Right-angled trigonometry

Junior Cycle · Higher Level

Understand the idea

How to start

These sine, cosine and tangent ratios apply to right-angled triangles. The side names depend on the angle you choose.

1. Label opposite, adjacent and hypotenuse from the chosen angle.

2. Choose the ratio containing the known side and the side you need.

3. Write the equation, rearrange it and calculate in degree mode.

Key terms & definitions

Opposite
The side across from the chosen angle.

Adjacent
The side beside the chosen angle other than the hypotenuse.

Inverse trigonometric function
A calculator function used to recover an angle from a ratio.

Key ideas

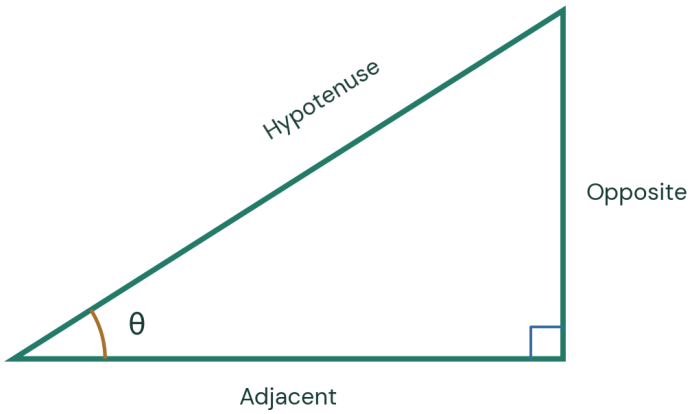
• Relative to the chosen angle, label the opposite side, adjacent side and hypotenuse.

•
$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$$
,
$$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$
,
$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$
.

• Choose the ratio containing the known side and the side you need. Write the equation before rearranging.

• For an angle, use the inverse ratio on your calculator, such as $\theta = \sin^{-1}\left(\frac{\text{opposite}}{\text{hypotenuse}}\right)$.

• Use degree mode. Keep extra decimal places during working, including decimal angles.



Label sides relative to θ: opposite across from θ, adjacent beside θ, hypotenuse opposite the right angle.

Quick reminder

• Label opposite, adjacent and hypotenuse relative to the angle.

• Choose the ratio containing the known and unknown sides.

• Use degree mode; use an inverse ratio to find an angle.

Worked examples

Example 01 · Start here: choose the ratio before calculating

A right triangle has hypotenuse 10 cm and angle 30°. Find the side opposite this angle.

Why this method?

Label the triangle relative to the marked angle. Choose sine because the question uses opposite and hypotenuse; do not choose a ratio just because it is familiar.

$\sin 30^\circ = \frac{o}{10}$

Step 1

The known side is the hypotenuse and the unknown is opposite. Sine connects exactly these two sides.

$o = 10\sin 30^\circ$	**Step 2** Multiply both sides by 10 to undo the division by 10.
$o = 10(0.5) = 5$	**Step 3** In degree mode, $\sin 30^\circ$ is 0.5.
The opposite side is 5cm.	**Step 4** State the length and its unit.

Example 02 · Find an angle

A right triangle has opposite side 7 cm and hypotenuse 12 cm relative to angle θ. Find θ to one decimal place.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

$\sin\theta = \frac{7}{12}$	**Step 1** Choose sine
$\theta = \sin^{-1}\left(\frac{7}{12}\right) \approx 35.685^\circ$	**Step 2** Use inverse sine in degree mode
$\theta \approx 35.7^\circ$	**Step 3** Round at the end

Example 03 · Find a denominator side

A ladder makes an angle of 65° with level ground and reaches $4m$ up a vertical wall. Find its length.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

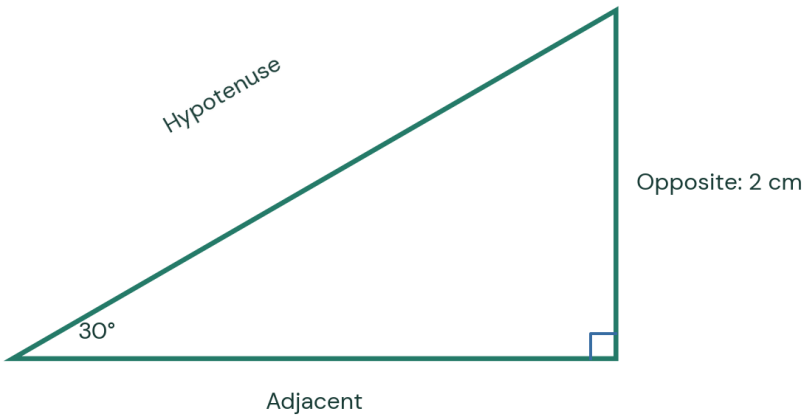
The ladder is the hypotenuse; the height is opposite the 65° angle.	**Step 1** Label the right triangle
$\sin 65^\circ = \frac{4}{L}$, so $L = \frac{4}{\sin 65^\circ}$.	**Step 2** Choose and rearrange sine

$L \approx 4.41\text{m}$

Step 3
Divide 4 by $\sin 65^\circ$ in degree mode, then round the length to two decimal places.

Example 04 · Sine ratio at 30°

In a right-angled triangle, the angle θ is 30°. The side opposite θ is 2 cm. Find the hypotenuse.



Right triangle for this question. Angle 30 degrees; known opposite θ is 2 cm. Other sides are not labelled with answers.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

$\frac{1}{2} = 2 \div$ hypotenuse

Step 1
$\sin\theta =$ opposite $\div$ hypotenuse, and $\sin 30^\circ = \frac{1}{2}$

$2 \div \left(\frac{1}{2}\right) = 4$

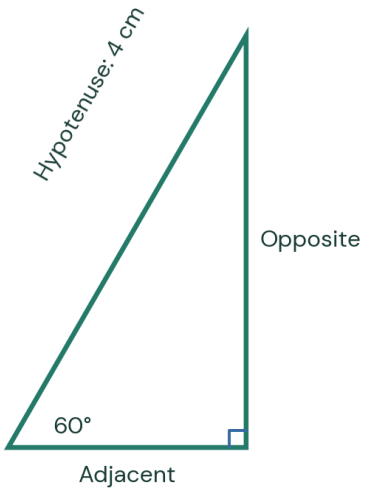
cm

Step 2
Rearrange: hypotenuse $=$ opposite $\div \sin\theta$

Think about it: Before moving on: why is the side opposite $a30^\circ$ angle half the length of the hypotenuse?

Example 05 · Cosine ratio at 60°

In a right-angled triangle, the angle θ is 60°. The hypotenuse is 4 cm. Find the side adjacent to θ.



Right triangle for this question. Angle 60 degrees; known hypotenuse is 4 cm. Other sides are not labelled with answers.

Why this method?

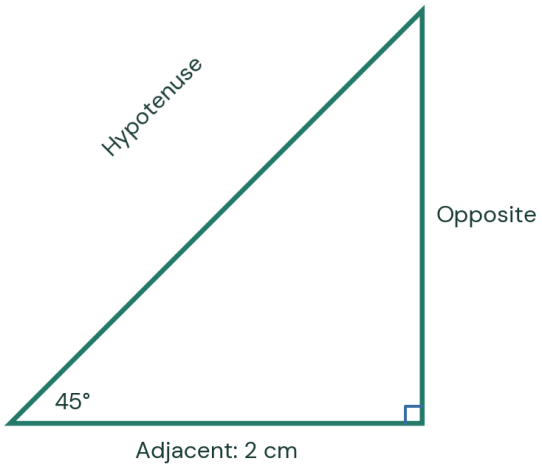
Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

$\frac{1}{2} =$ adjacent $\div 4$	**Step 1** $\cos\theta =$ adjacent $\div$ hypotenuse, and $\cos 60^\circ = \frac{1}{2}$
$4 \times \frac{1}{2} = 2$ cm	**Step 2** Rearrange: adjacent $=$ hypotenuse $\times \cos\theta$

Think about it: Before moving on: why is the adjacent side always shorter than the hypotenuse?

Example 06 · Tangent ratio at 45°

In a right-angled triangle, the angle θ is 45°. The side adjacent to θ is 2 cm. Find the side opposite θ.



Right triangle for this question. Angle 45 degrees; known adjacent to θ is 2 cm. Other sides are not labelled with answers.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

$1 =$ opposite $\div 2$	**Step 1** $\tan\theta =$ opposite $\div$ adjacent, and $\tan 45^\circ = 1$
$2 \times 1 = 2$ cm	**Step 2** Rearrange: opposite $=$ adjacent $\times \tan\theta$

Think about it: Before moving on: why are the two shorter sides equal when θ is 45°?

Example 07 · Trigonometric ratios for whole-degree angles

Using a calculator in degree mode, find $\tan 46^\circ$ to three decimal places.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

$\tan 46^\circ = 1.036$	**Step 1** Check the calculator is in degree mode, then enter the ratio of the angle

Think about it: Before moving on: why does a calculator in radian mode give a different answer for the same angle?

Example 08 · Trigonometric ratios for whole-degree angles — another example

Using a calculator in degree mode, find $\cos 64^\circ$ to three decimal places.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

$\cos 64^\circ = 0.438$	**Step 1** Check the calculator is in degree mode, then enter the ratio of the angle

Example 09 · Trigonometry with decimal angles

Evaluate $\sin(18.3^\circ)$. Give 4 decimal places.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

Use degrees and enter 18.3°.	**Step 1** Check the mode and decimal angle
$\sin(18.3^\circ) \approx 0.31399246.$	**Step 2** Evaluate the stated ratio
0.3140	**Step 3** Keep calculator precision until this final line, then round to the requested accuracy and state the unit if there is one.

Think about it: When using an inverse trigonometric function, does the calculator output a ratio or an angle?

Example 10 · Trigonometry with decimal angles — another example

In a right-angled triangle, $\cos\theta = 0.399$. Find θ to 1 decimal place, with $0^\circ < \theta < 90^\circ$.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

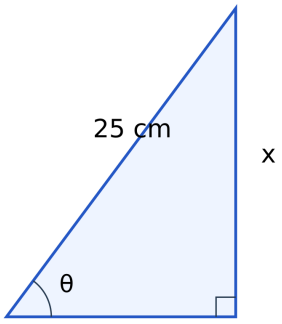
$\theta = \cos^{-1}(0.399).$	**Step 1** Use the matching inverse in degree mode
$\theta \approx 66.484321^\circ.$	**Step 2** Keep precision before rounding

66.5°	**Step 3** Keep calculator precision until this final line, then round to the requested accuracy and state the unit if there is one.

Example 11 · Finding sides with decimal-angle trigonometry

A right triangle has a marked angle of 53.4°. The hypotenuse is 25 cm. Find the opposite, to one decimal place. Use degrees.

$$\theta = 53.4^\circ$$



Use the marked angle. Round only the final length.

Right triangle. Marked angle 53.4 degrees at the left. Known hypotenuse 25 cm; find the opposite. Hypotenuse is the sloping side.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

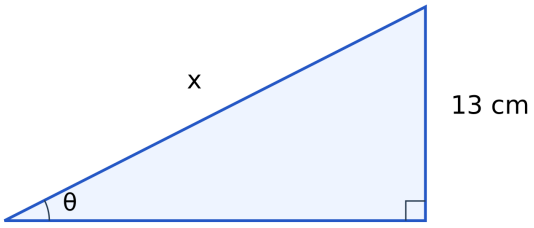
Use $\sin(53.4^\circ)$.	**Step 1** Choose the ratio from the known and unknown sides
$\text{opposite} = 25 \times \sin(53.4^\circ)$.	**Step 2** Rearrange, then evaluate in degree mode
20.1 cm.	**Step 3** Keep calculator precision until this final line, then round to the requested accuracy and state the unit if there is one.

Think about it: If $\sin\theta =$ opposite / hypotenuse, why do you divide by $\sin\theta$ when finding the hypotenuse?

Example 12 · Finding sides with decimal-angle trigonometry — another example

A right triangle has a marked angle of 26.9°. The opposite is 13 cm. Find the hypotenuse, to one decimal place. Use degrees.

$$\theta = 26.9^\circ$$



Use the marked angle. Round only the final length.

Right triangle. Marked angle 26.9 degrees at the left. Known opposite 13 cm; find the hypotenuse. Hypotenuse is the sloping side.

Why this method?

Label opposite, adjacent and hypotenuse relative to the chosen angle. Choose the ratio that contains the known and required sides.

Use $\sin(26.9^\circ)$.	**Step 1** Choose the ratio from the known and unknown sides
$\text{hypotenuse} = 13 \div \sin(26.9^\circ)$.	**Step 2** Rearrange, then evaluate in degree mode
28.7 cm.	**Step 3** Keep calculator precision until this final line, then round to the requested accuracy and state the unit if there is one.

Common mistake

Treating the same side as “opposite” whichever angle is used. Identify the chosen angle first. The opposite side faces that angle; the adjacent side touches it and is not the hypotenuse.

Exam technique

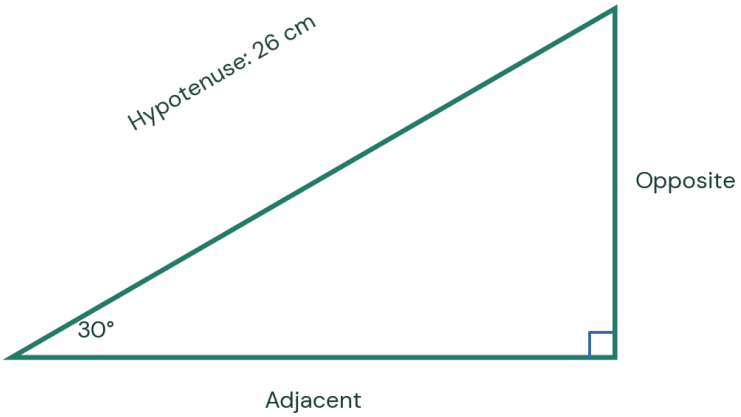
An angle of elevation is measured upwards from a horizontal line.

Try it yourself

Work on paper before checking the answers at the end. These questions are for self-checking, not submitted homework.

Question 1

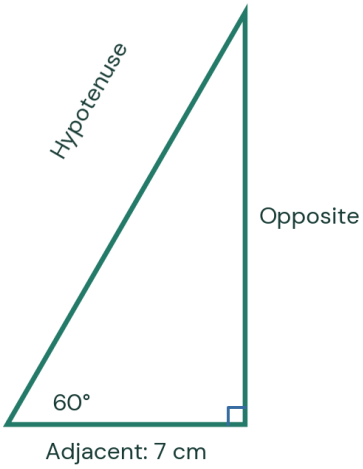
In a right-angled triangle, the angle θ is 30°. The hypotenuse is 26 cm. Find the side opposite θ.



Right triangle for this question. Angle 30 degrees; known hypotenuse is 26 cm. Other sides are not labelled with answers.

Question 2

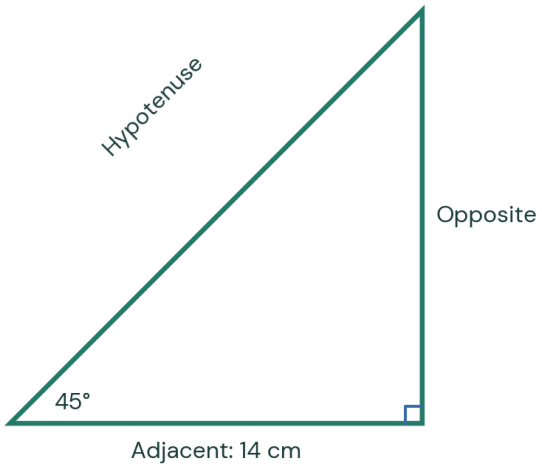
In a right-angled triangle, the angle θ is 60°. The side adjacent to θ is 7 cm. Find the hypotenuse.



Right triangle for this question. Angle 60 degrees; known adjacent to θ is 7 cm. Other sides are not labelled with answers.

Question 3

In a right-angled triangle, the angle θ is 45°. The side adjacent to θ is 14 cm. Find the side opposite θ.



Right triangle for this question. Angle 45 degrees; known adjacent to θ is 14 cm. Other sides are not labelled with answers.

Question 4

Using a calculator in degree mode, find $\cos 25^\circ$ to three decimal places.

A. 0.991

B. 0.906

C. 0.423

D. 0.466

Question 5

Evaluate $\sin(68.1^\circ)$. Give 4 decimal places.

A. 1.0778

B. 0.3730

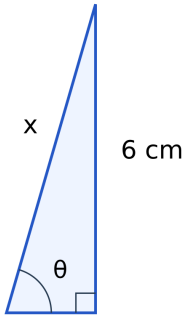
C. 0.9278

D. -0.8495

Question 6

A right triangle has a marked angle of 73.9°. The opposite is 6 cm. Find the hypotenuse, to one decimal place. Use degrees.

$\theta = 73.9°$



Use the marked angle. Round only the final length.

Right triangle. Marked angle 73.9 degrees at the left. Known opposite 6 cm; find the hypotenuse. Hypotenuse is the sloping side.

A. -6.0

B. 5.8

C. 6.2

D. 21.6

Watch an explanation

Corbettmaths — Trigonometry introduction:

Corbettmaths — Trigonometry missing sides:

Corbettmaths — Trigonometry missing angles:

Open the website chapter to load the embedded players. Use the rates and rules in your question for financial examples.

Self-check answers

Question 1

13

Question 2

14

Question 3

14

Question 4

0.906

Question 5

0.9278

Question 6

6.2

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