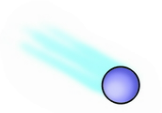
Waves

TRY IT...IT'S LIKE A CELL PHONE WITH A MINI-OCEAN INSIDE...
...AND EXPOSE MYSELF TO THE MICRO-WAVES?
MARK PARISI 7-5
MarkParisi@aol.com
offthemark.com



Forms of Energy Transfer

Particle

- Transfers _____ and _____.

Wave

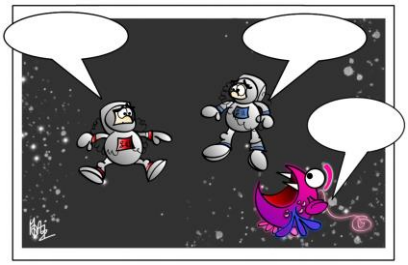
- Transfers _____ without transferring _____.

Mechanical

- a wave that _____ _____ to transfer energy.

Examples

- ○
- ○
- ○
- ○

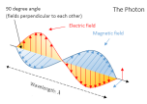


Electromagnetic

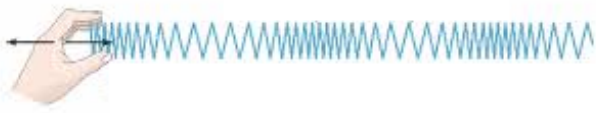
- a wave that _____ _____ to transfer energy.

Examples

- ○
- ○
- ○
- ○
- ○
- ○
- ○

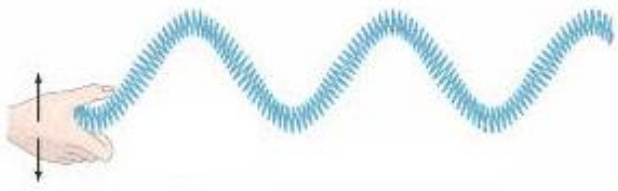


- **Longitudinal** – the particles of the medium move _____ to the direction of the wave energy.



Label the following parts: compression, rarefaction, wavelength

- **Transverse** – the particles of the medium move _____ to the direction of the wave energy.



Label the following parts: equilibrium position (line), crest, trough, node, amplitude, wavelength

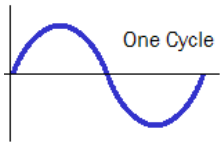
Components of a Wave

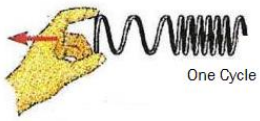
- Wave pulse – _____

  _____

- Cycle – _____

  _____

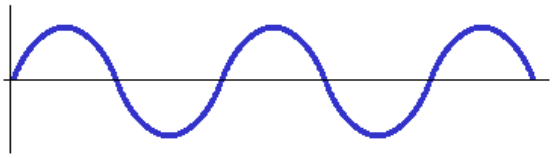




- Periodic Wave – _____

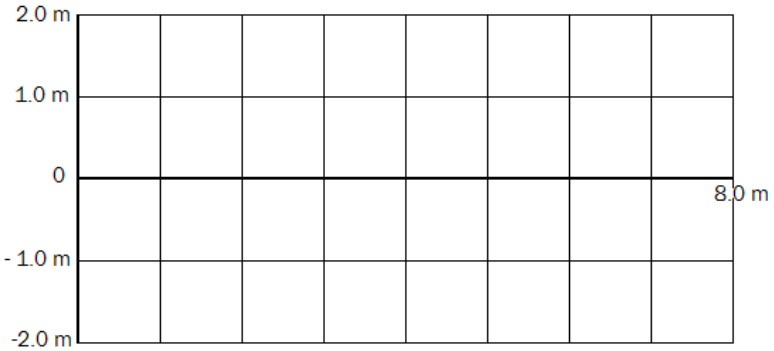
  _____

1. Record the correct amount of each of the following:

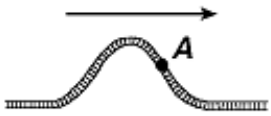


- Crest (s) _____ • Trough(s) _____ • Node(s) _____ • Cycle(s) _____

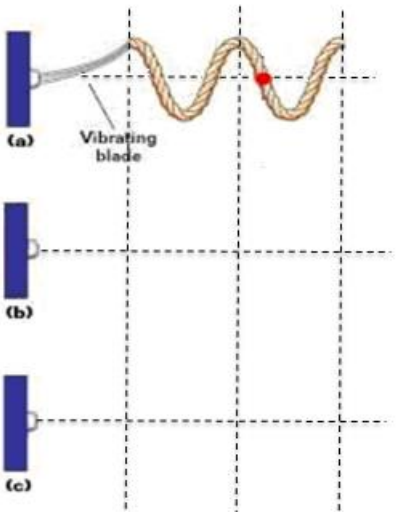
2. Draw a waveform having an amplitude of 2.0 m and a wavelength of 4.0 m.



3. In which direction will point A travel in the next instant of time?



1. A snapshot of a wave moving to the right on a string is shown below. Graphs of the motion of the wave and one of its particles are shown below.



- In which direction is the string particle moving at this instant?
- Sketch the wave and particle after ¼ of a period from the time shown in a).
- Sketch the wave and particle after ½ of a period from the time shown in a).
- How long does it take one complete cycle to pass a given point?
- How far will the wave energy travel in one period?

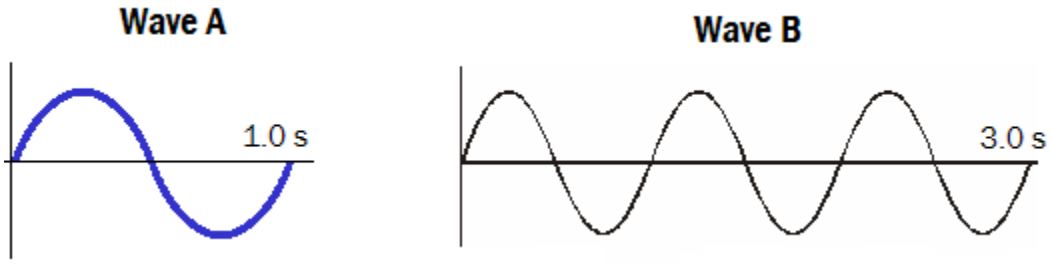
Frequency and Period

Frequency ( ) – _____

* Not on Reference Table

- Unit –

Which wave has a higher frequency? Explain.



Period ( ) – _____

* Not on Reference Table

- Unit -

1. Periodic waves (series of pulses) are produced by a wave generator at the rate of one wave every 0.50 second. What is the period of the wave to the correct number of significant figures?

2. If the frequency of a sound wave is 440. cycles per second, its period is closest to _____ seconds/cycle.

3. If the frequency of a sound wave is doubled, the period of the sound wave is
   (1) halved (2) doubled (3) unchanged (4) quadrupled

Determining the Velocity of a Wave

1. A wave traveling at 5.00×10^4 meters per second has a wavelength of 2.5×10^1 meters. What is the frequency of the wave?

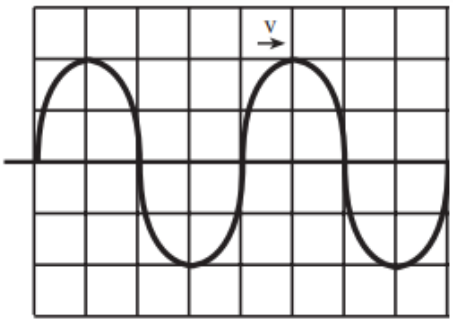
2. An 8.0 meter long ocean wave passes the end of a dock every 5.0 seconds. What is the speed of the wave?

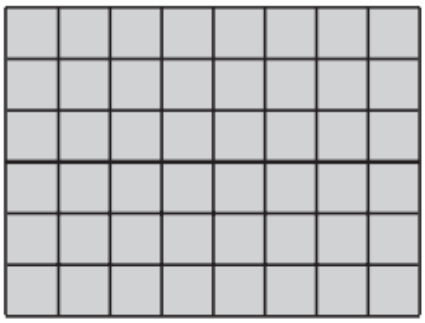
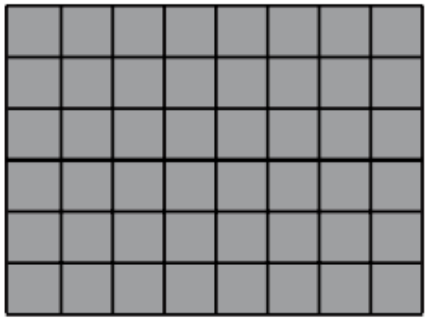
3. A sound wave has a frequency of 262 Hz and a wavelength measured at 1.29m.
   a. What is the speed of the wave?

   b. How long will it take the wave to travel the length of a football field, 91.4 m?

   c. What is the period of the wave?

4. Draw a wave with a greater amplitude and a smaller amplitude.

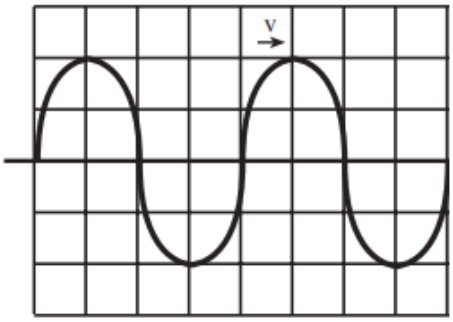


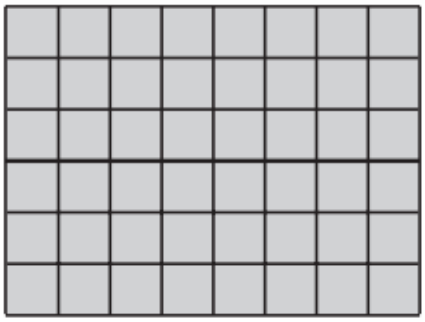
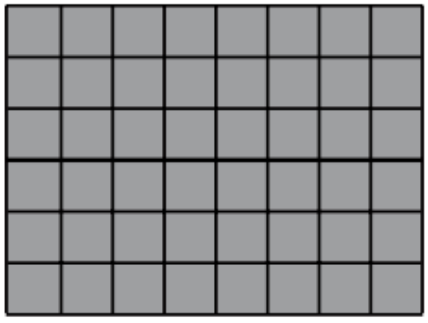



5. Does increasing the amplitude of a wave change the speed of the wave?

- A mechanical wave with a higher amplitude has more . . .

6. Draw a wave with a higher frequency and a smaller frequency.



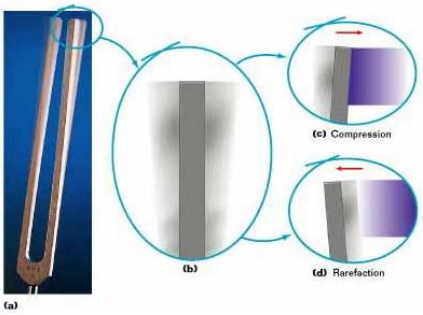
7. Does increasing the frequency change the speed of the wave?

- A wave with a higher frequency has . . .

8. How can the speed of a wave be changed?

- Examples:
  -
  -
  -

Sound Waves

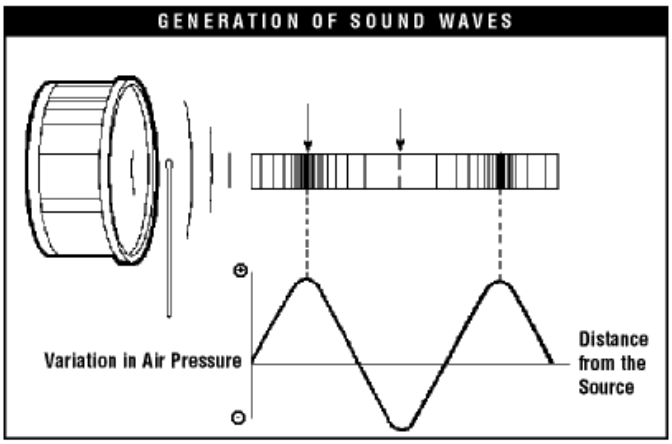


Form and Type of Wave

1. What type of wave is sound?

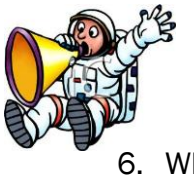
2. A sound wave traveling eastward through the air cause the air molecules to vibrate in which directions?

3. How are sound waves produced?

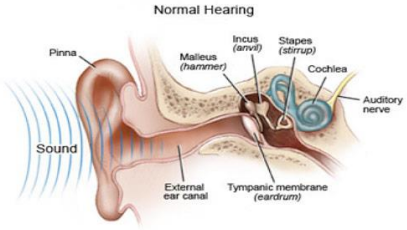


4. Indicate the parts of the wave at right.

5. Can sound be heard in outer space? Explain.



6. What happens when this wave of varying air pressure reaches your ear?



7. Does sound travel faster in a solid, liquid, or a gas? Explain.

8. How fast does sound travel in . . .

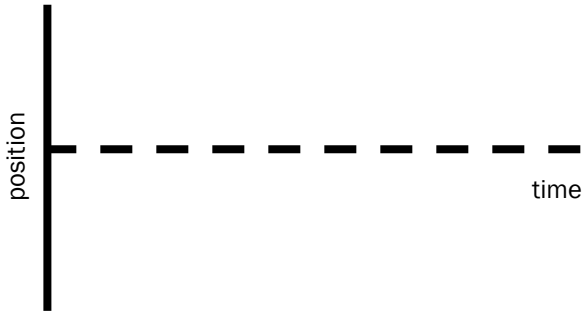
air at STP

air at room temperature

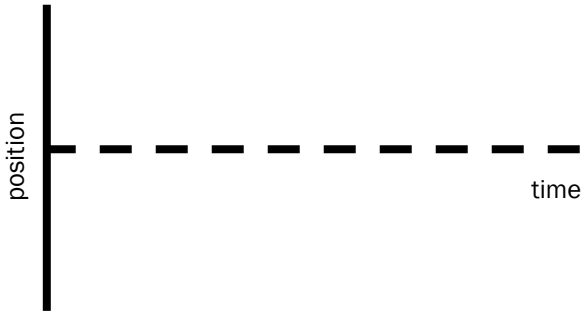
9. How is the speed of sound related to air temperature? Explain.

10. How could you increase the energy of your voice?

11. As you increase the loudness (volume) of a sound, you increase its . . .

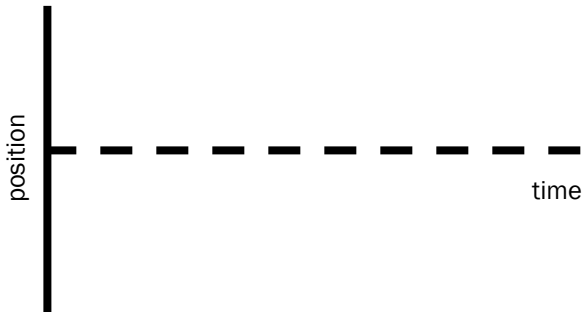


Soft

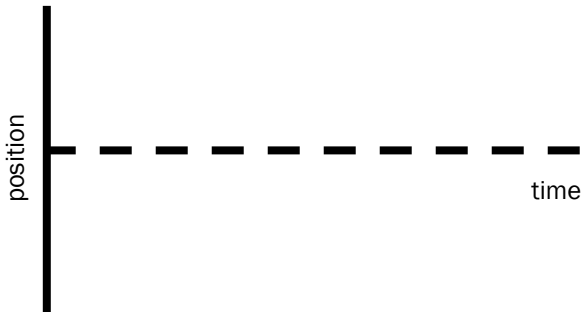


Loud

12. As you increase the pitch of a sound, you …

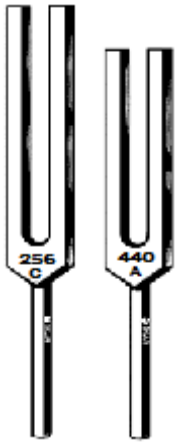


Low Pitch



High Pitch

13. In a classroom experiment, a student strikes first a 256 hertz tuning fork and then a 440 hertz one.



a) Which fork plays a note with a higher pitch?

b) Which fork has a greater period?

c) Which note has a longer wavelength?

d) Which note is traveling faster?

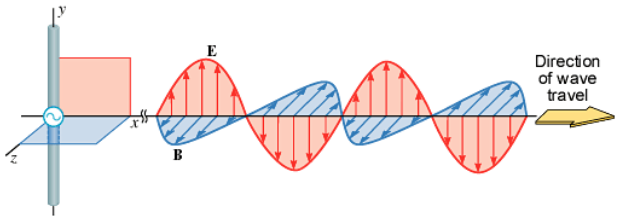
e) Calculate the wavelength and period of the 256 Hz tuning fork.

f) How long would it take a student located 7.5 meters away to hear the 256 hertz tuning fork?

Light & Electromagnetic Waves

1. How is light (an all electromagnetic waves) produced?

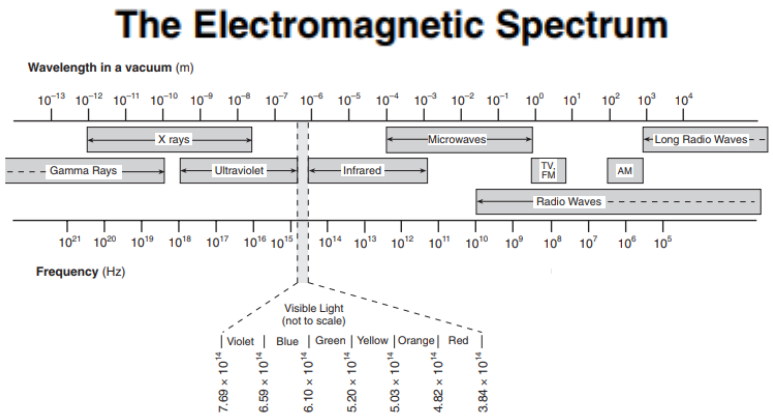
2. What type of wave is light?



3. How do we see?

4. How fast does light travel in . . .

a vacuum (c) **air** **other materials**



Use your reference table to answer the following questions.

5. Electromagnetic radiation with a wavelength of 10^{-7} m is known as _____.
6. Electromagnetic radiation with a frequency of 1.5 x 10^{13} Hz is known as _____.
7. Which type of wave has the most energy (is the most dangerous)?
8. What is the difference between an X-ray and a microwave?
9. Which type of electromagnetic radiation has the. . .
   a) highest frequency? b) Highest wavelength? c) Highest speed?

10. What range of frequencies is considered visible light?

11. Which color of visible light has the. . .

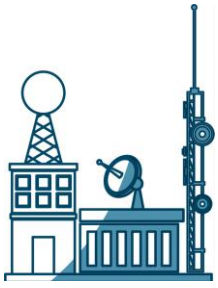
a) highest frequency? b) Highest wavelength? c) Highest speed? d) most energy?

12. What range of frequencies are considered to be green light?

13. What range of wavelengths is considered to be visible light?

14. What type/color of EM wave has a wavelength of 5.89×10^{-7} m?

15. When the Apollo astronauts landed on the Moon and communicated with Earth, how long did it take their radio signal to travel back to Houston?



16. What is the difference between a radio wave and a sound wave?

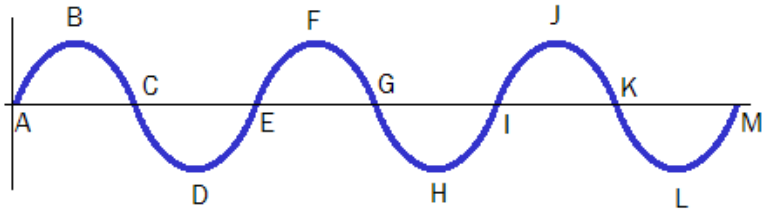
Sound vs. Light

	Sound	Light
Form of Wave		
Wave Type		
Speed		
Amplitude		
Frequency		
Energy		

Phases

- phase –

Inspect the labeled graph at right and name points that are:



- in phase
- out of phase by 180° (λ)
- out of phase by 90° (λ)
- out of phase by 270° (λ)

Waves at Boundaries

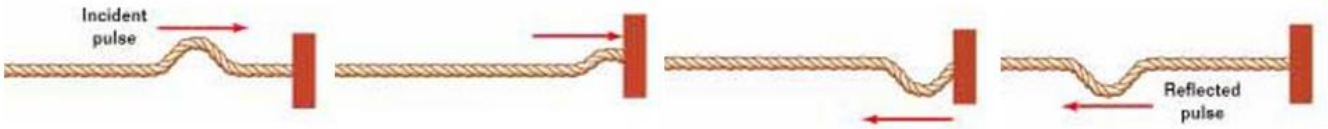
When a wave hits a boundary, it can be

-
-
-
-

Free End Reflection (Soft Reflection)

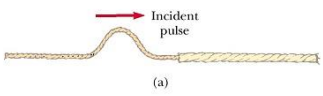
- The reflected pulse is . . .

Fixed End Reflection (Hard Reflection)

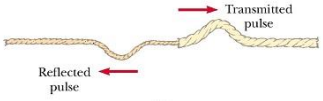


- The reflected pulse is . . .
    - Reason for inversion of pulse:
- In general, whenever a wave (or pulse) reaches a boundary between two media. . .

    - If the properties of the two media are very different:



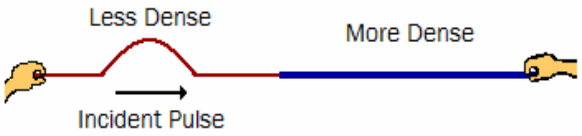
    - If the properties of the two media are very similar:



Crossing Wave Boundaries

1. What characteristic(s) of a wave must remain the same as the wave crosses a boundary between two different media? Explain.

2. Determine the following wave properties when a pulse traveling in a less dense medium (thin rope) transmits to a more dense medium (thick rope).

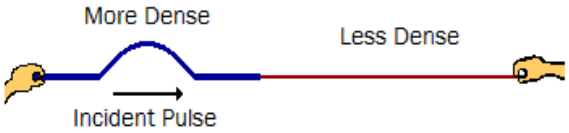


Wavelength	
Amplitude	
Speed	
Position	

Wavelength	
Amplitude	
Speed	
Position	

Draw what happens to the pulse after it reaches the boundary.

3. Determine the following wave properties when a pulse traveling in a more dense medium (thick rope) transmits to a less dense medium (thin rope).



Wavelength	
Amplitude	
Speed	
Position	

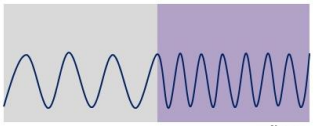
Wavelength	
Amplitude	
Speed	
Position	

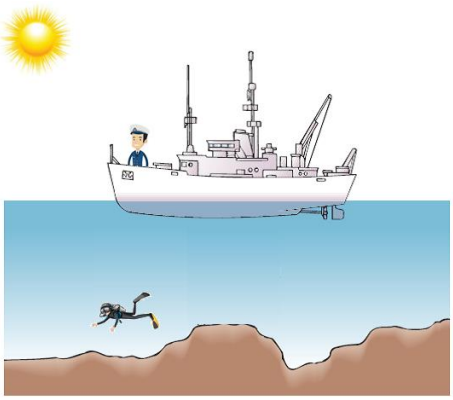
Draw what happens to the pulse after it reaches the boundary.

4. Determine which of the two springs is more dense by noticing how the pulse is reflected and transmitted after reaching the boundary.

5. When a wave travels in a **single medium**, the control variable is . . .

6. When a wave crosses a boundary between **two media**, the control variable is . . .





7. Both the person on the boat and the scuba diver underwater, look up to see the sun. Compare the **light** waves in air and in water.

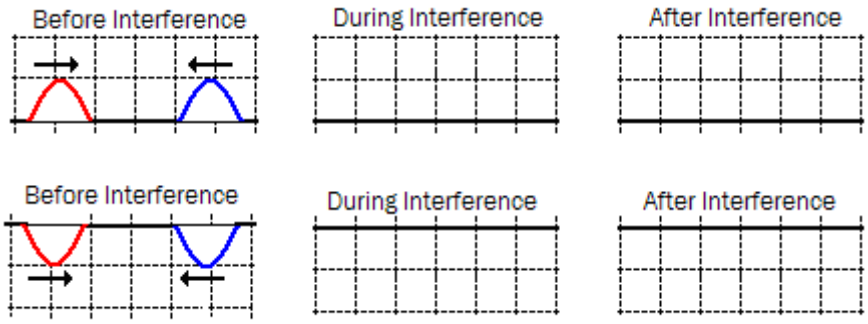
8. Both the person on the boat and the scuba diver underwater, hear the boat's engine. Compare the **sound** waves in air and in water.

Superposition & Interference

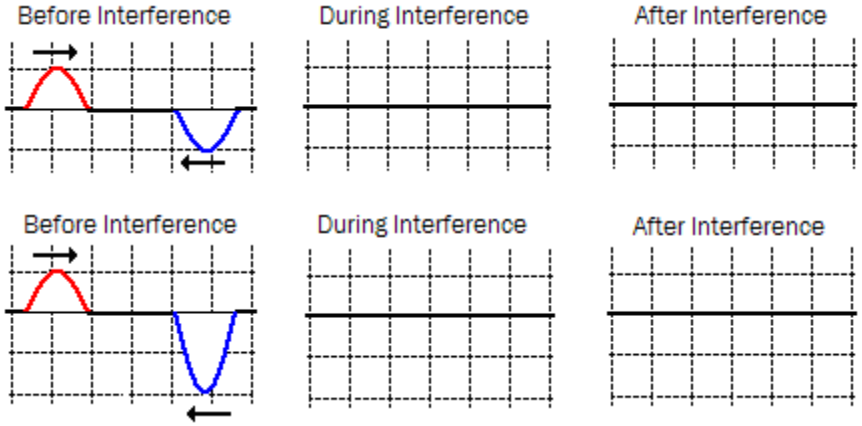
- Principle of Superposition – _____

_____

1. Waves travel on a string as shown. Show how the string would look when the waves interfere.

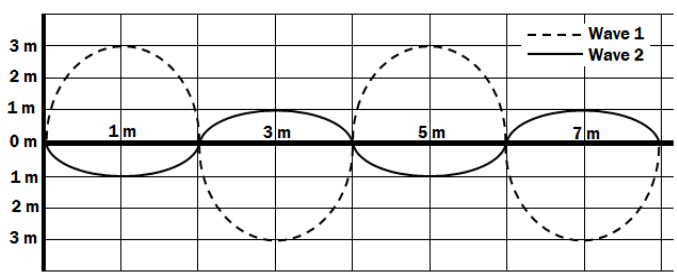


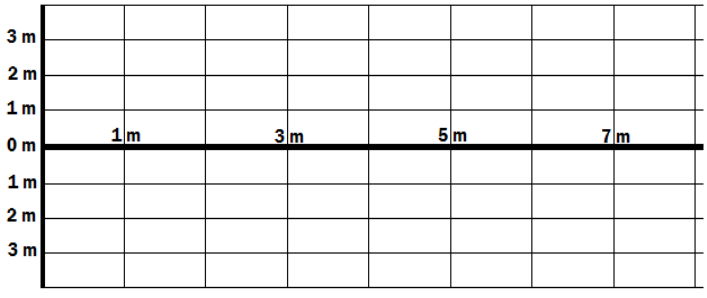
- Constructive Interference – superposition of two or more pulses or waves in phase



- Destructive Interference – superposition of two or more pulses or waves out of phase

2. Two waves are traveling in the same medium at the same time, as shown. Draw the resultant wave on the grid provided.

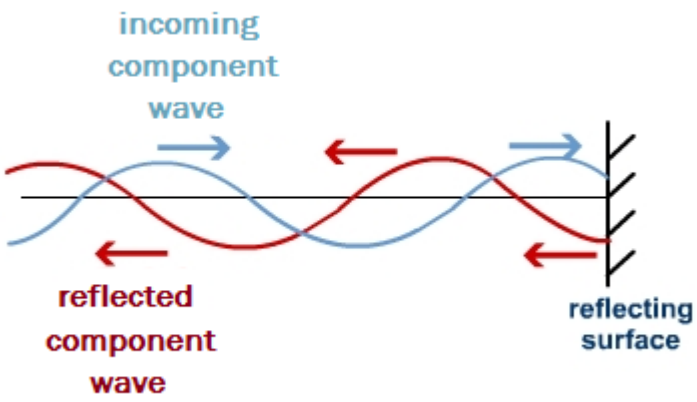




Standing Waves

Formation of Standing Waves

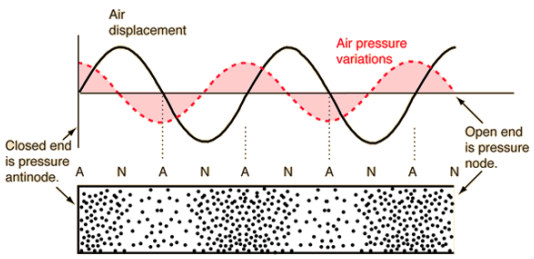
1. A traveling wave moving in one direction in a medium is reflected off the end of the medium.
2. This sends a reflected wave traveling in the opposite direction in the medium. This second wave is (nearly) identical with the first traveling wave. It has the same frequency, same wavelength, almost same amplitude.



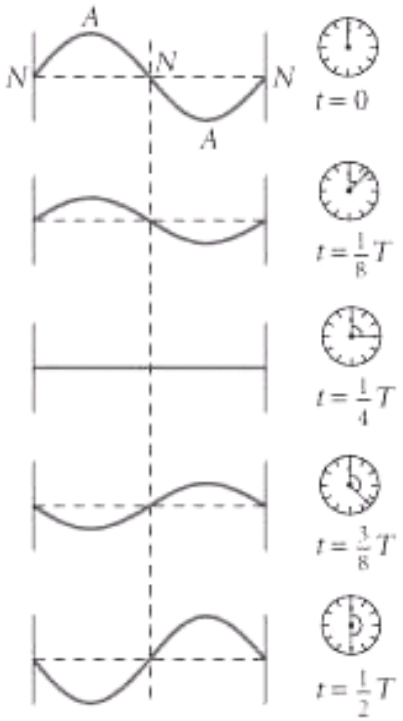
3. The two identical **component** waves traveling in opposite directions interfere with each other creating the standing wave. The standing wave is the **resultant** wave. Its amplitude at any point is the superposition of the components' amplitudes.

- Standing (Stationary) Wave - The **resultant** wave formed when two waves of equal amplitude and frequency traveling in opposite directions in the same medium interfere.

- Node: _____
  -
- Anti-Node: _____
  -

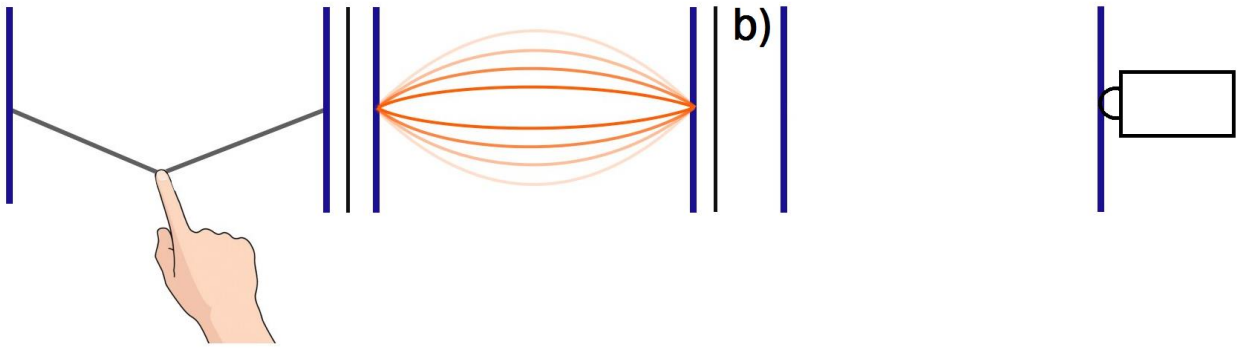


	Sound	Light
Node		
Anti-node		



This graphic shows what the standing wave looks like after each fraction of a period. Notice that you never see the two component traveling waves but only see the resultant standing wave.

	Traveling (Progressive) Wave	Standing (Stationary) Wave
1. Energy	Energy is transferred by the wave.	Energy is not transferred by the wave, but it does have energy stored in it.
2. Amplitude	All points on the wave have the same amplitude so we say it has *fixed amplitude* (provided energy is not dissipated.)	All points on the wave have different amplitude so we say it has *variable amplitude*. The maximum amplitude is at the antinodes and is 0 at the nodes.
3. Wavelength	Equal to the shortest distance along the wave between any two points that are in phase.	Same as the wavelength of the component waves. Equal to twice the distance between any two consecutive nodes (or antinodes).
4. Frequency	All particles oscillate in SHM with the same frequency.	All particles oscillate in SHM with the same frequency as the component waves.
5. Phase and phase difference	All points within one wavelength have a different phase. Thus, all phase differences are possible.	All points in one section between two consecutive nodes (or antinodes) are moving in phase. All points in the next section are 180^0 out of phase with all points in this section. Thus, the only possible phase differences are 0^0 and 180^0.



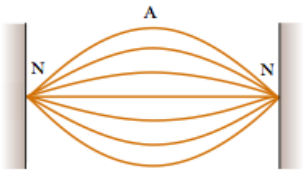
1. The diagram above shows the first harmonic (fundamental) standing wave vibrating at 73 Hz on a string that is 0.85 meter long.

   a) Determine the speed of the waves on the string.

   b) Sketch the standing wave that results when the string is vibrated at twice this fundamental frequency.

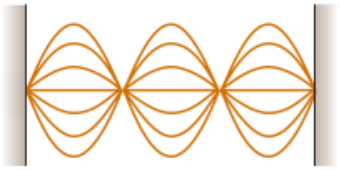
   c) Determine the speed of the waves on the string when it is vibrated at this new frequency.

2. Standing waves are formed on a string that is 4.0 meters long. For the standing waves shown below, sketch them in the spaces provided and determine their characteristics. The speed of the component waves making up these standing waves is 12 m/s.

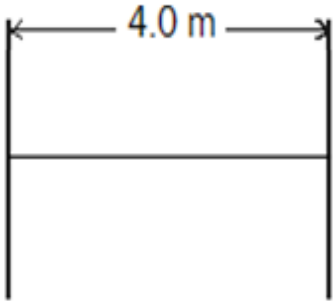


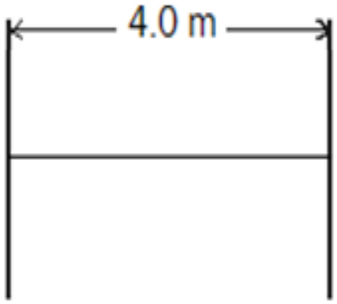
Name

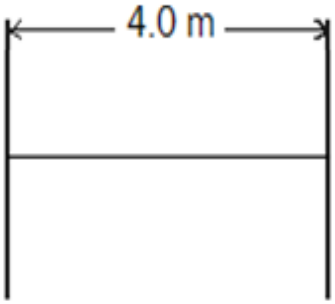
Name



Name





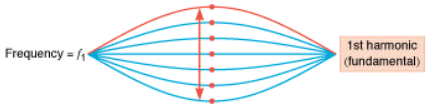


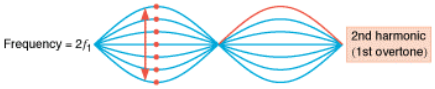
Wavelength	
Node(s)	
Antinode(s)	
Frequency	

Wavelength	
Node(s)	
Antinode(s)	
Frequency	

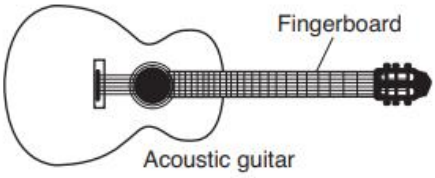
Wavelength	
Node(s)	
Antinode(s)	
Frequency	

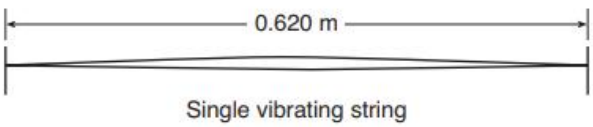
3. How do the frequencies of the harmonic waves compare to the frequency of the fundamental wave?





4. A musician plucks a 0.620-meter-long string on an acoustic guitar, as represented in the diagram at right. Describe what happens to the frequency when the musician shortens the vibrating portion of the string by pinching the string against the fingerboard while the string continues to vibrate.





Resonance

- Natural Frequency – _____

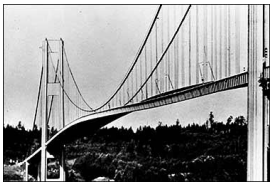
_____

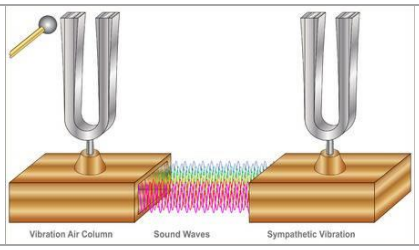
1. What do you think would happen if the opera singer below sang a note at the same natural frequency as the crystal wine glass?

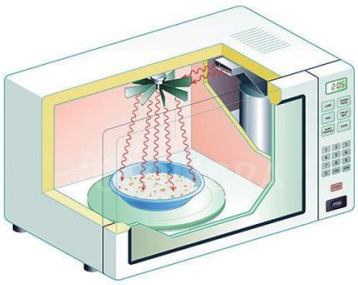
- Resonance – _____

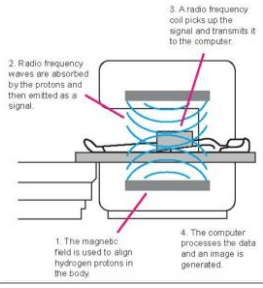
_____

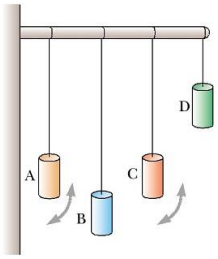
Other Examples of Resonance

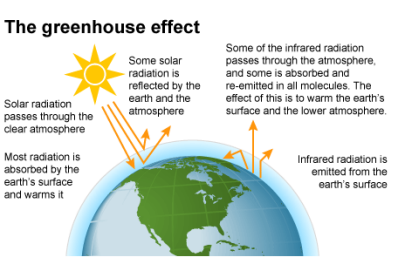










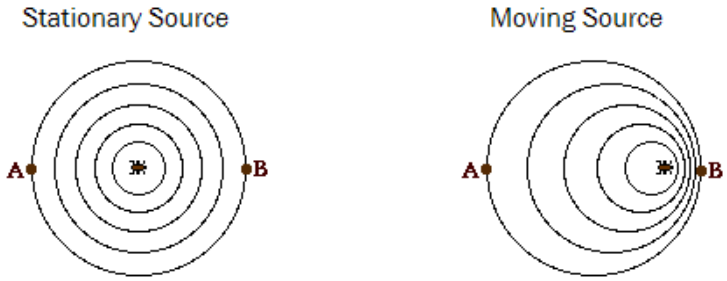


The Doppler Effect

Describe what you hear when a speeding car drives by.

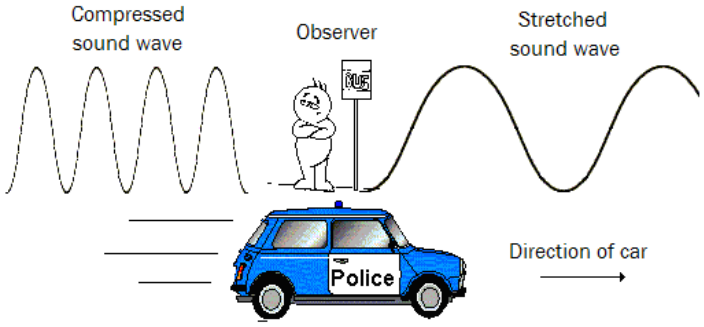
How does the siren sound to the person BEFORE the car passes him; and how does the siren sound AFTER the car passes him?

The pictures below represent the sound waves produced by a chirping bug. In the picture on the left, the bug is stationary, while in the picture on the right the bug is moving towards point B.



How do the sound waves on the left (A) of the bug compare?

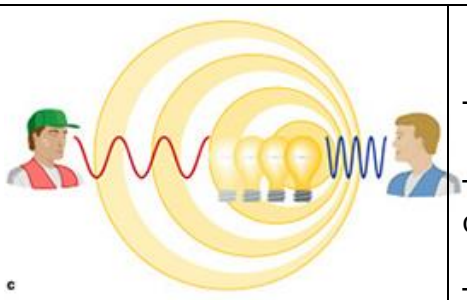
How do the sound waves on the right (B) of the bug compare?



Compressed sound waves produce a _____ frequency and a _____ pitch.

Stretched sound waves produce a _____ frequency and a _____ pitch.

Doppler Effect on Light

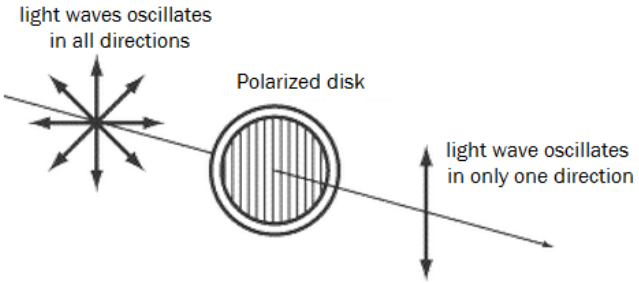
Redshift		Blueshift
The light of an object moving _____ an observer is shifted toward a _____, or toward the color _____.		The light of an object moving _____ an observer is shifted toward a _____, or toward the color _____.

Polarization

Polarization - _____

_____

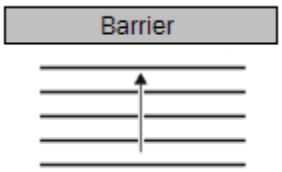
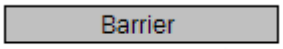
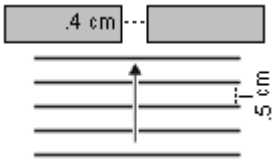
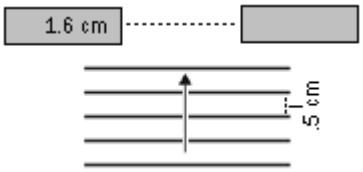
- _____



Waves in Two Dimensions

Circular Wavefronts	Plane Wavefronts
Draw a circular wavefront.	Draw a plane wavefront.

Behavior of Waves at Barriers

Head on Collision with a Complete Barrier		Head on Collision with an Incomplete Barrier	
Before	After	Narrow Slit	Wide Slit
			

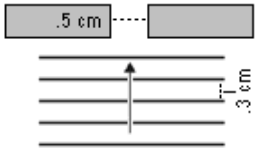
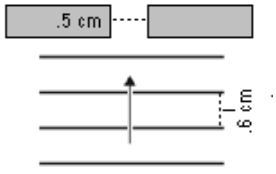
How does the size of a slit affect the amount a wave bends?

Diffraction – _____

_____

- _____

Effects of Wavelength on Diffraction

Small Wavelength	Large Wavelength
	

When the wavelength of the incident wave is _____ than the slit opening, the amount of diffraction _____.

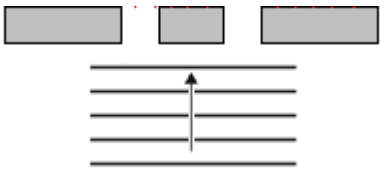
- _____

  _____

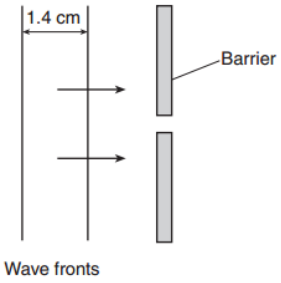
  _____

  - _____

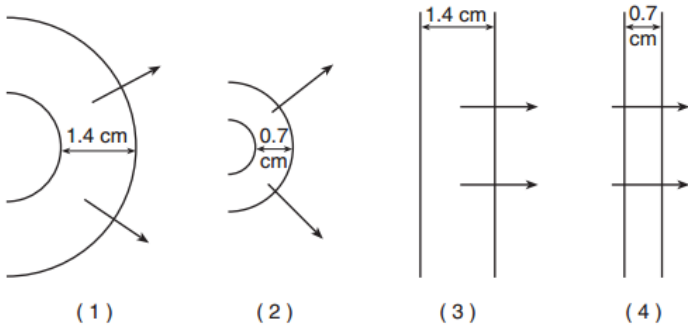
Double Slit Diffraction

Double Slit


1. The diagram below shows a series of straight wave fronts produced in a shallow tank of water approaching a small opening in a barrier.



Which diagram represents the appearance of the wave fronts after passing through the opening in the barrier?

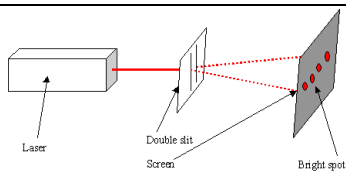


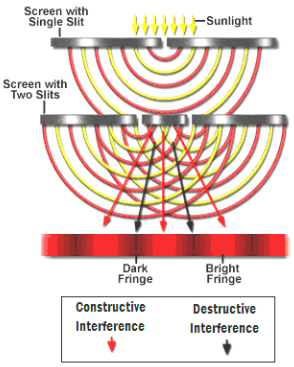
Thomas Young's Double Slit Experiment

Early scientists such as Sir Isaac Newton believed that light was composed of fast-moving tiny particles, which Newton himself called *corpuscles*.

In 1801, Young developed an experiment that allowed him to

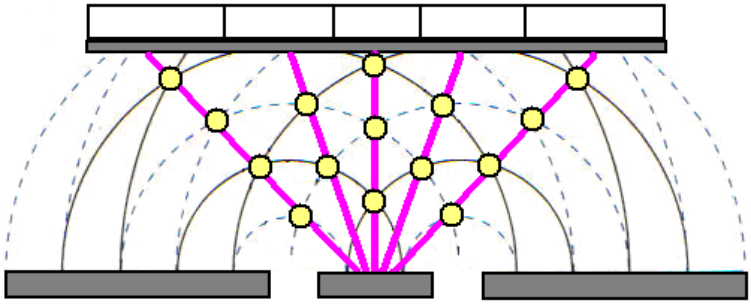
- _____
  _____
- _____





Two Sources in Phase in the Same Medium

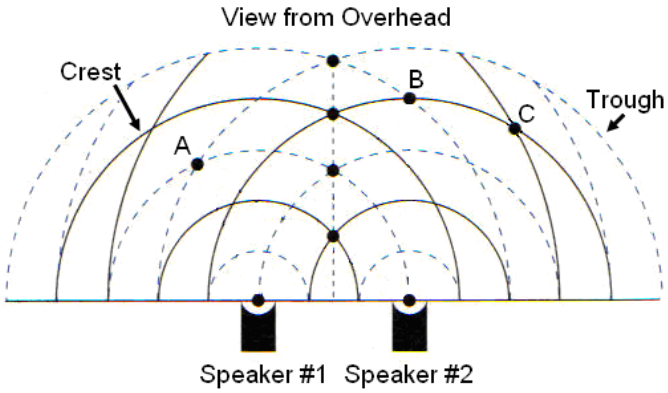
In the diagram below, laser light is diffracted after passing through a double slit. Indicate which regions on the screen will be dark as a result of destructive interference, by coloring the appropriate boxes.



- The _____ spots occur when the wave is _____, or _____ apart.
- The _____ spots occur when the wave is _____, or _____ apart.

Two Sources in Phase in the Same Medium

When two in-phase point sources generate waves in the same medium, a symmetrical interference pattern results because of maximum constructive and destructive interference.



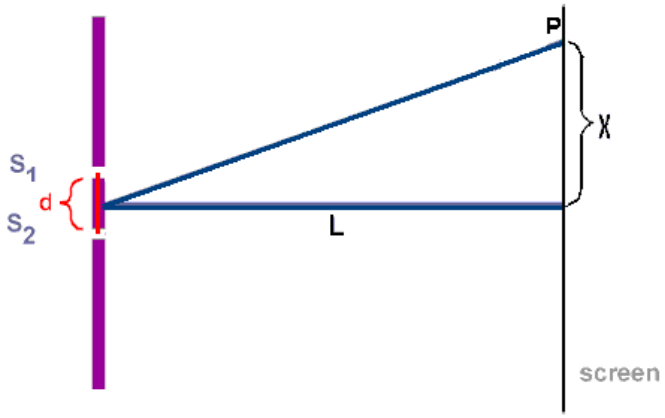
1. Describe what is occurring at point A.

2. Describe what is occurring at point B.

3. Describe what is occurring at point C.

Determining Wavelength using Double Slit Diffraction

The setup shown below was used by Thomas Young as he determined the wavelength of different colors of light waves.



Bright spot/Maximum – _____

_____

Central Maximum – _____

* Not on Reference Table

A two-slit experiment is performed to measure the wavelength of a monochromatic light. The slits are 250 micrometers apart. A screen is placed 10.0 meters away and the distance between the central maximum and the first maximum is measured to be 20. millimeters.

a. Calculate the wavelength of the light wave.

b. Calculate the frequency of the light wave.

c. What color is this light wave?

Name: _____ Date: _____

Honors Physics Test #12 Review

Waves

1. Read Chapters 12, 13, & 14.

2. Terms to know: mechanical wave, transverse wave, longitudinal wave, surface wave, electromagnetic wave, pulse, medium, cycle, crest, trough, equilibrium position, traveling wave, period, frequency, wavelength, amplitude, phase, principle of superposition, constructive interference, destructive interference, node, antinode, standing wave, resonance, diffraction, pitch, volume (loudness), Doppler shift.

3. What is the difference between a transverse and a longitudinal wave? Draw a picture of each. Give an example of each.

4. What is the difference between a traveling wave and a standing wave? What are the conditions necessary to produce a standing wave?

5. What is the difference between a mechanical wave and an electromagnetic wave? Give an example of each.

6. Sketch two pulses that will interfere constructively. Sketch two pulses that will interfere destructively.

7. How can you change the speed of a wave in a rope? How can you change the frequency? How can you change the amplitude? How can you change the wavelength?

8. When a wave crosses a boundary from one medium to another (say, from air to water or from a thick spring to a light spring) what characteristic of the wave remains the same?

9. Sketch a picture of each of the following wave phenomena: reflection, diffraction, interference.

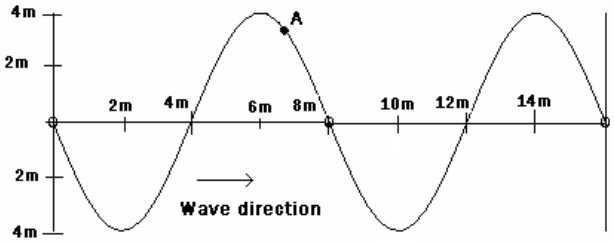
10. As a car honking its horn approaches you standing on a street corner, what do you notice about the frequency, amplitude and wavelength of the sound of the horn? What do you notice about these things as the car passes you and travels away? What is the name for this phenomenon?

11. Sketch one cycle of a standing wave and label the nodes and antinodes. Sketch one-half cycle. Sketch 1 ½ cycles.

12. As the pitch of a sound increases, what happens to its frequency? As the loudness of a sound increases, what happens to its amplitude?

13. Which two factors will result in a wave diffracting more: narrow opening or wide opening? Small wavelength or large wavelength?

Directions: Read each question carefully and record your answers in the space provided. Be sure to show all work! Answers should be in significant figures. You will be graded on proper use of the GUESS method. If the GUESS method is not appropriate, show all work to receive partial credit. **These will be the same directions on the test. Practice the GUESS method now.**



Use the wave to answer questions 1 - 6.

1. What is the wavelength of the wave?
2. What is the amplitude of the wave?
3. Over time, particle A will move in which direction?

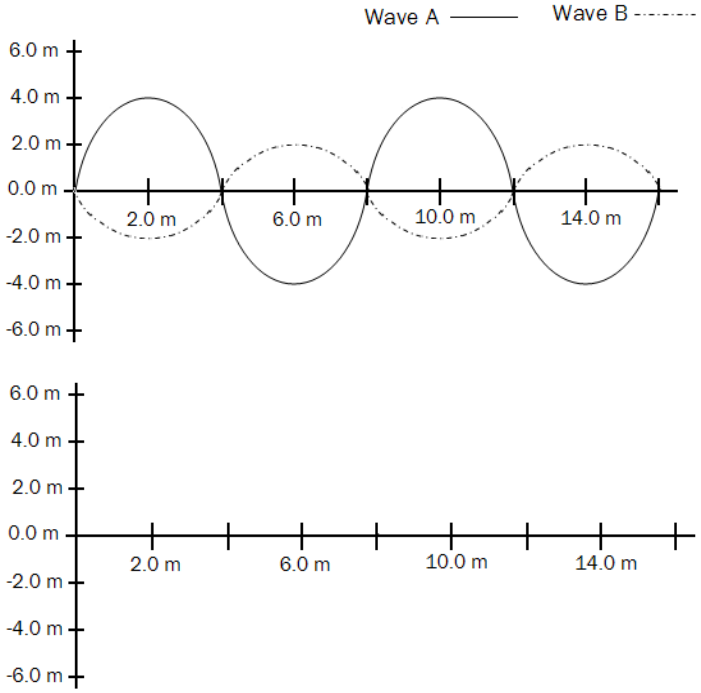
If a student observes 60.0 waves passing in 12 seconds:

4. What is the frequency of the wave?
5. What is the period?
6. What is the velocity of the wave?

Use the waves below to answer questions 7 – 12.

Two waves, A and B, are shown below. They are traveling in the same medium at the same time. Both have the same wavelength but different amplitudes.

7. In the space below, show the resultant wave if A and B interfere.

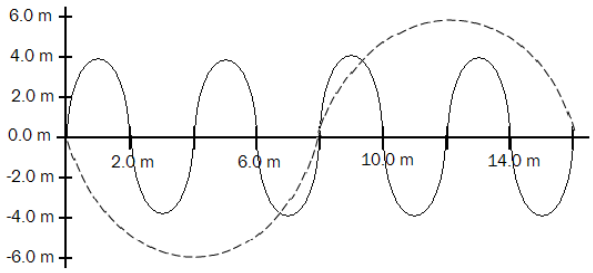


8. What is the wavelength of wave A?
9. What is the amplitude of wave B?
10. What is the wavelength of the combined wave?
11. What is the amplitude of the combined wave?
12. What type of interference is this?

13. What is the frequency of a 3.0 meter wave traveling at 100. m/s?

14. If the frequency of a wave doubles, while the speed remains constant, what happens to the wavelength?

15. What is the wavelength of the following waves? Wave A ——— Wave B – – – – -



16. A two-slit experiment is performed to measure the wavelength of a monochromatic light. The slits are 295 micrometers apart. A screen is placed 8.75 meters away and the separation between the central bright spot and the next bright spot is measured to be 21.4 millimeters.
    a. Calculate the wavelength of the light.

    b. Calculate the frequency of this light wave.

    c. What color is the light?

17. What is the frequency of a light whose wavelength is:
    a. 6.7×10^{-7} m?

    b. 5.9×10^{-7} m?

18. What is the wavelength of a light wave whose frequency is 3×10^{14} Hz.

19. A sound wave has a frequency of 292 Hz.
    a. Calculate the wavelength of the wave.

    b. How long will it take for the wave to travel 25 m?

    c. What is the period of the wave?

20. Which phenomenon does *not* occur when a sound wave reaches the boundary between air and a steel block?

(A) reflection (B) polarization (C) absorption (D) refraction

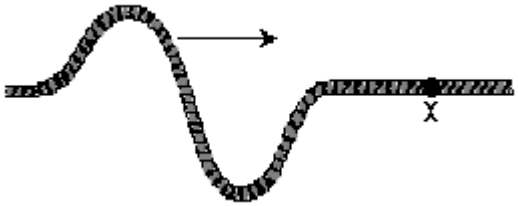
21. As a periodic wave travels from one medium to another, which pair of the wave's characteristics cannot change?

(A) period and amplitude
(B) period and frequency
(C) amplitude and wavelength
(D) frequency and velocity

22. The distance from the Moon to Earth is 3.9×10^8 meters. What is the time required for a light ray to travel from the Moon to Earth?

(A) 0.65 s (B) 3.9 s (C) 1.3 s (D) 2.6 s

23. The diagram below shows a transverse wave moving to the right along a rope.



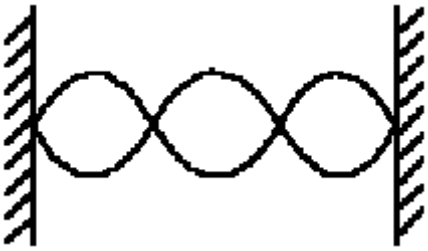
As the wave passes point X, the motion of x will be

(A) left, then right (B) up, then down (C) in a circle (D) down, then up

24. Two waves have the same frequency. Which wave characteristic must also be identical for both waves?

(A) intensity (B) phase (C) amplitude (D) period

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



(A) 6 (B) 4 (C) 3 (D) 1

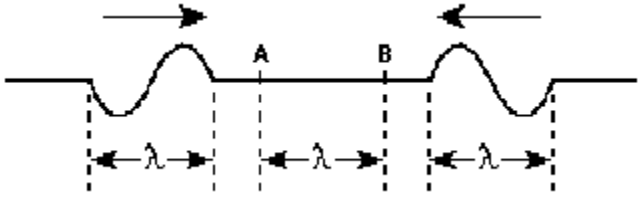
26. The frequency of a light wave is 5.0×10^{14} hertz. What is the period of the wave?

(A) 6.0×10^7 s (B) 5.0×10^{-14} s (C) 2.0×10^{-15} s (D) 1.7×10^6 s

27. An astronomer on Earth studying light coming from a star notes that the observed light frequencies are lower than the actual emitted frequencies. The astronomer concludes that the distance between the star and Earth is

(A) increasing (B) not changing (C) decreasing

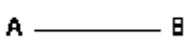
28. The diagram below shows two pulses, each of length λ, traveling toward each other at equal speed in a rope.



Which diagram best represents the shape of the rope when both pulses are in region AB?

A)

B)

C) 

D)

29. What is the wavelength of a 30. hertz period wave moving at 60. meters per second?

(A) 1,800 m (B) 2.0 m (C) 20. m (D) 0.50 m

30. The driver of a car sounds the horn while traveling toward a stationary person. Compared to the sound of the horn heard by the driver, the sound heard by the stationary person has

(A) higher pitch and longer wavelength
(B) lower pitch and shorter wavelength
(C) lower pitch and longer wavelength
(D) higher pitch and shorter wavelength

31. When an opera singer hits a high-pitch note, a glass on the opposite side of the opera hall shatters. Which statement *best* explains this phenomenon?

(A) The singer and the glass are separated by an integral number of wavelengths.
(B) The frequency of the note and natural vibration frequency of the glass are equal.
(C) The vibrations of the note are polarized by the shape of the opera hall.
(D) The amplitude of the note increases before it reaches the glass.

32. The periodic wave in the diagram below has a frequency of 40. hertz.

What is the speed of the wave?

(A) 13 m/s (B) 120 m/s (C) 60. m/s (D) 27 m/s

33. What is the angle between the direction of propagation of a transverse wave and the direction in which the amplitude of the wave is measured?

(A) 90^0 (B) 180^0 (C) 45^0 (D) 0^0

34. In the diagram below, the distance between points A and B on a wave is 0.10 meter.

This wave must have

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

35. Light is to brightness as sound is to

(A) period (B) loudness (C) speed (D) color

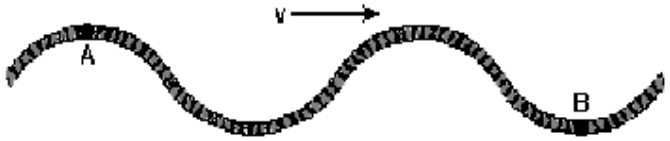
36. What is the period of a periodic wave that has a frequency of 60. hertz?

(A) 1.7×10^{-2} s (B) 3.3×10^{2} s (C) 2.0×10^{4} s (D) 3.0×10^{-3} s

37. A monochromatic beam of light has a frequency of 6.5×10^{14} hertz. What color is this light?

(A) orange (B) yellow (C) blue (D) violet

38. A periodic wave travels through a rope, as shown in the diagram below.



As the wave travels, what is transferred between points A and B?

(A) neither mass nor energy
(B) energy, only
(C) both mass and energy
(D) mass, only

39. The distance between successive antinodes in the standing wave pattern shown below is equal to

(A) 2 wavelength (B) 1/2 wavelength (C) 1/3 wavelength (D) 1 wavelength

Answers:

1. 8 m
2. 4 m
3. up
4. 5.0 Hz
5. 0.20 s
6. 40 m/s right
7. see sheet
8. 8.0 m
9. 2.0 m
10. 8.0 m
11. 2.0 m
12. Destructive
13. 33 Hz
14. Cut in ½
15. A = 4.0 m, B = 16.0 m
16. ..
    a. 7.21×10^{-7} m
    b. 4.16×10^{14} Hz
    c. red
17. ..
    a. 4.5×10^{14} Hz
    b. 5.1×10^{14} Hz
18. 1×10^{-6} m
19. ..
    a. 1.13 m
    b. 0.076 s
    c. 0.00342 s

20. B
21. C
22. D
23. D
24. B
25. C
26. A
27. C
28. B
29. D
30. B
31. C
32. A
33. B
34. B
35. A
36. C
37. B
38. B

Name _____ Date _____

Honors Physics SAT Review #12

SAT Review: Waves

PART A

Directions – For each group of questions below, there is a set of five letter choices, followed by numbered questions. For each question select the one choice in the set that best answers the question. You may use a lettered choice once, more than once, or not at all in each set. Do not use a calculator or table of reference.

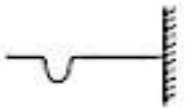
Questions 1 – 4 relate to the following.

(A) polarization
(B) Doppler shift
(C) diffraction
(D) constructive interference
(E) destructive interference

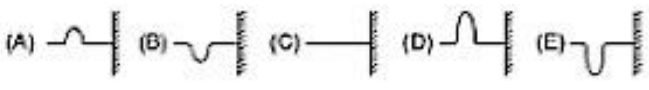
1. Which of the above occurs when two waves that are in phase with each other meet at the same time in the same medium?
2. Which of the above occur when a light wave is made to vibrate in only one plane?
3. Which of the above occurs when an observer notices a change in a train whistle's pitch as it passes by?
4. Which of the above occurs when a wave passes through a small opening?

PART B

Directions – Each of the questions or incomplete statements below is followed by five answer choices. Select the choice that best answers the question or completes the statement. Do not use a calculator or any tables of reference.

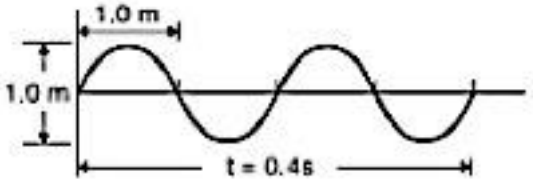


5. One end of a horizontal string is fixed to a wall, as shown above. A transverse wave pulse is generated at the other end, moves toward the wall, and is reflected at the wall. Which of the diagrams below best represents the pulse after it is reflected from the wall?



6. A girl on the beach observes 4 waves pass by in 2 seconds, each with a wavelength of 0.5 meter. The speed of the wave is
   A) 0.25 m/s
   B) 0.5 m/s
   C) 1.0 m/s
   D) 2.0 m/s
   E) 4.0 m/s

Questions 7 – 9 refer to the following.

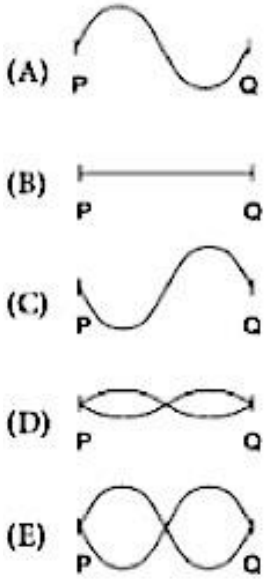


7. The wavelength of the wave above is
   A) 0.5 m
   B) 1.0 m
   C) 2.0 m
   D) 4.0 m
   E) 6.0 m
8. The amplitude of the wave shown above is
   A) 0.5 m
   B) 1.0 m
   C) 2.0 m
   D) 4.0 m
   E) 6.0 m
9. The frequency of the wave shown above is
   A) 0.2 Hz
   B) 0.4 Hz
   C) 2 Hz
   D) 4 Hz
   E) 5 Hz
10. As a wave passes from a spring to another spring with a greater tension
    A) the speed of the wave decreases.
    B) the frequency of the wave increases.
    C) the frequency of the wave decreases.
    D) the amplitude of the wave increases.
    E) the speed of the wave increases.

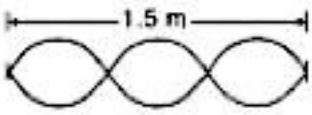
11. The diffraction of a wave through a single opening produces
    A) refraction.
    B) an angle of incidence.
    C) an increase in speed of the wave.
    D) a semicircular wave pattern.
    E) a decrease in speed of the wave.

12. Two waves approach each other in the same rope at the same time, as shown.

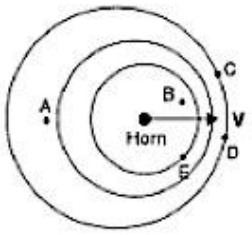
When the two waves are exactly between points P and Q, the shape of the rope will be



13. A standing wave is produced in a vibrating string as shown.



If the length of the string is 1.5 m and the frequency of the vibrating motor is 60 Hz, the speed of the wave is
    A) 15 m/s
    B) 20 m/s
    C) 40 m/s
    D) 60 m/s
    E) 90 m/s



14. Sound waves of a constant frequency are being emitted by a horn as it moves to the right, as shown above. At which point would a listener hear a pitch that was lower than she would hear if the horn was at rest?
    A) A
    B) B
    C) C
    D) D
    E) E

15. Which of the following colors, when passed through a double-slit opening, will produce the widest central band of light?
    A) red
    B) orange
    C) yellow
    D) green
    E) blue

16. The Doppler effect produces apparent changes in
    A) loudness.
    B) pitch.
    C) amplitude.
    D) velocity.
    E) acceleration.

17. If light is passed through a double-slit opening onto a screen, the pattern produced on the screen is
    A) a bright central band of light with slightly diminished, alternating bright and dark bands called antinodes and nodes.
    B) a bright central band of light with tiny lines toward the edge of the screen.
    C) a large circle of light with tiny circles around it.
    D) equally sized concentric circles of light.
    E) one antinode and no node.

Answers: 1) D 2) A 3) B 4) C 5) A 6) C 7) C 8) A 9) E 10) E 11) D 12) B 13) D 14) A 15) A 16) B 17) A