

TRIGONOMETRY, Part 1:

22 Minutes

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FOR USE IN: Mathematics

LEVEL: Grades 7-9

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EDUCATIONAL OBJECTIVES:

To help the students understand:

similar triangles

finding an unknown height in a similar triangle

tangent ratios of varying angles

hypotenuse, adjacent, and opposite sides

using a calculator to find the tangent ratio of any angle

using tangent ratios to find either an unknown adjacent or opposite side length

BACKGROUND INFORMATION:

The solution of many problems requires the measurement of line segments and angles. When we use a ruler or tape measure to determine the length of a segment, or a protractor to find the measure of an angle, we are taking a *direct measurement* of the segment or the angle. In many situations, however, it is inconvenient or impossible to make a measurement directly. For example, it is difficult to make the direct measurements needed to answer the following questions:

What is the height of a 100-year-old oak tree?

What is the width of a river?

What is the distance to the sun?

We can answer these questions by using methods that involve *indirect measurement*. Starting with some known lengths of segments or angle measures, we apply a formula or a mathematical relationship to *indirectly* find the measurement in question. In geometry, when we worked with similar triangles and the Pythagorean Theorem, we used indirect measurement.

One application of *trigonometry* relates the ratio of the lengths of two sides of a right triangle to an acute angle of the triangle. By combining a knowledge of trigonometry with

that of similar triangles, we can measure line segments and angles indirectly. Engineers, surveyors, physicists, and astronomers frequently use these trigonometric methods in their work.

CONTENT OF THE VIDEO:

Trigonometry means the measurement of triangles, right angle triangles. The ancient Greeks used it to measure the angles of elevation of planets above the horizon, and so plot their positions. Astronomers, land surveyors, and construction personnel still use trigonometry. The ancient Greeks worked out how to calculate the unknown height of an object by measuring its shadow, and also the shadow of an object with a known height and shadow length at the same time of day. Because these form two right triangles with the same angle of elevation; they are called **similar triangles**. Similar triangles, regardless of size, **have the same ratio of base (shadow length) to height**. The calculation is then shown on how to find the hitherto unknown height. However, when the angle of elevation changes, the ratio of base to height changes. The Greeks then calculated the changing ratios of base length to height for each change in the angle of elevation, and called those ratios, the **tangents** of the angles. In a right triangle, the tangent ratio of a 54 degree angle is used with a known base (shadow) length, to calculate an unknown height.

There are ratios other than the tangent ratio, which can be used. For clarity, names are given to the three sides of a right triangle which relate to which angle we are measuring. **Adjacent side** and **opposite side** are the sides next to and opposite the angle being measured. **The longest side, the hypotenuse** is never an adjacent side and is always opposite the right angle.

Various problems are presented, with optional pauses for the students to find the solutions. Using the tangent of a known acute angle, and a known length of the opposite side, the unknown length of the adjacent side is determined using a calculator. Similarly, using the tangent of a known acute angle and a known length of the adjacent side, the unknown length of the opposite side can be calculated.

There are intermittent reviews during the video, and at the end, an overall review of Part 1.

AFTER SHOWING THE VIDEO:

The students may be given the following problems:

1. Use a calculator to find each of the following rounded off to the nearest 5 decimal places:

$$\begin{array}{l} \tan 10^{\circ} \\ \tan 1^{\circ} \end{array}$$

$$\begin{array}{l} \tan 30^{\circ} \\ \tan 89^{\circ} \end{array}$$

$$\begin{array}{l} \tan 70^{\circ} \\ \tan 36^{\circ} \end{array}$$

$$\begin{array}{l} \tan 45^{\circ} \\ \tan 60^{\circ} \end{array}$$

2. Use a calculator to find the measurement of the angle A to the nearest degree:

$$\tan A = 0.0875 \quad \tan A = 2.0503 \quad \tan A = 1.0000 \quad \tan A = 3.0777$$

3. Does the tangent of an angle increase or decrease as the degree measurement of the angle varies from 1° to 89° ?
4. Is the tangent of the angle doubled when the measurement of the angle is doubled?
5. At a point on the ground 50 feet from the foot of a tree, the measure the angle of elevation of the top of the tree is 48° . Find the height of the tree to the nearest foot.
6. An airplane climbs at an angle of 11° with the ground. Find to the *nearest hundred feet* the distance the airplane has traveled when it has attained an altitude of 400 feet.
7. Find to the *nearest degree* the measure of the angle of elevation of the sun if a child 3 feet high casts a shadow 6 feet long.
8. A wire attached to the top of a pole reaches a stake in the ground 20 feet from the foot of the pole and makes an angle of 58° with the ground. Find to the *nearest foot* the length of the wire.

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