

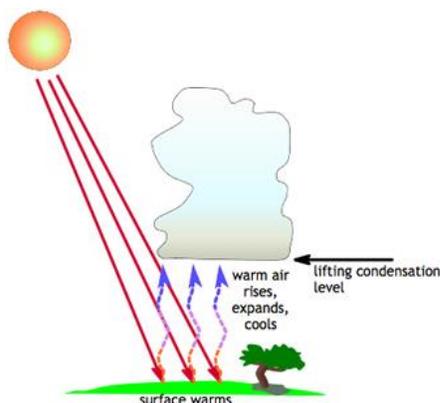
## Lesson Plan for “Cloud in a Bottle”

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### Introduction/Background Info

Clouds are a familiar sight to any child yet they can be as mysterious as the stars in the night sky. This lesson uses some of this natural curiosity to teach basic concepts of chemistry such as phase change while making miniature clouds. The basic theory states that vapor can condense into clouds by adding pressure or adding more vapor. In the first part of the experiment a hand pump introduces more pressure, in the second part rubbing alcohol introduces more vapor.

These main ideas can be related back to real life examples. For instance, when the sunlight is in contact with a body of water, the water evaporates to form water vapor. Water vapor molecules jumble together and rise upwards into the air. When the thermal energy between molecules is not strong enough to pull the molecules apart, the molecules stick together and form little droplets which eventually comprise of a cloud.



### Student Objectives

- To understand the processes of evaporation and condensation
- To understand the solid, liquid, and gas phases
- To introduce the concepts of atoms and molecules

### Topics

- Evaporation: the process by which material in a liquid state changes to the form of a gaseous state
- Condensation: the process by which material in a gaseous state changes to the form of a liquid state.
- Lowering pressure (on the cloud bottle) results in air expansion and temperature lowering. As the temperature lowers, the molecules stick together (condensation) and forms water droplets.

- Consider the ideal gas law, which states that  $PV=nRT$ . There is an inverse relation between the pressure and volume and a direct relation between pressure and temperature. Thus, when the pressure decreases, the temperature decreases but the volume increases.

### Overview of Lesson Process

- Ask the students about the water cycle. Introduce evaporation and condensation. Can they think of any everyday happenings where condensation and evaporation takes place? (5 min)
- Use analogies to introduce the relationship between pressure and volume. In what everyday sense do we see this relationship take place? (5 min)
- Have the students brainstorm and hypothesize what the cloud size will be based on the amount of pressure, then conduct the experiment step by step by varying the amount of pressure. (25 min)
- Wrap up the lesson by reiterating the concept of the water cycle and the relationship between pressure and volume. Have the students describe what they saw during the experiment. (10 min)
- Clean up all the materials and dispose bottles appropriately. (5min)

### Materials

#### Water

1 liter clear plastic bottle w/ cap	1 per group	Supplied by mentors	
Foot pump w/ rubber stopper	1 per site	Dick's Sporting Goods	\$15
Rubbing Alcohol	1 per site	Global Industrial	\$3.17
			<i>Total: \$18.17</i>

### Procedures

1. Pour just enough warm water to cover the bottom of the plastic bottle. NOTE: Mentors must handle the hot water for safety reasons.
2. Swirl the plastic bottle to allow the hot water to spread more within the bottle. Then place the rubber stopper on top.
3. Connect the stopper to the pump and hold on tightly as you pump air in.
4. After roughly 5 pumps let go of the stopper. Some faint clouds should form. Play around with the pump to get a thicker but smaller cloud. Encourage students to think about how the pumping process could affect the size of the cloud. How does this relate to the process of condensation?
5. Now, double the pressure by pumping 10 times instead. Ask students what they observe. Does the cloud appear to be thicker or thinner? The cloud should be more apparent once the stopper is released.
6. Repeat this experiment pumping 20 times (about 20 lbs of pressure). Once again, ask students what they observe. Is there a correlation between pressure and the cloud size?
7. Empty the water from the bottle.
8. Place a few drops of rubbing alcohol in the plastic bottle.
9. As done previously with the water, swirl the liquid inside so it coats the sides of the bottle and then place the rubber stopper.

10. Use the pump once again to build up the pressure and then release the stopper to make the cloud appear. Have students observe the cloud size. What effect does the alcohol have on the cloud?

**Resources**

Steve Spangler Science: <http://www.stevespanglerscience.com/experiment/cloud-in-a-bottle-experiment>

Web Weather for Kids: <http://eo.ucar.edu/webweather/cloud3.html>