Cambridge IGCSE · Mathematics 0580 · Notes

Exact values and trigonometric functions

Read online at **pastopic.com/cambridge/mathematics-0580/notes/trigonometric-functions**

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Read first: **Pythagoras' theorem and right-angled triangles**, **Powers, roots, indices and surds**

What you need to know

This whole topic is **Extended only** (Papers 2 and 4). Core students don't need it. By the end of it you should be able to:

1. **Extended only:** know the **exact values** of $\sin x$ and $\cos x$ for $x = 0^\circ$, 30°, 45°, 60° and 90°, and of $\tan x$ for $x = 0^\circ$, 30°, 45° and 60°, and use them without a calculator, including inside right-angled triangles.
2. **Extended only: recognise, sketch and interpret** the graphs of $y = \sin x$, $y = \cos x$ and $y = \tan x$ for $0^\circ \leqslant x \leqslant 360^\circ$.
3. **Extended only: solve equations** in $\sin x$, $\cos x$ or $\tan x$ for $0^\circ \leqslant x \leqslant 360^\circ$, such as $4\sin x = 1$ or $3\cos x + 2 = 0$, finding **every** solution in the range.

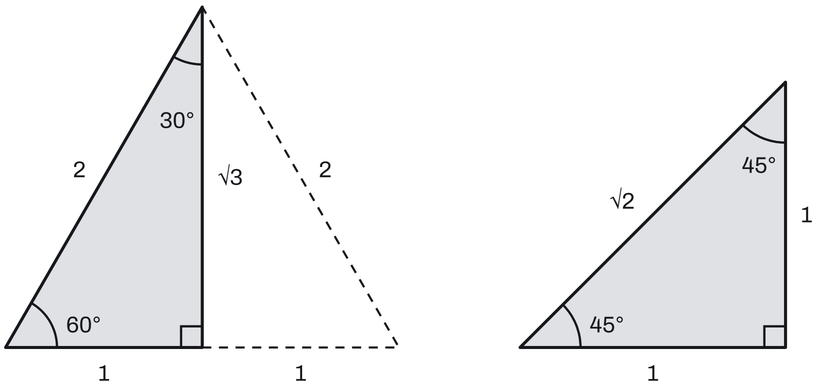
Paper 2 has no calculator, so equations there use the exact values; Paper 4 allows a calculator, so the numbers can be anything. Sine, cosine and tangent in right-angled triangles are in Pythagoras' theorem and right-angled triangles; the sine and cosine rules are in Non-right-angled triangles.

Understand it

Where the exact values come from

You don't need a calculator for 30°, 45° and 60°, because two simple triangles give their ratios exactly.

- **Half an equilateral triangle.** Take an equilateral triangle with sides 2 and cut it down the middle. Each half is a right-angled triangle with hypotenuse 2, base 1 and angles 30°, 60° and 90°. Pythagoras gives the height: $\sqrt{2^2 - 1^2} = \sqrt{3}$.
- **Half a square.** A right-angled triangle with both shorter sides 1 has two angles of 45°, and its hypotenuse is $\sqrt{1^2 + 1^2} = \sqrt{2}$.



Now read the ratios off with SOH CAH TOA. From the 60° angle, the opposite side is $\sqrt{3}$, the adjacent is 1 and the hypotenuse 2, so $\sin 60^\circ = \frac{\sqrt{3}}{2}$, $\cos 60^\circ = \frac{1}{2}$ and $\tan 60^\circ = \sqrt{3}$. From the 30° angle the opposite and adjacent swap: $\sin 30^\circ = \frac{1}{2}$, $\cos 30^\circ = \frac{\sqrt{3}}{2}$ and $\tan 30^\circ = \frac{1}{\sqrt{3}}$. From 45°: $\sin 45^\circ = \cos 45^\circ = \frac{1}{\sqrt{2}}$ and $\tan 45^\circ = 1$.

x	0°	30°	45°	60°	90°
$\sin x$	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
$\cos x$	1	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0
$\tan x$	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	(none)

Some patterns make the table easy to rebuild in the exam:

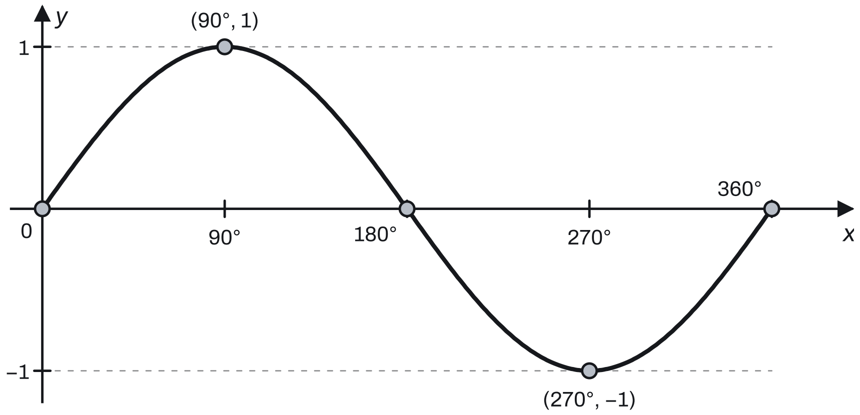
- $\frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2}$ and $\frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$ (multiply top and bottom by the surd). Either form is fine.
- The $\sin$ row is the $\cos$ row backwards: $\sin x = \cos(90^\circ - x)$.
- $\sin$ goes up from 0 to 1; $\cos$ goes down from 1 to 0; $\tan$ goes up from 0 and has no value at 90°.
- $\tan$ is always $\sin \div \cos$ for the same angle, for example $\tan 60^\circ = \frac{\sqrt{3}}{2} \div \frac{1}{2} = \sqrt{3}$.

Using them in a triangle. In a right-angled triangle with hypotenuse 10 and an angle of 30°, the side opposite 30° is $10 \sin 30^\circ = 10 \times \frac{1}{2} = 5$ exactly. If a side is on the bottom of the fraction, you divide by a surd: with opposite side 4 and an angle of 60°, the adjacent side is $\frac{4}{\tan 60^\circ} = \frac{4}{\sqrt{3}} = \frac{4\sqrt{3}}{3}$.

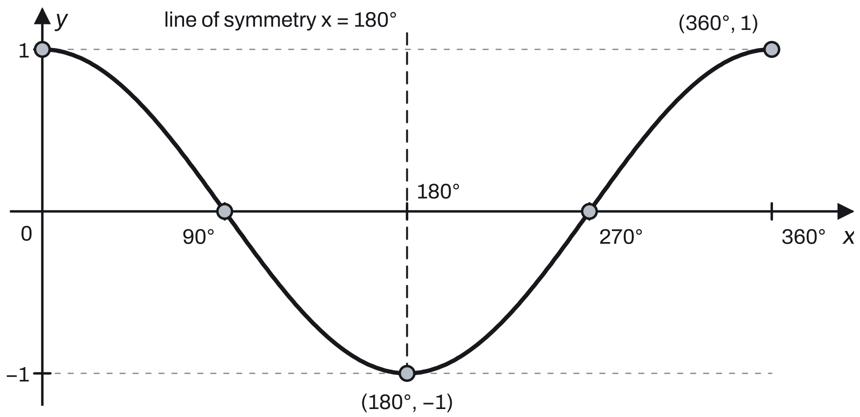
Sine, cosine and tangent for any angle

In a right-angled triangle the angles are always acute, but a calculator gives $\sin$, $\cos$ and $\tan$ of any angle, and their values follow repeating graphs. You need these three graphs from 0° to 360°.

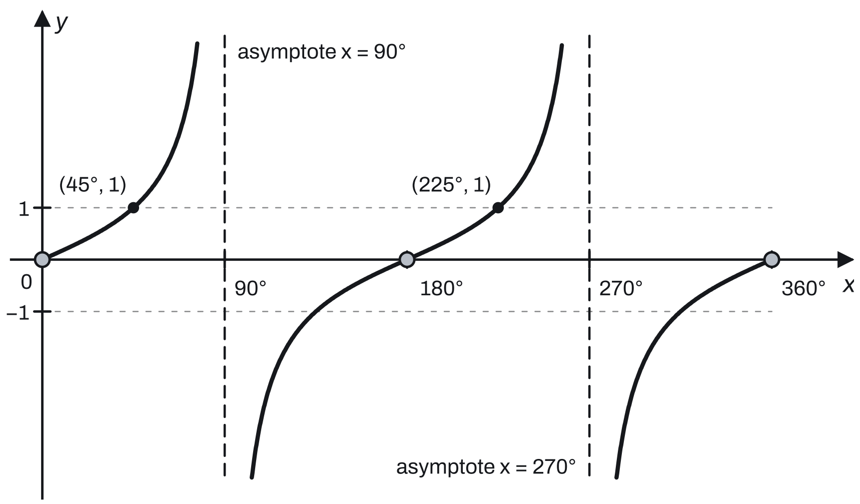
$y = \sin x$ starts at 0, rises to 1 at 90°, is back to 0 at 180°, falls to -1 at 270° and returns to 0 at 360°. It is one smooth wave.



$y = \cos x$ is the same wave moved 90° to the left: it starts at its highest point $(0^\circ, 1)$, crosses the axis at 90°, reaches -1 at 180°, crosses again at 270° and is back to 1 at 360°. It is symmetrical about $x = 180^\circ$.



$y = \tan x$ looks nothing like the other two. It passes through $(0, 0)$, $(180^\circ, 0)$ and $(360^\circ, 0)$ and climbs steeply on every piece. At 90° and 270° it has **no value**, and the curve shoots off towards $+\infty$ on the left and comes back from $-\infty$ on the right. The vertical lines $x = 90^\circ$ and $x = 270^\circ$ are **asymptotes**: the curve gets closer and closer but never touches them. It repeats every 180°, so $\tan 225^\circ = \tan 45^\circ = 1$.

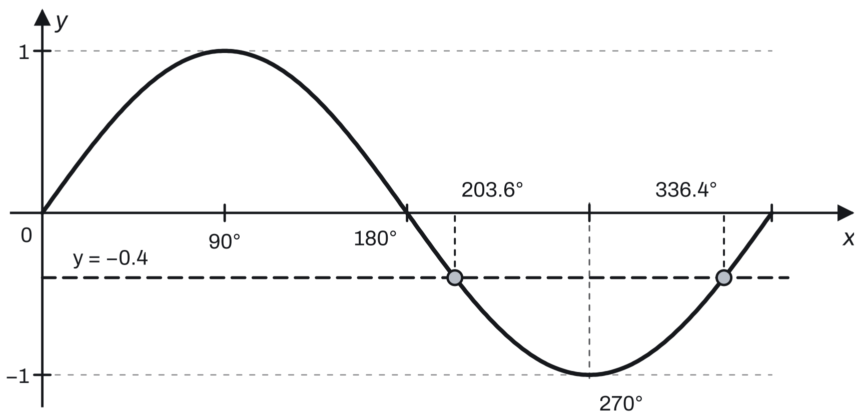


Interpreting the graphs. They answer questions without any working:

- $\sin x$ and $\cos x$ are always between -1 and 1. So $\sin x = 1.2$ has **no** solutions, and the largest value of $5\cos x$ is 5.
- A horizontal line $y = k$ with $-1 < k < 1$ crosses the sine or cosine wave **twice** between 0° and 360°, so equations like $\sin x = 0.3$ have two solutions. A line $y = k$ crosses the tan graph twice for any k except 0 (which it meets at 0°, 180° and 360°).
- The sign of each function in each quarter: $\sin x$ is positive between 0° and 180°; $\cos x$ is positive below 90° and above 270°; $\tan x$ is positive below 90° and between 180° and 270°.

Solving an equation: why there are two answers

The calculator's $\sin^{-1}$, $\cos^{-1}$ and $\tan^{-1}$ give only **one** angle. The graph shows where the other one is.



sin⁻¹(−0.4) = −23.6° (out of range) → 180° + 23.6° and 360° − 23.6°

To solve $\sin x = -0.4$: the calculator gives $\sin^{-1}(-0.4) = -23.6^\circ$, which is outside the range. The line $y = -0.4$ meets the wave twice, and both points are equally far from the lowest point at 270°: at $180^\circ + 23.6^\circ = 203.6^\circ$ and $360^\circ - 23.6^\circ = 336.4^\circ$. Their sum is 540°.

Each graph has its own symmetry, which gives a rule for the second answer. If the calculator gives α:

Equation	Solutions between 0° and 360°	Check
$\sin x = k$	α and $180^\circ - \alpha$ (if α is negative: $180^\circ - \alpha$ and $360^\circ + \alpha$)	two non-reflex answers add to 180°; two reflex answers add to 540°
$\cos x = k$	α and $360^\circ - \alpha$	the two answers add to 360°
$\tan x = k$	α and $\alpha + 180^\circ$ (if α is negative: $\alpha + 180^\circ$ and $\alpha + 360^\circ$)	the two answers differ by 180°

The same rules work with exact values. $\sin x = -\frac{1}{2}$: the angle whose sine is $\frac{1}{2}$ is 30°, and the negative value puts the answers where sine is negative, between 180° and 360°, so $x = 180^\circ + 30^\circ = 210^\circ$ and $x = 360^\circ - 30^\circ = 330^\circ$ (two reflex answers with sum 540°, as it should be).

Key facts and formulas

"Given" means it is on the List of formulas printed on page 2 of Papers 2 and 4. Nothing in this topic is on it, so learn it all.

Formula	Status
$\sin 0^\circ = 0, \sin 30^\circ = \frac{1}{2}, \sin 45^\circ = \frac{\sqrt{2}}{2}, \sin 60^\circ = \frac{\sqrt{3}}{2}, \sin 90^\circ = 1$	Learn it
$\cos 0^\circ = 1, \cos 30^\circ = \frac{\sqrt{3}}{2}, \cos 45^\circ = \frac{\sqrt{2}}{2}, \cos 60^\circ = \frac{1}{2}, \cos 90^\circ = 0$	Learn it
$\tan 0^\circ = 0, \tan 30^\circ = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}, \tan 45^\circ = 1, \tan 60^\circ = \sqrt{3}$	Learn it
$y = \sin x$: through $(0, 0)$, $(180^\circ, 0)$, $(360^\circ, 0)$; maximum 1 at 90°, minimum -1 at 270°	Learn it
$y = \cos x$: through $(0, 1)$, $(360^\circ, 1)$; minimum -1 at 180°; zero at 90° and 270°	Learn it
$y = \tan x$: through $(0, 0)$, $(180^\circ, 0)$, $(360^\circ, 0)$; asymptotes $x = 90^\circ$ and $x = 270^\circ$; repeats every 180°	Learn it
$\sin x = k$: $x = \alpha$ or $180^\circ - \alpha$	Learn it
$\cos x = k$: $x = \alpha$ or $360^\circ - \alpha$	Learn it
$\tan x = k$: $x = \alpha$ or $\alpha + 180^\circ$	Learn it
$-1 \leqslant \sin x \leqslant 1$ and $-1 \leqslant \cos x \leqslant 1$	Learn it

How to do it

In the questions we have tagged for this topic (27 questions, 2021–2025), the types came up this often. 13 of the 27 questions mix two types (usually a sketch followed by an equation), so the counts add up to more than 27.

Question type	Questions
Solve an equation with a calculator	17
Sketch the graph of $\sin x$, $\cos x$ or $\tan x$	12
Solve an equation with exact values (no calculator)	8
Exact values on their own or in a right-angled triangle	3

1. Solve an equation with a calculator (17 questions)

1. **Rearrange** to get $\sin x$, $\cos x$ or $\tan x$ on its own, as with any linear equation. For $3 + 4\cos x = 0$: $4\cos x = -3$, so $\cos x = -0.75$ (giving 138.6° and 221.4°). Write this line down.
2. **Use the inverse** on your calculator to get the first angle α. Keep it unrounded.
3. **Find the second angle** with the rule for that function (or read it off a sketch).
4. **Throw out anything outside** 0° **to** 360°, and give both answers to 1 decimal place.
5. **Check** the pair: sine pairs add to 180° or 540°; cosine pairs add to 360°; tangent pairs differ by 180°. Put each answer back into the calculator to be sure.

For example, $\cos x = 0.6$ gives $\alpha = 53.1^\circ$ and $360^\circ - 53.1^\circ = 306.9^\circ$. $\tan x = 3$ gives 71.6° and $71.6^\circ + 180^\circ = 251.6^\circ$. $\sin x = 0.7$ gives 44.4° and $180^\circ - 44.4^\circ = 135.6^\circ$.

Variations you will meet:

- **A negative value.** $\sin x$ negative: the calculator gives a negative α, so the answers are $180^\circ - \alpha$ and $360^\circ + \alpha$, both reflex. $\tan x$ negative: add 180° and 360° to the negative α. $\cos x$ negative: $\cos^{-1}$ already gives an angle between 90° and 180°, so the answers are α and $360^\circ - \alpha$ as usual.
- **Brackets or the unknown on both sides**, such as $2(1 + \sin x) = 1.4$: divide or expand first, to reach $\sin x = -0.3$, then solve (197.5° and 342.5°).
- **"Find all the solutions"** or "find all the possible values": there are two unless the question limits them. Write both in the answer space and no others.
- **A value such as** $\tan x = 8.2$: large values are fine for $\tan$ (the answers, 83.0° and 263.0°, are close to 90° and 270°), but $\sin x$ or $\cos x$ bigger than 1 means you rearranged wrongly.
- **Two unknowns.** Solve simultaneous equations in p and q first, then use $p = \sin u$ and $q = \cos v$ to find the angles.

2. Sketch the graph of $\sin x$, $\cos x$ or $\tan x$ (12 questions)

The axes are usually printed, with 1, -1 and some angles marked. You need the shape and the key points, not a plotted table.

1. **Mark the key points** lightly first:
   - $\sin x$: $(0, 0)$, $(90^\circ, 1)$, $(180^\circ, 0)$, $(270^\circ, -1)$, $(360^\circ, 0)$;
   - $\cos x$: $(0, 1)$, $(90^\circ, 0)$, $(180^\circ, -1)$, $(270^\circ, 0)$, $(360^\circ, 1)$;
   - $\tan x$: $(0, 0)$, $(180^\circ, 0)$, $(360^\circ, 0)$, and dashed asymptotes at 90° and 270°.
2. **Join them with a smooth curve.** The waves are rounded at the top and bottom (not pointed) and cover the whole range from 0° to 360°. They reach exactly 1 and -1 and no further.
3. **For $\tan x$, draw three separate branches**: from $(0, 0)$ up towards the 90° asymptote; from low down next to 90°, through $(180^\circ, 0)$, up towards 270°; from low down next to 270° up to $(360^\circ, 0)$. The branches must not cross or join across the asymptotes.

Variations you will meet:

- **"Recognise the graph"**: $\sin$ starts at 0 going up, $\cos$ starts at 1, $\tan$ has breaks at 90° and 270°.
- **Use the sketch in the next part.** Nearly every sketch is followed by an equation; draw the line $y = k$ across your sketch to see where the answers lie.

3. Solve an equation with exact values (8 questions)

On the non-calculator paper, the value you reach is always one in the exact-value table.

1. **Rearrange** to $\sin x = k$, $\cos x = k$ or $\tan x = k$. For $2\cos x + \sqrt{2} = 0$ that is $\cos x = -\frac{\sqrt{2}}{2}$.
2. **Ignore the sign and find the acute angle** from the table: $\cos 45^\circ = \frac{\sqrt{2}}{2}$, so the acute angle is 45°.
3. **Place the two answers** using the sign and the graph:
   - $\sin$ positive: θ and $180^\circ - \theta$; $\sin$ negative: $180^\circ + \theta$ and $360^\circ - \theta$;
   - $\cos$ positive: θ and $360^\circ - \theta$; $\cos$ negative: $180^\circ - \theta$ and $180^\circ + \theta$;
   - $\tan$ positive: θ and $180^\circ + \theta$; $\tan$ negative: $180^\circ - \theta$ and $360^\circ - \theta$.

   Here $\cos$ is negative, so $x = 180^\circ - 45^\circ = 135^\circ$ or $x = 180^\circ + 45^\circ = 225^\circ$.

Variations you will meet:

- **An extra condition**, such as "x is a reflex angle" or "x is obtuse": find both answers, then keep the one that fits. $\sin x = \frac{\sqrt{3}}{2}$ with x obtuse gives only 120°.
- **The value hides a surd**: $\tan x = \frac{1}{\sqrt{3}}$ is the same as $\frac{\sqrt{3}}{3}$, so the acute angle is 30°. Rationalise or un-rationalise to match the table.
- **Values 0, 1 and -1** come from the ends of the waves, and there may be just one or three answers: $\cos x = -1$ only at 180°; $\sin x = 0$ at 0°, 180° and 360°.

4. Exact values on their own or in a right-angled triangle (3 questions)

1. **"Write down the exact value of $\tan 60^\circ$"**: give it from the table ($\sqrt{3}$); no working is needed.
2. **A triangle on the non-calculator paper** with a 30°, 45° or 60° angle: label the sides from the angle, choose the ratio, write the equation, then **substitute the exact value** and simplify the surd.

For example, a right-angled triangle has an angle of 60° with the side opposite it 9 cm. The adjacent side a has $\tan 60^\circ = \frac{9}{a}$, so $a = \frac{9}{\tan 60^\circ} = \frac{9}{\sqrt{3}} = \frac{9\sqrt{3}}{3} = 3\sqrt{3}$ cm.

Variations you will meet:

- **Two right-angled triangles sharing a side**, with letters instead of numbers: find the shared side in terms of the letter (for example $2n$), then use it in the second triangle, and simplify.
- **Dividing by a surd.** $\frac{8}{\sqrt{3}} = \frac{8\sqrt{3}}{3}$; dividing by $\frac{\sqrt{3}}{2}$ is multiplying by $\frac{2}{\sqrt{3}}$.

Worked examples

The bold codes show where marks are earned, as in Cambridge mark schemes. The number is how many marks.

- **M1** method mark: for a correct method, even if the numbers slip.
- **A1** accuracy mark: for a correct answer; it needs the M mark before it.
- **B1** mark for a correct result on its own, with no method needed.

Example 1

Non-calculator.

Triangle PQR has a right angle at Q. $PR = 12$ cm and angle $QPR = 60^\circ$.

(a) Find the exact length of PQ. **[2]**

(b) Find the exact length of QR. **[2]**

(c) Find the exact area of triangle PQR. **[1]**

(a) From the 60° angle, PQ is adjacent and PR the hypotenuse: $\cos 60^\circ = \dfrac{PQ}{12}$ **M1**, so $PQ = 12 \times \frac{1}{2} = 6$ cm. **A1**

(b) QR is opposite: $QR = 12 \sin 60^\circ$ **M1** $= 12 \times \dfrac{\sqrt{3}}{2} = 6\sqrt{3}$ cm. **A1**

(c) Area $= \frac{1}{2} \times 6 \times 6\sqrt{3} = 18\sqrt{3}$ cm². **B1**

Example 2

Non-calculator.

(a) Sketch the graph of $y = \sin x$ for $0^\circ \leqslant x \leqslant 360^\circ$. **[2]**

(b) Solve the equation $2 \sin x + \sqrt{2} = 0$ for $0^\circ \leqslant x \leqslant 360^\circ$. **[3]**

(a) A smooth wave through $(0, 0)$, $(180^\circ, 0)$ and $(360^\circ, 0)$, with maximum 1 at 90° and minimum -1 at 270°, as in the first graph in "Understand it". **B2** (**B1** for the right wave shape starting at the origin).

(b) $2 \sin x = -\sqrt{2}$, so $\sin x = -\dfrac{\sqrt{2}}{2}$. **M1**

The acute angle with $\sin = \frac{\sqrt{2}}{2}$ is 45°. $\sin x$ is negative between 180° and 360°, so

$$x = 180^\circ + 45^\circ = 225^\circ \quad \text{or} \quad x = 360^\circ - 45^\circ = 315^\circ.$$

A1 A1 (two reflex answers, and $225 + 315 = 540$ ✓).

Example 3

Calculator.

Solve the equation $4\cos x + 7 = 5.6$ for $0^\circ \leqslant x \leqslant 360^\circ$. **[3]**

$4\cos x = -1.4$, so $\cos x = -0.35$. **M1**

$x = \cos^{-1}(-0.35) = 110.487\ldots = 110.5^\circ$. **A1**

The second answer is $360^\circ - 110.487\ldots = 249.512\ldots = 249.5^\circ$. **A1** (Check: $110.5 + 249.5 = 360$.)

Example 4

Calculator.

(a) Sketch the graph of $y = \tan x$ for $0^\circ \leqslant x \leqslant 360^\circ$. **[2]**

(b) Solve the equation $2(3 - \tan x) = 11$ for $0^\circ \leqslant x \leqslant 360^\circ$. **[3]**

(a) Three branches through $(0, 0)$, $(180^\circ, 0)$ and $(360^\circ, 0)$, each rising from left to right, with asymptotes at 90° and 270° that the curve does not cross, as in the third graph in "Understand it". **B2** (one correct branch earns **B1**).

(b) $6 - 2\tan x = 11$, so $-2\tan x = 5$ and $\tan x = -2.5$. **M1**

$\tan^{-1}(-2.5) = -68.198\ldots^\circ$, which is out of range. Adding 180° and 360°:

$$x = -68.198\ldots + 180 = 111.8^\circ \quad \text{or} \quad x = -68.198\ldots + 360 = 291.8^\circ.$$

A1 A1. The sketch agrees: $\tan x$ is negative on the branches just after 90° and just after 270°.

Common mistakes

- **Giving only one answer.** The most common loss in every year's reports: the calculator's angle is written down and the second solution is never looked for. There are nearly always two.
- **The wrong second angle.** Examiners report $\alpha + 90^\circ$, $270^\circ - \alpha$, $360^\circ - \alpha$ for sine, or $180^\circ + \alpha$ for cosine. Use the rule for that function, or draw a quick sketch or a four-quadrant diagram and read the answers off.
- **Keeping a negative answer.** -23.6° is not between 0° and 360°; turn it into 336.4° (and find the other one).
- **Losing the minus sign when rearranging.** $4\sin x + 1 = 0$ gives $\sin x = -\frac{1}{4}$ (so 194.5° and 345.5°), not $\frac{1}{4}$. Examiners regularly see an acute and an obtuse pair, here 14.5° and 165.5°, that comes from the missing sign.
- **Too many answers.** Writing extra angles (for example four answers to a sine equation) costs marks. Give exactly the ones in the range.

- **Poor sketches.** Waves that are pointed, straight-sided, too tall, or stop short of 360°; a sine curve that doesn't start at the origin; a cosine curve that doesn't start at $(0, 1)$; a tan graph with the wrong period or branches joined across the asymptotes; or the wrong function altogether.
- **Not knowing the exact values.** On the non-calculator paper, students who can't recall $\tan 60^\circ$ or $\sin 30^\circ$ set up the right equation and then stall. Learn the two triangles so you can rebuild the table.
- **A table with no choice made.** Writing out every exact value but never saying which one you used earns nothing. Write the one you need in the working, such as $\tan 30^\circ = \frac{1}{\sqrt{3}}$.
- **Decimals when "exact" is asked.** $6\sqrt{3}$, not 10.4.
- **Calculator in radians.** $\sin^{-1}(0.5)$ should show 30. If it doesn't, change the mode to degrees.

How to get the marks

- **Write the rearranged equation**, such as $\cos x = -0.75$. That line alone earns the method mark even if both angles go wrong.
- **One correct angle earns most of the marks** (usually 2 out of 3), and a pair with the right symmetry (sum 180°, 360° or 540°, or a difference of 180°) can earn a special mark. So always give a second angle.
- **Accuracy**: angles to 1 decimal place, from an unrounded α (so $110.487\ldots$ gives 110.5, not 110.4).
- **Sketches** earn one mark for the right shape (a wave through the origin for sine, through $(0, 1)$ for cosine, one correct branch for tangent) and the second for going through all the key points over the whole range. Use the printed 1 and -1.
- **"Exact"** means surds and fractions: $\frac{\sqrt{3}}{2}$, $6\sqrt{3}$, $\frac{4\sqrt{3}}{3}$. Equivalent forms, such as $\frac{1}{\sqrt{3}}$ or $\frac{\sqrt{3}}{3}$, are all accepted.
- **"Write down"** means no working is needed; **"find"** or **"solve"** means show the rearranging.
- **"Hence"** or a sketch in part (a): use it. It tells you which quarters the answers are in.

Quick check

1. Write down the exact values of $\cos 30^\circ$ and $\tan 45^\circ$.
2. Without a calculator, solve $\tan x = -1$ for $0^\circ \leqslant x \leqslant 360^\circ$.
3. Without a calculator, solve $2\cos x = \sqrt{3}$ for $0^\circ \leqslant x \leqslant 360^\circ$.
4. Solve $7\sin x - 3 = 0$ for $0^\circ \leqslant x \leqslant 360^\circ$.
5. Solve $4\tan x + 9 = 0$ for $0^\circ \leqslant x \leqslant 360^\circ$.

Answers

1. $\cos 30^\circ = \dfrac{\sqrt{3}}{2}$ and $\tan 45^\circ = 1$.
2. $\tan 45^\circ = 1$ and $\tan$ is negative, so $x = 180^\circ - 45^\circ = 135^\circ$ or $x = 360^\circ - 45^\circ = 315^\circ$ (they differ by 180°).
3. $\cos x = \dfrac{\sqrt{3}}{2}$, so the acute angle is 30°; cosine is positive, so $x = 30^\circ$ or $x = 360^\circ - 30^\circ = 330^\circ$.
4. $\sin x = \frac{3}{7}$, so $x = \sin^{-1}\left(\frac{3}{7}\right) = 25.37\ldots = 25.4^\circ$, or $x = 180^\circ - 25.37\ldots = 154.6^\circ$.
5. $\tan x = -2.25$; $\tan^{-1}(-2.25) = -66.04\ldots^\circ$, so $x = -66.04\ldots + 180 = 114.0^\circ$ or $x = -66.04\ldots + 360 = 294.0^\circ$.

Past questions to try

- **0580/42/F/M/25 Q19**: a cosine equation with a negative value, on the calculator paper.
- **0580/23/O/N/24 Q20**: a tangent equation with a negative value.
- **0580/42/F/M/23 Q12**: sketch $y = \tan x$, then use it to find both solutions of an exact-value equation.
- **0580/23/M/J/25 Q23**: exact values in two right-angled triangles that share a side, with letters.