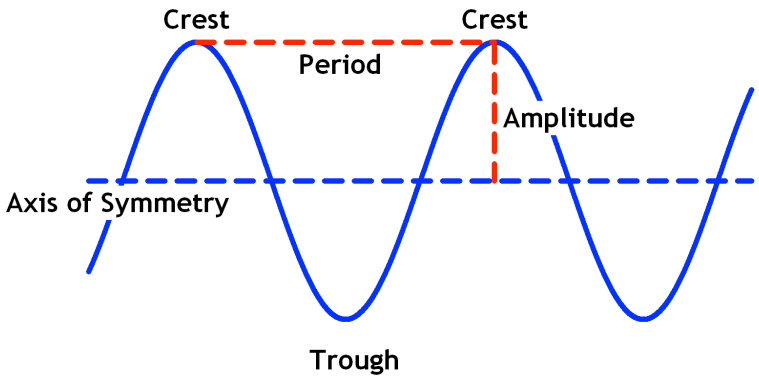
Using Functions in Models and Decision Making: Cyclical Functions

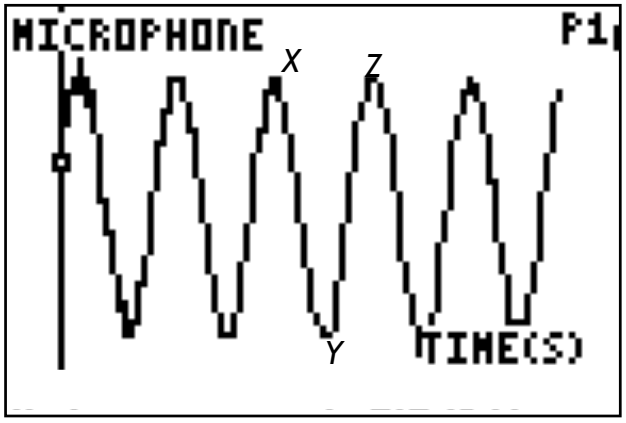
V.B Student Activity Sheet 7: Making Decisions from Cyclical Functions in Science and Economics

Recall from your science class that sound travels in waves. A wave has several important parts:



The *crest* is the maximum height of a wave, and the *trough* is the minimum height of a wave. The *period* is the distance between two consecutive crests or two consecutive troughs. The *axis of symmetry* is a horizontal line that runs exactly halfway between the crests and troughs. The *amplitude* is the distance between a crest or trough and the axis of symmetry.

Mr. Licefi's math class used a calculator-based laboratory (CBL) and a microphone to collect the following sound data. Notice that Points *X*, *Y*, and *Z* are labeled in the graph.



X (0.0054, 6.5)

Y (0.0065, 2.5)

Z (0.0076, 6.5)

1. If *X* and *Z* each represent a crest, what is the period of the sound wave? (Do not forget your units!)

2. The frequency of a sound wave can be found by taking the reciprocal of the period. What is the frequency of this sound wave? The unit for frequency is hertz.

3. If *B* represents a trough, what is the amplitude of the sound wave?

4. In a sound wave, the frequency represents the pitch of the sound, and the amplitude represents the volume. For the sound wave that Mr. Licefi's class measured, what is the pitch and volume?

5. What amplitude is required to produce a sound wave that is twice as loud?

6. What are the domain and range of the function that models the sound wave?

7. If the sound that Mr. Licefi's class measured lasted for 8 seconds and stayed the same pitch (from Question 4), what are the domain and range of the sound wave?

8. Compare the domain and range for the function that models the sound wave and the domain and range for the sound wave itself. Explain any similarities or differences.

Mrs. Kline's economics class was studying a data set that gives the price per pound of ground beef for the month of January from 1980 to 1996.

Year	Year Number	Cost (dollars)
1980	0	1.821
1981	1	1.856
1982	2	1.794
1983	3	1.756
1984	4	1.721
1985	5	1.711
1986	6	1.662
1987	7	1.694
1988	8	1.736

Year	Year Number	Cost (dollars)
1989	9	1.806
1990	10	1.907
1991	11	1.996
1992	12	1.926
1993	13	1.970
1994	14	1.892
1995	15	1.847
1996	16	1.799

Source: U.S. Bureau of Labor Statistics

9. Use your graphing calculator to make a scatterplot of cost by year number.

10. Does the data set appear to be cyclical? Explain your reasoning.

11. An economics textbook suggests that the function $y = 0.169\sin[0.52(x + 2.78)] + 1.82$ can be used to model the data approximately. Graph this function over your scatterplot to verify that suggestion. Describe the axes and scaling, and sketch your graph.

12. **EXTENSION:** Recall that sine functions can be represented using the general form $y = A\sin(B(x - C)) + D$, where

- A represents the amplitude,
- B represents the angular frequency,
- C represents a factor of a horizontal translation, and
- D represents the vertical translation.

For this function, determine the values of A, B, C, and D.

A =

B =

C =

D =

13. Find the length of one cycle by dividing 2π by the frequency (B).

14. How well does the suggested function model the data?

15. Use the regression equation to predict the cost per pound of ground beef in January 2009.

16. Use the Internet to determine the actual cost per pound of ground beef in January 2009.

17. How well did your model predict the cost of ground beef in January 2009? Why do you think the model performed this way?

18. REFLECTION: What can you say about using a cyclical model to predict values beyond a given data set?

OR

How well could ocean waves be modeled using a sinusoidal function?

19. EXTENSION: What other natural or business phenomena could be modeled using a cyclical model? How well do you think those models could predict future values?

OR

Using a CBL and a microphone probe, capture your own data from sound waves that you generate. Then compare these data to the data used in the lesson.