

Teacher Notes

Name _____
Date _____

REGENTS EARTH SCIENCE
Laboratory # _____



Title: FLAT BOTTOM CLOUDS (PART 1)

Introduction: You have probably heard people say “hot air rises”, after all isn’t that why hot air balloons rise? Well, if this were the case shouldn’t we be sun bathing instead of skiing on the mountains? What happened to all that hot air? There must

This is a fun inquiry lab investigating the relationship between pressure changes and temperature. You will need a pressure pump such as the Fizz Keeper to pressurize the bottle. There is a lot that you can do with one of these pressure pumps. Neat experiments can be found at:
www.rose-hulman.edu/~moloney/AppComp/2000Entries/Entry04/menagerie.htm
 Buy Fizz Keepers at:
www.arborsci.com/Products_Pages/Pressure&Fluids/Pressure&FluidsBuy1.asp#VacuumPumper

pressure affects clouds in the and relative have to rise to between changes because there is and examine what

happens to the mass and temperature of the air inside the bottle.

Data Table 1

Problem: What happens to air temperature when pressure increases?

Hypothesis:

Regular thermometers will work fine or you can use a digital tape thermometer in order for students to more easily read the temperatures.

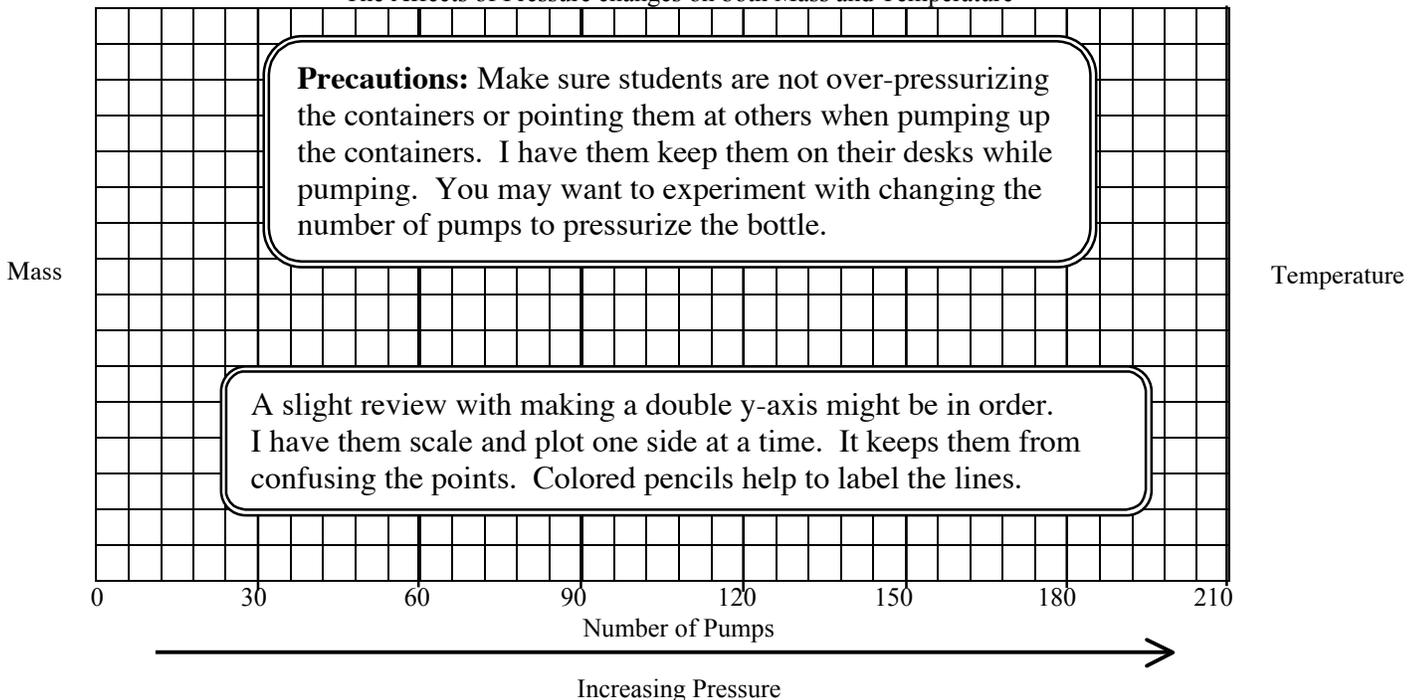
Materials: Digital Scale, empty 2 liter bottle, fizz keeper pressure pump, thermometer, smoke from incense

Procedure Part 1: Relationships

1. Attach a pressure pump to a two-liter bottle.
2. Measure the Mass the container and record the temperature.
3. Pump 30 times. Record mass and temperature each 30 pumps.
4. Complete Data Table then release the pressure and record data.
5. Define a scale for mass and temperature and graph your data.
6. Connect your data points for mass and temperature (two lines).

Pumps	Mass (g)	Temperature °F
0		
90		
120		
150		
180		
210		
Release		

The Affects of Pressure changes on both Mass and Temperature

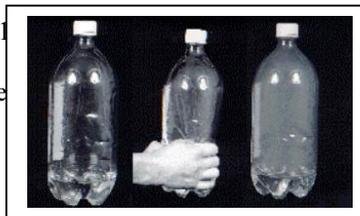


Teacher Notes



Procedure Part 1: Creating a Cloud

1. Pressurize your two-liter bottle by pumping it at least 10 times.
2. Release the pressure. Do you see a cloud? **NO**
3. Bring your bottle to the incense burner and collect 2 seconds of incense.
4. Re-pressurize your bottle to the same amount.
5. Release the pressure. Do you see a cloud? **YES!**
6. Define: Condensation Nuclei:



7. Wh

Students can actually make a cloud by simply squeezing the bottle and releasing. If you don't have incense a match works fine.

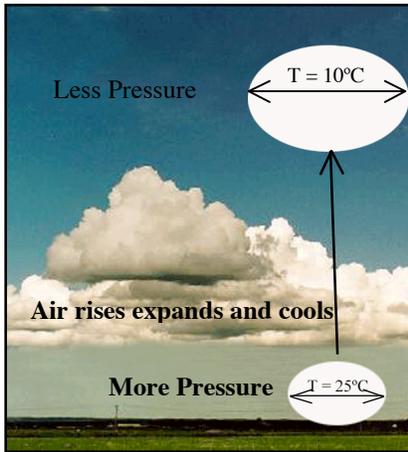
Caution: be aware of students with allergies and asthma. Sometimes it only takes a single match to send someone into an asthma attack.

Part 1 Conclusion: What is the relationship between pressure and temperature? Were you correct?

Make sure to check and see if their graph supports their conclusion.

Part 1 Questions:

1. What happened to the mass and temperature of the air when you released the pressure?
They both decreased.
2. How did the volume of the air change during your experiment? How do you know?
The volume of the air did not change during the experiment. The 2 liter container was the same container used throughout the entire experiment.
3. How did the density of the air change during your experiment? How do you know?
The air became more dense when air was pumped into the container and less dense when the pressure was released. More mass in the same amount of volume = greater density.
4. Why does a change in air pressure affect the temperature of the air (think molecular)?
Temperature increases when pressure increases because the air molecules are more compact and they collide with each other more frequently. This increases the molecular friction which we measure as temperature.
5. Why do farmers in the Midwest "seed" the sky with dust in times of drought?
Clouds cannot form without condensation as students should have seen above. Farmers "seed" the sky to provide a place for cloud droplets to form. About 1 million cloud droplets form one rain drop. Note: The size of the condensation nuclei has been found to impact nature's ability to form precipitation. Very small pollutants may make it less likely for rain to fall and increase the albedo affect of raindrops: www.sp.ph.ic.ac.uk/cows/archive/clouds_and_pollution/pollutionandclouds.htm
6. What does precipitation do to the quality of the air?
Precipitation cleans the air by bringing down all those pollutants!
7. Are clouds water vapor? Why or why not? Explain:
Clouds are not water vapor. Water vapor is an invisible gas. Clouds are made of tiny water droplets that form on tiny particles called condensation nuclei.



Title: FLAT BOTTOM CLOUDS (PART 2)

Problem: Why do clouds have flat bottoms?

Introduction: According to Part 1 of this laboratory you should have learned that pressure has an affect on the temperature of air. These temperature changes are called *adiabatic* temperature changes. Adiabatic

You can have students use the sling psychrometers or regular psychrometers just do not have the set up look exactly the same as what is used for the performance exam. Two thermometers taped to either side of a ruler works fine.

clouds. In this laboratory you will use a psychrometer in order to find out the dewpoint, relative humidity and cloud base of the air in a given area.

Background: Like the word moisture, **humidity** is a general term that refers to the amount of **water vapor** that is in the air. We have all felt days in which the air feels “muggy” or “heavy”, days in which we cannot seem to cool off even if we perspire. These are days when the air has a relatively high humidity or high percentage of moisture in the form of water vapor. We cannot see water vapor in the air but we can measure it with an instrument called a **psychrometer**. A psychrometer is a simple instrument made of two thermometers, one of which has an end covered in a wet cloth. As the thermometers are exposed to air, the thermometer with the wet bulb cools down due to the evaporation of the water. The difference between the thermometers is taken and the Dew Point or Relative Humidity can be read from the charts on your reference tables. Make sure you are using the **dry-bulb temperature** and the **difference between the dry and wet bulbs** when you read information off of your reference tables.

Materials

- P
- R
- C

Procedur

- 1.
2. Find the Dew Point, Relative Humidity, and Cloud Base Height.
3. Divide into groups and collect data at different locations throughout the school.
4. Share your data with the entire class and fill out the rest of your data table.
5. Answer the analysis and conclusion questions.

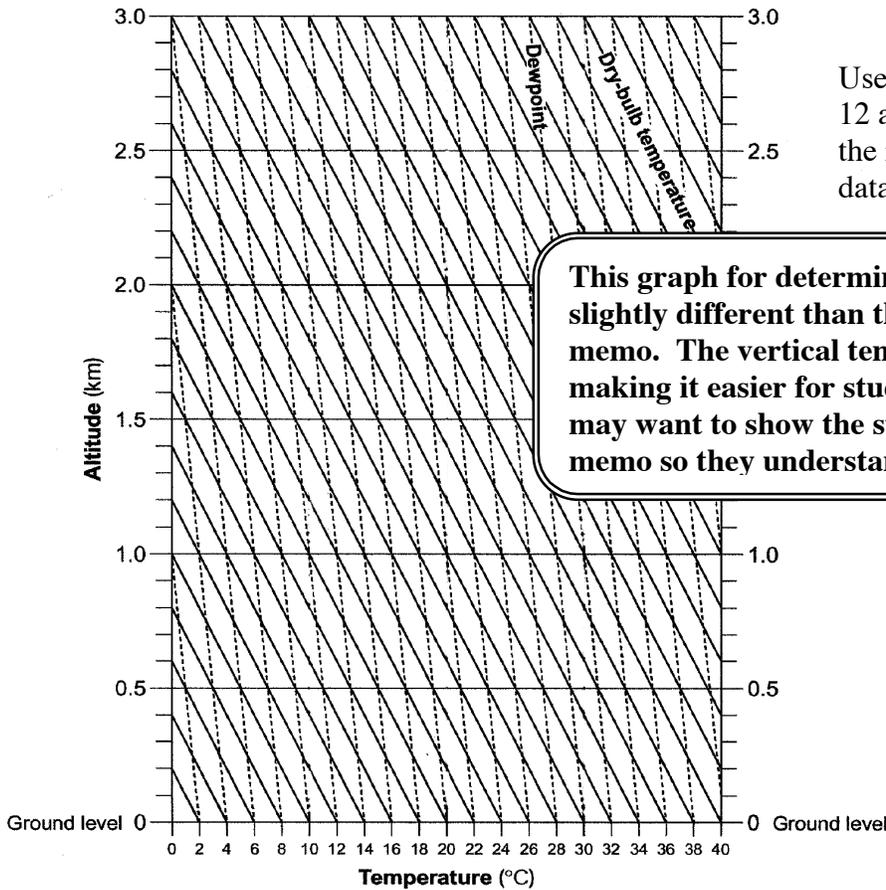
If you set up your psychrometers using a flask to dip the wet-bulb sock students may think that the water is what is cooling the wet-bulb thermometer and not the process of evaporation. One hint may be to place another thermometer in the water flask to show that the water is at room temperature.

DATA TABLE

Location	Dry Bulb	Wet Bulb	Difference	Dew Point	Relative Humidity	Cloud Base Height
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

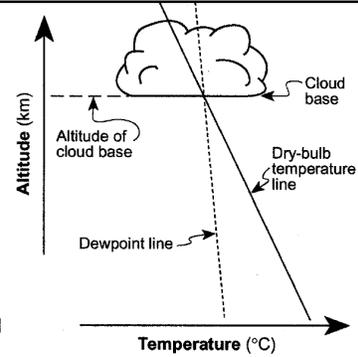
Have students decide the places to collect makes the lab more fun and gives them a part in the design of the lab. You could also set up stations throughout the school and have offices or other classrooms become involved in your laboratory, a nice way to observe if there is any variation throughout the day.

Generalized Graph for Determining Cloud Base Altitude



Use your reference tables on page 12 along with this graph to fill out the rest of the information in your data table.

This graph for determining cloud base height is slightly different than the one given out in the State's memo. The vertical temperature lines are deleted making it easier for students to read this graph. You may want to show the students the graph on the state memo so they understand what those lines mean.



Analysis and Conclusion Questions:

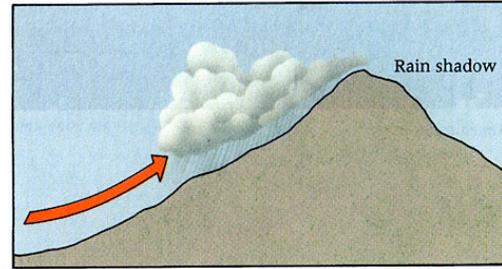
1. What is the cloud base for air with a dry-bulb temperature of 32°C and dewpoint of 22°C? **1.3 km**
2. If the surface dewpoint temperature is 18°C and the clouds in the sky have a base elevation of 2 km, what is the dry-bulb surface temperature? **34°C**
3. What is the cloud height when the dry-bulb temperature is equal to the dewpoint temperature? **0km**
4. What name do we give that type of cloud? **Fog**
5. What happens to the cloud height when the dry bulb and dewpoint temperature approach one another?
As the dry bulb and dewpoint temperatures approach one another the cloud height lowers.
6. Why do clouds have flat bottoms?
Clouds have flat bottoms because as air rises the pressure lowers bringing the temperature down to the dewpoint temperature. At that temperature (altitude) condensation occurs creating clouds.
7. What happens to the temperature of air in the troposphere when it sinks? **The temperature increases because of a increase in air pressure. This change in temperature is called adiabatic heating.**

Teacher Notes

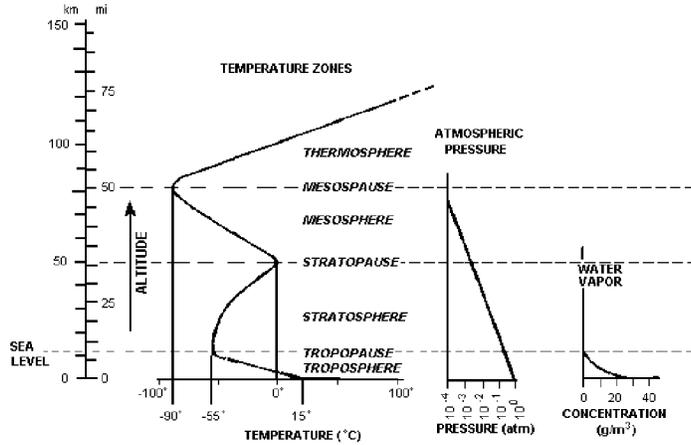
8. Explain this drawing of the Orographic effect:

Why is rain only falling on one side of this mountain?

As air is forced over the mountain air pressure decreases cooling the air to the dewpoint and condensation/precipitation occurs. On the other side of the mountain air sinks and heats due to an increase in air pressure producing the rain shadow.



Orographic



9. According to the Earth Science Reference Tables what happens to the temperature of the troposphere as elevation increases?

Temperature decreases with altitude

10. What happens to the pressure as altitude increases? **Pressure decreases**

11. In what layer of the atmosphere is all water vapor contained? **Troposphere**

12. What happens to the temperature of the atmosphere in the Stratosphere? **Increases.**



13. Explain why these clouds have flat tops: **These anvil clouds show the thickness of the troposphere. In the Stratosphere few clouds occur because the temperature begins to increase and there is little water vapor.**

14. Why shouldn't you over exert yourself on a calm humid day? **Evaporation of our perspiration is what cools our body. On a calm humid day little evaporation takes place and we cannot cool down leading toward heat exhaustion or heat stroke.**

15. Why does it rain along weather fronts? **Similar to the orographic effect air is forced up the weather front, cools as it rises due to adiabatic processes and forms condensation/precipitation.**

