

LAB PHYSICS TEST CHAPTERS 11-12 1994-1995 A

\* SHM, WAVE MOTION AND SOUND \*

Matching: Each of the following statements matches up with one of the terms at the bottom of the page. Read each statement and then select the BEST term [only one per statement!] and place the corresponding letter in the space provided. Please use capital, block letters! [1 pt each]

- \_\_\_ 1. The action where a wave passes from one medium into another.
- \_\_\_ 2. This is the gradual reduction in the energy content due to the effects of friction.
- \_\_\_ 3. The process of limiting a transverse waves vibrations to a single plane.
- \_\_\_ 4. When two waves interfere with one another in a pattern of alternating constructive and destructive interference.
- \_\_\_ 5. This characteristic of a wave does not change as the wave travels from one medium into another.
- \_\_\_ 6. The lowest frequency at which a system naturally vibrates.
- \_\_\_ 7. A wave where the displacement of the medium is in the same direction as the motion of the wave.
- \_\_\_ 8. The resistance of a medium to the passage of a wave.
- \_\_\_ 9. According to this, the angle with which a wave strikes an interface will be equal to the angle with which the wave bounces off the interface.
- \_\_\_ 10. A point in a longitudinal wave where the density of the medium is the greatest.
- \_\_\_ 11. When two waves occupy the same position in a medium at the same time so as to produce a new wave which has an amplitude smaller than either of the waves separately.
- \_\_\_ 12. This is equal to the ratio of  $2\pi$  divided by the period.
- \_\_\_ 13. According to this characteristic, long waves should be better able to bend around barriers than short waves.
- \_\_\_ 14. Every mechanical wave requires this in order to exist.
- \_\_\_ 15. This will enable a wave to pass from one medium into another without any loss of energy.
- \_\_\_ 16. According to this, the amplitude of two waves together is equal to the sum of the separate amplitudes of the individual waves.
- \_\_\_ 17. According to this, as a wave passes through an interface the ratio of the speeds in the two mediums will be equal to the ratio of the sines of the angles in these two mediums.
- \_\_\_ 18. Complete destructive interference can occur if the amplitudes of two waves have opposite \_\_\_\_\_.
- \_\_\_ 19. Any wave where the displacement of the medium is perpendicular to the direction of motion of the wave.
- \_\_\_ 20. This characteristic of a wave must be **increased** in order to **increase** its information carrying capability.
- \_\_\_ 21. Any multiple of the fundamental frequency.
- \_\_\_ 22. The energy content of a wave is proportional to the square of this wave characteristic.
- \_\_\_ 23. Any time two waves occupy the same place at the time this wave interaction is the result.
- \_\_\_ 24. Any place in a standing wave pattern where complete destructive interference **always** occurs.
- \_\_\_ 25. According to this the direction of motion of a wave is always perpendicular to the wave front.

A. pulse  
 B. amplitude  
 C. transverse  
 D. refraction  
 E. crest  
 F. normal  
 G. longitudinal  
 H. compression

I. diffraction  
 J. period  
 K. superposition  
 L. harmonic  
 M. damping  
 N. interference  
 O. polarization  
 P. phase

Q. trough  
 R. impedance  
 S. elastic medium  
 T. frequency  
 U. node  
 V. angular velocity  
 W. transmittance  
 X. rarefaction

Y. standing wave  
 Z. fundamental  
 Γ. Law of Refraction  
 Ω. Law of Reflection  
 Σ. impedance matching  
 Δ. destructive interference  
 Φ. rectilinear propagation  
 Θ. constructive interference

SELECT AND ANSWER EACH OF THE FOLLOWING PROBLEMS - SHOW ALL WORK CAREFULLY!

26. A sound source, in the shape of a point, generates a frequency of 512 Hz at a power level of 0.85 Watts. The temperature is  $5.0^{\circ}\text{C}$ . [Assume that the speed of sound is 346 m/s at  $25^{\circ}\text{C}$ .]

- What will be the speed on sound under these conditions? [4 pts]
- What will be the sound intensity, in  $\text{Watts/cm}^2$ , a distance of 2.20 meters from this source? [4 pts]
- What will be the sound intensity of this sound in decibels? [4 pts]

Suppose that you are at rest while this source [still 512 Hz] is moving away from you with a speed of 18.0 m/sec.

- What will be the frequency that you hear? [4 pts]

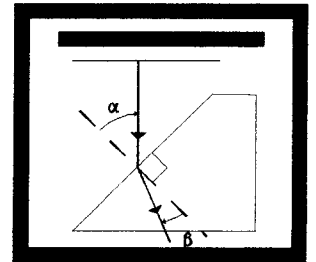
Suppose that this sound source [still 512 Hz] is placed over the end of a tube closed at one end and open at the other so as to produce resonance.

- What will be the shortest possible length for this tube ? [4 pts]

27. Consider a ripple tank where waves are being produced by a bar of wood with a rotating, unbalanced motor attached. An over head light is shined through the resulting waves and images of these waves are projected onto a screen below. [Sound familiar?] A motorized strobe disc, which has eight (8) open slits, is mounted between the light source and the wavetank. The strobe disc is rotating at the fastest speed that will make the waves appear to stand still and the disc makes 10 complete rotations in 4.2 seconds. The resulting waves are measured to have wavelengths of 3.4 cm.

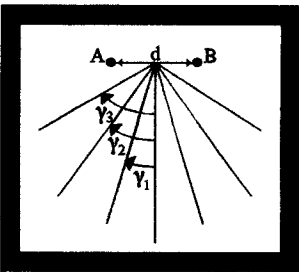
- What is the frequency of these waves? [4 pts]
- What is the speed of these waves? [4 pts]

A glass plate is added to the water so as to produce an area in the wave tank where the water is shallow. The wave front intercepts the interface at an angle of  $\alpha = 52^{\circ}$  and then refracts to  $\beta = 37^{\circ}$  as shown to the right .



- What will be the wave speed in the shallow water? [5pts]
- What will be the frequency of the wave in the shallow water? [4 pts]

Suppose that the wooden bar is then raised and two point sources are inserted into the bar. These two sources are then used to generate circular waves. The two point sources are  $d = 22.0\text{ cm}$  apart and the waves generate an anti nodal pattern as shown to the left where the angle of the second antinode is  $\gamma_2 = 32^{\circ}$ .

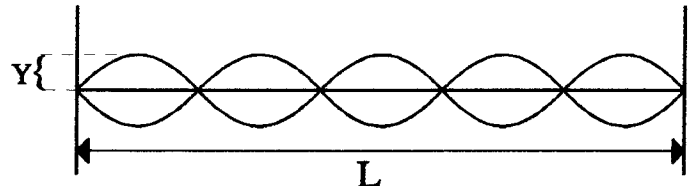


- What is the frequency of the waves being produced by these two sources? [4 pts]
- At what angle will the third order antinode occur? [4 pts]

28. A pendulum consists of a 1.8 kg mass suspended from the end of a light string which has a length of 225 cm. The pendulum is pulled back a distance of 65.0 cm and is then released at  $t = 0$  seconds.

- What will be the period of this pendulum? [4 pts]
- How will the period of the pendulum be affected if the mass hanging on the string is increased to 3.6 kg? Explain!
- What will be the angular velocity of this pendulum? [4 pts]
- What will be the position of the pendulum after 5.0 seconds? [4 pts]
- What will be the maximum velocity of the pendulum? [4 pts]

29. A slinky is being vibrated as shown to the right so as to generate a standing wave pattern. The maximum amplitude of the standing wave is  $Y = 38.0\text{ cm}$ , the frequency of the vibration is 10.0 Hz, and the distance between the end points of the spring is  $L = 5.0$  meters.



- What is the wavelength of this wave? [4 pts]
- What is the speed of the waves in this spring? [4 pts]
- What is the lowest frequency that could generate resonance in this spring? [4 pts]
- Suppose that you were to increase the amplitude of the standing wave to 76.0 cm. How would this affect the energy content of the standing wave? Explain! [4 pts]
- Could a wave with a wavelength of 20.0 meters generate resonance in this spring? Explain! [4 pts]

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1. D	6. Z	11. Δ	16. K	21. L
2. M	7. G	12. V	17. Γ	22. B
3. O	8. R	13. I	18. P	23. N
4. Y	9. Ω	14. S	19. C	24. U
5. J	10. H	15. Σ	20. T	25. Φ

26.  $f := 512 \cdot \text{Hz}$     $P := 0.85 \cdot \text{watt}$     $T_0 := (5.0 + 273) \cdot \text{K}$     $s := 346 \cdot \frac{\text{m}}{\text{sec}}$     $\Delta s := .6 \cdot \frac{\text{m}}{\text{sec}}$

a.  $s := s - 20 \cdot \Delta s$     $s = 334 \cdot \frac{\text{m}}{\text{sec}}$    **26a. The speed of sound at 5 deg. [4 pts]**

b.  $r := 2.20 \cdot \text{m}$     $A := 4 \cdot \pi \cdot r^2$     $I := \frac{P}{A}$     $I = 0.01398 \cdot \frac{\text{watt}}{\text{m}^2}$    **26b. The intensity 2.2 m from the source. [4 pts]**

c.  $I_0 := 1 \cdot 10^{-16} \cdot \frac{\text{watt}}{\text{cm}^2}$     $\text{db} := 10 \cdot \log\left(\frac{I}{I_0}\right)$     $\text{db} = 101.454 \text{ db}$    **26c. The intensity in decibels. [4 pts]**

d.  $s_s := 18 \cdot \frac{\text{m}}{\text{sec}}$     $f_1 := f \left( \frac{s}{s + s_s} \right)$     $f_1 = 487 \text{ Hz}$    **26d. The frequency generated if the source is moving toward the observer. [4 pts]**

e.  $\lambda := \frac{s}{f}$     $d := 2.5 \cdot \text{cm}$   
 $\lambda = 4 \cdot (L + .4 \cdot d)$     $L := .25 \cdot \lambda - .4 \cdot d$     $L = 0.159 \cdot \text{m}$    **26e. The shortest tube that will produce resonance. [4 pts]**

27.  $n := 8$     $N := 10$     $t := 4.2 \cdot \text{sec}$     $\alpha := 52 \cdot \text{deg}$     $\beta := 37 \cdot \text{deg}$     $d := 22.0 \cdot \text{cm}$     $\gamma_2 := 32 \cdot \text{deg}$     $\lambda := 3.4 \cdot \text{cm}$

a.  $f := \frac{N \cdot n}{t}$     $f = 19.048 \cdot \text{Hz}$    **27a. The frequency of the initial waves. [4 pts]**

b.  $s_1 := f \lambda$     $s_1 = 0.648 \cdot \frac{\text{m}}{\text{sec}}$    **27b. The speed of the waves in the deep water. [4 pts]**

c.  $\frac{s_1 \sin(\alpha)}{s_2 \sin(\beta)}$     $s_2 := s_1 \frac{\sin(\beta)}{\sin(\alpha)}$     $s_2 = 0.495 \cdot \frac{\text{m}}{\text{sec}}$    **27c. The speed of the waves in the shallow water. [4 pts]**

d.  $f_2 := f$     $f_2 = 19.048 \cdot \text{Hz}$    **27d. The frequency of the waves in the shallow is the same as the frequency in the deep water. [4 pts]**

e.  $n := 2$     $n \cdot \lambda = d \cdot \sin(\gamma_2)$     $\lambda := d \cdot \frac{\sin(\gamma_2)}{n}$     $\lambda = 0.058 \cdot \text{m}$   
 $f := \frac{s_1}{\lambda}$     $f = 11.11 \cdot \text{Hz}$    **27e. The frequency of the waves being produced by the two point sources. [4 pts]**

f.  $n := 3$     $n \cdot \lambda = d \cdot \sin(\gamma_3)$     $\gamma_3 := \text{asin}\left(n \cdot \frac{\lambda}{d}\right)$     $\gamma_3 = 52.644 \cdot \text{deg}$    **27f. The angle at which the third order antinode will appear. [4 pts]**

28.  $m_b := 1.8 \cdot \text{kg}$   $L := 2.25 \cdot \text{m}$   $A_o := 65.0 \cdot \text{cm}$

a.  $T := 2 \cdot \pi \cdot \sqrt{\frac{L}{g}}$   $T = 3.01 \cdot \text{sec}$  **28a. The period of the pendulum. [4 pts]**

b. **No effect. The mass of the pendulum does not appear in the equation for the period. [4 pts]**

c.  $\omega := \frac{2 \cdot \pi}{T}$   $\omega = 2.088 \cdot \frac{\text{rad}}{\text{sec}}$  **28c. The angular velocity of the pendulum. [4 pts]**

d.  $t := 5.0 \cdot \text{sec}$   $A := A_o \cdot \cos(\omega \cdot t)$   $A = -0.344 \cdot \text{m}$  **28d. The position of the pendulum after t seconds. [4 pts]**

e.  $v_{\max} := A_o \cdot \omega$   $v_{\max} = 1.357 \cdot \frac{\text{m}}{\text{sec}}$  **28e. The maximum velocity of the pendulum. [4 pts]**

29.  $L := 5.0 \cdot \text{m}$   $Y := 38.0 \cdot \text{cm}$   $f := 10.0 \cdot \text{Hz}$

a.  $\lambda := \frac{2}{5} \cdot L$   $\lambda = 2 \cdot \text{m}$  **29a. The wavelength of this wave. [4 pts]**

b.  $s := f \cdot \lambda$   $s = 20 \cdot \frac{\text{m}}{\text{sec}}$  **29b. The speed of the wave. [4 pts]**

c.  $\lambda := 2 \cdot L$   $f_o := \frac{s}{\lambda}$   $f_o = 2 \cdot \text{Hz}$  **29c. The fundamental vibrational frequency. [4 pts]**

d. **The energy content would be 4x the original energy because the energy content of a wave is proportional to the SQUARE of the amplitude! [4 pts]**

e. **No! Because the smallest part of a wave that could resonate on this spring has a frequency of 2 Hz (as calculated above) and since  $s=f\lambda$  the maximum allowable wavelength would be 10 meters! [4 pts]**

$\lambda := \frac{s}{f_o}$   $\lambda = 10 \cdot \text{m}$