

Chapter 20.2 (Cloud Formation)

Activity D. A Cloud in the Hand

This activity provides a rough analogy for cloud formation in the atmosphere. Water is added to a 1-liter plastic bottle along with smoke from a burning match and then capped. Squeezing the bottle dramatically increases the pressure (and slightly increases the temperature) inside the bottle. At this higher pressure some of the water that was in the vapor phase returns to the liquid phase until a new equilibrium state is reached. When the pressure on the bottle is released the pressure (and temperature) within the bottle drops suddenly, creating a partial vacuum. To re-attain equilibrium, water now goes from the liquid phase to the vapor phase. At this point the area above the liquid becomes saturated with water vapor which condenses on the "airborne" smoke particles (condensation nuclei) to form a cloud. This saturation is caused by unequal pressures of the liquid and vapor phases upon expansion of the bottle. Think of the inequality of pressure as an instantaneous partial vacuum.

After going through a few squeeze and release cycles hold the bottle up to a fluorescent (overhead) light. By releasing and applying the pressure slowly, various colors may be evident (primarily purple and orange). This occurs because light passing through the bottle is differentially scattered by the smoke particles as the pressure varies, similar to the atmospheric effects seen at sunset!

Concepts

- Condensation
- Cloud formation
- Gas laws

Materials

Clear plastic bottle, 1-L

Matches

Cap for bottle

Water, 10 mL

Procedure

1. Add approximately 10 mL of water (room temperature) to the 1-L bottle and screw on the cap.
2. Shake the bottle to distribute the water on the interior surface and let the bottle stand for at least a few minutes. This will allow time for some of the water to evaporate.
3. Uncap the bottle and light a match. Allow the match to burn for a few moments. Extinguish the match and immediately toss it into the bottle. Quickly cap the bottle very tightly, trapping some of the smoke from the extinguished match.
4. Using both hands, squeeze the bottle. The pressure in the bottle will increase significantly.
5. Quickly release your grip and observe the bottle interior. A cloud will form. Repeat as often as desired.
6. Answer the questions in the *Observations and Results* section.

Observations and Results

1. What does the smoke from the match represent?
2. What causes the cloud to form in the bottle?
3. What would happen if the smoke from the match was not present? Why?