students have worked their way through the activity sheets, ask the students, "Why do you think the blue LED voltage is different from the red LED voltage?" Give them some time to think about this and take some different answers. Some of their answers are likely to be close to the fact that different colors require different energies. Once they have understood this, you can let them know that they are correct. The reason the voltages are different for different colors is that different colors require different energies. Voltage is a measure of electrical energy. If different colored LEDs require different amounts of electrical energy to produce light, then the voltage across a blue LED and a red LED will be different.

Additional Resources

For additional information on how an LED works:
http://electronics.howstuffworks.com/led.htm

Assessment

1) Collect or copy page 6 of the student handout. The first assessment is to determine if the students understand how the resistor color code works. Exercises 1 and 2 will be used to determine this.
2) Collect or copy page 9 of the student handout. The answers to the questions about the voltage across the red LED, the blue LED, and the 9V battery will be used to determine if students understand how to measure voltage with the multimeter.
3) Collect or copy page 10 of the student handout. The answer to the question: "What does a light emitting diode (LED) do?" will be used to determine whether or not students understand that an LED is an electrical component that changes electrical energy into light energy.

References

No additional references

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Contributors: No additional contributors

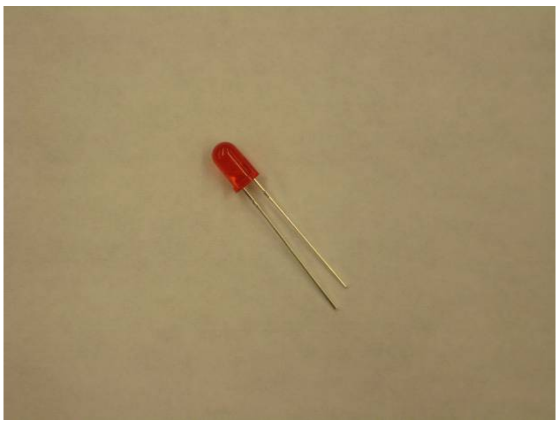
Activity 1: Light Emitting Diodes (LEDs) Student Handout

Name: ________________________

Date: __________

In this activity, you will learn how to build simple circuits on a breadboard and how to measure voltage.

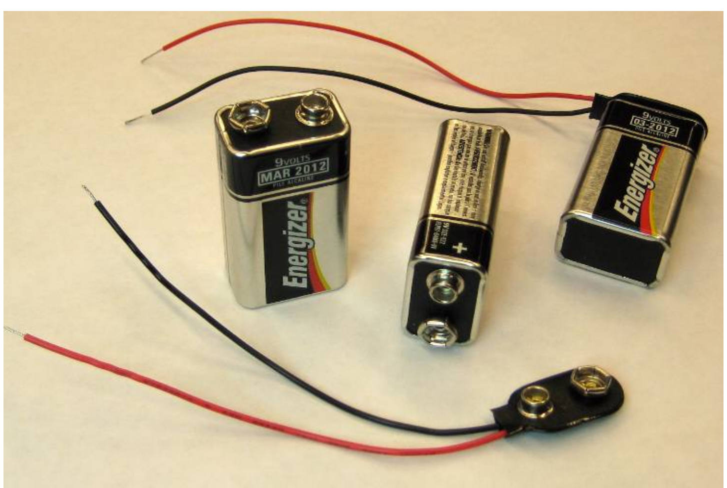
A **Light Emitting Diode**, or **LED**, converts electrical energy into light of a single color. It has two metal leads. The longer lead is positive and the shorter lead is negative.



Picture of an **LED**
The longer lead is positive (**+**) and the shorter lead is negative (**-**).

Look closely at your LEDs. You should have red, yellow, green, blue LEDs. Note that one lead is longer than the other on each LED.

Electrical energy is **voltage** and is supplied by a **battery**. We will use a 9 V (Volt) battery.



Picture of **9 V batteries and snaps.**

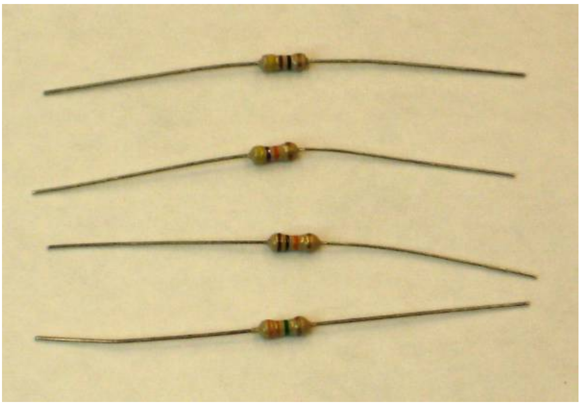
Each battery has **+** and **–** terminals marked on the battery.

Battery snaps have **red (+)** and **black (-)** wires attached.

Look closely at your **battery**. Look for the **+** and **–** terminals.

Warning! The terminals of a battery should never be directly connected together! This is a **short circuit** and can be **dangerous**. Later in this activity, when the battery snap is connected to your battery, **make sure that the wires do not touch each other!**

A **resistor limits** the **energy** flow between the battery and the LED. **Resistors convert electrical energy into heat**.



Picture of **resistors**.

Each resistor has four colored bands. The fourth band is gold on each resistor.

Look closely at your **resistors**. What is the color of the fourth band on all of your resistors?

The first three **colored bands** indicate the **value** of the **resistor** in **Ohms (Ω)**.

Each **color** has a **number** associated with it.

Resistor Color Code

Color	**Number**
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

The first two colored bands provide the **significant figures** and the third band provides the **number of zeroes that follow the two significant figures**. For example, suppose the first three colored bands are brown, black and red. The **resistor color code** produces:

Brown (1)   Black (0)   Red (2)

The value of the resistor is 10 followed by two zeroes or 1,000 Ω. This is read 1000 ohms. It can also be written 1 kΩ, where "k" means kilo or 1,000. This is read 1 kilo-ohm and means exactly the same thing as 1000 ohms.

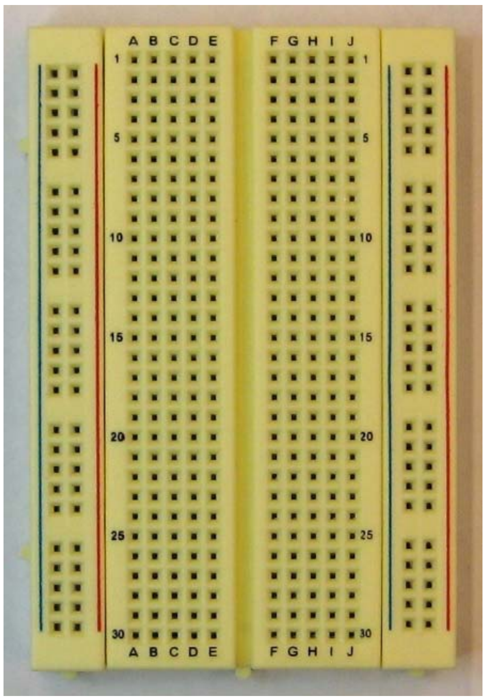
Exercise 1: Using the above chart, what would the value of a resistor with the color code Red, Yellow, Orange be?

____

Exercise 2: What would the color code for a resistor with the value 50,000 Ω (50 kΩ) be?

____

You will build your circuits on a **breadboard**.



Look closely at your breadboard. There are two **bus strips** and one **terminal strip**.

The **bus strips** are on the sides and have blue and red stripes from top to bottom.

The **terminal strip has 10 columns**, each labeled with a letter:

(A, B, C, D, E, F, G, H, I, J)

The **terminal strip has 30 rows**.

There are a total of 400 holes in your breadboard (300 terminal strip holes and 100 bus strip holes).

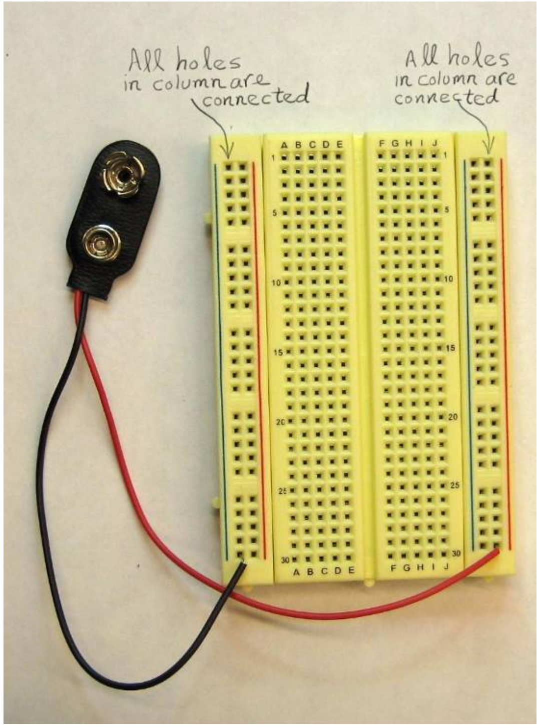
Can you locate holes A1? J5? F26?

Exercise 3: Make up a hole location and ask your partner to find it on the breadboard. Change roles and repeat the exercise.

Exercise 4: Point to a hole in the breadboard and have your partner tell you the hole location. Change roles and repeat the exercise.

Navigating your Breadboard

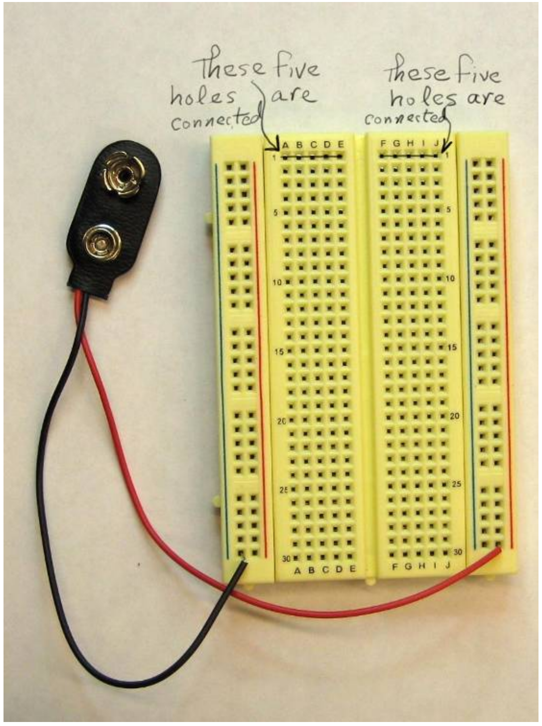
All 25 holes in a column of a bus strip are connected together inside of the breadboard.



The **bus strips** are used for **power supply rails**.

Connect your battery snap with the **red (+) wire in the bottom hole of the red bus strip on the right**, and the **black (-) wire in the bottom hole of the blue bus strip on the left**.

Later, when you connect your battery to the snap, this will make **+9 V** of energy available in every hole along the red stripe on the right and **ground (0 V)** available in every hole along the blue stripe on the left.

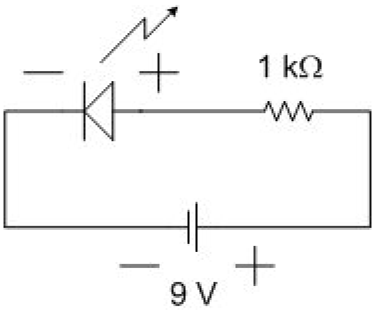


The **terminal strip is used to connect components** such as resistors and LEDs.

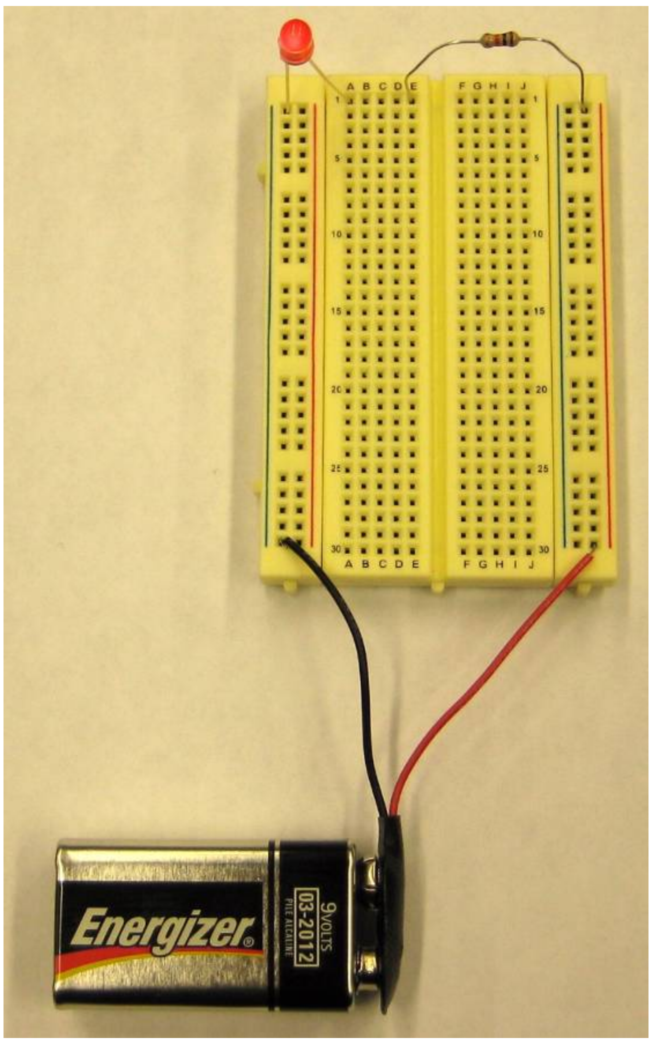
All five holes in one row on one side of the terminal strip are connected together inside the breadboard.

LED Circuit

We are going to build the following circuit:



This circuit diagram is called a **schematic** and shows a 9 V battery in series with a 1 kΩ (1000Ω) resistor and an LED.



Obtain a 1 kΩ (1000Ω) resistor (brown, black, red) and a red LED. Build the circuit by plugging these elements into your breadboard as shown in the picture. Remember that the **longer lead** of the **LED** is **positive (+)** and the **shorter lead** is **negative (-)**.

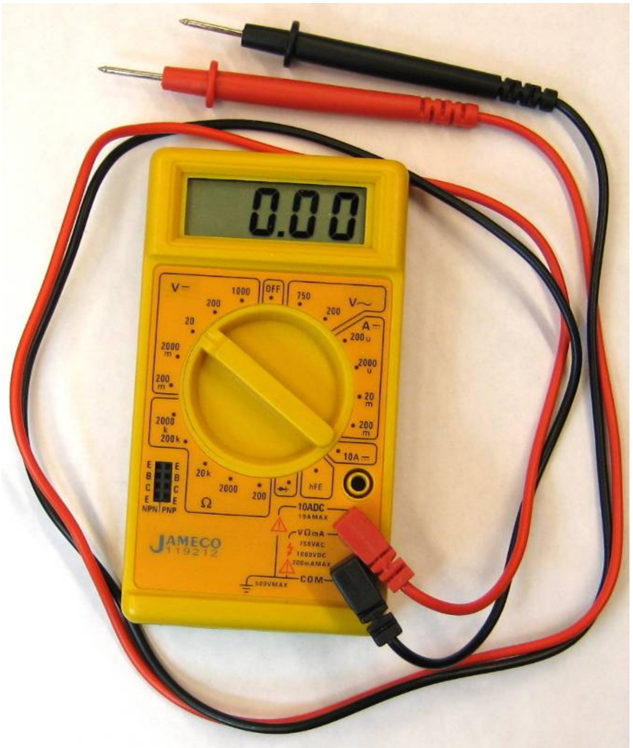
One of the resistor leads is plugged into hole 1E and the other lead is plugged into the positive power supply rail. The + terminal of the LED is plugged into hole 1A and the – terminal is plugged into the negative power supply rail.

Plug in your battery to the battery snap. The red LED should glow. If it does not glow, check your connections and make sure the negative lead of the LED is in the negative power supply rail.

Remove the red LED and plug in the green LED.
Remove the green LED and plug in the yellow LED.
Remove the yellow LED and plug in the blue LED.

Measuring Voltage using a Multimeter as a Voltmeter

A **voltmeter measures voltage**. The **red** probe is **positive** (**+**) and the **black** probe is **negative** (**-**).



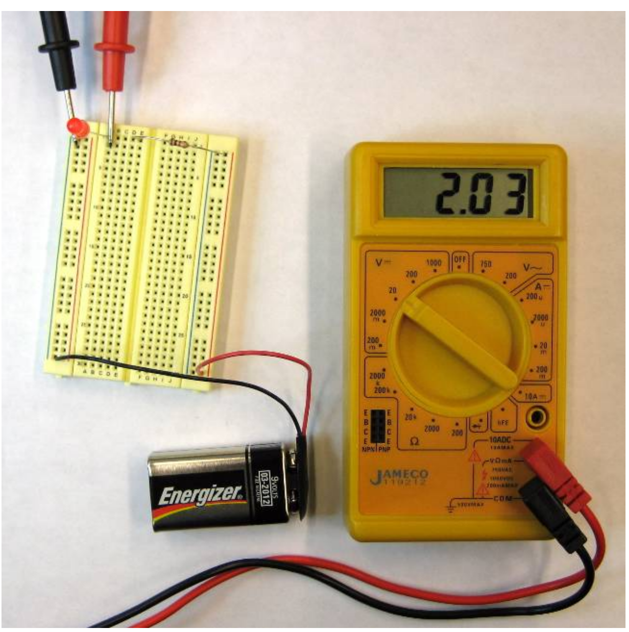
Set the dial on the front of the multimeter to 20 V DC (DC means constant). You do this by rotating the dial until the indicator points to 20 V DC as shown in the picture to the left.

Unplug your 9 V battery from the battery snap.

Measure the **voltage** across your 9 V battery by touching the red probe (+) to the + terminal of the battery and touching the black probe (-) to the – terminal of the battery.

9 V battery voltage = ____________

Connect your battery to the battery snap. Rebuild your red LED circuit and measure the voltage across the LED.



To measure the voltage across the LED, touch the red probe (+) of the voltmeter to the positive terminal of the LED and touch the black (-) probe of the voltmeter to the negative terminal of the LED.

Red LED voltage = _______________

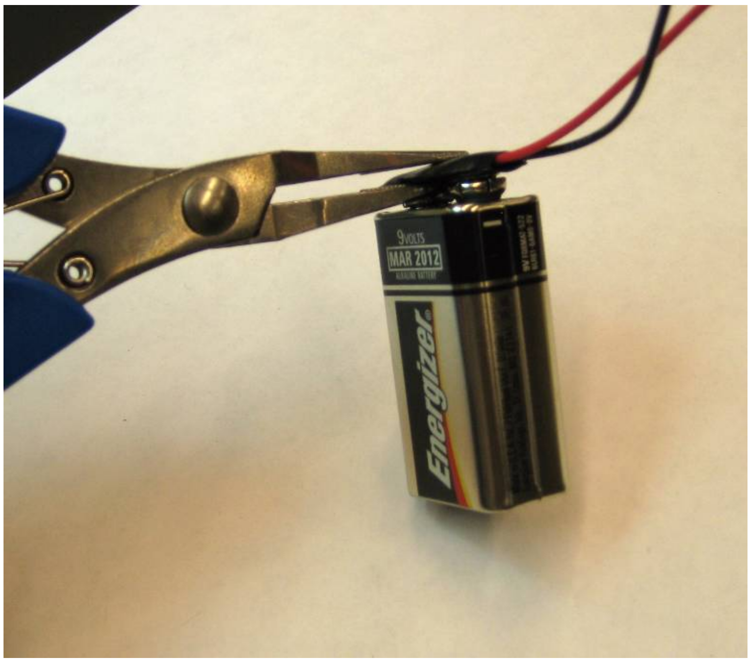
Replace the red LED with a blue LED and measure the voltage across the blue LED.

Blue LED voltage = _______________

What does a light emitting diode do?

Disassembly and Cleanup

Disassemble your circuit.



Remove the battery snap from your battery. You may need to use the needle nose pliers to remove the battery snap.

It is important to remove the battery snap after you are finished using the battery because this keeps the leads from touching each other and draining the battery.

Return the circuit components to their proper storage bags as instructed. All of your small components from the breadboard will go in the Activity 1 bag except the battery snap.

Activity 1 Bag Contents:

- Red LED
- Yellow LED
- Green LED
- Blue LED
- 1 KΩ Resistor (Brown, Black, Red)

The battery snap and breadboard will go in a bag together. Finally, return the battery to your instructor.