

# 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<sup>3</sup>  
*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  $90^\circ$ . 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.

$$x = vt = (343 \text{ m/s})(0.23 \text{ s}) = \boxed{78.89 \text{ m}} \quad (1)$$

## 1.2 Solution (b)

The is calculatable the same way.

$$y = vt = (343 \text{ m/s})(0.12 \text{ s}) = \boxed{41.16 \text{ m}} \quad (2)$$

## 1.3 Solution (c)

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

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

## 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.

$$\Delta s = vt = (343 \text{ m/s})(15 \text{ s}) = 5145 \text{ m} \quad (4)$$

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

$$L = \frac{\Delta s}{2} = \frac{5145 \text{ m}}{2} = \boxed{2572.5 \text{ m}} \quad (5)$$

### 2.2 Solution (b)

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

$$n = \frac{5145 \text{ m}}{25.7 \text{ m}} = 200.19 \quad (6)$$

$$\lfloor n \rfloor = \boxed{200} \quad (7)$$

### 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

## 13 Problem 35

### 13.1 Solution

## 14 Problem 39

### 14.1 Solution

## 15 Problem 41

### 15.1 Solution



## 16 Problem 47

### 16.1 Solution

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## 18 Problem 51

### 18.1 Solution

## **19 Problem 53**

### **19.1 Solution**

## 20 Problem 55

### 20.1 Solution

## 21 Problem 57

### 21.1 Solution

## 22 Problem 61

### 22.1 Solution

## **23 Problem 63**

### **23.1 Solution**



## 24 Problem 71

### 24.1 Solution

## 25 Problem 81

### 25.1 Solution

## 26 Problem 87

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## 28 Problem 107

### 28.1 Solution

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