1. The diagram shown represents four waves traveling to the right in the same transmitting medium. Which type of wave is represented?
   A. elliptical  B. longitudinal  C. torsional  D. transverse

2. Which wave has the greatest frequency?
   A. A  B. B  C. C  D. D

3. Which wave has the greatest amplitude?
   A. A  B. B  C. C  D. D

4. Which characteristic is determined by the source of a wave train and will not change when the wave passes into another medium?
   A. frequency  B. wavelength  C. velocity  D. amplitude

5. The pattern shown was recorded by a tape timer. The space between the dots represents 0.02 second. What is the frequency of the timer?
   A. 0.02 cycle/sec  B. 5 cycles/sec  C. 50 cycles/sec  D. 500 cycles/sec

6. Which waves require a medium for transmission?
   A. light waves  B. radio waves  C. sound waves  D. cosmic waves

7. Periodic waves are being produced in a ripple tank. As the rate at which the waves are produced is increased, the wavelength of the waves will
   A. decrease  B. increase  C. remain the same

8. Which part of the longitudinal waveform shown represents a rarefaction?
   A. A  B. B  C. C  D. D
9. Which area of the longitudinal waveform area best represents the wavelength of the wave shown?
   A. A and B  B. B and C  C. C, only  D. D

10. For a standing wave, the distance between two consecutive minimums (nodes) is equal to
   A. 1 wavelength  B. 2 wavelengths  C. $\frac{1}{2}$ wavelength  D. $\frac{1}{4}$ wavelength

11. The frequency of a wave with a velocity of 30 meters per second and a wavelength of 5.0 meters is
   A. 150 waves/sec  B. 25 waves/sec  C. 6.0 waves/sec  D. 5.0 waves/sec

12. What is the velocity of a water wave that travels a distance of 10 meters in 5.0 seconds?
   A. 5.0 m/sec  B. 2.0 m/sec  C. 15 m/sec  D. 50 m/sec

13. Two waves have the same frequency in a medium. The wave with the greater energy has the greater
   A. amplitude  B. velocity  C. wavelength  D. period

14. If the velocity of a constant-frequency wave increases, the wavelength
   A. decreases  B. increases  C. remains the same

15. The number of waves passing a point in a unit of time is called
   A. frequency  B. wavelength  C. amplitude  D. period

16. Two pulses are traveling along a string toward each other as represented in the diagram shown. Which phenomenon will occur as the pulses meet
   A. reflection  B. diffraction  C. interference  D. refraction

17. Which characteristic of a wave changes as the wave travels across a boundary between two different media?
   A. frequency  B. period  C. phase  D. speed

18. What is the period of a wave with a frequency of $2.0 \times 10^2$ hertz?
   A. $6.0 \times 10^{-10}$ s  B. $2.0 \times 10^{-3}$ s  C. $5.0 \times 10^{-3}$ s  D. $1.5 \times 10^6$ s
19. As shown in the diagram, a transverse wave is moving along a rope. In which direction will segment X move as the wave passes through it?

A. down, only  
B. up, only  
C. down, then up  
D. up, then down

20. The diagram shows a transverse water wave moving in the direction shown by velocity vector $v$. At the instant shown, a cork at point $P$ on the water’s surface is moving toward

A. $A$  
B. $B$  
C. $C$  
D. $D$

21. Which point on the wave diagram shown is in phase with point $A$?

A. $E$  
B. $B$  
C. $C$  
D. $D$

22. How many nodes are represented in the standing wave diagram?

A. 1  
B. 6  
C. 3  
D. 4

23. As a periodic wave travels from one medium to another, which pair of the wave’s characteristics cannot change?

A. period and frequency  
B. period and amplitude  
C. frequency and velocity  
D. amplitude and wavelength

24. The diagram pictured shows radar waves being emitted from a stationary police car and reflected by a moving car back to the police car. The difference in apparent frequency between the incident and reflected waves is an example of

A. constructive interference  
B. refraction  
C. the Doppler effect  
D. total internal reflection
25. Two wave sources operating in phase in the same medium produce the circular wave patterns shown in the diagram. The solid lines represent wave crests and the dashed lines represent wave troughs. Which point is at a position of maximum destructive interference?

A. A  B. B  C. C  D. D

26. The diagram pictured shows two pulses, each of length \( \lambda \), traveling toward each other at equal speed in a rope. Which diagram best represents the shape of the rope when both pulses are in region \( AB \)?

A.  

B.  

C.  

D.  

27. In the diagram shown, the distance between points \( A \) and \( B \) on a wave is 0.10 meter. This wave must have

A. an amplitude of 0.10 m  
B. an amplitude of 0.20 m  
C. a wavelength of 0.10 m  
D. a wavelength of 0.20 m

28. The diagram shown represents a rope along which two pulses of equal amplitude, \( A \), approach point \( P \). When the two pulses meet at \( P \), the vertical displacement of the rope at point \( P \) will be

A. \( A \)  
B. \( 2A \)  
C. 0  
D. \( \frac{A}{2} \)

29. Which graph best represents the relationship between the frequency and period of a wave?

A.  

B.  

C.  

D.  

30. A wave generator located 4.0 meters from a reflecting wall produces a standing wave in a string, as shown in the accompanying diagram.

If the speed of the wave is 10. meters per second, what is its frequency?

A. 0.40 Hz  
B. 5.0 Hz  
C. 10 Hz  
D. 40. Hz
31. The accompanying diagram shows two waves approaching each other in the same uniform medium.

Which diagram best represents the appearance of the medium after the waves have passed through each other?

A. 

B. 

C. 

D. 

32. What is the period of a wave if 20 crests pass an observer in 4 seconds?

A. 80 s  B. 0.2 s  C. 5 s  D. 4 s

33. A train sounding its whistle is moving rapidly away from an observer. The frequency the observer hears appears to

A. decrease  B. increase  C. remain the same

34. A term often used to describe the frequency of a sound is

A. amplitude  B. volume  C. pitch  D. tone

35. When the sound made by one tuning fork causes another tuning fork to vibrate, the principle demonstrated is

A. reflection  B. refraction  C. interference  D. resonance

36. The length of a vibrating air column is shortened. The sound wave produced by the shortened air column will have an increase in

A. frequency  B. wavelength  C. amplitude  D. speed

37. As the frequency of a sound wave decreases, its pitch

A. decreases  B. increases  C. remains the same
38. An opera singer’s voice is able to break a thin crystal glass if the singer’s voice and the glass have the same natural frequency. 

A. frequency B. speed 
C. amplitude D. wavelength

39. The diagram pictured shows a parked police car with a siren on top. The siren is producing a sound with a frequency of 680 hertz, which travels first through point A and then through point B, as shown. The speed of the sound is 340 meters per second. 

If the sound waves are in phase at points A and B, the distance between the points could be 

A. $1\lambda$ B. $\frac{1}{2}\lambda$ C. $\frac{3}{2}\lambda$ D. $\frac{1}{4}\lambda$

40. What is the wavelength of the sound produced by the car’s siren? 

A. 0.50 m B. 2.0 m 
C. $2.3 \times 10^{-5}$ m D. $2.3 \times 10^{-6}$ m

41. Two speakers, $S_1$ and $S_2$, operating in phase in the same medium produce the circular wave patterns shown in the diagram below. 

At which two points is constructive interference occurring? 

A. A and B B. A and D 
C. B and C D. B and D

42. An echo heard when a person shouts in a canyon is due to the sound waves being 

A. mixed B. refracted 
C. diffracted D. reflected

43. Two tuning forks are struck at the same time. Their sound is observed to become louder and softer at regular intervals. This is caused by wave interference. 

A. condensation B. refraction 
C. interference D. amplification

44. Beats are produced by two sound waves having different frequencies. 

A. frequencies B. amplitudes 
C. loudness D. energies
45. Increasing the amplitude of a sound wave will make it

A. louder  B. have a higher pitch
C. travel faster  D. produce beats

46. At an outdoor physics demonstration, a delay of 0.50 second was observed between the time sound waves left a loudspeaker and the time these sound waves reached a student through the air. If the air is at STP, how far was the student from the speaker?

A. $1.5 \times 10^{-3}$ m  B. $1.7 \times 10^{2}$ m
C. $6.6 \times 10^{2}$ m  D. $1.5 \times 10^{3}$ m

47. Which diagram best illustrates wave refraction?

A.          B.          C.          D.          

48. Which wave phenomenon is represented in the diagram here?

A. refraction  B. diffraction
C. reflection  D. interference

49. The diagram represents wave fronts traveling from medium $X$ into medium $Y$. All points on any one wave front shown must be

A. traveling with the same speed  B. traveling in the same medium
C. in phase  D. superposed

50. Parallel wave fronts incident on an opening in a barrier are diffracted. For which combination of wavelength and size of opening will diffraction effects be greatest?

A. short wavelength and narrow opening  B. short wavelength and wide opening
C. long wavelength and narrow opening  D. long wavelength and wide opening
51. The diagram shows a wave phenomenon. The pattern of waves shown behind the barrier is the result of

A. reflection  
B. refraction  
C. diffraction  
D. interference

52. Base your answer(s) to the following question(s) on the information and diagram below.

A stationary research ship uses sonar to send a $1.18 \times 10^3$-hertz sound wave down through the ocean water. The reflected sound wave from the flat ocean bottom 324 meters below the ship is detected 0.425 second after it was sent from the ship.

Calculate the wavelength of the sound wave in the ocean water. [Show all work, including the equation and substitution with units.]

53. The sonar of a stationary ship sends a signal with a frequency of $5.0 \times 10^3$ hertz down through water. The speed of the signal is $1.5 \times 10^3$ meters per second. The echo from the bottom is detected 4.0 seconds later.

a) What is the wavelength of the sonar wave? [Show all calculations, including the equation and substitution with units.]

b) What is the depth of the water under the ship? [Show all calculations, including the equation and substitution with units.]

54. Base your answer(s) to the following question(s) on the information below.

One end of a rope is attached to a variable speed drill and the other end is attached to a 5.0-kilogram mass. The rope is draped over a hook on a wall opposite the drill. When the drill rotates at a frequency of 20.0 Hz, standing waves of the same frequency are set up in the rope. The diagram below shows such a wave pattern.

Determine the wavelength of the waves producing the standing wave pattern.
55. Base your answer(s) to the following question(s) on the diagram below, which shows a wave in a rope.

Determine the wavelength of the wave.

56. Determine the amplitude of the wave.
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