**Chapter 17**

1. How can an object move with respect to an observer so that the sound from it is not shifted in frequency?

Answer:

2. An experimenter wishes to generate in air a sound wave that has a displacement amplitude of $5.5 × 10^{6}$ m. The pressure amplitude is to be limited to 0.840 Pa. What is the minimum wavelength the sound wave can have?

Solution:

3. A student holds a tuning fork oscillating at 256 Hz. He walks toward a wall at a constant speed of 1.33 m/s. (a) What beat frequency does he observe between the tuning fork and its echo? (b) How fast must he walk away from the wall to observe a beat frequency of 5.00 Hz?

Solution:

4. The windpipe of one typical whooping crane is 5.00 feet long. What is the fundamental resonant frequency of the bird’s trachea, modeled as a narrow pipe closed at one end? Assume a temperature of 378 C.

Solution:

**Solutions for Chapter 17**

1. How can an object move with respect to an observer so that the sound from it is not shifted in frequency?

Answer:

For the sound from a source not to shift in frequency, the radial velocity of the source relative to the observer must be zero; that is, the source must not be moving toward or away from the observer. The source can be moving in a plane perpendicular to the line between it and the observer. Other possibilities: The source and observer might both have zero velocity. They might have equal velocities relative to the medium. The source might be moving around the observer on a sphere of constant radius. Even if the source speeds up on the sphere, slows down, or stops, the frequency heard will be equal to the frequency emitted by the source.

2. An experimenter wishes to generate in air a sound wave that has a displacement amplitude of $5.5 × 10^{6}$ m. The pressure amplitude is to be limited to 0.840 Pa. What is the minimum wavelength the sound wave can have?

Solution:

We use



3. A student holds a tuning fork oscillating at 256 Hz. He walks toward a wall at a constant speed of 1.33 m/s. (a) What beat frequency does he observe between the tuning fork and its echo? (b) How fast must he walk away from the wall to observe a beat frequency of 5.00 Hz?

Solution:

 The source moves toward the wall:

 *v*s = +*v*student, *v*0 = 0, and 

 The wall acts as stationary source, reflecting the wave of frequency  The observe moves toward the source: *v*s = 0, *v*0 = +*v*student, and

 

 (a) When the student walks toward the wall  is larger than *f*; the beat frequency is

 

 

 (b) When he is moving away from the wall, the sign of *v*student changes and  is smaller than f:

 

 Solving for *v*student gives

 

4. The windpipe of one typical whooping crane is 5.00 feet long. What is the fundamental resonant frequency of the bird’s trachea, modeled as a narrow pipe closed at one end? Assume a temperature of 378 C.

Solution:

 Assuming an air temperature of *T* = 37.0°C = 310 K, the speed of sound inside the pipe is

 

 In the fundamental resonant mode, the wavelength of sound waves in a pipe closed at one end is  Thus, for the whooping crane,

 

 and

 