

TEMPERATURE INVESTIGATION

Overview:

In this lesson, students investigate temperature variability in several locations within a small, local area and examine temperature inversions in Interior Alaska. Students also learn that factors affecting temperature also affect fuel consumption.

Objectives:

The student will:

- identify conditions that could make temperatures vary within a small area (sunlight, wind, elevation);
- compare the atmospheric conditions that create a temperature inversion to normal temperature conditions; and
- explain how repeating experiments improves the likelihood of accurate results.

Targeted Alaska Grade Level Expectations:

Science

- [7-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [8] SD3.1 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by recognizing the relationship between the seasons and Earth's tilt relative to the sun and describing the day/night cycle as caused by the rotation of the Earth every 24 hours.
- [7] SG2.1 The student demonstrates an understanding of the bases of the advancement of scientific knowledge by explaining differences in results of repeated experiments.
- [8] SG2.1 The student demonstrates an understanding of the bases of the advancement of scientific knowledge by describing how repeating experiments improves the likelihood of accurate results.

Math

- [7] S&P-3 The student demonstrates an ability to analyze data (comparing, explaining, interpreting, evaluating, making predictions; drawing or justifying conclusions by determining mean, median, mode, or range.

Vocabulary:

elevation – the height above sea level

heat – a form of energy produced by the motion of molecules

inversion – a reversal of a normal order

temperature – the degree of heat present in a substance or object

thermometer – an instrument for measuring temperature

topography – an arrangement of features on a landscape (mountains, hills, lakes, etc.)

weather - a description of the state of the atmosphere at a certain time

Whole Picture:

The Athabaskan people are highly respectful of weather phenomenon. In "Make Prayers to the Raven: A Koyukon View of the Northern Forest," Richard K. Nelson writes, temperature (hot and cold) is often personified as "an essence, as if a wild animal controlled its own living heat. Because cold is confining and dangerous, Koyukon people avoid causing it." In other words, they refrain from activity seen as provoking cold weather to come. "People used to be so very careful about causing bad weather, because if they couldn't go out they would get behind. So everything was just [taboo]." Too long confined by dangerously cold weather could mean running out of food. In former times people influenced spirits with songs and offerings, praying that bad spirits would leave them alone.

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Temperature may be affected by the amount of a location's exposure to the sun or wind. Topography is also a factor. Under normal conditions, temperature decreases as elevation increases.

Wintertime temperatures in the Interior have the greatest range in Alaska, with a possible high of 50° F (10° C) down to a possible low of -65° F (-54° C). Extremely low temperatures happen because of low-level temperature inversions. Inversions often occur under the clear skies and calm winds of high pressure systems when more heat can radiate away from Earth's surface. In the winter time, the sun is at a lower angle in the sky and therefore supplies less warmth to Earth's surface. A layer of warm air acts as a lid across a valley and traps the cold air beneath. Inversions may be broken by wind and clouds moving into the area.

This lesson addresses temperature variability through the scientific process. More specifically, students need to recognize the value of repeating experiments. Repeated trials in an experiment or investigation increase the confidence

Materials:

- Thermometers (one per group)
- Clipboards (one per group)
- Timer or stopwatch (one per group)
- Calculators (one per group)
- STUDENT WORKSHEET: "Temperature Investigation"
- STUDENT WORKSHEET: "Winter Temperatures in Interior Alaska"
- VIDEO: "Winter Temperatures in Interior Alaska"

Activity Preparation:

1. Identify five locations outside for students to take temperature readings. If possible, choose at least one near a building and one away from a building, one in the shade and one in the sun. Try to select locations that vary in wind exposure and elevation.
2. Look up National Weather Service Data at www.nws.noaa.gov. Enter your village or city to see the forecast for the day as well as current weather conditions. Write the temperature on the board.

Activity Procedure:

1. Explain students will look at the different factors that influence air temperatures.
2. Distribute and briefly review the STUDENT WORKSHEET: "Temperature investigation." Explain the class will go outside and measure the temperature in various places around the school. Briefly describe the five locations where students will take measurements. Brainstorm the variables in these environments (sun, wind, elevation) and decide on clear names/labels for each.
3. Ask students to make a hypothesis and to record it on the STUDENT WORKSHEET.
4. Divide students into groups and direct them to the five identified locations. Remind students it takes a thermometer several minutes to take an accurate reading. Explain students should not hold the thermometer while taking the temperature, but instead should set it down on a clipboard or sheet of paper. Holding the thermometer will take the temperature of one's hand, not the air.
5. Instruct students to fill in the data chart. They should list each location and take three temperature readings at each one..
6. Return to the classroom. Instruct the class to complete the remainder of their worksheets. Discuss results.
7. Pose the questions: "What was the coldest temperature you have ever experienced?" and "What makes the temperature so cold in Interior Alaska?" Call on students for responses.
8. Distribute STUDENT WORKSHEET: "Winter Temperatures in Interior Alaska."
9. Instruct students to complete the worksheet individually or in small groups. After students have completed the worksheet, discuss results.

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Answers:

STUDENT WORKSHEET: "Temperature Investigation"

Hypothesis: Answers will vary

Data:

1. Answers will vary
2. Answers will vary
3. Answers will vary but must show student work (calculating the mean of all 12 temperature readings).

Analysis of Data:

Answers will vary

Conclusion:

1. Answers will vary
2. Answers will vary
3. E. A, B, and C

Further Questions:

1. Answers will vary
2. Answers will vary
3. Answers will vary
4. A. to increase the likelihood of accurate experiment results
5. C. repeating the experiment three times
6. the shade
7. high wind

STUDENT WORKSHEET: "Winter Temperatures in Interior Alaska"

1. 115°F (64°C) and student shows work
2. Robert Charlie compares cutting firewood to cutting metal. The cold makes tools like axe and saw dull sooner. Branches easily snap off trees and the bark crackles.
3. Robert Charlie's coldest weather experience involves mushing dogs. They ran through the cold. When Robert finally got to the cabin, he collapsed from exhaustion.

Statement	Normal conditions	Temperature inversion
4. As altitude increases, the air temperature decreases	X	
5. A high pressure system leaves the sky clear and winds calm.		X
6. Water vapor freezes on air pollution particles creating ice fog.		X
7. A layer of warmer air acts as a lid, holding cold air and air pollution beneath it.		X

8. E. B, C, and D
9. B. a house on a hill
10. A. a house in a valley
11. C. The tilt allows certain latitudes of Earth to be heated at a greater rate while Earth rotates.

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Testable Question:

Will temperatures taken at the same time, in various places outside in a small area, be the same or different?

Hypothesis:

Temperatures recorded in various places outside in a small area will mostly be: A. the same B. different

Investigation:

Materials:

- Thermometer
- Watch or stopwatch
- Clipboard
- Calculator

Procedure:

1. You will record temperatures at five locations. For each temperature reading, place the thermometer on a flat surface and let it sit for at least two minutes. Use a watch or a stopwatch to keep the time. Repeat the reading three times at each location.
2. Record the temperature readings on the data chart below.

Data:

1. Record a brief description of each location and all three temperature readings in the chart below. A different person should read the thermometer each time. To calculate the average temperature, add the three temperature trials together and divide by three.

Locations	Temperature readings			Average Temperature
	#1	#2	#3	
A.				
B.				
C.				
D.				
E.				

2. What is the range of all 12 temperature readings? (*range = highest value – lowest value*) _____
3. What is the average, or mean, of all 12 temperature readings? _____
Show your work here.

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Analysis of Data:

- The temperatures recorded in the chart above are mostly: A. the same B. different
- Which location was the coldest? _____
- What do you think made it the coldest? _____
- Which location was the warmest? _____
- What factor made this location the warmest? _____
- Were any individual recorded temperatures unusually low or unusually high? _____
If yes, why do you think so? _____

Conclusion:

- Temperatures recorded in various places outside the school were mostly: A. the same B. different
- Was your hypothesis proved or disproved? _____
- Circle the reason why temperatures measured in different places within a small area might be different?
 - The sun is shining on some, but not all, of the thermometers.
 - The wind is blowing on some, but not all, of the thermometers.
 - The temperature is different at different elevations, or heights.
 - A and B only.
 - A, B, and C.

Further Questions:

- Write the temperature forecasted for your area by the National Weather Service. _____
- Is the average of all 12 temperature readings the same or different? _____
- What would make them different? _____
- Why do scientists perform multiple trials of the same experiment? Circle the best answer.
 - to increase the likelihood of accurate experiment results
 - to complete the steps of the experiment in less time
 - to include additional variables
 - to find a less expensive way to conduct the experiment
- A scientist is performing an experiment to determine the freezing point of a new substance. Which action could increase the likelihood of obtaining accurate results? Circle the best answer.
 - writing out the procedure after the experiment
 - experimenting with multiple substances
 - repeating the experiment three times
 - using three types of thermometers in the experiment

Which conditions would increase the fuel consumption of a house during a cold winter. Circle your answer.

- A house built in: the sun the shade.
- A house built in an area of: high wind calm wind.

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WINTER TEMPERATURES IN INTERIOR ALASKA

Directions: Access the VIDEO: "Winter Temperatures in Interior Alaska" to answer the following questions.

1. What is the range of winter temperatures in Interior Alaska? To calculate range, subtract the lowest value from the highest value. Show your work in the space below. _____

2. According to Athabascan Elder Robert Charlie, how do extreme cold temperatures affect gathering firewood?

3. Summarize Robert Charlie's coldest weather experience.

Check the type of Interior winter temperature conditions (normal or temperature inversion) described by each statement.

Statement	Normal conditions	Temperature inversion
4. As elevation (height) increases, the air temperature decreases.		
5. A high pressure system leaves the sky clear with winds calm.		
6. Water vapor freezes on air pollution particles creating ice fog.		
7. A layer of warmer air acts as a lid, holding cold air and air pollution beneath it.		

8. In Interior Alaska, temperature inversions are most likely to happen

- A. under a low pressure system.
- B. when the sun's radiation comes in at a lower angle in the winter.
- C. when Earth's surface radiates more heat away.
- D. under a high pressure system.
- E. B, C, and D.

9. In normal conditions, which house is most likely to use more fuel for heat?

- A. a house in a valley
- B. a house on a hill

10. In a temperature inversion, which house is most likely to use more fuel?

- A. a house in a valley
- B. a house on a hill

11. How does the tilt of Earth's axis and its rotation affect the weather?

- A. The tilt of Earth allows Earth to rotate fast enough to allow surface cooling to occur at night.
- B. The tilt of Earth allows Earth to absorb all the Sun's radiation as it rotates.
- C. The tilt allows certain latitudes of Earth to be heated at a greater rate while Earth rotates.
- D. The tilt allows energy to be evenly distributed throughout the atmosphere while Earth rotates.