Name _____ REGENTS EARTH SCIENCE
Date_____ 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 mountaintops? What happened to all that hot air? There must be more to this story. In this laboratory you will be investigating how pressure affects the temperature of air and how this relates to the formation of clouds in the troposphere. You will form a cloud in a bottle, find the dew point and relative humidity of air at different places in the school and use a chart to estimate how high that air would have to rise to form a cloud.

Part 1: In order to explore how clouds form in the atmosphere we have to examine the relationship between changes in air pressure and temperature. As air rises in the atmosphere the air pressure decreases. This is because there is less air (atmosphere) above it pushing down. You will be adding air to a two liter soda-pop bottle and examine what happens to the mass and temperature of the air inside the bottle.

Problem: What happens to air temperature when pressure increases?
Hypothesis:

_____

_____

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).

Data Table 1

Pumps	Mass (g)	Temperature °F
0		
30		
60		
90		
120		
150		
180		
210		
Release		

The Affects of Pressure changes on both Mass and Temperature

Mass

Temperature

0 30 60 90 120 150 180 210

Number of Pumps

Increasing Pressure

Procedure Part 1: Creating a Cloud

1. Pressurize your two-liter bottle by pumping it at least 100 times.
2. Release the pressure. Do you see a cloud? _____
3. Bring your bottle to the incense burner and collect 2 seconds of smoke.
4. Re-pressurize your bottle to the same amount.
5. Release the pressure. Do you see a cloud? _____
6. Define: Condensation Nuclei:

   _____

   _____

7. Why didn't a cloud form each time? _____

_____

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

_____

_____

_____

Part 1 Questions:

1. What happened to the mass and temperature of the air when you released the pressure?

   _____

   _____

2. How did the volume of the air change during your experiment? How do you know?

   _____

   _____

3. How did the density of the air change during your experiment? How do you know?

   _____

   _____

4. Why does a change in air pressure affect the temperature of the air (think molecular)?

   _____

   _____

   _____

5. Why do farmers in the Midwest "seed" the sky with dust in times of drought?

   _____

   _____

   _____

6. What does precipitation do to the quality of the air?

   _____

   _____

7. Are clouds water vapor? Why or why not? Explain:

   _____

   _____

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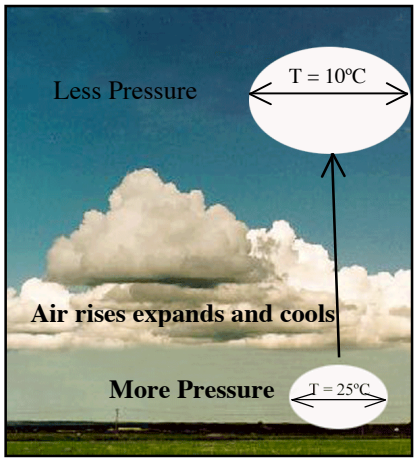


Title: FLAT BOTTOM CLOUDS (PART 2)

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 temperature changes do not change the overall amount of heat energy in the air but do change the measured air temperature. As air expands the heat energy is spread out which brings about a change in the measured temperature of the air mass. As the temperature of the air decreases there comes a point where the dewpoint temperature is reached and water vapor condenses onto the condensation nuclei forming tiny droplets that form 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:

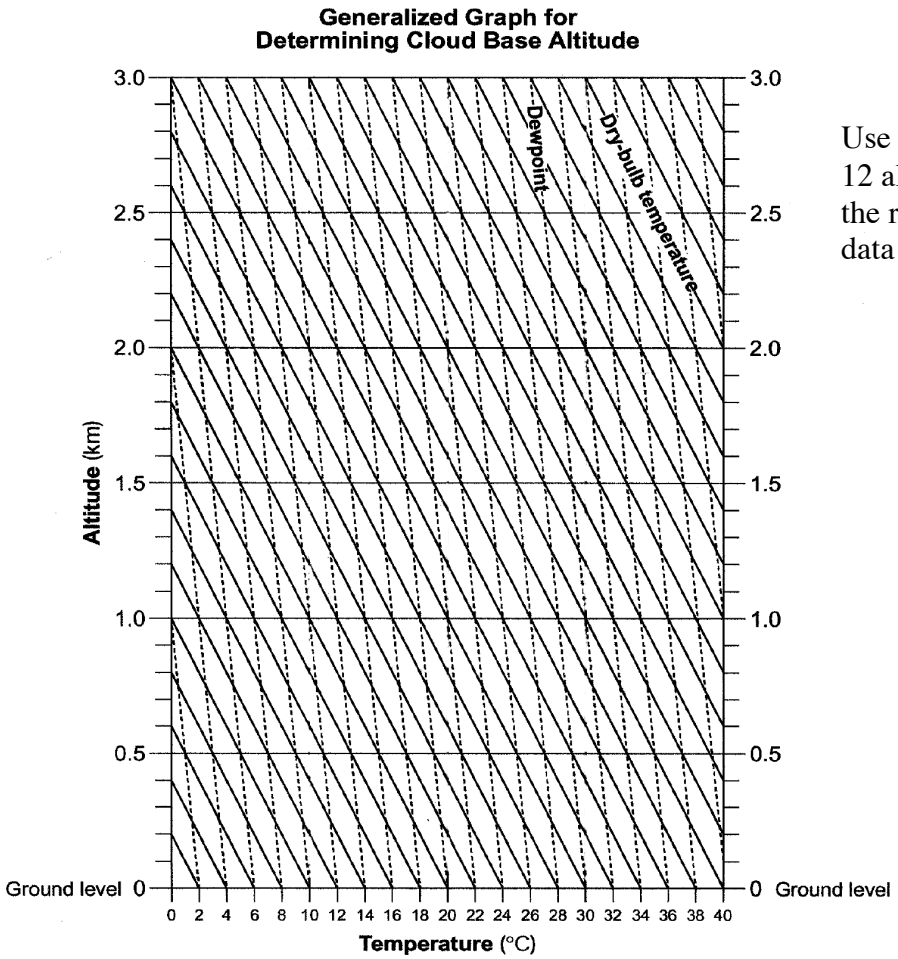
- Psychrometers (one for each location)
- Reference Tables (dew point and relative humidity tables)
- Generalized graph for determining cloud base altitude

Procedure Part 2:

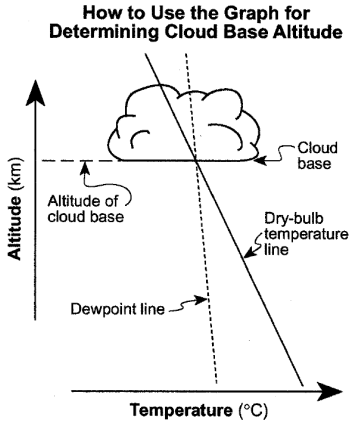
1. As a class read the Dry Bulb and Wet bulb thermometers on a psychrometer.
2. Find the Dew Point, Relative Humidity, and Cloud Base Height.
3. Divide into groups and collect data at different locations throughout the school.
4. Share your data with the entire class and fill out the rest of your data table.
5. Answer the analysis and conclusion questions.

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.						



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



Analysis and Conclusion Questions:

1. What is the cloud base for air with a dry-bulb temperature of 32ºC and dewpoint of 22ºC? _____

2. If the surface dewpoint temperature is 18ºC and the clouds in the sky have a base elevation of 2 km, what is the dry-bulb surface temperature? _____

3. What is the cloud height when the dry-bulb temperature is equal to the dewpoint temperature? _____

4. What name do we give that type of cloud? _____

5. What happens to the cloud height when the dry bulb and dewpoint temperature approach one another?

   _____

   _____

6. Why do clouds have flat bottoms?

   _____

   _____

   _____

   _____

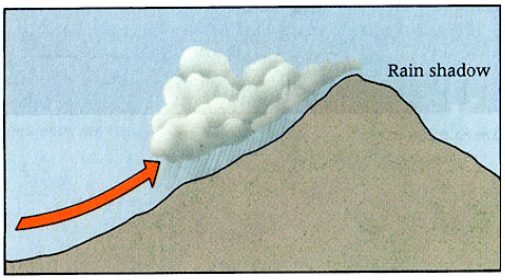
   _____

7. What happens to the temperature of air in the troposphere when it sinks? _____

_____

8. Explain this drawing of the Orographic effect:

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



Orographic

_____

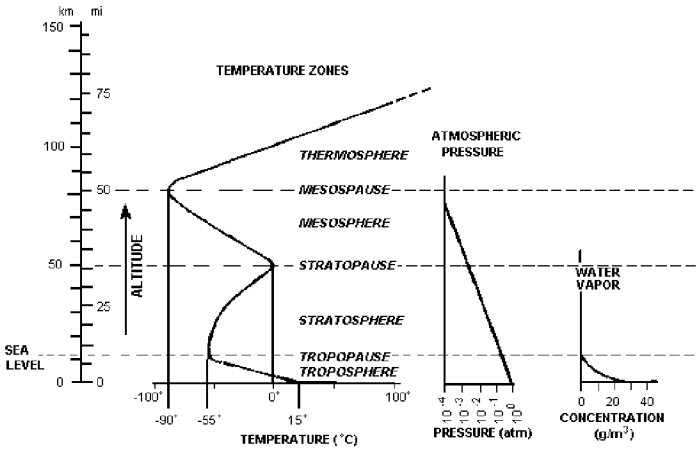
_____

_____

_____

_____

_____



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

_____

10. What happens to the pressure as altitude increases? _____

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

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

_____

13. Explain why these clouds have flat tops: _____

_____

_____

14. Why shouldn't you over exert yourself on a calm humid day? _____

_____

_____

_____

15. Why does it rain along weather fronts? _____

_____

_____

_____

_____