



## The Study of the Science of Sound and Tuning Forks!

Name: \_\_\_\_\_

From Oracle ThinkQuest website:

In the 6th century BC Pythagoras of Samos observed someone playing a stringed instrument and as he observed the string being plucked, he related the amplitude of its vibration (which he saw as the width of the blurred area the motion of the string produced) with the perceived loudness of the sound. He also noted that when the vibration stopped altogether, the sound stopped as well. He even saw that the shorter strings vibrated more rapidly, and that this more rapid vibration seemed to produce a shriller, higher-pitched sound.

By 400 BC, a member of the Pythagorean school, Archytus of Tarentum was postulating that sound was produced by the striking together of objects. From this he also gathered that a fast motion resulted in a high pitch and slow motion resulted in a low pitch. Though he was on the right track, today we know this to be true only under certain circumstances.

Around 350 BC, Aristotle observed that the vibrating string was actually striking the air. He also concluded that each bit of air struck a neighboring bit of air, which in turn struck another bit, and so on. From this Aristotle hypothesized that air was needed as a medium through which sound could be conducted. He further postulated that sound would not be conducted without a medium; that is, it would not be conducted in a vacuum.

Realizing that a vibrating string strikes the air many times in a series of blows, not just once, 1st century Roman engineer Marcus Vitruvius Pollio suggested that the air not only moved, but vibrated. He thought that it did so in response to the vibrations of the string. He maintained that it was actually these air vibrations that we heard and perceived as sound.

It was not until about 500 A.D. that the connection between the motion of sound and the motion of waves was suggested. The Roman philosopher Anicius Manilius Severinus Boethius specifically compared the conduction of sound through the air to the waves produced by dropping a pebble into calm water. Though today we know that sound waves and water waves represent two distinct types of wave motion, (longitudinal and transverse, respectively) the realization that sound moved as a wave at all was an important step in the study of sound.

The invention of the tuning fork in 1711 by John Shore and its further development by Frenchman Rudolph K ning eased the study of sound considerably. Later breakthroughs in sound were made when, in 1842, Christian Doppler first identified and quantified the change in pitch that occurred when a source of sound moves toward or away from a stationary observer, or an observer moves toward or away from a stationary source of sound. This effect now bears his name and is known as the Doppler Effect. Other modern contributors to the study of sound included the likes of Helmholtz, Lord Rayleigh, Weber, Fechner, Fletcher, Bekesy and Mach, who observed the Mach cone and whose name gives us the Mach number, which is how fast an object is going compared to the speed of sound.

1. In the first paragraph: What are two concepts about sound waves that are introduced? Draw below what is being described. You can use the “Wave on a String” PhET simulation if you like.

2. What did Aristotle postulate about how sound travels? Draw a picture of how this might look.

3. What did Roman Marcus Vitruvius Pollio add to Aristotle’s postulate?

4. When was it first suggested that sound travels as a wave?

5. What invention really helped scientists study sound?

#### **Tuning Fork discovery**

6. *Prediction:* Do you think longer tuning forks have larger or smaller frequencies?

7. *Prediction:* Do you hear a lower or higher pitch with larger frequencies?

8. Walk around to other tables and compare your tuning fork to others. Find at least 5 different comparisons. Try and determine a) how fork length relates to frequency and b) how frequency relates to the pitch that you hear.

Frequency of your fork	Frequency of other	Length (compare)	Pitch (compare)

- a. How does fork length compare to frequency based on your above observations?
- b. How does the pitch that you hear compare to the frequency of the tuning fork?

Now test other frequencies of tuning forks to see if one fork that is vibrating can make another fork start vibrating by simply holding them next to each other – do not physically touch them. (Warning: be sure that the quiet fork is *completely* silenced first. Hold the tines firmly in your hand, to silence the fork, before beginning your test)

- c. Which pairs of forks, if any, can make another vibrate? You may have to go back and ask other people what they found.

The 261.6 Hz fork is “middle C” and the 523.2 Hz fork is the C one octave higher on the musical scale. The 440 Hz fork and the 880 Hz forks both make an A note on the musical scale.

9. Based on the above information, how do the frequencies of notes an octave apart compare?
10. What happens if you place a tuning fork on/in calm water? Does it depend on your technique or the frequency of the fork?