Physics 2204 Universal Wave Equ WS Name:_____

Multiple Choice:

1. Wave motion in a medium transfers
   (A) Neither mass nor energy
   (B) Mass, only
   (C) Energy, only
   (D) Both mass and energy

2. Assuming that the speed of a wave stays the same, what must happen for the frequency of the wave to increase?
   (A) The amplitude must decrease.
   (B) The wavelength must decrease. .
   (C) The amplitude must increase.
   (D) The wavelength must increase

3. As the frequency of a wave increases, the period of that wave
   (A) Increases
   (B) Decreases
   (C) Remains the same
   (D) Not enough information given

4. A wave traveling at 5.0×10^4 meters per second has wavelength of 2.5×10^1 meters. What is the frequency of the wave?
   (A) 5.0×10^{-4} Hz
   (B) 1.25×10^6 Hz
   (C) 2.0×10^3 Hz
   (D) 5.0×10^3 Hz

5. A periodic wave in a rope has a wavelength of 0.50 m. Two complete waves pass a knot on the rope in 2.0 s. What is the speed of the wave?
   (A) 0.25 m/s
   (B) 0.50 m/s
   (C) 1.0 m/s
   (D) 2.0 m/s

6. The velocity of a particular wave is 23.8 m/s. Find the wavelength of this particular wave if the frequency is 11.0 Hz.
   (A) 0.462 m
   (B) 262 m
   (C) 2.16 m
   (D) 2.62 m

7. The higher the frequency of a wave
   (A) The smaller its speed.
   (B) The shorter its wavelength.
   (C) The greater its amplitude.
   (D) The longer its period.

Physics 2204 Universal Wave Equ WS Name:_____

Long Answer:

1. A water wave has a frequency of 2 hertz and a wavelength of 5 meters. Calculate its speed. **[Ans = 10m/s]**

2. A wave has a speed of 50 m/sec and a frequency of 10 Hz. Calculate its wavelength. **[Ans = 5 m]**

3. A wave has a speed of 30 m/sec and a wavelength of 3 meters. Calculate its frequency. **[Ans = 10 Hz]**

4. A wave has a period of 2 seconds and a wavelength of 4 meters. Calculate its frequency and speed. **[Ans = 2 m/s]**

5. A sound wave travels at 330 m/sec and has a wavelength of 2 meters. Calculate its frequency and period.
   [Ans = 165 Hz, 6.0 x 10 – 3s]

6. The frequency of wave A is 250 hertz and the wavelength is 30 centimeters. The frequency of wave B is 260 hertz and the wavelength is 25 centimeters. Which is the faster wave? **[Ans = Wave A]**

7. The period of a wave is equal to the time it takes for one wavelength to pass by a fixed point. You stand on a pier watching water waves and see 10. wavelengths pass by in a time of 40. seconds.
   (A) What is the period of the water waves? **[Ans = 4.0 s]**
   (B) What is the frequency of the water waves? **[Ans = 0.25 Hz]**
   (C) If the wavelength is 3 meters, what is the wave speed? **[Ans = 0.75 m/s]**

8. An air mattress floating on a lake bobs up and down 45 times in 5.0 minutes. Calculate the speed of the water waves produced if the distance between their crests is 4.0 m. **[Ans = 0.60 m/s]**

9. A student was able to generate six full waves on a 15.0 m slinky. If a single pulse could move up and down the slinky in 1.8 s, what would be the student's hand frequency to achieve the six wavelengths? **[Ans = 0.56 Hz]**

10. While anchored off in boat one day you notice waves bobbing the nose of the boat upward every 6 seconds. When you look you notice that your boat, a 5.0 m craft, snugly fits from crest to crest of the wave. How fast are the waves moving? **[Ans = 0.85 m/s]**

11. A 1.00×10^3 Hz wave travels with a speed of 50.0 m/s along a wire. How far apart are the crests? **[Ans = 0.050 m]**

12. A wave on a rope has a speed of 12 m/s. If the wavelength is 230 cm, determine the frequency. **[Ans = 5.2 Hz]**

13. While sitting on the wharf one day, a fisherman notices that a buoy bobs up and down six times every ten seconds with the approaching wave crests. He estimates that the waves are 1.8 m long. How fast are the waves moving? **[Ans = 1.1 m/s]**

MC Ans: 1C 2B 3B 4C 5B 6C 7B

Physics 2204 Speed of Sound / Echos Name:_____

Multiple Choice:

1. An ultrasonic wave is sent from a ship towards the bottom of the sea. It is found that the time interval between the sending and receiving of the wave is 1.6 s. What is the depth of the sea, if the velocity of sound in the seawater is 1400 m/s?
   (A) 1120 m
   (B) 560 m
   (C) 1400 m
   (D) 112 m

2. The phenomena of echo of sound wave is due to
   (A) Reflection
   (B) Refraction
   (C) Interference
   (D) Diffraction

3. Echoes are produced when
   (A) Sound is absorbed by a material
   (B) Lightning strikes during a thunderstorm
   (C) Sound waves reflect off a body
   (D) The eardrum vibrates

4. An echo is a repeated sound often heard when shouting near a cliff. What causes an echo?
   (A) The breaking up of sound
   (B) The refraction of sound
   (C) The dispersion of sound
   (D) The reflection of sound

5. On a certain day, the speed of sound in air is 330 m/s. A girl stands in front of a cliff and shouts. She hears her echo six seconds later. Approximately how far away is the cliff?
   (A) 25 m
   (B) 2 km
   (C) 1 km
   (D) 55 m

6. On a certain day, the speed of sound in air is 344 m/s. A boy sees a lightning flash five seconds before he hears its corresponding thunder. How far away is the lightning approximately?
   (A) 500 m
   (B) 1,700 m
   (C) 100 m
   (D) Immediately above the boy

7. A Newly built classroom has problems with sound echoes. A number of suggestions were made to reduce the echoes occurring. Which one of the following would NOT help reduce the echoes?
   (A) Add more glass windows
   (B) Put heavy curtains on each window
   (C) Add a foam ceiling
   (D) Carpet the room

MC Ans: 1A 2A 3C 4D 5C 6B 7A

Long Answer:

1. A ship using an Echo locator (SONAR) to find a school of fish. The pulsed wave is transmitted from the ship, which is then reflected off the top of the shoal and is then picked up by the receiver. The time taken to receive the echo is 0.20 s after transmission. The speed of the ultrasonic wave is 1500m/s. Calculate how deep the ship has to lower its fishing nets to catch the top of the school. **[Ans = 150 m]**

2. The echo of a ship's foghorn reflected from an iceberg is heard 5.00 seconds after the horn was blown. If the temperature of the air is - 10.0 °C, how far away is the iceberg? **[Ans = 815 m]**

3. How many seconds will it take an echo to reach your ears if you yell toward a mountain 82 m away on a day when the air temperature is 0.0 °C? **[Ans = 0.49 s]**

4. On a day when the temperature is -8.0°C, a boat is traveling at 4.0 m/s towards a cliff. The boat sounds its horn and hears the echo 0.54 s later. How long does the boat have to turn before it smashes to bits on the cliff? **[Ans = 22 s]**

5. On a day when the temperature is 18° C, a bat is traveling at 20.0 m/s towards a cliff. The bat sends out a sound signal and hears the echo 0.96 s later. How long does the bat have to turn before it smashes its brains on the cliff? **[Ans = 8.7 s]**

6. How many seconds will it take an echo to reach your ears if you yell toward a mountain 144 m away on a day when the air temperature is 22.0 °C? **[Ans = 0.83 s]**

7. On a day when the temperature is 26° C, a bird is traveling at 18.0 m/s towards a cliff. The bird sends out a sound signal and hears the echo 0.68 s later. How long does the bat have to turn before it smashes its brains on the cliff? **[Ans = 6.2 s]**

8. By what factor does the intensity change if the distance from the source changes from 2.0 m to 6.0 m? **[Ans = Decreases by a factor of 9]**

9. By how much will the intensity of a sound change at the following distances from the source:

   (A) The distance from the source doubles. **[Ans = 1/4]**
   (B) The distance from the sources quadruples **[Ans = 1/16]**
   (C) The distance from the source is halved **[Ans = 4]**
   (D) The distance from the source decreases by a third **[Ans = 9]**

MC Ans: 1A 2A 3C 4D 5C 6B 7A

Physics 2204 Doppler Shift WS Name:_____

Multiple Choice:

1. Betty is running at 5 m/s toward a whistle, which is stationary. An identical whistle is approaching Bob at 5 m/s. Which statement about the pitch of the whistle is correct?
   (A) Betty and Bob both hear a pitch which is higher than normal.
   (B) Betty and Bob both hear a pitch which is lower than normal.
   (C) Betty perceives the pitch to be higher and Bob perceives it to be lower than normal.
   (D) Betty perceives the pitch to be lower and Bob perceives it to be higher than normal.

2. An aircraft is moving away from you at half the speed of sound, which, on that day is about 340 m/s. The jet engines make a sound that is primarily about 300 Hz. What is the apparent frequency of the jet engines?
   (A) 150 Hz
   (B) 200 Hz
   (C) 470 Hz
   (D) 600 Hz

3. A fast-moving car is sounding its horn as it moves by you. What will you observe just as the car passes by you?
   (A) The pitch gets lower
   (B) The pitch gets higher
   (C) The pitch alternates behind high and low, repeatedly
   (D) The pitch is unchanged

4. A police car travelling at 30.0 m/s sounds its 525 Hz siren as it approaches a person standing on the side of the road. If the speed of sound is 344 m/s, what frequency is heard by the person?
   (A) 483 Hz
   (B) 525 Hz
   (C) 555 Hz
   (D) 575 Hz

5. An ambulance approaches an observer at 31.5 m/s on a day when the speed of sound is 341 m/s. If the frequency heard is 525 Hz, what is the actual frequency of the siren?
   (A) 477 Hz
   (B) 481 Hz
   (C) 573 Hz
   (D) 578 Hz

6. The Doppler effect produces apparent changes in
   (A) Loudness
   (B) Frequency
   (C) Amplitude
   (D) Velocity

7. An observer approaches a stationary 1000 Hz sound source at half the speed of sound. What frequency does the observer hear?
   (A) 4,000 Hz
   (B) 3,000 Hz
   (C) 2,000 Hz
   (D) 1,000 Hz

8. What frequency do you hear if you are traveling at 15 m/s toward a train with a 750 Hz whistle and the temperature is 15°C.?
   (A) 668 Hz
   (B) 729 Hz
   (C) 785 Hz
   (D) 845 Hz

Long Answer:

1. Two fire trucks with sirens on speed towards and away from an observer as shown below.
   (A) Which truck produces a higher than normal siren frequency?
   (B) Which truck produces a lower than normal siren frequency?

2. An ambulance siren emits a frequency of 440 Hz. If the air temperature is 22°, calculate the frequency heard by an observer if the ambulance is coming toward him at 26 m/s. **[Ans = 480 Hz]**

3. A car is moving towards a stationary observer at 15.1 m/s when the driver blows the horn with a frequency of 870 Hz. If the speed of sound is 344 m/s what is the frequency of the sound perceived by the observer? **[Ans = 910 Hz]**
4. A cop cars siren has a frequency of 700. Hz. If the air temperature is 20°, calculate the frequency heard by an observer standing on the sidewalk as the cop car moves away from you at a speed of 15.0 m/s? **[Ans = 670 Hz]**

5. Carl goes for a drive on a beautiful 25° C day. Carl gives a long beep on the horn, which you know is a 660. Hz sound. But you instead hear a 550. Hz sound. How fast is the car moving? Is it moving towards you or away? **[Ans = 69 m/s]**

6. A car is moving away a stationary observer at 30.0 m/s when the driver blows the horn with a frequency of 770. Hz. However you hear a sound with frequency of 710. Hz. What is the speed of sound on this day? **[Ans = 355 m/s]**
7. The engine of a race car produces a sound with a frequency of 350 Hz. The car is moving at 85 m/s. (The air temperature is 20°)
   (A) If the car is coming towards you, what will you perceive its frequency to be? **[Ans = 460 Hz]**
   (B) If the car is moving away from you, what will you perceive its frequency to be? **[Ans = 280 Hz]**
   (C) Suppose that the car approaches you and passes you by. Describe the sound that you hear.

8. Explain the red and blue shift in terms of movements of celestial objects. Use the fact that the speed of light must remain constant.

9. A galaxy has a known wavelength of 450 nm and an observed wavelength of 480 nm.
   (A) Calculate its speed. **[Ans = 2.00×10^7 m/s]**
   (B) Is this a red shift or a blue shift? **[Ans = Red Shift]**
   (C) Is this galaxy moving toward us or away from us? **[Ans = Moving Away]**

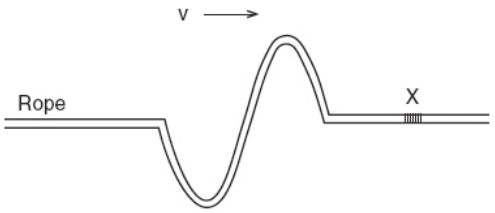
10. A galaxy emits light of wavelength 6.00×10^2 nm. On Earth, we measure the wavelength to be 604 nm.
    (A) Is the galaxy moving toward or away from us? **[Ans = Away, Red Shift]**
    (B) Calculate its speed. **[Ans = 2.00×10^6 m/s]**
    (C) Assume that the galaxy is moving at this speed but in the opposite direction. Find the measured wavelength. **[Ans = 596 nm]**

MC Ans: 1A 2B 3A 4D 5A 6B 7C 8C

Physics 2204 Mechanical Waves WS Name:_____

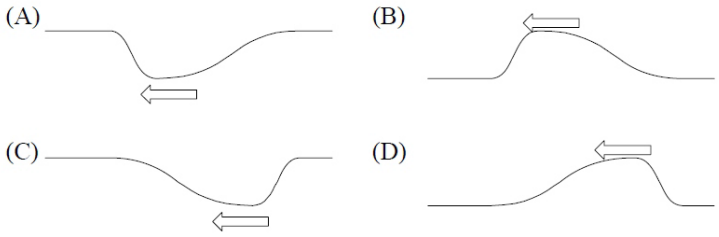
Multiple Choice:

1. As shown in the diagram below, a wave is moving with velocity v 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, then down
   (D) Up, then down, then up

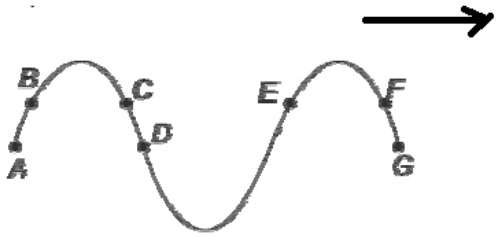
2. A single pulse travels down a rope as shown below. It reflects from a free end. Which choice below shows the reflected pulse?



3. A girl on a swing may increase the amplitude of the swing's oscillations if she moves her legs at the natural frequency of the swing. What is this an example of?
   (A) Destructive interference
   (B) Resonance
   (C) The Doppler Effect
   (D) Wave transmission

4. Which of the following is the result of two or more sound waves overlapping
   (A) Reflection
   (B) Diffraction
   (C) Interference
   (D) Resonance

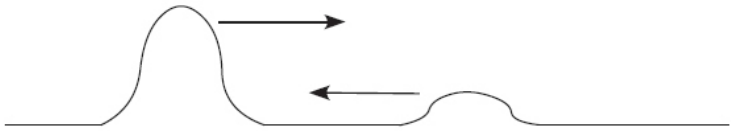
5. In the following wave, which points on the wave are in phase?



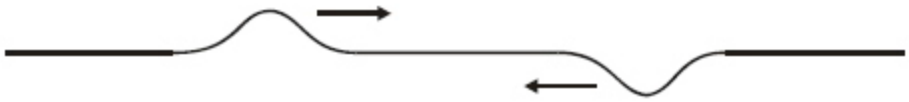
   (A) B and C
   (B) B and E
   (C) B and F
   (D) B and G

6. In order that the interference between the waves emitted by two light sources can be observed, it is essential that the sources must emit waves that
   (A) Have the same amplitude.
   (B) Are in phase.
   (C) Have the same colour.
   (D) Have a constant phase difference between them

7. 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



8. 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)

9. If two sound waves interfere constructively, you will hear
   (A) A high-pitched sound.
   (B) A louder sound.
   (C) A softer sound.
   (D) No change in sound.

10. Constructive interference occurs when
   (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)

11. Destructive interference occurs when
   (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

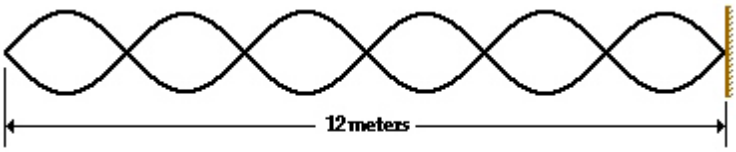
12. When destructive interference occurs, a sound will be
   (A) Louder because the amplitude is increased.
   (B) Louder because the amplitude is decreased.
   (C) Softer because the amplitude is increased.
   (D) Softer because the amplitude is decreased.

MC Ans: 1D 2B 3B 4C 5B 6C 7C 8A 9B 10D 11B 12D

Physics 2204 Standing Waves WS Name:_____

Multiple Choice:

1. Consider the standing wave pattern shown below. A wave generated at the left end of the medium undergoes reflection at the fixed end on the right side of the medium. The number of antinodes in the diagram is
   (A) 3
   (B) 5
   (C) 6
   (D) 7



2. The standing wave pattern in the diagram above is representative of the ____ harmonic.
   (A) third
   (B) fifth
   (C) sixth
   (D) seventh

3. The distance between successive nodes in any standing wave pattern is equivalent to ____ wavelengths.
   (A) 1/4
   (B) 1/2
   (C) 3/4
   (D) 1

4. The lowest resonant frequency of a standing wave is called the
   (A) Fundamental.
   (B) third overtone
   (C) Node.
   (D) Amplitude.

5. Resonant frequencies higher than the lowest resonant frequency of a standing wave are called
   (A) Nodes.
   (B) Fundamentals.
   (C) Overtones.
   (D) Amplitudes

6. A string is plucked producing four loops (antinodes). The length of the string is 12.00 m. The wavelength of the wave must be
   (A) 48.0 m
   (B) 24.0 m
   (C) 6.00 m
   (D) 3.00 m

7. A standing wave of frequency 5 hertz is set up on a string 2 meters long with nodes at both ends and in the center. Find the speed at which waves propagate on the string.
   (A) 5 m/s
   (B) 2.5 m/s
   (C) 10 m/s
   (D) 20

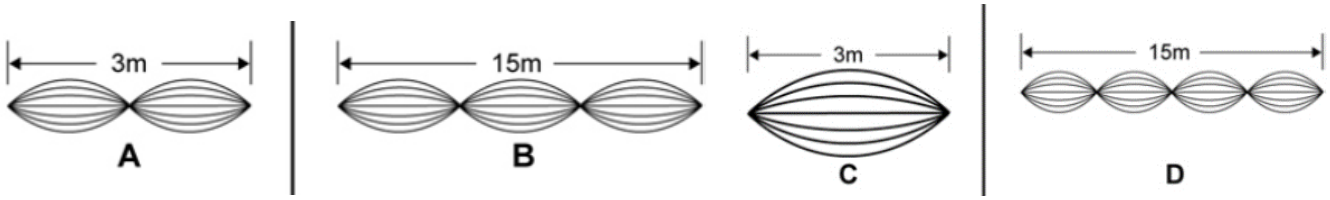
8. Using question 7, find the fundamental frequency of vibration of the string.
   (A) 5 Hz
   (B) 7.5 Hz
   (C) 10 Hz
   (D) 2.5 Hz

Long Answer:

1. A string is 6.0 meters long and is vibrating as the third harmonic. The string vibrates up and down with 45 cycles in 10.0 seconds. Determine the frequency, period, wavelength and speed for this wave. **[Ans = 4.5 Hz, 0.22 s, 18 m/s]**

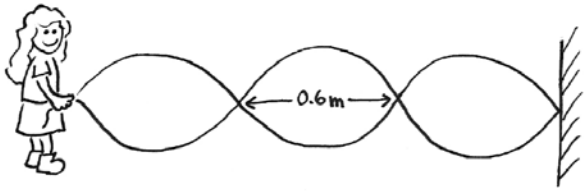
2. A string is 8.2 meters long and is vibrating as the fifth harmonic. The string vibrates up and down with 21 cycles in 5.0 seconds. Determine the frequency, period, wavelength and speed for this wave. **[Ans = 4.2 Hz, 0.24s, 14 m/s]**

3. Use the graphic below to answer these questions.

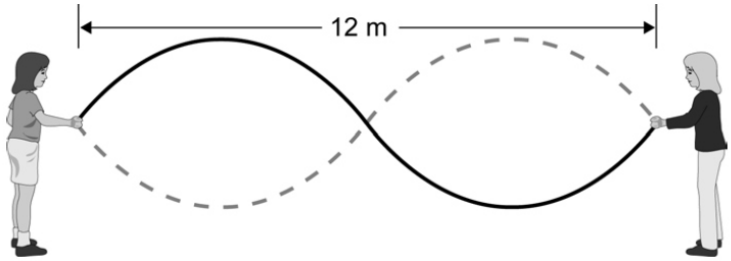


   (A) Which harmonic is shown in each of the strings above?
   (B) Label the nodes and antinodes on each of the standing waves shown below.
   (C) How many wavelengths does each standing wave contain? **[Ans = A = 1, B = 1.5, C = 0.5, D = 2]**
   (D) Determine the wavelength of each standing wave. **[Ans = A = 3.0 m, B = 10. m, C = 6.0 m, D = 7.5 m]**

4. A student makes a standing wave pattern with a skipping rope as shown. If the waves are moving at 7 m/s, with what frequency does the student move her hand up and down? **[Ans = 5.8 Hz]**



5. Two students want to use a 12-m long rope to create standing waves.
   They first measure the speed at which a single wave pulse moves from one end of the rope to another and find that it is 36 m/sec. This information can be used to determine the frequency at which they must vibrate the rope to create each harmonic. Follow the steps below to calculate these frequencies.



   (A) Draw the standing wave patterns for the first five harmonics.
   (B) Determine the wavelength for each harmonic on the 12-meter rope.
   [Ans = λ_1 = 24m, λ_2 = 12 m, λ_3 = 8.0m, λ_4 = 6.0m λ_5 = 4.8m]
   (C) Use the equation for wave speed ($v = f\lambda$) to calculate each frequency.
   [Ans = f_1 = 1.5 Hz, f_2 = 3.0 Hz, f_3 = 4.5 Hz, f_4 = 6.0 Hz, f_5 = 7.5Hz]

MC Ans: 1C 2C 3B 4A 5C 6C 7C 8D

Physics 2204 Resonance WS Name:_____

Remember: $L_n = \frac{2n-1}{4}\lambda$ $\lambda = \frac{4L_n}{2n-1}$

Multiple Choice:

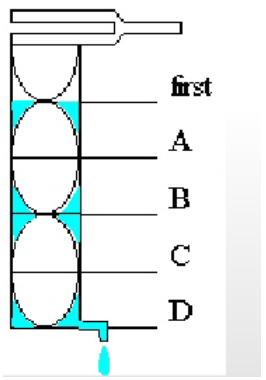
1. Sometimes a wind blows over the top of a pop bottle and a whistling sound is heard. What name best describes this phenomenon?
   (A) Interference
   (B) Resonance
   (C) Sonic boom
   (D) Beats

2. A tuning fork was held over a tube, open at one end only. The length of the tube was slowly increased until resonance was heard. If the first resonance was detected when the tube was 15 cm long, what length will give the next resonance?
   (A) 30 cm
   (B) 45 cm
   (C) 60 cm
   (D) 75 cm

3. A tuning fork was held over a tube, open at one end. The length of the tube was slowly increased until resonance was heard. If the second resonance was detected when the tube was 7.5 cm long, what is the wavelength length of the sound?
   (A) 10.0 cm
   (B) 15.0 cm
   (C) 30.0 cm
   (D) 60.0 cm

4. In a lab experiment, using an adjustable tube closed at one end, two successive resonant lengths were found at 0.415 m and 0.580 m. Assuming the speed of sound is 340 m/s, what must be the frequency of the source?
   (A) 515 Hz
   (B) 687 Hz
   (C) 1030 Hz
   (D) 2060 Hz

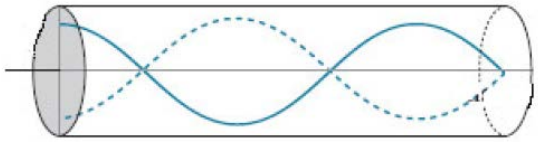
5. The picture shows a tube, open at one end, and a tuning fork above the open end. The fork is sounded and water is slowly let out until the sound is noticeably louder. This position is noted as “first” in the picture. If the water continues to slowly drain out, at which level will the sound NEXT sound louder?
   (A) A
   (B) B
   (C) C
   (D) D



Physics 2204 Resonance WS Name:_____

6. An empty pop bottle is to be used as a musical instrument in a band. In order to be tuned properly the fundamental frequency of the bottle must be 440.0Hz. If the bottle is 0.260 m tall, how high should it be filled with water to produce the desired frequency if the speed of sound in air is 343 m/s?
   (A) 0.065 m
   (B) 0.120 m
   (C) 0.195 m
   (D) 0.260 m

7. Which overtone is shown in the closed air column below?
   (A) 1st
   (B) 2nd
   (C) 3rd
   (D) 4th



Long Answer:

1. 3.10×10^2 Hz tuning fork is held over the mouth of an air column open at one end. If the speed of sound is 352 m/s, calculate the length of the air column which produces the second resonant sound. **[Ans = 0.851 m]**

2. When a tuning fork is held over an adjustable tube open at one end, the distance between the 1st and 2nd resonant lengths is measured to be 0.12 m.
   (A) Draw the standing wave pattern for the 1st and 2nd resonant length
   (B) What is the wavelength of the sound causing the resonance? **[Ans = 0.24 m]**

3. A 840 Hz tuning fork is held over an air column that is open at one end. If the temperature is 15° C, calculate the length of the air column that produces the second resonant sound. **[Ans = 0.30 m]**

4. A 145 Hz tuning fork is held over the open end of an adjustable air column that is closed at the other end. The speed of sound in the air column is 345 m/s. Calculate the length of the air column which produces the second resonant sound. **[Ans = 1.8 m]**

5. An air column that is open at one end is 1.50 m long. A specific frequency is heard resonating from the column. What is the longest wavelength and its associated frequency that could be responsible for this resonance? The speed of sound is 345 m/s. **[Ans = 6.00 m, 57.5 Hz]**

6. A closed air column resonates at two consecutive lengths of 82.0 cm and 137 cm. If the fundamental frequency on a given day for the tube is 321 Hz, what is the temperature on this day? **[Ans = 35.2° C]**

7. A 1024 Hz tuning fork is held up to a closed air column (closed at one end and open at the other) at 30.0ºC. What is the minimum length of an air column that would resonate with this frequency? **[Ans = 0.0854 m]**

8. Organ pipes, open at one end, resonate best at their third resonant length. Two pipes have length 23.0 cm and 30.0 cm respectively.
   (A) What is the wavelength of the sound emitted by each pipe? **[Ans = 0.184 m, 0.240 m]**
   (B) What are the respective frequencies if the speed of sound is 341 m/s? **[Ans = 1850 Hz, 1420 Hz]**

9. A closed air column resonates at two consecutive lengths of 54.0 cm and 96.0 cm. If the speed of sound on a given day is 362 m/s, what is the wavelength of the sound frequency of the sound wave? **[Ans = 431 Hz]**

10. A tuning fork was sounded over an adjustable closed air column. It was found that the difference between the second and fifth resonant length was 90.0 cm. What was the frequency of the tuning fork if the experiment was done in a lab with air temperature 25.0ºC? **[Ans = 578 Hz]**

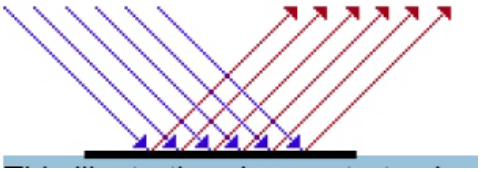
MC Ans: 1B 2B 3A 4C 5B 6A 7B

Physics 2204 Reflection & Refraction Name:_____

Multiple Choice:

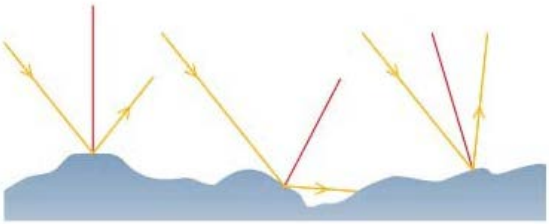
1. In the ray model of light, light is represented by
   (A) A series of curves.
   (B) Circles.
   (C) Continuous waves.
   (D) Straight lines.

2. The illustration below demonstrates how light travels. What name is given to this diagram?
   (A) Light sketch
   (B) Light diagram
   (C) Ray sketch
   (D) Ray diagram



3. Why does the light scatter?
   (A) The rough surface refracts light rays.
   (B) The light rays are absorbed when they strike a rough surface.
   (C) The light rays strike the rough surface at different angles.
   (D) The light rays do not obey the law of reflection on a rough surface.

4. The lines in the diagram without arrows are known as
   (A) Incident rays.
   (B) Angles of incidence.
   (C) Normal lines.
   (D) reflected rays

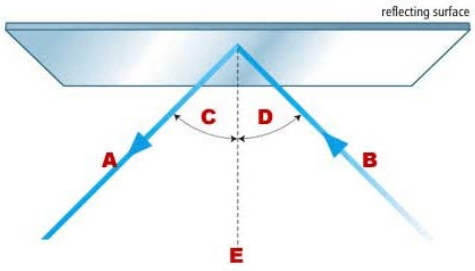


5. Which property light allows you to see yourself in a mirror?
   (A) Absorption
   (B) Dispersion
   (C) Reflection
   (D) Refraction

6. In plane mirrors, the image is always
   (A) Real and the same size as an object
   (B) Real and different size as the object
   (C) Virtual and the different size as the object
   (D) Virtual and the same size as the object

7. Reflection is the process in which light strikes a surface and bounces off that surface. The reflected ray will bounce back directly to the light source if it is lined up with the ...
   (A) Incident ray
   (B) Normal line
   (C) Reflected ray
   (D) Reflecting surface

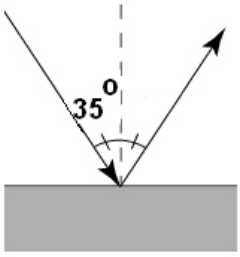
8. What does the letter "C" in the diagram indicate?
   (A) Angle of incidence
   (B) Angle of refraction
   (C) Reflected ray
   (D) Angle of reflection



9. What does the letter "B" in the diagram indicate?
   (A) Normal
   (B) Incident Ray
   (C) Angle of incidence
   (D) Reflected ray

10. What does the letter "E" in the diagram indicate?
   (A) Angle of reflection
   (B) Incident ray
   (C) Normal
   (D) Reflected ray

11. Use the diagram below, what is the measure of the angle of reflection?
   (A) 0°
   (B) 35°
   (C) 55°
   (D) 65°



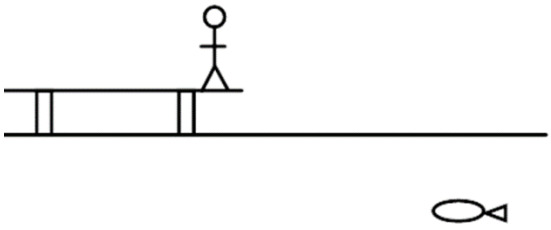
Long Answer:

1. A bird thinks that it is approaching another bird when it is in front of a plane mirror. The bird is moving at a constant speed of 15.0 m/s directly towards the mirror and sees his own image 60.0 m away. How much time will it take before the bird hits the mirror and realizes his mistake? **[Ans = 2.0s]**

2. List four properties of images in plane mirrors.

3. A fish is below the surface of the water and is being observed by a man standing on a boat just above the water. Use ray diagrams to show the following:

   (A) How the man observes the fish.
   (B) How the fish would view the man if it were to look up to see him



4. Optical fibers are generally composed of silica, with an index of refraction around 1.44. How fast does light travel in a silica fiber? **[Ans = 2.08 x 10^8 m/s]**

5. The speed of light in an unknown medium is measured to be 2.76 x 10^8 m/s. What is the index of refraction of the medium? **[Ans = 1.09]**

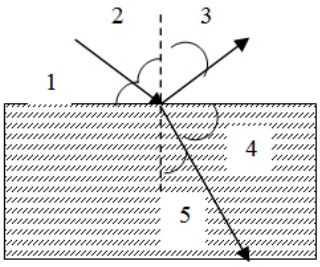
MC Ans: 1D 2D 3C 4C 5C 6D 7B 8D 9B 10C 11B

Physics 2204 Snell's Law Name:_____

Multiple Choice:

1. Refraction is the bending of a wave disturbance as it passes at an angle from one ____ into another.
   (A) glass
   (B) medium
   (C) area
   (D) boundary

2. A beam of light passes from the air through a thick piece of glass as shown. Which of the following angles is the angle of refraction?



   (A) 1
   (B) 2
   (C) 4
   (D) 5

3. Total internal reflection occurs when
   (A) Light passes from air into water.
   (B) Light refracts as it exits glass into air.
   (C) Light reflects off of a mirror.
   (D) Light passing through glass is reflected inside the glass.

4. The index of refraction is based on the ratio of the speed of light in
   (A) Two transparent materials.
   (B) Air to the speed of light in the transparent material.
   (C) Water to the speed of light in the transparent material.
   (D) A vacuum to the speed of light in the transparent material

5. What is the critical angle for light passing from mineral oil (n=1.47) into water (n=1.33)?
   (A) 42.9°
   (B) 90°
   (C) 64.8°
   (D) 25.2°

6. What is the critical angle for light passing from mineral oil (n= 1.47) to air (n=1.00)?
   (A) 42.9°
   (B) 90°
   (C) 64.8°
   (D) 25.2°

7. The critical angle for a beam of light passing from water into air is 49°. Which of the following statements is true for a beam of light with an incident angle less than the critical angle?
   (A) The beam will all be absorbed
   (B) The beam will be totally reflected
   (C) The beam will be partially reflected and partially transmitted
   (D) The beam will be totally transmitted

8. The ____ of light can change when light is refracted because the velocity changes.
   (A) Frequency
   (B) Medium
   (C) Wavelength
   (D) Transparency

9. When light passes at an angle to the normal from one material into another material in which its speed is lower,
   (A) It is bent toward the normal to the surface.
   (B) It always lies along the normal to the surface.
   (C) It is unaffected.
   (D) It is bent away from the normal to the surface.

Long Answers:

1. A light ray moves from sapphire (n = 1.77) to air (n = 1.00). Does the light ray bend toward or away from the normal?

2. A light ray moves from water (n = 1.33) to a transparent plastic (n = 1.59). Will the light ray bend toward or away from the normal?

3. A ray of light passes from air into cubic zirconia at an angle of 46.9° to the normal. The angle of refraction is 19.4°. What is the index of refraction of cubic zirconia? **[Ans = 2.20]**

4. Calculate the index of refraction for material X if the angle in air is 57° and the refracted angle is 35°**[Ans = 1.46]**

5. Calculate the index of refraction for material X if the angle in air is 34° and the refracted angle is 23°**[Ans = 1.43]**

6. Could the index of refraction for a material ever be less than 1.0? Explain.

7. Which light ray will be bent more, one moving from diamond (n = 2.42) to water (n = 1.33), or a ray moving from sapphire (n = 1.77) to air (n = 1.00)?

8. A ray of light passes from air (n = 1.000) into ice (n = 1.31) at an angle of 23.7° to the normal. The refracted ray of light then passes from ice into glycerin (n = 1.47). What is the angle of refraction of the ray of light in glycerin? **[Ans = 15.9°]**
9. A ray of light passes from air into carbon disulfide (n = 1.628) at an angle of 55.6° to the normal. The refracted ray of light then passes from carbon disulfide into water (n = 1.33). What is the refracted angle in the water? **[Ans = 38.3°]**
10. Calculate the critical angles for the following refractive indices (assume it is in air).
    (A) 1.21 **[Ans = 55.7°]**
    (B) 1.76 **[Ans = 34.6°]**
    (C) 2.43 **[Ans = 24.3°]**
    (D) 1.84 **[Ans = 32.9°]**

MC Ans: 1B 2D 3D 4B 5C 6A 7C 8C 9A

Physics 2214 Diffraction WS Name: _____

Multiple Choice:

1. A double-slit experiment is done in the usual way with 480-nm light and narrow slits that are 0.050 cm apart. At what angle to the straight-through beam will one observe the third-order bright?
   (A) 0.17°
   (B) 0.0017°
   (C) 0.055°
   (D) 2.88°

2. A double-slit experiment is done in the usual way with 480-nm light and narrow slits that are 0.050 cm apart. At what angle to the straight-through beam will one observe the second minimum from the central maximum?
   (A) 0.083°
   (B) 0.00083°
   (C) 0.165°
   (D) 0.170°

3. Red light of wavelength 644 nm, from a point source, passes through two parallel and narrow slits which are 1.00 mm apart. Determine the distance between the central bright fringe and the third dark interference fringe formed on a screen parallel to the plane of the slits and 1.00 m away.
   (A) 1.61 mm
   (B) 1.93 mm
   (C) 1.61 μm
   (D) 2.25 mm

4. A single slit of width 0.140 mm is illuminated by monochromatic light, and diffraction bands are observed on a screen 2.00 m away. If the second dark band is 16.0 mm from the central bright band, what is the wavelength of the light?
   (A) 560 nm
   (B) 56 nm
   (C) 55 mm
   (D) 1.12 μm

Long Answers:

1. In Young's double slit experiment, a monochromatic source of wavelength 550 nm illuminates slits that are 4.0×10^{-6} m apart. Find:
   (A) The angle at which the first-order maximum occurs. **[Ans = 7.9°]**
   (B) The angle at which the third-order minimum occurs. **[Ans = 20.1°]**

2. Given that the second-order maximum occurs at 22° and light of wavelength 600 nm is used, what is the double slit separation? **[Ans = 3.2×10^{-6} m]**
3. Two slits are 0.015 mm apart and the second order maximum is 7.8 mm away from the center line. If the screen is 1.1 m away, what is the wavelength of light used? **[Ans = 53 nm]**
4. In an interference experiment, yellow light of wavelength 580 nm illuminates a double slit. If the screen is 1.3 m away and the distance between the center line and the ninth dark spot is 3.0 cm, find the slit separation. **[Ans = 2.1×10^{-4} m]**
5. For a single slit of width 1.0×10^{-5} m illuminated by red light of wavelength 640 nm, find the angle at which
   (A) The second-order minimum occurs. **[Ans = 7.4°]**
   (B) The second-order maximum occurs. **[Ans = 9.2°]**
6. Light of wavelength 595 nm passes through a slit 1.23×10^{-3} cm wide. Given that the screen is 1.2 m away, calculate the position relative to the center line of
   (A) The third-order minimum. **[Ans = 0.173 m]**
   (B) The second-order maximum. **[Ans = 0.145 m]**

MC Ans: 1A 2A 3A 4B