AP Physics Study Guide   Chapters 11, 12, 24 Waves, Sound, Light & Interference

Name______________________

Write the equation that defines each quantity, **include units for all quantities.**

wave speed-wavelength equation   natural frequencies of standing waves in a rope fixed at both ends

natural frequencies for closed pipe resonator   natural frequencies for open pipe resonator

diffraction/interference equation

Chapter 11

The most important fact about waves is that they transfer ________________ but not _______________.

Explain the differences between mechanical waves and electromagnetic waves. Give examples of each.

Define transverse waves and longitudinal waves. Draw a simple diagram of each

Define each of the 5 wave properties below. Include symbols AND units of each.

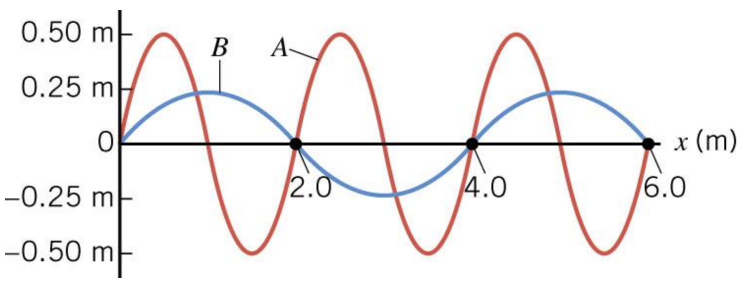
wave speed:

wavelength:

frequency:

period:

amplitude:



The amplitude of wave A = ___________ m; the wavelength of wave A = ___________ m

The amplitude of wave B = ___________ m; the wavelength of wave B = ___________ m

What does wave speed depend on?

What does wave frequency depend on?

Indicate 2 ways in which you can INCREASE the wavelength of a wave in a rope that has constant properties.

1)

2)

Explain how rope wave pulses reflect off of a boundary when the boundary is

Fixed so that it cannot vibrate:

Free so that it is able to vibrate:

State the law of reflection. Draw a diagram of a ray being reflected from a surface which illustrates this law. Include the incident ray, reflected ray and the normal.

Explain wave interference.

What happens to a medium when two wave pulses constructively interfere?

What happens to a medium when two wave pulses destructively interfere?

Explain what resonance is and how it creates standing waves in a rope fixed at both ends.

An antinode is a point on a standing wave with ____________________ displacement.

A node is a point on a standing wave with ____________________ displacement.

What is the fundamental frequency and how are the higher natural frequencies related to it?

Chapter 12

The two main characteristics of sound waves is that they are ________________________ and ________________________.

Briefly explain how the natural frequencies in an open pipe resonator and a closed pipe resonator are each related to their fundamental frequency.

The phenomenon of beats occurs when sound waves ____________________ with each other. Briefly explain how this occurs and what you hear when it does occur.

A stationary observer, as a result of the Doppler Effect, perceives a(n) ________________ in the

___________________ of the sound waves from an approaching sound source.

Explain the cause of the Doppler Effect.

A stationary observer, as a result of the Doppler Effect, perceives a(n) ________________ in the

___________________ of the sound waves from a sound source that is moving away.

The frequency of the sound waves from the source remains __________________ as it approaches or recedes.

Chapter 24

Explain the process of diffraction. Include a diagram showing the diffraction of water waves.

Explain Young's double slit experiment in detail. Draw a diagram showing the experiment. Include on your diagram the resulting interference pattern of the light on the screen. Label the important variables d, x, L and θ on your diagram.

Young's double slit experiment, including both interference and diffraction of light, is proof of the

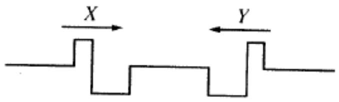
_______________ nature of light.

Briefly explain how the diffraction pattern created on a screen by a single slit differs from that created by a double slit.

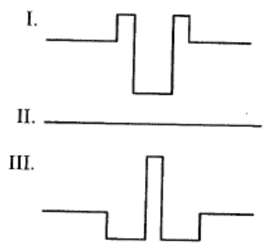
What is a diffraction grating? Include the equation for how the slit separation d is calculated.

Describe the interference pattern it creates and how it is different from the pattern created by the double slit and single slit.

No process is required for these multiple choice questions. Put answers on lines provided.



1) e two wave pulses, X and Y, shown above moving toward each other in the same dium. Which of the following interference patterns could result at some instant as the pulses pass through each other?

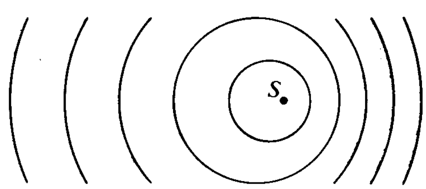


(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

1)________________

2. A vibrating tuning fork sends sound waves into the air surrounding it. During the time in which the tuning fork makes one complete vibration, the emitted wave travels
(A) one wavelength
(B) about 340 meters
(C) a distance directly proportional to the frequency of the vibration
(D) a distance directly proportional to the square root of the air density
(E) a distance inversely proportional to the square root of the pressure

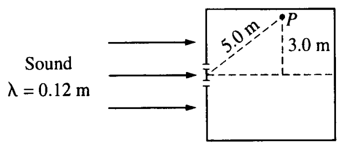
2)_______



3) A small vibrating object S moves across the surface of a ripple tank producing the wave fronts shown above. The wave fronts move with speed v. The object is traveling in what direction and with what speed relative to the speed of the wave fronts produced?

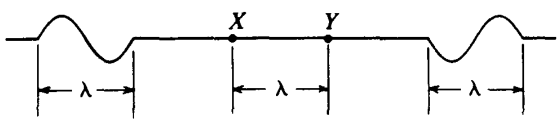
Direction	Speed
(A) To the right	Equal to v
(B) To the right	Less than v
(C) To the right	Greater than v
(D) To the left	Less than v
(E) To the left	Greater than v

3)_______



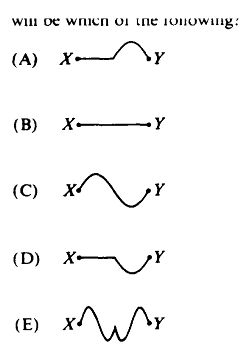
4) Plane sound waves of wavelength 0.12 m are incident on two narrow slits in a box with nonreflecting walls, as shown above. At a distance of 5.0 m from the center of the slits, a first-order maximum occurs at point *P*, which is 3.0 m from the central maximum. The distance between the slits is most nearly

a. 0.07 m b. 0.09 m c. 0.16 m d. 0.20 m e. 0.24 m 4)______



5) Two wave pulses, each of wavelength λ, are traveling toward each other along a rope as shown above. When both pulses are in the region between points X and Y. which are a distance λ apart. the shape of the rope can be best represented by which of the following?

5)________



6)

An organ pipe of length L is open at one end and closed at the other. The standing wave of next-to-lowest frequency which can exist in this pipe has a wavelength nearest to

(A) $\frac{1}{3}L$

(B) $\frac{1}{2}L$

(C) L

(D) $\frac{4}{3}L$

(E) $2L$

6)______

7 & 8)

Two tuning forks with which of the following pairs of frequencies will produce the greatest frequency of beats when sounded together?

(A) 250 and 256 Hz
(B) 300 and 303 Hz
(C) 634 and 639 Hz
(D) 763 and 764 Hz
(E) 1420 and 1422 Hz

The principle of superposition states that

(A) every point on a wave front may be considered to behave like a point source of waves
(B) the width of a single-source diffraction pattern depends on the ratio of the wavelength to the size of the source
(C) transverse waves can be polarized, but longitudinal waves cannot
(D) as a wave moves from one medium to another, the wave speed changes
(E) the displacement of the medium at a point where waves meet is the sum of the displacements of the individual waves

7)______ 8)_______

9)

A stationary source emits sound waves of frequency f and wavelength λ that travel through the air with speed v. If the frequency of the source is changed to $2f$, what will be the wavelength and speed of the new wave?

	Wavelength	Speed
(A)	2λ	v
(B)	λ	$2v$
(C)	λ	$v/2$
(D)	$\lambda/2$	$2v$
(E)	$\lambda/2$	v

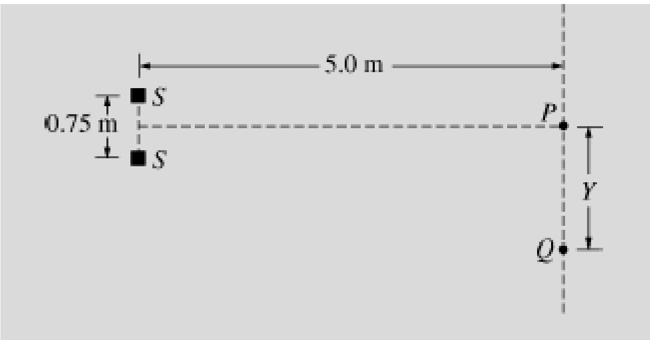
9)_______

10)

A parallel beam of light of wavelength 4.5×10^{-7} m is incident on a pair of slits that are 5.0×10^{-4} m apart. The interference pattern is focused on a screen 2.0 m from the slits. The separation between two adjacent bright fringes is most nearly

(A) 0.9×10^{-3} m
(B) 1.8×10^{-3} m
(C) 2.7×10^{-3} m
(D) 3.6×10^{-3} m
(E) 5.4×10^{-3} m

10)________



Note: Figure not drawn to scale.

1) Two small speakers S are positioned a distance of 0.75 m from each other, as shown in the diagram above. The two speakers are each emitting a constant 2500 Hz tone, and the sound waves from the speakers are in phase with each other. A student is standing at point P, which is a distance of 5.0 m from the midpoint between the speakers, and hears a maximum as expected. Assume that reflections from nearby objects are negligible. Use 343 m/s for the speed of sound.

a) calculate the wavelength of these sound waves a)_____________

b) the student moves a distance Y to point Q and notices that the sound intensity has decreased to a minimum. Calculate the shortest distance the student could have moved to hear this minimum.

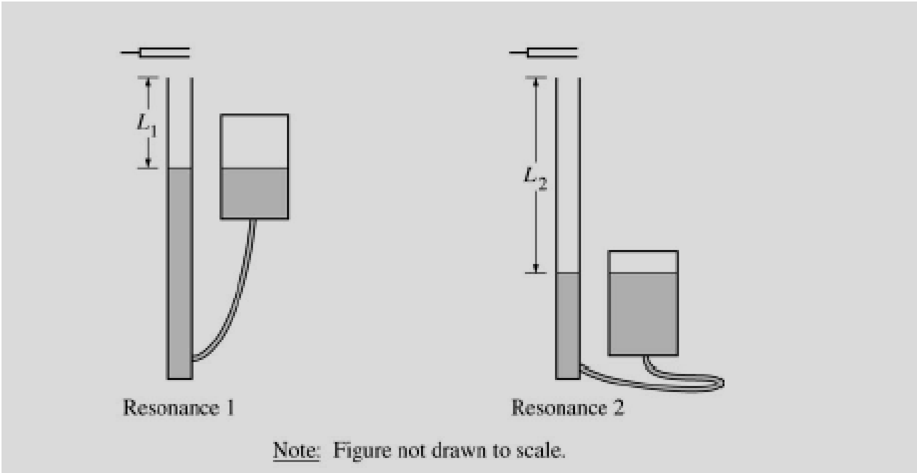
b)____________

c) identify another location on the line that passes through P and Q where the student could stand in order to observe a minimum.   Justify your answer.

c)_______________

d) i. How would your answer to (b) change if the two speakers were moved closer together? Justify your answer.

ii. How would your answer to (b) change if the frequency emitted by the two speakers was increased? Justify your answer.



2) A vibrating tuning fork is held above a column of air, as shown in the diagrams above. The reservoir is raised and lowered to change the water level, and thus the length of the column of air. Resonance is heard when the length of air column is $L_1 = 0.25$ m, and the next resonance is heard when the air column is $L_2 = 0.80$ m long. The speed of sound in air at 20^oC is 343 m/s and the speed of sound in water is 1490 m/s.

a) calculate the wavelength of the standing sound wave produced by this tuning fork.

a)_____________

b) calculate the frequency of the tuning fork that produces the standing wave, assuming the air is at 20^oC.

b)____________

c) calculate the wavelength of the sound waves produced by this tuning fork in the water.

c)_____________

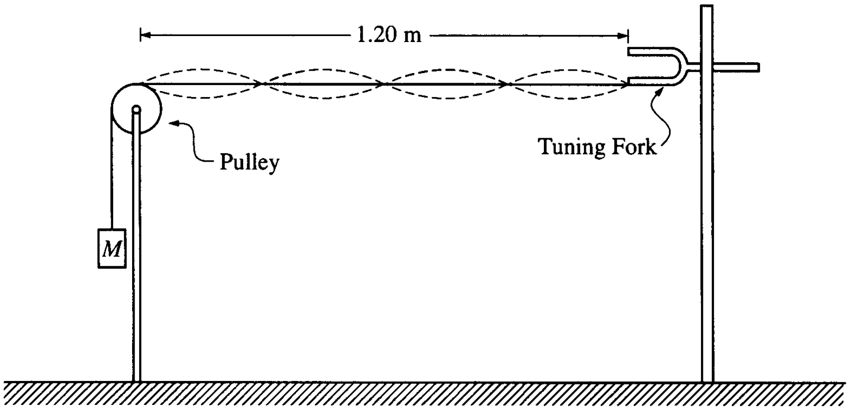
d) the water level is lowered again until the next resonance is heard. Calculate the length L_3 of the air column that produces this resonance.

d)____________

e) the student performing this experiment determines that the temperature of the room is actually slightly higher than 20°C. Is the calculation of the frequency in part (b) too high, too low or still correct?

__________ too high ____________too low ________still correct

Justify your answer



3) To demonstrate standing waves, one end of a string is attached to a tuning fork with frequency 120 Hz. The other end of the string passes over a pulley and is connected to a suspended mass M as shown in the figure above.
The value of M is such that the standing wave pattern has four "loops." The length of the string from the tuning fork to the point where the string touches the top of the pulley is 1.20 m. The linear density of the string is 1.0×10^{-4} kg/m, and remains constant throughout the experiment.

a. Determine the wavelength of the standing wave.

a)______________

b. Determine the speed of transverse waves along the string.

b)____________

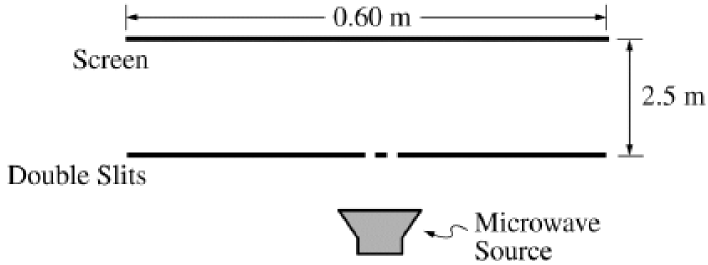
c. The speed of waves along the string increases with increasing tension in the string. Indicate whether the value of M should be increased or decreased in order to double the number of loops in the standing wave pattern. Justify your answer.

c)________________

d. If a point on the string at an antinode moves a total vertical distance of 4 cm during one complete cycle, what is the amplitude of the standing wave?

d)_______________

4)



Note: Figure not drawn to scale.

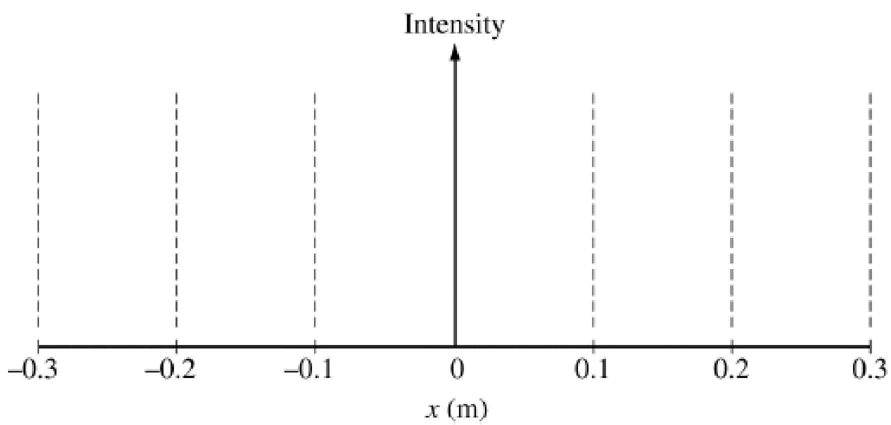
(15 points)

A microwave source is placed behind two identical slits, as represented in the diagram above. The slit centers are separated by a distance of 0.20 m, and the slit widths are small compared to the slit separation but not negligible. The microwave wavelength is 2.4×10^{-2} m. The resulting interference pattern is centered on a screen 0.60 m wide, located 2.5 m from the slits.

(a) Calculate the frequency of the microwave radiation.

a)_______________

(b) On the graph below, where the x-axis represents the distance along the screen and $x = 0$ represents the center of the pattern, sketch the intensity of the interference pattern expected for that arrangement.

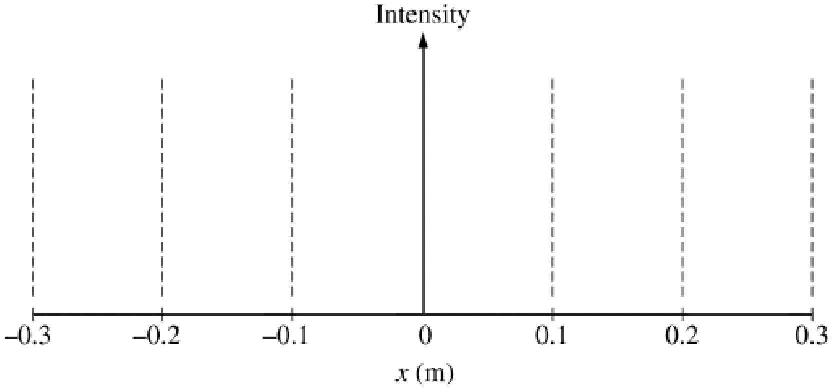


(c) Consider points on the screen located at $x = 0.00$ m, $x = 0.15$ m, and $x = 0.30$ m. Rank the intensity at those points from highest to lowest, with number 1 corresponding to the highest intensity. If two points have equal intensity, give them the same ranking.

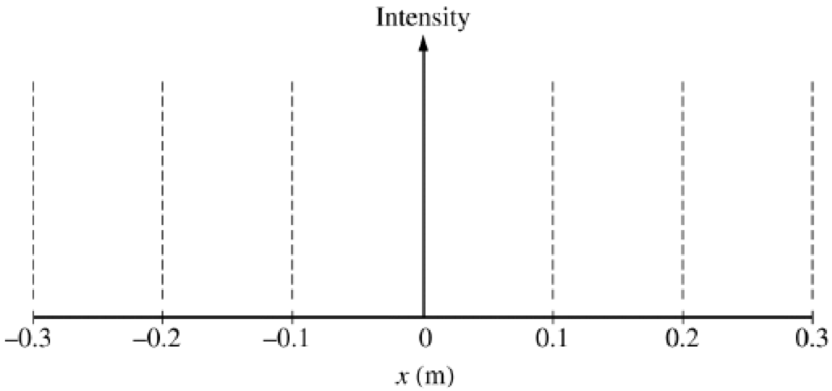
____ $x = 0.00$ m ____ $x = 0.15$ m ____ $x = 0.30$ m

Justify your ranking.

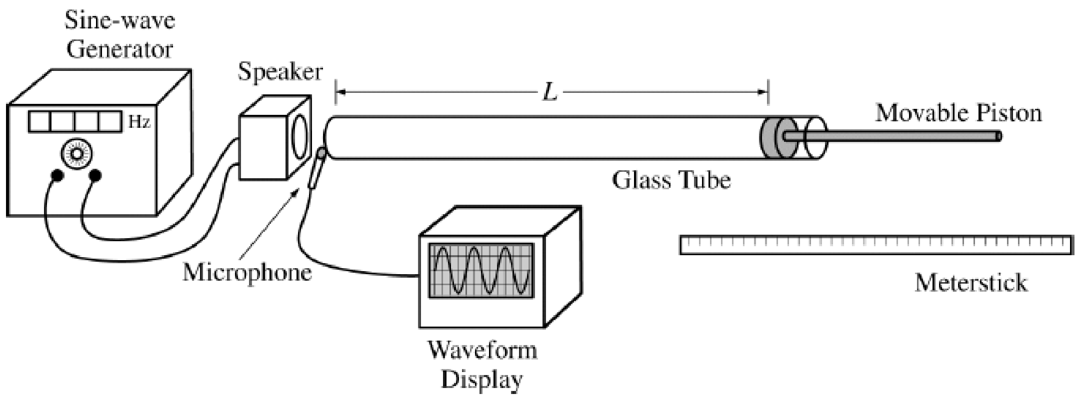
(d) Suppose the microwave wavelength is decreased by a factor of three, to 0.80×10^{-2} m . Sketch the resulting interference pattern below.



(e) Suppose the material separating the two slits is removed so that there is now one slit approximately 0.20 m in width. The wavelength is held at 0.80×10^{-2} m . Sketch the resulting diffraction pattern below.



5)



You are given the apparatus represented in the figure above. A glass tube is fitted with a movable piston that allows the indicated length L to be adjusted. A sine-wave generator with an adjustable frequency is connected to a speaker near the open end of the tube. The output of a microphone at the open end is connected to a waveform display. You are to use this apparatus to measure the speed of sound in air.

(a) Describe a procedure using the apparatus that would allow you to determine the speed of sound in air. Clearly indicate what quantities you would measure and with what instrument each measurement would be made. Represent each measured quantity with a different symbol.

b) Using the symbols defined in part (a), indicate how your measurements can be used to determine an experimental value of the speed of sound.

over for more

c) A more accurate experimental value can be obtained by varying one of the measured quantities to obtain multiple sets of data. Indicate one quantity that can be varied, and describe how a graph of the resulting data could be used to determine the speed of sound. Clearly identify independent and dependent variables by labeling the coordinate plane axes below. Explain how the slope of the best fit straight line graph relates to the speed of sound.