LESSON MAKER PRO

Wave Equation Builder

Build sine and cosine models from periodic features.

HIGH SCHOOL · AII-F.TF.5

AII-F.TF.5 "Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, horizontal shift, and midline."

NAME _____ DATE _____

BUILD THE MODEL

Use $y = A \sin(2\pi f(x - h)) + k$ or $y = A \cos(2\pi f(x - h)) + k$. The amplitude is $|A|$, f is the frequency in cycles per unit, h is the horizontal shift, and k is the midline. Choose sine when a midline crossing is useful, or cosine when a maximum or minimum is useful.

WORKED EXAMPLE

Write a sine model with amplitude 11, frequency 1/9 cycle per unit, a shift right 2 units, and midline $y = -4$.

1. Start with $y = A \sin(2\pi f(x - h)) + k$.
2. Use $A = 11$, $f = 1/9$, $h = 2$, and $k = -4$.
3. Compute $2\pi f$: $2\pi(1/9) = 2\pi/9$.
4. Substitute the values into the model.

Answer: $y = 11 \sin((2\pi/9)(x - 2)) - 4$

PRACTICE 6 problems

1 Write a sine model with amplitude 3, frequency 1/5 cycle per unit, a shift right 1 unit, and midline $y = 7$.

ANSWER _____

2 Write a cosine model with amplitude 14, frequency 1/6 cycle per unit, a shift left 3 units, and midline $y = -1$.

ANSWER _____

3 For $y = -8 \sin(10\pi(x - 4)) + 7$, state the amplitude, frequency, horizontal shift, and midline.

ANSWER _____

4 A cosine model has a minimum of -3, a maximum of 13, a period of 12 units, and a maximum at $x = 6$. Write the model.

ANSWER _____

5 Write a sine model with amplitude 15, period 14 units, midline y = -5, and a midline crossing that rises at x = 3.

ANSWER _____

6 Choose the model with amplitude 13, frequency 1/4 cycle per unit, a shift left 5 units, and midline y = 6. A. y = 13 cos((π/2)(x + 5)) + 6 B. y = 13 cos((π/4)(x + 5)) + 6 C. y = 13 cos((π/2)(x - 5)) + 6 D. y = 6 cos((π/2)(x + 5)) + 13

ANSWER _____

APPLY IT Show your work

1 A video game's screen glow has a brightness that ranges from 44 to 80 units. It repeats every 8 seconds and is brightest when x = 0. Write a cosine model B(x) for the brightness.

WORK SPACE

ANSWER _____

2 In an audio-editing app, a sound signal ranges from -5 volts to 5 volts and repeats 2 times each second. The signal is at a maximum when x = 1/8 second. Write a cosine model S(x) for the signal.

WORK SPACE

ANSWER _____

CHALLENGE One step up

A motion sensor's reading has a minimum of -3, a maximum of 13, and a period of 6 seconds. At x = 1 second, it crosses its midline while decreasing. Write a sine model M(x). Explain how your coefficient and phase shift make that crossing decrease.

WORK SPACE AND ANSWER

ANSWER KEY

Wave Equation Builder

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Write a sine model with amplitude 3, frequency 1/5 cycle per unit, a shift right 1 unit, and midline y = 7.	**y = 3 sin((2π/5)(x - 1)) + 7**
2	Write a cosine model with amplitude 14, frequency 1/6 cycle per unit, a shift left 3 units, and midline y = -1.	**y = 14 cos((π/3)(x + 3)) - 1**
3	For y = -8 sin(10π(x - 4)) + 7, state the amplitude, frequency, horizontal shift, and midline.	**amplitude = 8; frequency = 5 cycles per unit; shift right 4 units; midline y = 7**
4	A cosine model has a minimum of -3, a maximum of 13, a period of 12 units, and a maximum at x = 6. Write the model.	**y = 8 cos((π/6)(x - 6)) + 5**
5	Write a sine model with amplitude 15, period 14 units, midline y = -5, and a midline crossing that rises at x = 3.	**y = 15 sin((π/7)(x - 3)) - 5**
6	Choose the model with amplitude 13, frequency 1/4 cycle per unit, a shift left 5 units, and midline y = 6. A. y = 13 cos((π/2)(x + 5)) + 6 B. y = 13 cos((π/4)(x + 5)) + 6 C. y = 13 cos((π/2)(x - 5)) + 6 D. y = 6 cos((π/2)(x + 5)) + 13	**A. y = 13 cos((π/2)(x + 5)) + 6**

PART 2 · APPLY IT

1. **B(x) = 18 cos((π/4)x) + 62** The amplitude is (80 - 44)/2 = 18 and the midline is (80 + 44)/2 = 62. A period of 8 gives a frequency of 1/8, so the coefficient is 2π(1/8) = π/4.
2. **S(x) = 5 cos(4π(x - 1/8))** The amplitude is 5 and the midline is 0. A frequency of 2 gives coefficient 2π(2) = 4π, and cosine reaches a maximum at its horizontal shift.

CHALLENGE

One model is M(x) = -8 sin((π/3)(x - 1)) + 5. Its amplitude is 8, midline is 5, and period is 6. At x=1 the sine input is 0; as x increases, sine initially rises, so multiplying by -8 makes the reading decrease. The equivalent model 8 sin((π/3)(x - 4)) + 5 has a positive coefficient: at x=1 its input is -π, where sine decreases. Either coefficient sign can work with a suitable phase shift.

Accept algebraically equivalent models, including sine or cosine models with an equivalent phase shift. Amplitude should be reported as a positive value, even when the sine or cosine coefficient is negative.