

Reciprocal Trigonometric Functions

Name: _____ Date: _____ Score: _____ / 24

Q Quick Review

The three **reciprocal trig functions** are the partners of sine, cosine, and tangent:

$$\csc \theta = \frac{1}{\sin \theta} \text{ (where } \sin \theta \neq 0\text{)}.$$

$$\sec \theta = \frac{1}{\cos \theta} \text{ (where } \cos \theta \neq 0\text{)}.$$

$$\cot \theta = \frac{1}{\tan \theta} = \frac{\cos \theta}{\sin \theta} \text{ (where } \sin \theta \neq 0\text{)}.$$

Watch the pairings. Cosine pairs with *secant*, not cosecant. The “co” in cosecant tells you it pairs with sine, the function *without* “co”. A quick way to remember: each reciprocal has exactly one “co” between it and its partner.

To compute a reciprocal value. Find the underlying sin, cos, or tan value, then flip the fraction. The sign is unchanged (reciprocating doesn’t flip sign). So if $\sin \theta = -\frac{\sqrt{2}}{2}$, then $\csc \theta = -\frac{2}{\sqrt{2}} = -\sqrt{2}$.

Where each is undefined. *csc* blows up where $\sin \theta = 0$ (at integer multiples of 180°). *sec* blows up where $\cos \theta = 0$ (at $90^\circ + 180^\circ n$). *cot* blows up where $\sin \theta = 0$ (same as *csc*).

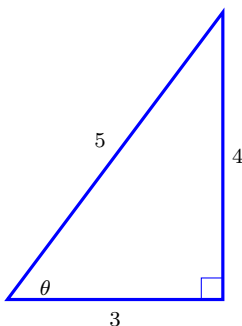
Range facts. For real θ wherever defined, $|\sec \theta| \geq 1$ and $|\csc \theta| \geq 1$. (Because the original sine and cosine are at most 1 in absolute value, their reciprocals are at least 1 in absolute value.) Cotangent, like tangent, covers all real numbers.

Common slips. Pairing secant with sine. Treating $\sin^{-1} \theta$ (inverse sine – gives an angle) as the same thing as *csc* θ (reciprocal of sine – gives a ratio). Computing $\sec 90^\circ$ as if it equals 1 – it’s actually undefined because $\cos 90^\circ = 0$.

PRACTICE

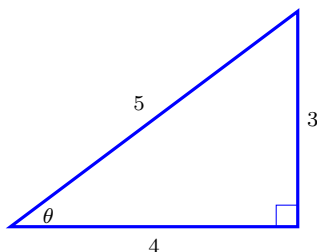
Compute reciprocal trig values. Flip the parent ratio and keep the sign.

1. For the acute angle θ in the triangle below, $\sin \theta = \frac{4}{5}$. Find *csc* θ . _____



2. *sec* θ if $\cos \theta = -\frac{2}{3}$. _____

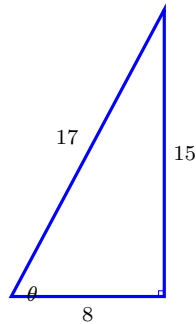
3. For the acute angle θ below, $\sin \theta = \frac{3}{5}$ and $\cos \theta = \frac{4}{5}$. Find *cot* θ . _____



4. *sec* 60° . _____



- 5. $\csc 30^\circ$. _____
- 6. Where is $\sec \theta$ undefined? _____
- 7. $\csc \theta$ if $\sin \theta = -\frac{\sqrt{2}}{2}$. _____
- 8. $\sec 180^\circ$. _____
- 9. $\csc 180^\circ$. _____
- 10. $\cot 45^\circ$. _____
- 11. $\cot 60^\circ$. _____
- 12. $\sec 45^\circ$. _____
- 13. If $\sin \theta = -\frac{7}{25}$ and $\cos \theta = -\frac{24}{25}$ with θ in Q3, find $\cot \theta$. _____
- 14. $\csc 60^\circ$. _____
- 15. $\sec 90^\circ$. _____
- 16. $\cot 90^\circ$. _____
- 17. If $\sec \theta = \frac{5}{3}$, find $\cos \theta$. _____
- 18. $\csc 270^\circ$. _____
- 19. For the acute angle θ below, $\cos \theta = \frac{8}{17}$. Find $\sec \theta$. _____



- 20. $\sec 0^\circ$. _____

◆ Word Problems

- 21. In a right triangle, the side opposite the acute angle θ is 7 and the hypotenuse is 25. Find $\csc \theta$, $\sec \theta$, and $\cot \theta$ exactly. _____
- 22. An angle θ in Quadrant II satisfies $\sin \theta = \frac{4}{5}$. Find $\sec \theta$ and $\csc \theta$ exactly. _____
- 23. Why is $\sec \theta$ never strictly between -1 and 1 ? Answer in one short sentence. _____
- 24. A surveyor's protractor reads angle θ where $\cos \theta = \frac{5}{13}$ and θ is acute. The calculations call for $\csc \theta$. Find it exactly. _____



Answer Keys

<p>1. $\frac{5}{4}$</p> <p>2. $-\frac{3}{2}$</p> <p>3. $\frac{4}{3}$</p> <p>4. 2</p> <p>5. 2</p> <p>6. $\cos \theta = 0$</p> <p>7. $-\sqrt{2}$</p> <p>8. -1</p> <p>9. undefined</p> <p>10. 1</p> <p>11. $\frac{\sqrt{3}}{3}$</p> <p>12. $\sqrt{2}$</p>	<p>13. $\frac{24}{7}$</p> <p>14. $\frac{2\sqrt{3}}{3}$</p> <p>15. undefined</p> <p>16. 0</p> <p>17. $\frac{3}{5}$</p> <p>18. -1</p> <p>19. $\frac{17}{8}$</p> <p>20. 1</p> <p>21. $\csc \theta = \frac{25}{7}, \sec \theta = \frac{25}{24}, \cot \theta = \frac{24}{7}$</p> <p>22. $\sec \theta = -\frac{5}{3}, \csc \theta = \frac{5}{4}$</p> <p>23. $\sec \theta \geq 1$</p> <p>24. $\frac{13}{12}$</p>
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Step-by-Step Explanations

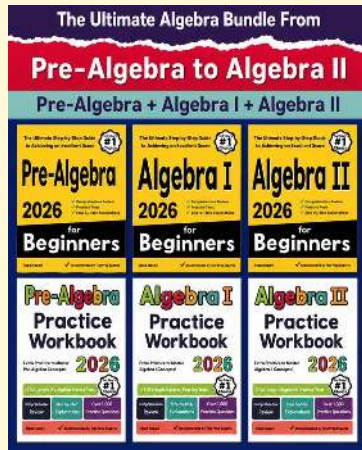
1. In the triangle, opposite = 4 and hypotenuse = 5, so $\sin \theta = \frac{4}{5}$. Cosecant flips that: $\csc \theta = \frac{\text{hyp}}{\text{opp}} = \frac{5}{4}$. (For an acute angle every ratio is positive, so no sign to worry about.)
2. Secant is the reciprocal of cosine, so flip the fraction and keep the sign: $\sec \theta = \frac{1}{-\frac{3}{2}} = -\frac{2}{3}$. Taking a reciprocal never flips a negative to a positive.
3. One steady path is: $\cot \theta = \frac{\cos \theta}{\sin \theta} = \frac{4/5}{3/5} = \frac{4}{3}$, the reciprocal of $\tan \theta = \frac{3}{4}$. This is the part to check before moving on, because it keeps the answer tied to the original question.
4. Start with the key idea: $\cos 60^\circ = \frac{1}{2}$, so $\sec 60^\circ = 2$. This is the part to check before moving on, because it keeps the answer tied to the original question.
5. A careful way to see it: $\sin 30^\circ = \frac{1}{2}$, so $\csc 30^\circ = 2$. This is the part to check before moving on, because it keeps the answer tied to the original question.
6. Because $\sec \theta = \frac{1}{\cos \theta}$, it blows up wherever the denominator is zero – that is, wherever $\cos \theta = 0$, which happens at $90^\circ + 180^\circ n$ for any integer n .
7. One steady path is: Flip: $\frac{-2}{\sqrt{2}} = -\sqrt{2}$ (multiply by $\frac{\sqrt{2}}{\sqrt{2}}$ to rationalize). This is the part to check before moving on, because it keeps the answer tied to the original question.
8. At 180° the unit-circle point is $(-1, 0)$, so $\cos 180^\circ = -1$. Then $\sec 180^\circ = \frac{1}{-1} = -1$. (Notice $|\sec| = 1$ here, the smallest it can be.)
9. A careful way to see it: $\sin 180^\circ = 0$, so $\csc 180^\circ = \frac{1}{0}$ – undefined. This is the part to check before moving on, because it keeps the answer tied to the original question.
10. Keep the rule visible: $\tan 45^\circ = 1$, so $\cot 45^\circ = 1$. This is the part to check before moving on, because it keeps the answer tied to the original question.
11. One steady path is: $\tan 60^\circ = \sqrt{3}$, so $\cot 60^\circ = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$. This is the part to check before moving on, because it keeps the answer tied to the original question.
12. Start with the key idea: $\cos 45^\circ = \frac{\sqrt{2}}{2}$, 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.
13. A careful way to see it: $\cot \theta = \frac{\cos \theta}{\sin \theta} = \frac{-24/25}{-7/25} = \frac{24}{7}$. (Two negatives in

Q3 -> positive cotangent, consistent with ASTC.) That gives a quick check on the answer.

14. Keep the rule visible: $\sin 60^\circ = \frac{\sqrt{3}}{2}$, so $\csc 60^\circ = \frac{2}{\sqrt{3}} = \frac{2\sqrt{3}}{3}$ (rationalize). This is the part to check before moving on, because it keeps the answer tied to the original question.
15. One steady path is: $\cos 90^\circ = 0$, so $\sec 90^\circ = \frac{1}{0}$ – undefined. 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: $\cot \theta = \frac{\cos \theta}{\sin \theta} = \frac{0}{1} = 0$. (Tangent is undefined at 90° , but cotangent equals zero.) That gives a quick check on the answer.
17. Cosine and secant are reciprocals of each other, so flipping secant lands you back on cosine: $\cos \theta = \frac{1}{5/3} = \frac{3}{5}$.
18. The point at 270° is $(0, -1)$, so $\sin 270^\circ = -1$. Cosecant is its reciprocal: $\csc 270^\circ = \frac{1}{-1} = -1$.
19. With $\cos \theta = \frac{8}{17}$ the adjacent leg is 8 and the hypotenuse is 17. Secant is the reciprocal of cosine: $\sec \theta = \frac{\text{hyp}}{\text{adj}} = \frac{17}{8}$.
20. Start with the key idea: At 0° the unit-circle point is $(1, 0)$, so $\cos 0^\circ = 1$ and $\sec 0^\circ = \frac{1}{1} = 1$. That gives a quick check on the answer.
21. Adjacent = $\sqrt{25^2 - 7^2} = \sqrt{576} = 24$. So $\sin \theta = \frac{7}{25}$, $\cos \theta = \frac{24}{25}$, $\tan \theta = \frac{7}{24}$. Flip each: $\csc = \frac{25}{7}$, $\sec = \frac{25}{24}$, $\cot = \frac{24}{7}$.
22. In Q2, sine is positive (given) and cosine is negative. From $\sin^2 + \cos^2 = 1$: $\cos^2 \theta = 1 - \frac{16}{25} = \frac{9}{25}$, so $\cos \theta = -\frac{3}{5}$ (negative in Q2). Then $\sec \theta = -\frac{5}{3}$ and $\csc \theta = \frac{5}{4}$ (positive because sine is).
23. Because $|\cos \theta| \leq 1$ always, its reciprocal $|\sec \theta| = \frac{1}{|\cos \theta|}$ must be at least 1 wherever it's defined. (The reciprocal of a number with absolute value ≤ 1 has absolute value ≥ 1 .)
24. Acute angle with $\cos \theta = \frac{5}{13}$ means adjacent = 5, hyp = 13, opposite = $\sqrt{169 - 25} = 12$. So $\sin \theta = \frac{12}{13}$ and $\csc \theta = \frac{13}{12}$. (A 5-12-13 triangle once again.)



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