



Is it Colder in the Mountains and Why?

NS 696 V: Weather and Climate for Educators

Intended grade level:

Fifth grade

Standards:

- Students apply the processes of scientific investigation and design, conduct, communicate about, and evaluate about such investigations.
 - Design, plan, and, conduct an investigation
 - Select and use appropriate tools and technology to gather and display quantitative and qualitative data related to an investigation
- Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space
 - The atmosphere has basic composition, properties, and structure
 - There are quantitative changes in weather conditions over time and space

Materials:

- tire tubes (Walmart)
- bike pumps with pressure gauge (have students bring in or look around at thrift stores for bike pumps)
- two litter bottles (students can bring in or other teachers)
- tire valves to fit in cap of bottle (Ace Hardware)
- dum-dum suckers to use the end of the sucker to release the pressure (students can eat the sucker afterwards; can get them at Sam's club)
- fish tank thermometers (PetSmart or Petco)
- diagram of air pressures as altitude increases
- air pressure article and worksheet (see attached pdf file)

Background information assumed:

- Hopefully most of them have been up to the mountains or at least to the foothills and have noticed how it is colder up there. I don't expect all of them to have been up to the mountains.
- Students will have been working with the scientific method up until now so the lesson will be focused more on the pressure and temperature part with the scientific method incorporated.
- The students will also know how to make a chart to best collect data they observe.

Objective:

- Students will understand how pressure affects temperature on a basic level. They will develop an awareness of pressure and temperature but I don't expect them to be masters at understanding

the science behind it because they are in fifth grade and this will be their first exposure to the concept of increasing and decreasing pressure.

Theory

Mountains are colder than the Earth's surface because the sun heats the Earth from the ground up. The sun's radiation travels through the atmosphere to the ground, where Earth absorbs the heat. Air closest to the Earth's surface is warmest and it rises. When it rises it moves to areas of lower pressure. As air rises to areas of lower pressure, it expands which means it also cools. (This would probably be as far as I would take it with fifth graders.)

It takes thermal energy for the air to expand so the temperature decreases. In general as you go up 1000 meters (about 3281 feet) the temperature decreases by 6.5 degrees Celsius (which is about 44 degrees Fahrenheit). This is known as the environmental lapse rate which is the measurement of the actual change in temperature with height in the atmosphere. There is also a dry adiabatic lapse rate which is the change of temperature that an air parcel would experience if it were displaced vertically with no condensation or heat exchange.

Structure of Lesson:

Engage:

- Show students a tire tube with no air in it.
 - What needs to be added to the tube?
 - How can I add it? (Students are guided to start discussing air the pressure.)
 - What happens if I release the air in the tire tube?
 - What happens to the pressure?
- Students will get a few minutes to practice adding air to a tire tube and decreasing air pressure in a tire tube. (I want students to feel the difference in the pressure and also to learn how to use the bike pumps.)

- Pose question to students: Is it colder in the mountains and why is it or isn't it?
- Students will then create a hypothesis based on this question.

Explore:

- Students will work in groups of four for this experiment. (If possible I will have a parent volunteer in the room to help.)
- (Follow the Little Shop of Physics "If hot air rises, why is it colder in the mountains?" instructions for doing the experiment.)
- Show the students how to put the bottle together and how to pump up the bottle. Students will be given a specific pressure to add to their bottle. I will also guide the students on how to read the thermometer.
- Bottle will cool to room temperature which will be decided ahead of time by observation of the students.

- Air will be released out of the valve and students are to notice the cooling of the bottle (At first I want students to observe things they notice on their own and if I need to I will have them pay attention to the cooling of the bottle.)
- Students will be recording data (bottle at room temperature, bottle with pressure added to it, and bottle with pressure released) and observations as they do the experiment. (Their data tables will be created ahead of time. Students will decide what the best way is to record their data and observations.)
- Experiment will be repeated at least four times so every student in the group has a chance to try experiment.

Explain:

- Put all quantitative data into a class data chart then discuss students' observations as they performed the experiment.
- Guide students to the idea that as pressure increases temperature increases because you are adding energy (specifically thermal energy) and then when the pressure decreased the temperature decreases (because it takes thermal energy for the air to push back into the atmosphere.)
- Students will be shown a diagram of air pressures and how there is a higher pressure at sea level and less pressure on top of mountains especially on top of Mount Everest. (Sea level pressure is about 1000 mb and Fort Collins is about 850 mb.)

Extend:

- Air pressure article with follow-up questions (See attached pdf file) Students can work on it with a partner.

Evaluate:

- Have students write a conclusion stating whether their hypothesis was correct or incorrect and why. In their conclusion they also need to include what they learned from the experiment. I will collect their hypotheses, data, and conclusions to see if students understood main concepts from experiment.

Air Pressure

Air is always around us. Even though we can't see or feel air, we know that it is there. We can observe its effects in the forces of air pressure and wind. Did you know that air pushes on us? Air pressure is the weight of the air pushing down on us and on everything else around us. Air pushes on you with a force of about 14.7 pounds per square inch. That's like a bowling ball on every square inch of your body! Why don't we feel it? Because we're used to it. It's constant. We've felt it every minute of every day since we were born.

Air pressure is what makes your ears pop when you fly in an airplane. This happens because the air pressure inside your body and the air pressure outside are usually balanced. When you go up in an airplane, the pressures become unbalanced. There is less pressure from the air the higher up you go. So your ears pop to let the pressures even out.

Weather forecasters use air pressure every day in their job. They use an instrument called a barometer to measure air pressure. Barometers measure air pressure in units called millibars. Meteorologists are scientists who study and forecast, or predict, the weather. They receive data from weather stations. They record air pressure measurements on a large map. They connect lines to all the same measurements. These lines are called isobars. Isobars tell meteorologists many things. If they are close together, there is a large air pressure difference over a small distance. In this area, the wind will be blowing hard. Isobars that are far apart mean little wind.

The most important thing meteorologists learn from isobars is where high and low pressure systems are. If the pressure readings get higher toward the center of the isobars, that is a high-pressure system or a high. It is shown as a big H on the weather map. In a high-pressure system, the air moves in clockwise circle. The air in the middle will sink. Clouds can't form when air is sinking. Because of this, highs usually mean fair weather and sunny skies. The air may be cool and windy. If the pressure readings are lower, there is an area of low-pressure, shown as a big L. Air in a low pressure area rises. Moisture rises with the air. Lots of clouds form. The air moves in a counter-clockwise direction. Lows usually mean rain or snow precipitation.

Knowing the air pressure helps meteorologists to predict whether the day will be clear, rainy, or stormy. When the barometer shows that the air pressure is high, they can forecast cool, clear weather. When the air pressure is low, they forecast warmer weather and maybe rain or storms.

You can make a simple barometer to see how air pressure is measured. You will need a glass bottle about half full of water, a clear plastic straw that you put in the bottle, and a stopper to close up the rest of the top of the bottle. As the air pressure changes, the water in the straw should move up or down. It will be easier to see if you put some food coloring in the water.

Air pressure and wind cause weather. Tornadoes, hurricanes, and thunderstorms are all powered by air pressure and wind. It is important for meteorologists to know what the air pressure is over a large area. Differences in air pressure can help meteorologist predict what the weather is going to do. Warning people of severe weather that is coming can save lives.

Air Pressure Quiz

Name _____

Date _____

Fill in the blank

1. The force of air pushing down on us is called _____.
2. The amount of air pressure is _____ pounds per square inch.
3. An instrument called a _____ is used to measure air pressure.
4. Air pressure is measured in units called _____.
5. Lines on a map connecting similar air pressure measurements are called _____.
6. _____ pressure areas mean fair weather and sunny skies.
7. _____ pressure areas mean warmer weather, cloudy skies, and perhaps precipitation.
8. Clouds form in areas of _____ pressure.

Matching

Match the word to its definition.

- | | |
|-------------------|--|
| 1. meteorologists | a. lines on a map connecting like air pressure |
| 2. high pressure | b. instrument that measures air pressure |
| 3. low pressure | c. an area of air that moves in counter-clockwise motion |
| 4. isobars | d. an area of air that moves in clockwise motion |
| 5. barometer | e. people who study and forecast weather |

Air Pressure Quiz Answers

Fill in the blank:

1. air pressure
2. 14.7
3. barometer
4. millibars
5. isobars
6. high
7. low
8. low

Matching:

1. e
2. d
3. c
4. a
5. b