

INSTRUCTOR NOTES

Cloud Formation

Goals:

- Understand how clouds form
- Try an experiment demonstrating cloud formation
- Have interns demonstrate their understanding

Estimated Completion Time: ~60 minutes

Materials Required:

- 2-liter plastic bottle with the label off
- bicycle foot pump with valve stem
- a little bit of rubbing alcohol
- A large glass jar (pickle or extra large mason jar)
- A rubber glove
- Large rubber band (that will fit around the top of the jar)
- Matches
- Cup with water
- Optional: a black background (poster board, notebook, etc.)

Part 1. How do clouds form? (~20 minutes)

(YouTube Tutorial: <https://www.youtube.com/watch?v=23-Ks9Wy19I>)

**Note: This tutorial uses a cork to tighten the seal between the bottle and pump, but this is not required.*

Opening Demonstration:

Have the students take out their **Lab 2 Worksheet** for notetaking. First we are going to demonstrate an experiment for cloud formation. Provided for this lab will be a 2-liter plastic bottle, bicycle pump with valve stem, and a little bit of rubbing alcohol. In front of the students, put a little (a tbsp or so) bit of rubbing alcohol in the 2-liter bottle and swirl the rubbing alcohol around the whole inside of the bottle. Attach the bicycle pump with valve stem to the top of the bottle, hold this tightly on so that the pump does not come off the bottle. Have one of the students pump air into the bottle using the bicycle pump. After about 10 pumps, the bottle should feel firm. Pull off the pump and watch the cloud form inside the bottle. Demonstrate this a couple of times for the students.

After the above demonstration, have the students write down in the notebooks their observations. *Ask the students to explain what they observed and why they think the cloud formed inside of the bottle.*

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Cloud Formation Discussion

Ask the students to write down what clouds need in order to form. Allow them a couple of minutes to think and come up with some ideas. Have the students discuss these ideas and write them down on the whiteboard. This will segway into the descriptions below of how the cloud in the bottle works and how clouds form within the bottle. Relate this to real-world cloud formation and be sure to mention the lifting mechanism clouds need in order to get to the location where they are able to form if there are proper conditions.

There are only three ingredients required to make a cloud: **water (moisture)**, **condensation particles**, and a **drop in temperature** to the saturation point or **pressure change**. For real-world clouds to form, a lifting mechanism is also required.

Water: As a part of the water cycle, the water is evaporated from the earth's surface in preparation for making a cloud.

Condensation particles are required for the water vapor to have something to condensate onto. Examples of such particles are dust, clay, soot, sea salt, pollen, and aerosols. For this experiment, we will use smoke as our condensation particle.

Drop in temperature: Warm air can hold more water vapor than cold air, so dropping the temperature causes water to condense. In this experiment, we will use changes in pressure to change the temperature. Warmer temperatures yield higher pressure, for the water molecules become excited as result of the heat. Therefore a drop in pressure would result in a drop in temperature.

Water vapor condenses on condensation particles when the temperature cools to a saturation point. When the clouds we see in the sky are formed, an updraft (air moving upward) pushes water vapor upward. The pressure decreases as the air rises higher, resulting in a temperature drop. When the saturation point (or dew point) is met, the water vapor condenses on condensation particles in the atmosphere and forms clouds.

Fog, a surface level cloud, is seen in cold temperatures and often over ponds. The warm pond contrasts to the cold air and provides a source of moisture.

The temperature and pressure relationship can be described with a simple classroom analogy. If there were twice as many students in the room, everyone would bump into each other and generate a lot of heat. This would be an example of a high pressure situation. But, as it is with a regular class size, the students have "elbow room" and are in a more low pressure situation, thus generating less heat.

Part 2. Cloud in a bottle (Student hands-on) (~20 minutes)

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Instructors walk students through this so that the interns are actually doing the experiment.

Materials:

- A large jar (such as an extra large mason jar or large pickle jar)
- A rubber glove
- Large rubber band (that will fit around the top of the jar)
- Matches
- Cup with water
- Optional: a black background (poster board, notebook, etc.)

Procedure (written for two people):

1. Pour some water from the cup into the empty jar then roll the jar on its side to coat the inside surface with water.
2. Put the rubber band around the rim of the jar.
3. Lab Partner A: put on the rubber glove and insert this hand into the jar. Lab Partner B: Wrap the cuff of the glove around the mouth of the jar and secure it using the rubber band.
4. Lab Partner A: with your hand still in the glove, ball your fist and pull it upwards (but not out of the jar!). What do you see?
 - *As you pull out your hand, the volume of air in the jar increases, but the amount of air stays the same, so the pressure and temperature must decrease. However, since there isn't any condensation nuclei inside the jar, there shouldn't be a cloud that forms (or if there is it will be very faint). Next we'll add condensation nuclei and repeat the process.*
5. Lab Partner B: Undo one side of the glove from the top of the jar, just enough space to drop a match in.
6. Lab Partner B: Light a match and let most of the stick burn. Blow out the match and quickly drop it inside the jar and re-secure the glove around the top of the jar using the rubber band.
7. Lab Partner A: ball your hand into a fist and pull it upward. Now what do you see?
 - *A cloud! The smoke from the match created condensation nuclei that allowed the condensing water vapor to stick to.*
 - *When you push your hand back into the jar, the cloud should disappear.*

Part 4. Cloud observations (~20 minutes)

Try to tie in the base heights of the clouds to the experiments done earlier in lab. Use cloud observations sheet from Lab 1.