Title: The Sky's The Limit: A Data Analysis and Graphing Unit

Brief Overview:

This is a data analysis and graphing unit about structures and things that are tall. This unit is linked to both science and social studies through the information about mountains, domes, skyscrapers, and bridges.

NCTM Content Standard/National Science Education Standard:

Number and Operations

- understand the place-value structure of the base-ten number system and be able to represent and compare whole numbers and decimals

Data Analysis and Probability

- collect data using observations
- represent data using tables and graphs such as bar graphs
- compare different representations of the same data and evaluate how well each representation shows important aspects of data
- describe events as likely or unlikely and discuss the degree of likelihood using such words as certain, equally likely, and impossible
- predict the probability of outcomes of simple experiments

Problem Solving

- build new mathematical knowledge through problem solving
- solve problems that arise in mathematics and in other contexts
- monitor and reflect on the process of mathematical problem solving

Geometry

- build and draw geometric objects
- use geometric models to solve problems in other areas of mathematics, such as number and measurement
- recognize geometric ideas and relationships and apply them to other disciplines and to problems that arise in the classroom or in everyday life

Communication

- organize and consolidate their mathematical thinking through communication
- communicate their mathematical thinking coherently and clearly to peers, teachers, and other
- use the language of mathematics to express mathematical ideas precisely

Grade/Level:

Grade 5

Duration/Length:

5 days (50 minutes each day)

Student Outcomes:

Students will:

- Collect and organize data to answer questions using the appropriate vocabulary
- Develop and interpret bar graphs, pictographs, and stem and leaf plots
- Make statements and draw conclusions based on data using words, numbers, and pictures
- Describe the probability of an outcome, such as on a spinner, as more likely, less likely, unlikely, certain, impossible, and equally likely
- Apply knowledge of fractions, measurement, area, and perimeter in writing

Materials and Resources:

Student Resource Sheets 1-17
Teacher Resource 1-9
Overhead projector
6 Transparency Sheets
Toothpicks-56 per pair of students
Gumdrops-28 per pair of students
Chart paper
Film: Building Big With Bridges
Books:
Up Goes The Skyscraper By: Gail Gibbons
Into The Sky By: Ryan Ann Hunter
The Little Red Lighthouse and The Great Gray Bridge By: Hildegarde Swift
Bridges Are To Cross By: Philemon Sturges

Development/Procedures:

Lesson 1: Mountains

Preassessment – Begin by asking the class what methods they would use to represent data. Once the students explain the idea of graphs and plots, ask students about some of the specific graphs and plots they have used and/or seen. Discuss the idea of probability. Teacher will use an overhead to show a sample spinner and discuss probability.

Launch – Present students with pictures of bar graphs. Explain to the students that they are going to be learning about probability and bar graphs.

Teacher Facilitation –Distribute Student Resource Sheet (SR1) to students and discuss the material. Ask students what they notice about the data. Emphasize words such as likely or unlikely and discuss the degree of likelihood using such words as certain, equally likely, and impossible.

Student Application – Students will complete Student Resource Sheet (SR2). After completing SR2, students will share their explanations with a classmate. Students will complete Student Resource Sheet (SR3) using the Mountain Elevations spinner. Following the completion of the data chart, students will construct a bar graph (SR4) of mountain elevations. Students will analyze mountain elevation data and write a letter interpreting the data (SR5).

Embedded Assessment – Students will successfully complete a bar graph with 90% accuracy with data from Mountain Range Elevations. Graphs will be shared with other classmates. All bar graphs must have labeled axis, bars accurately drawn, a title, and an appropriate scale (TR2).

Reteaching/Extension –

- For those who have not completely understood the lesson, review what is needed.
- For those who have understood the lesson, take them to the next step in development of the concept.

Lesson 2-Domes

Preassessment-Students should be familiar with line graphs.

Launch-Ask students what they know about domes and have them discuss any domes they know about. Put overhead (TR3) on projector and discuss the scenario of working as an architect to design domes with students.

Teacher Facilitation-Distribute "Diameter of Domes" handout (SR6, 7).

Student Application-Students will make observations about the data presented and answer questions (SR6, 7). Following completion, teacher will put "Domes of the World" chart (TR4/SR8) on an overhead and distribute copies to students. Class will discuss data and make observations about differences between the date construction began and date of completion. Students will graph this information concerning construction time in a bar graph (SR9).

Embedded Assessment-Students will successfully complete a bar graph with data from "Domes of the World" showing length of construction time. Graphs will be shared with other classmates. All bar graphs must have labeled axis, bars accurately drawn, a title, and an appropriate scale (TR2).

Reteaching/Extension-

- Construct a graph showing the length of time needed to build each dome
- Word search

Lesson 3-Skyscrapers

Preassessment-Students should be familiar with stem and leaf plots for this lesson. You may want to give a brief review.

Launch- Ask students what they know about skyscrapers and have them discuss any skyscrapers they know about. Put TR5 on overhead and discuss. Put overhead "10 Tallest Buildings in the United States" (SR10) on projector and discuss the data. Explain to students that they will be building skyscrapers of their own, in pairs, using toothpicks and gumdrops

Teacher Facilitation-Distribute Student Resource Sheets (SR 11, 12, 13) to students. Go over directions for building a skyscraper. Be sure to talk about the importance of having a strong base when constructing a building.

Student Application-Students will make a prediction about how many minutes it will take their team to build a skyscraper and record their prediction. Students begin building their 7 story tall skyscrapers. Once all pairs have built their bases, timing will begin. Students should keep track of how many minutes it takes them to complete their skyscraper and the teacher will record the results on the board. Once all skyscrapers are complete, students will work together to construct a stem and leaf plot of the data (SR 12). Rubric for teacher (TR6)

Embedded Assessment –Check individual stem and leaf plots. They should be completed with 90% accuracy and the question at the bottom answered accurately.

Reteaching-Students will represent a given set of data in stem and leaf plot.

Extensions-

- Students will create a scatter plot comparing the number of stories and height in feet of the ten tallest skyscrapers in the United States. Students will determine if a correlation exists between height of building and number of stories.
- Picture book selections to read aloud:
  Up Goes The Skyscraper! By Gail Gibbons
  Into The Sky By Ryan Ann Hunter

Lesson 4-Bridges

Preassessment- Students should be familiar with pictographs for this lesson. You may want to give a brief review.

Launch-Read The Little Red Lighthouse and the Great Gray Bridge by Hildegarde H. Swift or Bridges Are To Cross by Philemon Sturges aloud to the class.

Teacher Facilitation-Put overhead (TR7) on the board and discuss the term "bridge span". Distribute "Largest Suspension Bridges in the United States" (TR8/SR14) and have students make observations about the data. Explain that students will create pictographs representing the length of various bridge spans in the United States. Distribute several copies of bridge pictures (SR15) to each pair of students. Teacher will need to modify the sizes of the bridges based on the size of the paper being used to create graphs.

Student Application-Students will work in pairs to determine the number of symbols needed to represent the span of each bridge in the pictograph to be used in their pictograph. Students will create a pictograph of the data.

Embedded Assessment-Completed pictographs will have a title, list of measured items, appropriate number of symbols to represent data, and key to show what each symbol represents (see Rubric TR 9).

Extensions

- Students will construct a bridge using Popsicle sticks, yarn, straws, and masking tape.
- Students will explore the web site
  http://www.pbs.org/wgbh/buildingbig/profile/

Summative Assessment:

Students will complete the Assessment Activity (SR 16, 17). They will apply their knowledge of probability, bar graphs, pictographs, and stem and leaf plots.

Additional Resources to Supplement Unit:

Skyscrapers! Super Structures to Design and Build By Carol Johmann
Unbuilding By David Macaulay
Bridges! Amazing Structures to Design, Build, and Test By Carol Johmann
The Haunted Bridge (Nancy Drew Mystery Stories No. 15) By Carolyn Keene
Crossing the Starlingt Bridge By Alice Mead
My Side of the Mountain By Jean Craighead George
When I Was Young In The Mountains By Cynthia Rylant
Mountain Top Mystery (Boxcar Children Series No. 9) By Gertrude Chandler Warner and David Cunningham
Owen and the Mountain By Malachy Doyle and Giles Greenfield
The Handy Science Answer Book By The Science and Technology Department of the Carnegie Library of Pittsburgh
Building Big By David Macaulay

Authors:

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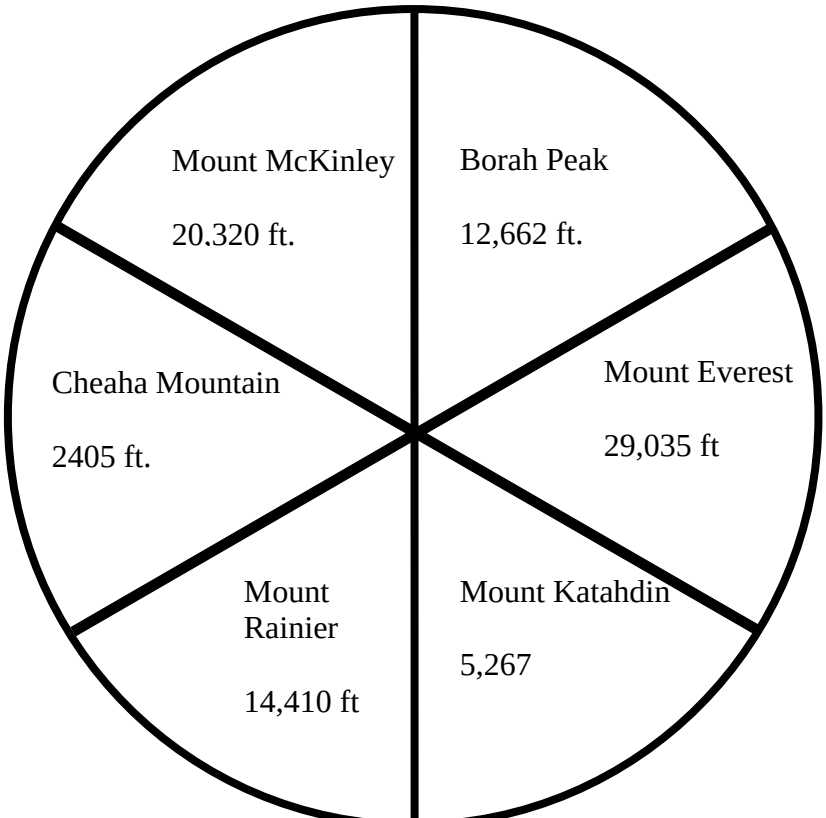
SR1/TR1

DoraLora's teenage daughter wants to organize a mountain climbing expedition. She and her friends are having a disagreement as to which mountain they should climb first. Joy Fair suggests that they use a spinner to determine the site of their next climb. Look at the spinner below to answer the following questions.

Mountain Elevations



SR2

Name: _____ Date:_____

1. Does every site have an equal chance of being selected? Explain.

_____

_____

_____

_____

2. What is the probability of choosing Mt. McKinley? Express as a fraction.

_____

3. How many times do you think the spinner will land on Mt. Everest in thirty spins? Explain your answer using words, numbers and/or pictures.

SR3

Name: _____ Date: _____

Ima Climber, the famous teenager mountain climber, wants to gather data to compare the highest mountains in the world. Help her organize the data from the spinner into a chart. Order the mountain elevations from least to greatest.

MOUNTAINS	ELEVATION

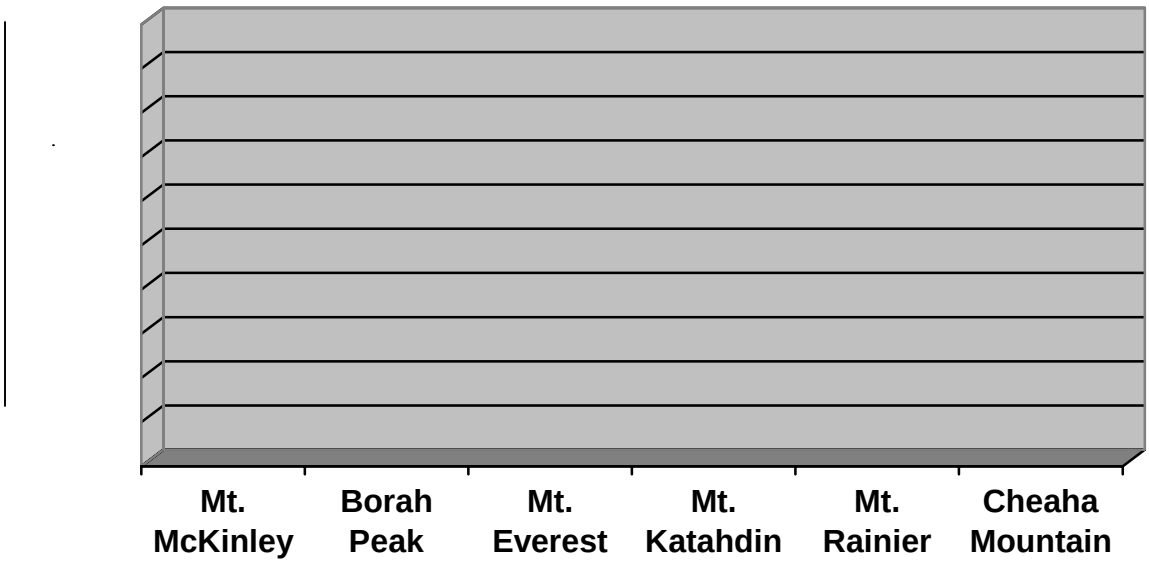
Make a bar graph of the data in the chart above.

SR4

Name: _____ Date: _____

Title:

_____



Mountain Names

SR5

Name:_____ Date:_____

Pretend you are Alma Climber. Write a letter to your mother DoraLora telling her about what you learned from constructing a bar graph with mountain elevation data. Be sure to tell her which are the smallest and largest mountain peaks.

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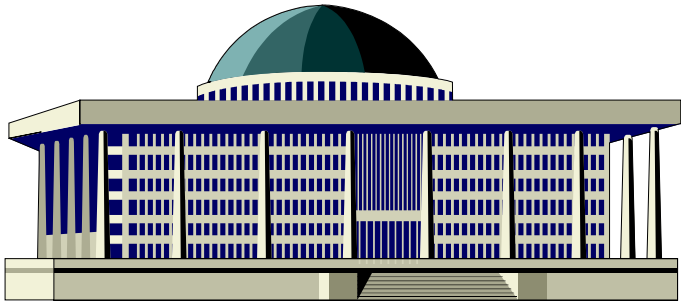
TR2

Scoring Rubric for Bar Graphs

Rating Scale: 3 2 1

Goal	Rating
Graph has clear title that summarizes key points of graph	
X and Y axis are clearly labeled	
Appropriate scale	
Graph clearly and accurately conveys data	

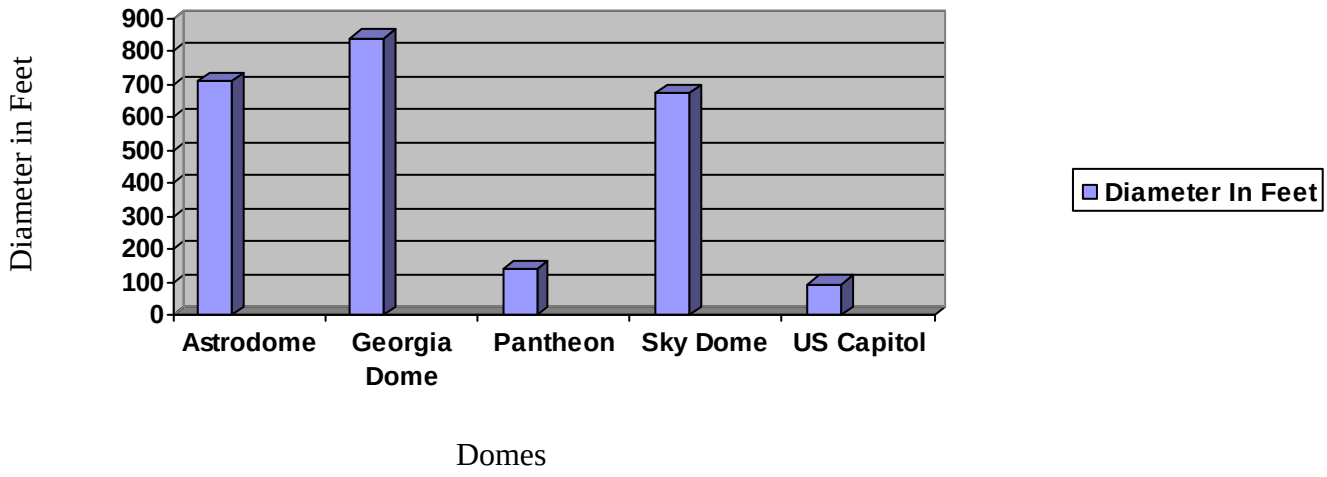
Imagine you are an architect planning to build a dome. The builder wants to know how long it will take you to build the dome. Since you have no idea, you will look at how long it has taken to build eight of the most famous domes in the world.



SR6

Name: _____ Date: _____

Diameter of Domes



1. What information can you determine from this bar graph?

_____

_____

_____

2. What is the range of diameters in the graph above?

_____

Use what you know about statistics to explain why your answer is correct. Use numbers and/or words in your explanation.

3. What is the mean diameter of the five domes listed above? You may use a calculator if you want.

_____

Use what you know about statistics to explain why your answer is correct. Use numbers and/or words in your explanation.

SR8/TR4

Domes of the World

Dome-Location	Date Construction Began	Date of Completion
Pantheon-Rome, Italy	118	125
Hagia Sophia-Istanbul, Turkey	532	537
Sehzade, Mosque-Istanbul, Turkey	1544	1548
St. Peter's Basilica-Vatican City, Italy	1585	1590
Les Invalides-Paris, France	1680	1691
St Paul's-Paris, France	1675	1710
US Capitol-Washington, DC	1856	1863
Astrodome-Houston, TX	1962	1965

SR9

Title:_____

You work in one of the tallest buildings in the United States. Whenever there is a fire drill you have to run down the stairs from the top floor to leave the building safely. Which building would you most like to work in? Least? Explain your choices.

SR10

10 Tallest Buildings in the United States

Building, City	Number of Stories	Height (feet)
Sears Tower, Chicago	110	1450
Empire State Building, New York	102	1250
Aon Centre, Chicago	80	1136
John Hancock Center, Chicago	100	1127
Chrysler Building, New York	77	1046
Bank of America Plaza, Atlanta	55	1023
Library Tower, Los Angeles	75	1018
AT&T Corporate Center, Chicago	60	1007
JP Morgan Chase Tower, Houston	75	1002
Two Prudential Plaza, Chicago	64	995

SR11

Name:_____ Date:_____

Prediction:
It will take my team _____ minutes to build our skyscraper.

Class Data

Time Needed To Build Skyscraper (minutes)

Directions: Construct a stem and leaf plot of the data we collected as a class.

Why is a stem and leaf plot the best way to organize this data? What other methods could you use to organize our data?

TR6

Scoring Rubric for Stem and Leaf Plots

Rating Scale: 3 2 1

Goal	Rating
Graph has clear title that summarizes key points of graph	
X and Y axis are clearly labeled	
Units of measure are equally spaced	
Graph clearly and accurately conveys data	
Plot key is accurate	

Directions for Constructing Your Skyscraper

Build your base:

1. Connect 4 toothpicks in a square using gumdrops at the joints
2. Once you are sure you have a strong base, start timing

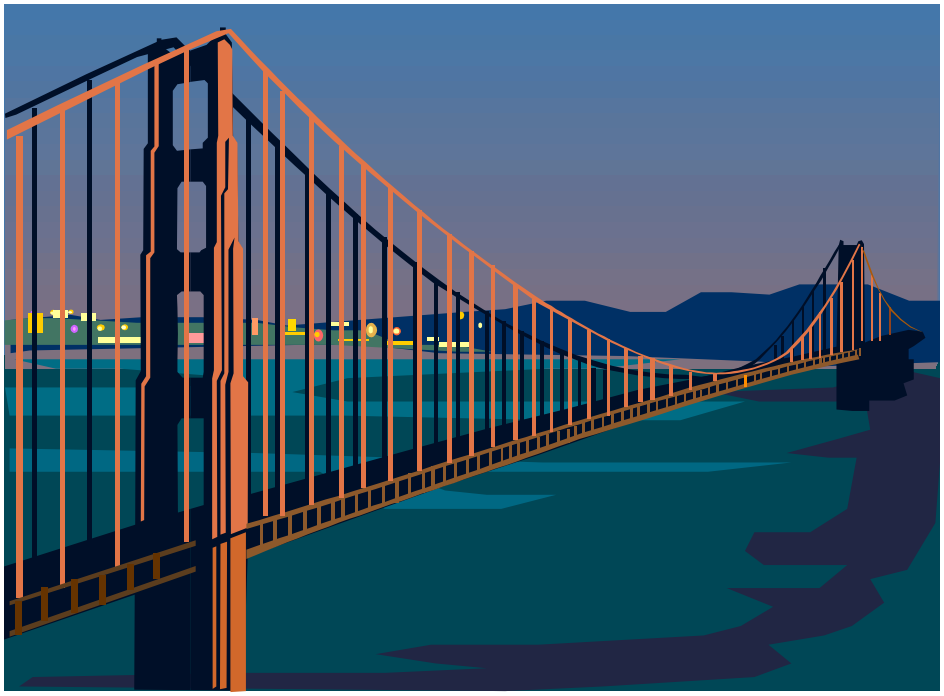
Build the floors:

1. Place one toothpick pointing up into each gumdrop
2. Place gumdrops on the top of each of these toothpicks
3. Connect gumdrops with toothpicks forming another square
4. Repeat steps 1-3 until you have built 7 stories, including the base as the first floor.

Stop timing and record.

TR7

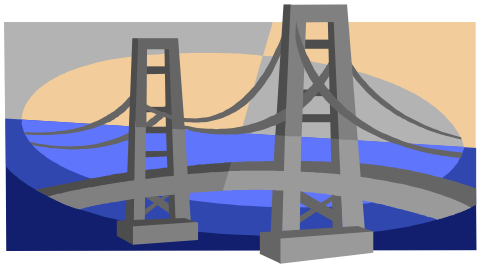
There is a bridge race in your city this weekend. Participants run the entire length of the bridge span. Which bridge would you most want to run on? Why? Which bridge would you least want to run on? Why?



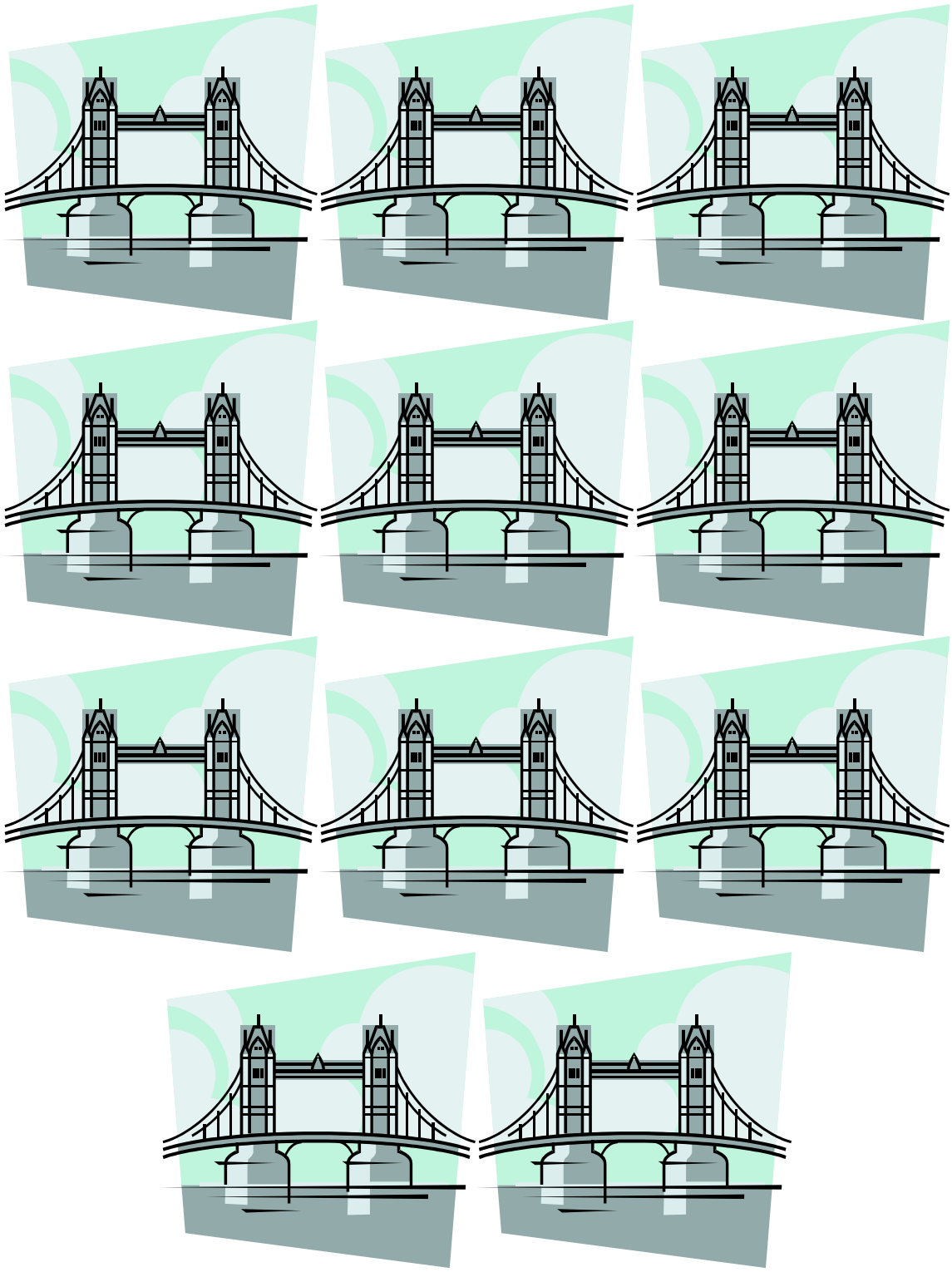
TR8/SR14

Largest Suspension Bridges in the United States

Name	Location	Length of main span in feet
Verrazano-Narrows	Lower New York Bay	4260
Golden Gate	San Francisco Bay	4200
Mackinac	Mackinac Straits, Michigan	3800
George Washington	Hudson River at New York City	3500
Tacoma Narrows II	Puget Sound at Tacoma, Washington	2800
San Francisco-Oakland Bay	San Francisco Bay	2310
Bronx-Whitestone	East River, New York City	2300
Delaware Memorial	Delaware River near Wilmington, Delaware	2150
Seaway Skyway	St. Lawrence River at Ogdensburg, New York	2150
Walt Whitman	Delaware River at Philadelphia	2000
Ambassador International	Detroit River at Detroit	1850
Throgs Neck	East River, New York City	1800
Benjamin Franklin	Delaware River at Philadelphia	1750
Bear Mountain	Hudson River at Peekskill, New York	1632
William Preston Lane, Jr	Chesapeake Bay, Maryland	1600



SR15



Scoring Rubric for Pictographs

Rating Scale: 3 2 1

Goal	Rating
Graph has clear title that summarizes key points of graph	
List of measured items	
Appropriate number of symbols to represent data	
Key to show what each symbol represents	

Name: _____ Date: _____

"Let's Talk Tunnels"
Summative Assessment

0. What is the best type of graph to use to analyze class test scores?
    a. bar graph
    b. line plot
    c. stem and leaf plot
    d. pictograph

1. If I have a spinner with four equal sections and each section has a different color, (red, blue, yellow, orange) what is the probability that I will land on red or blue?

    a. ¼
    b. ½
    c. ¾
    d. 4/4

2. What kind of graph would you use to display favorite flavors of ice cream?

    a. stem and leaf plot
    b. pictograph
    c. probability wheel
    d. bar graph

TR10

Answer Key

Name: _____ Date: _____

"Let's Talk Tunnels"
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3. What kind of graph would you use to display favorite flavors of ice cream?

   a. stem and leaf plot
   b. pictograph
   c. probability wheel
   d. bar graph

S

Brief Constructed Response

Name	Length in feet	Cost to build	Setting
Channel Tunnel	163,680	$21,000,000,000	Underwater
Holland Tunnel	8,558	$48,000,000	Underwater
Paw Paw Tunnel	3,118	$600,000	Rock
Thames Tunnel	1,200	unknown	Underwater
Central Artery Tunnel	18,480	$10,000,000	Soft ground

Part A

What is the difference between the length of the largest and shortest tunnels?

Create a bar graph that displays the data in the table above.

Part B

Use what you know about data analysis to explain why your answer is correct. Use number and/or words in your explanation.