Name _____ Date _____
Regents Physics Lab #28R
Period _____ Mrs. Nadworny

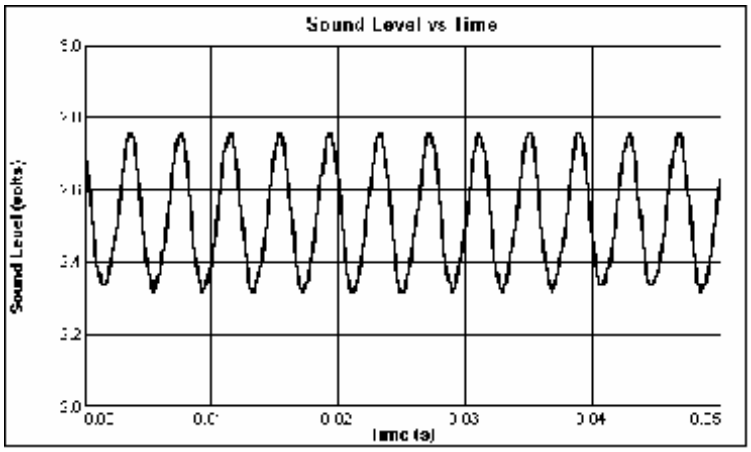
Partners: Due Date _____

Sound Waves

NO Lab Write-Up Required

Research Problem

- The sound produced by a tuning fork in air exists as variations in air pressure that spread out longitudinally in three dimensions from the tuning fork. In this way, energy is transported from the tuning fork to your ear which you perceive as a musical tone.
- In this lab, you will investigate the properties of these sound waves using a microphone attached to a calculator-based lab (CBL) system. The variations in air pressure received by the microphone's diaphragm are translated into variations in voltage in the CBL circuitry that are displayed graphically as a function of time, as shown below.



Materials

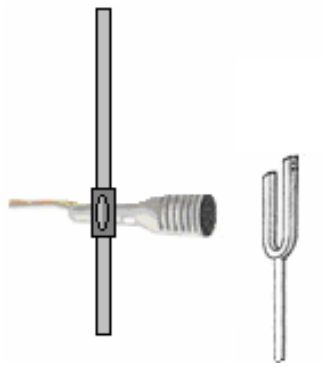
- Tuning forks (4)
- Mallet
- Microphone Probe
- Calculator with PHYSICS program
- Ring stand
- Clamp
- Power Cord

Part One – Learning to use the equipment

Procedure

1. Set up the ring stand and clamp the microphone to it so that the microphone is horizontal. The microphone should be close to the table.
2. Turn on the calculator. Change the calculator into **radian** mode.
3. Press APPS on the calculator. Start the PHYSICS program and proceed to the MAIN MENU.
4. Connect the microphone probe to the CH1 input on the CBL.
   - Firmly press in the cable ends.
   - Be sure the CBL is plugged into an outlet.
   - Check to make sure all cords are connected securely.

5. Set up the calculator and CBL for the microphone.



   - Select SET UP PROBES from the MAIN MENU.
   - Select ONE as the number of probes.
   - Select MICROPHONE from the SELECT PROBE menu.
   - Press ENTER to continue to the SELECT MICROPHONE menu.
   - Select CBL from the SELECT MICROPHONE menu.
   - Select WAVEFORM from the COLLECTION MODE menu.

6. Choose a tuning fork and strike it **gently** with the mallet or against a rubber stopper.
   - Hitting it with or on a hard surface may damage the tuning fork!

7. Hold it close to the microphone so that the tines of the tuning fork vibrate the air longitudinally toward the microphones diaphragm and then press ENTER. A transverse representation of the sound waveform will appear on the screen.

8. By using the arrow keys, you can trace the graph of the waveform. The (x, y) coordinates of the points on the waveform will be displayed at the bottom of the screen.
   - The x coordinate represents *time*
   - The y coordinate represents *voltage*, which is proportional to displacement of the microphone diaphragm caused by the longitudinal air pressure variations of the sounds wave.
   - Each time you do a test run, the program automatically rescales the axis to fit the graph comfortably on the screen.

9. Once you are confident you can produce a "clean" waveform and can trace the graph, you can begin the investigations.

Part Two – Investigating Volume

Purpose To investigate how the amplitude of a wave will change with loudness

Research Question What is the effect of volume on the amplitude of a wave?

Variables (6 pts)

Independent –

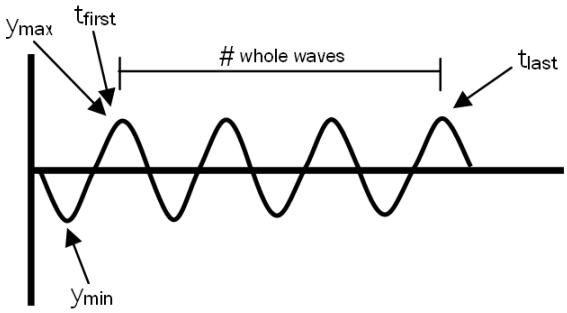
Dependent –

Control –

Hypothesis (4 pts)

Procedure

10. Take a tuning fork. Record the frequency listed on it.
11. Hit the tuning fork with the rubber stopper **softly**.
12. Hold it in front of the microphone and press enter to gather the data.
13. You will be tracing the graph, using the arrow keys, to analyze the changes in amplitude and frequency.
    - See diagram above for details.
    - Round your data to four decimal places.
    a. Record the y value for a single crest.
    b. Record the y value for a single trough (keep the negative).



14. To calculate **amplitude**, use the formula $\text{Amplitude} = (y_{max} - y_{min})/2$.
15. Repeat steps 10 – 16 hitting the same tuning fork **normally** and then **hard**.

Data Collection (15 pts)

Tuning fork frequency _____

Strength	y_{max} (V) crest	y_{min} (V) trough	Amplitude (V)
Soft			
Medium			
Hard			

Data Processing (5 pts)

In the space below, show one sample calculation of the amplitude using the GUESS method and proper significant figures.

Part Three – Investigating Pitch

Purpose To investigate how the frequency of a wave will change with pitch

Research Question What is the effect of pitch on the frequency of a wave?

Variables (6 pts)

Independent –

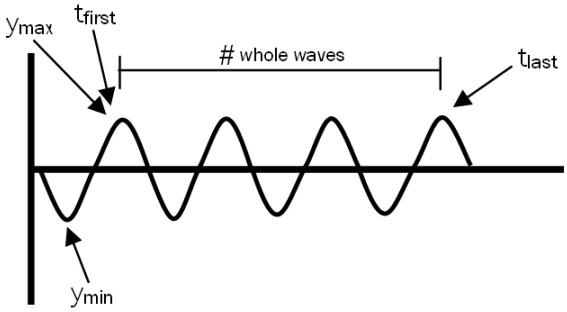
Dependent –

Control –

Hypothesis (4 pts)

Procedure

16. Take a tuning fork. Record the frequency listed on it.
17. Hit the tuning fork with the rubber stop **normally**.
18. Hold it in front of the microphone and press enter to gather the data.
19. You will be tracing the graph to analyze the changes in amplitude and frequency.



- See diagram above for details.
- Round your data to four decimal places.

a. Record the time (**x value**) for the first crest visible on the screen.
b. Record the time (**x value**) for the last crest visible on the screen.
c. Count the number of **whole** waves between the first and last crest. Record.

20. To calculate **frequency**, use the formula $f = (\#\ \text{waves}) \big/ (t_{last} - t_{first})$.
21. Repeat steps 18 - 24 using a tuning fork of different pitch each time. Make sure you hit each one with approximately the same strength.
22. For each tuning fork, calculate the percent error between the turning fork frequency (accepted value) and your calculated frequency (experimental value).

Data Collection (25 pts)

♦ = data that must be collected before clearing your wave

Pitch	Tuning Fork Frequency (Hz)	$t_{first\ crest}$ (s) ♦	$t_{last\ crest}$ (s) ♦	# whole waves between t_{first} & t_{last} ♦	Frequency (Hz)	Percent Error (%)
High						
Medium						
Low						

Data Processing (10 pts)

In the space below, show one sample of each calculation performed using the GUESS method and proper significant figures.

- Frequency:

- Percent Error:

Post Lab Questions (30 pts)

1. If you strike the tuning fork harder, what will happen to the sound wave's: (5 pts)
    a) Amplitude
    b) Frequency
    c) Period
    d) Wavelength
    e) Speed

2. If you switch to a tuning fork of a smaller size, what will happen to the sound wave's: (5 pts)

    a) Amplitude

    b) Frequency

    c) Period

    d) Wavelength

    e) Speed

3. Was your hypothesis confirmed or refuted from Part 2 – Investigating Volume? Provide evidence. (5 pts)

    _____

    _____

    _____

4. Was your hypothesis confirmed or refuted from Part 3 – Investigating Pitch? Provide evidence. (5 pts)

    _____

    _____

    _____

5. State one source of error that may have occurred during Part 2 – Investigating Volume or during Part 3 – Investigating Pitch. Explain how the error occurred. Explain how the error affected your data (y_{max}, y_{min}, t_{first}, t_{last}, #waves). Explain how it affected your results (amplitude or frequency). (5 pts)

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