Graphing the Sine Function

Name: _____	Date: _____	Score: _____ / 35

Quick Review

The sine function is the y-coordinate of a point sliding around the unit circle as the angle grows. Plot $y = \sin x$ on a long x-axis and you get a smooth wave that rises and falls forever.

The five anchor points of one cycle. Start at $(0, 0)$, climb to the top at $\left(\frac{\pi}{2}, 1\right)$, drop back to zero at $(\pi, 0)$, dip to the bottom at $\left(\frac{3\pi}{2}, -1\right)$, and come home to $(2\pi, 0)$. Memorize those five points; the whole wave is just that shape copied left and right forever.

Key facts you can read straight off the graph.

Domain: all real numbers.

Range: $[-1, 1]$.

Period: 2π (one full wave).

Amplitude: 1 (half the height from trough to crest).

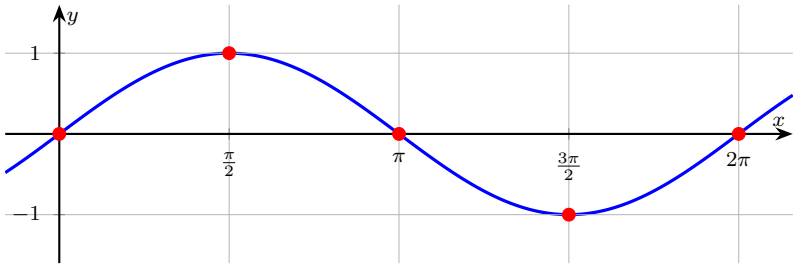
Zeros: $x = n\pi$ for any integer n.

Symmetry: about the origin – sine is odd, $\sin(-x) = -\sin x$.

Quick transformation read. In $y = a\sin(bx)$ the amplitude is $|a|$ and the period is $\frac{2\pi}{|b|}$. A negative a flips the wave upside down – it starts by going down instead of up.

Common slips. Saying the period is π (that's tangent). Calling the amplitude -2 for $y = -2\sin x$ (amplitude is always positive – it's 2). Marking x-intercepts only at $x = 0$ and $x = 2\pi$ and forgetting $x = \pi$ in the middle of the cycle.

Here's the parent sine wave, one full cycle from 0 to 2π on the standard radian axis:



PRACTICE

Read amplitude, period, and key features from each sine graph. Sketch when asked.

1. State the amplitude and period of $y = \sin x$. _____
2. State the amplitude and period of $y = 3\sin(2x)$. _____
3. At which values of x does $\sin x = 0$? _____
4. Where does $\sin x$ reach its maximum value on $[0, 2\pi]$? _____
5. Evaluate $\sin\left(\frac{3\pi}{2}\right)$. _____
6. What is the range of $y = \sin x$? _____
7. State the domain of $y = \sin x$. _____
8. How does the graph of $y = -\sin x$ compare to $y = \sin x$? _____
9. What are the x-intercepts of $y = \sin x$ on $[0, 2\pi]$? _____
10. A sine curve has amplitude 5 and period 4π with no shift. Write its equation. _____

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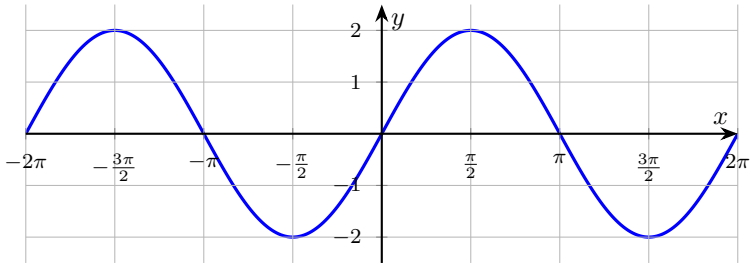
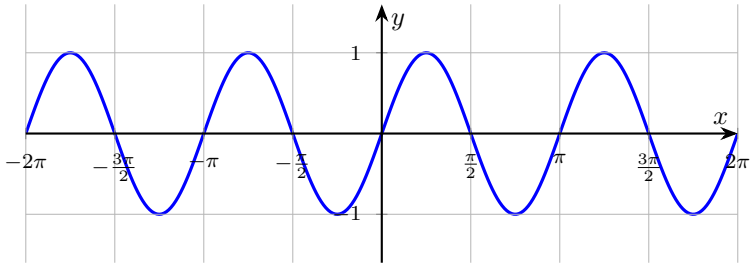
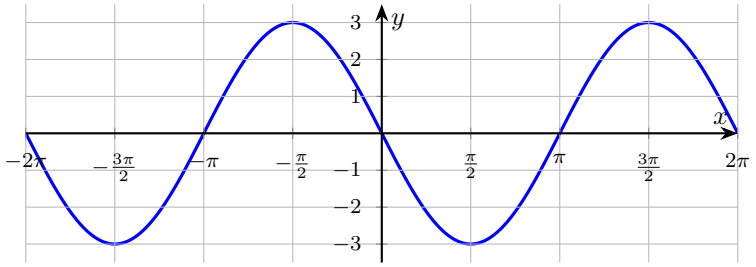
11. Identify the amplitude and period from the graph below.



12. Identify the period from the graph below.



13. Identify amplitude and period from the graph below.



14. $y = \sin x$ is symmetric about which feature?

15. State the amplitude and period of $y = -4\sin\left(\frac{x}{3}\right)$.

16. At what x does $\sin x$ reach its minimum on $[0, 2\pi]$?

17. How many complete cycles of $y = \sin x$ are visible on $[0, 4\pi]$?

18. Evaluate $\sin(2\pi)$.

19. For $y = \sin x$, evaluate $\sin\left(-\frac{\pi}{2}\right)$.

20. Write the equation of a sine function with amplitude 3 and period π, no shifts.

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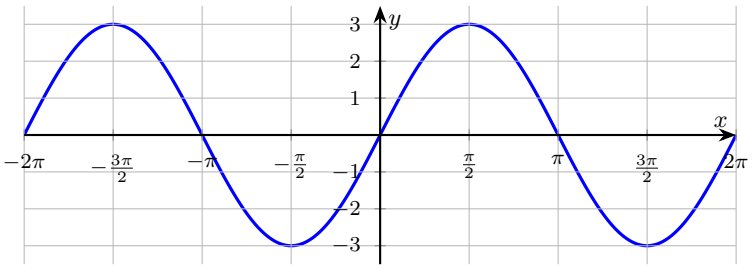
Word Problems

21. A Ferris wheel is built with center 30 feet above the ground and radius 25 feet. A rider's height in feet, as a function of the angle θ (radians, measured from horizontal at the platform), is $h(\theta) = 25\sin\theta + 30$. State the amplitude, period, and the rider's maximum height. ____

22. A buoy bobs vertically in the ocean according to $y(t) = 2\sin t$ meters, where t is time in seconds. How high does the buoy rise above its rest position, and how long does each full bob (up-and-down cycle) take? ____

23. The graph below shows a sine model of a sound wave. Read the amplitude and period from the graph. Then write the equation of the wave. _____



24. An AC voltage signal follows $V(t) = 120\sin(t)$, where V is in volts and t is in radians. Find the peak voltage, and find the first time $t > 0$ at which the voltage hits its minimum. ____

Additional Practice

25. Amplitude of $y = 4\sin x$. _____

26. Period of $y = \sin(2x)$. _____

27. Amplitude of $y = -3\cos x$. _____

28. Period of $y = \tan(5x)$. _____

29. Midline of $y = 2\sin x - 7$. _____

30. Phase shift of $y = \sin(x - \pi/3)$. _____

31. Range of $y = 5\cos x$. _____

32. Range of $y = 2\sin x + 1$. _____

33. Asymptotes of $y = \tan x$ in one period. _____

34. Domain of $y = \sec x$ excludes what? _____

35. Range of $y = \csc x$. _____

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Answer Keys

1. amplitude 1, period 2π
2. amplitude 3, period π
3. $x = n\pi,\ n \in \mathbb{Z}$
4. $x = \dfrac{\pi}{2}$
5. -1
6. $[-1,\ 1]$
7. $\mathbb{R}$
8. reflected across the x-axis
9. $x = 0,\ \pi,\ 2\pi$
10. $y = 5\sin\left(\dfrac{x}{2}\right)$
11. amplitude 2, period 2π
12. π
13. amplitude 3, period 2π
14. the origin
15. amplitude 4, period 6π
16. $x = \dfrac{3\pi}{2}$
17. 2
18. 0
19. -1
20. $y = 3\sin(2x)$
21. amplitude 25, period 2π, $\max = 55$ ft
22. 2 m; 2π s
23. amplitude 3, period 2π, $y = 3\sin x$
24. peak 120 V; $t = \dfrac{3\pi}{2}$

Additional Practice Answers

25. 4
26. π
27. 3
28. $\frac{\pi}{5}$
29. $y = -7$
30. $\frac{\pi}{3}$ right
31. $[-5, 5]$
32. $[-1, 3]$
33. $x = \pm\frac{\pi}{2}$
34. $\cos x = 0$
35. $(-\infty, -1] \cup [1, \infty)$

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

Step-by-Step Explanations

1. The parent sine wave swings 1 unit above and below the midline (amplitude 1) and completes one full cycle every 2π.
2. Match $y = a\sin(bx)$: here $a = 3$ and $b = 2$. Amplitude is $|a| = 3$, so the wave swings 3 units above and below the midline. Period is $\dfrac{2\pi}{|b|} = \dfrac{2\pi}{2} = \pi$ – divide 2π by b, never by a – so the wave finishes a full cycle twice as fast.
3. Sine is the y-coordinate on the unit circle; that y-value is zero on the x-axis – at every integer multiple of π.
4. The maximum is 1, reached at the top of the unit circle – $x = \dfrac{\pi}{2}$. The whole pattern repeats every 2π, so in general $x = \dfrac{\pi}{2} + 2n\pi$.
5. A careful way to see it: $\dfrac{3\pi}{2}$ lands at the bottom of the unit circle, point $(0, -1)$, so the y-coordinate is -1. That gives a quick check on the answer.
6. Sine outputs the y-coordinate of a unit-circle point, which is trapped between -1 and 1 inclusive.
7. One steady path is: Every real angle has a sine – no restrictions, no holes. That gives a quick check on the answer.
8. The negative sign flips outputs to the opposite sign, which is a reflection across the x-axis. The new wave starts at $(0, 0)$ and goes *down* first.
9. Sine is zero exactly on the x-axis – at 0, halfway around at π, and back at 2π.
10. Amplitude 5 means $a = 5$. For the period, set $\dfrac{2\pi}{b} = 4\pi$ and solve: $b = \dfrac{2\pi}{4\pi} = \dfrac{1}{2}$. With no shift, $c = d = 0$, so $y = 5\sin\left(\dfrac{x}{2}\right)$. A smaller b stretches the wave wider, which fits a longer period.
11. The curve maxes at 2 and mins at -2, giving amplitude 2. One full cycle runs from 0 to 2π, so the period is 2π. Equation: $y = 2\sin x$.
12. The wave squeezes – it finishes a full cycle from 0 to π, then repeats. Period $= \pi$, so the equation is $y = \sin(2x)$.
13. Crests at 3 and troughs at -3 give amplitude 3. The wave starts heading down from the midline at $x = 0$, so the equation is $y = -3\sin x$ – but amplitude is $|a| = 3$. Period is 2π (one cycle).
14. Sine is odd: $\sin(-x) = -\sin x$. Geometrically that means $180°$ rotational symmetry about the origin.
15. Read off $a = -4$ and $b = \dfrac{1}{3}$. Amplitude is the absolute value, $|-4| = 4$ – the negative sign only flips the wave upside down, it never makes the amplitude negative. Period is $\dfrac{2\pi}{|b|} = \dfrac{2\pi}{1/3} = 6\pi$.
16. Start with the key idea: The minimum is -1, hit at the bottom of the unit circle: $x = \dfrac{3\pi}{2}$. That gives a quick check on the answer.
17. One cycle takes 2π. The interval $[0, 4\pi]$ has length 4π, which holds exactly 2 cycles.
18. After one full lap around the unit circle you're back at $(1, 0)$. The y-coordinate is 0.
19. Use the odd-function rule: $\sin\left(-\dfrac{\pi}{2}\right) = -\sin\left(\dfrac{\pi}{2}\right) = -1$. Or read it from the unit circle – $-\dfrac{\pi}{2}$ lands at $(0, -1)$.
20. Amplitude 3 means $a = 3$. For the period, set $\dfrac{2\pi}{b} = \pi$ and solve: $b = \dfrac{2\pi}{\pi} = 2$. No shifts means $c = d = 0$, so $y = 3\sin(2x)$.
21. Match against $y = a\sin(b\theta) + d$: $a = 25$ (amplitude), $b = 1$ (period 2π), $d = 30$ (midline). The maximum is one amplitude above the midline: $30 + 25 = 55$ ft. (Sanity check: the top of a 25-ft radius wheel whose center is 30 ft up is 55 ft up. ✓)
22. The amplitude is 2, so the buoy rises 2 m above (and dips 2 m below) its rest position. The period is $\dfrac{2\pi}{1} = 2\pi$ seconds, so one full bob lasts about 6.28 s.
23. The crests reach 3 and the troughs reach -3, so the amplitude is 3. One full cycle takes 2π horizontally, so the period is 2π and the equation is $y = 3\sin x$ (no horizontal compression or shift).
24. The amplitude is 120, so the peak voltage is $+120$ V (and the minimum is -120 V). The minimum of $\sin t$ first happens at $t = \dfrac{3\pi}{2}$, which is the first time after $t = 0$ where $V(t) = -120$.

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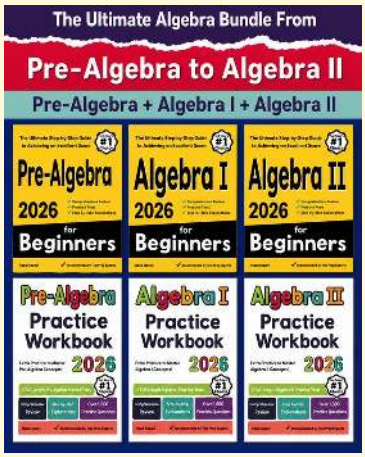

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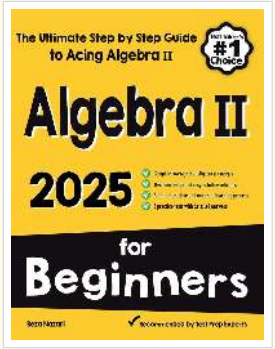

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