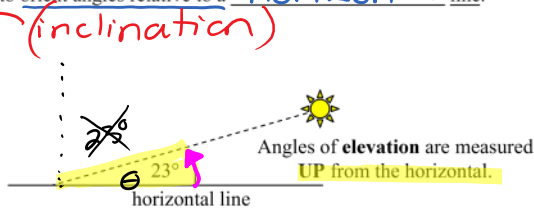# 4 Angle of Elevation & Depression

September 24, 2018   9:22 PM

Applications of Right Triangle Trigonometry:
Angles of **Elevation** & Angles of **Depression**

Preliminary Information: On most maps, it is customary to orient oneself relative to the direction north: for this reason, north is almost always indicated on every map.   Likewise, when working with real-life trigonometry problems, it is very common to orient angles relative to a __Horizontal__ line.

An **angle of** __Elevation__ refers to the acute angle a line (or ray, segment, etc.) makes with a horizontal line, when measured <u>above</u> the horizontal (hence an angle of *elevation*).

(inclination)

Angles of **elevation** are measured UP from the horizontal.

23°

horizontal line

For example, the sun's rays could form a 23° angle of elevation *(above the horizon)*.

An angle of __Depression__

refers to the acute angle a line makes with a horizontal line, when measured below the horizontal (hence an angle of depression).

horizontal line

35°

Angles of depression are measured down from the horizontal.
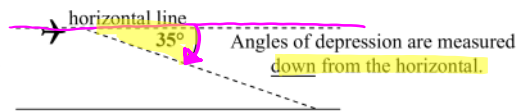
For example, an airplane pilot could look down and see a feature on the ground below at a 35° angle of depression (below the horizon).
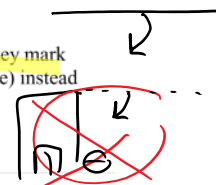
Angles of elevation and depression typically have their vertex at the point where an observer is positioned. In the previous example, notice that the vertex of the 35° angle is located at the pilot's location.

$\theta_1 = \theta_2$

Because horizontal lines are everywhere parallel, **angles of depression and elevation** are numerically __EQUIVALENT__ because they form *alternate interior angles* of parallel lines:

θ_1 angle of depression

angle of elevation θ_2

2 parallel lines
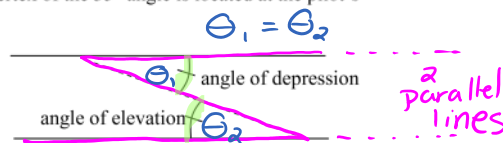
Students should always be encouraged to consider the following two ideas when they see either phrase mentioned in a problem:

- **You may** always ***draw an additional horizontal line on any diagram*** extending from any point in the diagram. Just as you did in Geometry, drawing such an *auxiliary line* can help to make a complex problem simpler.

- **The most common error** students make when they encounter these terms is they mark an angle relative to a <u>vertical</u> line (such as an angle with a wall, building, or tree) instead of with a <u>horizontal</u> line.

P a g e **15 |Trigonometry**   Copyright Mathbeacon.com. Use with permission. Do not use after June 2019

Solve each of the following word problems. Include a diagram in your solution.

70. From a point 220 m from the Empire State Building, a tourist measures the angle of inclination to the top to be 60°. Calculate the height of the building to the nearest metre...
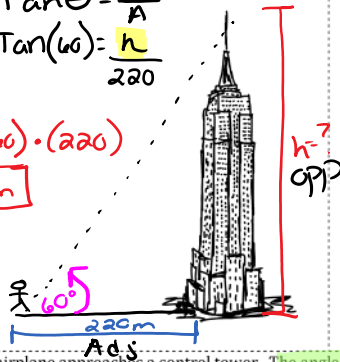
71. A hiker loses track of her direction and wanders 22 degrees off course. If she continues to walk for 12 km to the river destination, how far away from her original destination will she be? (nearest tenth of a kilometer)

Handwritten work (70):

KNOW
∠60°
Adj = 220
WANT
? = h
OPP = ? = h

$\tan\theta = \frac{O}{A}$

$\tan(60) = \frac{h}{220}$

$h = \tan(60) \cdot (220)$

$h = 381\,m$

h = ? OPP

(60°) 220 m Adj

Diagram (71): 12 km, 22°, Original Destination
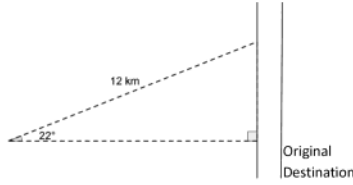
72. An airplane approaches a control tower. The angle of depression from the pilot to the tower is 12°. If the plane is flying at an altitude of 1500 m, how far is the plane from being directly above the tower (to the nearest kilometer)?

Handwritten work (72):

Adj, 12°, 1500 m

$\tan\theta = \frac{OPP}{Adj}$

$\tan(12°) = \frac{(1500\,m)}{Adj?}$

$Adj = \frac{1500\,m}{\tan(12°)} = 7057\,m$

$\div 1000$

$= 7.057\,km \cong 7\,km$

73. Find the area of a rectangle with a diagonal of 20 m if the angle between the diagonal and longer side is 25 degrees. (nearest unit)

74. A student crossing to the west building casts a shadow on the path. She is 165 cm tall and the angle to the sun is 25°. How long is the shadow on the path to the nearest centimetre?

Handwritten notes:

N W S E

165, 25°, shadow

165, 25, ? shadow
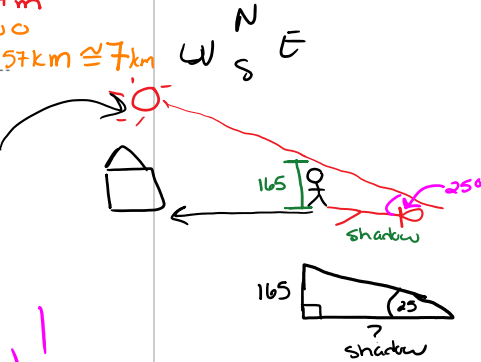
HW, up to Q #74
Quiz tomorrow!

75. A radio tower is 396 feet tall. How far from the base of the tower is a technician if the angle of inclination to the top of the tower is 27°? Answer to the nearest foot.

76. A lighthouse attendant has a range of visibility of 24 km. A ship on the horizon passes by the lighthouse. The attendant sees the ship for a total of 120 degrees. For how many kilometers was the ship within the attendant's range of sight? (nearest tenth)
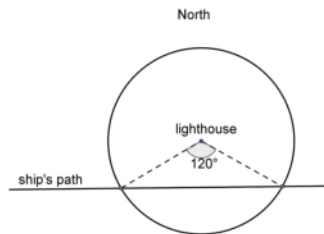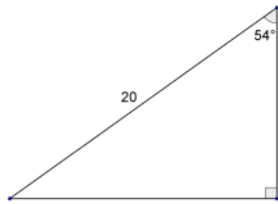

Draw a scale diagram that would **represent** each of the following.

77. Draw a triangle that has a the following:

$sin\alpha = \frac{1}{5}$, hypotenuse is 10 cm long.

78. Draw a triangle that has a the following:

$tan\beta = \frac{12}{5}$, hypotenuse is 26 cm long.

79. Solve the triangle.

54°

20

80. Solve the triangle.

63°

12.3 cm
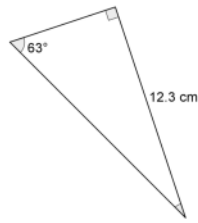
81. Find the perimeter of the following rectangle.
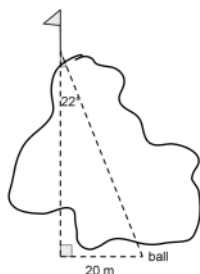

27°

14.2 mm
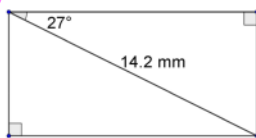
82. Find the total area.

5.0 cm

37°
27°

4.5 cm
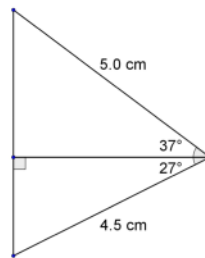
Lesson 4 (after Quiz 1)

83. While golfing with his father-in-law, Mr. J hits a shot short of a pond. He walks 20 m to his left to a point directly across the pond from the hole. The angle between the two lines of sight is 22°. Find the distance from his ball to the hole to the nearest tenth of a metre.

22°

ball

20 m

84. Find the area of the circle that is not covered by the shaded triangles. Answer to the nearest tenth.


53°

radius is 5 cm

20 m → ball
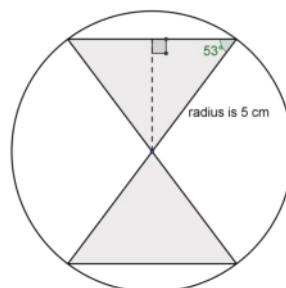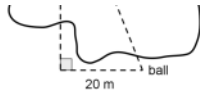
85. Anya lets out 125 feet of kite string at Clover Point. The wind pulls the kite string tight at an angle of 55° to the ground. Approximate the height of the kite to the nearest foot.

What assumptions did you make?

86. The radius of a circular tunnel in Shanghai is 15.43 m. During a flood, a worker in the water at the side of the tunnel measured an angle to the centre to be 37°. Find the depth of the water at its deepest point. (The water surface forms a chord across the tunnel.)

15.43 m

water surface   37°
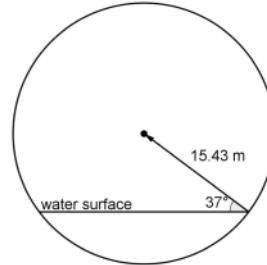
Solve the following problems involving triangles.

87. Find the area of the triangle below to the nearest square inch.
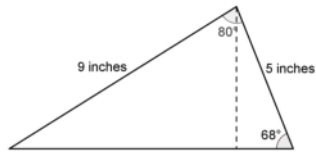
88. At 11:00 in the morning, the angle of elevation to the sun 58°. A tree in the school yard casts a shadow of 56 m. How tall is the tree to the nearest metre?

---

89. Tucker has two choices to get his ball to the hole at the 17th at Cordova Bay, go around the lake or go over it. He decides to go around the lake as shown on the diagram. How much farther does he have to hit the ball going around the lake instead of going straight over it? Answer to the nearest yard.
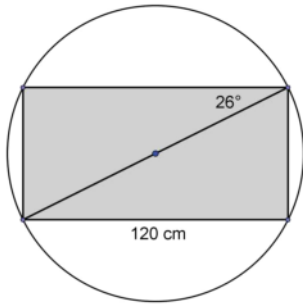
(Careful, not a right triangle shown.)
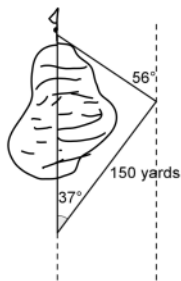
90. Find the area of the circle that is not covered by the shaded rectangle to the nearest square unit.
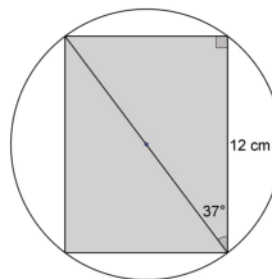
91. Find the area of the circle not covered by the shaded **rectangle** to the nearest 100 cm.

26°

120 cm

92. Sandra stands at the midpoint between two buildings and measures the angles of elevation to their tops to be 14° and 18°. If the two buildings are 80 metres apart, what is the difference in their heights? Answer to the nearest metre.

93. Find the length of AG to the nearest tenth of a millimetre.

238°

G

21.3 mm

A   H
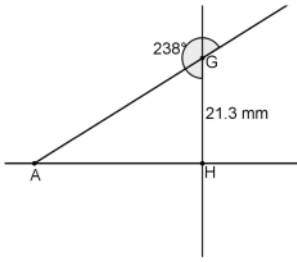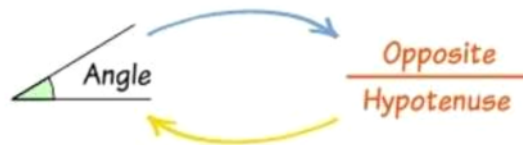
94. Find the area of rectangle WXYZ to the nearest square unit.

X   Y

4 cm

39°   Z

W

8 cm
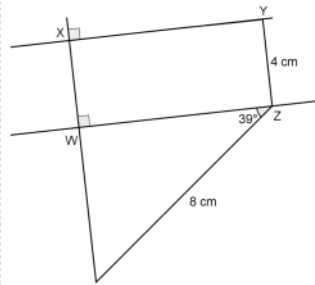
Solving for Angles

Inverse Functions

$$\theta = \cos^{-1}(x) \qquad \Leftrightarrow \qquad x = \cos(\theta)$$
$$\theta = \sin^{-1}(x) \qquad \Leftrightarrow \qquad x = \sin(\theta)$$
$$\theta = \tan^{-1}(x) \qquad \Leftrightarrow \qquad x = \tan(\theta)$$

For example, if we are doing the "inverse of sinθ"...we are trying to FIND the angle, when we are GIVEN both side lengths.
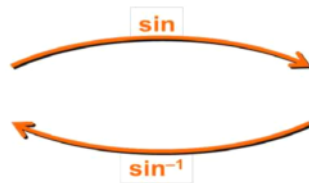
Angle ⟷ $\dfrac{Opposite}{Hypotenuse}$

The inverse of sin

sin θ = 0.5, what is the value of θ?

To work this out use the **sin⁻¹** key on the calculator.

$$\sin^{-1} 0.5 = \boxed{}$$

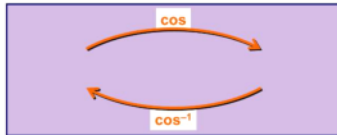sin⁻¹ is the inverse of sin. It is sometimes called arcsin.

sin

sin⁻¹

The inverse of cos

Cos θ = 0.5, what is the value of θ?

To work this out use the **cos⁻¹** key on the calculator.

$$\cos^{-1} 0.5 = \boxed{}$$

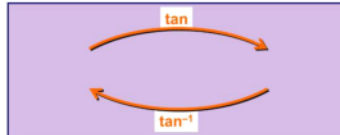Cos⁻¹ is the inverse of cos. It is sometimes called arccos.

The inverse of tan

tan θ = 1, what is the value of θ?

To work this out use the **tan⁻¹** key on the calculator.

$$\tan^{-1} 1 = \boxed{}$$

tan⁻¹ is the inverse of tan. It is sometimes called arctan.


4 steps we need to follow:

Step 1 Find _____ →out of Opposite, Adjacent and Hypotenuse.

Step 2 Use _____ to decide which one of Sine, Cosine or Tangent ratio to use in this question.

Step 3 For _____calculate Opposite/Hypotenuse, for _____ calculate Adjacent/Hypotenuse or for _____calculate Opposite/Adjacent.

Step 4 _____ from your **calculator**, using one of sin⁻¹, cos⁻¹ or tan⁻¹ *(these are inverse, or 2ⁿᵈ function settings)*
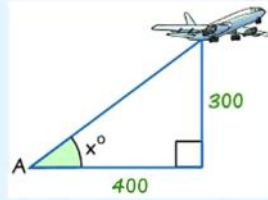
Examples: Finding angles
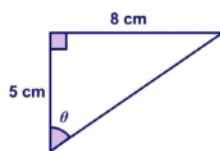
Example

The ladder leans against a wall as shown.

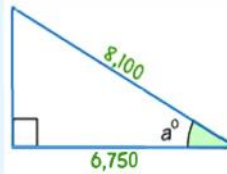What is the **angle** between the ladder and the wall?

Example

Find the angle of elevation of the plane from point A on the ground.

Example

Find the size of angle a°

Example: Find the angle "a"

We know

- The distance down is 18.88 m.
- The cable's length is 30 m.

And we want to know the angle "a"

Finding Angles Using the Three Ratios

Recall:

The three primary trig. ratios:

> Unless otherwise stated, calculate the measure of angles to the nearest tenth of a degree.
>
> Eg. 42.8°

Tangent Ratio: $\tan \theta = \frac{length\ of\ side\ opposite\ \theta}{length\ of\ side\ adjacent\ \theta}$

Sine Ratio: $sin\theta = \frac{length\ of\ side\ opposite\ \theta}{length\ of\ hypotenuse}$

Cosine Ratio: $cos\theta = \frac{length\ of\ side\ adjacent\ \theta}{length\ of\ hypotenuse}$

The stored values in your calculator allow you to find angles using the ratios.

The magic of sin^{-1}, cos^{-1}, and tan^{-1}.

> The "inverse trigonometric functions". These functions convert the stored ratios in your calculator to the angle.

Challenge
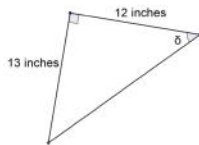
95.   Find the measure of angle A in a right triangle if $tanA = 1.000$.

Challenge

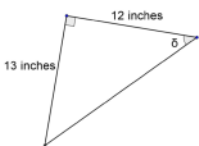96.   Find the measure angle B in a right triangle if $sinB = \frac{1}{1}$

Challenge

97.   What ratio would you use to find the measure of the indicated angle?

12 inches

δ

13 inches

Find the measure of the indicated angle.

Use the Inverse functions to find the indicated angle to the nearest tenth.

98. Find the measure angle A in a right triangle if tanA=1.000.	99. Find the measure angle B in a right triangle if sinB=0.5000.	100. What ratio would you use to find the measure of the indicated angle?
Use the tan⁻¹ button. Type: tan⁻¹(1.000)=A A = 45 °	Use the sin⁻¹ button. Type: sin⁻¹(1 ÷ 2)=B B = 30 °	Use the tangent ratio: $tan\delta = \frac{13}{12}$ 12 inches 13 inches Find the measure of the indicated angle. Type: tan⁻¹(13 ÷ 12)= δ δ = 47.3 °

101. Find angle A, if $sinA = 0.2654$.	102. Find angle B, if $cosB = \frac{5}{7}$.	103. Find angle Q, if $tanQ = \frac{15}{4}$.

| 104. Find angle T, if $sinT = \frac{15}{11}$.	105. Find angle D, if $cosD = \frac{11}{10}$.	106. Find angle U, if $tanU = 2.6784$.

107. In a right triangle, one acute angle has sine ratio of 0.5. Find the sine ratio of the other acute angle.	108. In a right triangle, one acute angle has cosine ratio of $\frac{1}{\sqrt{1}}$. Find the sine ratio of the other acute angle.	109. In a right triangle, one acute angle has cosine ratio of $\frac{1}{1}$. Find the tangent ratio of the other acute angle.

| 110. Which of the three trigonometric ratios (sine, cosine, tangent) can have a value greater than 1 ?	111. Draw a right triangle and use it to explain your answer to the previous question.

112. Draw a right triangle with an acute angle that has an adjacent side equal in length to the opposite side. Find the cosine ratio for that angle. (Round your answer to 3 decimals.)

113. Draw a right triangle with an acute angle that has a hypotenuse 50% longer than the adjacent side. Find the cosine ratio for that angle.

114. Use a protractor to measure the indicated angle. Then determine the length of side x using the cosine ratio.
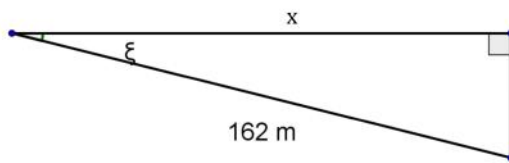

115. Use a protractor to measure the indicated angle. Then determine the length of side x using the cosine ratio.
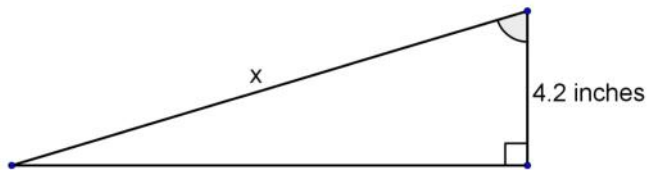
Working with the ratios to find angles.

Have a plan...
1. Choose the correct ratio {sine, cosine, or tangent}.
2. Fill in the known side lengths into your chosen ratio.
3. Use the "inverse trig. function" to convert ratio → angle.
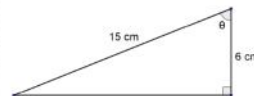
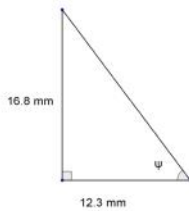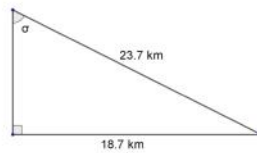|		
116. What ratio do the given sides form for the indicated angle?	117. What ratio do the given sides form for the indicated angle?	118. What ratio do the given sides form for the indicated angle?

116.

16.8 mm

12.3 mm
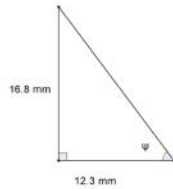
Sine   Cosine   Tangent

117.

σ

23.7 km

18.7 km
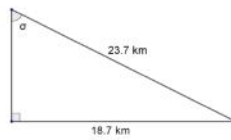
Sine   Cosine   Tangent

118.

15 cm

6 cm

θ

Sine   Cosine   Tangent

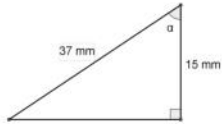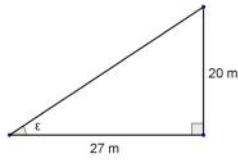|		
119. Calculate the measure of angle ψ to the nearest tenth of a degree.	120. Calculate the measure of angle σ to the nearest tenth of a degree.	121. Calculate the measure of angle θ to the nearest tenth of a degree.

119.

16.8 mm

ψ

12.3 mm

120.

σ

23.7 km

18.7 km

121.

15 cm

6 cm

θ

Working with the ratios to find angles.

122. What ratio do the given sides form for the indicated angle?
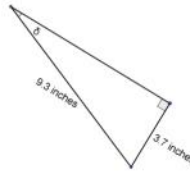
37 mm
15 mm
α

Sine   Cosine   Tangent

123. What ratio do the given sides form for the indicated angle?

20 m
27 m
ε

Sine   Cosine   Tangent

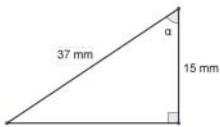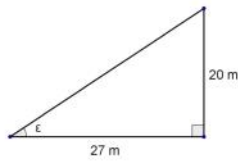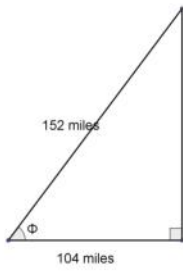124. What ratio do the given sides form for the indicated angle?

δ
9.3 inches
3.7 inches

Sine   Cosine   Tangent

125. Calculate the measure of angle ∝ to the nearest tenth of a degree.

37 mm
15 mm
α

126. Calculate the measure of angle ε to the nearest tenth of a degree.

20 m
27 m
ε

127. Calculate the measure of angle θ to the nearest tenth of a degree.
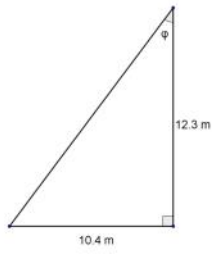
9.3 inches
3.7 inches

Unit 2 Trigonometry Page 15

Find the measure of the indicated angle. Round answers to the nearest tenth of a degree.

128.

152 miles

Φ

104 miles

129.

φ

12.3 m

10.4 m

130.

1.75 mm

2.23 mm   θ

131.

27.2 yards

34°

16 yards

θ

56°
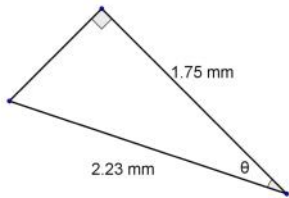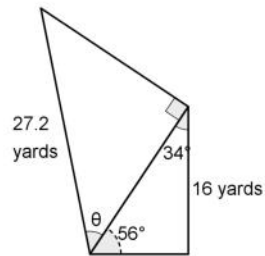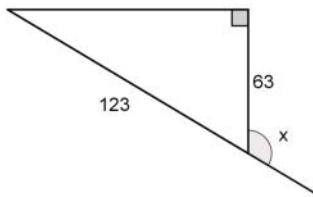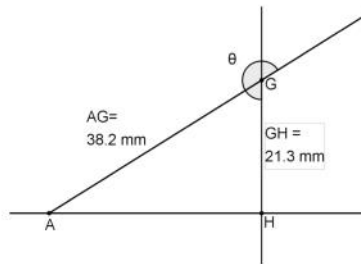
132. Find the measure of angle x to the nearest tenth of a degree..

123

63

x

133. Find the measure of angle θ to the nearest degree.

θ

G

AG= 38.2 mm

GH = 21.3 mm

A   H
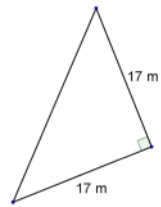

Solve the following triangles. Calculate answers to the nearest tenth.

134.	135.

134.

14 mm

5 mm

135.

17 m

17 m

136.

2

$\sqrt{3}$

137.

63°

27°
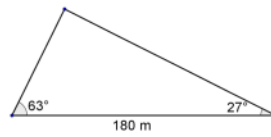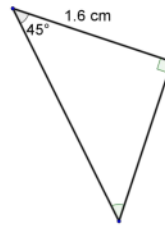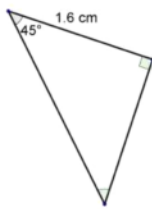
180 m

138.
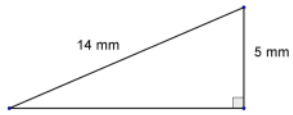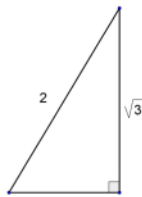
135°   18.7 mm
27°   18°

139. **Challenge.**

Find the Area of the following triangle to the nearest tenth of a square unit.

1.6 cm
45°

Find the area of the following triangles. Units for each question are indicated.

140.   Nearest tenth.

1.6 cm
45°

$$Area = \frac{base \times height}{2}$$

Find base:

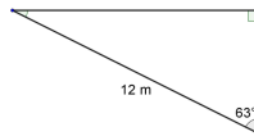$$tan45 = \frac{opposite}{1.6}$$

$$\therefore base = 1.6 \ cm$$
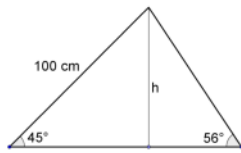
$$Area = \frac{1.6 \times 1.6}{2}$$

$$Area = 1.2 cm^2$$

141.   Nearest square metre.

12 m
63°

142. Nearest hundred square centimetres.

143. Nearest square foot.
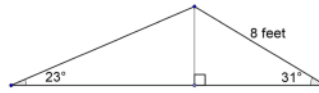
144. A triangle has side lengths of 8 cm, 7cm and 12 cm. Find the area of the triangle if the angle between the 8 cm and 12 cm side is 34°. Answer to the nearest square cm.

145. A triangle has side lengths of 10 km, 23 km and 32 km. The angle opposite the 10 km side is 9.2° Find the area of the triangle. Answer to the nearest square km.

Applications of trigonometry.

146. A kite stuck in a nearby tree. A child standing 25 m from the base of a tree pulls the string tight. If the tree is 30 m tall, approximately how far is the kite from the child to the nearest metre?

147. A surveyor measures the angle of elevation to the top of a building to be 23°. If the surveyor is 1345 feet from the base of the building, how tall is the building to the nearest foot?

148. From the top of a 20 m cliff above a road, the angle of depression to two approaching cars is 25° and 40° respectively. How far apart are the cars to the nearest metre?

149. Two hot air balloons float above the ocean at a height of 1000 feet. From a sailboat an observer measures the angle of elevation to one balloon is 60° and to the other balloon is 50°. [both balloons are on the same bearing from the observer] How far apart are the balloons to the nearest foot?

150. Two boys on opposite sides of the tree below measure the angle of elevation to the top of the tree. If the tree is 175 feet tall, how many feet apart are the boys?
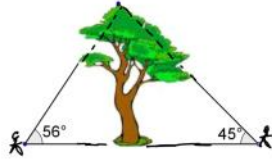

151. Highway sign shows that the road descends at a rate of 8%. Draw a diagram that shows what this means.


If a 3 km section of straight road descends at this grade, what is the drop in elevation?

152. While golfing with his father-in-law, Mr. J hits a shot short of a pond. The flag (hole) is directly across the pond from his ball. He paces 20 m to the right of his ball and measures the angle back to the hole to be 76°. How far is the ball from the hole to the nearest metre?
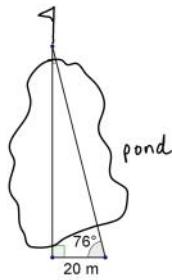
153. A hiker leaves base camp travelling due north at 5 km/h. After two hours, she turns and travels east. Three hours later, she sprains her ankle. At what bearing would a rescue team need to travel to reach the injured hiker? How far away is she from base camp? (nearest tenth)
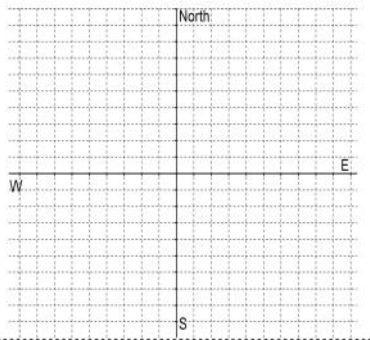
154. A student approaches a large Sequoia tree outside the entrance to the school and wonders how tall the tree is. He paces 150 metres from the base of the tree and measures the angle of elevation to the top of the tree to be 35°. Find the height of the tree to the nearest metre.

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155. A homeowner wants to cut a new board to replace a decaying roof truss. He can measure the horizontal distance and the angle of inclination but needs to know how long to cut the board. The horizontal distance is 14 feet and the angle of inclination is 24°. Find the distance to the nearest tenth of a foot.

poor board

14 feet
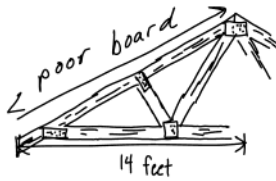
156. An engineer is constructing a Ferris wheel for a downtown park. There are 16 passenger carts and the radius of the wheel is 10 metres. How far apart are the passenger carts to the nearest hundredth of a metre?
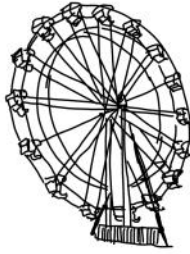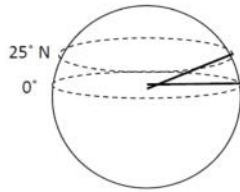
157. Find the area of the circle to the nearest square centimetre. $[A = \pi r^2]$
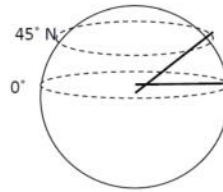
4 cm

53.1°
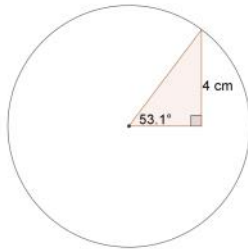
158. Find the perimeter of the octagon inscribed in a circle of radius 8 cm. (Nearest cm)
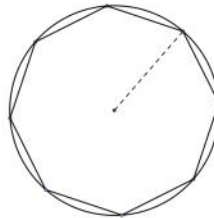
159. Find the length of the 25° line of latitude. The Earth's radius is 6380 km. Answer to the nearest km.

25° N

0°

160. Find the length of the 45° line of latitude. The Earth's radius is 6380 km. Answer to the nearest km.

45° N

0°

161. Mr. Teespré 's backyard slopes away from his house towards the beach. The instructions for his new lawnmower state that the mower should not be used if the slope is greater than 15°. Being a trigonometry specialist, he extends a level string 125 feet from the base of his house. From that point, he measures that the distance along the ground back to his house is 130 m. Is his yard too steep for this mower?

level string

sloped yard
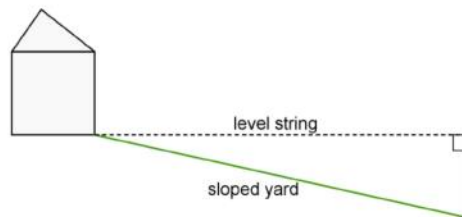
162. A regular pentagon is inscribed in a circle of radius 10 cm. Calculate the perimeter of the pentagon. Answer to the nearest cm.
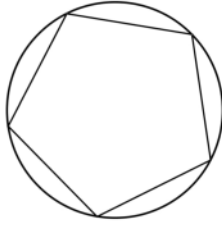
163. A regular decagon (10 sides) is inscribed inside a circle of radius 8 cm. Find the perimeter of the decagon. Answer to the nearest cm.

164. Find the area of the octagon inscribed in a circle of radius 8 cm. Answer to the nearest square cm.
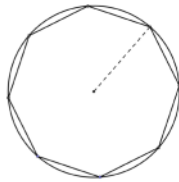
165. A regular hexagon is inscribed in a circle with a radius 18 cm. What would be the side length of the hexagon? Answer to the nearest cm.

166. From a point 15 m from the base of a tree, a woman found the angle of inclination to the top of the tree to be 45°. Her sister found the angle to be 18° from a point farther away from the base of the tree. How far away are the two women away from each other?
(nearest tenth of a metre)
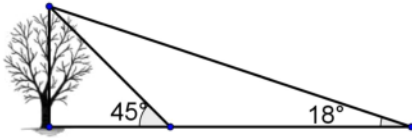
More word problems using right triangles:

- Draw a diagram.
- Fill in known values.
- Let a variable represent unknown(s)
- Choose an appropriate strategy to solve for the unknown(s).
- Interpret the problem.

167. Solve the triangle given the following.
$\triangle XYZ$
$x = 9\ cm$
$\angle Y = 90°$
$\angle Z = 36°$

168. A firefighter is walking along the river at point C when she spots two fires on the opposite river bank. She measures the angles below and paces a distance of 300 m from point C to point D. Point D is directly across the river from one of the fires. How far apart are the fires to the nearest metre?
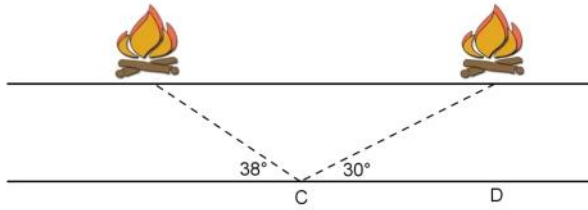
169. Anya stands on top of a building in downtown Victoria. From her position, the angle of elevation to the top of an adjacent building is 47°. The angle of depression to the base of the building is 62°. She is told that the buildings are 45 m apart. Based on this information, what is the height of the taller building to the nearest metre?
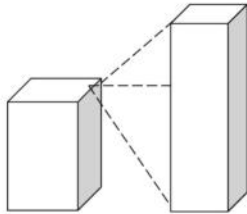
170.   Find the length of diagonal BG in the rectangular prism. Answer to the nearest tenth of a millimeter.
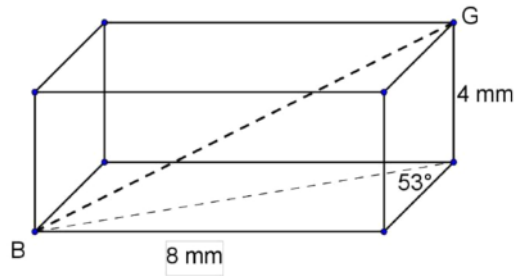
171.   The line of sight from an inflatable boat to the top of an oil derrick is 24 degrees. If the derrick is 45 m tall, how far is the boat from its base? (nearest tenth)

172. A pilot on a level path knows she should descend at an angle of 3 degrees to maintain comfort and safety. If she is flying at an altitude of 12 000 feet, how many miles from the runway should she begin her descent?

----

173. An aircraft ascends after takeoff at an angle of 22 degrees. What will be the altitude of the aircraft after it flies at that angle for 1200 m? (nearest metre)

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174. A hamster scurries up a ramp at a speed of 1.5 m/s. The ramp is inclined at an angle of 18 degrees. How many metres above the ground will the hamster be after 30 seconds?

175. Anya travels down a zip line at 25 km/h. The angle of descent of the zip line is 11 degrees. How many vertical metres has she fallen after 3 minutes?

---

176. The Earth's radius is 6380 km.
    A) Find the length of the 35° latitude to the nearest 10 km.

    B) What assumptions did you make?

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177. Find the angle of inclination at the back of the roof. The "rise" of the roof is 0.9 m. (nearest tenth)
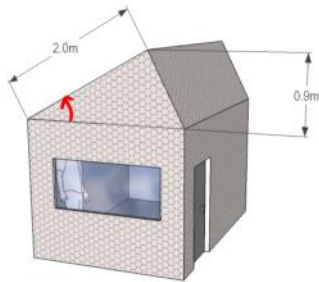
178. A ladder should make an angle of 72° with the ground for maximum safety. If the ladder is 4 m long, how far should it reach up the wall? (nearest tenth)

---

179. The angle of elevation to the top of a tree, measured on a 1.5 m transit from a distance of 30 m, is 15°. Find the height of the tree. (nearest tenth)

---

180. Find the value of 'x'.

18 cm

x   22°

18 cm
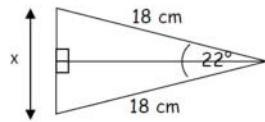
181. Mr. J has developed the ideal ice cream cone. The cone has a slant height of 13 cm and a diameter of 7.8 cm. Find the angle that the curved surface makes with the diameter.
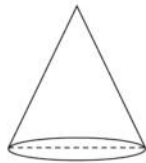
182. Mr. J continues to work on his isolated surf hut. Below is two-thirds of a roof truss he wants to complete. Find the length of wood he must cut (nearest tenth) to complete the truss. The long side is 8.2 m and the short side is 6.8 m. The angle between them is 35°.
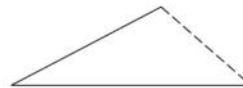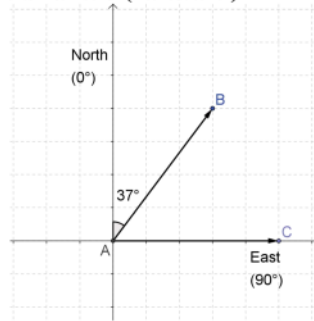
183. Both triangles (large and smaller inset) are isosceles. Find the area of the shaded trapezoid to the nearest tenth of a square unit.
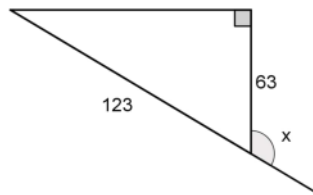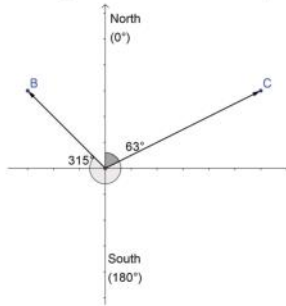
10 / 53°

30
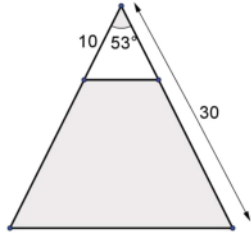
184. From a fire station in central BC, Georgia travels on a bearing of 37° at 6 km/h. Shelby leaves the station at the same time travelling due east at 5 km/h. How far apart are they after 4.5 hours? (Nearest tenth)

North
(0°)

B

37°

A

C

East
(90°)

185. Find the measure of angle x to the nearest tenth of a degree.

63

123

x

186. At 9:00 am, a ship leaves port traveling at 30
      km/h on a bearing of 63°. At the same time,
      another ship leaves port on a bearing of 315° at
      a speed of 19 km/h. When the boats stop after
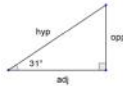   two hours, how far east is the boat at point C?

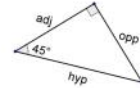**Draw an accurate diagram to answer each of the following questions.**

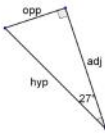|	
187. In $\triangle QRS$, $\angle QSR = 90°$, $QR = 12\ cm$ and $QS = 10\ cm$. Find the measure of $\angle QRS$	188. In $\triangle TUV$, $\angle TVU = 90°$, $TU = 115\ m$ and $TV = 99\ m$. Find the measure of $\angle UTV$
189. In $\triangle DEF$, $\angle DFE = 90°$, $DE = 12\ cm$ and $\angle DEF = 30°$. Find the length of FE.	190. In $\triangle ABC$, $\angle ACB = 90°$, $BC = 5\ cm$ and $\angle ABC = 12°$. Find the length of AC.

Answers:

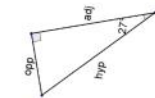1. 25.0
2. 18.9
3. 24.0
4. 8.0
5. 84.0
6. 54.4
7.

8.

9.

10.

11. $\tan\theta = \frac{3}{4}$
    $\sin\theta = \frac{3}{5}$
    $\cos\theta = \frac{4}{5}$

12. $\sin\theta = \frac{1}{0}$
    $\cos\theta = \frac{4}{0}$
    $\tan\theta = \frac{3}{1}$

13. $\sin\theta = \frac{8}{17}$
    $\cos\theta = \frac{15}{17}$
    $\tan\theta = \frac{8}{15}$

14. $\sin\theta = \frac{1}{\sqrt{1}}$
    $\cos\theta = \frac{1}{\sqrt{1}}$
    $\tan\theta = 1$

15. $\sin\theta = \frac{4}{5}$
16. $\cos\theta = \frac{14}{17.5}$
17. $\tan\theta = \frac{5.0}{16}$
18. Tangent
19. Tangent
20. Sine
21. 0.5000
22. 2.7475
23. 0.8192
24. 0.6691
25. 1.0000
26. 0.5000
27. A right triangle with an acute angle of 45° is an isosceles triangle with equal legs therefore $\frac{opp}{adj}$ will always equal 1, tangent 45 will always equal 1.
28. Sine is a ratio of opposite to hypotenuse. If the sine ratio is $\frac{1}{1}$ it means the hypotenuse is twice as long as the opposite side.
29. $x = 3$
30. $x = 24$
31. $x = 2.2$
32. $x = 25$
33. $x = 1.54$
34. $x = 15$
35. $x = 10\ cm$
36. $y = 5.3$
37. Answered on page.
38. Answered on page.
39. 261.8 miles
40. $w = 5.5\ feet$
41. $x = 17.0$
42. $t = 7.9\ cm$
43. $t = 6.4\ mm$
44. $q = 374.0\ km$
45. $w = 2.3\ cm$
46. $y = 3.3\ m$
47. $v = 13.6\ m$
48. $r = 47.1\ miles$
49. $d = 22.2\ cm$
50. $x = 56.7\ mm$
51. $z = 159.2\ mm$

52. $z = 67.2\ inches$
53. $12.7\ km\ , 6.5\ km$
54. $x = 22.6\ mm$
55. $x = 7.6$
56. Opposite and adjacent
57. Not directly. The tangent ratio does not involve the hypotenuse.
58. Yes, the sine ratio involves the hypotenuse.
59. 16 cm and 12 cm
60. 3.6 m and 7.1 m
61. Not possible, the hypotenuse would need to be shorter than the adjacent side to have a cosine ratio greater than 1.
62. Not possible, like the answer above, a sine ratio cannot be greater than 1.
63. $\cos J = \frac{adj}{hyp} = \frac{11}{11\sqrt{1}} = \frac{1}{\sqrt{1}}$
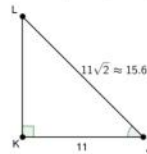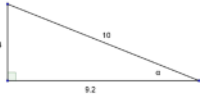

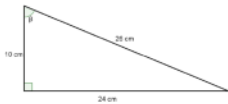64. $\tan P = \frac{opp}{adj} = \frac{1}{A}$
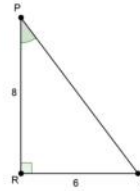
65. Answer will vary. But you will need to use the given side and angle to find another side length. Then choose to find another side or remaining angles.
66. $AB = 11.9$, $AC = 11.3$
67. 16.6 in, 20.8 in

68. 84.3 m, 150.8 m
69. 4.7 m, 6.4 m, 8.8 m
70. 381 m
71. 4.5 km
72. 7 km (7057 m)
73. 153.2 m²
74. 354 cm
75. 777 ft
76. 41.6 km
77.

78.


79. 11.7, 16.2, 36°
80. 6.3 cm, 13.8 cm, 27°
81. 38.2 mm
82. 10 cm²
83. 53.4 m
84. 54.5 cm²
85. 102 feet, assuming the ground is level and the string is straight.
86. 6.14 m
87. 22 in²
88. 90 m
89. 78 yd
90. 69 cm²
91. 7000 cm²
92. 3 m
93. 40.2 mm
94. 24.9 cm²
95. 45°
96. 30°
97. Tangent ratio, 47.3°
98. Answered on page.
99. Answered on page.
100. Answered on page.
101. 15.4°
102. 44.4°
103. 61.9°
104. 42.3°
105. No Solution
106. 69.5°

107. 0.8660 or $\frac{\sqrt{3}}{1}$
108. 0.7071 or $\frac{1}{\sqrt{1}}$
109. 0.5774 or $\frac{1}{\sqrt{3}}$
110. Tangent
111.

The side opposite to angle A can be greater than the side adjacent to angle A. As a ratio, $\frac{\ddot{e}\ddot{i}\ \dot{i}\ \acute{e}\acute{i}\ \ddot{i}\dot{i}\eth}{\dot{n}\grave{o}\acute{c}\hat{n}\hat{o}\hat{o}\acute{o}\bar{i}}$ would be greater than 1. The sine and cosine ratios can not produce values greater than 1 because the denominator in the ratio will always be larger than the numerator.
112. $cos\theta = 0.707$ (side lengths of 3 were arbitrarily chosen)
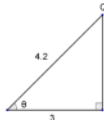
113. $cos\theta = 0.6667$

114. 14°, 157 m
115. 73.5°, 14.8 in
116. Tangent
117. Sine
118. Cosine
119. 53.8°
120. 52.1°
121. 66.4°
122. Cosine
123. Tangent

124. Sine
125. 66.1°
126. 36.5°
127. 23.4°
128. 46.8°
129. 40.2°
130. 38.3°
131. 44.8°
132. 120.8°
133. 236.1°
134. 20.9°, 69.1°, 13.1 mm
135. 45°, 45°, 24.0 m
136. 30°, 60°, 1
137. 81.7 m, 160.4 m, 90°
138. 12.7 mm, 29.1 mm
139. 1.2 m²
140. Answered on page.
141. 29 m²
142. 4190 cm²
143. 34 square feet
144. 27 cm²
145. 59 km²
146. 39 m
147. 571 ft
148. 19 m
149. 262 ft
150. 293 ft
151.
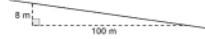
The units are simply an example. A descent of 8% means that the road "falls" 8 units for every 100 units of horizontal travel.
A 3 km section of road falls 0.24km.
152. 80 m
153. A rescue team would need to travel 18.0 km at 56.3°.
154. 105 m
155. 15.3 ft
156. 3.90 m
157. 78.5 cm²
158. 49 cm
159. 36 331 km
160. 28 346 km
161. Yes. His yard slopes at an angle of 16°. Too steep for the mower.
162. 59 cm
163. 49 cm

164. 181 cm^2
165. 18 cm
166. 31.2 m
167. 6.5 cm, 11.1 cm, 54°
168. 522 m
169. 133 m
170. 10.8 mm
171. 101.1 m
172. 43 miles

173. 450 m
174. 14 m
175. 239 m
176. 32 840 km
177. 26.7°
178. 3.8 m
179. 9.5 m
180. 6.9 cm
181. 72.5°

182. 4.7 m
183. 319.6 square units
184. 22.4 km
185. 120.8°
186. 80 km
187. $\angle QRS = 56.4°$
188. $\angle UTV = 30.6°$
189. 10.4 cm
190. 1.1 cm