Unit 4: Day 13: Sinusoidal Swing

MCT 4C

Minds On: 10 Action: 55 Consolidate: 10 Total=75 min	**Learning Goal**: • Identify periodic and sinusoidal functions, including those that arise from real-world applications involving primary data. • Make connections between the change in a graph and a change in context.	**Materials** • BLM 4.13.1 • BLM 4.13.2 • CBR • Graphing calculator • "TICTOC" application • Pendulum • Stop watch

		Assessment Opportunities
Minds On…	**Small Groups → Brainstorm** Have students review concepts learned so far and work individually to write down what they know about sinusoidal functions. They will then share their thoughts with small groups and summarize the terms they came up with. **Whole Class → Discussion** Each group shares one response with the class that is different from those already presented and then posts one or more of the key words on the word wall (i.e. period, phase shift, periodic, amplitude, maximum, minimum, etc.) **Mathematical Process Focus:** Reflecting - Students will **reflect** upon their prior learning to clarify their understanding.	Circulate and assist students in remembering terms Literacy: Word Wall
Action!	**Small Groups → Investigation** Using BLM 4.13.1, students complete the investigation. **Learning Skills/Observation/Checklist** As students complete the investigation, assess their teamwork skills and initiative. **Mathematical Process Focus:** Connecting – Students will **connect** the graph of a sinusoidal function with primary data.	The "TICTOC" application needs to be installed on the calculator attached to the CBR. The "TICTOC" application can be downloaded from www.education.ti.com.
Consolidate Debrief	**Whole Class → Discussion** Discuss properties of the graphs developed from each of the changing scenarios. Encourage students to discuss "what's the same, what's different?" Students should be able to predict what properties of the sinusoidal graph would change given a change in context.	
Exploration Application	**Home Activity or Further Classroom Consolidation** Complete BLM 4.13.2. (data reference http://www.nsa.gov/teachers/hs/trig06.pdf)	

4.13.1 Pendulum

Introduction

In this experiment you will be examining the motion of a pendulum over time. You will swing a pendulum back and forth so that it is always in the line of sight of the CBR. The CBR will measure the pendulum's distance from the CBR over regular time intervals. A distance vs. time graph will be plotted.

You will be examining the effects of changing two variables independently:

1. the length of the pendulum
2. the initial displacement of the pendulum from resting position (vertical position)

Hypotheses:

1. The shorter the pendulum, the ______________ period.
2. The greater the displacement from rest, the ____________ amplitude.

Equipment Needed:

- CBR
- graphing calculator with a link cable and "TICTOC" program loaded
- pendulum - string, a large object to swing (e.g. pop can, or juice jug, a bucket), metre stick, retort stand
- clock with a second hand or stop watch
- observation tables

Performing the Experiment:

1. Connect the calculator to the CBR.

2. Make sure the program "TICTOC" has been loaded on the calculator.

3. Set up the pendulum (with the length indicated in table 1) and the CBR so that the motion detector is at the same level as the swinging object when at rest.

4. Position a metre stick along the table so that you can measure the distance from the motion detector to the pendulum.

5. Measure the distance between the pendulum and the CBR in cm. The distance must be at least 75 cm. Adjust your set-up as needed when changing the length of the pendulum.

6. Use the stopwatch to determine the time it takes to complete 5 cycles. Record this information in table 1 on the next page.

7. Run the program "TICTOC" and follow the instructions on your calculator.

8. Complete the Tables of Observations and Analyses Questions. Use the graphing calculator (sinusoidal regression) to determine an equation of best fit.

9. Repeat the experiment, this time keeping the pendulum length fixed at 50cm and varying the initial displacement. Record your observations in table 2.

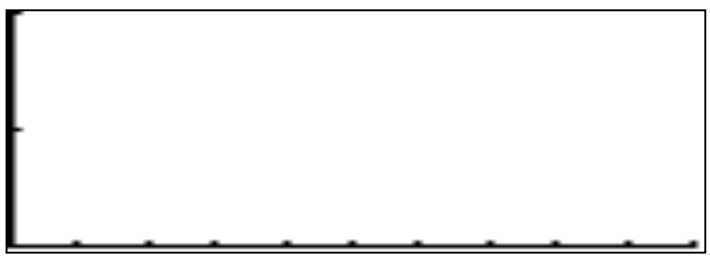
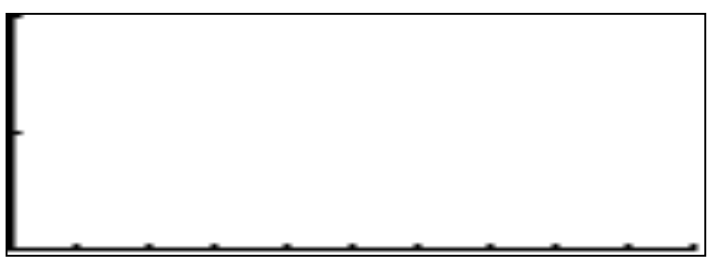
4.13.1 Pendulum (continued)

Tables of Observations

Table 1: The Effect of Changing the Length of the Pendulum

- Initial displacement is fixed at 40 cm.

Note: Label key values on your graphs by using the TRACE key to determine the value of the maximum y-value, minimum y-value, y–intercept and distance between consecutive y-max values.

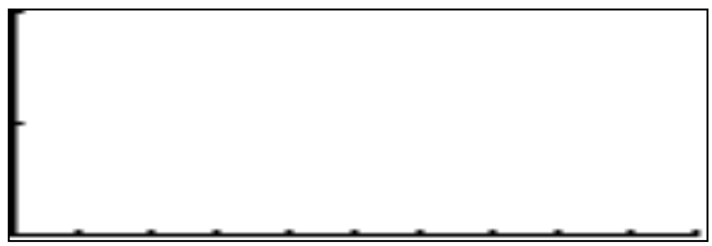
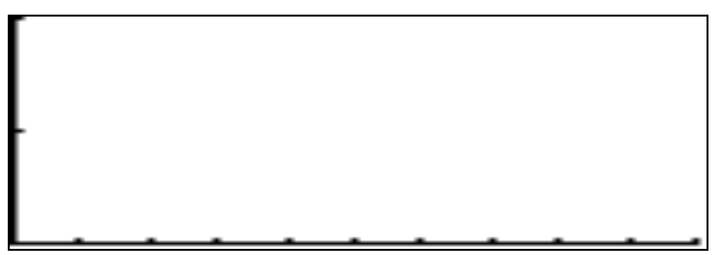
Pendulum Length (cm)	Time for 5 cycles (s)	Distance-Time Graphs
50		 y = ______________________________
40		 y = ______________________________
30		 y = ______________________________

4.13.1 Pendulum (continued)

Table 2: The Effect of Changing the Displacement of the Pendulum

- Pendulum length is fixed at 50 cm.

Note: Label key values on your graphs by using the TRACE key to determine the value of the maximum y-value, minimum y-value, y –intercept and distance between consecutive y-max values.

Displacement from Rest (cm)	Time for 5 cycles (s)	Distance-Time Graphs
50		 y = ______________________________
40		 y = ______________________________
30		 y = ______________________________

4.13.1 Pendulum (continued)

Analysis

Using mathematical terms, state what parameters of the distance-time graphs were affected by:

- changing the length of the pendulum, while keeping the displacement constant

- changing the displacement, while keeping the length of the pendulum constant

4.13.2 The Beat of My Heart

Sinusoidal functions can be used to represent repetitive behavior. EKGs (electrocardiograph) have been used in the medical field for the last three centuries to monitor heart activity. This instrument is able to detect the electrical changes when a person's heart beats.
The following two figures are actual data taken using a CBL and a graphing calculator. Both figures depict the heart activity for a 16-year-old male at rest. The horizontal axis measures time in seconds and on the vertical axis each peak represents a heart beat.

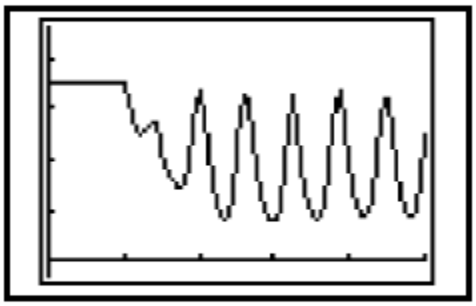


Figure 1

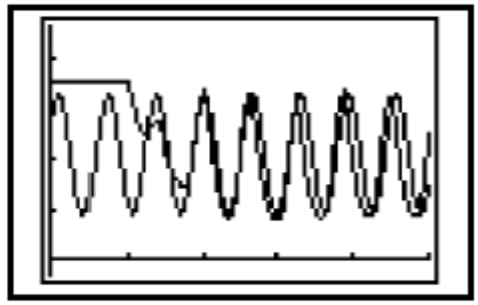


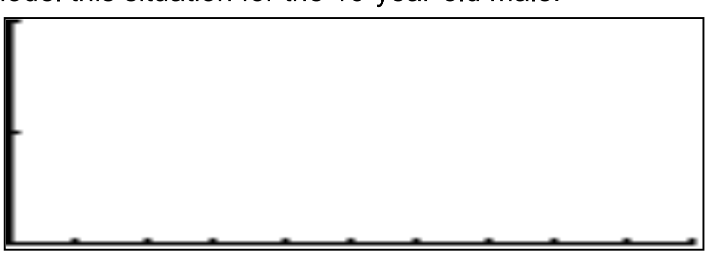
Figure 2

1. What factors would affect a person's heartbeat?

<u>Answer Questions 2 and 3 with reference to Figures 1 and 2</u>
(Note: Figure 2 has the graph from Figure 1 also plotted.)

2. Using mathematical terms, describe how the above graphs would change if the 16-year-old male ran quickly up ten flights of stairs?

3. Typically, while sleeping, a person's heart rate decreases. Sketch the curve that would model this situation for the 16-year-old male.



4. What changes in your heart rate might occur when additional adrenalin is introduced into the system? (i.e. fear,terror,…) How would this change the graph?