TUTORIAL CHAPTER 5(B) – SOUND WAVES

(Use 343 m/s as the speed of sound in air)

1. Children sometimes play with a homemade "telephone" by attaching a string to the bottoms of two cups. When the string is stretched and a child speaks into one of the cups, the sound can be heard at the other cup. Explain how the sound wave travels from one cup to the other.

2. Compare the intensities of an earthquake wave as it passes two points 10 km and 20 km from the source.

3. The intensities of a particular earthquake wave is measured to be 2.0×10^6 J/m^{2}s at a distance of 50 km from the source.

   (a) What was the intensity when it passed a point only 1.0 km from the source?

   (b) What was the rate energy passed through an area of 10.0 m^2 at 1.0 km?

4. What is the intensity of sound at the pain level of 120 dB? Compare it to that of a whisper at 20 dB.

5. What is the intensity level of a sound whose intensity is 2.0×10^6 W/m^2?

6. Human beings can typically detect a difference in sound intensity level of 2.0 dB. What is the ratio of the amplitudes of two sounds whose levels differ by this amount?

7. A person standing a certain distance from an airplane with four noisy jet engines is feeling a sound level intensity bordering on pain, 120 dB. What sound level intensity would this person experience if the captain shut down all but one engine?

8. Expensive stereo amplifier A is rated at 250 W per channel, while the more modest amplifier B is rated at 40 W per channel.

   (a) Estimate the intensity level in decibels you would expect at a point 3.0 m from a loudspeaker connected in turn to each amp.

   (b) Will the expensive amp sound twice as loud as the cheaper one?

9. At recent rock concerts, a dB meter registered 130 dB when placed 2.5 m in front of a loudspeaker on a stage.

   (a) What was the power output of the speaker, assuming uniform spherical spreading of sound and neglecting absorption in the air?

   (b) How far away would the intensity level be a somewhat reasonable 90 dB?

10. (a) Estimate the power output of sound from a person speaking in normal conversion at 65 dB. Assume the sound spreads roughly uniformly over a hemisphere 50 cm in front of the mouth.

    (b) How many people would produce a total sound output of 100 W of ordinary conversation?

11. As the people in a church sing on a summer morning, the sound level everywhere inside the church is 101 dB. The massive walls are opaque to sound, but all the windows and doors are open. Their total area is 22.0 m^2.

    (a) How much sound energy is radiated in 20.0 min?

    (b) Suppose the ground is a good reflector and sound radiates uniformly in all horizontal and upward directions. Find the sound level 1.00 km away.

12. Standing at a crosswalk, you hear a frequency of 560 Hz from the siren on an approaching police car. After the police car passes, the observed frequency of the siren is 480 Hz. Determine the car's speed from these observations. (Speed of sound wave is 340 m/s)

13. A train moving parallel to a highway at 20 m/s. A car is travelling in the same direction as the train at 40 m/s. The car horn sounds at 510 Hz and the train whistle sounds at 320 Hz.

    (a) When the car is behind the train, what frequency does an occupant of the car observe for the train whistle?

    (b) When the car is in front of the train, what frequency does a train passenger observe for the car horn just after passing?

14. The predominant frequency of a certain police car's siren is 1800 Hz when at rest. What frequency do you detect if you move with a speed of 30 m/s

    (a) toward the car, and

    (b) away from the car.

15. A bat at rest sends out ultrasonic sound waves at 50,000 Hz and receives then returned from an object moving radially away from it at 25 m/s. What is the received sound frequency?

Answer:

2. (*a*) 0.25. (*b*) 0.50.

3. (*a*) $I_2 = 5.0 \times 10^9$ J/$m^2 \cdot$ s. (*b*) 5.0×10^{10} W.

4. $I_1 =$ 1.0 W/m^2., $I_2 =$ 1.0×10^{-10} W/m^2.

5. 63 dB.

6. 1.58, 1.3.

7. 114 dB.

8. (*a*) $\beta_1 = 123$ dB; $\beta_2 = 115$ dB.

   (*b*) expensive amp is almost twice as loud.

9. (*a*) 7.9×10^2 W. (*b*) 2.5×10^2 m.

10. (a) 5×0^{-6} W

(b) 2×10^{7}.

11. (a) 332.36 J (b) 46.44 dB

12. v = 26.3 m/s

13.a) f = 338 Hz (b) f = 483 Hz

14. (*a*) f_1 = 1950 Hz. (*b*) f_2 = 1640 Hz.

15. f_2 = 43,200 Hz.