Practice Problems

Practice 13A Sound Waves, Sound Waves and Temperature
1. Playing middle C on the piano keyboard produces a sound with a frequency of 256 Hz. Assuming the speed of sound in air is 345 m/s, determine the wavelength of the sound corresponding to the note of middle C.

2. Determine the speed of sound on a cold winter day (T = 3°C).

3. An automatic focus camera is able to focus on objects by use of an ultrasonic sound wave. The camera sends out sound waves which reflect off distant objects and return to the camera. A sensor detects the time it takes for the waves to return and then determines the distance an object is from the camera. If a sound wave (speed = 340 m/s) returns to the camera 0.150 seconds after leaving the camera, how far away is the object?

Practice 13B Doppler Effect
1. An opera singer in a convertible sings a note at 600 Hz while cruising down the highway at 90 km/hr. What is the frequency heard by a person standing beside the road in front of the car? What is the frequency heard by a person on the ground behind the car? Assume the speed of sound in air is 345 m/s.

2. A whistle you use to call your hunting dog has a frequency of 21 kHz, but your dog is ignoring it. You suspect the whistle may not be working, but you can't hear sounds above 20 kHz. To test it, you ask a friend to blow the whistle, then you hop on your bicycle. In which direction should you ride (toward or away from your friend) to know if the whistle is working? At what minimum speed should you ride to know if the whistle is working? Assume the speed of sound in air is 345 m/s.
Practice 13C Intensity of Sound Waves

1. Calculate the intensity of sound waves from an electric guitar’s amplifier at a distance of 5.0 m when its power output is equal to each of the following values:
   a. 0.25 W
   b. 0.50 W
   c. 2.0 W

2. If the intensity of a person’s voice if $4.6 \times 10^{-7}$ W/m$^2$ at a distance of 2.0 m, how much sound power does that person generate?

3. How much power is radiated as sound from a band whose intensity is $1.6 \times 10^{-3}$ W/m$^2$ at a distance of 15 m?

4. At a maximum level of loudness, the power output of a 75-piece orchestra radiated as sound is 70.0 W. What is the intensity of these sound waves to a listener who is sitting 25.0 m from the orchestra?

5. The power output of a tuba is 0.35 W. At what distance is the sound intensity of the tuba $1.2 \times 10^{-3}$ W/m$^2$?
Practice 13D Relative Intensity
1. A speaker in a room produces a sound level of 75.0 dB at a point in a room. Another speaker aimed at the same point produces a sound level of 72.0 dB at that same point. When both speakers produce sound at the same time, what is the sound level in dB at that point?

2. On a good night, the front row of a rock concert would surely result in a 120 dB sound level. An IPod produces 100 dB. How many IPods would be needed to produce the same intensity as the front row of the concert?

Practice 13E Standing Waves on a Vibrating String
1. A violin string is 0.035 m long and is stretched with a tension of 27 N, so that it vibrates with a frequency of 256 Hz. What is the frequency when the length is 0.030 m and the tension is 32 N?

2. One string on an instrument has a density twice that of an adjacent string. If all other factors are equal, and the frequency of the first string is 330.0 Hz, what is the frequency of the second?

Practice 13F Standing Waves in an Air Column
1. What is the fundamental frequency of a 0.20 m long organ pipe that is closed at one end, when the speed of sound in the pipe is 352 m/s?
2. A flute is essentially a pipe open at both ends. The length of a flute is approximately 66.0 cm. What are the first three harmonics of a flute when all keys are closed, making the vibrating air column approximately equal to the length of the flute? The speed of sound in the flute is 340 m/s.

3. A child’s whistle is 15.0 cm long with a diameter of 1.25 cm. What is the frequency of the sound that resonates through the whistle if the temperature is 20.0°C?

4. A physics student discovers that a tuning fork with a frequency of 300 Hz will produce the best resonance with a 6.80-cm diameter tube closed at one end when the tube length is 26.0 cm. What is the speed of the sound? What is the air temperature in the lab that day?