Function Values of Special Angles

Name: ______________ Date: ______________ Score: ______ / 29

Quick Review

Three reference triangles unlock every exact trig value you'll be asked for: the 30-60-90, the 45-45-90, and the quadrantal angles on the axes. Memorize the Q1 values below and the rest fall out by reference angle plus quadrant sign.

Quadrant I (memorize). $\sin 0 = 0$, $\cos 0 = 1$; $\sin 30^\circ = \frac{1}{2}$, $\cos 30^\circ = \frac{\sqrt{3}}{2}$; $\sin 45^\circ = \cos 45^\circ = \frac{\sqrt{2}}{2}$; $\sin 60^\circ = \frac{\sqrt{3}}{2}$, $\cos 60^\circ = \frac{1}{2}$; $\sin 90^\circ = 1$, $\cos 90^\circ = 0$.

Signs by quadrant (ASTC). Use the mnemonic "All Students Take Calculus": in Q1 *All* ratios are positive; in Q2 only *Sine* (and its reciprocal csc); in Q3 only *Tangent* (and cot); in Q4 only *Cosine* (and sec).

The procedure. 1) Reduce θ into $[0, 360^\circ)$ if needed. 2) Find the reference angle. 3) Look up the Q1 value for the reference angle. 4) Apply the quadrant sign.

For example, $\cos 210^\circ$: Q3, reference 30°. $\cos 30^\circ = \frac{\sqrt{3}}{2}$. Cosine is negative in Q3, so $\cos 210^\circ = -\frac{\sqrt{3}}{2}$.

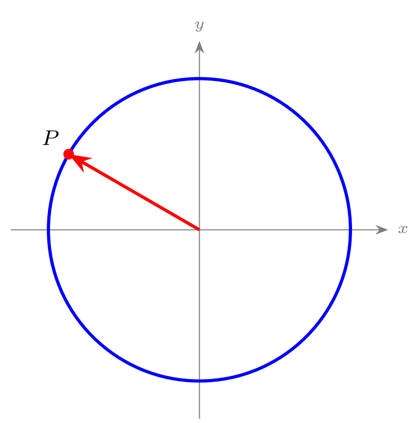
Terminal-point formulas. If θ in standard position has terminal side through (x, y) (not the origin), let $r = \sqrt{x^2 + y^2}$. Then $\sin\theta = \frac{y}{r}$, $\cos\theta = \frac{x}{r}$, $\tan\theta = \frac{y}{x}$. Sign comes automatically from the signs of x and y.

Common slips. Misplacing the sign on a Q3 angle (remember: only tangent is positive there). Mixing up $\sin 60^\circ = \frac{\sqrt{3}}{2}$ and $\sin 30^\circ = \frac{1}{2}$ – the bigger angle has the bigger sine. Forgetting that $\tan 90^\circ$ is *undefined* (cosine is zero).

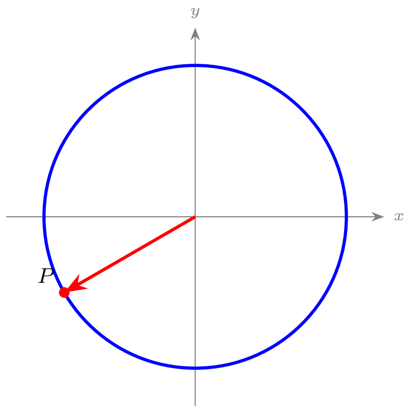
PRACTICE

Give exact values using reference angles and quadrant signs. No decimal approximations.

1. $\sin 30^\circ$. ________
2. $\cos 60^\circ$. ________
3. $\tan 45^\circ$. ________
4. Evaluate $\sin\theta$ for the angle $\theta = 150^\circ$ drawn below. ________



5. Evaluate $\cos\theta$ for the angle $\theta = 210°$ drawn below. ________



6. $\tan 300°$. ________

7. $\sin 0°$. ________

8. $\cos 0°$. ________

9. $\sin 90°$. ________

10. $\cos 90°$. ________

11. $\sin 180°$. ________

12. $\cos 180°$. ________

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

14. $\sin\left(\frac{2\pi}{3}\right)$. ________

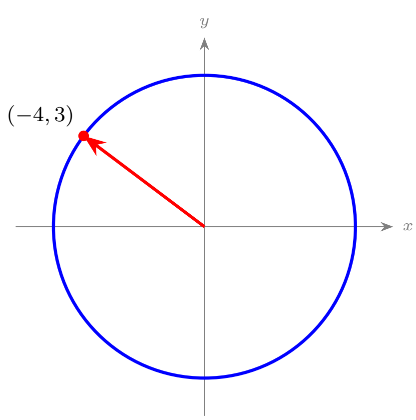
15. $\tan\left(\frac{5\pi}{4}\right)$. ________

16. $\cos 135°$. ________

17. $\sin 270°$. ________

18. $\tan 180°$. ________

19. The angle θ drawn below has terminal side through $(-4, 3)$. Find $\sin\theta$. ________



20. An angle θ has terminal side through $(-4, 3)$. Find $\cos\theta$. ________

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Word Problems

21. A ladder leans against a wall at exactly 60° with the ground. Express the height it reaches as a multiple of the ladder length L, using exact values. ____
22. Find the exact value of $\sin 240^\circ + \cos 240^\circ$. ____
23. A point in standard position has terminal side through $(-5, -12)$. Find $\sin\theta$ and $\cos\theta$ exactly. ____
24. On a unit circle, find the exact coordinates of the point at angle $\frac{7\pi}{6}$. ____

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

1. $\boxed{\frac{1}{2}}$
2. $\boxed{\frac{1}{2}}$
3. $\boxed{1}$
4. $\boxed{\frac{1}{2}}$
5. $\boxed{-\frac{\sqrt{3}}{2}}$
6. $\boxed{-\sqrt{3}}$
7. $\boxed{0}$
8. $\boxed{1}$
9. $\boxed{1}$
10. $\boxed{0}$
11. $\boxed{0}$
12. $\boxed{-1}$
13. $\boxed{-\frac{\sqrt{3}}{2}}$
14. $\boxed{\frac{\sqrt{3}}{2}}$
15. $\boxed{1}$
16. $\boxed{-\frac{\sqrt{2}}{2}}$
17. $\boxed{-1}$
18. $\boxed{0}$
19. $\boxed{\frac{3}{5}}$
20. $\boxed{-\frac{4}{5}}$
21. $\boxed{\frac{\sqrt{3}}{2}L}$
22. $\boxed{-\frac{\sqrt{3}+1}{2}}$
23. $\boxed{\sin\theta = -\frac{12}{13},\ \cos\theta = -\frac{5}{13}}$
24. $\boxed{\left(-\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)}$

Additional Practice Answers

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

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

Step-by-Step Explanations

1. Special-angle staple. (In the 30-60-90 triangle, the short leg is half the hypotenuse.)
2. Keep the rule visible: Another 30-60-90 value. ($\sin 30^\circ = \cos 60^\circ$ by cofunction.) This is the part to check before moving on, because it keeps the answer tied to the original question.
3. One steady path is: $\sin 45^\circ = \cos 45^\circ = \frac{\sqrt{2}}{2}$, so the quotient is 1. 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: Q2, reference 30°, sine is positive in Q2. So $\sin 150^\circ = \sin 30^\circ = \frac{1}{2}$. That gives a quick check on the answer.
5. A careful way to see it: Q3, reference 30°, cosine is negative in Q3. So $\cos 210^\circ = -\cos 30^\circ = -\frac{\sqrt{3}}{2}$. That gives a quick check on the answer.
6. Q4, reference 60°, tangent is negative in Q4 (cosine is positive but sine is negative). $\tan 60^\circ = \sqrt{3}$, so $\tan 300^\circ = -\sqrt{3}$.
7. One steady path is: At 0°, the unit-circle point is $(1,0)$ – y-coordinate is sine, so 0. That gives a quick check on the answer.
8. Start with the key idea: Unit-circle point $(1,0)$ – x-coordinate is cosine. This is the part to check before moving on, because it keeps the answer tied to the original question.
9. At 90° the terminal side hits the top of the unit circle, point $(0,1)$. Sine is the y-coordinate, so $\sin 90^\circ = 1$ (the largest sine can ever be).
10. Keep the rule visible: Same point $(0,1)$ at 90°; cosine is the x-coordinate, which is 0. That gives a quick check on the answer.
11. One steady path is: At 180° the point is $(-1,0)$. Sine is the y-coordinate, so $\sin 180^\circ = 0$. That gives a quick check on the answer.
12. Start with the key idea: At the same point $(-1,0)$, cosine is the x-coordinate: $\cos 180^\circ = -1$. That gives a quick check on the answer.
13. A careful way to see it: $\frac{5\pi}{6} = 150^\circ$. Q2, reference 30°, cosine negative. $\cos\frac{5\pi}{6} = -\frac{\sqrt{3}}{2}$. That gives a quick check on the answer.
14. Keep the rule visible: $\frac{2\pi}{3} = 120^\circ$. Q2, reference 60°, sine positive. $\sin 60^\circ = \frac{\sqrt{3}}{2}$. That gives a quick check on the answer.
15. One steady path is: $\frac{5\pi}{4} = 225^\circ$. Q3, reference 45°, tangent positive. $\tan 45^\circ = 1$. That gives a quick check on the answer.
16. Start with the key idea: Q2, reference 45°, cosine negative. $-\cos 45^\circ = -\frac{\sqrt{2}}{2}$. This is the part to check before moving on, because it keeps the answer tied to the original question.
17. A careful way to see it: Unit-circle point $(0,-1)$ – bottom of the circle. This is the part to check before moving on, because it keeps the answer tied to the original question.
18. Keep the rule visible: $\sin 180^\circ = 0$ and $\cos 180^\circ = -1 \neq 0$, so the quotient is $\frac{0}{-1} = 0$. This is the part to check before moving on, because it keeps the answer tied to the original question.
19. For a terminal point (x,y), first find $r = \sqrt{x^2+y^2} = \sqrt{(-4)^2+3^2} = \sqrt{25} = 5$. Then $\sin\theta = \frac{y}{r} = \frac{3}{5}$. It comes out positive because $y > 0$ – the point sits in Q2, where sine is positive.
20. Start with the key idea: $\cos\theta = \frac{x}{r} = \frac{-4}{5} = -\frac{4}{5}$. (Negative because $x < 0$ in Q2.) This is the part to check before moving on, because it keeps the answer tied to the original question.
21. The wall-height is opposite the 60° angle and the ladder is the hypotenuse: $\sin 60^\circ = \frac{h}{L}$. Since $\sin 60^\circ = \frac{\sqrt{3}}{2}$, the height is $h = \frac{\sqrt{3}}{2}L$. (For a 10-foot ladder, that's $5\sqrt{3} \approx 8.66$ feet.)
22. Keep the rule visible: 240° is in Q3 with reference 60°. Both sine and cosine are negative in Q3. So $\sin 240^\circ = -\frac{\sqrt{3}}{2}$ and $\cos 240^\circ = -\frac{1}{2}$. Sum:

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$-\frac{\sqrt{3}}{2} - \frac{1}{2} = -\frac{\sqrt{3}+1}{2}$. That gives a quick check on the answer.

23. One steady path is: $r = \sqrt{25+144} = 13$. So $\sin\theta = \frac{y}{r} = -\frac{12}{13}$ and $\cos\theta = \frac{x}{r} = -\frac{5}{13}$. Both negative – consistent with Q3 (both x and y negative).

That gives a quick check on the answer.

24. Start with the key idea: $\frac{7\pi}{6} = 210°$. Q3, reference $30°$. Q3 has both $x < 0$ and $y < 0$. $\cos 210° = -\frac{\sqrt{3}}{2}$, $\sin 210° = -\frac{1}{2}$. Unit-circle coordinates are $(\cos\theta, \sin\theta)$. That gives a quick check on the answer.

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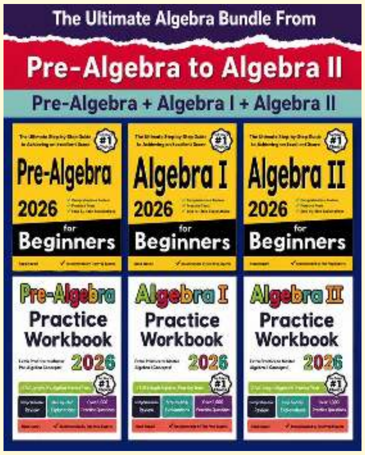

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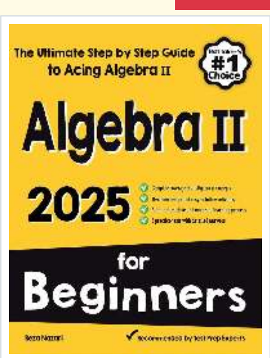

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