MAKEngineering Kit Facilitation Guide:

Rain Gauge

Task from Curiosity Machine, a program of Iridescent.

ENGINEERING TASK

Several cities across the U.S. are experiencing their wettest year-to-date. The National Weather Service is asking for your help in measuring and reporting the amount of rainfall in your city. Using the provided material, build a rain gauge to measure the amount of liquid precipitation over a set period of time.

MATERIALS IN KIT

- 2 AA batteries
- 1 Battery holder
- 5-6 LED lights
- Electrical Tape
- 2 Alligator clips with wires
- 2 Aluminum foil sheets
- 3-4 Paperclips
- Hot glue gun & stick
- 2-3 12-oz. Plastic cups
- 4-5 Binder clips
- 2-3 Thumb tacks
- 1 Ruler
- 1 Black Sharpie

STEP 1—RESEARCH

What is a rain gauge? How does it work? How is a rain gauge used by meteorologists (or weather forecasters) and hydrologists (or scientists that research the earth's underground and surface water)? Here are a few videos to get you started and don't forget to take notes:

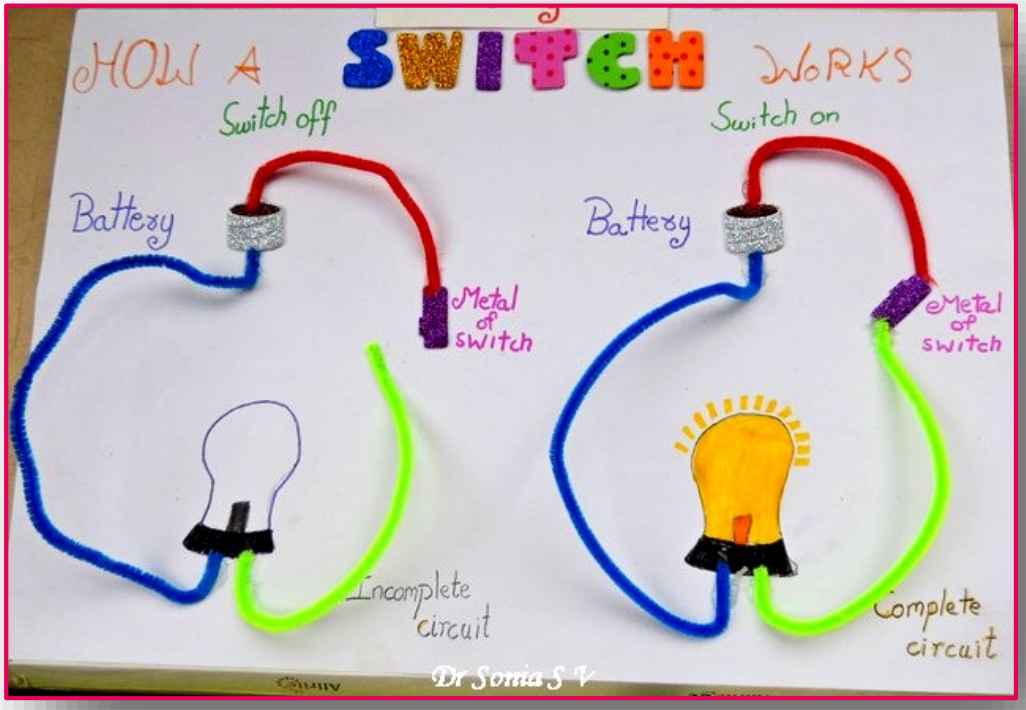
https://youtu.be/7gY-GWtmGFI

https://youtu.be/VYWbC61C1cA

Where have you seen a rain gauge?

STEP 1—RESEARCH

What is unique and rather cool about your rain gauge is that it will light up. So let's take a look at what is known as a simple circuit. Describe what you notice.



4-A

STEP 1—SUPPORT

Options questions to ask if particular parts of the circuit are not noticed or described.

- What's the difference between the switch off and switch on circuit?
- Why do you think we need metal in our simple circuit? Do you know the difference between conductive and non-conductive material? (Explain.) What examples in our home are conductive? What about non-conductive?
- Did you know that a battery has a positive and a negative side? Can I explain to you how electricity flows in a simple circuit? (ask for permission)

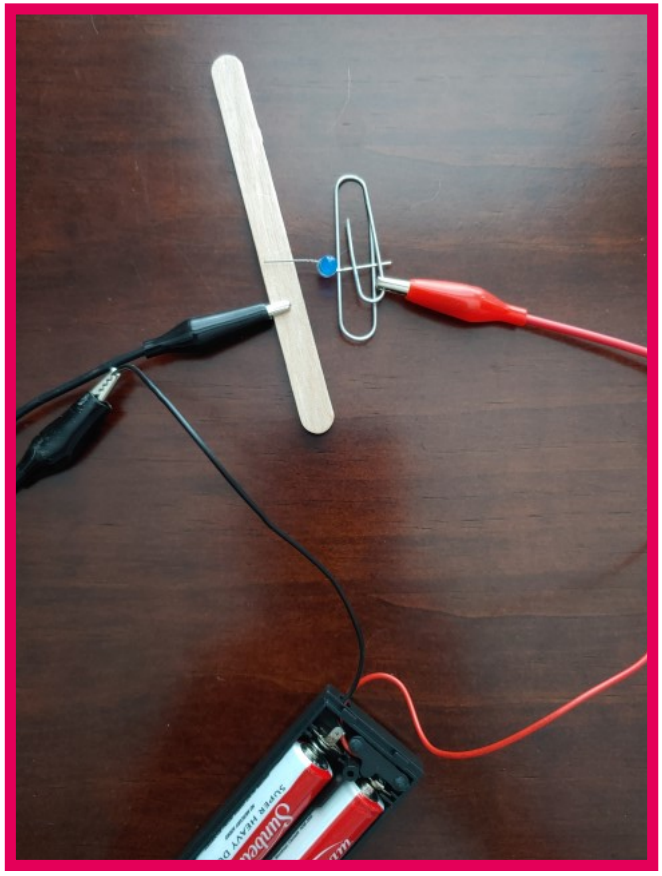
STEP 2—EXPLORE

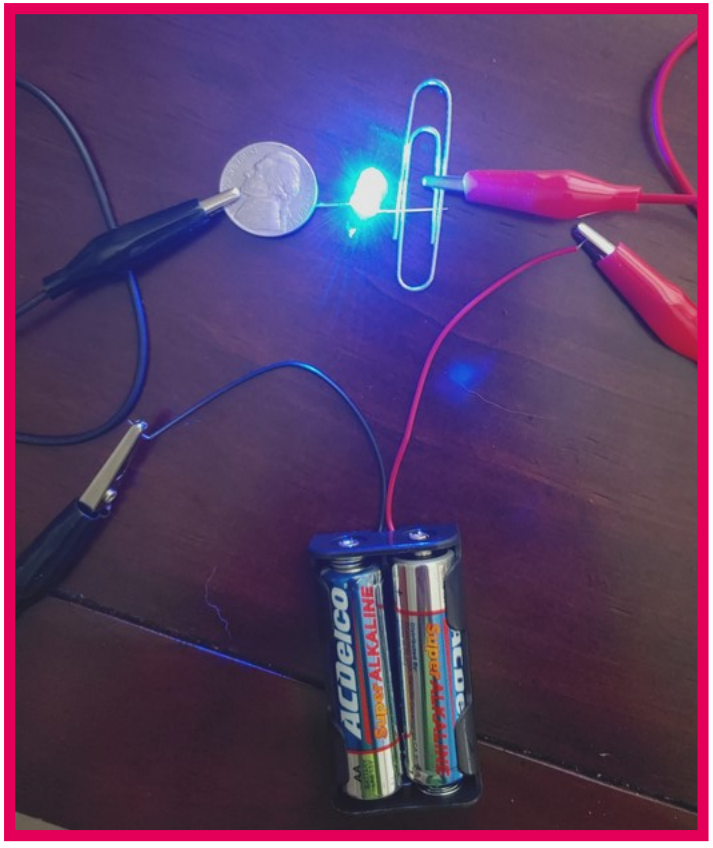
Using some of the materials in the kit, including the battery pack and LED lights, can you create a simple circuit? Can you find more than one way to do this—using different materials in the kit? What materials might be around your home that you can use as conductive material for a simple circuit? Test it out.

Also, the legs of the LED lights are different. Which one is positive and which one is negative? How do you know?

STEP 2—SUPPORT

Use these images help you ask questions and guide your support. Be sure to also include non-conductive materials to have a discussion as to why the light does not work.





5-B

COMMUNICATION

Have a conversation about what has been learned. The camera can be focused on the kit material.

1. What did you learn about rain gauges?
2. Explain or illustrate how a simple circuit works.
3. Provide examples of conductive material in your home. How do you know it is conductive?

STEP 3—CREATE

Discuss the measurement you will use to measure the rain fall. Millimeters? Centimeters? Inches? Take a plastic cup. Use the ruler to measure the vertical distance or the amount rain fall. Use the sharpie to mark this distance and add your units (e.g., cm, mm, inches) just like you saw in the videos. We will call this your vertical ruler.

STEP 3—SUPPORT

Optional questions to ask:

- Why are we not using volume as the measurement for the amount of rainfall? How would that change our approach? For example, would we be using mm, cm, or inches?
- What do you notice about the cup? How might the shape of the cup impact our measurement of rainfall?
- What other material or object could we use instead of this cup?

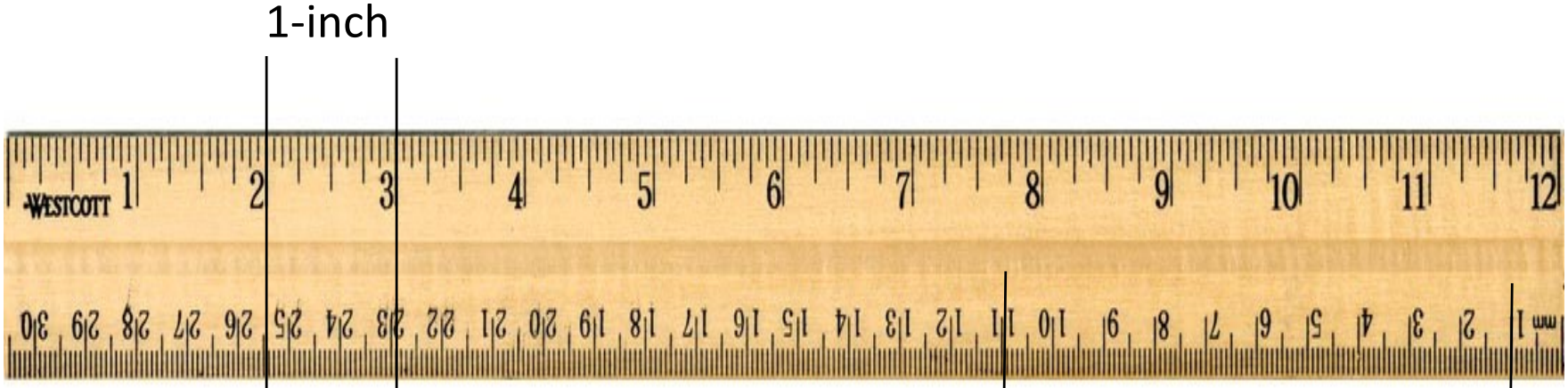
STEP 3—EXTENSION

You can use the ruler to explore how to convert between millimeters (mm), centimeters (cm), and inches (in).

1. About how many cm is in 1 inch? (2.5 or 2.6) How can we use this to find the length of the smallest type of goldfish, the Twisty Tailed Goldfish, in cm if it is 6 inches long? (2.5 cm x 6 in. = 15 cm or use the ruler)

2. How many mm is in 10 cm? (100 mm) Estimate how tall are you in mm. How might we find how tall you are in mm more accurately?

STEP 3—EXTENSION



STEP 3—CREATE

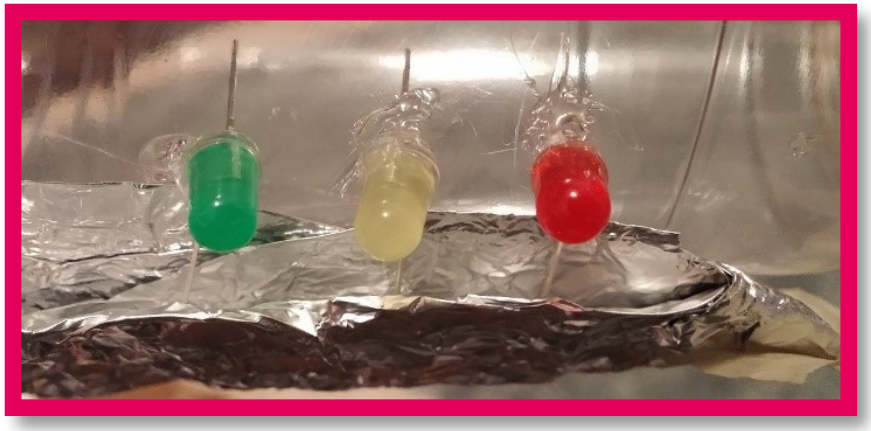
Using a thumb tack, poke a hole into your cup—one hole at each mark along your vertical ruler. Insert the longest leg (i.e., positive) of a LED light into each hole. Leave the other leg (i.e., negative) on the outside of the cup. Use hot glue to secure the LED lights and fill the holes.

Watch this time lapse video for support:

https://youtu.be/MRv1VsA7RBM

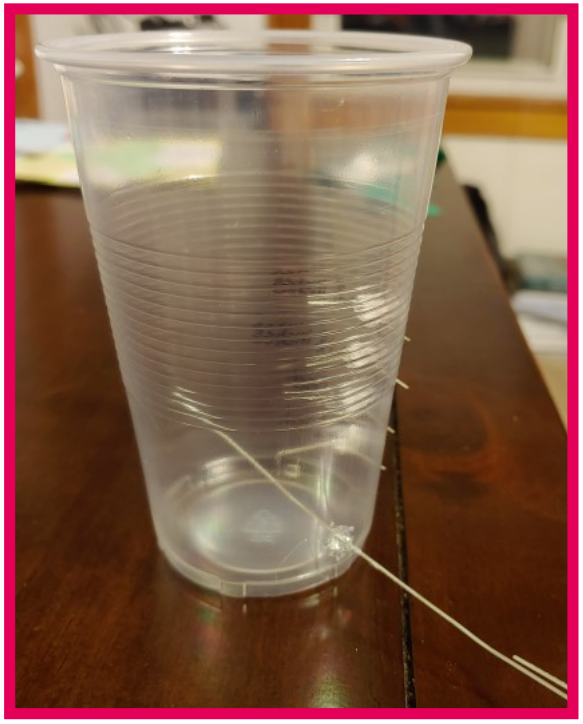
STEP 3—CREATE

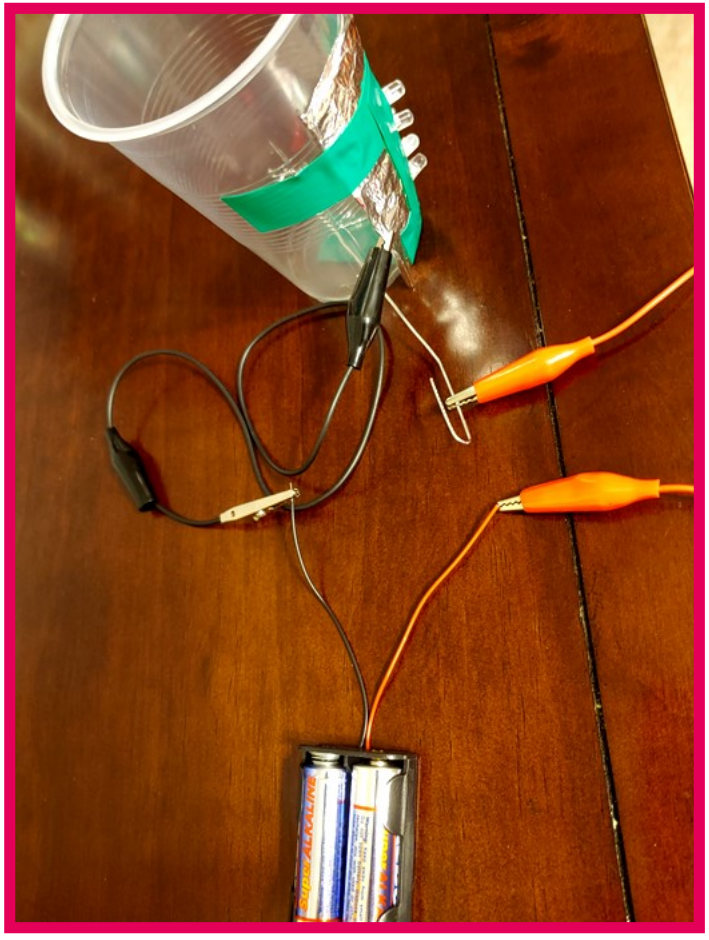
Take an aluminum foil sheet and wrap around the legs of the LED lights on the outside of the cup. Why are we using aluminum foil?



STEP 3—CREATE

Straighten one paper clip and insert into the bottom of the cup. Part of the paper clip should be inside the cup, while the other part should be outside the cup. You will use the thumb tack and the hot glue as you did when you inserted the LED lights into the cup.





STEP 3—CREATE

Look closely at the image, particularly the alligator clips. What do you notice? Which connection is positive and which connection is negative? How do you know? Think back to your research.

STEP 4—TEST

Now it's time to complete your circuit by pouring tap water into the cup.

- (Psst. Did you know pure water is a very poor conductor? But tap water, like rain water, contains charged ions that allow electricity to flow through.)

STEP 5—IMPROVE

Engineers often build and improve upon their prototypes before launching a final product. If it did not work properly, troubleshoot by walking through your steps again and thinking out loud with other family members. How will you redesign the prototype?

What improvements might you make to the rain gauge? Explain your thinking.

STEP 5—SUPPORT

Potential questions to ask to help in troubleshooting.

1. Are the alligator clips attached appropriately? Are they securely attached to all parts?
2. Are the LED lights (or paper clip) moving or loose? Why might this be a problem? What might we do if they are moving?
3. Are the legs securely connected to the aluminum foil? If not, what change might we make? Why?
4. Do you recall if the legs on the outside of the cup are all negative (shorter leg)?

COMMUNICATION

Have a conversation around the build, test, and improvement of the prototype. The camera can be focused on the rain gauge.

1. Let's reflect on the create steps. How did we construct the simple circuit? Illustrate this by showing and talking through the different parts.
2. Did you experience any frustrations? Why or why not? If so, what did you do?
3. How might you track or document the rainfall everyday for the next month?

EXTENSIONS

1. Using items around your home, plan and build something to cover the battery pack. This cover should uphold the elements of weather. Why is it important to cover the battery pack of the rain gauge from the elements of weather?
2. What might you add to the rain gauge to make sure that it does not blow over or blow away once set outside? Do some research, make a plan, and add on to your rain gauge.

PARALLEL PROTOTYPING

Now that you have an idea of how to create a rain gauge using the material from the kit, we challenge you to re-create another rain gauge. Keep in mind the process —plan, create, test, and improve. We challenge you to think outside the “kit” and use material in your home.

DID YOU KNOW…?

Atmospheric scientists study and predict the weather and climate and its impact on our lives. Many have degrees in atmospheric science, physics, chemistry, or mathematics. Job opportunities for atmospheric scientists are expected to grow 12% by 2026. If you are interested, this video show how people work together on an atmospheric science project—https://youtu.be/Fk-uqrXkkG8

Environmental engineers develop solutions to improve recycling, public health, and water and air pollution. Environmental engineers should have a strong science and math background, work well with others, and be imaginative. Check out https://youtu.be/k2epvAUEdCI for more information.

WHAT TYPE OF ENGINEER ARE YOU?

Add a sticker to your Engineering Passport that identifies the type of engineer you were most like in the design of a rain gauge. Don’t forget to write why you chose the type of engineer.

This engineering kit would not have been possible without funding and support from the National Science Foundation.