UNIT 4 Review

Knowledge/Understanding

True/False

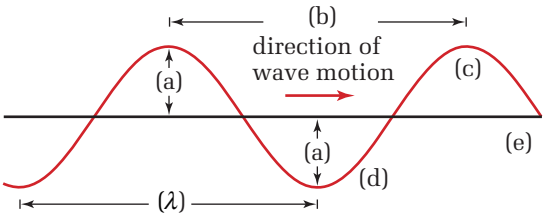
In your notebook, indicate whether each statement is true or false. Correct each false statement.

1. The time required to complete one cycle is called the frequency.
2. When a particle oscillates, its maximum displacement from its rest position is called its amplitude.
3. The medium through which a wave is passing experiences a net movement in the direction of travel of the wave.
4. The speed of a wave depends on the amount of energy used to create it.
5. Water waves are an example of transverse waves.
6. When two waves interact to produce destructive interference, there is a net loss of energy.
7. Sound travels around corners in a phenomenon known as refraction.
8. Constructive and destructive interference cannot occur in longitudinal waves.
9. When the source of a sound moves toward a stationary observer, the apparent pitch of the sound seems to be lower than the actual pitch of the source.
10. The critical angle for a substance decreases as the index of refraction increases.

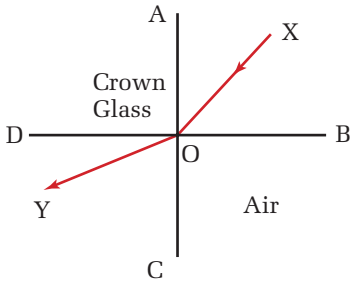
Multiple Choice

In your notebook, write the letter of the best answer for each of the following questions.

11. The period of a pendulum oscillating in periodic motion is
    - **(a)** the time to complete one cycle.
    - **(b)** the position the pendulum assumes when allowed to hang freely.
    - **(c)** one complete repeat of the pattern.
    - **(d)** the number of cycles completed in a specific time interval.
    - **(e)** the amplitude of the pendulum divided by its velocity.
12. The main reason the Tacoma Narrows bridge collapsed was
    - **(a)** extremely high winds
    - **(b)** the steel used was faulty, and could not support the weight of the traffic
    - **(c)** certain wind speeds caused the bridge to vibrate at its natural frequency
    - **(d)** the bridge was not made massive enough
    - **(e)** all of the above
13. In the diagram below, which of the features labelled (a)–(e) is the amplitude?



14. In the diagram for question 14, which of the features labelled (a)–(e) is the wavelength?
15. In the diagram for question 14, which of the features labelled (a)–(e) is the rest position?
16. Identify the false statement. When a wave travels from one medium to another,
    - **(a)** the frequency of the wave changes
    - **(b)** the amplitude of the wave changes
    - **(c)** the speed of the wave changes
    - **(d)** some of the energy is transmitted and some is reflected
    - **(e)** the period of the wave remains constant
17. The path of a light ray travelling from crown glass into air is shown in the diagram below. The angle of refraction is
    - **(a)** AOX
    - **(b)** XOB
    - **(c)** DOY
    - **(d)** BOC
    - **(e)** YOC



18. Which of the following is *not* a result of the superposition of waves?
    (a) destructive interference
    (b) diffraction
    (c) refraction
    (d) constructive interference
19. Electromagnetic waves differ from mechanical waves because
    (a) they undergo diffraction
    (b) they do not require a medium in which to travel
    (c) they are transverse waves
    (d) their speed is determined by the medium through which they are travelling

Short Answer

In your notebook, write a sentence or a short paragraph to answer each of the following questions.

20. If the fundamental mode of vibration for a standing wave on a vibrating string is 200 Hz, could a standing wave of 250 Hz exist on the same string? Explain why or why not.
21. How does the distance between the first and second resonant lengths compare for an air column that is closed at one end and an air column that is open at both ends?
22. Define the terms: light ray, wavefront, normal, regular reflection, and diffuse reflection.
23. When light passes from glycerine into crown glass at an angle, which will be smaller, the angle of incidence or the angle of refraction? Explain why.
24. Explain why you do not see interference effects from light entering a room from two different windows. What approximation was made in deriving the relationship, $\lambda \cong \frac{\Delta y d}{x}$, and under what conditions is the approximation valid?
25. Describe the necessary conditions for two light waves incident at a single location to produce a dark fringe.
26. Consider an electromagnetic wave propagating in the positive x-direction. At a time, t_0, the electric field points in the positive y-direction. In what direction does the magnetic field point at this time? Sketch the electromagnetic wave. In what directions will the electric and magnetic fields point half a period later?

Inquiry

27. Using your understanding of the diffraction of waves in general, describe how you could carry out an experiment to show that sound waves do or do not diffract.
28. Describe how you could use a meter stick, a pair of binoculars, a classmate with a drum, and a large pendulum hanging from the branch of a tree in an open valley to assist you in the approximate calculation of the speed of sound.
29. Research and analyze data related to the structure of different types of optical fibres. Over what range of angles of incidence is it possible for the light beams to enter each type of optical fibre? Explain why these restrictions are imposed on the angles of incidence.
30. You notice that a telephone pole casts a clear shadow of the light from a distant source. Why is there no such effect for the sound of a distant car horn?

Communication

31. Dolphins and whales often make use of submarine "sound channels" to communicate over very large distances. Find out and describe how these sound channels operate and are able to carry sound so far without losing much of its intensity.
32. Develop a report on the use of optical fibres in the medical field.
33. Although the wavelengths of visible light are very small, they can be measured with high accuracy. Explain how this is possible.
34. Compare the collision between two oppositely directed particles with the collision between two oppositely directed water waves. What are the similarities and differences between these interactions?

Making Connections

35. Research the various factors that are considered by jewelers as they determine the best positions

and angles to cut the facets on diamonds and other precious stones.

36. In an interferometer, light following different paths is allowed to interfere. By measuring the interference fringes, the different path lengths can be precisely determined. Gravitational wave detectors use interferometers to search for ripples in the fabric of space and time. These ripples were predicted by Einstein's theory of general relativity and are thought to be produced by collisions of two black holes or the collapse of massive stars in supernova explosions. Research the operations of the Laser Interferometer Gravity-Wave Observatory and the proposed Laser Interferometer Space Antenna or other gravitational wave observatories. Why are the interferometers used in these observatories so long? What sensitivity do the scientists hope to achieve? What are the goals of these projects? How will detection of gravitational waves change our view of the universe?

37. The coherence of a laser beam allows it to be broken up into extremely short pulses called "bits." These bits allow information to be stored in digital form. Investigate the role of the laser in the storage, transmission, and retrieval of information in various media. Evaluate the efficiency of this process and discuss how consumers might expect it to evolve in the future. Summarize your findings in a report.

38. Different physical processes are responsible for producing electromagnetic radiation of different wavelengths. For each wavelength region of the electromagnetic spectrum (radio, infrared, visible, ultraviolet, X ray, gamma ray), identify at least one physical process that produces radiation in that wavelength range.

Problems for Understanding

Show complete solutions for all problems that involve equations and numbers.

39. Calculate the speed of water waves hitting the shore if adjacent crests are 3.0×10^1 m apart and a wave hits the beach every 1.0×10^1 s.

40. A pendulum takes 1.50 s to swing from the rest line to its highest point. What is the frequency of the pendulum?

41. A wave with an amplitude of 50.0 cm travels down a 12.0 m spring in 3.00 s. The student who creates the wave moves his hand through 5 cycles in 1 s. What is the wavelength?

42. A klystron tube in a microwave oven generates radiation of wavelength 4.20 cm. What is the frequency of the microwave radiation? (Microwaves travel at the same speed as light.)

43. The international tuning note (A above middle C) has a frequency of 440 Hz. If the speed of sound in air is 320 m/s, what is the wavelength of the note in air?

44. A sound wave reflects from the end of an air column with a distance between any two consecutive nodes of 54.0 cm. If the air temperature is 10.0°C, what is the frequency of the vibration?

45. A tuning fork with a frequency of 324 Hz is held over a tube whose length can be changed by raising and lowering a column of water in the tube. The surface of the water, initially very near to the top of the tube, is gradually lowered. If the speed of sound in air is 336 m/s, how far from the top of the tube is the surface of the water when the first point of constructive interference is detected?

46. When two tuning forks vibrate simultaneously the sound grows louder and softer, with 100 intensity peaks every 80.00 seconds. If one tuning fork is known to have a true frequency of 384.0 Hz, what are the possible frequencies of the other tuning fork?

47. In archery class you shoot an arrow with a constant speed of 22.0 m/s at a target that is 5.0×10^1 m away. How long after you release the arrow will you hear it hit the target?

48. The sonar of a submarine uses a sonic "ping" with a frequency of 698 Hz. The echo returns from a distant submarine 5.60 km away after 8.00 s. What is the wavelength of the sound the first submarine is using to echolocate the other submarine?

49. A student had no thermometer, so in order to measure the temperature, she resourcefully used the following procedure. She accurately measured a distance of 1.00×10^2 m from a wall, and then struck two stones together so that each new strike coincided with the echo from the previous strike. The student found that the time to make 1.50×10^2 strikes was 92 seconds. To the nearest degree, what was the air temperature?

50. Determine the speed of light in a solid that has an index of refraction of 1.87.

51. Determine the time it takes for light to travel 35 cm through the water in an aquarium.

52. What is the index of refraction of a medium if the angle of incidence in air is 68˚, and the angle of refraction is 42˚?

53. What is the angle of refraction if the angle of incidence is 55˚, and the index of refraction of the medium is 1.92?

54. The speed of light in a clear plastic is 1.9×10^8 m/s. A beam of light strikes the plastic at an angle of 24˚. At what angle is the beam refracted?

55. A block of glass has a critical angle of 46.0˚. What is its index of refraction?

56. The critical angle for a special glass in air is 40˚. What is the critical angle if the glass is immersed in water?

57. Light is travelling from a diamond into the block of plexiglass in which it is embedded. Determine the critical angle of the light in the diamond.

58. A detector tuned to microwave wavelengths registers 2500 wave crests in 1.0 μs. What is the wavelength, frequency, and period of the incoming wave?

59. If an electromagnetic wave has a period of 4.8 μs, what is its frequency and wavelength?

60. How many cycles of a 5.5×10^{-9} m ultraviolet wave are registered in 1.0 s?

61. The most efficient antennas have a size of half the wavelength of the radiation they are emitting. How long should an antenna be to broadcast at 980 kHz?

62. A light-year is the distance light travels in one year. How far is this in metres? (There are 365.25 days in one year.)

63. A certain beetle has wings with a series of bands across them. When 600 nm light is incident normally and reflects off the wings, the wings appear to be bright when viewed at an angle of 49˚. How far apart are the lines in the bands?