The Primary Trigonometric Ratios – <u>Word Problems</u>

A. Determining the measures of the sides and angles of right triangles using the primary ratios

When we want to measure the height of an "inaccessible" object like a tree, pole, building, or cliff, we can utilize the concepts of trigonometry.
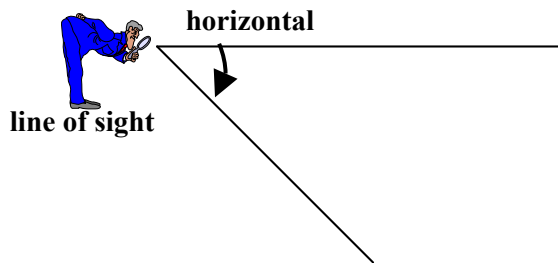
To solve such inaccessible heights or depths using trigonometry, the following angle definitions are necessary:

Angle of Elevation

line of sight
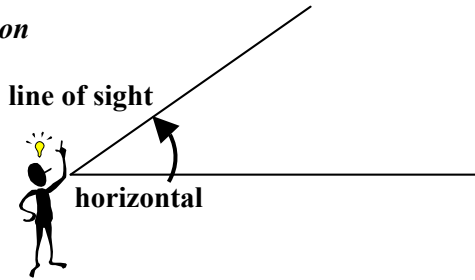
horizontal

> **The Angle of Elevation** is the angle from the horizontal to your line of sight. (i.e. you are looking upwards at the object)

Angle of Depression

horizontal

line of sight

> **The Angle of Depression** is the angle from the horizontal to the line of sight. (i.e. you are looking downwards at the


SOLVING FOR AN UNKNOWN SIDE OR ANGLE

Where Do I Begin…Where Does It End?

1. Sketch the triangle, if one has not been provided for you.
2. Label the given angle(s) and side(s). Include the variable for the unknown side or angle, where needed.
3. "Looking" from the given angle, label the opposite side, adjacent side, and hypotenuse.
4. Write the trig ratio (sin, cos, tan) that contains the given information and the unknown you want to find.
5. Substitute the given information, and solve for the unknown.

Example 1

If your distance from the foot of the tower is 20 m and
the angle of elevation is 40°, find the height of the tower.
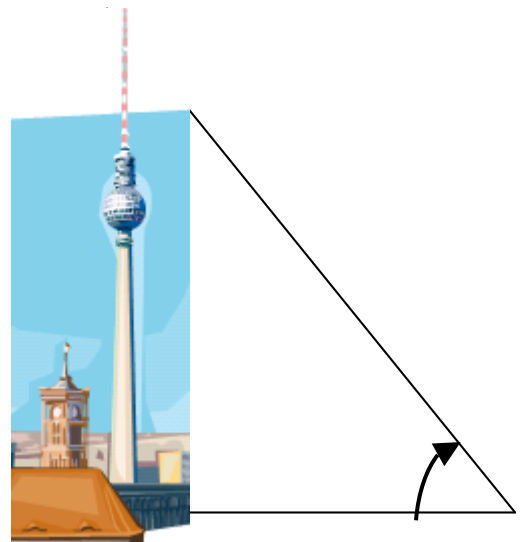
Example 2
The angle of depression from the top of the pagoda
to boat is 25°. If the boat is 50 m from
the base of the pagoda, how high is the pagoda
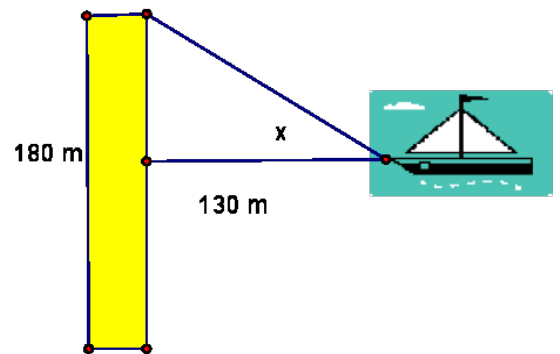(to the nearest meter)?

Assignment

1. The stringer, that supports the stairs, makes an angle of 50° with the floor. It reaches 3.2 m up the wall. How far is the base of the stringer from the wall?
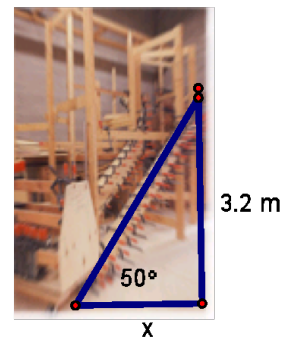

2. A ship is 130 m away from the centre of a barrier that measures 180 m from end to end. What is the minimum angle that the boat must be turned to avoid hitting the barrier?


3. A ramp has an angle of inclination of 20°. It has a vertical height of 1.8 m. What is the length, L metres, of the ramp?
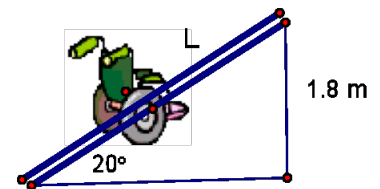
4.   A damaged tree is supported by a guy wire 10.0 m long. The wire makes an
      angle of 61° with the ground.
      (a) Calculate the height at which the guy wire is attached to the tree.
      (b) There is a bird's nest halfway down from the wire attachment point.
      Determine the angle of elevation from the ground attachment of the wire to
      this bird's nest.

h   10.0 m

                                              61°
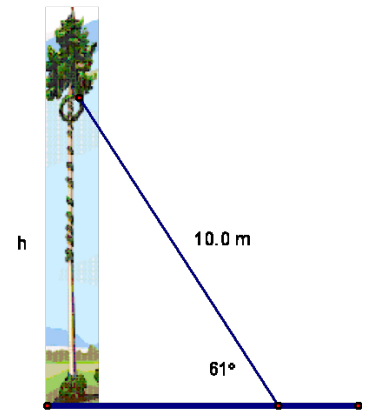
5.   A helicopter is hovering above a road at an altitude of 24 m.
      At a certain time, the distance between the helicopter and a car
      on the road is 45.0 m. Calculate the angle of elevation of the
      helicopter from the car.

                                    45.0 m

                            24 m

                                          x
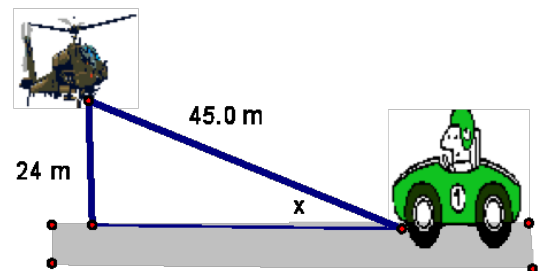
Answers: 1) 2.7 m   2) 34.7°   3) 5.3 m   4) 8.7 m   5) 32.2°

B. Solving problems involving two right triangles in two dimensions.

To solve a problem involving two right triangles using trigonometry,
• draw and label a diagram showing the given information, and the length or angle measure to be found
• identify the two triangles that can be used to solve the problem, and plan how to use each triangle
• solve the problem and show each step in your solution
• write a concluding statement giving the answer

Example 1
Two students want to determine the heights of two buildings. They stand on the
roof of the shorter building. The students use a clinometer to measure the angle
of elevation of the top of the taller building. The angle is 44°. From the same
position, the students measure the angle of depression of the base of the taller
building. The angle is 53°. The students then measure the horizontal distance
between the two buildings. The distance is 18.0 m. The students drew this
diagram. How tall is each building?

A

B   44°   C
      53°

                18.0 m
E   D
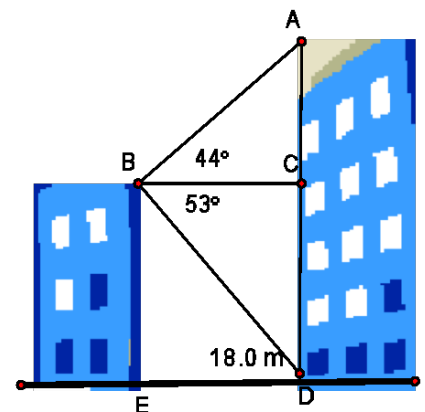
Example 2
How would you calculate the length of AB using the information
provided? Show all your steps.

A
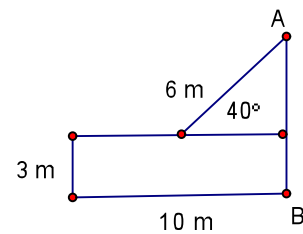
D

30°

20°

C

120 m

B
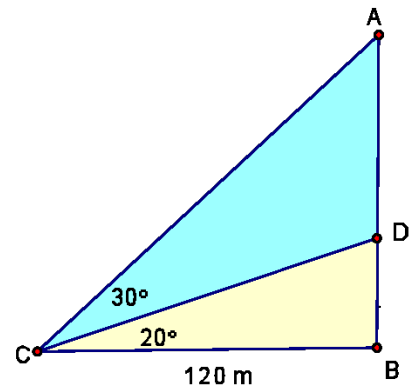
Assignment

1. From the top of a building 21.0 m tall, the angle of
elevation of the top of a taller building is 46°. The angle
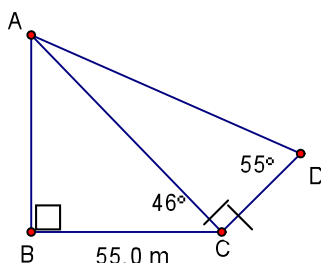of depression of the base of the taller building is 51°.

(a) How far apart are the two buildings?
(b) What is the height of the taller building?

A

B 46°

C

51°

21.0 m

E

D
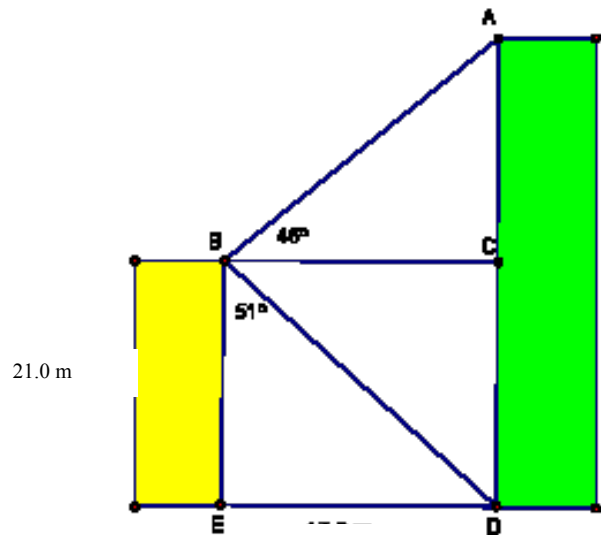
2. Find the length of AB.

A

6 m

40°

3 m

10 m

B

3. Find the length of AD. Show the steps of your solution.

A

55°

D

46°

C

B   55.0 m

4. Sean wishes to find the length of a pole, CD, that is on the roof of a building. The angles of elevation of C and D are 40° and 28°, respectively. The distance AB is 40.0 m. Find the length of the pole. Show the steps of your solution.

C

D

building

A

B

40.0 m
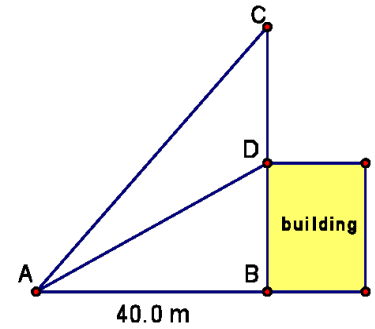
5. A person observes that from point A, the angle of elevation to the top of a cliff at D is 30°. Another person at point B, notes that the angle of elevation to the top of the cliff is 45°. If the height of the cliff is 80.0 m, find the distance between A and B. Show the steps of your solution.

D

30°   45°

A   B   C
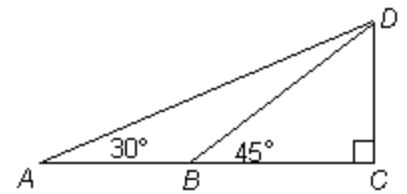
Answers:
   1.   47.9 m   2. 6.9 m   3. 96.7 cm.   4. 12.3 m   5. 58.6 km

Challenge Problem!

Mr. Smith and Mr. Santowski are trying to figure out the height of a new building recently constructed in Cairo. They call it the Super Building. Mr. Smith started from the base of the building and walked for a while… then took an angle measurement from the ground to the top of the building… the device read $80.8858°$. Then Mr. Smith realized he didn't count how far he was away from the base of the building. Mr. Santowski, not wanting to walk back, said… I have an idea. Mr. Santowski walked 13 more meters away from their current location and took another angle measurement from the ground. The measuring device read $73.3289°$.

It was now that Mr. Santowski could figure out how tall the building is…

1. Draw a picture of this problem.

2. How tall is the building? Show your work.

3. How far was Mr. Smith from the base of the building when he took his first measurement?