Right-Triangle Trigonometry

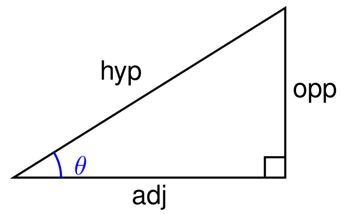
Name: ____________	Date: ____________	Score: ______ / 24

Quick Review

In a right triangle, label the side **opposite** the angle θ, the side **adjacent** to it, and the **hypotenuse** (the long side, across from the right angle). The three core ratios are:

$\sin\theta = \frac{\text{opp}}{\text{hyp}}$ $\cos\theta = \frac{\text{adj}}{\text{hyp}}$ $\tan\theta = \frac{\text{opp}}{\text{adj}}$

The mnemonic **SOH-CAH-TOA** keeps them in order: Sine = Opp/Hyp, Cosine = Adj/Hyp, Tangent = Opp/Adj.



Choosing a ratio. Pick the one whose two named sides are the ones you have or want. Have hypotenuse and want opposite? Sine. Have adjacent and want opposite? Tangent. Have two legs and want the angle? Inverse tangent.

Finding angles with inverse trig. If $\sin\theta = k$ for an acute θ, then $\theta = \sin^{-1}(k)$ (also written $\arcsin k$). Same for $\cos^{-1}$ and $\tan^{-1}$. Calculators do this in degree mode for these worksheets.

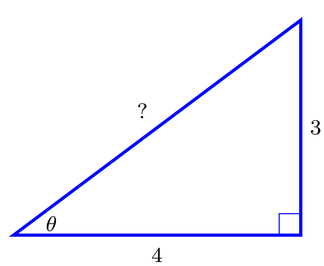
Quick Pythagorean check. Whenever two sides of a right triangle are known, the third comes from $a^2 + b^2 = c^2$. Combined with the trig ratios, this lets you solve any right triangle with one side and one acute angle, or two sides.

Common slips. Mixing opposite with adjacent (always re-label after picking a new angle of interest). Using $\sin$ when you wanted $\cos$ (check: is the side adjacent or opposite to θ?). Forgetting that an acute angle has $0 < \sin\theta < 1$ and $0 < \cos\theta < 1$, while $\tan\theta$ can grow arbitrarily large.

PRACTICE

Use SOH-CAH-TOA and the Pythagorean theorem. For angles, round to the nearest degree unless asked otherwise.

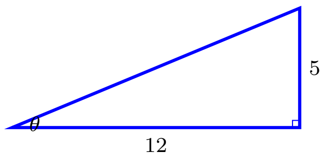
1. Fill in: $\sin\theta =$ opp/ _____. ________
2. Fill in: $\cos\theta =$ _____/hyp. ________
3. In the right triangle below, θ is opposite the leg of length 3. Find $\sin\theta$. ________



4. Same 3-4-5 triangle. Find $\cos\theta$ (with θ opposite the leg of length 3). ________
5. Same triangle, find $\tan\theta$. ________
6. If $\sin\theta = \frac{5}{13}$ for an acute θ, find $\cos\theta$. ________
7. Right triangle, hypotenuse 20, one acute angle $30°$. Find the side opposite the $30°$ angle. ________
8. Right triangle, hypotenuse 14, acute angle $60°$. Find the leg adjacent to the $60°$ angle. ________

9. Fill in: $\tan\theta = \text{opp}/$ ____. ________

10. In the right triangle below, θ is opposite the leg of 5. Find θ to the nearest degree. ________



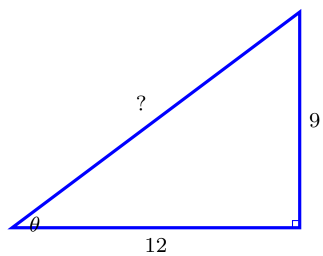
11. Right triangle, acute angle $40°$, adjacent side 18. Express the opposite side. ________

12. If $\cos\theta = \frac{3}{5}$ for an acute θ, find $\sin\theta$. ________

13. If $\sin\theta = \frac{1}{2}$ for an acute θ, find θ. ________

14. If $\cos\theta = \frac{\sqrt{2}}{2}$ for an acute θ, find θ. ________

15. Find the hypotenuse of the right triangle below. ________



16. A right triangle has an acute angle of $52°$ and the side adjacent is 10. Express the hypotenuse. ________

17. A right triangle has acute angle $30°$ and side opposite 9. Find the hypotenuse. ________

18. Right triangle with legs 6 and 11. Find the larger acute angle to the nearest degree. ________

19. If $\tan\theta = 1$ for an acute θ, find θ. ________

20. Right triangle, hypotenuse 25 and acute angle $40°$. Find the other acute angle. ________

♦ Word Problems

21. A 15-foot ladder leans against a wall, making a $68°$ angle with the ground. How high up the wall does it reach? Round to the nearest tenth of a foot. ____

22. From a point 40 feet from the base of a flagpole, the angle of elevation to the top is $35°$. How tall is the flagpole? Round to the nearest tenth of a foot. ____

23. A right triangular roof truss has a horizontal base of 24 feet and rises 7 feet at the middle (apex). Find the acute angle the rafter makes with the base. Round to the nearest degree. ____

24. A surveyor sights the top of a tower at a $52°$ angle of elevation from a point 50 meters from the base. How tall is the tower? Round to the nearest tenth of a meter. ____

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Answer Keys

1. hyp
2. adj
3. $\frac{3}{5}$
4. $\frac{4}{5}$
5. $\frac{3}{4}$
6. $\frac{12}{13}$
7. 10
8. 7
9. adj
10. $\approx 23^\circ$
11. $18\tan 40^\circ$
12. $\frac{4}{5}$
13. 30°
14. 45°
15. 15
16. $\frac{10}{\cos 52^\circ}$
17. 18
18. $\approx 61^\circ$
19. 45°
20. 50°
21. ≈ 13.9 ft
22. ≈ 28.0 ft
23. $\approx 30^\circ$
24. ≈ 64.0 m

Step-by-Step Explanations

1. Sine compares the opposite side to the hypotenuse – the long diagonal across from the right angle.
2. Cosine pairs the adjacent leg with the hypotenuse. (Adjacent means "next to θ" and not the hypotenuse.)
3. Opposite $= 3$, hypotenuse $= \sqrt{3^2 + 4^2} = 5$, so $\sin\theta = \frac{3}{5}$. This is the classic 3-4-5 triangle.
4. Start with the key idea: Adjacent to θ is the other leg, 4; hypotenuse is 5. So $\cos\theta = \frac{4}{5}$. That gives a quick check on the answer.
5. A careful way to see it: $\tan\theta = \frac{\text{opp}}{\text{adj}} = \frac{3}{4}$. (Check: $\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{3/5}{4/5} = \frac{3}{4}$ ✓.) This is the part to check before moving on, because it keeps the answer tied to the original question.
6. Keep the rule visible: Opposite $= 5$, hypotenuse $= 13$. Adjacent $= \sqrt{13^2 - 5^2} = \sqrt{144} = 12$. So $\cos\theta = \frac{12}{13}$. That gives a quick check on the answer.
7. One steady path is: $\sin 30^\circ = \frac{1}{2} = \frac{\text{opp}}{20}$, so opp $= 10$. (Or: in a 30-60-90, the short leg is half the hypotenuse.) That gives a quick check on the answer.
8. Start with the key idea: $\cos 60^\circ = \frac{1}{2} = \frac{\text{adj}}{14}$, so adj $= 7$. This is the part to check before moving on, because it keeps the answer tied to the original question.
9. A careful way to see it: Tangent compares the two legs – opposite over adjacent. That gives a quick check on the answer.
10. Keep the rule visible: $\tan\theta = \frac{5}{12}$, so $\theta = \arctan\frac{5}{12} \approx 22.62^\circ \approx 23^\circ$. This is the part to check before moving on, because it keeps the answer tied to the original question.
11. One steady path is: $\tan 40^\circ = \frac{\text{opp}}{18}$, so opp $= 18\tan 40^\circ$. (Calculator gives ≈ 15.10.) That gives a quick check on the answer.
12. Start with the key idea: Adjacent $= 3$, hyp $= 5$, so opposite $= \sqrt{25 - 9} = 4$. $\sin\theta = \frac{4}{5}$. This is the part to check before moving on, because it keeps the answer tied to the original question.
13. A careful way to see it: $\sin 30^\circ = \frac{1}{2}$, so $\theta = 30^\circ$. (A staple special-angle value.) This is the part to check before moving on, because it keeps the answer tied to the original question.
14. Keep the rule visible: $\cos 45^\circ = \frac{\sqrt{2}}{2}$, so $\theta = 45^\circ$. This is the part to check before moving on, because it keeps the answer tied to the original question.
15. One steady path is: $c = \sqrt{9^2 + 12^2} = \sqrt{225} = 15$. (This is a 9-12-15 triangle – the 3-4-5 scaled by 3.) That gives a quick check on the answer.
16. Cosine ties the adjacent side to the hypotenuse: $\cos 52^\circ = \frac{\text{adj}}{h} = \frac{10}{h}$, so $h = \frac{10}{\cos 52^\circ} \approx \frac{10}{0.6157} \approx 16.24$. The hypotenuse comes out longer than the 10-unit leg, as it must.
17. A careful way to see it: $\sin 30^\circ = \frac{1}{2} = \frac{9}{h}$, so $h = 18$. (Short leg is half the hypotenuse in a 30-60-90.) That gives a quick check on the answer.
18. The larger acute angle is opposite the longer leg. $\tan\theta = \frac{11}{6}$, so $\theta = \arctan\frac{11}{6} \approx 61.4^\circ \approx 61^\circ$.
19. One steady path is: $\tan 45^\circ = 1$ (the 45-45-90 triangle has equal legs). This is the part to check before moving on, because it keeps the answer tied to the original question.
20. The two acute angles of any right triangle add to 90°: $90^\circ - 40^\circ = 50^\circ$. (Faster than computing sides first.)
21. The ladder is the hypotenuse and the wall-height is opposite the 68° angle. Sine: $\sin 68^\circ = \frac{h}{15}$, so $h = 15\sin 68^\circ \approx 15(0.9272) \approx 13.9$ feet.
22. Opposite the 35° angle is the pole's height; adjacent is the 40-foot ground distance. $\tan 35^\circ = \frac{h}{40}$, so $h = 40\tan 35^\circ \approx 40(0.7002) \approx 28.0$ feet. (Sanity: a 35° elevation should give a height less than the ground distance, since $\tan 35^\circ < 1$. ✓)
23. Split the truss by its vertical center line. Each half is a right triangle with horizontal leg $24/2 = 12$ and vertical leg 7. The angle at the base satisfies $\tan\theta = \frac{7}{12}$, so $\theta = \arctan\frac{7}{12} \approx 30.3^\circ \approx 30^\circ$.
24. Adjacent $= 50$, opposite $=$ tower height h. $\tan 52^\circ = \frac{h}{50}$, so $h = 50\tan 52^\circ \approx 50(1.2799) \approx 64.0$ m. (Reality check: above 45°, $\tan > 1$, so height should exceed the 50-meter ground distance – and $64.0 > 50$. ✓)

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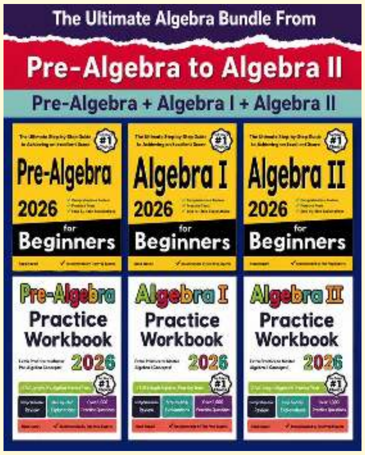

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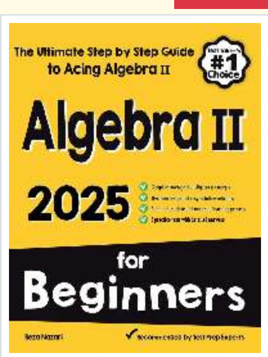

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