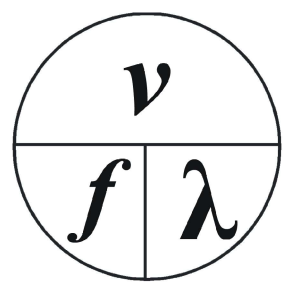
Conceptual Physics: Form TR-Ex.19_CP Name ________________________________

ADDITIONAL TEST REVIEW Date __________________ Period _____

Additional Test Review

The Nature of Waves. A wave is a rhythmic disturbance that carries energy without carrying matter. For example, when a rock is thrown in a pond, ripples move across the pond in concentric rings, but the water is not moving across the pond. There are two main types of Waves, mechanical waves and electromagnetic waves. Mechanical waves use matter, or a medium, to transfer energy. There are two types of mechanical waves, transverse and longitudinal or compressional waves. A transverse wave causes the medium to move at right angles to the direction the wave is traveling.A water wave, for example, spreads across a body of water but the water moves up and down. The high points are called crests, and the low points are called troughs. In a compressional or longitudinal wave the medium moves back and forth in the same direction that the wave passes. A sound wave, for example causes the particles in the medium to be alternately pushed together (compression) and spread apart (rarefaction).The series of compressions and rarefactions moving through a medium is a longitudinal wave. Electromagnetic waves are waves that can travel through space where no matter is present. Examples are radio waves, infrared, visible light, ultraviolet, X rays, and gamma rays. Ninety two percent of the electromagnetic waves that reach earth from the sun is infrared and visible light. Infrared makes you warm, while visible light enables you to see. Some of the radiant energy from the sun is ultraviolet, which causes tanning and sunburn.

Wave Properties. Amplitude refers to the size of a wave. For transverse waves, amplitude is how high a wave rises above or falls below the rest position, or half the distance between the top of the crest and the bottom of the trough. For longitudinal waves, it is the degree to which the particles are squeezed together during a compression, and spread apart during a rarefaction. As the amplitude of a wave increases, its energy also increases. Wavelength is the distance between the repeating parts of the wave. For transverse waves, it is the distance from crest to crest, or from trough to trough. For longitudinal waves, it is the distance from compression to compression, or from rarefaction to rarefaction. Electromagnetic waves vary in length from kilometers for radio waves to less than the diameter of an atom for X-rays and gamma rays. Frequency is the number of wave lengths that pass a given point per second. For transverse waves, it is the number of crests or troughs passing a point per second. For longitudinal waves, it is the number of compressions or rarefactions passing a point per second. Frequency is measured in wavelengths per second or hertz (Hz). For waves of the same speed, the shorter the wavelength is, the higher the frequency is. Wavelength or frequency determine the color of light, and the pitch of a sound. Waves travel at different speeds. Light waves travel faster than sound waves in air. Mechanical waves travel fastest through solids and slowest through gases but not at all in a vacuum. Electromagnetic waves, on the other hand, travel fastest in a vacuum, but in a medium, they travel fastest through gases and slowest through solids. Wave speed can be determined using the equation $v = f\lambda$, where v is speed in meters per second [$^m/_s$], f is frequency in wavelengths per second or hertz [Hz], and λ is wave length in meters [m].



Wave Behavior . Waves can bend around a barrier. This is called **diffraction**. The closer an object's size is to the wavelength of the wave, the more the wave bends, and the greater the diffraction is. Waves can also interact with each other. When the waves meet and overlap, they combine to form a new wave. The ability of two waves to combine and form a new wave when they overlap is called **interference**. There are two types, constructive interference and destructive interference. Constructive interference results in a wave with greater amplitude. Destructive interference results in a wave with smaller amplitude. Constructive interference occurs when the crest of one wave overlaps the crest of another wave to form a wave with higher amplitude. Destructive interference occurs when the crest of one wave overlaps the trough of another wave to form a wave with lower amplitude. When a sound wave interferes destructively with another sound wave its amplitude or volume is reduced. Since a wave that interferes destructively with one wave does not have the same effect on waves with different properties it is possible to reduce noise without reducing the volume of what you want to hear. Interference and diffraction are properties of waves only, not particles. When a wave strikes an object or surface it can bounce off. A bouncing wave is a **reflection**. Sound reflections are echos, while light reflections are mirror images. When light bounces off a smooth surface, a sharp mirror like image forms. Uneven or rough surfaces scatter light making the image unclear. When a wave passes from one substance to another, it may bend. Bending of a wave as it passes from one medium to another is called **refraction**. Waves travel at different speeds in different mediums. Refraction occurs when a wave changes speed as it passes from one medium to another. The direction the wave bends depends on whether it is slowing down or speeding up. It is best understood relative to an imaginary line perpendicular to the surface of the medium called the normal. A wave speeding up as it enters a medium bends away from the normal. A wave slowing down as it enters a medium bends toward the normal. When light passes through a raindrop or a prism, it is refracted twice – once on the way in, and once on the way out. Red light (the longest wave length) is refracted least, and violet light (the shortest wavelength) is refracted most. As a result the colors of light are separated. Rainbows form from many separate water droplets acting as prisms.

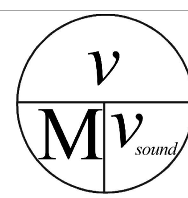
Nature of Sound. A vibrating object causes molecules in the surrounding medium to move back and forth. Those molecules collide with nearby molecules in the medium and cause them to move back and forth. The molecules move back and forth parallel to the direction the energy is moving. As the vibrating object moves towards the medium, it squeezes molecules together forming a region of higher density or a **compression**. As the vibrating object moves away from the medium, a region of lower density forms as the particles of the medium spread. This region of lower density is called a **rarefaction**. The vibrating object creates a series of compressions and rarefactions that move through the medium away from the source of the vibration. This is a longitudinal wave called a sound wave. It transfers energy through the medium parallel to the direction of molecular motion. The frequency of the sound wave is the number of compressions or rarefactions that pass a given point per second. The further apart the compressions and rarefactions are, the higher the wavelength is and the lower the frequency is. An object that vibrates faster forms a sound wave with a shorter wavelength and a higher frequency. The higher the frequency of a sound wave is, the higher the pitch is. **Pitch** is how high or low a tone sounds. Humans can detect sounds with frequencies between 20 Hz and 20,000 Hz. The speech of a typical adult male will have a fundamental frequency from 85 to 180 Hz, and that of a typical adult female from 165 to 255 Hz. There are also higher frequency overtones that are important to speech. Human sound is formed when air passing the vocal cords causes them to vibrate. The length and thickness of the vocal cords determine the pitch. Shorter, thinner vocal cords vibrate at higher frequencies producing a higher pitch. Muscles in the throat can stretch the vocal cords, enabling people to vary their pitch within a limited range.

Loudness. The higher the amplitude of a sound wave is, the more compressed the particles in a compression are, and the more spread out the particles in the rarefaction are. Sound waves with higher amplitude have higher energy, and are generally perceived as louder. To humans, however, sounds with frequencies between 1,000 Hz and 4,000 Hz are perceived as louder than sound waves with the same energy at other frequencies. Loudness is measured in decibels (dB). The decibel scale is a logarithmic scale based on the ratio of the energy of a sound wave to a reference level at the threshold of human hearing which is 20 micropascals or 0 dB (200 trillionths that of normal air pressure).An increase of 10 decibels refers to a tenfold increase in loudness (10 times as much energy for a sound wave). An increase in loudness from 0 dB to 10 dB is 10 times as loud, while an increase in loudness from 0 dB to 20 dB is 100 times as loud. Hearing damage begins around 85 dB.

Frequency and pitch. The higher the frequency of a sound wave is, the higher the pitch is. Humans can detect sounds with frequencies between 20 Hz and 20,000 Hz. The frequency of most dog whistles is within the range of 23,000 to 54,000 Hz. Dogs and cats can hear it, but we can't. The voiced speech of a typical adult male will have a fundamental frequency from 85 to 180 Hz, and that of a typical adult female from 165 to 255 Hz. Speech also has overtones at higher frequencies that affect the quality of the sound and make it understandable. Human sound is formed when air passing the vocal cords causes them to vibrate. The length and thickness of the vocal cords determine the pitch. Shorter, thinner vocal cords vibrate at higher frequencies. Muscles in the throat can stretch the vocal cords, enabling people to vary their pitch within a limited range.
Echoes. Sound is a wave. Like other waves it can bounce off surfaces and be reflected. A reflected sound wave is an **echo**. Echoes are sound waves. They travel at the same speed as other sound waves. This is helpful in making use of echoes. **Sonar** uses sound waves to map objects under water by sending out sound pulses, and tracking the echoes. The amount of time it takes an echo to return depends on the distance of the reflecting surface. Measuring the time between an emitted pulse of sound and detecting the echo tells the distance to the ocean floor or object reflecting the sonar sound pulse. Some animals use echoes to navigate and hunt. This is called **echolocation**.
The Doppler Effect. The Doppler effect is the change in frequency that occurs when a source of sound is moving relative to the listener. As the sound source and listener approach each other the pitch and frequency increase. This is because the time between when you encounter compressions or rarefactions is shortened as you approach the source of sound. As the sound source and listener separate from each other the pitch and frequency decrease. This is because the time between when you encounter compressions or rarefactions is lengthened as you leave the source of sound. The Doppler effect is used in both radar and ultra sound. Radar detects Doppler shifts in radio wave echoes. This makes it possible to tell whether the object reflecting the radio waves is approaching or receding. Ultrasound consists of sound waves at frequencies above the normal hearing range. Ultrasound waves focused on the kidney or gall bladder can cause stones to vibrate until they break apart. Ultrasound echoes can be used to form images of the inside of the body. Ultrasound can also be used to measure blood flow in arteries by using the Doppler effect. When moving blood reflects ultrasound waves, the frequency gets higher if blood is moving toward the probe and a lower if blood is moving away from the probe. The larger the frequency change is, the faster the blood is moving.
Speed of Sound. The speed of sound is affected by the medium. Particles are closest in solids and furthest apart in gases. Since sound is transmitted by collisions between molecules of the medium, sound usually travels fastest in solids and slowest in gases. The higher the temperature is, the faster the molecules move. The faster the molecules move the higher the rate of collisions is. As a result, the speed of sound increases as temperature increases. A whip or a bullet go faster than sound. Prior to the 1950s, however, aircraft could not exceed the speed of sound (343 m/s or 1,235 km/h), due to drag and instability. As a result, the speed of sound actually was a barrier! Changes in airplane design eventually broke through the barrier. On October 14, 1947, Chuck Yeager officially broke the sound barrier in level flight. A jet makes is a sonic boom much like the loud crack a whip when it breaks the sound barrier. A sonic boom is a shock wave that forms from bunched up sound waves. Ernst Mach, an Austrian physicist, described and photographed shock waves. The Mach Number is named after him. The Mach Number describes the speed of an object in a medium relative to the speed of sound. Mach 1 is the speed of sound. Mach 2 is twice the speed of sound. The Mach number depends on the medium.

$$M = \frac{v}{v_{sound}}$$

- M = mach number
- v = speed relative to the medium
- v_{sound} = speed of sound in the medium



Hearing Sound. Your ears collect, amplify, and interpret sound. The outer ear, with its funnel shape, is a sound collector. It funnels sound into the auditory canal which carries the waves to the ear drum. The middle ear, which consists of the eardrum and three small bones, is an amplifier. The eardrum vibrates in response to sound. Three small bones, the hammer, anvil, and stirrup amplify sound by leverage, and transfer vibrations from the eardrum to the oval window on the cochlea. The inner ear, which contains the cochlea, a snail shaped, fluid filled chamber, is a sound interpreter. The stirrup presses on the oval window producing pressure waves in the fluid of the cochlea. The oval window, a small membrane on the cochlea, amplifies vibrations of the eardrum (NOTE: $P = F/A$ - the relatively smaller area of the oval window result in an increase in the pressure resulting from the applied force). The cochlea contains the receptors called hair cells. Different hair cells respond to different frequencies and send information to the brain. Constant exposure to loud noise can damage hair cells. Hair cells also degenerate with age and disease. Mammalian hair cells do not regenerate. Damage to hair cells results in hearing loss.

Answer the questions below by circling the number of the correct response

1. The type of wave that has rarefactions is a –?–. (1) mechanical wave (2) longitudinal wave (3) transverse wave (4) electromagnetic wave

2. The distance between two adjacent crests of a transverse wave is the –?–. (1) wavelength (2) rarefaction (3) diffraction (4) amplitude

3. The more energy a wave carries, the greater its –?– is. (1) wavelength (2) rarefaction (3) diffraction (4) amplitude

4. A(n) –?– can travel through space without a medium. (1) electromagnetic wave (2) mechanical wave (3) transverse wave (4)reflection

5. What is the material through which mechanical waves travel? (1) charged particles (2) space (3) a vacuum (4) a medium

6. What is carried from particle to particle in a water wave? (1) speed (2) amplitude (3) energy (4) matter

7. What are the lowest points on a transverse wave called? (1) crests (2) troughs (3) compressions (4) rarefactions

8. What determines the pitch of a sound wave? (1) amplitude (2) frequency (3) speed (4) refraction

9. What is the distance between adjacent wave compressions? (1) one wavelength (2) 1 km (3) 1 m/s (4) 1 Hz

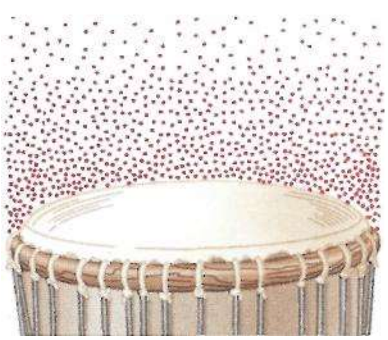
10. What type of wave is the sound wave pictured to the right?

(1) transverse

(2) electromagnetic

(3) longitudinal

(4) refracted

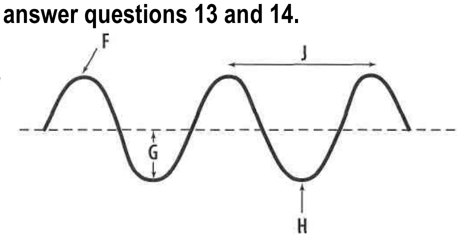


11. What color light has the shortest wave-length and the highest frequency? (1) red (2) green (3) orange (4) blue

12. What do waves carry as they move? (1) matter (2) energy (3) matter and energy (4) particles and energy

Use the figure below to answer questions 13 and 14.

13. What property of the wave is shown at F?
(1) amplitude
(2) wavelength
(3) crest
(4) trough



14. What property of the wave is shown at J? (1) amplitude (2) wavelength (3) crest (4) trough

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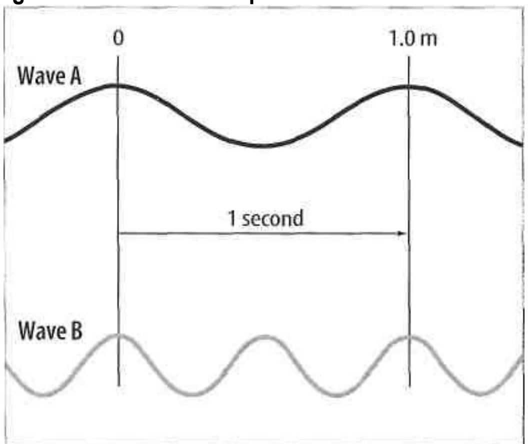
15. What kind of wave does NOT need a medium through which to travel? (1) mechanical (2) sound (3) light (4) refracted

16. What happens as a sound wave's energy decreases? (1) Wave frequency decreases. (2) Wavelength decreases. (3) Amplitude decreases. (4) Wave speed decreases.

17. What unit is used to measure frequency? (1) meters (2) meters/second (3) decibels (4) hertz

18. What properties of a light wave determines its color? (1) wavelength (2) amplitude (3) speed (4) interference

Use the figure below to answer questions 19 and 21.



19. How does the wavelength of wave A compare to the wave length of wave B? (1) it is half as big, (2) It is twice as big. (3) It is 3 times as big. (4) It is 1½ times as big.

20. What is the frequency of wave B? (1) 1 Hz (2) 2 Hz (3) 3 Hz (4) 1.5 Hz

21. If both waves are traveling through the same medium, how do their speeds compare? (1) Wave A is faster. (2) Wave B is faster. (3) Waves A and B move at the same speed. (4) There is no way to tell.

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22. An earthquake in the middle of the Indian Ocean produces a tsunami that hits an island. Is the water that hits the island the same water that was above the place where the earthquake occurred? (1) Yes, because the earthquake pushed it there. (2) Yes, because the wave carried it there. (3) No, because a wave only transfers energy, not the medium. (4) There is no way to tell.

23. The speed of a wave is equal to: (1) the amplitude divided by the frequency. (2) the amplitude multiplied by the frequency. (3) the wavelength divided by the frequency. (4) the wavelength multiplied by the frequency.

24. In dry air at 20.°C, sound travels at 343.3 $^{m}/_{s}$. Middle C has a frequency of 261.6 Hz. What is its wavelength? (1) 604.9 m (2) 1.31 m (3) 81.7 m (4) 89,807 m

25. The speed of light is 3.00×10^{8} $^{m}/_{s}$. Green light has a wavelength of 6.30×10^{-7} *m*. What is its frequency? (1) 4.76×10^{14} Hz (2) 9.30×10^{1} Hz (3) 3.30×10^{15} Hz (4) 189 Hz

26. What determines the pitch of a sound wave? (1) amplitude (2) frequency (3) speed (4) refraction

27. The change in direction of a wave going from one medium to another is (1) refraction (2) reflection (3) diffraction (4) wavelength

28. What occurs when a wave strikes an object or surface and bounces off? (1) diffraction (2) refraction (3) a transverse wave (4) reflection

Use the figure below to answer questions 29 and 30.

29. What behavior of light waves lets you see a sharp, clear image of yourself? (1) refraction (2) diffraction (3) reflection (4) interference

30. Why can't you see a clear image of yourself if the water's surface is rough? (1) The light bounces off the surface in only one direction. (2) The light scatters in many different directions. (3) There is no light shining on the water's surface. (4) The light changes speed when it strikes the water.

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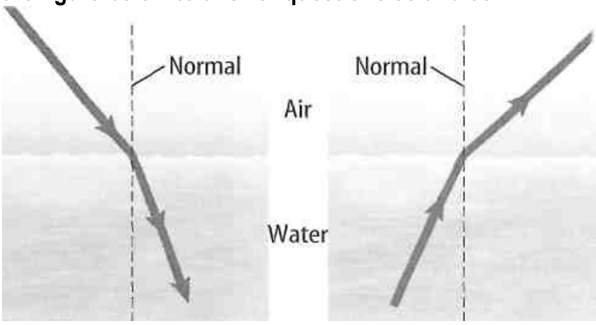
31. What happens when light travels from air into glass? (1) It speeds up. (2) It slows down. (3) It travels at 300,000 km/s. (4) It travels at the speed of sound.

32. What is the name for a change in the direction of a wave when it passes from one medium into another? (1) refraction (2) interference (3) reflection (4) diffraction

33. In a science fiction movie, a spaceship explodes. The people in a nearby spaceship see the explosion, but can't hear it because (1) light is an electromagnetic wave and sound is a mechanical wave, (2) light is a mechanical wave and sound is an electromagnetic wave, (3) light is diffracted and sound is not, (4) sound is diffracted and light is not.

34. A tone that is lower in pitch is lower in what characteristic? (1) frequency (2) wavelength (3) loudness (4) resonance

Use the figure below to answer questions 35 and 36.



35. Why does the light ray bend toward the normal when is passes from air into water? (1) Water is wet. (2) Light slows down when it enters water. (3) Light speeds up when it enters water. (4) Water is blue.

36. Compared to its actual position, to a fish in the water, a bird in the air appears to be (1) closer to the normal, (2) further from the normal, (3) at the normal, (4) in its actual position.

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37. When two waves overlap and interfere constructively, what does the resulting wave have? (1) a greater amplitude (2) less energy (3) a change in frequency (4) a lower amplitude

38. You are standing outside a classroom with an open door. You hear people talking but cannot see them because (1) the sound is diffracted but the light is not, (2) the light is diffracted but the sound is not, (3) light is an electromagnetic wave and sound is a mechanical wave, (4) light is a mechanical wave and sound is an electromagnetic wave.

39. How does the size of an obstacle affect the diffraction of a wave? (1) The smaller the wavelength is compared to the size of the obstacle, the more the wave is diffracted. (2) The larger the wavelength is compared to the size of the obstacle, the more the wave is diffracted. (3) The more similar the wavelength is to the size of the obstacle, the more the wave is diffracted. (4) The is no relationship between the wavelength and the size of the obstacle with respect to diffraction.

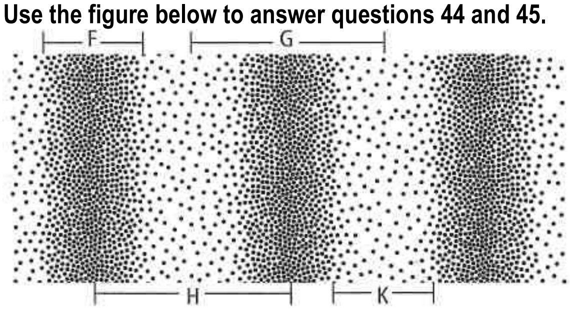
40. If a wave speed stays the same, which of the following decreases as the frequency increases? (1) pitch (2) wavelength (3) loudness (4) resonance

41. What is an echo? (1) diffracted sound (2) resonating sound (3) reflected sound (4) an overtone

42. Sound waves are which type of wave? (1) slow (2) transverse (3) longitudinal (4) electromagnetic

43. How can the pitch of the sound made by a guitar string be lowered? (1) by shortening the part of the string that vibrates (2) by tightening the string (3) by replacing the string with a thicker string (4) by plucking the string harder

Use the figure below to answer questions 44 and 45.



44. What part of the wave is shown at F? (1) rarefaction (2) compression (3) wavelength (4) amplitude

45. What part of the wave is shown at H? (1) rarefaction (2) compression (3) wavelength (4) amplitude

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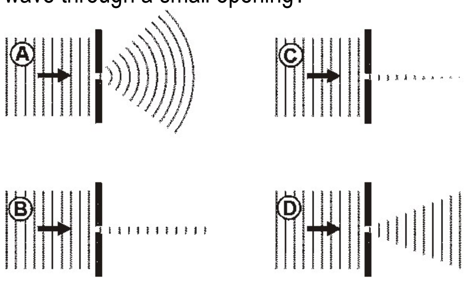
46. What happens to the particles of matter when a longitudinal wave moves through the matter? (1) The particles do not move. (2) The particles move back and forth along the wave direction. (3) The particles move back and forth and are carried along with the wave. (4) The particles move at right angles to the direction the wave travels.

47. Which wave phenomenon is pictured in the photograph to the right showing the waves flowing around the rocks? (1) refraction (2 infarction (3) reflection (4) diffraction

48. When a sound wave passes through an opening, what does the amount of diffraction depend on? (1) the size of the opening only (2) the wavelength only (3) both the size of the opening and the wavelength (4) neither the size of the opening nor the wavelength

49. Constructive interference occurs when two waves: (1) add up to create a wave that is **smaller** than either single wave. (2) add up to create a wave that is **larger** than either single wave. (3) are moving at the same speed. (4) have equal and opposite amplitudes.

50. Which of the diagrams below best illustrates the movement of a wave through a small opening?



(1) A (2) B (3) C (4) D

51. Which of the following will INCREASE the natural frequency of a vibrating string? (1) Making the string longer, and keeping the tension the same (2) Making the string shorter, and keeping the tension the same (3) Keeping the length the same, and decreasing the tension (4) Keeping the length the same, and keeping the tension the same

52. Which of the following is NOT related to the amplitude of a sound wave? (1) energy carried by the wave (2) loudness of a sound (3) pitch of a sound (4) how spread out the particles are in the compressions and rarefactions

53. The decibel scale is used to measure: (1) the loudness of a sound. (2) the pitch of a sound. (3) the harmonic content of a sound. (4) the variation in frequency of a sound.

54. The wavelength of a sound wave can be calculated by: (1) multiplying the amplitude by the frequency. (2) dividing the amplitude by the frequency. (3) multiplying the speed by the frequency. (4) dividing the speed by the frequency.

55. The average human ear cannot hear frequencies above: (1) 20 hertz. (2) 2,000 hertz. (3) 20,000 hertz. (4) 200,000 hertz.

56. Sounds that make up the human voice include mostly frequencies: (1) lower than 100 hertz. (2) between 100 and 2,000 hertz. (3) between 2,000 and 10,000 hertz. (4) above 10,000 hertz.

57. The wavelength of low frequency sound is: (1) smaller than the wavelength of high frequency sound. (2) about the same as the wavelength of high frequency sound. (3) larger than the wavelength of high frequency sound. (4) proportional to the loudness of the sound in decibels.

58. The "pitch" of a sound is determined by its (1) overtones frequencies (2) harmonics frequencies (3) fundamental frequency (4) resonance frequencies

59. The intensity or loudness of a musical sound is related to the sound wave's (1) wavelength (2) frequency (3) amplitude (4) wave speed

60. Suppose you play a note of a certain pitch on a violin You can produce a lower-pitched note by (1) shortening the length of the string that is allowed to vibrate (2) increasing the tension of the string (3) decreasing the linear mass density of the string (4) lengthening the part of the string that vibrates.

61. A tone that is lower in pitch is lower in what characteristic? (1) frequency (2) loudness (3) wavelength (4) resonance

62. The speed of sound in air is approximately: (1) 34 m/s. (2) 340 m/s. (3) 3,400 m/s. (4) 34,000 m/s.

63. If you were on a moving train, what would happen to the pitch of a bell at a crossing as you approached and then passed by the crossing? (1) It would seem higher, then lower. (2) It would remain the same. (3) It would seem lower and then higher. (4) It would keep getting lower.

64. The nerves that give humans the ability to sense sound are located in: (1) the eardrum. (2) the auditory canal. (3) the cochlea. (4) the three small bones of the inner ear.

65. We can tell what direction a sound is coming from because: (1) the eardrum can sense the direction as well as the frequency of sound. (2) the right ear hears higher frequencies than the left ear. (3) sounds reaching one ear are slightly out of phase with sounds reaching the other ear. (4) the wavelength of sounds reaching one ear is longer than the wavelength of sounds reaching the other because both ears are separated by the width of your head.

66. What does the middle ear do? (1) focuses sound (2) collects sound (3) interprets sound (4) transmits and amplifies sound

Answers

1. 2	**15.** 3	**29.** 3	**43.** 3	**57.** 3
2. 1	**16.** 3	**30.** 2	**44.** 2	**58.** 3
3. 4	**17.** 4	**31.** 2	**45.** 3	**59.** 3
4. 1	**18.** 1	**32.** 1	**46.** 2	**60.** 4
5. 4	**19.** 2	**33.** 1	**47.** 4	**61.** 1
6. 3	**20.** 2	**34.** 1	**48.** 3	**62.** 2
7. 2	**21.** 3	**35.** 2	**49.** 2	**63.** 1
8. 2	**22.** 3	**36.** 1	**50.** 1	**64.** 3
9. 1	**23.** 4	**37.** 1	**51.** 2	**65.** 3
10. 3	**24.** 2	**38.** 1	**52.** 3	**66.** 4
11. 4	**25.** 1	**39.** 3	**53.** 1	
12. 2	**26.** 2	**40.** 2	**54.** 4	
13. 3	**27.** 1	**41.** 3	**55.** 3	
14. 2	**28.** 4	**42.** 3	**56.** 2	