

# Evaluating Trigonometric Functions

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_\_ / 29

## Q Quick Review

This section pulls everything together: given any angle (degrees or radians, positive or negative) and any of the six trig functions, find the exact value.

**Three tools, used in this order.**

1) *Reference-angle method* for non-quadrantal angles: reduce to  $[0, 360^\circ)$ , find the quadrant and reference angle, look up the special-angle value, apply the quadrant sign.

2) *Unit-circle method* for quadrantal angles ( $0, 90, 180, 270$  in degrees, or  $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$  in radians): read  $\cos \theta$  and  $\sin \theta$  directly off the unit-circle coordinates.

3) *Terminal-point method* for angles given by a point  $(x, y)$ : with  $r = \sqrt{x^2 + y^2}$ ,  $\sin \theta = \frac{y}{r}$ ,  $\cos \theta = \frac{x}{r}$ ,  $\tan \theta = \frac{y}{x}$ .

**Even/odd properties.** Sine and tangent are *odd*:  $\sin(-\theta) = -\sin \theta$ ,  $\tan(-\theta) = -\tan \theta$ . Cosine is *even*:  $\cos(-\theta) = \cos \theta$ . These let you handle negative angles without first finding a coterminal positive one.

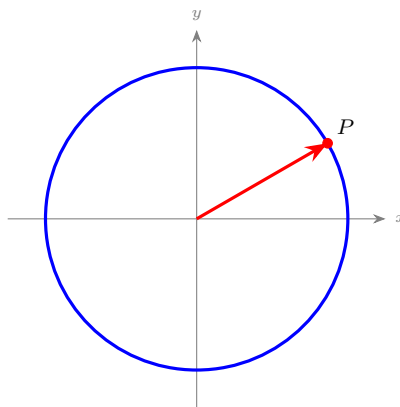
**Periodicity.** Sine, cosine, secant, and cosecant repeat every  $360^\circ$  (or  $2\pi$ ):  $\sin(\theta + 360^\circ) = \sin \theta$ . Tangent and cotangent repeat every  $180^\circ$  (or  $\pi$ ):  $\tan(\theta + 180^\circ) = \tan \theta$ .

**Common slips.** Forgetting that  $\tan$  has period  $180^\circ$ , not  $360^\circ$  – it makes shortcuts easier. Mixing up which trig function is even vs odd. Treating  $\tan 90^\circ$  as zero (it's undefined: cosine is zero there).

## PRACTICE

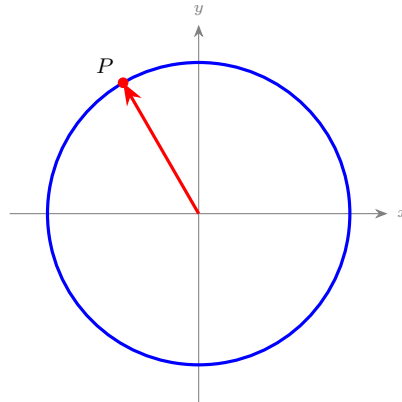
Find exact values. Use reference angles, the unit circle, or terminal points as appropriate.

1. Evaluate  $\sin\left(\frac{\pi}{6}\right)$  for the angle drawn below. \_\_\_\_\_



2. Evaluate  $\cos\left(\frac{2\pi}{3}\right)$  for the angle drawn below.

\_\_\_\_\_



3.  $\tan\left(\frac{5\pi}{4}\right)$ .

\_\_\_\_\_

4.  $\sin\left(-\frac{\pi}{3}\right)$ .

\_\_\_\_\_

5.  $\sec\left(\frac{7\pi}{6}\right)$ .

\_\_\_\_\_

6.  $\sin^2\left(\frac{\pi}{4}\right) + \cos^2\left(\frac{\pi}{4}\right)$ .

\_\_\_\_\_

7.  $\sin\left(-\frac{\pi}{2}\right)$ .

\_\_\_\_\_

8.  $\cos\left(\frac{5\pi}{6}\right)$ .

\_\_\_\_\_

9.  $\tan\left(\frac{4\pi}{3}\right)$ .

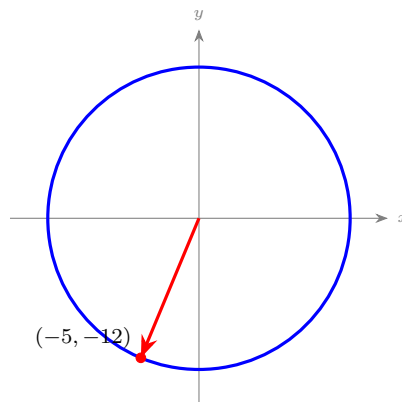
\_\_\_\_\_

10.  $\csc\left(\frac{3\pi}{2}\right)$ .

\_\_\_\_\_

11. For the angle  $\theta$  drawn below (terminal side through  $(-5, -12)$ ), find  $\sin \theta$ .

\_\_\_\_\_



12. For  $\theta$  in standard position with terminal side through  $(-5, -12)$ , find  $\cos \theta$ .

\_\_\_\_\_

13. Evaluate exactly:  $2 \cos \frac{\pi}{3} - \tan \frac{3\pi}{4}$ .

\_\_\_\_\_

14.  $\sin 390^\circ$ .

\_\_\_\_\_

15.  $\cos(-60^\circ)$ .

\_\_\_\_\_



16.  $\tan\left(-\frac{\pi}{4}\right)$ . \_\_\_\_\_

17.  $\sin 405^\circ$ . \_\_\_\_\_

18.  $\cos\left(\frac{11\pi}{6}\right)$ . \_\_\_\_\_

19.  $\sec 0^\circ$ . \_\_\_\_\_

20.  $\cot \frac{\pi}{2}$ . \_\_\_\_\_

### ◆ Word Problems

21. A point  $P$  on the terminal side of an angle  $\theta$  in standard position has coordinates  $(-3, 4)$ . Find  $\sin \theta$ ,  $\cos \theta$ , and  $\tan \theta$  exactly. \_\_\_\_\_

22. Evaluate exactly:  $\sin \frac{5\pi}{4} + \cos \frac{5\pi}{4}$ . \_\_\_\_\_

23. Find  $\tan 765^\circ$  exactly. (Hint: tangent has period  $180^\circ$ .) \_\_\_\_\_

24. For an angle  $\theta$  with  $\sin \theta = -\frac{3}{5}$  and  $\theta$  in Q4, find  $\cos \theta$  and  $\tan \theta$  exactly. \_\_\_\_\_

### 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  $\sin 30^\circ$ . \_\_\_\_\_

29. Find  $\cos 60^\circ$ . \_\_\_\_\_



Answer Keys

<p>1. <math>\frac{1}{2}</math></p> <p>2. <math>-\frac{1}{2}</math></p> <p>3. 1</p> <p>4. <math>-\frac{\sqrt{3}}{2}</math></p> <p>5. <math>-\frac{2\sqrt{3}}{3}</math></p> <p>6. 1</p> <p>7. -1</p> <p>8. <math>-\frac{\sqrt{3}}{2}</math></p> <p>9. <math>\sqrt{3}</math></p> <p>10. -1</p> <p>11. <math>-\frac{12}{13}</math></p> <p>12. <math>-\frac{5}{13}</math></p> <p><b>Additional Practice Answers</b></p> <p>25. <math>\frac{5}{13}</math></p> <p>26. <math>\frac{12}{13}</math></p> <p>27. <math>\frac{7}{4}</math></p>	<p>13. 2</p> <p>14. <math>\frac{1}{2}</math></p> <p>15. <math>\frac{1}{2}</math></p> <p>16. -1</p> <p>17. <math>\frac{\sqrt{2}}{2}</math></p> <p>18. <math>\frac{\sqrt{3}}{2}</math></p> <p>19. 1</p> <p>20. 0</p> <p>21. <math>\sin \theta = \frac{4}{5}, \cos \theta = -\frac{3}{5}, \tan \theta = -\frac{4}{3}</math></p> <p>22. <math>-\sqrt{2}</math></p> <p>23. 1</p> <p>24. <math>\cos \theta = \frac{4}{5}, \tan \theta = -\frac{3}{4}</math></p> <p>28. <math>\frac{1}{2}</math></p> <p>29. <math>\frac{1}{2}</math></p>
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Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

- A careful way to see it:  $\frac{\pi}{6} = 30^\circ$ . Special-angle value. This is the part to check before moving on, because it keeps the answer tied to the original question.
- Keep the rule visible:  $\frac{2\pi}{3} = 120^\circ$ , Q2, reference  $\frac{\pi}{3}$ , cosine negative. This is the part to check before moving on, because it keeps the answer tied to the original question.
- One steady path is:  $\frac{5\pi}{4} = 225^\circ$ , Q3, reference  $\frac{\pi}{4}$ , tangent positive. This is the part to check before moving on, because it keeps the answer tied to the original question.
- Start with the key idea: Sine is odd:  $\sin(-\theta) = -\sin \theta$ .  $-\sin \frac{\pi}{3} = -\frac{\sqrt{3}}{3}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $\frac{7\pi}{6} = 210^\circ$ , Q3,  $\cos = -\frac{\sqrt{3}}{2}$ .  $\sec = \frac{1}{\cos} = -\frac{2}{\sqrt{3}} = -\frac{2\sqrt{3}}{3}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- Keep the rule visible: Pythagorean identity – equals 1 for every angle where both are defined. That gives a quick check on the answer.
- One steady path is: Sine is odd, and  $\sin \frac{\pi}{2} = 1$ , so  $\sin\left(-\frac{\pi}{2}\right) = -1$ . (Or: the point at  $-90^\circ$  is  $(0, -1)$ .) That gives a quick check on the answer.
- Start with the key idea:  $\frac{5\pi}{6} = 150^\circ$ , Q2, reference  $\frac{\pi}{6}$ , cosine negative. This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $\frac{4\pi}{3} = 240^\circ$ , Q3, reference  $\frac{\pi}{3}$ , tangent positive (both sin and cos negative in Q3). That gives a quick check on the answer.
- Keep the rule visible:  $\sin \frac{3\pi}{2} = -1$  (point  $(0, -1)$ ), so  $\csc = \frac{1}{-1} = -1$ . This is the part to check before moving on, because it keeps the answer tied to the

original question.

- One steady path is:  $r = \sqrt{25 + 144} = 13$ .  $\sin \theta = \frac{y}{r} = -\frac{12}{13}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- Start with the key idea: Same triangle:  $\cos \theta = \frac{x}{r} = -\frac{5}{13}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $\cos \frac{\pi}{3} = \frac{1}{2}$  and  $\tan \frac{3\pi}{4} = -1$  (Q2, reference  $\frac{\pi}{4}$ , tangent negative). So  $2\left(\frac{1}{2}\right) - (-1) = 1 + 1 = 2$ . That gives a quick check on the answer.
- Keep the rule visible: Period of sine is  $360^\circ$ :  $\sin 390^\circ = \sin 30^\circ = \frac{1}{2}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- One steady path is: Cosine is even:  $\cos(-60^\circ) = \cos 60^\circ = \frac{1}{2}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- Start with the key idea: Tangent is odd:  $\tan\left(-\frac{\pi}{4}\right) = -\tan \frac{\pi}{4} = -1$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- A careful way to see it:  $\sin 405^\circ = \sin(405^\circ - 360^\circ) = \sin 45^\circ = \frac{\sqrt{2}}{2}$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- Keep the rule visible:  $\frac{11\pi}{6} = 330^\circ$ , Q4, reference  $\frac{\pi}{6}$ , cosine positive. This is the part to check before moving on, because it keeps the answer tied to the original question.
- One steady path is:  $\cos 0^\circ = 1$ , so  $\sec 0^\circ = 1$ . This is the part to check before moving on, because it keeps the answer tied to the original question.
- Start with the key idea:  $\cot \theta = \frac{\cos \theta}{\sin \theta}$ . At  $\frac{\pi}{2}$ :  $\cos = 0$ ,  $\sin = 1$ . So



$\cot = \frac{0}{1} = 0$ . This is the part to check before moving on, because it keeps the answer tied to the original question.

**21.** A careful way to see it:  $r = \sqrt{9+16} = 5$ . So  $\sin \theta = \frac{y}{r} = \frac{4}{5}$ ,  $\cos \theta = \frac{x}{r} = -\frac{3}{5}$ ,  $\tan \theta = \frac{y}{x} = \frac{4}{-3} = -\frac{4}{3}$ . (Q2: sine positive, cosine negative, tangent negative – matches the ASTC sign rules.) That gives a quick check on the answer.

**22.** Keep the rule visible:  $\frac{5\pi}{4} = 225^\circ$ , Q3, reference  $\frac{\pi}{4}$ . Both sine and cosine are

negative in Q3.  $\sin \frac{5\pi}{4} = -\frac{\sqrt{2}}{2}$ ,  $\cos \frac{5\pi}{4} = -\frac{\sqrt{2}}{2}$ . Sum:  $-\frac{\sqrt{2}}{2} - \frac{\sqrt{2}}{2} = -\sqrt{2}$ . That gives a quick check on the answer.

**23.** Reduce using tangent's  $180^\circ$  period:  $765 = 4(180) + 45$ , so  $\tan 765^\circ = \tan 45^\circ = 1$ . (Cross-check with  $360^\circ$  period:  $765 - 2(360) = 45$ , and  $\tan 45^\circ = 1$  ✓.)

**24.** From  $\sin^2 \theta + \cos^2 \theta = 1$ :  $\cos^2 \theta = 1 - \frac{9}{25} = \frac{16}{25}$ , so  $\cos \theta = \pm \frac{4}{5}$ . Q4 has cosine positive, so  $\cos \theta = \frac{4}{5}$ . Then  $\tan \theta = \frac{\sin \theta}{\cos \theta} = \frac{-3/5}{4/5} = -\frac{3}{4}$ .



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