Cloud in a Bottle Lesson Plan

Amount of time Demo takes: 3 mins.
Don’t try this at home!

Materials
- Glass jug
- Air pump
- Rubber Stopper
- Matches (1 box/event)
- Spray bottle with water
- Poster of clouds

Set-up Instructions/Instructional Procedure
1. Spray a fine mist of water into the glass jug. (Make sure the jug is clean and does not have alcohol left from version 2 of the demo. You could burn yourself or others.)
2. Light a match and put it inside the jug. Make sure you get some smoke particles trapped inside the jug and stopper it closed.
3. Pump air into the jug until you feel resistance on the pump - hold onto the stopper as you do this. Do not overfill the jug - the stopper could pop off in your face or glass jug could break.
4. Remove stopper and watch the cloud appear.
5. You may be able to make a cloud from the same ingredients a few times in a row to show people you are demonstrating it to by pumping in air and releasing the stopper.

SAFETY!
- Wear safety glasses when pressurizing the jug.
- Hold onto stopper as you are pumping. Do not over pressurize the bottle - the stopper could pop off, or the jug could be damaged.
- Children should not handle matches.

Lesson’s Big Idea
- If you pump air back into the cloud filled bottle, the cloud will disappear as the temperature increases, when released the cloud will reappear.
- High pressure: Clear skies and clear bottle
Low pressure: Cloudy skies and a cloud in the bottle

**Background Information**

1. Discuss the ingredients for a cloud, and how clouds form. Use examples they may be familiar with, like seeing their breath on a cold day. Hot moist air hits cold dry air, and a cloud forms from your breath.
   a. Water molecules are in the air all around us called water vapor. When the molecules are bouncing around in the atmosphere, they don't normally stick together. Pumping the bottle forces the molecules to squeeze together or compress. Releasing the pressure allows the air to expand, and in doing so, the temperature of the air becomes cooler. This cooling process allows the molecules to stick together, condense, more easily. The reason the rubbing alcohol forms a more visible cloud is because alcohol evaporates more quickly than water. Alcohol molecules have weaker bonds than water molecules, so they let go of each other more easily. Since there are more evaporated alcohol molecules in the bottle, there are also more molecules able to condense.
   b. Clouds on Earth form when warm air rises and its pressure is reduced. The air expands and cools, and clouds form as the temperature drops below the dew point. Invisible particles in the air in the form of pollution, smoke, dust or even tiny particles of dirt help form a nucleus on which the water molecules can attach.
   c. Clouds generally form when rising air is cooled to its dew point, the temperature at which the air becomes saturated. Condensation at surface level results in the formation of fog. If sufficient condensation particles are not present, the air will become supersaturated and the formation of cloud or fog will be inhibited. There are four main mechanisms for cooling the air to its dew point: adiabatic cooling (air rises and expands) which tends to produce cloud, and conductive, radiational, and evaporative cooling that can result in the formation of fog. The air can rise due to convection, large-scale atmospheric lift along weather fronts and around centers of low pressure, or as a result of being forced over a physical barrier such as a mountain (orographic lift).[5] Conductive cooling occurs when the air comes into contact with a colder surface,[6] usually by being blown from one surface to another, for example from a liquid water surface to colder land. Radiational cooling occurs due to the
emission of infrared radiation, either by the air or by the surface underneath.[7] Evaporative cooling occurs when moisture is added to the air through evaporation, which forces the air temperature to cool to its’ wet-bulb temperature, or until it reaches saturation.[8]

3. Show the cloud poster and discuss cloud types, if outside you can help them identify the types of clouds in the air. Different types of weather, wind, air pressure, temperatures form different types of clouds.
1. What ingredients do you need to make a cloud? (water vapor, dust particles, change in air pressure)
2. What causes the sound you hear when the stopper is removed? (the air rushing out)
3. High pressure equals what kind of sky? Low pressure equals what kind of sky? (clear; cloudy)
4. What causes the cloud to form in the bottle? (We add the water, dust and air, but there is no cloud until the stopper is removed. The air pressure is very high when you pump air into the jug, when you pull out the stopper the air pressure goes down very quickly. This change in air pressure drops the temperature in the bottle and forms the cloud because of condensation.)

Clean Up
- Clean up between demos if needed. When completely finished gather all materials listed for this demonstration and make sure everything is accounted for. If something was used up, broken or damaged. Let someone know so it can get replaced or fixed.
- Clean out the bottle, get all the matches out. **Do not** put matches down the drain.

References
- [http://web.gccaz.edu/~lnewman/gph111/topic_units/Pressure_winds/pressure/pressure2.html](http://web.gccaz.edu/~lnewman/gph111/topic_units/Pressure_winds/pressure/pressure2.html)

Next Generation Science Standards
- K-5
  - K-ESS2-1/2
  - 3-ESS2-1