Chapter 11 HW Answers

Review Questions:

9. The image appears to be the same distance from the mirror as the object.

Object ⟷ Mirror ⟷ Image $d_1 = d_2$

d_1 d_2

11. The law of reflection holds for each piece of a diffuse reflector.

16. Blue light has a higher frequency than red light.

22. Clouds scatter all wavelengths of white light so there must be a variety of particles to scatter the variety of wavelengths.

24. Violet light travels more slowly in glass. Shorter wavelengths spend more time interacting with the material than longer wavelengths of light.

Exercises:

6. Radio waves are electromagnetic waves, which travel at the speed of light, at 3×10^8 m/s.

15. The angle of incidence (light between you and the mirror) equals the angle of reflection (light between the mirror and the driver), and vice versa.

16. Mirrors produce an image that is left-right reversed, so if you see an ambulance in your rear-view mirror you will see the word correctly if it has been written "backwards" on the ambulance.

24. Some sunlight is refracted through our atmosphere and partially illuminates the moon. Only reds are able to pass all the way through the atmosphere and these are the rays that travel to the moon.

44. The colors of the rainbow come from a different set of raindrops for each observer.

Problems:

2. $d = 3.8 \times 10^8$ m t = ?

Radio waves travel at the speed of light (3×10^8 m/s), and the equation for speed is…

$s = \frac{d}{t}$ need to rearrange this equation and solve for time (t)

$t = \frac{d}{s} = \frac{3.8 \times 10^8 \text{ m}}{3 \times 10^8 \text{ m/s}} =$ **1.26 seconds** (one way)

The round trip time = 2.52 seconds

4. The equation that relates these quantities is: $v = \lambda f$

$$\lambda = \frac{v}{f} = \frac{3 \times 10^8 \text{ m/s}}{6 \times 10^{14} \text{ Hz}} = \frac{3 \times 10^8 \text{ m/s}}{6 \times 10^{14} \text{ /s}} = \mathbf{5 \times 10^{-7} \text{ m}}$$

Compare means to take a ratio…

$$\frac{5 \times 10^{-7} \text{ m}}{1 \times 10^{-10} \text{ m}} = \frac{\mathbf{5000}}{\mathbf{1}}$$

Additional:

1. All of the white light is reflected from the white page. All of the white light is absorbed by the ink.

2. You will need to assume the seashell is actually closer to you than it appears.

3a. Shortest → longest: x-rays, ultraviolet, green light, yellow light, red light, infrared, microwaves and radio waves. **Note that microwaves are a subset of radio waves.**

3b. Smallest → Largest: radio waves, microwaves, infrared, red light, yellow light, green light, ultraviolet, x-rays

4. All of the electromagnetic waves will have the same speed in a vacuum: $v = 3 \times 10^8$ m/s.

5.

a. 7.5×10^{14} Hz

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8 \text{ m/s}}{7.5 \times 10^{14} \text{ /s}} = 4 \times 10^{-7} \text{ m} = \mathbf{400 \text{ nm}}$$ **Violet**

b. 580 nm **Yellow-Green**

c. 0.45 micrometers

$\lambda = 0.45 \ \mu\text{m} = 0.45 \times 10^{-6}$ m = **450 nm** **Blue**

6.

a. $\lambda = 400$ nm

$$T = \frac{3{,}000{,}000}{400 \text{ nm}} = \mathbf{7{,}500 \text{ K}}$$

b. $\lambda = 580$ nm T = **5,172 K**

c. $\lambda = 450$ nm T = **7,500 K**

7. Radio Waves

a. f = 93.1 Megahertz = 93.1 x 10^6 Hz

$$\lambda = \frac{v}{f} = \frac{3 \times 10^8 \text{ m/s}}{93.1 \times 10^6 \text{ /s}} = \mathbf{3.22\ m}$$

b. f = 1220 Megahertz = 1220 x 10^6 Hz

$$\lambda = \frac{v}{f} = \frac{3 \times 10^8 \text{ m/s}}{1220 \times 10^6 \text{ /s}} = \mathbf{0.25\ m}$$

8.

a. $v = \frac{c}{n} = \frac{3 \times 10^8 \text{ m/s}}{1.52} = \mathbf{1.97 \times 10^8\ m/s}$

b. **v = 2.26 x 10^8 m/s** in water

c. **v = 2.99 x 10^8 m/s** in air