Math and Meteorology

A meteorologist is a scientist who uses scientific principles to explain, understand, observe, and forecast the Earth's atmospheric phenomena and weather. While we're used to seeing meteorologists on TV forecasting and predicting the weather, not all meteorologists specialize in this field. Some meteorologists specialize in air pollution, changes in the global climate, and/or numerical analysis and forecasting.

The mathematics of meteorology is varied and sometimes quite complicated. Meteorologists collect data and use this data to make weather predictions; apply formulas to calculate heat indexes, dew point, and wind chill factors; and record weather phenomena, including record temperatures, rainfalls, and so on.

The mathematics of meteorology is algebra, data collection, organization and analysis, graphing, computation and percentages, and a great deal of problem solving.

Keeping Track of Highs and Lows

Math Skills

- Collecting data
- Assigning units to graph coordinates
- Graphing

Materials Needed

- Weather reports for a ten-day period
- Colored pencils
- “Data Collection Sheet” (p. 5) for each student
- “Data Graphing Sheet” (p. 6) for each student

Background Information and Suggested Teaching Strategies

This lesson takes place over a ten-day period of time, but students can enter their data on the data table and on the graph daily. Because some students have difficulty with assignments that span an extended period of time, daily recordings narrow the duration of the activity.

On the line graph, a different-colored pencil should be used to record the high and low temperature for each day. Students can connect the coordinates because the temperature fluctuates between highs and lows. Students will also design a bar graph to compare the highs and lows.

You can ask students to analyze the graphs using the following types of questions:

1. Was the difference between the high and low temperature consistent?
2. What was the average difference between the high and low temperatures during this ten-day period?
3. Do you think the data we obtained now would be the same at other times of the year (at different seasons)?
4. Did all of the highs occur during the same time of day? Did all of the lows appear during the same time of day? Why do you think this occurred?

Communicating through Journaling

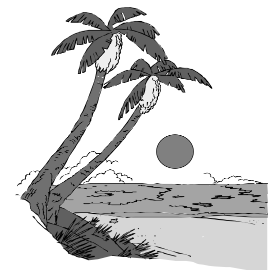
You designed two different graphs to represent the data you collected. Which graph do you think better pictured the data? Explain your answer.

Possible Extension Ideas

Students can enter the data into a computer spreadsheet and use the computer to design different types of graphs (such as bar graphs) Students can experiment with a variety of different graphs. Ask them which of these graphs are appropriate and which are not.

Name ______________________________ *Date* ____________

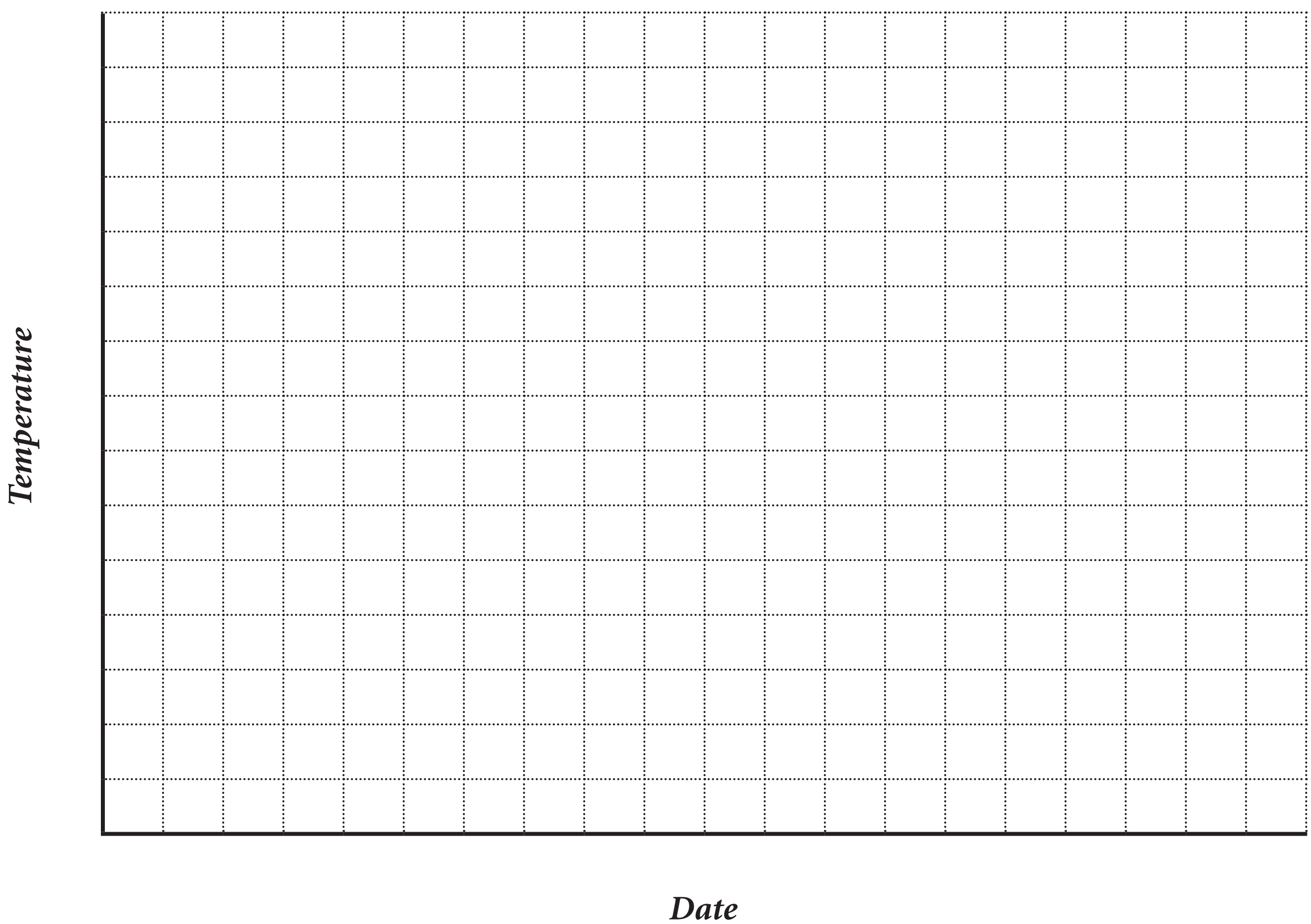
Data Collection Sheet



Directions: Use the table below to record the high and low temperatures for your city for ten days. Then design a line graph to show the range of daily temperatures in your area.

Date																				
Temp																				
	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L

Title ____

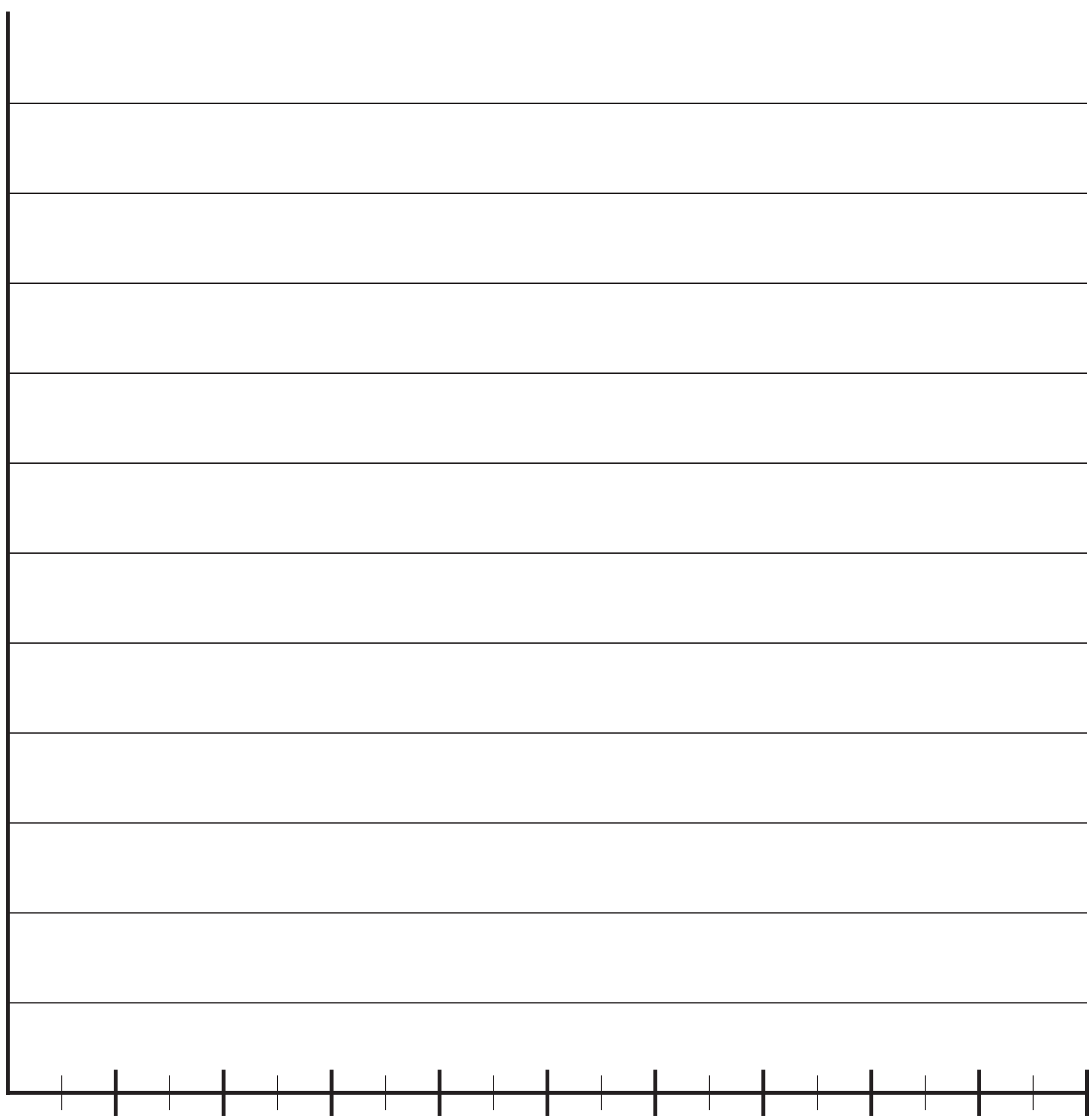


Name ______________________________ *Date* ______________

Data Graphing Sheet

Directions: Use the temperature data from the "Data Collection Sheet" to design a double bar graph of the high and low temperatures. Be sure to label the two axes of your graph.

Title ______________________________



Continental Hot Spots

Math Skills

- Substituting for a variable (algebra)
- Converting temperature
- Using computation skills

Materials Needed

- "Continental Hot Spots" (p. 8) activity sheet for each student
- Calculators

Background Information and Suggested Teaching Strategies

This activity asks students to convert temperatures from degrees Celsius to degrees Fahrenheit. This can be done by substituting the Celsius temperatures into a given equation, but it is a good idea to give students some benchmarks to help them better understand the approximate associations between the two scales. These are some familiar benchmarks:

1. Normal body temperature: 98.6°F ≈ 37°C
2. Room temperature: 68°F ≈ 20°C
3. Freezing point of water: 32°F ≈ 0°C
4. Boiling point of water: 212°F ≈ 100°C
5. A hot summer day: 90°F ≈ 32°C
6. A very cold winter day: 10°F ≈ –12°C

In other words, every 1° on the Celsius scale is approximately 2.12° on the Fahrenheit scale or every 1° on the Fahrenheit scale is approximately 0.47° on the Celsius scale. The conversion formulas are:

Fahrenheit to Celsius: $C^\circ = \frac{5}{9}(^\circ F - 32^\circ)$

Celsius to Fahrenheit: $F^\circ = (\frac{9}{5} \times {}^\circ C) + 32^\circ$

The table in "Continental Hot Spots" records the highest temperatures recorded on each of the continents and at the South Pole. Students are asked to convert the temperatures given in degrees Celsius to degrees Fahrenheit. There are a number of Web sites that contain conversion calculators. One of these is http://www.onlineconversion.com/temperature.htm. This site also converts to degrees Rankine, Reaumur, and Kelvin.

Communicating through Journaling

You are in a country where temperature is recorded in degrees Celsius. The local news tells you that the high for the day will be 24°. Without actually doing a conversion, how could you estimate this temperature in degrees Fahrenheit? About how many °F is 24°C? Explain how you solved this problem.

Answer: Students can use a variety of strategies to solve this problem. 24°C ≈ 75°F

Possible Extension Ideas

Students can use the Internet to research other temperature scales. The conversion calculator shown above can be used to convert temperatures in these scales to Fahrenheit.

Activity Answers

These answers have been rounded to the nearest degree:

Africa	136°F
North America	135°F
Asia	129°F
Australia	127°F
Europe	122°F
South America	120°F
Antartica	59°F
South Pole	7°F

Name ______________________ *Date* ____________

Continental Hot Spots

While temperature varies from place to place on the Earth, in most places the temperature is always between +50°C and –50°C. Just how hot or cold is this? In most of the world, temperature is measured using a scale developed in 1742 by a scientist named Anders Celsius. In the United States, we still use a scale developed in the early 1700s by a scientist named G. Daniel Fahrenheit. If you are given temperatures in degrees Celsius and you wish to convert it to degrees Fahrenheit, you can use this formula:

$$F° = \left(\frac{9}{5} \times °C\right) + 32°$$

Directions: The following table shows the highest temperatures recorded in each of the continents of the world and at the South Pole. Use the conversion formula to problem-solve what these temperatures would be on the Fahrenheit scale. These temperatures have been rounded to the nearest degree.

Continent	*Place*	*Year*	*Degrees Celsius*	*Degrees Fahrenheit*
Africa	El Azizia, Libya	1922	58	
North America	Death Valley, CA	1913	57	
Asia	Tirat Tsvi, Israel	1942	54	
Australia	Cloncurry, Queensland	1889	53	
Europe	Seville, Spain	1881	50	
South America	Rivadavia, Argentina	1905	49	
Antarctica	Vanda Station	1974	15	
South Pole	Unpopulated	1978	–14	

Let's Climb a Mountain

Math Skills

- Using ratio and proportion to solve problems
- Scale drawing
- Computing percentages
- Analyzing using statistics

Materials Needed

- "The Temperature at the Top" activity sheet (p. 11) for each student
- "Drawings to Scale" activity sheet (p. 12) for each student
- Calculators
- A world map (extension activity)

Background Information and Suggested Teaching Strategies

Begin the lesson by discussing the information given at the beginning of the activity sheet. After reading it with students, ask: "What do you think is meant by the fact that 'temperature drops 3.5°F for every 1,000 ft' "? How do you know that it is colder on the top of a mountain than at its base? Why do you think this occurs? How do you think this might affect mountain climbers? How do you think you might solve this type of problem? What strategies could we use?" Give students an opportunity to discuss possible strategies because there are many ways to get to the correct answer. When students begin their calculations, remind them that there are questions that help to analyze their answers—remind them that these must be answered, as well.

A final activity asks students to draw a scale model of two mountains, Mt. Cook in Oceania and Mt. Everest in Nepal/Tibet. The graph paper is $\frac{1}{4}$ inch. Students need to problem-solve a scale that will allow both mountains to be drawn on this size paper.

Communicating through Journaling

Using metric measurements, temperature drops approximately 6.5°C for every 1,000 meters. Mt. Everest is 8,846 meters. How many degrees Celsius is the drop in temperature?

Answer: approx. 52.50°C.

Possible Extension Ideas

1. Using a world atlas or world map, ask students to locate each of the countries mentioned in the activity.
2. Students can use the Internet to research information about the tallest mountains. Some possible sites are:

   http://www.scaruffi.com/travel/tallest.html

   http://hypertextbook.com/facts/2001/BeataUnke.shtml

Activity Answers

All measurements have been rounded to the nearest whole unit.

The Temperature at the Top (°F):

Mt. Everest	–34
Mt. Aconcagua	–12
Mt. McKinley	–3
Mt. Kilimanjaro	0.3
Mt. Elbrus	3
Vinson Massif	12
Puncak Jaya	12
Mont Blanc	13
Mt. Cook	25
Mt. Kosciusko	42

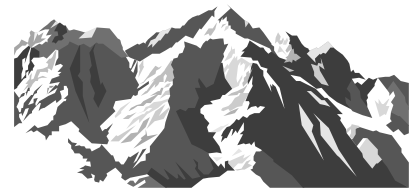
1. The range is 29,022 – 7,310 = 21,712 ft.

2. The median height is (18, 506 + 16,050) ÷ 2 = 17,278 ft.

3. About four times the height

Name ______________________________ Date ______________

The Temperature at the Top



Did you know that the higher you go up a mountain, the colder it becomes? Because air cools as it rises, the temperature drops approximately:

3.5°F for every 1,000 ft

What if it were 68° F at the base of each of these mountains? What would the temperature be at the very top?

Directions: Use the ratio to help you solve these problems.

Name of Mountain	*Location*	*Height in Feet*	*Temperature at the Top (°F)*
Mt. Everest	Nepal/Tibet	29,022	
Mt. Aconcagua	South America	22,841	
Mt. McKinley (Denali)	Alaska, USA	20,320	
Mt. Kilimanjaro	Africa	19,336	
Mt. Elbrus	Russia	18,506	
Vinson Massif	Antarctica	16,050	
Puncak Jaya	New Guinea	16,023	
Mont Blanc	France/Italy	15,774	
Mt. Cook	New Zealand	12, 316	
Mt. Kosciusko	Australia	7,310	

Use the temperatures you calculated to help you answer these questions:

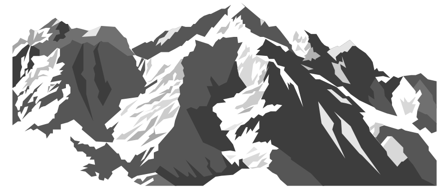
1. What is the range of heights of the mountains in this table? ____________

2. What is the median height of these mountains? ____________

3. How many times taller is Mt. Everest than Mt. Kosciusko? ____________

Name ______________________ Date ____________

Drawings to Scale



Directions: Use the graph paper to draw Mt. Cook (12,316 ft) and Mt. McKinley/Denali (20,320 ft) to scale. The scale is $\frac{1}{4}$ inch = 750 ft. Each square is $\frac{1}{4}$ inch.