

Using Digital Probes to Collect Periodic Data

5.10



Digital probes are small machines that collect data directly from an experiment. The data collected can be sent directly to a computer or graphing calculator for analysis and decision making.

Experiment 1: A Graph of Sound

Your task is to find the frequency of two different tuning forks. You will examine the graph and the corresponding equation that models the vibration of the tuning fork.

Equipment

- a microphone/amplifier with CBL DIN adapter
- two different tuning forks
- a rubber tuning fork hammer

You will need the BEATS and SOUND programs for the Calculator-Based Laboratory (CBL).

Procedure: Setting Up and Operating the CBL Unit

Ensure that both the unit and the graphing calculator are turned off before beginning.

1. Connect the CBL to the graphing calculator using the unit-to-unit link cable and the INPUT/OUTPUT (I/O) port located on the bottom edge of each unit.
2. Connect the microphone to Channel 1 (CH1) on the top edge of the CBL unit.
3. Turn the CBL unit and the calculator ON.
4. Start the SOUND program.



5. Take one of the tuning forks and strike it with the rubber hammer. Place the vibrating fork close to, but not touching, the microphone.
6. Press **[ENTER]** to start collecting data.
7. The resulting plot should appear to be sinusoidal. If it is not, then press **[CLEAR]** **[ENTER]** and repeat steps 4 to 6 until you are satisfied with the graph.



Analyzing the Data

1. What variables are stored in L1 and L2?
2. Describe the type of graph.
3. (a) Determine the amplitude of the graph.
(b) Determine the period of the graph.
(c) Determine the equation of the axis of the graph.
4. Determine the equation that models the sound wave of the first tuning fork. Check the accuracy of your model using sinusoidal regression.
5. The frequency of a tuning fork can be determined using the relationship $f = \frac{1}{T}$, where f is the frequency in hertz (Hz) and T is the period of the sound wave. Calculate the frequency of the tuning fork. (One hertz is equal to one cycle per second.)
6. Repeat the experiment for the other tuning fork and answer questions 1 to 5 for that tuning fork.

Experiment 2: A Graph of the Motion of a Ping-Pong Paddle Along a Horizontal Axis

In this experiment, you will use the CBL, or the Calculator-Based Ranger (CBR), to record data associated with the movement of a Ping-Pong paddle as someone repeatedly moves the paddle toward and away from the motion detector. Use the HIKER program with the CBL and the RANGER program with the CBR to collect and graph the data.

Procedure: Setting Up and Operating the CBL Unit or the CBR Unit (CBL/CBR)

Ensure that both the unit and the graphing calculator are turned off before beginning.

1. Connect the CBL/CBR to the calculator using the unit-to unit connector cable. Connect the cable to the INPUT/OUTPUT(I/O) port on the bottom of the calculator.
2. Connect the motion detector to the SONIC port on the CBL. This port is on the left side of the unit. (This step is not required when using the CBR.)
3. Turn the CBL/CBR and the calculator ON.
4. Place the motion detector on the edge of a table or chair. Place the motion detector so that it can detect the motion of the Ping-Pong paddle as the paddle repeatedly moves toward and away from the detector.
5. If you are using the CBL, then start the HIKER program on the calculator. The program should pause and display a message, Press Enter To Start Graph. Press **ENTER** and move the Ping-Pong paddle back and forth, at the same speed, about 10 cm each way 10 to 15 times. The motion detector should make a clicking sound.



If using the CBR, start the RANGER program and press **ENTER**. Select 2: SET DEFAULTS. Press **ENTER** to choose START NOW. Then move the Ping-Pong paddle back and forth, at the same speed, about 10 cm each way 10 to 15 times.

Analyzing the Data

1. (a) Determine the amplitude of the graph.
(b) Determine the period of the graph.
(c) Determine the axis of the graph.
2. Write the equation that models the motion of the Ping-Pong paddle. Check the accuracy of your model using sinusoidal regression.
3. Repeat the experiment. Move the paddle more slowly and about 20 cm each way.
4. Compare these two graphs. How are the equations different? How are they the same?