The Tangent Ratio

Lesson Plan

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Goal: The goal of this lesson is to introduce students to the tangent ration of a right triangle and how the definition may be used to determine unknown leg lengths. A further goal is to demonstrate the utility of the definition by employing it to find the heights of several objects in the school parking lot (e.g., light poles and flag poles).

Grade and Course: tenth grade geometry

KY Standards: **MA-11-2.1.3** Students will apply definition and properties of right triangle relationships (right triangle trigonometry and the Pythagorean theorem) to determine length and angle measures to solve real-world problems.

Objectives: The students will:
1. learn the definition of the tangent ratio
2. be able to determine the tangent ratio for a right triangle with known leg lengths
3. be able to find an unknown leg length given a known side and an angle
4. use what they have learned along with a clinometer (see Fig. 1 and 2) and meter stick to find the heights of several objects

Resources/materials needed: The following items are needed:
- lecture slides and worksheet (found below)
- a meter stick for each group participating
- a clinometer for each group participating

Description of Plan: The lesson begins with a lecture introducing tangent. This is approached by posing the problem of finding the unknown height of a tree. After introducing the definition of tangent ration, students quickly see how it can be used to find the desired height. In order to give students an idea of how tangent behaves, they are asked to predict, by drawing the triangles and thinking of the definition, what values tangent will produce for various angles between 0º and 90º. Next, several homework-type problems are solved as examples.

The following day students are asked to apply their knowledge by going out into the parking lot and finding the heights of several objects. This is accomplished by using a meter stick to measure a baseline from the object and then finding the angle to the top of the object with the aide of a clinometer (see Fig. 1,2). After the students have made their calculations, it should be noted that the height found is from the observer's eye to the top of the flag pole. It is necessary to adjust this value by adding the observer's height. All three classes at Bath County were able to realize this for themselves unprompted. Objects measured included light poles, flagpoles, and the top of the building.

Lesson Source: canonical

Instructional Mode: A lecture followed by homework problems the first day. The second day is a hands-on data-gathering activity using technology in the form of clinometers.

Date Given: April 20, 2007

Estimated Time: two days

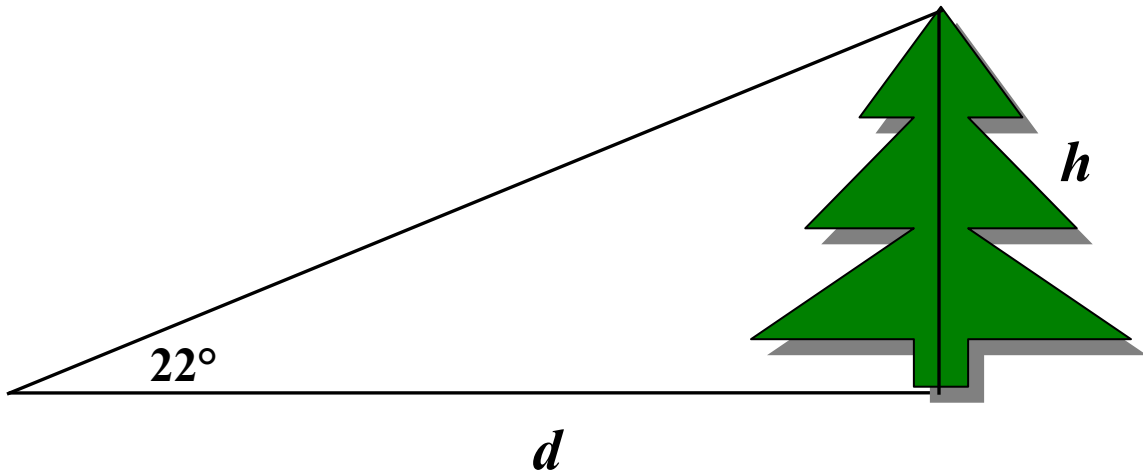**Date Submitted to Algebra[3]:** May 9, 2007

Figure 1: Brunton compass in clinometer mode

Figure 2: clinometer in use
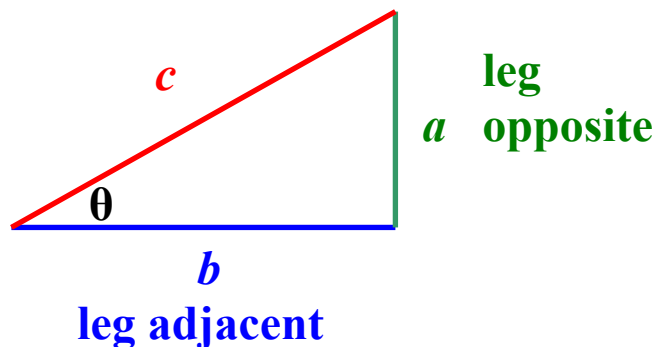
The Tangent Ratio

Suppose that you wanted to know the height of a tree but that it was too tall to measure. How could you figure it out?
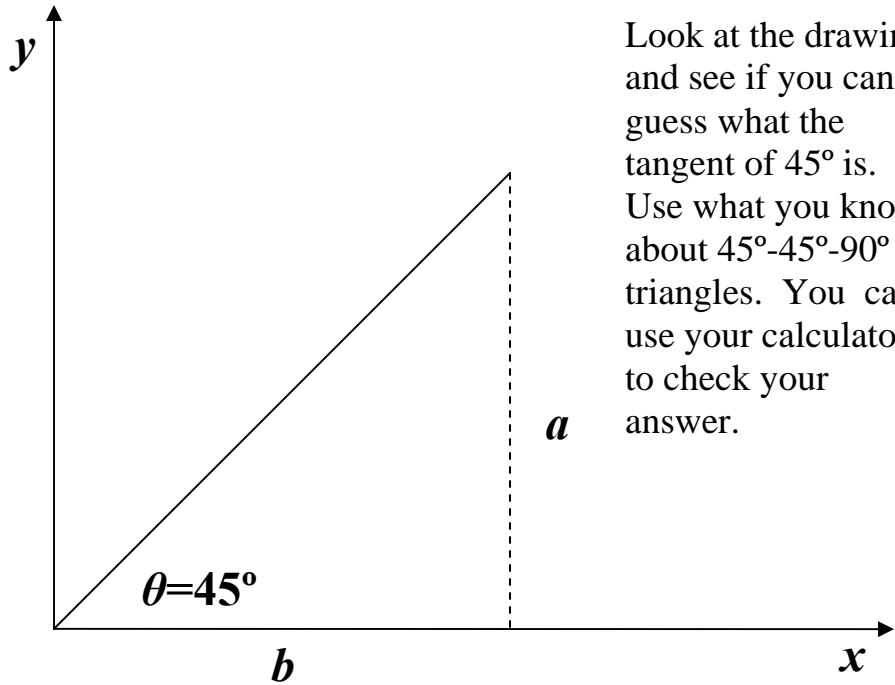
22°

h

d

This problem (as well as many others) may be solved by using the tangent ratio:

TANGENT RATIO: for any acute angle θ of a right triangle

$$\tan(\theta) = \frac{leg\ opposite\ \theta}{leg\ adjacent\ to\ \theta} = \frac{a}{b}$$

c

leg
a **opposite**

θ

b
leg adjacent

y

θ=45°

b

a

x

Look at the drawing and see if you can guess what the tangent of 45° is. Use what you know about 45°-45°-90° triangles. You can use your calculator to check your answer.

y

θ=60°

b

a

x
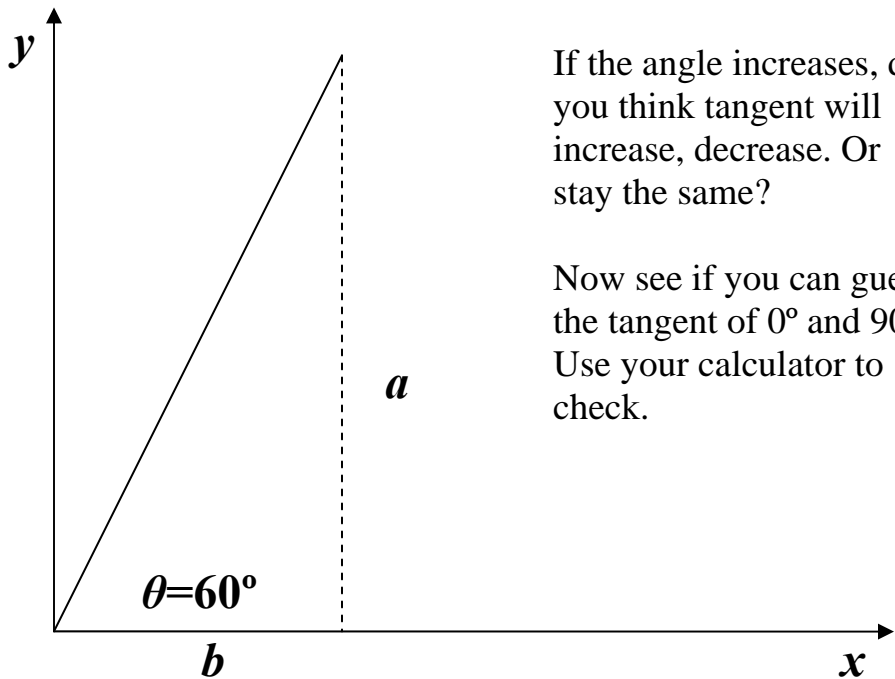
If the angle increases, do you think tangent will increase, decrease. Or stay the same?

Now see if you can guess the tangent of 0° and 90°. Use your calculator to check.

Is there something familiar about tangent? Does it remind you of something you have seen before (think Algebra I)? What tangent does is associate an angle with the slope that you learned in Algebra class!
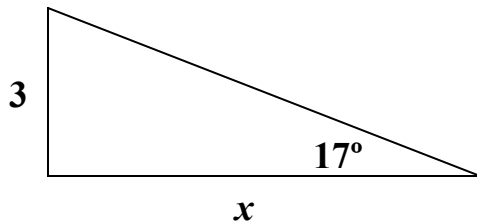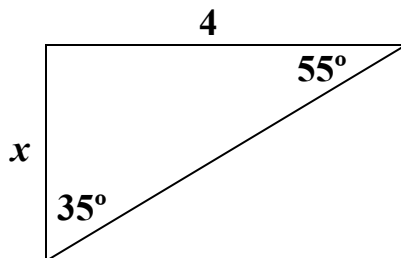
Problems:

1. *Find the tangent ratio of angle Q:*

```
          /|
      10 / |
        /  | 8
       /   |
    Q /____|
        6
```
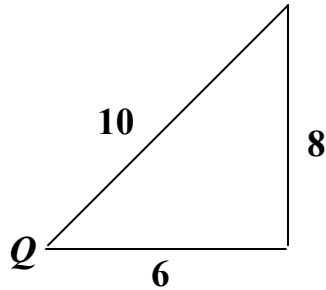
For the following problems, find the unknown leg length, x.

2.

```
   |‾‾‾‾‾‾‾‾‾\
   |          ‾‾‾\
 3 |            17°‾‾\
   |_____\
          x
```

3.

```
        4
    _____
    \          / 55°
     \        /
   x  \      /
       \    /
        \  /
      35° \/
```

4.

```
   |\
   | \
   | \  60°
   |  \
20 |   \
   |    \
   |_____\
      x
```
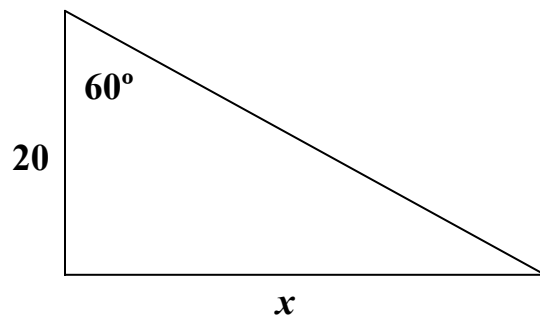
Using Tangent to Find Heights

Name_____

Now we will go outside and use the tangent ratio to find the heights of some objects. We will use a meter stick to measure one leg of the right triangle (your distance from the object) and a clinometer to find the angle. Don't forget to record the name of your group mate that is using the clinometer (you'll see why later).

OBJECT 1: _____

distance from object:_____

angle: _____

name of student using the clinometer _____

find the height:_____

OBJECT 2: _____

distance from object:_____

angle: _____

name of student using the clinometer _____

find the height:_____