

Periodic Pattern Builders

Build sine and cosine models from key features.

HIGH SCHOOL • HSF-TF.B.5

CCSS.Math.Content.HSF-TF.B.5 "Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. *"

NAME _____

DATE _____

MODEL THE CYCLE

Use $y = A \sin(2\pi f x) + D$ or $y = A \cos(2\pi f x) + D$. The amplitude is $|A|$, D is the midline, and f is the frequency in cycles per unit. If a situation gives a starting position or direction, choose sine or cosine and a sign that fit it.

WORKED EXAMPLE

Write a sine model with amplitude 17, frequency $7/13$ cycle per second, and midline $y = -11$.

1. Start with $y = A \sin(2\pi f x) + D$.
2. Substitute $A = 17$, $f = 7/13$, and $D = -11$.
3. Simplify: $y = 17\sin(14\pi x/13) - 11$.

Answer: $y = 17\sin(14\pi x/13) - 11$

PRACTICE 6 problems

- 1** Write a sine model with amplitude 4, frequency $1/5$ cycle per unit, and midline $y = 3$.

ANSWER _____

- 2** Write a cosine model with amplitude 6, frequency 2 cycles per unit, and midline $y = -1$.

ANSWER _____

- 3** Write a sine model with amplitude $1/2$, frequency $3/4$ cycle per unit, and midline $y = 8$.

ANSWER _____

- 4** For $y = -5\cos(\pi x/2) + 9$, state the amplitude, frequency, and midline.

ANSWER _____

- 5** Write a cosine model with amplitude 3, frequency 3 cycles per unit, and midline $y = -9$. The graph begins at a maximum when $x = 0$.

ANSWER _____

- 6** For $y = -2\sin(5\pi x/3) + 4$, state the amplitude, frequency, and midline.

ANSWER _____

APPLY IT Show your work

- 1** A music app shows a visualizer bar whose vertical position, p , is measured in pixels. The bar moves 18 pixels above and below its midline of 40 pixels, completes one cycle every 8 seconds, and is at the midline moving upward when $t = 0$. Write a model for p in terms of t .

WORK SPACE

ANSWER _____

- 2** A Ferris wheel car has a height, h , in meters. Its midline height is 22 meters, its amplitude is 12 meters, and it completes one rotation every 16 seconds. At $t = 0$, the car is at its highest point. Write a model for h in terms of t .

WORK SPACE

ANSWER _____

CHALLENGE One step up

CHALLENGE

A game character's height repeats in a cycle. Its greatest height is 35 units, its least height is 15 units, and it completes 3 cycles every 4 seconds. At $t = 0$, it is at its midline and moving upward. Write a sine model and explain how you found its amplitude, midline, and frequency.

PART 1 • PRACTICE

#	PROBLEM	ANSWER
1	Write a sine model with amplitude 4, frequency $1/5$ cycle per unit, and midline $y = 3$.	$y = 4\sin(2\pi x/5) + 3$
2	Write a cosine model with amplitude 6, frequency 2 cycles per unit, and midline $y = -1$.	$y = 6\cos(4\pi x) - 1$
3	Write a sine model with amplitude $1/2$, frequency $3/4$ cycle per unit, and midline $y = 8$.	$y = (1/2)\sin(3\pi x/2) + 8$
4	For $y = -5\cos(\pi x/2) + 9$, state the amplitude, frequency, and midline.	Amplitude: 5; frequency: $1/4$ cycle per unit; midline: $y = 9$
5	Write a cosine model with amplitude 3, frequency 3 cycles per unit, and midline $y = -9$. The graph begins at a maximum when $x = 0$.	$y = 3\cos(6\pi x) - 9$
6	For $y = -2\sin(5\pi x/3) + 4$, state the amplitude, frequency, and midline.	Amplitude: 2; frequency: $5/6$ cycle per unit; midline: $y = 4$

PART 2 • APPLY IT

- $p = 18\sin(\pi t/4) + 40$** The amplitude is 18, the midline is 40, and a period of 8 seconds gives frequency $1/8$. Starting at the midline and moving upward matches a positive sine model.
- $h = 12\cos(\pi t/8) + 22$** The frequency is $1/16$ because one cycle takes 16 seconds. A positive cosine model starts at a maximum, so $h = 12\cos(2\pi(1/16)t) + 22$.

CHALLENGE

$h = 10\sin(3\pi t/2) + 25$. The amplitude is $(35 - 15)/2 = 10$, the midline is $(35 + 15)/2 = 25$, and the frequency is $3/4$ cycle per second.

Accept equivalent forms that leave the frequency factor unexpanded, such as $4\sin(2\pi(1/5)x) + 3$. For model-writing items, accept equivalent sine or cosine forms with a phase shift when they satisfy all stated conditions.