

# CLOUD FORMATION (A.K.A. CLOUD IN A BOTTLE!)

## Overview

Clouds are made of tiny water droplets and ice crystals up in the atmosphere. Clouds provide shade when they block the sun by reflecting its rays of light and can produce rain when the water droplets grow big enough to fall due to gravity.

Clouds are formed when warm air rises and its pressure is reduced. As the pressure decreases, the air expands and cools. When the temperature falls below the dew point, the air becomes saturated with respect to water vapor and water droplets condense upon the surfaces of tiny particles called cloud condensation nuclei. In this activity, students will learn how temperature and pressure changes lead to the formation of clouds.

**Target Audience:** K+, works well in small group / STEM fair format

## Prior Knowledge

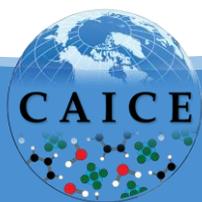
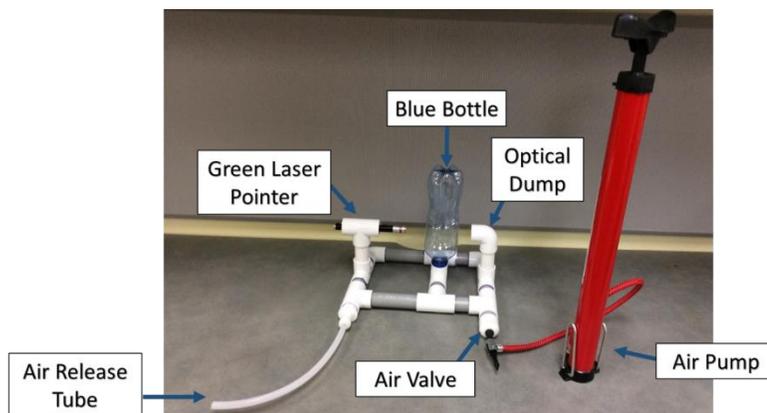
- Clouds are composed of water
- Clouds play an important role in determining the temperature of the earth.

## Learning Objectives

- Learn how clouds form in the atmosphere due to the relationship between temperature, pressure and phase changes
- The impact clouds have on climate (scattering of light)
- The importance of tiny particles as cloud condensation nuclei.

## Materials List

- Cloud-making kit (see photo; replacement water bottles are Propel brand.)
- Laser pointer
- Water (warm and cold)
- Matches (optional)
- Safety glasses (for all participants)



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## Instructions

### To make a cloud in a bottle:

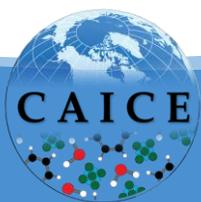
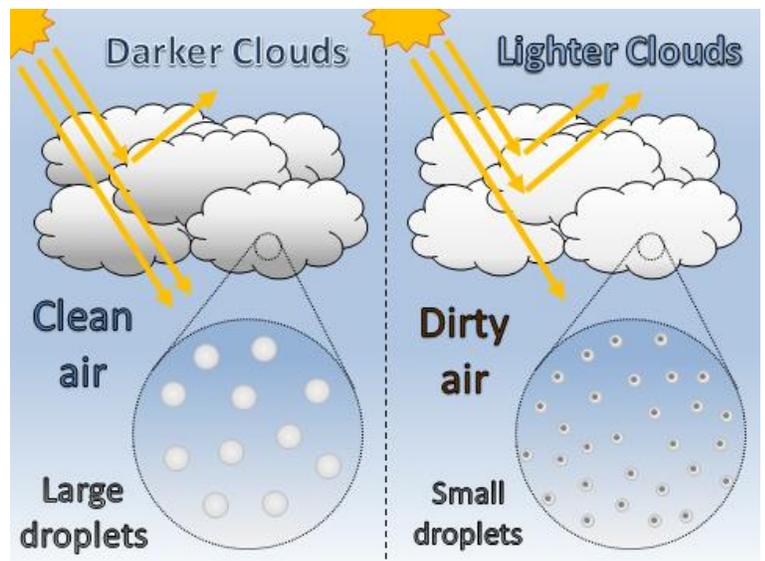
1. Pour liquid into bottom of bottle (just enough to cover the bottom) and rotate/shake bottle to encourage evaporation.
2. Turn bottle upside down and screw into the threaded PVC pipe. Ensure that bottle is screwed on completely so that the system is air-tight.
3. Attach the air pump to the air valve.
4. Have one student use their thumb to plug the air release tube.
5. Increase the pressure in the system by having another student pump the air pump about 5 times to achieve a pressure of 8-10 PSI. The bottle should feel pressurized to the touch.
6. Ask the student to release their thumb from the air release tube, thus decreasing the pressure.
7. Immediately turn on the laser pointer to see if a cloud has formed. (CAUTION: Laser pointer should always be pointed into the attached optical dump)

### Explanation:

When pressurized, the liquid water evaporates into the air as water vapor. When the pressure in the bottle is released, the water vapor condenses to form small particles, or cloud droplets. In the atmosphere, heat at the Earth's surface causes liquid water to evaporate into water vapor. Warm air containing water vapor rises in the atmosphere, because it is less dense than cold air. As the air rises, it cools and the pressure decreases, then water vapor condenses to form cloud droplets.

**Variations:** Repeat steps 4-7 with the following variations:

- A) **Compare warm and cold water**, with equal pressures, to determine which makes a bigger cloud. (The warmer water evaporates more readily and more water droplets are formed. Thus, the cloud is thicker and brighter.)
8. **Add cloud condensation nuclei** by lighting a match, blowing it out, and then adding it to the bottle prior to pressurizing it. (The presence of



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these cloud condensation nuclei provide a surface upon which the water vapor can condense. In the atmosphere, tiny particles called aerosols provide a nucleus for cloud droplets. The result is small water droplets that make the cloud thicker and brighter. In contrast, clouds formed in clean air consist of large droplets, these clouds allow light to pass through them and appear dark and translucent.) To repeat the demo, remove the match from the bottle, rinse the bottle, and pump some air through the apparatus to remove as much of the CCN as possible.

## Safety and waste disposal

Because of the pressures used in this demonstration, the demonstrator and participants should wear safety goggles to protect their eyes from any flying objects. Ensure that the laser pointer is properly pointed towards an optical dump and never towards anybody's eyes. Ensure matches are fully extinguished before disposal. Excess water solutions may be poured down the drain.

