OERB

Virtual

CLASSROOM

Instructor: Jackie Jackson
Grade Level: 9 - 12
Subject: Geometry & Basic Trigonometry

Students will use parallel lines and transversals, angles of elevation and depression, and trigonometric ratios to solve real world problems.

Wonder Why:

Have you ever wondered why it's so hard to measure the height of a tree with a ruler or yardstick? Or wondered how you could measure the height or distance of an object without using traditional measuring tools?

Goal:

Students will make a hypsometer and use it to measure and calculate the height of a tall object in their neighborhood.

Lesson Guide Agenda:

- ❖ <u>Vocabulary</u>
- ❖ <u>Theorems and Equations</u>
- ❖ <u>Materials Listed</u>
- ❖ <u>Printable Protractor</u>
- ❖ <u>Activity Instructions</u>
- ❖ <u>Challenge</u>
- ❖ <u>Additional Resources</u>
- ❖ <u>Oklahoma Academic Standards</u>

Parallel Lines – Two lines that are always the same distance apart and never touch.

Transversals – A line that cuts across two or more (usually parallel) lines.

Line of Sight – A line from an observer's eye to a distant point. An observer's line of sight would be above the horizontal.

Angle of Elevation – The angle formed by the line of sight and the horizontal plane for an object above the horizontal.

Angle of Depression – The angle formed by the line of sight and the horizontal plane for an object below the horizontal.

Alternate Interior Angles – The angles that are created where a transversal crosses two (usually parallel) lines. Each pair of these angles are inside the parallel lines, and on opposite sides of the transversal.

<u>Hypotenuse side of a right triangle</u> – The hypotenuse is the longest side of the right triangle.

<u>Opposite side of a triangle</u> - The opposite side is the side that is across from a given angle.

<u>Adjacent side of a right triangle</u> – The adjacent side of the triangle is the side next to the given angle.

<u>Trigonometric Functions</u> – A function of an angle expressed as the ratio of two of the sides of a right triangle that contains that angle. The main functions in trigonometry are Sine, Cosine, and Tangent.

<u>Congruent</u> – Two objects are congruent if they have the same dimensions and shape. Angles are congruent when they are the same size (in degrees or radians). Sides are congruent whey are the same length.

<u>Proportions</u> – A name we give to a statement that two ratios are equal.

- **Alternate Interior Angles Theorem:** If two parallel lines are cut by a transversal, alternate interior angles are congruent.
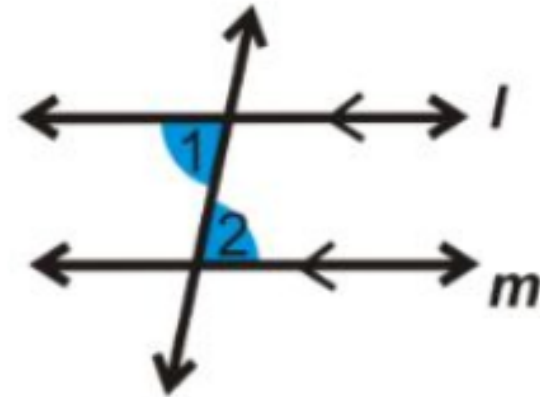
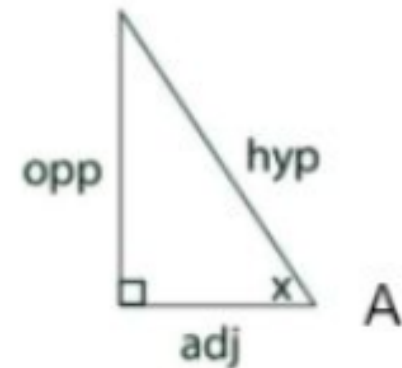- **Right Triangle Trigonometric Ratios**

  Acronym to help you remember the ratios:

  SOHCAHTOA

  $$sinA = \frac{opp}{hyp} \qquad cosA = \frac{adj}{hyp} \qquad tanA = \frac{opp}{adj}$$

Making a Hypsometer

Materials Needed:

Tape

Index Card

Protractor

Straw
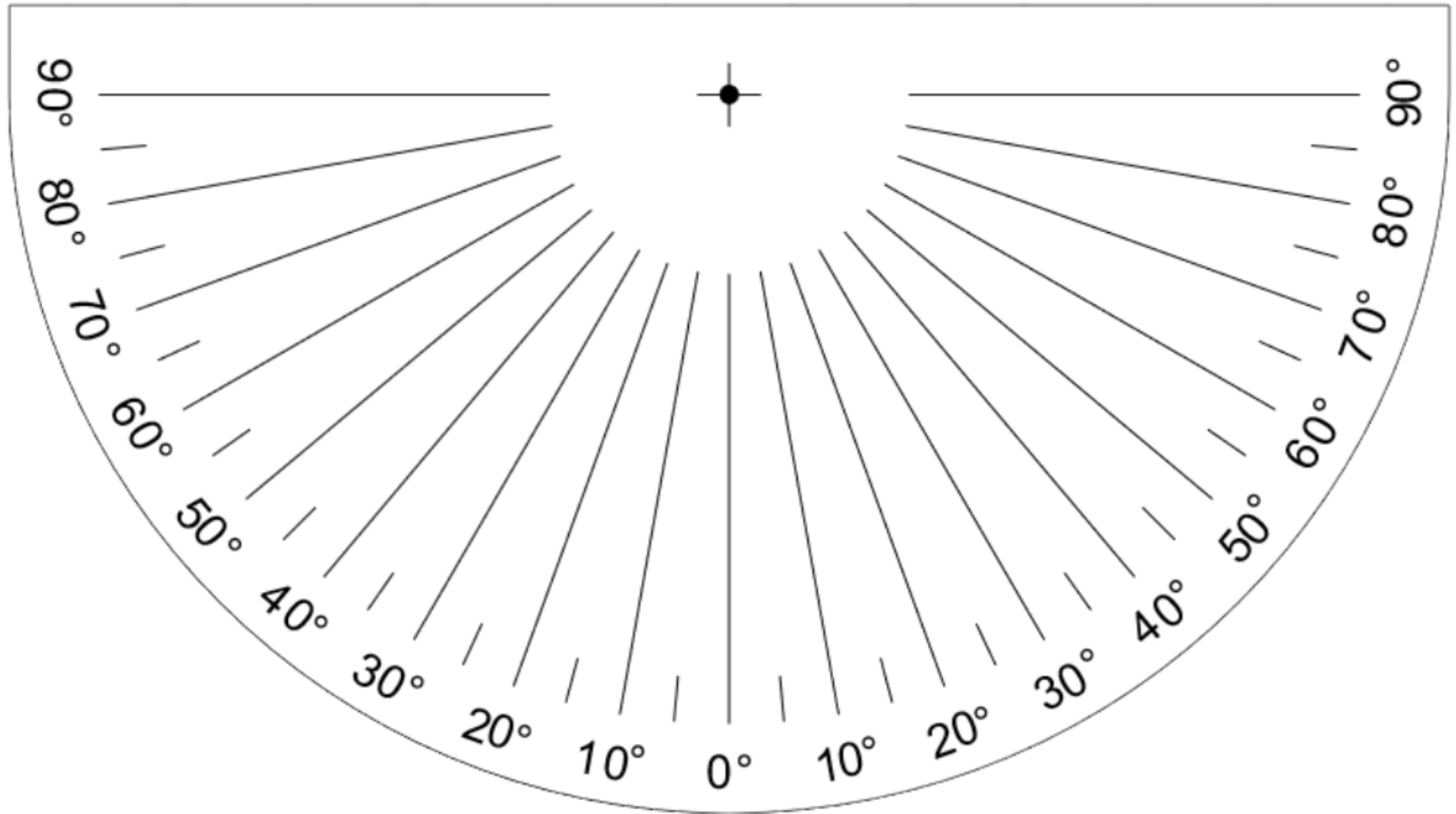
String (8-10 inches, trim as necessary)

Paper clips or small fishing weight

Measuring Tape

Scientific calculator (online calculator or app will work)

Note: You can print and cut out the protractor in this lesson guide, or on the HomeRoom website. Any protractor will work but having one with zero at the center is helpful.

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Watch the "Are You Hyp(someter) to the Height?" video before continuing to the challenge!

Get ready for some Trigonometry fun!

If you have any questions throughout this lesson,
please email teachers@oerb.com.
We would love to hear from you!

Instructions:

1. To make the hyposometer:
   a. Print the protractor and cut it out.
   b. Bend one of the paper clips so that you can poke a hole through the protractor at the dot.
   c. Insert the end of the string through the hole and tape on the back side.
   d. Tape an index card to the back of the protractor, making sure that the 90° marks line up with the top edge of the index card. Fold the top of the protractor over the index card and tape it down on the back.
   e. Tie the paper clips to the other end of the string so that it hangs down past the 0° mark. Trim the string if needed.
   f. Tape the straw to the top edge of the index card along the 90° marks.

2. Measure the length of your show.

3. Measure the height from your eye down.

4. Once you have identified the object to measure, step off several places from the object, placing one foot directly in front of the other. You can multiply the length of your shoe by the number of steps you take to find the distance you walk away from the object.

5. After you have stepped far enough away from the object, turn around and look through the straw on the hypsometer to the top of the object. Check the angle of elevation on your hypsometer. Have a friend or family member help you if needed.

6. For the calculations:

   a. You will use the tangent ratio to help you solve because you are looking for the object OPPOSITE of you and your angle, and you stepped off the distance ADJACENT to you and your angle. Set it up as follows:

   $$tan(\text{angle of elevation}) = \frac{x}{\text{your distance from the tree}}$$

   b. Add your height from your eyes down to the value of x. This will give you the entire height of your object.

Challenge:

What objects in your neighborhood can you find that are difficult to measure with traditional tools?

Choose an object in your neighborhood and calculate the height using the hypsometer you made in this lesson!

WANT TO WIN A PRIZE?

Take a picture of you with your hypsometer and the object measured! Share your picture with us by emailing teachers@oerb.com and on Facebook/Instagram by tagging us @oerbok.

Be sure to include your name, grade, school, and teachers!

The teacher with the most student submissions will win a $100 Amazon Gift Card!

Check out these additional resources!

1. "Measuring angles using an Inclinometer" | Gary Hall
    https://garyhall.org.uk/measure-angles-inclinometer.html

2. Standards and Competencies for Oklahoma Mathematics
    https://sde.ok.gov/standards-and-assessments-oklahoma-mathematics

Lesson Guide | Oklahoma Academic Standards

G.RT.1.4 Apply the trigonometric functions as ratios (sine, cosine, and tangent) to find side lengths in right triangles in real-world and mathematical problems.

G.2D.1.1 Apply the properties of parallel and perpendicular lines, including properties of angles formed by a transversal, to solve real-world and mathematical problems and determine if two lines are parallel, using algebraic reasoning and proofs.

Additional standards may apply to your extensions of this lesson and can be viewed here.