Chapter 17 End-of-Chapter Problems

Halliday & Resnick, 10th Edition

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Hit me where it Matters

Where needed in the problems, use
speed of sound in air = 343 m/s
and
density of air = 1.21 kg/m^3
unless otherwise specified.

1 Problem 1

Two spectators at a soccer game see, and a moment later hear, the ball being kicked on the playing field. The time delay for spectator A is 0.23 s, and for spectator B it is 0.12 s. Sight lines from the two spectators to the player kicking the ball meet at an angle of 90°. How far are (a) spectator A and (b) spectator B from the player? (c) How far are the spectators from each other?

1.1 Solution (a)

This is a simple question to answer. The distance traveled to A would be equal to the speed of sound times the time taken to travel the distance.

$$x = vt = (343\,\mathrm{m/s})(0.23\,\mathrm{s}) = \boxed{78.89\,\mathrm{m}} \tag{1}$$

1.2 Solution (b)

The is calculatable the same way.

$$y = vt = (343\,\mathrm{m/s})(0.12\,\mathrm{s}) = \boxed{41.16\,\mathrm{m}} \tag{2}$$

1.3 Solution (c)

The 90 degree angle of their sight lines makes the triange of the two spectators and the ball a right triangle, so we can use the Pythagorean theorem to find the distance between the spectators.

$$h = \sqrt{x^2 + y^2} = \sqrt{(78.89\,\mathrm{m})^2 + (41.16\,\mathrm{m})^2} = \boxed{88.98\,\mathrm{m}} \tag{3}$$

2 Problem 3

When the door of the Chapel of the Mausoleum in Hamilton, Scotland, is slammed shut, the last echo heard by someone standing just inside the door reportedly comes 15 s later. (a) If that echo were due to a single reflection off a wall opposite the door, how far from the door is the wall? (b) If, instead, the wall is 25.7 m away, how many reflections (back and forth) occur?

2.1 Solution (a)

Use the speed and the time taken to calculate the distance covered.

$$\Delta s = vt = (343\,\mathrm{m/s})(15\,\mathrm{s}) = 5145\,\mathrm{m} \tag{4}$$

This is twice the length of the church, so if we divide this by two, we will get the length of the church.

$$L = \frac{\Delta s}{2} = \frac{5145\,\mathrm{m}}{2} = \boxed{2572.5\,\mathrm{m}} \tag{5}$$

2.2 Solution (b)

We can divide the total distance covered by the length of the church to fnd the number of reflections.

$$n = \frac{5145\,\mathrm{m}}{25.7\,\mathrm{m}} = 200.19 \tag{6}$$

$$\lfloor n \rfloor = \boxed{200} \tag{7}$$

3 Problem 5

Earthquakes generate sound waves inside Earth. Unlike a gas, Earth can experience both transverse (S) and longitudinal (P) sound waves. Typically, the speed of S waves is about 4.5 km/s, and that of P waves 8.0 km/s. A seismograph records P and S waves from an earthquake. The first P waves arrive 3.0 min before the first S waves. If the waves travel in a straight line, how far away did the earthquake occur?

3.1 Solution

4 Problem 7

A stone is dropped into a well. The splash is heard 3.00 s later. What is the depth of the well?

4.1 Solution

5 Problem 11

Diagnostic ultrasound of frequency 4.50 MHz is used to examine tumors in soft tissue. (a) What is the wavelength in air of such a sound wave? (b) If the speed of sound in tissue is 1500 m/s, what is the wavelength of this wave in tissue?

5.1 Solution

6 Problem 15

6.1 Solution

7 Problem 17

7.1 Solution

8 Problem 19

8.1 Solution

9 Problem 20

9.1 Solution

10 Problem 25

10.1 Solution

11 Problem 27

11.1 Solution

12 Problem 29

12.1 Solution

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