# Rainbow Connection

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Your Name

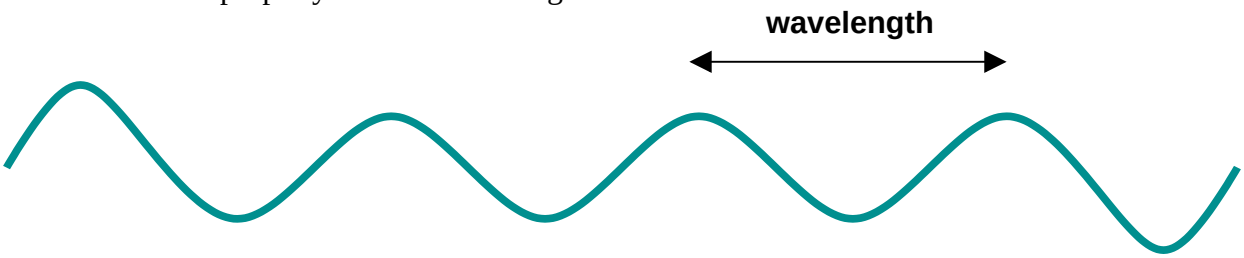
# LIGHT AND ENERGY

Imagine standing outside on a sunny day. Sunlight falling on your skin makes it feel warm. This is because the sunlight carries energy and the heat you feel is another form of energy. You could also use the same sunlight to generate energy to run a solar calculator. Plants use the energy from light to grow.

Light from the sun doesn't appear to have any color to it, but we can easily separate out the different colors it is made up of by using a prism.

In what order do you see the colors of a rainbow?

From rainbows, we know that there are different types of light, but it's hard to see what makes them different. First, it helps to know that light is a wave. All waves – light, sound, water or stadium – have a property called a wavelength.




Making waves on a rope allows you to try out different wavelengths for yourself.

What happens to the wavelength of rope waves when you move your hand back and forth faster?

Which takes more energy to make, short wavelength waves or long wavelength waves?

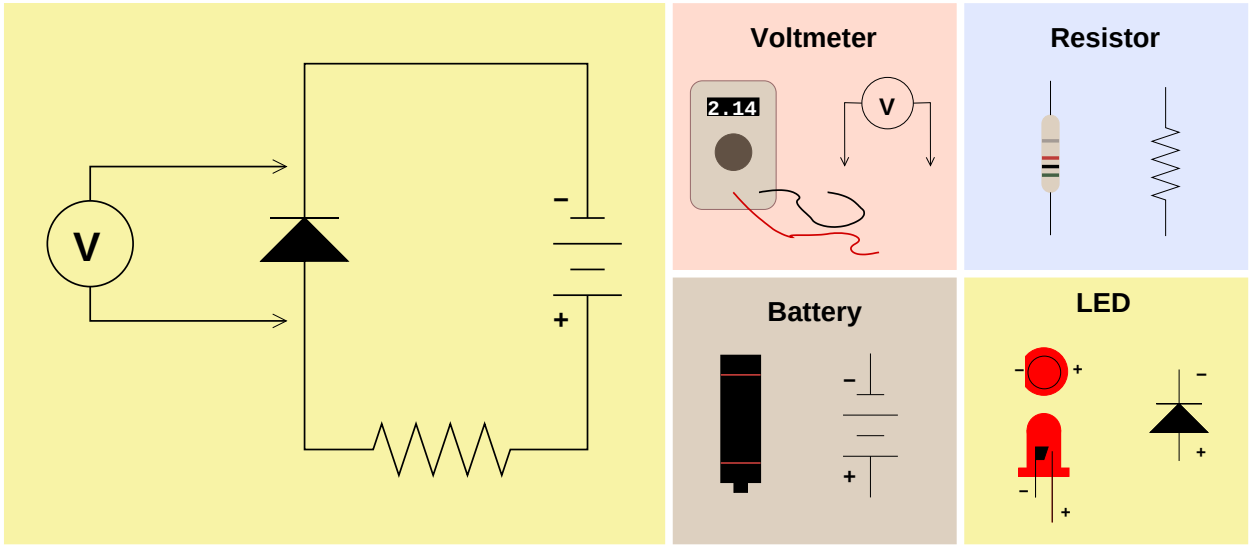
Light is also a wave, and different colors of light have different wavelengths. Scientists like to measure such short distances as these in *nanometers*. One billion nanometers fit into a meter! If that's hard to imagine then you could also say that 1000 nanometers is about the width of a human hair, and this is also about the wavelength of light. So, we cannot see the wavelength of light, although scientists can measure how long it is.

## MAKING AN LED LIGHT UP

LEDs are like lightbulbs, but use much less energy. By changing the material inside the LED, engineers can make different color LEDs.

You will construct an electric circuit composed of a battery (energy source), an LED (uses energy to make light), and a resistor (uses up the extra energy). A circuit needs to have all of its ends connected in order to have the electricity move through it.

The diagram below shows how this is to be done, using standard electrical symbols. The key to the right shows which symbols go with which parts. Note that the resistor and the battery both have "direction" to them: if one is reversed with respect to the other, the LED will not light up.




## TAKING MEASUREMENTS

Once your circuit is working, you can use a voltmeter to measure how much energy from the battery the LED is using up in order to make the light. We want to know how this energy changes for different color LEDs.

First, we need to find out how much energy the batteries have available. Attach the voltmeter to the two ends of the battery pack and take a reading. If the number you get is negative, switch the direction of the battery.

> How many volts does the battery produce?

For each LED, attach the wires to the clips on the battery so that the light turns on. Measure the voltage (energy used) across the LED using the voltmeter, as shown in the circuit diagram. Record the voltage and the wavelength (from the printed catalog) for each LED in the collection.

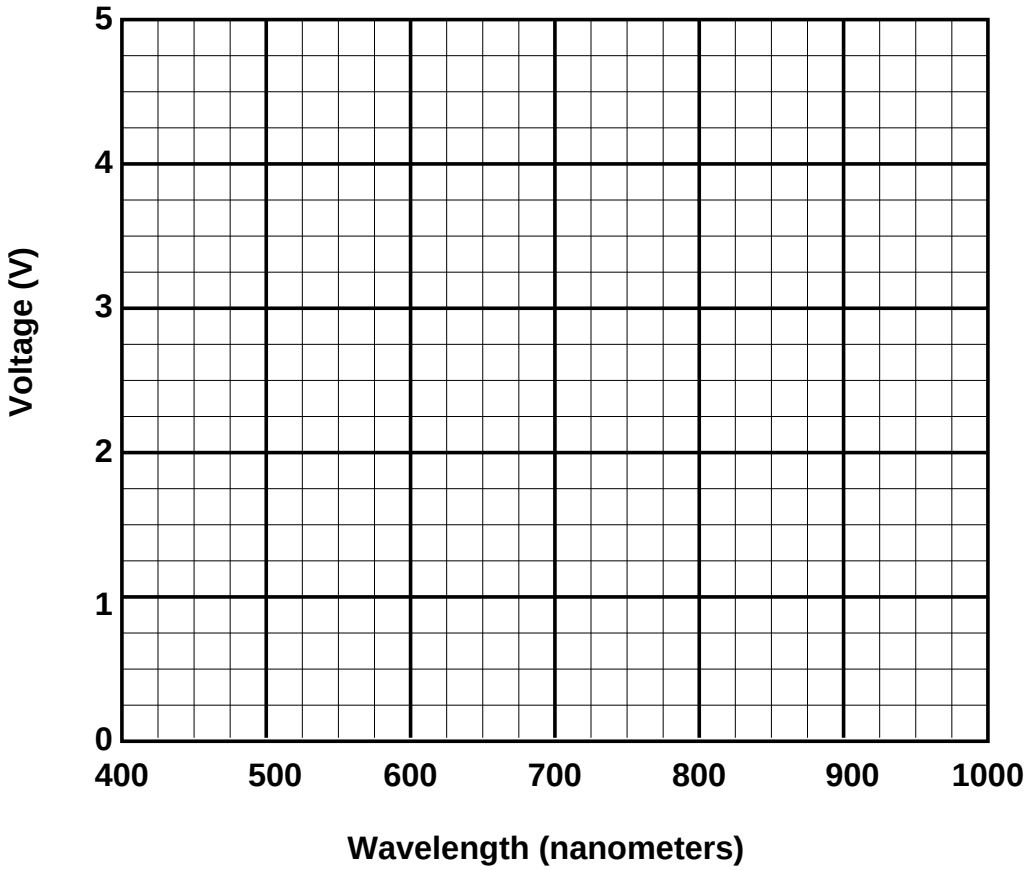
## DATA TABLE

| LED Color | | | | | | |
|---|---|---|---|---|---|---|
| Wavelength $\lambda$ (nm) | | | | | | |
| Voltage $V$ (volts) | | | | | | |

Check your work: since you know how much energy the battery can produce, all of your voltage measurements in the data table should be less than the voltage produced by the battery. If you are having trouble getting the blue LED to light up, you can join your battery to the another group's battery to get twice as much voltage.

# ANALYSIS

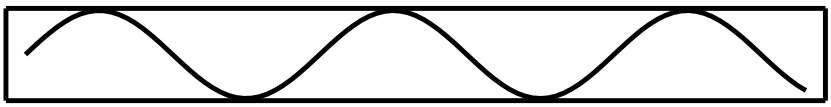
## GRAPH



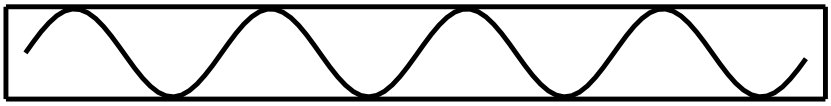

Plot your data on this graph, using a pen/pencil which is the same the color as each LED to draw the data point. Draw a line or curve to indicate the trend you see in your data.

## Color, Wavelength, and Energy

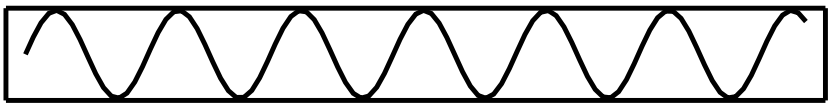
From our graph, we can relate three important properties of light: the color, the wavelength, and the energy. Using this information, match the color with appropriate long, medium, or short wavelength wave.



Blue



Green



Red

Now, recall the rope demonstration: which took more energy to make, short wavelength waves or long wavelength waves? Does the trend on your graph agree with what you observed after watching the rope demo? Explain.

## Mystery LED

You will have an opportunity to make a measurement on an mystery LED, whose color you cannot see. Make the same measurements you did before, to determine how much energy the LED uses.

What color do you think the LED is?

## FIND OUT MORE!

Where else can we see that the color and energy of light are related?

- Astronomers use the color of a star to take its temperature. While stars generally look whitish, a more careful examination reveals that some of them are reddish while others are bluish. This is due to their differing surface temperatures. Which do you think are hotter, reddish stars or bluish stars? What color is our star?
- In our circuit we used a battery as an energy source to produce light. Plants work the other way around! Photosynthesis takes in light and uses it to produce energy for the plant to live on.
- Pyrotechnicians need to know what chemicals make different colored fireworks, which work in a similar way to our LEDs. The fuse ignites the chemicals in the fireworks, that energy gets turned into light.