

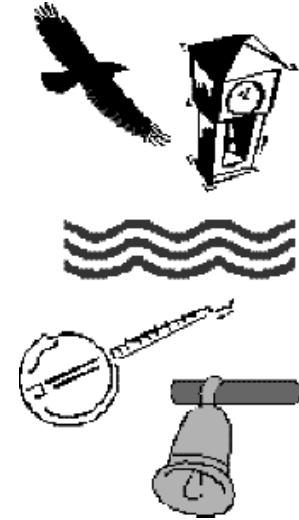
Waves, Sounds, Noise and Music 'Notes' and Singing Pipes

When we studied a car rolling down a hill or a ball thrown through the air, we used speed and acceleration to describe and understand their motion.

When we study motion which repeats itself over and over again, we need different language to describe and understand this motion.

Motion which naturally repeats itself is called **Periodic Motion**.

Think of three examples of periodic motion.



Let's learn some of the special language for describing **Periodic Motion**.

Cycle - the smallest complete unit of motion that repeats

Period - the time it takes to complete one cycle

Frequency - the number of cycles that happen in a given period of time

Resonance - when the natural frequency of a system, is reinforced and /or prolonged by the sympathetic vibrations of something else.

Fundamental Frequency - the lowest frequency that produces (excites) a resonance

Harmonic Frequency - frequencies that produce resonances other than the fundamental frequency

Some periodic motion can be described as **Waves**. A wave repeats its motion in distance as well as in time.

Some terms that describe waves are:

Wavelength - the length of one wave

Amplitude - the maximum displacement (height/depth) of the wave from the rest position

Trough - the lowest point of a wave

Crest - the highest point of a wave

1. With the Timer in FREQUENCY mode, adjust the Frequency until the Wiggler is clicking about once every second.

What does the timer read? _____

What does this mean? _____

2. Now put the timer in PERIOD Mode.

What does the timer read? _____

What does this mean? _____

Exciting the Fundamental Frequency

With the Timer back in FREQUENCY Mode, raise the frequency until you excite the **Fundamental Frequency** of the elastic string (probably around 10 to 20 Hertz). The string should vibrate back and forth just like in the picture at the right.

3. Where is the string moving the most? _____

4. Where is the string moving the least? _____

5. What is the Fundamental Frequency? _____

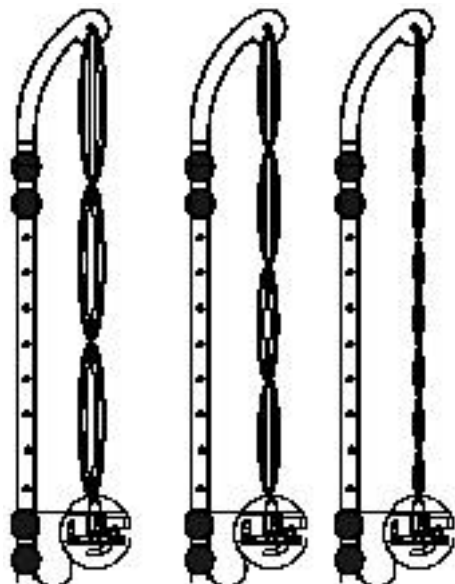
Exciting other Standing Waves

Increase the frequency, and try to get the string to look like the pattern at the right.

6. What is the frequency now? _____

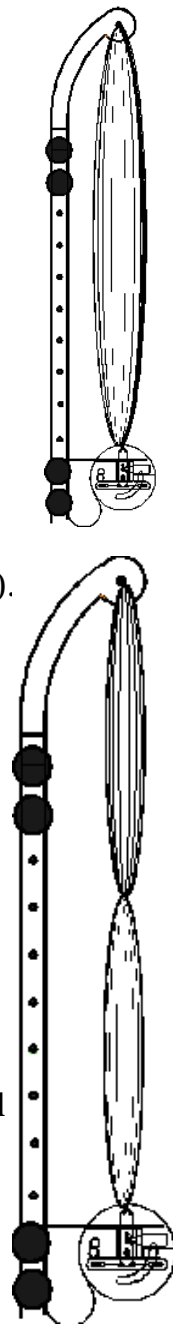
7. How does the magnitude of this frequency compare to the previous fundamental frequency?

Indicate using arrows, where the string is moving the most and where is it moving the least. Place these arrows to the right of the diagram, and put the words "**most**" and "**least**" along with the arrows.



8. Now get some of the other patterns shown in this picture to the left?

Come up with a rule for getting these patterns, that is related to their frequency.



9. Did interesting patterns happen at all frequencies? _____

Below you will make a table of your results.

Frequency (Hz)	Description (include general shape and the number of places where the string is not moving)

One wavelength is one complete **back and forth** motion of the string. A complete wave has the movement of the string both ways, not just half of the wave.

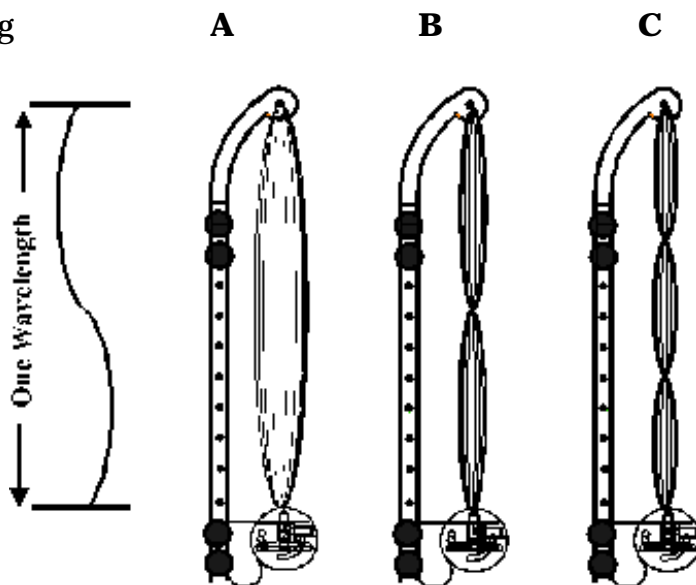
10. Which of the pictures at right, shows the string with a standing wave **one wavelength long**?

11. How many complete waves are shown on each string?

A _____

B _____

C _____



The table that follows below, shows sample data from a number of set ups similar to what you've already seen.

Number of Waves on the String	Wavelength (cm)	Frequency (Hz)
.5	200	15
1	100	30
1.5	67	45
2	50	60
2.5	40	75
3	33	90

12. Come up with a mathematical rule for how the frequency changes with wavelength?

With the power on to the Timer (the switch is on the left side), the Sound and Wave Generator may now be making some noise from the speaker. Press the Timer select button once, or until the "Frequency" light is lit. The display should probably read 0.440. Adjust the Volume slide along the bottom of the Sound and Wave Generator. It should be loud enough to hear, but not so loud that it sounds distorted or drives people crazy.

The Limits of Your Hearing

13. Lower the frequency until about 5 students can't hear anything anymore (you might have to hold your head close as the sound becomes faint). Write down this frequency. Keep going until nobody can hear it anymore. Do this for about 5 students.

Name _____ lowest frequency heard _____

Name _____ lowest frequency heard _____

Name _____ lowest frequency heard _____

Name _____ lowest frequency heard _____

Name _____ lowest frequency heard _____

The lowest frequency heard by someone in the class _____

14. Now try raising the frequency until it can't be heard anymore. Write down names the same way as before.

Name _____ highest frequency heard _____

Name _____ highest frequency heard _____

Name _____ highest frequency heard _____

Name _____ highest frequency heard _____

Name _____ highest frequency heard _____

The highest frequency heard by someone in the class _____

What is the difference between **noise** and **music**? Look up the answer in your textbook or a dictionary and write it below.

Singing Pipes

Hold a tube from your teacher, over the speaker of the Sound & Wave Generator, and keep your ear close. Slowly change the frequency up and down. (Start around 300 Hz).

15. Does the sound get suddenly louder at any frequencies? _____
See if you can find some frequencies where the pipe "sings" when held near the speaker.

(If it is difficult to hear the singing, try moving the pipe back and forth across the speaker. At frequencies where the pipe sings, the sound will get louder when the pipe passes over the speaker. At other frequencies, you won't hear any difference when the pipe passes back and forth).

Can you hear the pipe sing? _____

Write down the frequencies where this happens. _____

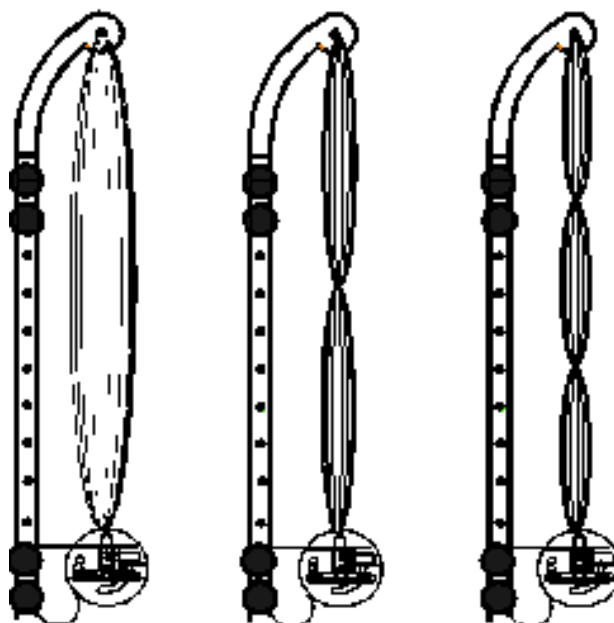
16. What is the **lowest** frequency that makes the pipe sing? _____
(Are you sure? Try half of this frequency to make sure).

17. What is the **highest** frequency that makes the pipe sing? _____
(Should there be yet higher frequencies?).

What is the Wavelength of Sound?

Remember how we found the wavelength of the wave on the string? We counted the number of **complete back and forth motions** of the string.

The **lowest** frequency that made the string vibrate in a visible pattern was the frequency that fit exactly **one half wave** on a string. The wavelength was then exactly **twice the length** of the string.



the number of waves is:

1/2 wave

1 wave

1 1/2

the wavelength is:

200 cm

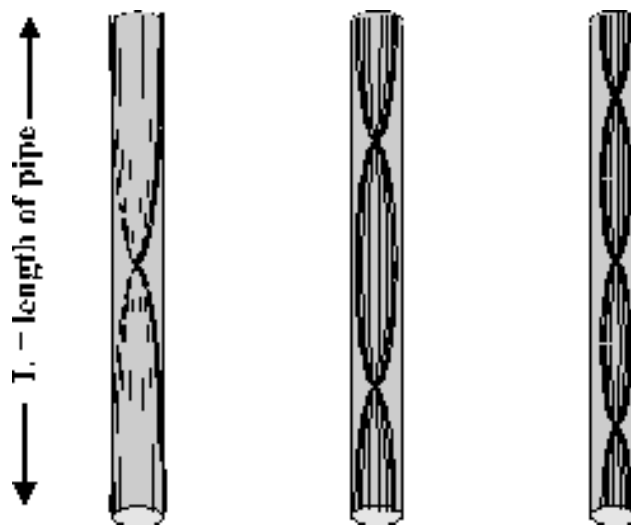
100 cm

67 cm

Do the same thing with the pipe:

Waves of sound fit in the pipe nearly the same way as waves fit on the string. The pipe sings only at certain frequencies because only multiples of "half waves" can fit in the pipe.

Just as with the waves on the string, the lower frequencies match the longest waves. The lowest frequency that makes the pipe sing is the one that exactly fits **one half wave** in the pipe, so the wavelength is **twice the length** of the pipe.



the number of waves is:

1/2 wave

1 wave

1 1/2

the wavelength is:

2 L

L

2/3 L