# Water in a Cup Activity

In this activity, students will investigate the phenomenon that occurs when a cup of water covered with an index card is inverted. Following their time for investigation, students will discuss what they have observed, proposing explanations for the .

**Materials for each group of 3-5:**

- Cups of various heights, widths
- Index cards of various sizes, materials
- Playing cards, other card sizes that can fit over cups' "mouth"
- Tub (to catch water)
- Pitcher (for holding water)
- Various tools for measuring volume (e.g. grad cylinder, measuring cup)
- Ruler

**Step 1: Demonstrate the Phenomenon**

1. Fill the cup full with water and place the index card on top of the cup.
2. Put one hand on top of the card and invert the cup, holding the card in place.
3. Take the hand that was holding the card slowly away. (*The water should stay in the cup*.)
4. **Ask:** "What do you think is keeping the water in the inverted cup? Write down your ideas on the piece of paper." Encourage participants to include a drawing to help them to explain their idea.

**Step 2: Explore the Phenomenon**

1. **Ask / state:** "We do not 'believe' things in science – we collect evidence to support our assertions. Your goal today is to replicate this phenomenon, and then use the materials at your table to collect evidence that helps to explain why the water stays in the inverted cup. In 20 minutes, you will share your findings with the group."
2. Participants take ~20 minutes to explore, using the materials at their tables.
3. Facilitator could provide a visual timer, or remind at 5-minute intervals.

**Step 3: Discuss the Phenomenon**

1. Facilitate a discussion with the group of participants, starting by allowing each group to share their findings. Be sure to clarify participants' 'findings' (what was observed) vs. their conclusions (what was inferred).
2. Some sample language includes:
    a. What evidence do you have to support your assertion?
    b. How did you arrive at that conclusion? What made you think that?
    c. Did it always work that way?
    d. Who can add on to the idea that this group is building?
    e. Are you saying the same thing as what the other group says, or something different? How is it different?

**Step 4: Evaluate our Understanding**

1. **Ask:** "Considering what you have seen and heard today, summarize your thinking on a sheet of paper in front of you. How would you add to / change your initial statement?"
2. Compare to neighbors for self-evaluation, or collect from participants.

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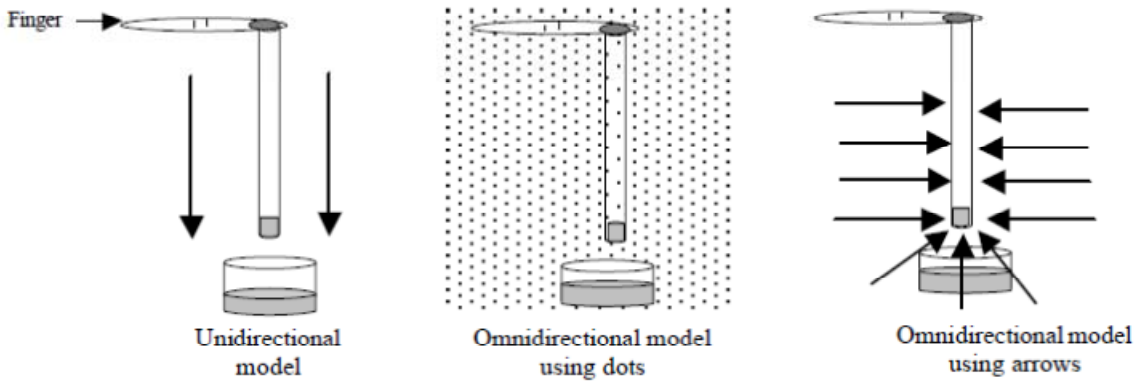
**Note to Teacher:** The reason this activity works is because the air pressure (14.75 lbs. per square inch) acting omnidirectionally outside the cup is greater than the air pressure inside the cup. If the cup is completely full, there is no air, and therefore no air pressure in the cup, so only outside air pressure is acting to keep the water in the cup. If the cup is not completely full, then Boyle's Law is in action. As you invert the cup, some water drips out, and the volume containing the air pocket increases. However, no more air can enter the cup, so the air in the pocket spreads out to fill the available space and the air pressure is lowered. The outside air pressure is greater than the inside air pressure, so the water stays in the cup.

What is the difference between the *Water in a Straw* activity and this activity (see diagram below)? In the straw activity, you don't need a card across the bottom of the straw because the diameter is small enough that the **surface tension** of the water forms a meniscus and prevents the water from dripping and the air from displacing the water. Unlike the *Water in a Straw* activity, turning the cup sideways often results in the seal to the paper breaking and the water spilling out. Theoretically, however, one should be able to turn it sideways




So, if we are high school teachers, this is called "Boyles's Law" and it is represented by symbols: P1V1 = P2V2 and we say that decreasing volume increases collisions and increases pressure and a model of how that looks is:

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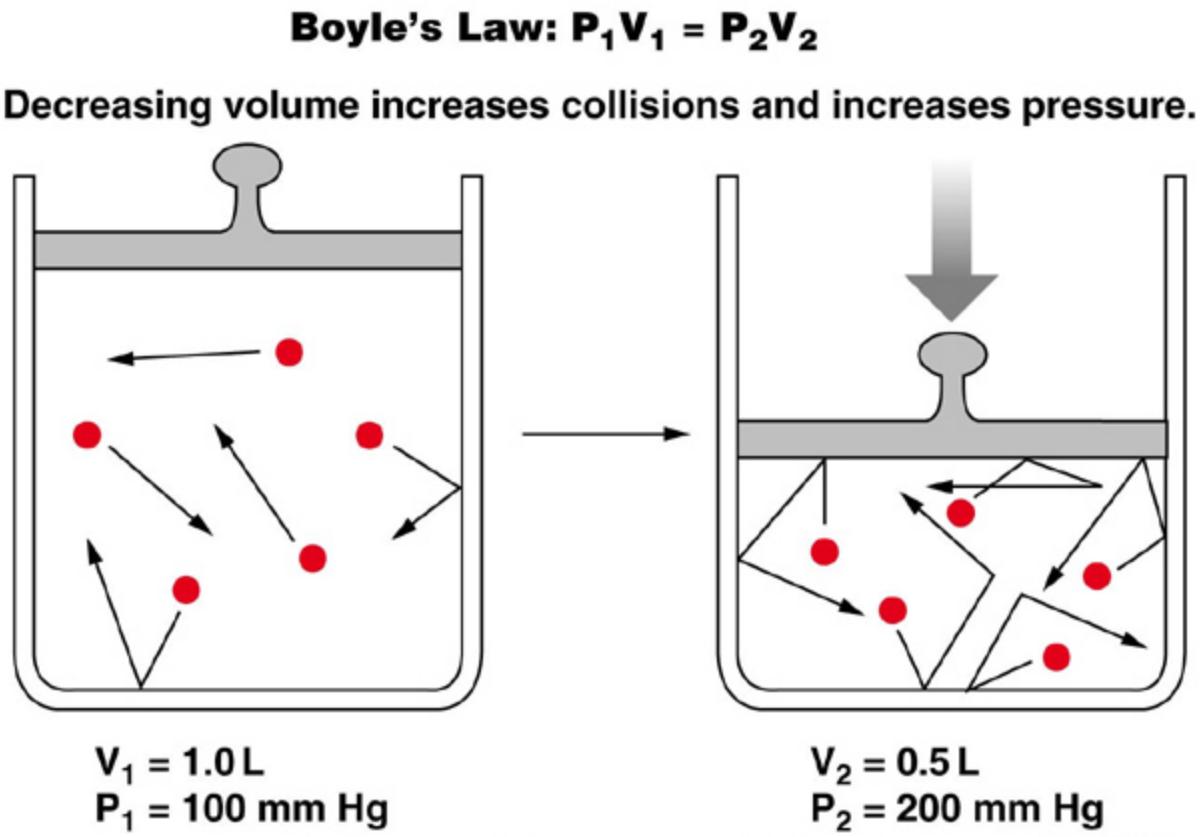


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Fig. 17-5

Show clip from *A Private Universe: Where does most of a tree's mass come from?*

Ask for reactions to clip. Why do these students believe that most of a tree's mass comes from water or soil?

Do we explicitly teach students that the mass of trees comes from water or soil?

Why do they believe that?

How do we usually teach photosynthesis? (Usually, the equation first or near the beginning)

Is the equation conceptual or procedural?

What is the concept behind photosynthesis?