Unit 4b Study Guide KEY: Waves, Sound & Light

1. What is the EM spectrum?

   An arrangement of wavelengths which electromagnetic radiation

2. What is the unit for frequency?

   Hertz (Hz)

3. How do the waves/rays of the spectrum travel?

   EM waves do not need a medium and travel as a transverse wave.

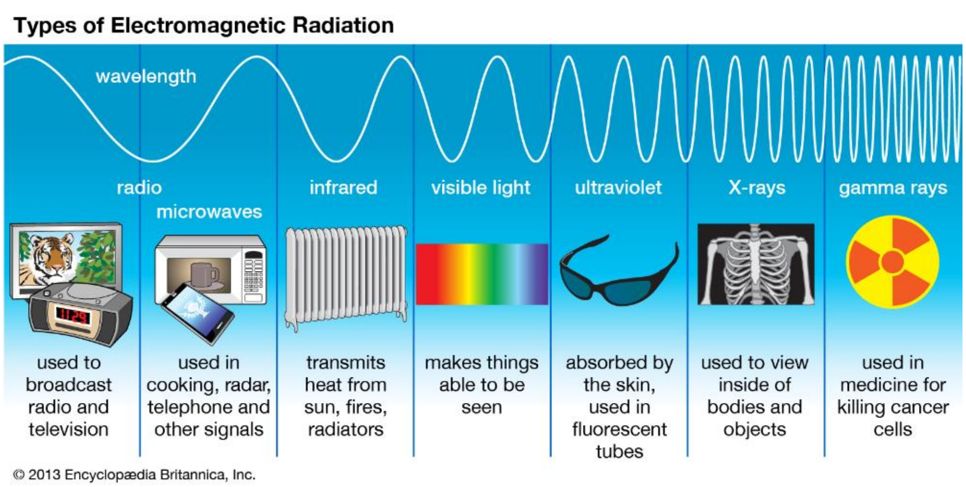
4. Can EM rays travel in a vacuum?

   Yes. They are not mechanical waves; therefore, they can travel through a vacuum.

5. List the waves/rays of the EM (according to wavelength).

   Radio, microwaves, infrared, visible (ROYGBIV), ultraviolet, x-rays, gamma rays

6. What are multiple uses for each type of wave/ray on the EM spectrum?



7. How do the two types of mechanical waves travel?
   a. Longitudinal- the particles vibrate parallel to the direction the wave travels
   b. Transverse- the particles of the medium travel perpendicular to the direction of the wave

8. What are the types of wave interactions? Give an example of each.

Reflection-the bouncing of light off a surface

Example: When light strikes a smooth or shiny surface such as a mirror, it reflects in a uniform way and the mirror produces an image.

Refraction-the change in direction of a wave as it passes from one medium into another at an angle. Refraction is due to the change in speed as a wave enters a new medium.

Example: a straight object, such as a straw looks bent or broken when part of it is underwater. Light from the straw changes directions when it passes from water to glass and from glass to air.

Diffraction- occurs when a wave bends as it passes through an opening or around an object

Example- light bends or diffracts as it passes through an opening in a barrier.

Interference- the combination of two or more waves that results in a single wave.

Constructive Interference- waves overlap and combine to form a wave with a larger amplitude, or height. The greater amplitude causes the waves to produce a sound that is louder than before. Constructive interference can cause very loud sounds, such as sonic booms.

Destructive - waves combine to form a wave with a smaller amplitude. The sound will be softer because the amplitude is decreased. Some noise-canceling headphones use destructive interference.

9. What is the relationship between amplitude and energy?

   For a mechanical wave, the wave with greater amplitude carries more energy.

10. How does amplitude relate to sound and light?

Sound- sound waves with greater amplitude transfer more energy to your eardrum, so they sound louder.

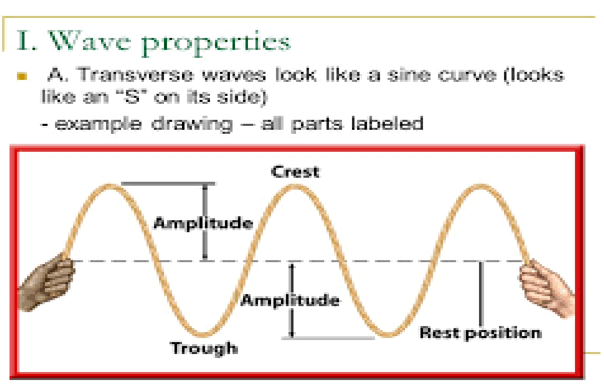
Light- the intensity of light is directly proportional to the square of the amplitude.

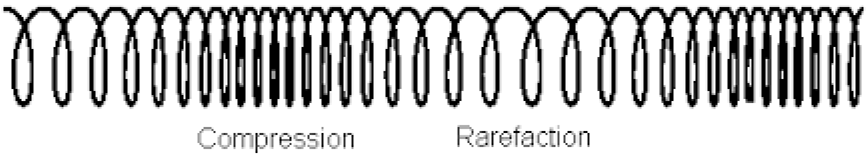
11. What are standing waves? What is resonance?

Standing wave- a pattern of vibration that looks like a wave that is standing still

Resonance-occurs when standing waves are formed

12. Draw and label both a transverse and longitudinal wave with the following parts - crest, trough, compression, rarefaction, amplitude, rest position and wavelength

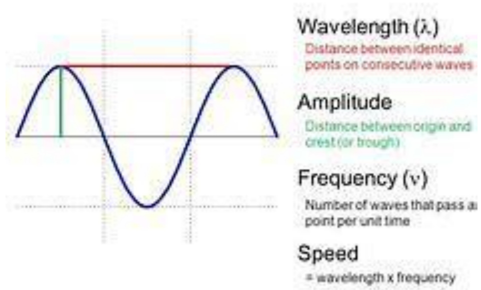


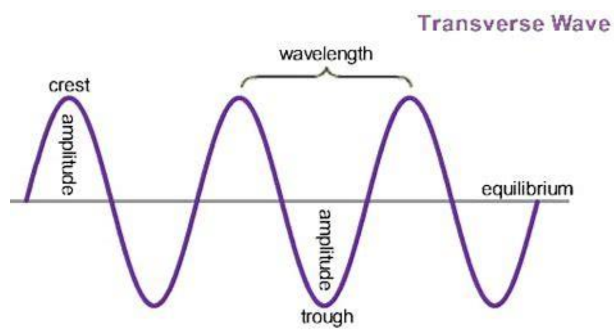


13. How do you measure a wave?

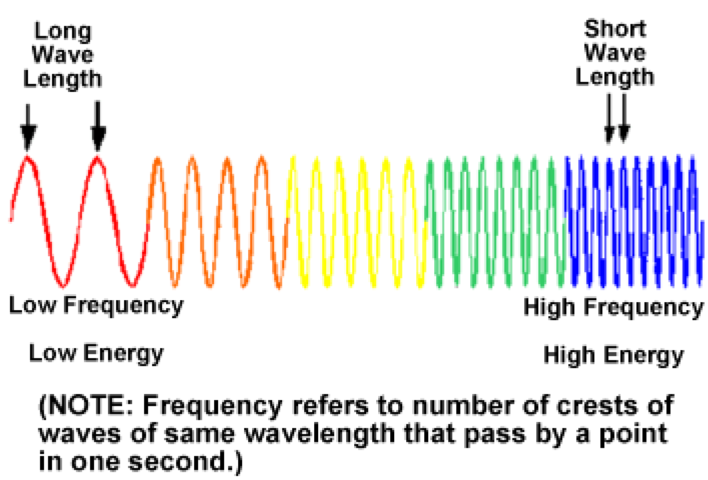
Wavelength – The distance between two consecutive points on a wave, from top of crest to top of crest or beginning of trough to the beginning of the next trough. In other words, a measurement including one complete crest and one complete trough. In a longitudinal wave the wavelength would include one complete compression and one complete rarefaction.

Amplitude – The distance from the rest position to the bottom of a trough or to the top of a crest. How high or low the hills and valleys are on a transverse wave. In a longitudinal wave amplitude is seen by how tightly packed a compression is and how spread apart a rarefaction is.





Frequency – The number of wavelengths passing a point in a certain amount of time.



Speed – How far the wave travels (distance) divided by the time to make the trip. You can also measure speed by multiplying wavelength by frequency.

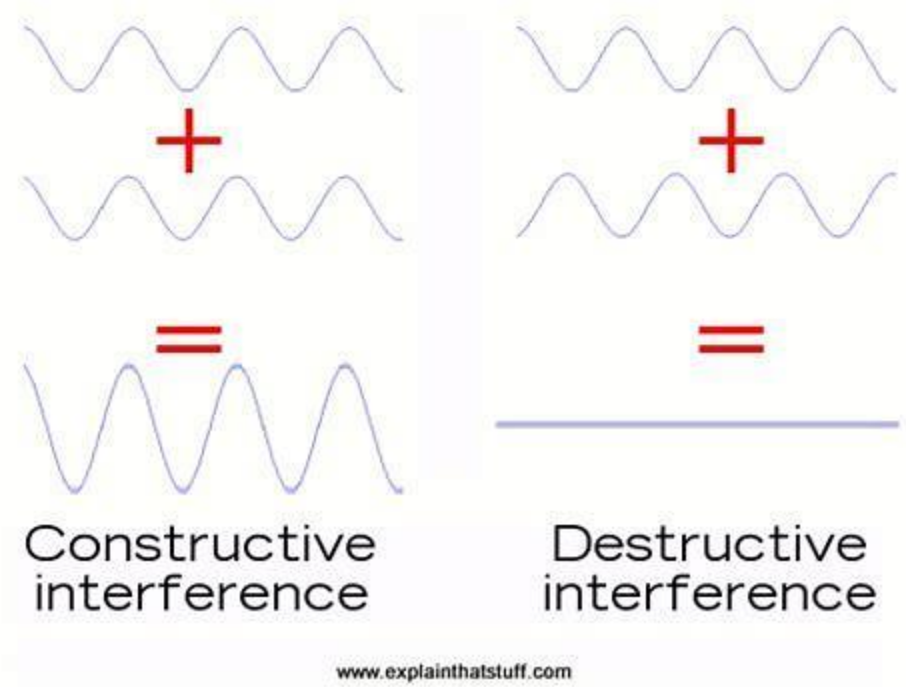
14. What do waves carry?

Waves carry energy.

15. What is a medium? Give three examples.

A medium is the matter that a wave travels though. Ex. Solids, liquids and gases

16. Draw a wave impacted by constructive interference and destructive interference. Show the effect of each.



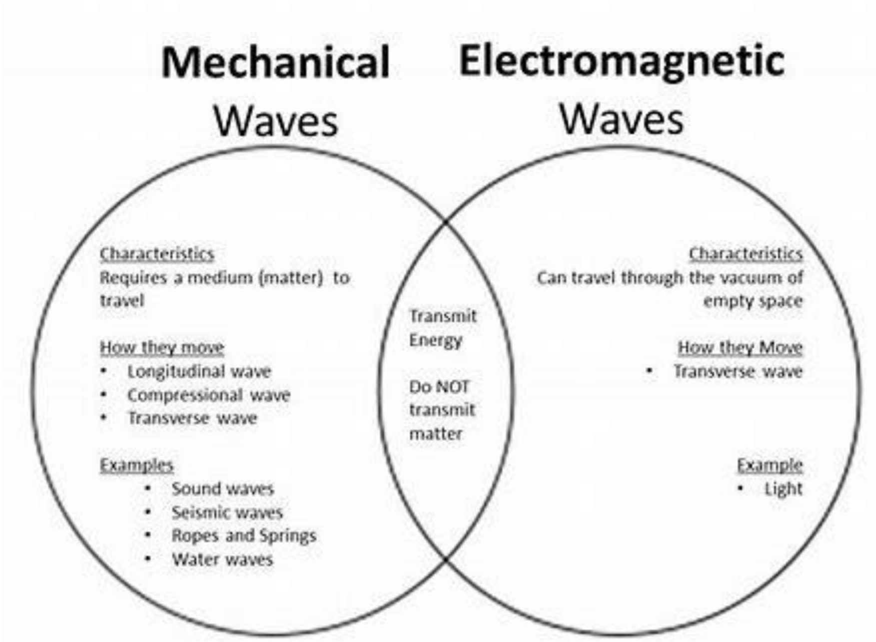
Constructive Interference- when two waves meet at the same point. Crests match up with other crests or compressions match up with other compressions. Their amplitudes combine to make a single higher amplitude wave.

Destructive Interference- when two waves combine at opposite points. Crests match up with troughs or compressions match up with rarefactions. Their amplitudes combine to make a smaller amplitude wave or to cancel each other out.

17. Draw a T chart listing the differences between transverse and longitudinal waves.

Transverse Waves	**Longitudinal Waves**
• Have a crest, trough, amplitude, wave height, and wavelength. • The particles of the medium a transverse wave travels through, vibrate perpendicular to the direction the wave travels.	• Have compressions, rarefactions, amplitudes, wavelengths. • The particles of the medium the wave travels through, vibrate parallel to the directions of the wave.

18. Draw a Venn diagram showing characteristics of EM waves compared to mechanical waves.



Light:

19. What are the two types of radio waves, and what are their uses?

Short radio waves are used for voice and music transmission, while long radio waves are used for navigation systems and communication satellites.

20. What does ROY G BIV stand for?

Red, Orange, Yellow, Green, Blue, Indigo, Violet

21. Why is red the first color in the rainbow? Why is violet last?

Red has the longest wavelength of the visible spectrum but, is shorter than infrared and longer than orange. Violet has the shortest wavelength in the visible light spectrum. It has a longer wavelength than ultraviolet and a shorter wavelength than indigo.

22. Describe what happens when light is absorbed, reflected, and refracted?

Absorption - energy from the wave is transferred to the particles of a medium and is often turned into thermal energy.

Reflected - a wave hits a barrier and bounces back at the same angle. Nothing about the wave changes.

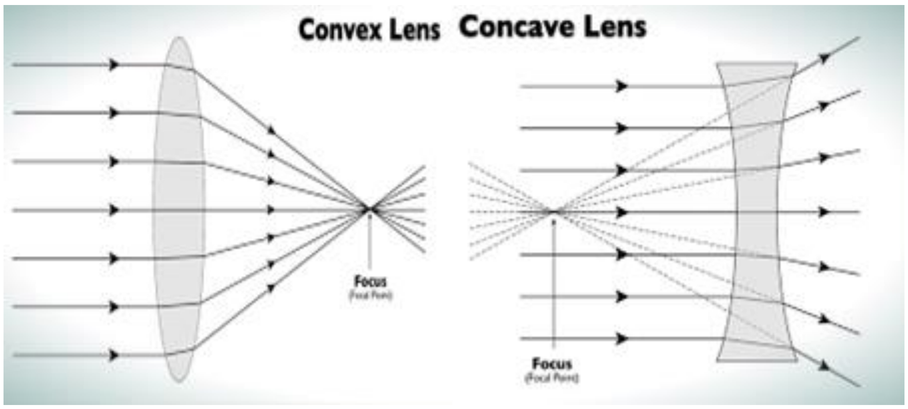
Refracted - a wave bends when going through two or more mediums due to a change in speed.

23. Why do we see a red shirt as red?

We see a red shirt as red, because the shirt reflects the red wavelengths/colors of light and absorbs all other wavelengths/colors.

24. Define and give an example of the following terms.
    a. Transparent – a wave is easily transmitted through a transparent material. Ex. window-
    b. Translucent – some waves transmit and some scatter. Ex. wax paper-
    c. Opaque – no waves will transmit. Ex. Book

25. Draw how light refracts through a convex lens and a concave lens.



26. Which lens (concave or convex) corrects – nearsightedness, farsighted

What kind of lens corrects farsightedness?

Convex **lenses**.

These **lenses** are used to **correct farsightedness** (**hyperopia)**

Concave Lenses Are for the **Nearsighted.**

27. What are some uses for light?
    a. Camera - A **camera** lens takes all the **light** rays bouncing around and uses glass to redirect them to a single point, creating a sharp image. When all of those **light** rays meet back together on a digital **camera** sensor or a piece of film, they create a sharp image.

    b. Laser - Lasers work to amplify a light source and turn it into one powerful, concentrated beam. Electricity must be supplied to the laser through a power supply. Lasers can be powered through the use of batteries, electricity, or even another laser. Lasers also must have a medium that produces amplification of light. Once a laser has power and something to pass through, it becomes a concentrated beam. This beam can then be emitted outward in a single line of bright light.

c. Microscope - (parts)

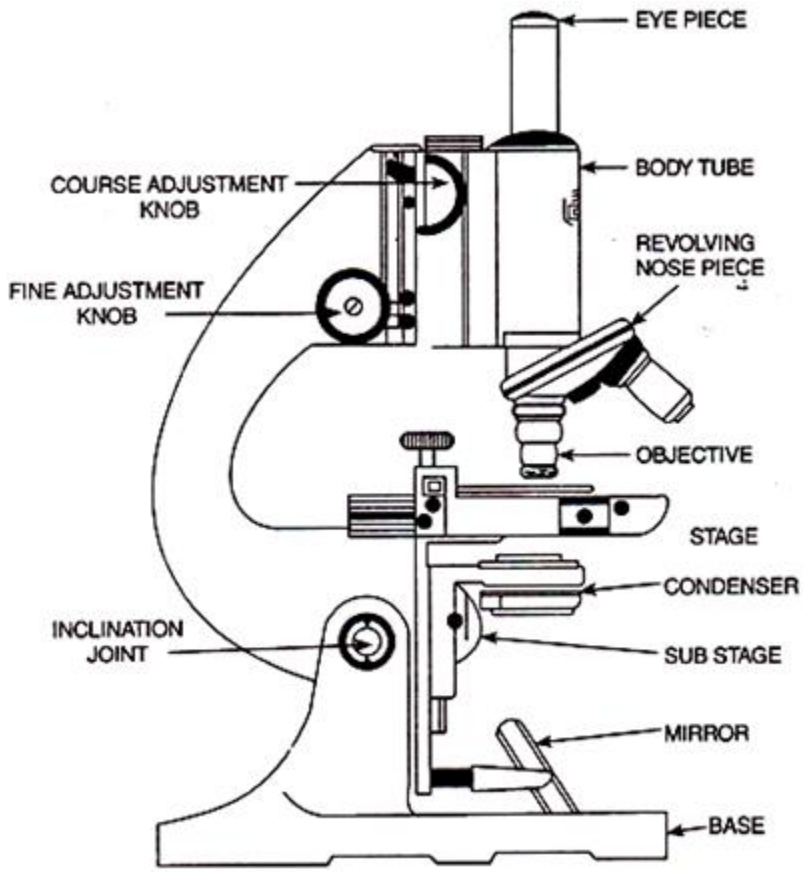


FIG. 15.1. The compound microscope showing its various parts.

d. Telescope - The refractor telescope, which uses glass lenses.

e. Telescope: The refractor telescope, which uses glass lenses. The reflector telescope, which uses mirrors instead of the lenses. -A telescope has two general properties: how well it can collect the light how much it can magnify the image A telescope's ability to collect light is directly related to the diameter of the lens or mirror -- the **aperture** -- that is used to gather light. Generally, the larger the aperture, the more light the telescope collects and brings to focus, and the brighter the final image. The telescope's **magnification**, its ability to enlarge an image, depends on the combination of lenses used. The eyepiece performs the magnification. Since any magnification can be achieved by almost any telescope by using different eyepieces, aperture is a more important feature than magnification.

28. What are the three types of seismic waves? What type of wave are each?

Types of seismic waves

There are three basic types of seismic waves – P-waves, S-waves and surface waves. P-waves and S-waves are sometimes collectively called body waves.

P-waves

P-waves, also known as primary waves or pressure waves, travel at the greatest velocity[6] through the Earth. When they travel through air, they take the form of sound waves – they travel at the speed of sound (330 ms^{-1}) through air but may travel at 5000 ms^{-1} in granite[7]. Because of their speed, they are the first waves to be recorded by a seismograph[8] during an earthquake.

They differ from S-waves in that they propagate through a material by alternately compressing and expanding the medium, where particle motion is parallel to the direction of wave propagation[9] – this is rather like a slinky that is partially stretched and laid flat and its coils are compressed at one end and then released. P-waves are longitudinal.

S-waves

S-waves, also known as secondary waves, shear waves or shaking waves, are transverse waves that travel slower than P-waves. In this case, particle motion is perpendicular[10] to the direction of wave propagation. Again, imagine a slinky partially stretched, except this time, lift[11] a section and then release it, a transverse wave will travel along the length of the slinky.

Surface waves

Surface waves are similar in nature to water waves and travel just under the Earth's surface. They are typically generated when the source of the earthquake is close to the Earth's surface. Although surface waves travel more slowly than S-waves, they can be much larger in amplitude[12] and can be the most destructive type of seismic wave. A ***surface wave*** is a combination of a ***transverse*** wave and a ***longitudinal*** wave.

Sound:

29. What is sound? **Sound** is produced when something vibrates. The vibrating body causes the medium (water, air, etc.) around it to vibrate. Vibrations in the air are called travelling longitudinal waves, which we can hear. **Sound** waves consist of areas of high and low pressure called compressions and rarefactions.

30. How do sound waves occur? **Sound** is produced when something vibrates.

31. Sound waves travel fastest through ___________solid__________ and slowest through_____gas________.

32. How does density, temperature and elasticity affect the speed of sound?

Speed of Sound

The speed of sound depends on the elasticity and density of the medium through which it is traveling. In general, sound travels faster in liquids than in gases and faster in solids than in liquids. The greater the elasticity and the lower the density, the faster sound travels in a medium. The mathematical relationship is speed = (elasticity/density).

The effect of elasticity and density on the speed of sound can be seen by comparing the speed of sound in air, hydrogen, and iron. Air and hydrogen have nearly the same elastic properties, but the density of hydrogen is less than that of air. Sound thus travels faster (about 4 times as fast) in hydrogen than in air. Although the density of air is much less than that of iron, the elasticity of iron is very much greater than that of air. Sound thus travels faster (about 14 times as fast) in iron than in air.

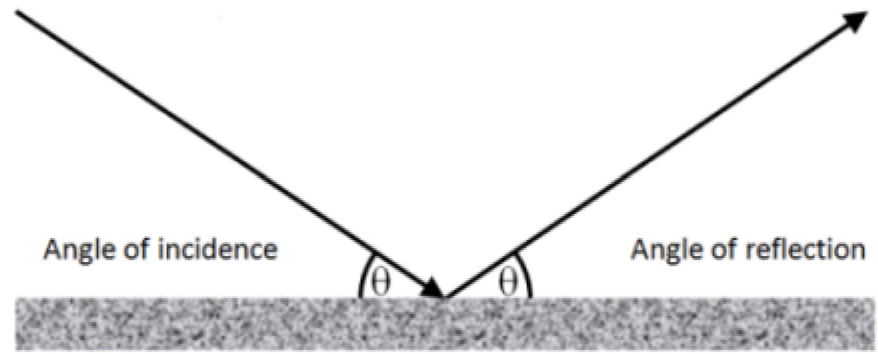
The speed of sound in a material, particularly in a gas or liquid, varies with temperature because a change in temperature affects the material's density. In air, for example, the speed of sound increases with an increase in temperature. At 32 °F. (0 °C.), the speed of sound in air is 1,087 feet per second (331 m/s); at 68 °F. (20 °C.), it is 1,127 feet per second (343 m/s).

33. What do sound waves carry?

Energy

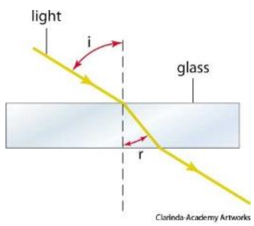
34. In what ways can sound interact with the surfaces they contact?

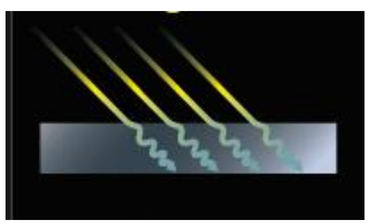
What happens to sound when it hits a surface?

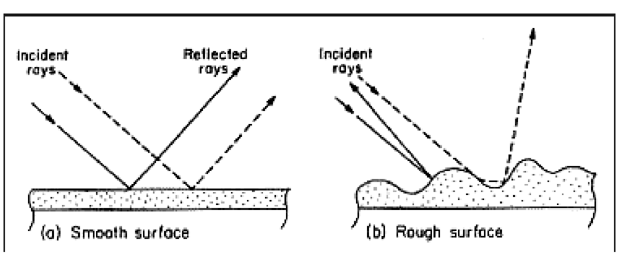


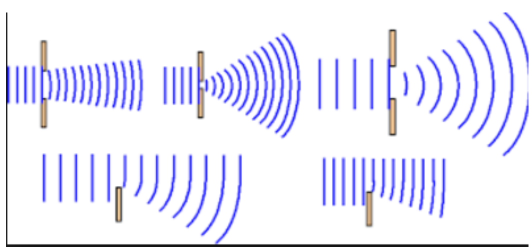
When sound hits a surface such as a wall or a floor, several things happen. A proportion of the sound is: Reflected back into the room (energy is preserved). Transmitted through the surface and escapes from the room (energy is lost). Absorbed by the surface (energy is lost).

35. Label each picture as reflection, scattering, diffraction, absorption, refraction, and write a word or short phrase below the picture that will help you remember it.









36. Give an example of how an echo is formed.

The sound waves left your mouth, traveled through the air, hit a hard surface, such as a wall, and then bounced back again, causing you to hear the sound again. An **echo is made** by sound waves bouncing off a hard surface.

37. How does temperature affect the speed of sound?

Temperature is also a condition that **affects** the speed of **sound**. ... Molecules at higher **temperatures** have more energy, thus they can vibrate faster. Since the molecules vibrate faster, **sound** waves can travel more quickly.

38. What does loudness describe?

The volume of a sound wave. It is determined by the amplitude of the wave.

39. What is the measurement unit of sound?

Decibel (Db)

40. How do decibel levels affect human hearing?

Any sound above 85 decibels is dangerous to human hearing

41. What is pitch? How is pitch related to frequency?

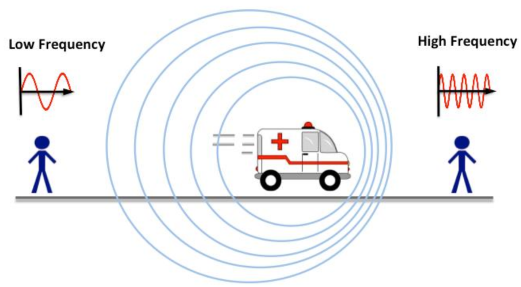
How high or low the sound is. It is determined by the frequency of the wave.

42. High pitch = high frequency, Low pitch = low frequency

43. Explain the difference between ultrasound and infra sound.

Ultrasound has a frequency higher than what humans can hear and infrasound has a lower frequency than humans can hear.

44. Explain what the picture below represents and how it works.



Doppler effect

The change in frequency due to the listener or sound source being in motion.

As the object approaches the observer, the pitch becomes higher due to high frequency. As the object moves away from the observer, the pitch is lower due to lower frequency of the waves.

45. Explain the Doppler effect is represented light.

Higher frequency is represented by brighter light. As an object moves toward the observer it gets brighter, as it moves away it gets more dim due to longer wavelengths and lower frequency.

46. Explain echolocation.

Echolocation is used by many animals to determine where they are and where other animals are. They send out a sound wave and if it reflects, they know there is an object nearby.

47. What is sonar?

Sonar is similar to echolocation but is used in cases such as submarines.

48. Can sound travel in a vacuum?

No, sound cannot travel in a vacuum. Sound requires particles to vibrate and there are no particles in a vacuum.

49. How are frequency and pitch related?

High frequency = high pitch, low frequency = low pitch

50. What type of interference is music? Noise?

Music is constructive interference because the volume gets louder as the crests and troughs are in sync. Noise is destructive interference because it is random and the crests and troughs are not in sync.