Sound - Harmonics Name _____

1. A saxophone plays a tune in the key of B-flat. The saxophone has a second harmonic frequency of 466.2 Hz when the speed of sound is 331 m/s. What is the length of the pipe that makes up the saxophone? A saxophone should be treated as a pipe open at both ends.

2. A clarinetist plays a clarinet on a cold day. At one point she produces the sound of middle F sharp, which has a frequency of 370 Hz, by playing the third harmonic of low B. If the speed of sound in the air is 331 m/s, what is the length of the clarinet? A clarinet resembles a pipe closed at one end.

3. A penny whistle plays a tune in the key of G with a fundamental frequency of 392.0 Hz. The speed of sound in air is 331 m/s. What is the length of the penny whistle? Treat the penny whistle as a pipe closed at one end.

4. An organ pipe that is open at both ends has a fundamental frequency of 370.0 Hz when the speed of sound in air is 331 m/s. What is the length of this pipe?

5. What is the fundamental frequency of a viola string that is 35.0 cm long when the speed of waves on this string is 346 m/s?

6. What is the fundamental frequency of a mandolin string that is 42.0 cm long when the speed of waves on this string is 329 m/s?

7. What is the fundamental frequency of a cello string that is 0.85 m long when the speed of waves on this string is 499 m/s?

8. A pipe that is open at both ends has a fundamental frequency of 277.2 Hz. If the pipe is 0.75 m long, what is the speed of the waves in the pipe?

9. A pipe that is closed on one end has a seventh harmonic frequency of 466.2 Hz. If the pipe is 1.53 m long, what is the speed of the waves in the pipe?

10. A pipe that is open at both ends has a fundamental frequency of 125 Hz. If the pipe is 1.32 m long, what is the speed of the waves in the pipe?

11. A 330 Hz tuning fork is vibrating after being struck. It is placed on a table near but not directly touching other objects, including other tuning forks. Eventually one glass and one other tuning fork start vibrating. Explain why this happens.

12. The first harmonic in a pipe closed at one end is 487 Hz.
    a. Find the next two harmonic frequencies that will occur in this pipe.
    b. What are the corresponding wavelengths of the first three harmonics?
        (Hint: assume the speed of sound is 341 m/s)
    c. What is the length of this pipe?
    d. Repeat this exercise for a pipe open at both ends.

13. A piano tuner uses a 440 Hz tuning fork to tune a string that is currently vibrating at 445 Hz.
    a. How many beats per second does he hear?
    b. What other frequency could produce the same sound effect?