Problems

Name _____

ON A SEPARATE SHEET OF PAPER, solve the following wave problems using our models for mechanical and electromagnetic waves.

1. A water wave has a frequency of 6 Hz and a wavelength of 3 m.
   (a) What is the period of this wave?
   (b) What is the wave velocity?

2. The lower frequency limit for human hearing is usually considered to be 20.0 Hz. What is the corresponding wavelength for this frequency if the air temperature is 20.0 °C?

3. A 520 Hz tone is sounded at the same time as a 516 Hz tone. How many beats per second will you hear?

4. Compare the distance traveled in 6.0 sec as a given sound moves through fresh water (v = 1,497 m/s) and seawater (v = 1,530 m/s).

5. A warning buoy is observed to rise every 5.0 sec as crests of waves pass by it.
   (*a*) What is the period of these waves?
   (*b*) What is the frequency?

6. The following sound waves have what velocity?
   (*a*) 20.0 Hz, λ = 17.15 m
   (*b*) 200.0 Hz, λ = 1.715 m
   (*c*) 2,000.0 Hz, λ = .1715 m
   (*d*) 20,000.0 Hz, λ = .01715 m

7. How much time is required for a sound wave to travel 1 mile (1609 m) if the air temperature is:
   (*a*) 0.0 °C
   (*b*) 20.0 °C
   (*c*) 40.0 °C
   (*d*) 80.0 °C

8. A ship at sea sounds a whistle blast, and echo returns from the shore 10.0 sec later. How far is the ship from the coast (in km) if the air temperature is 10.0 °C

9. How much time is required for reflected sunlight to travel from the Moon to Earth if the distance between them is 3.85×10^5 km?

10. How many minutes are required for a radio signal to travel from Earth to the land rovers on Mars if they are 7.83×10^7 km away?

11. The speed of light through a transparent substance is 2.0×10^8 m/s. What is the substance?

12. A monochromatic light source used in a diffraction experiment has a wavelength of 4.60×10^{-7} m. What is the energy of the photon associated with this light source?

13. In black-and-white photography, a photon of energy of about 4.0×10^{-19} J is needed to bring about the changes in the silver compounds used in the film. Explain why a red light can be used in the darkroom and not affect the film.

14. The wavelength of a single color of light is measured to be 6.80×10^{-7} m.
    (*a*) What is the frequency?
    (*b*) What color would you see?

15. How much greater is the energy of a photon of ultraviolet radiation ($\lambda = 3.0 \times 10^{-7}$ m) than the average energy of regular sunlight ($\lambda = 5.6 \times 10^{-7}$ m)?

16. What is the energy of a photon of red light with a frequency of 4.3×10^{14} Hz?

17. What is the energy of a photon of ultraviolet radiation with a wavelength of 3.0×10^{-7} m?

TABLE 7.1
Index of refraction

Substance	$n = c/v$
Glass	1.50
Diamond	2.42
Ice	1.31
Water	1.33
Benzene	1.50
Carbon tetrachloride	1.46
Ethyl alcohol	1.36
Air (0°C)	1.00029
Air (30°C)	1.00026

TABLE 7.2
Range of wavelengths and frequencies of the colors of visible light

Color	Wavelength (in meters)	Frequency (in hertz)
Red	7.9×10^{-7} to 6.2×10^{-7}	3.8×10^{14} to 4.8×10^{14}
Orange	6.2×10^{-7} to 6.0×10^{-7}	4.8×10^{14} to 5.0×10^{14}
Yellow	6.0×10^{-7} to 5.8×10^{-7}	5.0×10^{14} to 5.2×10^{14}
Green	5.8×10^{-7} to 4.9×10^{-7}	5.2×10^{14} to 6.1×10^{14}
Blue	4.9×10^{-7} to 4.6×10^{-7}	6.1×10^{14} to 6.6×10^{14}
Violet	4.6×10^{-7} to 3.9×10^{-7}	6.6×10^{14} to 7.7×10^{14}