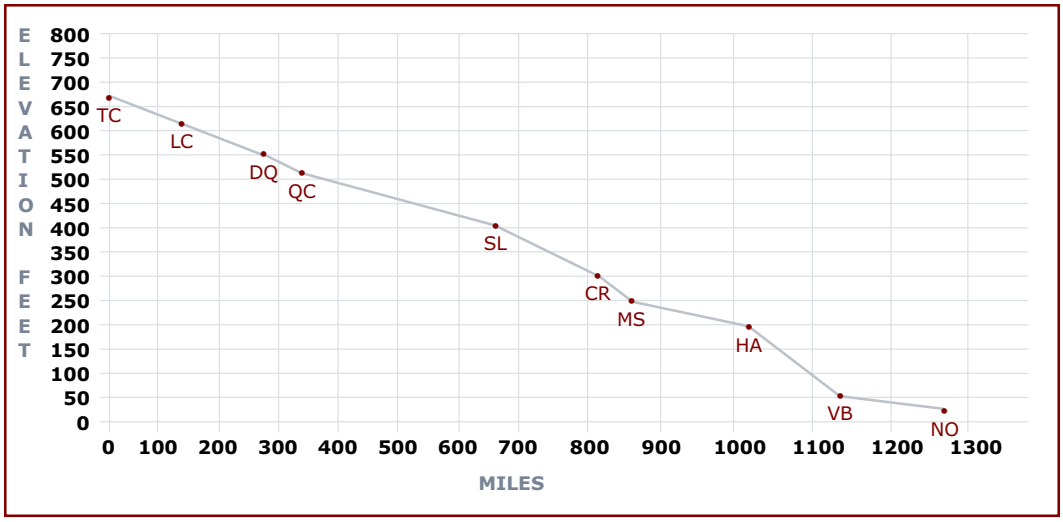
How Low Can You Go?

Students will use elevation and mileage data to graph elevation and figure out pitch, grade, and slope.

Teacher Notes for Discussion
Students should use Handout to draw their conclusions.

Answer Key

1. Using Twin Cities as zero, the graph will progress downhill as the students graph elevation and add up the miles [i.e., TC = 675 and 0, LC = 620 and 144, DQ = 580 and 283 (144 + 129)].



2. Identify the section between stops that has the steepest grade and the shallowest grade.

   A. The **steepest grade** is between the Quad Cities and Dubuque
   B. The **shallowest grade** is between Helena and Memphis.

3. Give the slope (vertical drop) of each of the identified riverbed grades in feet per mile.

   A. Quad Cities and Dubuque $\frac{62 \text{ feet}}{70 \text{ miles}} = 0.89$ feet per mile

   B. Helena and Memphis $\frac{18 \text{ feet}}{48 \text{ miles}} = 0.38$ feet per mile

Objective
By the end of this activity, students should be able to
- use given data to construct graphs.
- explain the gradient of given slopes.

Time Considerations
Instructor preparation: 30 minutes
Student activity: 2-3 classes

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4. Predict which areas of the Mississippi River might be traveling the fastest and slowest.

   A. The Mississippi River would be flowing at its fastest rate between the **Quad Cities** and **Dubuque**.
   B. The river would be flowing at its slowest between **Helena** and **Memphis**.

For the assessment, provide students with data from another river or highway.

Related Standards and Benchmarks

National Council of Teachers of Mathematics. *Curriculum and Evaluation Standards for School Mathematics.* <http://standards-e.nctm.org/1.0/normal/standards/intr_MAIN.html>, March 16, 2000.

Standard 2: Patterns, Functions and Algebra
- use symbolic forms to represent and analyze mathematical situations and structures

Standard 5: Data Analysis, Statistics and Probability
- pose questions and collect, organize, and represent data to answer those questions

Standard 6: Problem Solving
- apply a wide variety of strategies to solve problems and adapt the strategies to new situations

Standard 7: Reasoning and Proof
- select and use various types of reasoning and methods of proof as appropriate

Standard 8: Communication
- organize and consolidate their mathematical thinking to communicate with others

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How Low Can You Go?

CITY	ELEVATION (feet above sea level)	MILES BETWEEN CITIES	
TWIN CITIES (CT)	675	TWIN CITIES TO LA CROSSE	144
LA CROSSE (LC)	620	LA CROSSE TO DUBUQUE	129
DUBUQUE (DQ)	580	DUBUQUE TO QUAD CITIES	70
QUAD CITIES (QC)	518	QUAD CITIES TO ST. LOUIS	312
ST. LOUIS (SL)	360	ST. LOUIS TO CAIRO	103
CAIRO (CR)	267	CAIRO TO MEMPHIS	150
MEMPHIS (MS)	182	MEMPHIS TO HELENA	48
HELENA (HA)	164	HELENA TO VICKSBURG	133
VICKSBURG (VB)	93	VICKSBURG TO NEW ORLEANS	161
NEW ORLEANS (NO)	-5		

Fig. 1.0. Elevation and distance between river cities

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How Low Can You Go?

Understand Your Mission

By the end of this lesson, you should be able to calculate the grade of a riverbed in different places and tell which places have the fastest currents.

Learn the Lingo

altitude	height above ground (used by pilots)
elevation	height of a place compared to sea level
grade	slope of a riverbed or road
graduations	series of marks for measuring equal distances
ratio	a comparison of two numbers by division
rise	change in position up or down (elevation or altitude)
run	change in position forward or backward (or left or right)
slope	a number that describes the steepness of a line; slope is calculated by dividing the vertical change by the horizontal change (rise over run)

Gather Your Supplies

- ❑ calculator
- ❑ graph paper
- ❑ pencil
- ❑ ruler

Background

Water always flows downhill. How fast it flows depends upon the steepness (grade) of the riverbed. Slope is a mathematical term for expressing change in vertical position with change in horizontal position. Architects and builders use the term pitch to describe the slope of a roof. Ship captains, road builders, and truckers use the term grade to describe the slope of a river or road. Have you ever seen a road sign showing a truck going down a steep hill? These signs will often tell the steepness of the hill's grade (e.g., 7% grade).

Level roads, flat roofs, and ponds (where the water is not moving downhill) have a slope of zero. An undefined slope (like a wall) does not fit the definition of slope because there is no horizontal change in position (indivisible by zero).

How Low Can You Go?

Chart a Course for Exploration

1. Record the elevation at each of the stops made along the Mississippi River and the number of miles between each stop.

2. Chart your findings on graph paper using the y-axis for altitude and the x-axis for miles (distance). Graduations on the x-axis should not exceed 50 miles per square on your graph paper.

3. Identify the section between stops that has the steepest grade and the shallowest grade. Justify your answer.

4. Give the slope (vertical drop) of each of the identified riverbed grades in feet per mile.

5. Predict which areas of the Mississippi River might be traveling fastest and slowest. Justify your answer.

Go Beyond

Do some library research to find out the grades of some of the big rivers in the United States. Write a paragraph explaining how we use rivers with shallow grades, and another paragraph explaining how we use rivers with steep grades.

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How Low Can You Go?

Use the data from another river or highway to complete a line graph using the y-axis for elevation and the x-axis for miles. Identify the steepest and shallowest grades on the graph. Write a brief interpretation of your graph.

References

Chapin, Suzanne H., Mark Illingworth, Marsha S. Landau, Joanna O. Masingila, and Leah McCracken. *Middle Grades Mathematics,* Prentice Hall Publishing, Inc., 1995 ed.