Trigonometric Ratios

Name: ____________	Date: ____________	Score: ______ / 28

Quick Review

You already know the three main ratios – $\sin$, $\cos$, $\tan$. This section adds the three **reciprocal ratios** and the **quotient identity**, so you have all six.

The reciprocals.

$\csc\theta = \frac{1}{\sin\theta} = \frac{\text{hyp}}{\text{opp}}$ (cosecant pairs with sine).

$\sec\theta = \frac{1}{\cos\theta} = \frac{\text{hyp}}{\text{adj}}$ (secant pairs with cosine).

$\cot\theta = \frac{1}{\tan\theta} = \frac{\text{adj}}{\text{opp}}$ (cotangent pairs with tangent).

The quotient identity. $\tan\theta = \frac{\sin\theta}{\cos\theta}$, and consequently $\cot\theta = \frac{\cos\theta}{\sin\theta}$. These follow from the right-triangle definitions: $\frac{\sin\theta}{\cos\theta} = \frac{\text{opp/hyp}}{\text{adj/hyp}} = \frac{\text{opp}}{\text{adj}} = \tan\theta$.

Mnemonic. "co" with non-"co": $\sin$ pairs with $\csc$, $\cos$ pairs with $\sec$, $\tan$ pairs with $\cot$. The non-obvious one is that secant pairs with *cosine*, not sine – worth committing to memory.

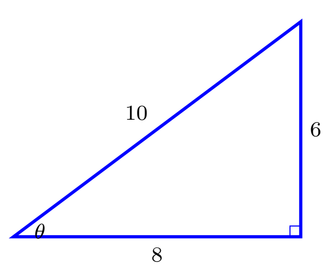
Sign behavior. Taking a reciprocal preserves sign. If $\sin\theta < 0$, then $\csc\theta < 0$ too; if $\cos\theta = -\frac{2}{3}$, then $\sec\theta = -\frac{3}{2}$.

Common slips. Confusing $\sin^{-1}\theta$ (inverse sine, an angle) with $\csc\theta$ (reciprocal of sine, a ratio). They are not the same thing. Pairing $\sec$ with $\sin$ instead of $\cos$. Forgetting that all six ratios are positive for an acute angle in a right triangle.

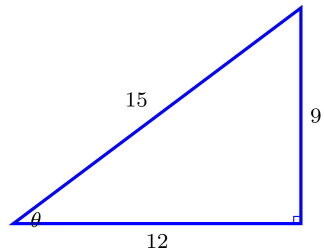
PRACTICE

Use right-triangle ratios and the reciprocal/quotient identities. All angles are acute unless stated.

1. If $\sin\theta = \frac{3}{5}$, find $\csc\theta$. ________
2. If $\cos\theta = \frac{8}{17}$, find $\sec\theta$. ________
3. If $\tan\theta = \frac{7}{24}$, find $\cot\theta$. ________
4. If $\sin\theta = \frac{3}{5}$ and $\cos\theta = \frac{4}{5}$, find $\tan\theta$. ________
5. In the right triangle below, θ is opposite the side 6. Find $\sec\theta$. ________



6. In the triangle below, θ is opposite the leg 9. Find $\tan\theta$. ______



7. Find $\sec 60°$. ______

8. Find $\csc 30°$. ______

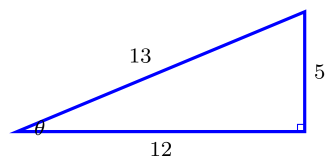
9. Find $\cot 45°$. ______

10. If $\sin\theta = \frac{-\sqrt{2}}{2}$, find $\csc\theta$. ______

11. If $\cos\theta = -\frac{2}{3}$, find $\sec\theta$. ______

12. If $\sin\theta = \frac{3}{5}$ and $\cos\theta = \frac{4}{5}$, find $\cot\theta$. ______

13. In the triangle below, θ is opposite the leg of 5. Find $\csc\theta$. ______



14. Find $\sec 45°$. ______

15. Find $\cot 60°$. ______

16. If $\tan\theta = \frac{5}{12}$ for an acute θ, find $\sin\theta$. ______

17. If $\tan\theta = \frac{5}{12}$ for an acute θ, find $\cos\theta$. ______

18. If $\tan\theta = \frac{5}{12}$ for an acute θ, find $\cot\theta$. ______

19. Where is $\sec\theta$ undefined? ______

20. Find $\csc 90°$. ______

Word Problems

21. A ramp makes an angle of θ with level ground where $\sin\theta = \frac{3}{5}$. Find $\sec\theta$. ____

22. A guy-wire runs from the top of a 9-foot pole to a point 12 feet from the pole's base on level ground. Let θ be the angle the wire makes with the ground. Find $\csc\theta$, $\sec\theta$, and $\cot\theta$. ____

23. A right triangle has legs 5 and 12. If θ is opposite the leg of length 12, find all six trig ratios at θ. ____

24. An acute angle θ satisfies $\cos\theta = \frac{12}{13}$. Find all five other trig values at θ. ____

Additional Practice

25. Find $\sin\theta$ if opposite $= 5$, hypotenuse $= 13$. ________

26. Find $\cos\theta$ if adjacent $= 12$, hypotenuse $= 13$. ________

27. Find $\tan\theta$ if opposite $= 7$, adjacent $= 4$. ________

28. Find $\sin 30°$. ________

Answer Keys

1. $\boxed{\frac{5}{3}}$
2. $\boxed{\frac{17}{8}}$
3. $\boxed{\frac{24}{7}}$
4. $\boxed{\frac{3}{4}}$
5. $\boxed{\frac{5}{4}}$
6. $\boxed{\frac{3}{4}}$
7. $\boxed{2}$
8. $\boxed{2}$
9. $\boxed{1}$
10. $\boxed{-\sqrt{2}}$
11. $\boxed{-\frac{3}{2}}$
12. $\boxed{\frac{4}{3}}$
13. $\boxed{\frac{13}{5}}$
14. $\boxed{\sqrt{2}}$
15. $\boxed{\frac{\sqrt{3}}{3}}$
16. $\boxed{\frac{5}{13}}$
17. $\boxed{\frac{12}{13}}$
18. $\boxed{\frac{12}{5}}$
19. $\boxed{\cos\theta = 0}$
20. $\boxed{1}$
21. $\boxed{\frac{5}{4}}$
22. $\boxed{\csc\theta = \frac{5}{3},\ \sec\theta = \frac{5}{4},\ \cot\theta = \frac{4}{3}}$
23. $\boxed{\sin = \frac{12}{13},\ \cos = \frac{5}{13},\ \tan = \frac{12}{5},\ \csc = \frac{13}{12},\ \sec = \frac{13}{5},\ \cot = \frac{5}{12}}$
24. $\boxed{\sin = \frac{5}{13},\ \tan = \frac{5}{12},\ \sec = \frac{13}{12},\ \csc = \frac{13}{5},\ \cot = \frac{12}{5}}$

Additional Practice Answers

25. $\boxed{\frac{5}{13}}$
26. $\boxed{\frac{12}{13}}$
27. $\boxed{\frac{7}{4}}$
28. $\boxed{\frac{1}{2}}$

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. Cosecant is the reciprocal of sine, so flip the fraction: $\csc\theta = \frac{1}{\sin\theta} = \frac{1}{3/5} = \frac{5}{3}$. (Remember the "co" in cosecant pairs it with sine, not cosine.)

2. Secant is the reciprocal of cosine, so flip: $\sec\theta = \frac{1}{8/17} = \frac{17}{8}$. (The tricky pairing to memorize: secant goes with *cosine*, not sine.)

3. Cotangent is the reciprocal of tangent, so flip the fraction: $\cot\theta = \frac{1}{7/24} = \frac{24}{7}$.

4. Start with the key idea: $\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{3/5}{4/5} = \frac{3}{4}$. (Same denominator – the fifths cancel.) That gives a quick check on the answer.

5. A careful way to see it: Adjacent $= 8$, hyp $= 10$. $\sec\theta = \frac{\text{hyp}}{\text{adj}} = \frac{10}{8} = \frac{5}{4}$. 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 $= 9$, adjacent $= 12$. $\tan\theta = \frac{9}{12} = \frac{3}{4}$. This is the part to check before moving on, because it keeps the answer tied to the original question.

7. One steady path is: $\cos 60^\circ = \frac{1}{2}$, so $\sec 60^\circ = \frac{1}{1/2} = 2$. This is the part to check before moving on, because it keeps the answer tied to the original question.

8. Start with the key idea: $\sin 30^\circ = \frac{1}{2}$, so $\csc 30^\circ = 2$. 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: $\tan 45^\circ = 1$, so $\cot 45^\circ = 1$. This is the part to check before moving on, because it keeps the answer tied to the original question.

10. Flip the fraction: $\csc\theta = \frac{-2}{\sqrt{2}} = -\sqrt{2}$. (Multiply top and bottom by $\sqrt{2}$ to rationalize.)

11. Secant is the reciprocal of cosine, and reciprocating never changes the sign: $\sec\theta = \frac{1}{-2/3} = -\frac{3}{2}$. A negative cosine forces a negative secant.

12. Start with the key idea: $\cot\theta = \frac{\cos\theta}{\sin\theta} = \frac{4/5}{3/5} = \frac{4}{3}$. 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: $\sin\theta = \frac{5}{13}$, so $\csc\theta = \frac{13}{5}$. 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 $\sec 45^\circ = \frac{2}{\sqrt{2}} = \sqrt{2}$. This is the part to check before moving on, because it keeps the answer tied to the original question.

15. One steady path is: $\tan 60^\circ = \sqrt{3}$, so $\cot 60^\circ = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$ (rationalize). This is the part to check before moving on, because it keeps the answer tied to the original question.

16. Start with the key idea: Opp $= 5$, adj $= 12$, so hyp $= \sqrt{25+144} = 13$. $\sin\theta = \frac{5}{13}$. This is the part to check before moving on, because it keeps the answer tied to the original question.

17. A careful way to see it: From the same 5-12-13 setup: $\cos\theta = \frac{12}{13}$. This is the part to check before moving on, because it keeps the answer tied to the original question.

18. Keep the rule visible: Cotangent is the reciprocal of tangent. This is the part to check before moving on, because it keeps the answer tied to the original question.

19. One steady path is: $\sec\theta = \frac{1}{\cos\theta}$ blows up exactly when $\cos\theta = 0$ – at $\theta = 90^\circ + 180^\circ n$ for integer n. That gives a quick check on the answer.

20. Start with the key idea: $\sin 90^\circ = 1$, so $\csc 90^\circ = \frac{1}{1} = 1$. This is the part to check before moving on, because it keeps the answer tied to the original question.

21. From $\sin\theta = \frac{3}{5}$: opposite $= 3$, hyp $= 5$, so adjacent $= \sqrt{25-9} = 4$. Then $\cos\theta = \frac{4}{5}$ and $\sec\theta = \frac{5}{4}$.

22. This is a 9-12-15 right triangle: the pole and the ground distance are the legs (9 opposite θ, 12 adjacent), and the hypotenuse is $\sqrt{9^2+12^2} = 15$. So

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$\sin\theta = \frac{9}{15} = \frac{3}{5}$, $\cos\theta = \frac{12}{15} = \frac{4}{5}$, $\tan\theta = \frac{9}{12} = \frac{3}{4}$. Flip each to get the reciprocals.

23. With θ opposite the leg of 12: opposite $= 12$, adjacent $= 5$, hyp $= \sqrt{25+144} = 13$. The three primary ratios: $\sin\theta = \frac{12}{13}$, $\cos\theta = \frac{5}{13}$, $\tan\theta = \frac{12}{5}$. Flip for the reciprocals: $\csc = \frac{13}{12}$, $\sec = \frac{13}{5}$, $\cot = \frac{5}{12}$.

24. Cosine gives adjacent $= 12$, hyp $= 13$. Opposite $= \sqrt{169-144} = 5$. So $\sin\theta = \frac{5}{13}$, $\tan\theta = \frac{5}{12}$. Reciprocals: $\sec = \frac{13}{12}$, $\csc = \frac{13}{5}$, $\cot = \frac{12}{5}$. (Notice this is the 5-12-13 Pythagorean triple again – it shows up a lot.)

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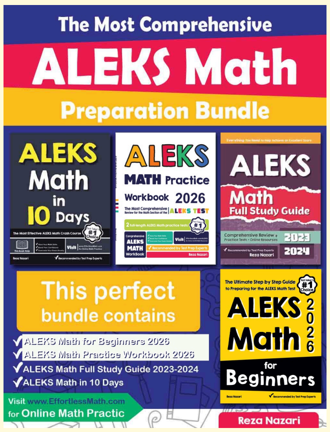

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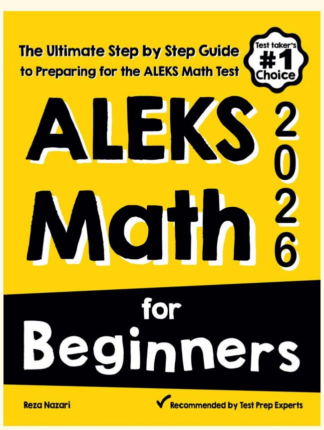

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