Rainfall, Part I

One of the phenomena that we are going to track throughout the year is rainfall. We often hear on the weather report that a certain amount of rain fell in a twenty-four hour period. We usually hear the total rainfall for the month reported as a number of inches. But what does this mean? How do we measure rain? When a weather reporter states that an inch of rain fell, how is this being measured? Did the reporter measure the sizes of raindrops on their way down?

“Inches of rain” is an example of a phrase that is used more often than it is understood. Science is full of words and phrases like that. Atom, gene, momentum, compound, and precipitation are other examples. To really understand any of these things, we have to work up from the simplest levels, starting with things that we are absolutely sure we understand and working our way toward things that we only think we understand. It is only then that we can try to grasp the things that we know we don’t understand. This process is part of what is called “critical thinking” and it is a crucial part of scientific study.

➢ Of course, we all have ideas about the ideas and phrases we encounter. Write down your best ideas as of this point to the question “What is meant by the phrase ‘an inch of rain’?”

THINKING ABOUT RAINFALL...

Rain is water. If you need to buy a container to hold water, you will need to specify how big the container should be. You could try to buy a container that holds "seventeen water" or "three miles of water" but neither one of those sounds right.

➢ If you need to know how much water a fish tank will hold, what units (and dimensions) do you need to know about?
MEASURING RAINFALL, PART I: USING RECTANGULAR CONTAINERS

Returning to our original question, what does it mean to say that we just had “one inch” of rain other than that we are really wet? Inches measure length or one-dimensional objects. But common sense tells us that rain needs to be measured in containers which means using three-dimensional objects or volume.

**Thought experiment:** Imagine that we leave two containers outside during a rainstorm. One of the containers is wide and flat but not very tall (a cake pan or a baking dish would be a good example). The other container is tall and very thin like a tube with the bottom end sealed off. A picture of the two containers is shown below.

![Diagram of a flat container and a tall container](diag.png)

We leave the two containers out for the same amount of time. A lot of rain falls but not enough for either container to overflow. When we collect the containers again, we will be able to compare the amount of water in the two containers.

Make a prediction and discuss it with your classmates: How will the water in the two containers compare?

*(We are going to try the experiment later.) Remember, predictions are not graded! They are a way to get us to check our assumptions and start thinking about a problem. The most important predictions in science are always the ones that turn out to be wrong!*

- **Prediction part 1:** In the diagram above, sketch how you think the water in the two containers will compare after they have been left out in the rain (the same rainstorm) for the same amount of time.

- **Prediction part 2:** Explain in words how the water in the flat container will compare with the water in the tall container. Describe what will be the same and what will be different. *(You may want to use a separate piece of paper.)*
Soon we will run the experiment for real, but first take a look at the equipment. Collect several open rectangular containers with different shapes and sizes. Take a good look at your containers. Imagine that you placed these outside on a rainy day in the same location for the same length of time, and imagine what would happen.

1. Would the amount of water in each container be the same? When we talk about amount of water, to what dimension(s) are we referring? (A dimension might be length, area, volume, mass, etc.)

2. Would the height of the water in each container be the same? When we talk about height, to what dimension(s) are we referring?

In your group, discuss again what you think will happen. Again, write your prediction! (It is okay if your prediction here is not the same as your prediction before you looked at the containers.)

PREPARING FOR RAIN

1) Measure the base area of each of your containers. Record your results. (We will write them in a table later.)

2) Imagine that you have one rectangular box with a base that has an area of twelve square centimeters. A picture of the base is sketched below…

```
  1  2  3
  4  5  6
  7  8  9
```

   a) If this box had a height of 1 cm, how many 1 cm³ plastic cubes could you fit in the box?

   b) What would the volume of the box be?
c) Are the answers to these questions the same? (Hint: the answer is "no," so what's different about the two answers?)

3) If that box had a height of 2.0 cm…
   a) How many 1 cm plastic cubes could you fit in the box?
   b) What would the volume of the box be?

4) If that box had a height of 2.5 cm…
   a) How many 1 cm plastic cubes could you fit inside the box?
   b) What would the volume of the box be?
   c) Are the numerical parts of the answers to these questions the same?
   d) What would you have to do (to the cubes) to make the numerical parts of the answers the same?

5) Pretend that you have to explain your answers to the questions above, to a child who does not know how to multiply. What would you say? What words would you use? The concept you are trying to relate is called proportional reasoning and it is one of the most useful tools in all of science. Discuss with your classmates how you might explain this proportional reasoning to a child, and record some of your ideas below
MAKING IT RAIN:

In the room you will find several “rain machines”. A rain machine is a box that would be water tight if it weren’t for all of the holes somebody punched in the bottom. Using your rain machine, make it rain over your collection of containers for a specified amount of time. (You may find you have enough water after ten seconds or you may need 30 seconds, but once you decide how much time you need, make sure that each container is rained on for the same length of time!)

- Measure the **volume** of rain in each container. Record your results in the following table.

DATA TABLE: fill in the *FIRST FIVE* columns now

<table>
<thead>
<tr>
<th>Table 2-4:</th>
<th>Length (cm)</th>
<th>Width (cm)</th>
<th>Height (cm)</th>
<th>Area (cm²)</th>
<th>Volume (cm³)</th>
<th>Volume/Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) What do you notice about the quantities entered in the “Height” column for each of the containers? (Are they pretty similar, pretty different…)

2) What do you notice about the quantities entered in the “Volume” column for each of the containers? (Are they pretty similar, pretty different…)

3) The sixth column asks you to divide the volume by the area. On your calculator this means to type in “volume ÷ area =”. Think about what the units for this number might be. What does it measure?

4) Using a separate sheet of graph paper, make a line graph with the base area of the containers as the independent variable (input) and the volume as the dependent variable (output). How would you describe this graph? (Straight? Curvy? Wiggly?)