LESSON MAKER PRO

Wave Model Studio

Build equations for repeating patterns.

HIGH SCHOOL · MA.912.T.3.1

MA.912.T.3.1 "Given a mathematical or real-world context, choose sine, cosine or tangent trigonometric functions to model periodic phenomena with specified amplitude, frequency, horizontal shift and midline."

NAME _____ DATE _____

CHOOSE THE FUNCTION

For a bounded repeating quantity, use y=A sin(2pi f(x-h))+k or y=A cos(2pi f(x-h))+k, where A is the amplitude, f is cycles per unit, h is the horizontal shift, and k is the midline. Choose sine when a pattern crosses its midline at the shift, and choose cosine when it reaches a maximum or minimum at the shift. Use tangent for repeating branches with vertical asymptotes, because tangent has no maximum, minimum, or amplitude.

WORKED EXAMPLE

Write a sine model for a water pattern with amplitude 9, frequency 1/14 cycle per minute, midline 20, and an upward midline crossing at x=7.

1. Use sine because the pattern crosses its midline upward at x=7.
2. Substitute A=9, f=1/14, h=7, and k=20: y=9sin(2pi(1/14)(x-7))+20.
3. Simplify 2pi/14 to pi/7.

Answer: y=9sin((pi/7)(x-7))+20

PRACTICE 6 problems

1 Write a sine model with amplitude 3, frequency 1/6 cycle per unit, midline -2, and an upward midline crossing at x=1.

ANSWER _____

2 Write a cosine model with amplitude 5, frequency 1/2 cycle per unit, midline 1, and a maximum at x=4.

ANSWER _____

3 Write a model with amplitude 6, frequency 1/4 cycle per unit, midline 3, and a downward midline crossing at x=-2.

ANSWER _____

4 Write a cosine model with amplitude 2, frequency 1/3 cycle per unit, midline 13, and a maximum at x=0.

ANSWER _____

5 Write a model with amplitude 1, frequency 1/2 cycle per unit, midline -5, and a minimum at x=-4.

ANSWER _____

6 A repeating graph has vertical asymptotes. It crosses its midline of -1 while increasing at x=2, and its frequency is 1/6 cycle per unit. Write a tangent model.

ANSWER _____

APPLY IT Show your work

1 At a music festival, LED wristbands brighten and dim together. Their brightness has amplitude 30 units, midline 50 units, and frequency 1/10 cycle per second. A wristband is brightest at x=2 seconds. Write a model for brightness y.

WORK SPACE

ANSWER _____

2 A concert stage platform moves up and down during a performance. Its height has amplitude 3/2 meters, midline 4 meters, and frequency 1/12 cycle per second. At x=0, the platform is at its midline and starts moving upward. Write a model for height y.

WORK SPACE

ANSWER _____

CHALLENGE One step up

CHALLENGE

A ride platform has amplitude 8, midline 12, and frequency 1/16 cycle per second. At x=3, it crosses its midline while moving downward. Write one sine model and one cosine model for the platform. In one sentence, explain why both models work.

_____

_____

ANSWER KEY

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PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Write a sine model with amplitude 3, frequency 1/6 cycle per unit, midline -2, and an upward midline crossing at x=1.	**y=3sin((pi/3)(x-1))-2**
2	Write a cosine model with amplitude 5, frequency 1/2 cycle per unit, midline 1, and a maximum at x=4.	**y=5cos(pi(x-4))+1**
3	Write a model with amplitude 6, frequency 1/4 cycle per unit, midline 3, and a downward midline crossing at x=-2.	**y=-6sin((pi/2)(x+2))+3**
4	Write a cosine model with amplitude 2, frequency 1/3 cycle per unit, midline 13, and a maximum at x=0.	**y=2cos((2pi/3)x)+13**
5	Write a model with amplitude 1, frequency 1/2 cycle per unit, midline -5, and a minimum at x=-4.	**y=-cos(pi(x+4))-5**
6	A repeating graph has vertical asymptotes. It crosses its midline of -1 while increasing at x=2, and its frequency is 1/6 cycle per unit. Write a tangent model.	**y=tan((pi/6)(x-2))-1**

PART 2 · APPLY IT

1. **y=30cos((pi/5)(x-2))+50** Use cosine because the brightness is at a maximum at x=2. Since 2pi(1/10)=pi/5, substitute the amplitude, shift, and midline into the cosine model.
2. **y=(3/2)sin((pi/6)x)+4** Use sine because the platform crosses its midline upward at x=0. Since 2pi(1/12)=pi/6, use a positive sine coefficient.

CHALLENGE

Sine model: y=-8sin((pi/8)(x-3))+12. Cosine model: y=8cos((pi/8)(x+1))+12. They are equivalent because a cosine graph can be shifted one-fourth of a period to match the downward sine crossing.

Accept algebraically equivalent equations with equivalent phase shifts, including sine and cosine forms that describe the same graph. For tangent, accept equivalent shifts by whole periods of 6.