

# Resonance & Standing Wave Problems

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

Date : \_\_\_\_\_

$$f = \frac{1}{T} \quad T = \frac{1}{f} \quad v = f\lambda \quad f_2 = \frac{f_1 v_s}{v_s \pm v_o}$$

**You must have a well labelled diagram for each question!**

*Adapted from pp. 512-514 of Physics: Concepts and Connections textbook.*

1. A 1024 Hz tuning fork is held up to a closed air column (closed at one end and open at the other) at 30°C. What is the minimum length of an air column that would resonate with this frequency?
2. Organ pipes, open at one end, resonate best at their first resonant length. Two pipes have length 23 cm and 30 cm respectively.
  - a) What is the wavelength of the sound emitted by each pipe?
  - b) What are the respective frequencies if the speed of sound is 341 m/s.
  - c) What is the air temperature in this church?
3. A tuning fork was sounded over an adjustable closed (at one end) air column. It was found that the difference between the second and fifth resonant length was 90 cm. What was the frequency of the tuning fork if the experiment was done in a lab with air temperature 25°C.
4. An air column that is open at both ends has a distance of 24 cm from one resonant length to another. What is the wavelength of sound that is in resonance with this tube?
5. Water is slowly drained out of a tube until the air column is 8 cm long. A loud sound is heard at the fundamental frequency (1<sup>st</sup> harmonic).
  - a) What is the wavelength of the sound that is produced by resonance?
  - b) How long would the tube have to be for the same note to resonate at the third resonance length?
6. A tuning fork vibrating with a frequency of 950 Hz is held near the open end of an open air column (closed at the other end) that has been adjusted to its first resonance length at 25°C.
  - a) What is the speed of sound in the room?
  - b) What is the wavelength of the sound produced?
  - c) How long is the tube in centimetres?
7. One of the tubes in a flute measures 10 cm from one open end to the other open end. The air temperature is 20°C.
  - a) What is the fundamental wavelength (1<sup>st</sup> harmonic) of the note that is heard?
  - b) What is the corresponding frequency?

8. Hollow tube chimes are made of metal and are open at each end. These columns resonate best at their third resonant length. One chime is 2.5 m long and the air temperature is 25°C.
- What is the speed of sound?
  - What is the wavelength of the sound produced?
  - What is the frequency of the sound that is heard?

**Numerical Answers:**

- 8.5 cm
- a) 0.92 m, 1.2 m      b) 371 Hz, 284 Hz      c) 15°C
- 578 Hz
- 0.48 m
- 40 cm
- a) 347 m/s      b) 0.37 m      c) 9.3 cm
- a) 20 cm      b) 1720 Hz
- a) 347 m/s      b) 1.67 m      c) 208 Hz