PHYSICS 2204
Unit 4: Waves
Worksheet #3: Behavior of Waves

Student Name: _____

Medium refers to a substance (solid, liquid or gas) that makes possible the transfer of energy from one location to another, especially through waves

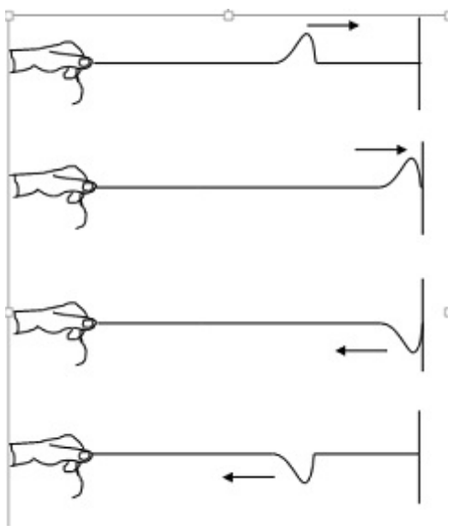
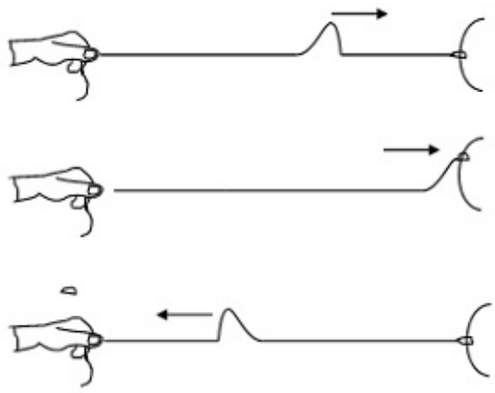
There are four ways waves can interact when passing through a medium:

1. REFLECTION OF WAVES

Reflection refers to when a wave reaches a boundary between two media, usually some or all of the wave bounces back into the first medium

Boundary refers to where on medium ends and another begins

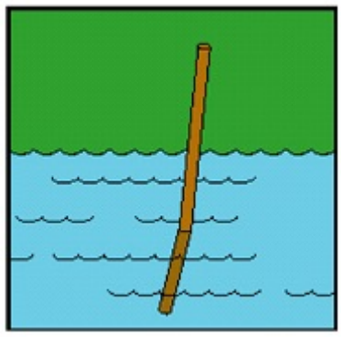
Boundary Behavior refers to the behavior of a wave (or pulse) upon reaching the end of a medium. Lets consider two situations:

REFLECTION -FIXED END	REFLECTION - OPEN END
	
Fix End refers to a reflection from a HARD boundary. For example a slinky fastened tightly to something The pulse becomes inverted upon reflecting off the fixed end. The displaced pulse is incident towards a fixed end boundary, it will reflect and return as a downward displaced pulse. This process is referred to as inversion This phenomena can be explained by newtons 3rd law	OPEN END: The far end of the medium will be free to move. An open end situation could be accomplished by means of a string tied to the end of the slinky In an open end reflection, the medium is free to move at the boundary. You will see an erect pulse traveling into the boundary came out erect. The pulse is not inverted.

2. REFRACTION OF WAVES

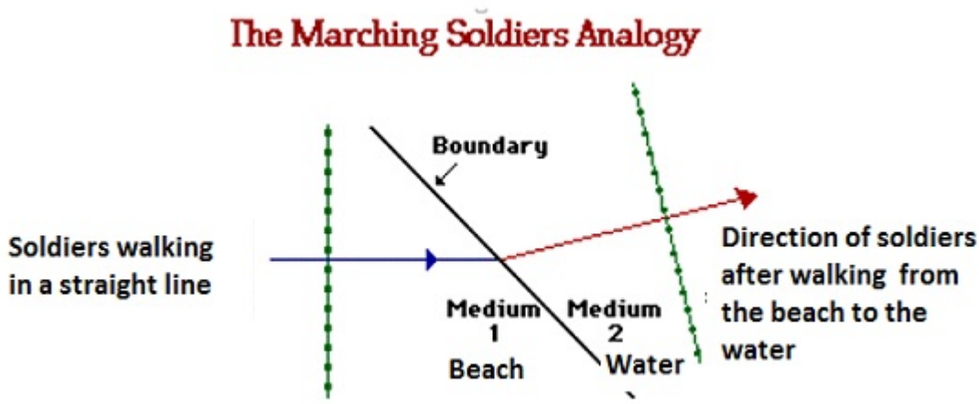
Refraction is the bending of waves as it enters a different medium.

For example a stick appears to bent as it is placed in water. This bending of light is caused by a change in the speed of light when it enters a medium at an angle other than 90 °



For a water wave the different mediums might be deep water and shallow water; for a sound wave the mediums could be warm air and cold air; for light waves the mediums could be air and glass, or any two transparent materials.

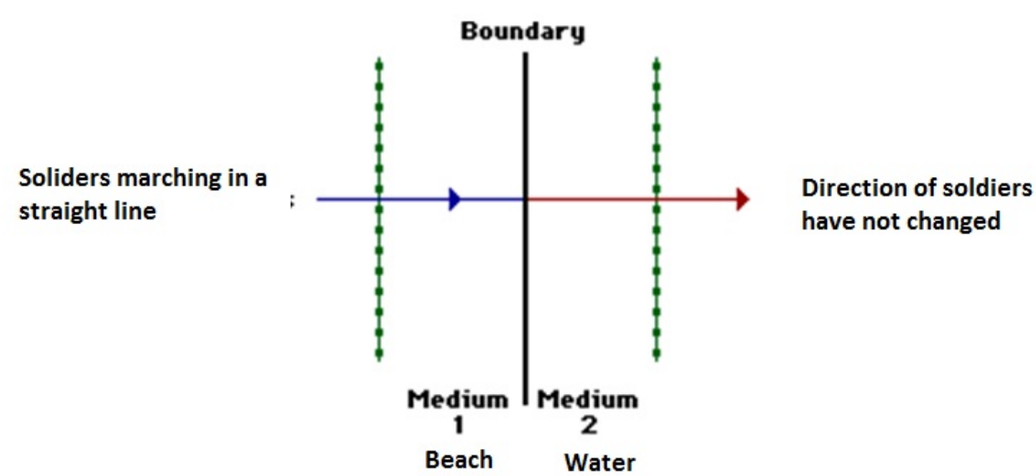
The analogy of marching soldiers can be used to demonstrate why waves bend as they change from one medium to another.



There are two conditions which are required in order to observe the change in direction of the path of the soldiers:

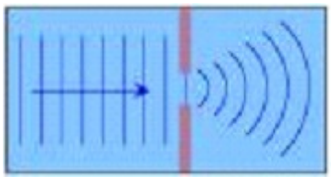
1) As a wave crosses a boundary into a new medium, its speed and wavelength change while its frequency remains the same. .

2) The soldiers must approach the boundary at an angle; refraction will not occur when they approach the boundary "head-on" (i.e., heading perpendicular to it).

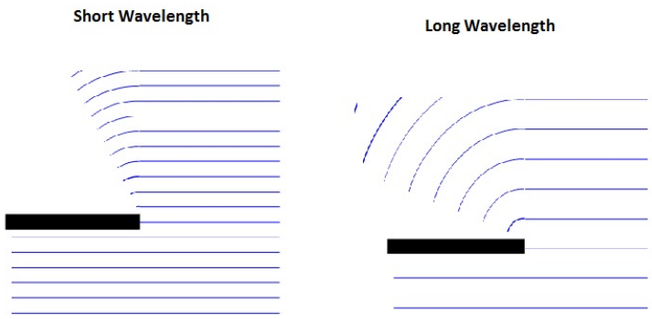


3. DIFFRACTION OF WAVES

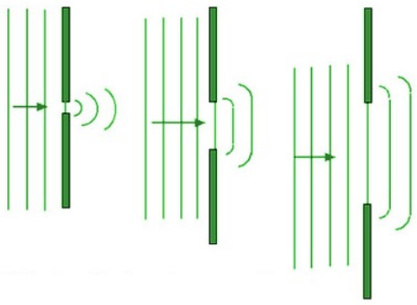
Diffraction means the bending of waves around an obstacle or through an opening



Diffraction Around an Obstacle: The longer the wave, the greater the diffraction effect



Diffraction Through an Opening : the diffracted wave will become more and more circular as the opening becomes smaller and smaller.

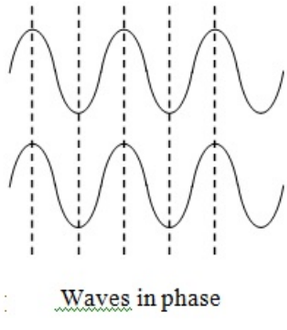


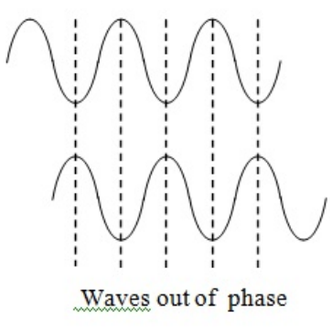
4. INTERFERENCE

Interference occurs when two or more waves are at the same location at the same time. For example, the wind may create tiny ripples on top of larger waves in the ocean. The waves may superimpose to form constructive interference or destructive interference.

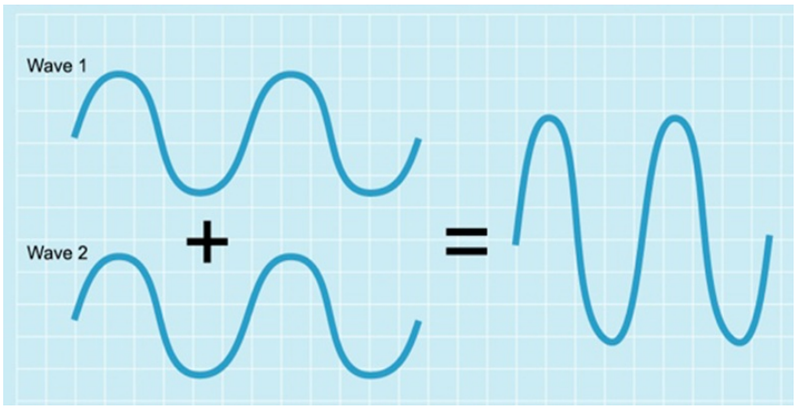
In phase term applied to two or more waves whose crests and troughs arrive at a place at the same time in such a way as to produce constructive interference

Out of phase
term applied to two or more waves for which the crest of one wave arrives at a point at the same time as the trough of a second wave arrives, producing destructive interference

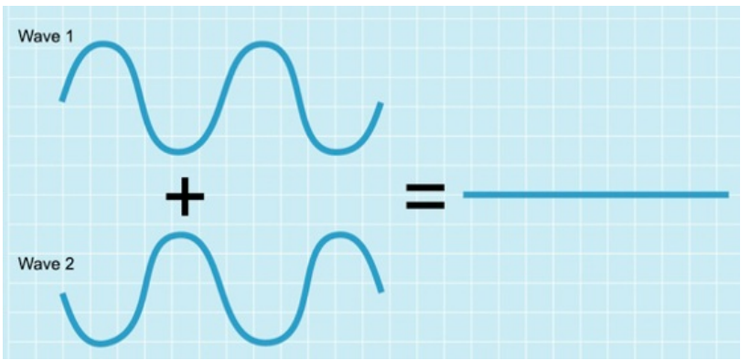

Waves in phase


Waves out of phase

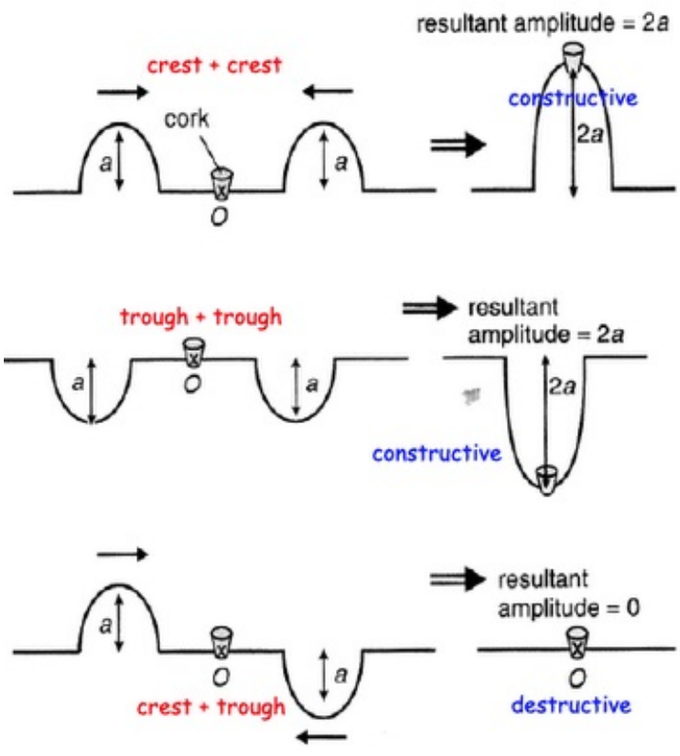
Constructive interference is when waves combine to make a larger wave. The waves are in phase.



Destructive interference is when waves combine to make a wave that is smaller than either of the individual waves. The waves are out of phase. Noise cancelling headphones work by producing a sound wave that perfectly cancels the sounds in the room.



S**uperposition Principle** states that the total vibration at any point is the sum of the vibrations produced by the individual waves.



PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided.

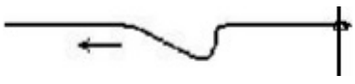
1. Which property light allows you to see yourself in a mirror?

(A) Absorption
(B) Dispersion
(C) Reflection
(D) Refraction

2. Which of the following best describes reflection?

(A) Wave bouncing off a surface
(B) Wave passing into a new medium
(C) Wave going around an obstacle
(D) Wave going through an opening

3. A pulse moves in a string as indicated in the sketch. At the end of a string is a ring that can slide without friction on a post. On reflection, the pulse would most nearly be represented by:

(A) 	(B) 
(C) 	(D) 

4. A wave pulse travels a long a thin part of a horizontal cord and reaches another part of the cord which is much thicker and heavier. Which of the following is true about the reflected and transmitted pulse by the boundary in the cord? Which of the following best describes the reflected pulse?

(A) Upright
(B) Inverted
(C) Zero amplitude
(D) Double in amplitude

5. When does refraction occur?

(A) When a wave enters a new medium at an angle
(B) When a wave hits a surface through which it cannot pass
(C) When a wave moves around a barrier
(D) When a wave interferes with another wave

6. Refraction is the bending of a wave disturbance as it passes at an angle from one ____ into another.

(A) Area
(B) Boundary
(C) Glass
(D) Medium

7. Why does a pencil appear to bend when you put it in a glass of water?

(A) The pencil quickly absorbs the water and it becomes wobbly – you can see this by moving it around.
(B) The light reflected off the pencil in the water is bent as it passes from water to air. The bending is caused by the light travelling more slowly in water than in air.
(C) The water gives the light a push so it gets to our eyes quicker. This makes the bit of the pencil in the water seem nearer and therefore the pencil appears bent.
(D) The pencil is made of wood so the end in the water starts to float towards the surface.

8. What is the bending of waves due to a change in speed called?

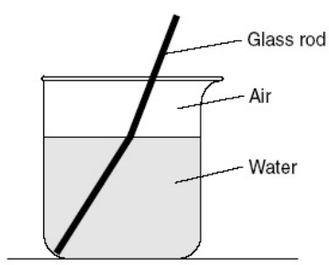
(A) Interference
(B) Diffraction
(C) Reflection
(D) Refraction

9. Which of the following terms can be use to describe the bending of a beam of light when it passes from air into water?

(A) Deviation
(B) Dispersion
(C) Reflection
(D) Refraction

10. A straight glass rod appears to bend when placed in a beaker of water, as shown in the diagram below. What is the best explanation for this phenomenon?

(A) Light is refracted as it crosses the air-water interface.
(B) Light travels faster in water than in air.
(C) Light is reflected at the air-water interface.
(D) The water is warmer than the air.



11. As a wave travels into a medium in which its speed increases, its wavelength would ____.

(A) Decrease
(B) Increase
(C) Remain the same

12. As a wave passes across a boundary into a new medium, which characteristic of the wave would NOT change?

(A) Speed
(B) Frequency
(C) Wavelength

13. At which angle does wave have to hit a boundary in order for refraction not to occur?

(A) 0º
(B) 30º
(C) 45º
(D) 90º

14. Which of the followin refers to the bending of waves around the edge of a barrier ?

(A) Interference
(B) Diffraction
(C) Reflection
(D) Refraction

15. What is diffraction?

(A) Bending of a wave when it changes media
(B) Bending of a wave around an obstacle or through an opening
(C) Combining of two identical waves moving in the same medium
(D) Reflection of a wave off of a barrier

16. Which wave phenomenon makes it possible for a player to hear the sound from a referee's whistle in an open field even when standing behind the referee?

(A) Diffraction
(B) Doppler effect
(C) Reflection
(D) Refraction

17. Which of the following is true about diffraction?

(A) Longer the wavelength, the greater the diffraction
(B) Shorter the wavelength, the greater the diffraction
(C) Larger the amplitude of the wave, the greater the diffraction
(D) Smaller the amplitude of the wave, the greater the diffraction

18. When is diffraction more pronounced?

(A) Large openings
(B) Same for each opening
(C) Small openings

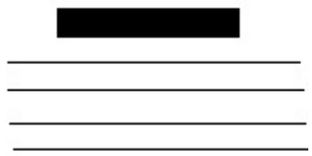
19. What wavelength causes waves to diffract the most?

(A) Long
(B) Short
(C) Both diffract the same

20. Which set of incident waves would be most likely to produce the pattern shown below?

(A)

(B)



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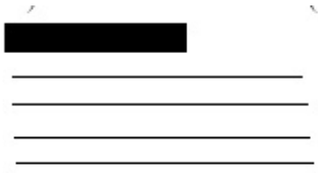


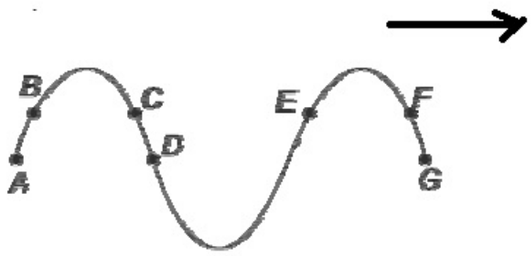
(D)

21. Which of the following is the result of two or more sound waves overlapping?

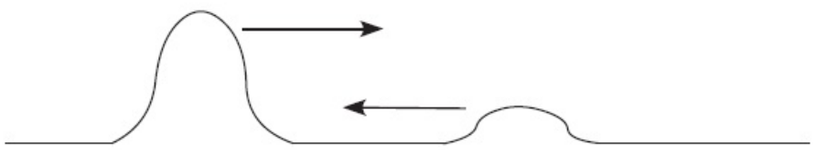
(A) Reflection
(B) Diffraction
(C) Interference
(D) Resonance

22. In the following wave, which points on the wave are in phase?

(A) B and C
(B) B and E
(C) B and F
(D) B and G



23. The two pulses shown below are about to pass through each other.



When the two pulses interfere with each other, the result is

(A) A standing wave pattern
(B) Destructive interference
(C) Constructive interference
(D) A constant nodal point

24. The diagram below shows two pulses on a string travelling toward each other.

Which of the following diagrams best shows the shape of the string after the pulses have passed through each other?

(A)	
(B)	
(C)	
(D)	

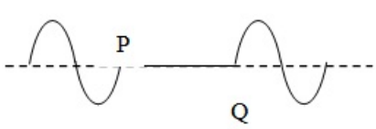
25. Which of the following is an example of constructive interference?

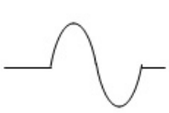
(A) The rarefactions of one wave overlap the rarefactions of another wave.
(B) The compressions of one wave overlap the rarefactions of another wave.
(C) The compressions of one wave overlap the compressions of another wave.
(D) Both (a) and (c)

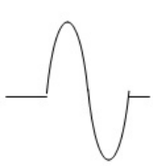
26. Which of the following is an example of destructive interference?

(A) The rarefactions of one wave overlap the rarefactions of another wave.
(B) The compressions of one wave overlap the rarefactions of another wave.
(C) The compressions of one wave overlap the compressions of another wave.
(D) None of the above

27. Two waves approach each other in the same rope at the same time, as shown below . When the two waves are exactly between points P and Q, the shape of the rope will be



(A) 

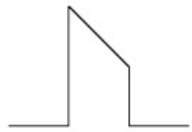
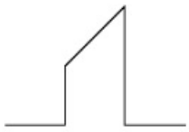
(B) 

(C)

(D) 

28. The diagram below shows two wave pulses moving towards one other.

Which one of the following diagrams show the resultant pulses are superposed ?

(A) 	(B) 
(C) 	(D) 

PART B: WRITTEN RESPONSE

The waves shown below are moving toward each other , what happens when they overlap