Chapter 16: Quick Activities

Water and Air Resources

Rain in a Can

When water vapor condenses in a closed container, very low pressure is created inside the container. The atmospheric pressure on the outside then has the capacity to crush the container. In this activity, you will see how this works for water vapor condensing inside an aluminum soda can. Note: avoid touching the steam produced in this activity—steam burns can be severe.

PROCEDURE

1. Add ice water (at least 1 inch deep) to a saucepan and set aside.

2. Put a tablespoon of water in an aluminum can and heat on a stove until steam can be seen coming from the top.

3. Grasp the can with tongs and quickly but carefully invert it (top first) into the ice water in the saucepan. Hold it there for a few moments until the can potentially implodes.

ANALYZE AND CONCLUDE

1. How much air was in the can when it was being heated and steam started coming out of the top? How much water vapor was in the can at that time?

2. What happened to the temperature inside the can when it was inverted in the ice water? What do you suppose then happened to the water vapor within the can?

3. Which occupies more volume: water in a gaseous phase or the same mass of water in a liquid phase?

4. What happened to the pressure within the can as the water vapor within it condensed? How did this internal pressure compare to the external pressure exerted by the atmosphere?

Personal Water

In this activity you will be estimating the volume of water you use daily for personal hygiene. You will need a metric ruler, a bucket, a 500-milliliter measuring cup, and a timer that can measure in seconds.

Flushing

Calculate the volume of water in your toilet's tank by multiplying the height, width, and depth of the water it contains in units of centimeters. Divide by 1000 to convert cubic centimeters to liters. Alternatively, shut off the water valve to the toilet, flush to empty the tank, and then fill to the normal fill line using the measuring cup while keeping track of how much water you add. This is the amount of water used each time you flush. Multiply this number by the average number of times you flush each day.

Shower/bath

Use a measuring cup to add 1 liter of water to the bucket. Mark the water level and then pour out the water, preferably over some plants. Turn on the shower or bath to a typical flow and time how many seconds it takes to fill the bucket to the marked level. Your volume— 1 liter—divided by the number of seconds is the flow rate in liters per second. To convert to liters per minute, multiply this value by 60 seconds/minute. For instance, if it takes 5 seconds to collect 1 liter of water, the flow rate is 1 L/5s : 60s/1min = 12 L/min. The next time you shower or bathe, note how many minutes you run the water and then calculate the volume of water consumed.

Bathroom sink activities

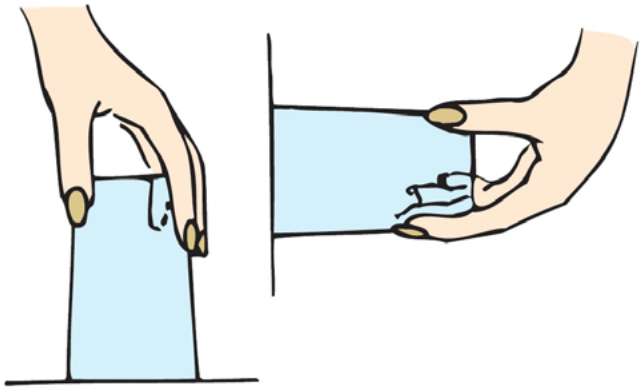
Turn on your bathroom sink faucet to a typical flow rate and measure the number of seconds it takes to fill the measuring cup. (Recall that 500 milliliters equals 0.5 liter.) Record the number of seconds you run the faucet at this rate over the course of a day as you wash, brush your teeth, or shave; then calculate the volume of water you've used.

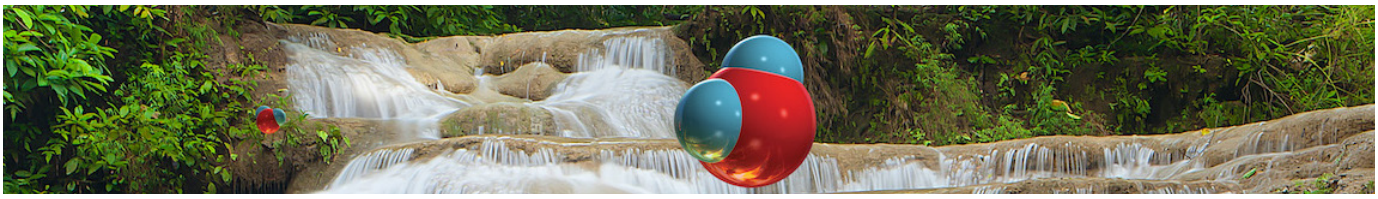
Grand Total

Estimate your water use from other household activities, such as the washing machine, washing dishes, food preparation, drinking water, or watering the lawn. Add up your total personal water use per day and multiply by 365 to find water use per year. Then multiply your water use per year by the population of the nation in which you live. How might this compare to water use in other nations?

Heavy Air

Place a card over the open top of a glass filled to the brim with water; then invert the glass. Why does the card stay in place? What happens when the glass is held sideways?





Author Responses to Quick Activities

Rain in a Can

1. After steam starts coming out the top, the inner volume of the can consists primarily of water vapor. The air gets pushed out by this water vapor.

2. When inverted into the ice water, the internal temperature of the can drops. As a result the water vapor within the can condenses to a liquid phase.

3. Gaseous water of the same mass occupies a much greater volume.

4. As the water vapor within the can condensed, there were fewer gaseous molecules to exert a pressure. The internal pressure thus quickly dropped. The can was then crushed by the greater atmospheric pressure.

Personal Water

Toilet tanks typically hold from 6 to 17 liters of water. Federal regulations mandate that new shower head flow rates cannot exceed more than 9.5 liters per minute (2.5 gallons per minute). Shorter showers and shallower baths save energy as well as water. The maximum flow rate of a faucet is determined by the aerator, which is a screen that screws on to the tip of the faucet. These screens need to be replaced periodically as they collect particles and corrode.

Heavy Air

The weight of the air pushing against the outer surface of the card is much greater than the weight of the water pushing against the inner surface of the card. This demonstration would not work on the moon. Do you understand why?