



Engineering Challenge: Design & Build a Rain Gauge

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Design & Build an Accurate Rain Gauge from Household Materials

Background:



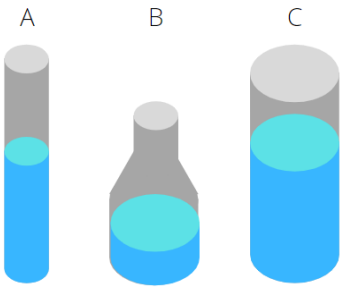
The driest place on Earth is the Atacama desert in South America, which receives only 0.6 inches of rain a year. Meanwhile, the village of Mawsynram in India gets the most rain in the world with 467 inches falling each year. There is a seasonal pattern to weather in most places. In fact, over half of the rain in Mawsynram falls in June and July. Knowing the weather patterns helps us make better choices. Which location would you rather visit?

Rainfall is measured with a rain gauge in inches or centimeters (cm) as a height - as if all the rain that fell stayed where it landed instead of draining away. You can make a rain gauge if you have a clear, open container to put outside and collect rainwater. As long as the container is shaped like a cylinder, you can simply use a ruler to mark the height in inches or cm from bottom to top to measure the amount of rainfall. **Can you build a rain gauge to accurately measure rainfall?**

To make your rain gauge as accurate as possible, keep the following in mind:

1) Your container will need to be as perfect a cylinder as it can be. Notice in the picture that container B's water level is lower than the others even though the same amount of water fell. That is because B's top diameter is smaller than B's bottom diameter, so it's not a perfect cylinder. Only containers A and C will give correct rainfall measurements.
2) Rainwater in the container may evaporate (change state from liquid to gas) and escape the container if the top of the container is left wide open to the air.
3) A rain gauge that is not stable and tips over in the wind may lose its water and no longer be able to collect rainfall.

Same Rainfall Collected in Different Containers



Recommended Design Materials:

- Clear plastic bottle (like a water bottle or 1-liter soda bottle)
- Scissors (adult supervision and help may be needed to cut tough plastic!)
- Tape
- Permanent marker
- Ruler
- Water
- Rocks
- If you have a professional rain gauge or graduated cylinder, it could be helpful for students to test their designs against it too!

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Solution Brainstorm

Use your materials to explore potential solutions to your problem. Draw and note your ideas here:

How can you make your container have the same diameter all the way down, like a perfect cylinder?

If the bottom is a different size/shape, how could you make the water start collecting just above that?

How can you let all the rainwater come down into your rain gauge, but stop so much water from evaporating up and out?

Prototype Test

Build your rain gauge and test it out!

Stuck? Answer these questions...

How can you simulate rainfall for your test?

Did your rain gauge stay upright? How can you make it more stable?

Did your rain gauge measure the correct amount? How can you make it more accurate?

Rain Gauge Design Test #	Amount of Simulated Rainfall	Your Rain Gauge Measurement & Other Observations
1		
2		
3		

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Final Test

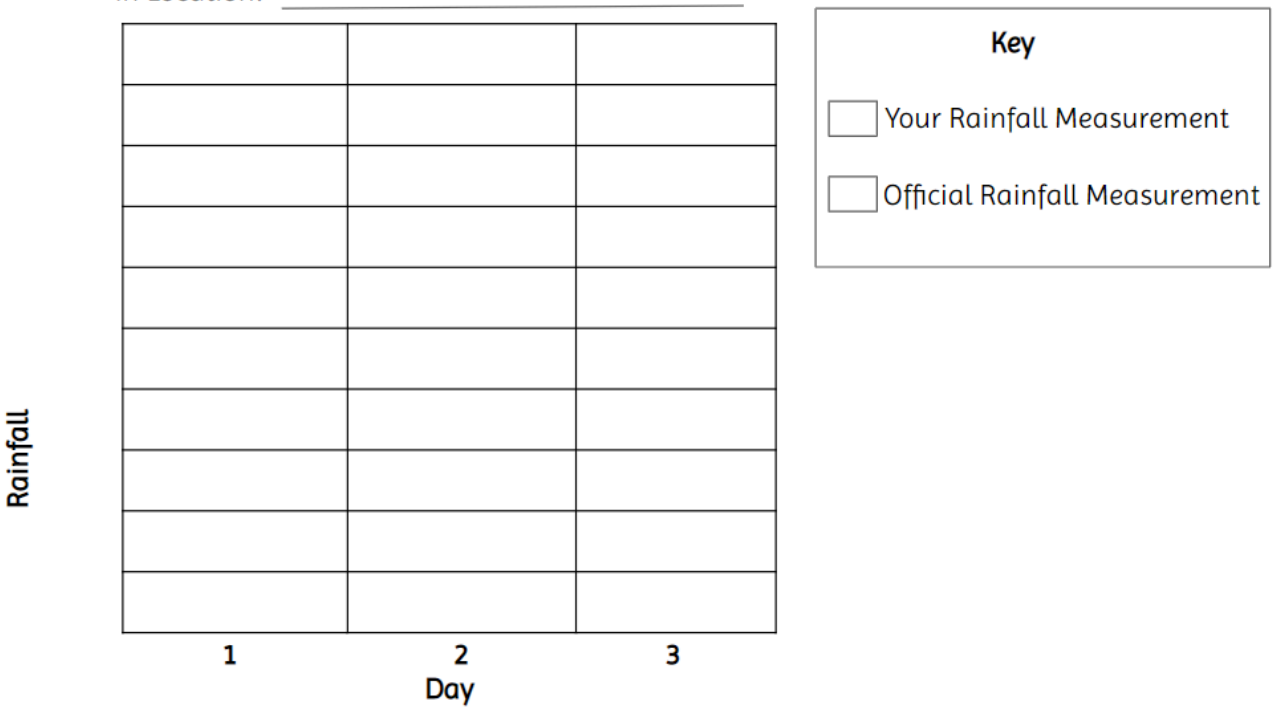
Build your final rain gauge and place it to start collecting data!

Day	Your Rain Gauge Rainfall Measurement	Official Weather Station Rainfall Measurement
1		
2		
3		

Graph of 3-day Rainfall

Title: Rainfall Over Dates: _____

In Location: _____



Analysis & Conclusion:

1. For my rain gauge design to be successful, it needed to have...

2. To see how accurate my rain gauge measurement was, I compared my rainfall measurement to the local weather station's measurement and I found...

3. To make my rain gauge even better, I think I could...

   This would help because...

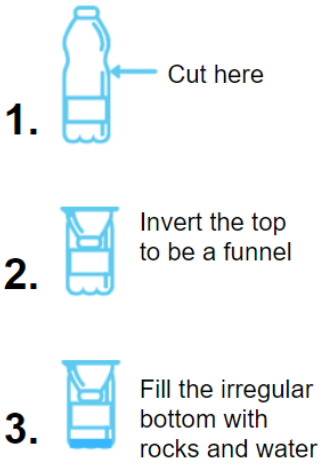
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Example Answer:

Solution Brainstorm

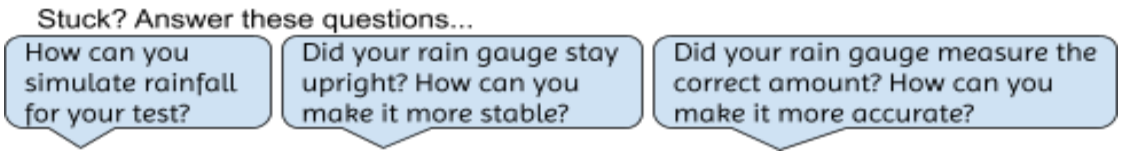
There's no such thing as a bad idea when brainstorming! Here are some useful ideas children might explore:

1. Many bottles have narrow tops, so this can be cut off, so water starts collecting where the diameter becomes the same all the way down.
2. Reduce evaporation by taking the top you cut off and turning it upside down back in the bottle, like a funnel. This way the whole area can collect water, but only a small hole is available for water vapor to escape up and out through.
3. Many bottles have irregular bottoms, but you can't cut that off without water leaking out! So instead, you can fill the bottom with rocks (to make it heavier & more stable) and water (to fill in the cracks between the rocks). Then, you start measuring your water height from that water level on up!



Prototype Test

Build your rain gauge and test it out!



Rain Gauge Design Test #	Amount of Simulated Rainfall	Your Rain Gauge Measurement & Other Observations
1	1 cup	Rain gauge tipped over, so we put rocks in bottom
2	1 cup	Noticed water dripping between cracks in rocks without getting measured, so we filled in cracks with water
3	1 cup	Worked great!

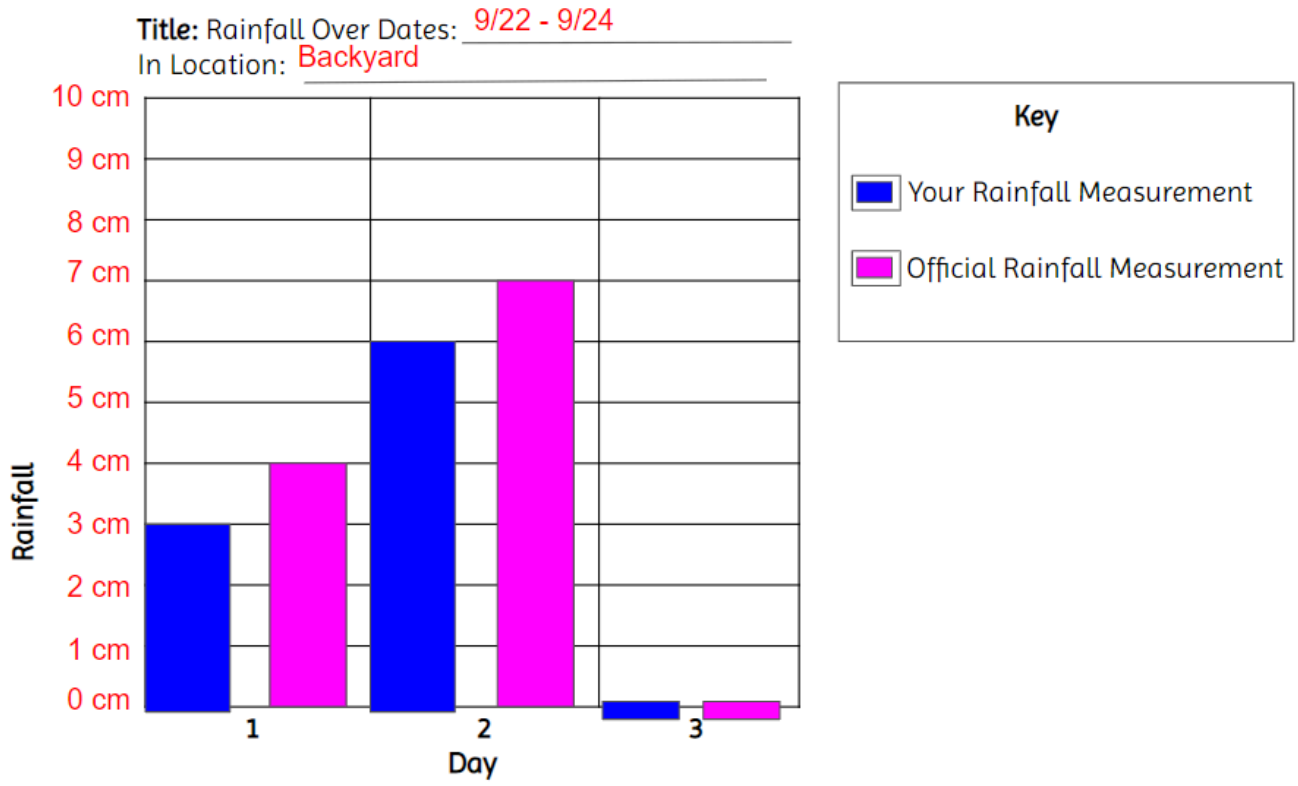
Final Test

Build your final rain gauge and place it to start collecting data!

Day	Your Rain Gauge Rainfall Measurement	Official Weather Station Rainfall Measurement
1	3 cm	4 cm
2	6 cm	7 cm
3	0 cm	0 cm

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Bar Graph of 3-day Rainfall



Analysis & Conclusion:

1. For my rain gauge design to be successful, it needed to have...
   straight sides, with the same diameter from top to bottom. And, we put a funnel on the top to let all the water in but not let much water evaporate out. It also needed to be weighted down to not tip over.

2. To see how accurate my rain gauge measurement was, I compared my rainfall measurement to the local weather station's measurement and I found...
   The weather station reported rainfall that was close to my measurements. My measurements were always a little less than the official rainfall measurements. My rain gauge may be allowing some rainfall to evaporate

3. To make my rain gauge even better, I think I could... make the funnel on my rain gauge go down even smaller.

   This would help because... less rainfall would be able to evaporate.

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