**BRIDGES** Suppose you are standing in the middle of the platform of the world’s longest suspension bridge, the Akashi Kaikyo Bridge. If the height from the top of the platform holding the suspension cables is 297 meters, and the length from the platform to the center of the bridge is 995 meters, what is the angle of depression from the center of the bridge to the platform?

\[
\tan^{-1} \left( \frac{\tan x}{\tan 297°} \right) = \frac{297}{995}
\]

\[x = \tan^{-1} \left( \frac{297}{995} \right)\]

\[x \approx 17°\]
Find $x$. Round angle measures to the nearest degree and side measures to the nearest tenth.

1. Given AAS Law of Sines
   
   \[
   \frac{\sin 35}{9} = \frac{x \sin 58}{\sin 58}
   \]
   
   \[
   9 \sin 35 = x \sin 58
   \]
   
   \[
   6.1 = x
   \]

2. Given AAS Law of Sines
   
   \[
   \frac{\sin 20}{18} = \frac{x \sin 135}{\sin 135}
   \]
   
   \[
   x \sin 20 = 18 \sin 135
   \]
   
   \[
   x = 37.2
   \]
\[
\frac{\sin 60}{x} = \frac{\sin 65}{73}
\]

\[
\frac{\sin 141}{x} = \frac{\sin 21}{13}
\]
Law of Cosines
Given SAS

\[ x^2 = 7^2 + 14.7^2 - 2(7)(14.7) \cos 18 \]
\[ x^2 = 49 + 216.09 - 205.8 \cos 18 \]
\[ \sqrt{x^2} = \sqrt{265.09 - 205.8 \cos 18} \]
\[ x \approx 8.3 \]

\[ 16.2^2 = 20^2 + 19.6^2 - 2(20)(19.6) \cos x \]

\[ 262.44 = 400 + 384.16 - 784 \cos x \]
\[ 262.44 = 784.16 - 784 \cos x \]
\[ -784.16 \]
\[ -521.72 = -784 \cos x \]
\[ -784 \]
\[ -784 \]

\[ \cos^{-1} \left( \frac{521.72}{784} \right) = \cos^{-1}(\cos x) \]

\[ 48.3 \approx x \]
7. **SAILING** Determine the length of the bottom edge, or foot, of the sail. *47.1 ft*
**CCSS STRUCTURE** Solve each triangle. Round angle measures to the nearest degree and side measures to the nearest tenth.

8. \( m\angle B = 77^\circ, \ AB \approx 7.8, \ BC \approx 4.4 \)

9. \( m\angle N = 42^\circ, \ MP \approx 35.8, \ NP \approx 24.3 \)

10. \( m\angle X = 63^\circ, \ m\angle Y = 54^\circ, \ XY \approx 9.9 \)
Go Over Quizzie Poos
**Unit 9: Right Triangles and Trigonometry**

8.7 Vectors

<table>
<thead>
<tr>
<th>Vector</th>
<th>Describes the <strong>magnitude</strong> (size) and <strong>direction</strong> of a quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Magnitude is the size (distance from initial point to terminal point)</td>
</tr>
<tr>
<td></td>
<td>Direction corresponds to arrow</td>
</tr>
</tbody>
</table>

Diagram:
- **Terminal point or tip**: $B$
- **Initial point or tail**: $A$

The vector $\vec{AB}$ represents the displacement from point $A$ to point $B$. The length of the arrow indicates the magnitude of the vector, and the arrowhead points in the direction of the vector.
Note about direction:

Measured either from horizontal or from north/south line

![Diagram showing vector directed 30° above horizontal](image1)

The direction of \( \vec{a} \) is 30° relative to the horizontal.

![Diagram showing vector directed 60° east of north](image2)

The direction of \( \vec{a} \) is 60° east of north.
<table>
<thead>
<tr>
<th>Standard Form</th>
<th>Vector begins at the origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component Form</td>
<td>( \langle x, y \rangle )</td>
</tr>
</tbody>
</table>

\[
\overrightarrow{OD} = \langle 4 - 0, 1 - 1 \rangle = \langle 4, 2 \rangle
\]

\[
\overrightarrow{PQ} = \langle -3 - (-1), -1 - 3 \rangle = \langle -2, -4 \rangle
\]
**Example**  
**Describing a Vector**

**Coordinate Geometry**  
Describe $\overrightarrow{OL}$ as an ordered pair. Give the coordinates to the nearest tenth.

\[(65)\sin 50^\circ = \frac{y}{65}\]
\[49.8 \approx y\]

Use the sine and cosine ratios to find the values of $x$ and $y$.

\[\cos 50^\circ = \frac{x}{65}\]
\[x = 65\cos 50^\circ\]
\[\approx 41.8\]

\[\sin 50^\circ = \frac{y}{65}\]
\[y = 65\sin 50^\circ\]
\[\approx 49.8\]

$L$ is in the fourth quadrant so the $y$-coordinate is negative. $\overrightarrow{OL} \approx (41.8, -49.8)$.

Describe the vector at the right as an ordered pair. Give the coordinates to the nearest tenth.
Find the magnitude and direction of each vector.

\[ \vec{t} = \langle 2, -4 \rangle \]

\[ \vec{f} = \langle -6, -5 \rangle \]

\[
\begin{align*}
2^2 + (-4)^2 &= t^2 \\
4 + 16 &= t^2 \\
20 &= t^2 \\
\sqrt{20} &= t \\
t &= 2\sqrt{5} \\
t &= 2.5
\end{align*}
\]

\[
\tan^{-1}\left(\frac{4}{5}\right) = \left(\frac{4}{2}\right)
\]

\[
X = 63.43
\]
<table>
<thead>
<tr>
<th>Vector Operations</th>
<th>If ( \langle a, b \rangle ) and ( \langle c, d \rangle ) are vectors and ( k ) is a scalar, then the following are true.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vector Addition</td>
<td>( \langle a, b \rangle + \langle c, d \rangle = \langle a + c, b + d \rangle )</td>
</tr>
<tr>
<td>Vector Subtraction</td>
<td>( \langle a, b \rangle - \langle c, d \rangle = \langle a - c, b - d \rangle )</td>
</tr>
<tr>
<td>Scalar Multiplication</td>
<td>( k \langle a, b \rangle = \langle ka, kb \rangle )</td>
</tr>
</tbody>
</table>
Find each of the following for \( \vec{r} = (3, 4) \), \( \vec{s} = (5, -1) \), and \( \vec{t} = (1, -2) \).

\[ \text{a. } \vec{r} + \vec{t} \]
\[ \langle 3, 4 \rangle + \langle 1, -2 \rangle = \langle 4, 2 \rangle \]

\[ \text{b. } \vec{s} - \vec{r} \]
\[ \langle 5, -1 \rangle - \langle 3, 4 \rangle = \langle 2, -5 \rangle \]

\[ \text{c. } 2\vec{t} - \vec{s} \]
\[ \langle 2, -4 \rangle - \langle 5, -1 \rangle = \langle -3, -3 \rangle \]
### EXAMPLE

**Real-World Connection**

**Aviation** An airplane lands 40 km west and 25 km south from where it took off. The result of the trip can be described by the vector \((-40, -25)\).

Use distance (for magnitude) and direction to describe this vector a second way.

To find the distance, use the Distance Formula:

\[ d = \sqrt{(-40 - 0)^2 + (-25 - 0)^2} \]
\[ d = \sqrt{1600 + 625} \quad \text{Simplify.} \]
\[ d = \sqrt{2225} \]
\[ d \approx 47.169906 \quad \text{Use a calculator to find the square root.} \]

To find the direction of the flight, find the angle of the vector south of west.

\[ \tan x^\circ = \frac{25}{40} \]
\[ x = \tan^{-1}\left(\frac{25}{40}\right) \quad \text{Find the tangent ratio.} \]
\[ \tan^{-1} 0.625 \]
\[ x \approx 32.005383 \quad \text{Use a calculator.} \]

- The airplane flew about 47 km at 32° south of west.
**EXAMPLE**

**Real-World Connection**

**Navigation** A ferry shuttles people from one side of a river to the other. The speed of the ferry in still water is 25 mi/h. The river flows directly south at 7 mi/h. If the ferry heads directly west, what are the ferry’s resultant speed and direction?

The diagram shows the sum of the two vectors. To find the ferry’s resultant speed, use the Pythagorean Theorem.

\[ c^2 = 25^2 + 7^2 \]

\[ c^2 = 674 \]

\[ c \approx 25.961509 \text{ Use a calculator.} \]

The lengths of the legs are 25 and 7.

To find the ferry’s resultant direction, use trigonometry.

\[ \tan \theta = \frac{7}{25} \text{ Use the tangent ratio.} \]

\[ x = \tan^{-1} \left( \frac{7}{25} \right) \text{ Use the inverse of the tangent.} \]

\[ x \approx 15.642246 \text{ Use a calculator.} \]

The ferry’s speed is about 26 mi/h. Its direction is about 16° south of west.