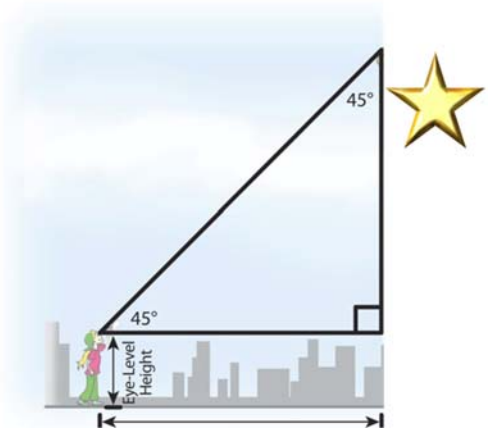
Height of the Stars Lesson Plan

Objectives:

- Find the measurement of a tall object
- Compare measurements and discuss errors
- Find mean, median, and mode of a set of data
- Select the best "average" measure to report



Materials:

- Protractors
- String or dental floss
- Scissors
- Small weights, such as washers or coins
- Drinking straws
- Tape
- Tape measure
- Clinometer Construction Overhead
- Star Height Activity Sheet

Instructional Plan:

Put students in pairs and pass out the following to each pair: a protractor, a small weight or washer, a piece of string or dental floss 4-6 inches long, a drinking straw, and 2 or 3 short pieces of tape. Explain that they will be measuring the height of different objects from space, such as an asteroid, shuttle, and the moon. Ask students to brainstorm how to measure objects that are taller than a person using only the materials provided. List the ideas on the board and discuss which ideas are practical and reasonable ways to measure a star.

Draw an isosceles right triangle on the board with one leg drawn on the bottom horizontally. Ask students questions that will introduce the properties of an isosceles right triangle. Here are some questions you may choose to ask the class:

- What does "isosceles" mean?
  [Two sides of the triangle are congruent.]
- What does "right" mean?
  [One angle of the triangle has a measure of 90°.]
- Can you identify the congruent sides and right angle?
  [Have a student volunteer label the appropriate parts of the triangle.]
- Do we know anything about the other angles of the triangle? Can we figure out their measures?
  [They are both 45°.]

Relate these properties back to the challenge of measuring the height of a star with the given materials, and ask for new or revised ideas on how to accomplish the task. Finally, introduce the idea of using a clinometer if it has not already been suggested. Pass out one Star

Height Activity Sheet to each pair of students. Read through the directions on the first page and ensure that students understand how a clinometer works.

Help each pair of students create their clinometer. Direct them to follow the steps provided on the Clinometer Construction Overhead. Create a clinometer along with students, step-by-step, at the front of the room.

Decide on a common definition of "height of the stars" for students to measure, which will vary depending on the star being measured. Allow students to find the height of the stars in the classroom following the instructions on the activity sheet. Once students are finished taking their measurements, collect data from each team. Each team should put their measurement for the height of the star on the board, and then record the data from the board onto the chart on page 2 of the activity sheet.

Now, lead a whole class discussion of the results using the following questions as a guideline:

- Were the answers from the groups the same or different? Why do you think this is?
  [There will most likely be variation among the answers from different teams. Explanations for this will vary, but possible answers could include accuracy in measurement, difficulty in reading the clinometer accurately, or precision in measurement (such as rounding error).]
- Does a person's height affect the measurement of the shuttle height?
  [No, measuring eye-level height accounts for a possible difference. A person 2 inches taller than another will stand 2 inches closer to the star when taking the measurement.]

Next, direct teams to complete Questions 3-5 on the activity sheet. Circulate among the pairs and provide assistance as needed. You may want to give hints for Questions 4 and 5, but do not provide direct answers. Once most pairs have finished, ask volunteers to put up their calculations for the mean, median, and mode, showing their work. Then have a class discussion about Questions 4 and 5.

Use the following as a guide for the discussion of Question 4, 5, and 6:

What measure of central tendency (mean, median, or mode) best represents the "average" height? (Question 4)

[Answers will vary, but students should choose either the mean or the median. If there is an outlier, median would be best. If there are no outliers, mean would be the best value to report.]

How could you improve the accuracy of the measurements? (Question 5)

[Answers will vary. Students may suggest standing still and using a more precise protractor.]

What are some ways we can improve this method to represent or simulate a more accurate measurement of a star height? (Question 6)

[Answers will vary. Students might suggest converting from feet to light years. Not accurate method of reality, but with simulation we can convert the space to a more accurate reality.]

Assessments:

Using the "best average" measure, ask the students a comparable question: Kaitlin wants to find the best way to average her data on the length of a satellite that is currently orbiting Earth. She measures the length 11 different times throughout the night. Her resulting measurements were 11,12,9,6,10,8,13,16,7,13, and 30 inches. She asks three of her friends what they think is the best measure of average. Tori tells her that she thinks the mode is the best measure of average while Sean tells her mean and Danielle tells her median.

- What is the mean, median, and mode of the data?
  [Mode: 13; Median:11; Mean:11+12+9+6+10+8+13+16+7+13+30/11=12.27]
- Who of Kaitlin's friends is correctly? [Since there is an outlier in the data set, we can say that the best measure of average is the median]
- What do you think caused the variation in the data?
  [There are multiple probable answers. It could be that she did not measure from the same spot for each time. Her clinometer could have been faulty. Since she is measuring a satellite instead of a star, the satellite moves as well as the planet moves; and thus, there could be a change in the height of the satellite.

Extension:

- Have students test the accuracy of a clinometer by measuring the height of something that they can directly measure with measuring tape.
- Students could also measure the height of other objects using their clinometers and tangent ratios.

Tennessee Mathematics Standards:

6th Grade:

Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

Summarize numerical data sets in relation to their context, such as by giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern any striking deviations from the overall pattern with reference to the context in which the data were gathered.

Summarize numerical data sets in relation to their context, such as by relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

Source:

National Council of Teachers of Mathematics, *Building Height*, 2016.

Adapted by Virginia Parkman, Cameron Cook, Suzanne Lenhart, and Greg Wiggins

Star Height

Name_____

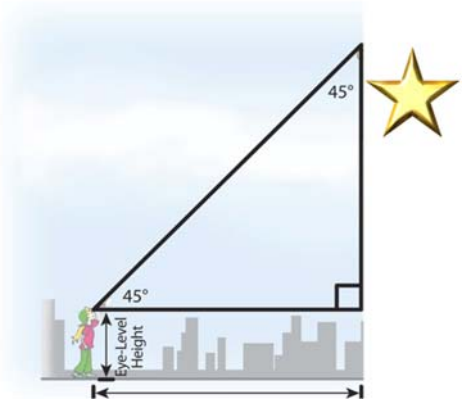
Instructions: Choose which partner will be the measurer and which will be the helper. Complete the table by first measuring accurately what is indicated by the instructions, and then recording your results. Make sure to read all the instructions for each part of the table below before measuring.

Eye-Level Height

Use the tape measure to measure the height from the eyes of the measurer to the ground. This measurement should be rounded to the nearest inch.

Distance from Star

1. The measurer should hold the clinometer so that the highest point of the star to be measured is visible through the straw.
2. The helper should now instruct the measurer to move backward or forward, until the angle measurement on the clinometers reads 45°. The measurer should make sure to keep the top of the star in the sight through the straw while moving.



3. Measure the distance on the ground between the measurer and the star, in inches.

Height of Star

Add eye-level height to the distance-from-star measurement. Record this measurement in the third column of the table. Then convert the measurement to feet, and record this in the last column.

EYE-LEVEL HEIGHT (IN INCHES)	DISTANCE FROM STAR (IN INCHES)	HEIGHT OF STAR (IN INCHES)	HEIGHT OF STAR (IN FEET)

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Collect data from the class and record it on the table below. Don't forget to include your data from the first page.

PAIR	HEIGHT OF STAR (IN FEET)

3. Using the data in the table above, find the mean, median, and mode of the star height measurements.
Mean:

Median:

Mode:

4. Select one measure of central tendency to report as the star height. Which measure did you choose? Why does this measurement most accurately represent the "average" of the data?

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5. Do you think the result is accurate? How could you improve the accuracy of this method of measurement?

6. Does this appear to be an accurate assessment of reality? What are some ways we can improve the method to represent or simulate a more accurate measurement of a star height?

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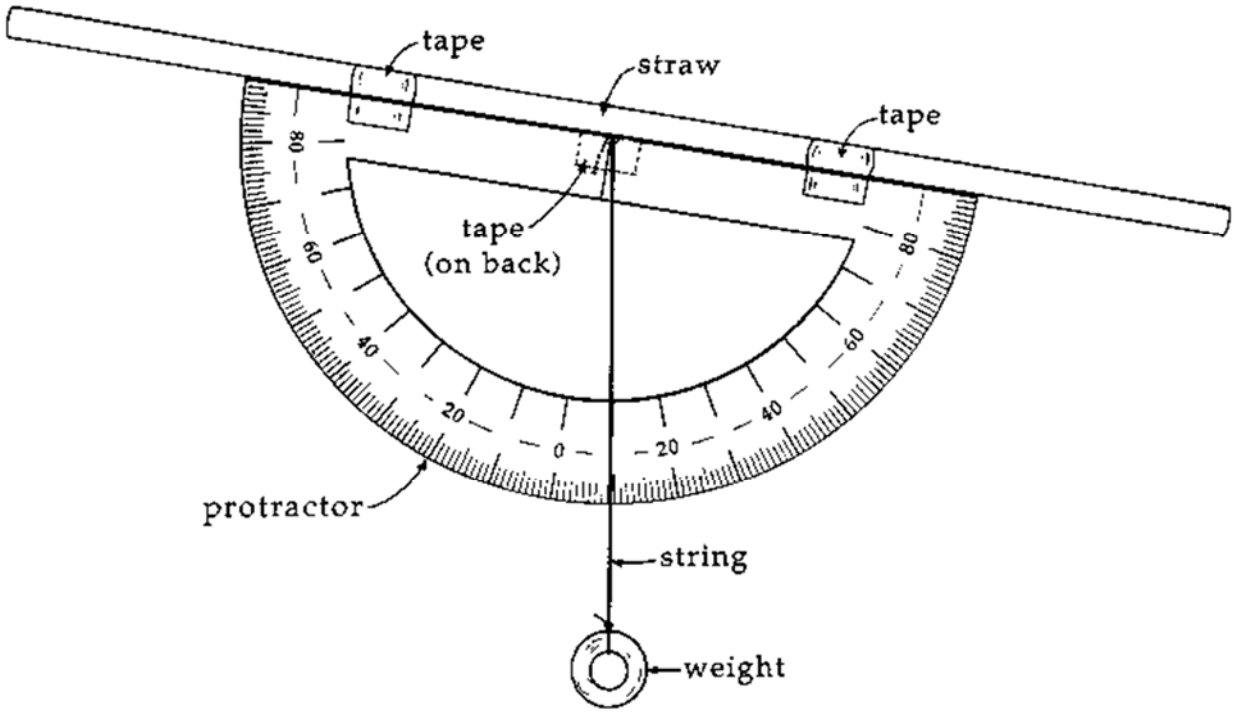

1. Tie one end of the string to the weight.
2. Tie the other end of the string to the center hole in the base of the protractor. Make sure the knot lines up with the center hole and not the outside or inside the protractor.
3. Tape the drinking straw to the flat edge of the protractor. Make sure the ends of the straw lies flush with the corners of the protractor.
4. Turn the protractor upside down. The weight should pull down the string so that it passes through the degree measures when the clinometer is turned.

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