Find That Side or Angle
Trigonometry Applications

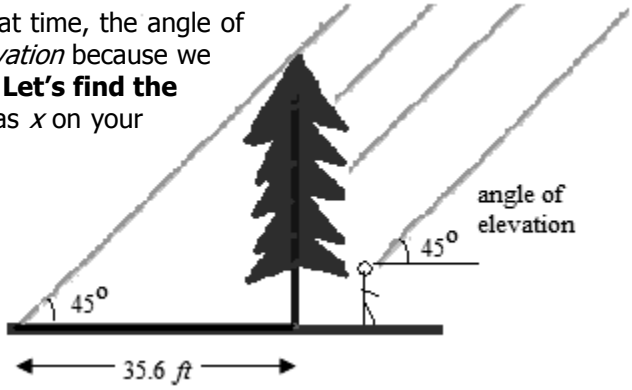
Name _____

Period _____ Date _____

Essential Question: How do we use trig ratios to find unknown sides or angles of right triangles?
NOTE: Make sure your calculator is in degree mode before starting.

Part I – Unknown Sides

1. A tree casts a shadow that is 35.6 feet long. At that time, the angle of elevation of the sun is 45°. (It's called angle of *elevation* because we have to raise, or *elevate*, our eyes to see the sun). **Let's find the height of the tree**. Label the height of the tree as *x* on your diagram.



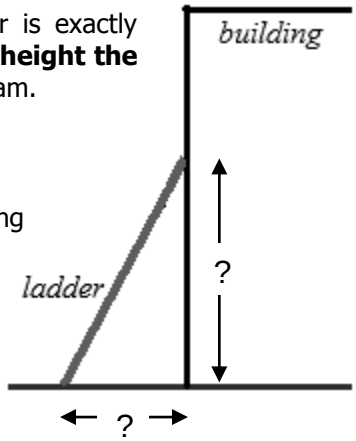
a. Explain why tan 45° (the ratio of opposite to adjacent) could help us find the height.

b. Use the given diagram to complete the trigonometric equation below:

$$\tan 45° = \frac{\text{opposite}}{\text{adjacent}} = \frac{x}{\quad}$$

c. Use your calculator to find the value of tan 45°. In your equation, replace tan 45° with this number, and solve your equation to find the tree's height.

2. A ladder is leaning against the outside wall of a building. The ladder is exactly 10 feet long and makes an angle of 60° with the ground. **Let's find the height the ladder reaches along the building.** Label this height as *x* in your diagram.



a. Label the figure with the given angle and the ladder's length.

b. Explain why cos 60° would ***NOT*** be the most helpful trig ratio for finding the height up the wall.

c. Which trig ratio *would* be the most helpful? Explain.

d. Use the given diagram to complete the equation below:

$$\sin 60° = \frac{\text{opposite}}{\text{hypotenuse}} = \frac{x}{\quad}$$

e. Use your calculator to find the value of sin 60°. In your equation, replace sin 60° with this number, and solve your equation to find the height up the wall.

f. **Now let's figure out how far the base of the ladder is from the building.** Label this distance as *z* in your diagram.

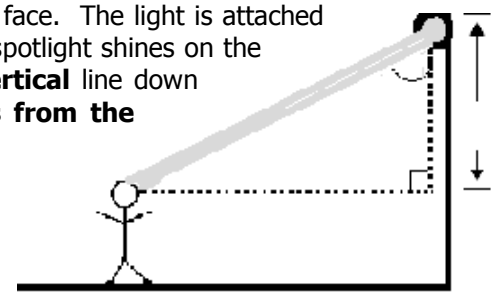
i. Which trig ratio (sin 60°, cos 60°, or tan 60°) would be most helpful for finding *z*? _____ Explain.

ii. Write and solve a trig equation to help you find *z* (Use **#1d** as a guide.)

The first 2 questions introduced you to a method to solve right triangle trigonometry word problems. You will use this same process to solve for unknown information in lots of trig problems. Here are the steps:

I. **Draw a picture of the scenario, if no picture is given;**
II. **Label the side and angles of the triangle with the information given, using variables to identify those sides which are unknown;**
III. **Write a trigonometric equation, choosing the appropriate trig ratio for the side you know and the side you wish to find;**
IV. **Solve the equation and write your answer.**

3. A lighting technician needs to shine a spotlight onto an actor's face. The light is attached to a ceiling that is 10 feet above the actor's face. When the spotlight shines on the actor's face, the light beam makes an angle of 70° with a **vertical** line down from the spotlight. **Let's figure out how far the light is from the actor's face.** Label this unknown quantity with a variable.



a. Label the triangle in the figure with the given information.

b. Label the given angle, its opposite and adjacent legs, and the triangle's hypotenuse.

c. Which side (opposite, adjacent, or hypotenuse) is a known length? _____

d. Which side (opposite, adjacent, or hypotenuse) is our variable? _____

e. Which trig ratio (sin, cos, or tan) relates the two sides you named in parts **c** and **d**? _____

f. Write and solve an equation using the trig ratio from part **e** to find the distance between the light and the actor's face.

4. A forest ranger is on a lookout tower in a forest. His observation position is 214.7 feet above the ground when he spots an illegal campfire. The angle of elevation from the fire to the top of the lookout tower is 78°. **Let's find the distance between the base of the tower and the fire.**

a. Sketch a picture to portray the situation described above. (Be sure it includes a right triangle. ☺)

b. Label the triangle in your diagram with the given information.

c. Choose a trig ratio which includes a *known* and the *unknown* side of your triangle. _____

d. Use this trig ratio to write and solve an equation to determine how far the base of the tower is from the fire.

Part II – Unknown Angles

So far, you have been using your calculator to find the length of missing sides. Now you will do the inverse—you will find missing angles. You will follow the same process as before (draw and label picture, set up trig ratio and equation), but when solving your equations you will use the inverse trig functions ($\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$) on your calculator. These inverse functions give you the angle measure that has the specified trig ratio.

Here's an example:

$\sin x = \frac{16}{20}$ — The angle is unknown.

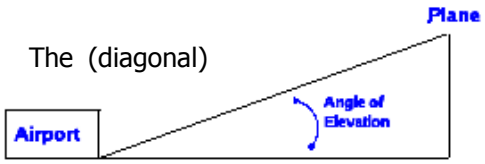
$\sin^{-1}(\sin x) = \sin^{-1}\left(\frac{16}{20}\right)$ — Take the inverse sine [$\sin^{-1}$] of both sides to "undo" the sine function

$x = \sin^{-1}\left(\frac{16}{20}\right)$ — Type this in your calculator. Usually the "$\sin^{-1}$" button is above the "sin" button

$\boldsymbol{x \approx 53.1°}$

Now try a few on your own.

5. An airport is tracking the path of one of its incoming flights. The (diagonal) distance from the airport to the plane is 850 ft. and the altitude of the plane is 400 ft. **Let's find the angle of elevation between the plane and the airport.** Label the unknown angle of elevation as x.



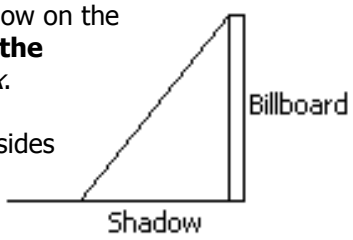
a. Label the diagram with known information. Be sure to note which sides are opposite and adjacent to the desired angle and which side is the hypotenuse.

b. Which trig ratio relates the angle of elevation to the two known side lengths? _____

c. The following equation could be used to find x: $\sin x = \frac{400}{850}$. Complete the chart below to solve.

$\sin x = \frac{400}{850}$	The angle is unknown.
$\sin^{-1}(\quad) = \sin^{-1}(\_\_\_\_\_)$	Take the inverse sine [$\sin^{-1}$] of both sides to "undo" the sine function
	Type this in your calculator. Usually the "$\sin^{-1}$" button is above the "sin" button
$x \approx$ _____°	Round to two decimal places.

6. The top of a billboard is 40 feet above the ground and casts a 30-foot shadow on the ground. **Let's figure out the angle of elevation between the end of the shadow and the top of the billboard.** Label this unknown quantity as x.



a. Label the diagram with known information. Be sure to note which sides are opposite and adjacent to the desired angle and which side is the hypotenuse.

b. Explain why *cosine* might ***NOT*** be the best trig ratio to use when solving for x.

c. Which trig ratio *would* be the best trig ratio to use to help us solve for x? _____

d. Let's use the tangent ratio to write and solve an equation to find the value of x:

$\tan x = \frac{\quad}{\quad}$	The angle is unknown.
$\_\_\_\_^{-1}(\tan x) = \_\_\_\_^{-1}\left(\frac{\quad}{\quad}\right)$	Take the inverse _____ of both sides to "undo" the tangent function
	Type this in your calculator.
$x \approx$ _____°	Round to two decimal places.

7. Reflect on the Essential Question: Complete the Venn Diagram below to show the similarities and differences between solving for unknown *sides* or unknown *angles* of a right triangle.