Name_____

PH2400 Exam I Spring 2001

Some Constants/Identities:

$\pi = 3.14159$

$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$

$\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$

$\sin A \pm \sin B = 2 \sin \frac{1}{2}(A \pm B) \cos \frac{1}{2}(A \mp B)$

$\cos A \pm \cos B = 2 \cos \frac{1}{2}(A + B) \sin \frac{1}{2}[\pm(A - B)]$

$I_0 = 1.00 \times 10^{-12}\ W/m^2 = 0\ dB$

velocity of sound in air (room temp, 1 atm) = 343 m/s.

Approximations

$\theta < 1$		$\theta << 1$
$\sin\theta \approx \theta - \theta^3/6 + \ldots$	$\approx$	θ
$\cos\theta \approx 1 - \theta^2/2 + \ldots$	$\approx$	1

If $|\epsilon| << 1$ then

$(1 + \epsilon)^N \approx 1 + N\epsilon$

$1/(1+\epsilon) \approx 1 - \epsilon$

Write your solutions on these pages, and turn in the entire exam along with your equation sheet. If you need extra paper, just ask.

For problems 11 to 15: to receive full credit for correct answers, you must show your work!

Report numerical answers to three (3) significant figures.

Score Summary (to be filled in by instructor)

Mult Choice	Short Answer	Problems
1._____	6._____	11._____
2._____	7._____	12._____
3._____	8._____	13._____
4._____	9._____	14._____
5._____	10._____	15._____

Totals _____ + _____ + _____ = _____

Multiple Choice:

(Circle your choice)

1. A vibrating source generates a (low amplitude) transverse sinusoidal wave on a long string. The string is under constant tension. If the amplitude of the wave and its frequency are both doubled then

a. the power input increases by a factor of eight.
b. the wavelength increases by a factor of four.
c. the wavelength increases by a factor of two.
d. the wavelength decreases to one-half of what it was.
e. the wave speed increases by a factor of four.

2. A point source emits sound with an intensity of 70 dB when measured 1.0 m away from the source. If the power is turned up so that the intensity 1.0 m away is increased by a factor of 10, the intensity 2.0 m away from the source will now be closest to

a. 64 dB b. 74 dB c. 80 dB d. 86 dB e. 175 dB

3. A saxophonist plays a note with a constant frequency of 440.0 Hz. A second player then joins in, attempting to play the same note. When the second player joins in, beats are heard which have a frequency of 4.0 Hz. Which one of the following could be the frequency of the tone produced by the second player?

a. 436 Hz b. 442 Hz c. 880 Hz d. 1760 Hz
e. none of the above.

4. With normal room lighting, a calcite crystal can produce a double image because it is a birefringent material. If one were to separately analyze the light from each of the two images, what would be different?

a. One is composed of the longer wavelengths of light, the other shorter wavelengths.
b. The two images are rotated 90^o from each other.
c. One image is due to constructive interference, the other from destructive interference.
d. The polarization of the light is different by 90^o.
e. None of the above.

5. Unpolarized light with intensity I_0 is sent through two (ideal) polarizers. The intensity of the light measured after the polarizers is found to be $I_0/4$. Which of the following is true?

a. The polarization axes of the two polarizers must be parallel.
b. The polarization axes of the two polarizers must be perpendicular.
c. There must also be a third polarizer present.
d. Only 1/16th of the light energy makes it through the polarizers.
e. None of the above.

Short Answer

Provide a short answer (1 or 2 sentences and/or appropriately labeled diagram) for each.

6. Coherent light is incident on two narrow slits which are a distance *d* apart yielding a two-slit diffraction pattern on a distant screen. Now one of the two slits is covered. Illustrate what is seen on the screen before and after one of the slits is covered.

7. Why can't red laser light be used to see diffraction effects from the planes of atoms in a single crystal?

8. A single wave pulse on a string is traveling towards -*x* with a speed *v*. At $t = 0$ the pulse is described by a displacement, *y*, given by

$$y(x,0) = 0.37 \sin(7x)\, e^{-x^2/100}$$

where x and y are in meters. Write the function $y(x,t)$ which describes this wave for any time, *t*.

9. Two flashlights held close together do not produce an interference pattern on a distant screen. Why?

10. Unpolarized light of intensity I_0 is sent through N polarizers. Each polarizer is rotated (clockwise) from the previous by an angle $\theta = 90^o/(N-1)$ so that the last polarizer is oriented perpendicular to the first. What is the intensity of the light which makes it through all N polarizers? (Your answer should be in terms of I_0, θ, and/or N).

(*If you have extra time* - I'll give you 5 extra bonus points if you also correctly derive the intensity above in the limit that $N \rightarrow \infty$)

Problems

(SHOW YOUR WORK, you will not get credit unless I can see how you got your answer.)

11. A transverse wave on a string is described by the displacement

$$y(x,t) = 0.23\sin(1.7x + 32t + 1.2)$$

where x and y are in meters and t is in seconds. For this wave, complete the following: (Show your work below!)

Amplitude = _____ m Wavelength = _____ m

Wave speed = _____ m/s Frequency = _____ Hz

Wave is traveling toward _____

12. You are driving north at a speed of 30.0 m/s and a second car is approaching you driving south on the same road at a speed of 20.0 m/s. The driver of the second car honks his horn. You measure the frequency of the second car's horn to be 305 Hz. What do the passengers of the second car measure for the frequency of their own horn?

13. What is the smallest thickness for a glass plate (n = 1.50) in air which gives a minimum reflection for light with a wavelength of 500 nm?

14. A laser beam (λ = 710 nm) is incident on two narrow slits which are 0.150 mm apart. How far apart are adjacent intensity minima on a screen 2.00 m away?

15. Find the fundamental frequency (the lowest frequency) and the next higher frequency that could cause a standing-wave pattern on a string that is 20.0 m long and has a mass of 315 g. The string is fixed at both ends and is stretched with a tension of 25.0 N.

END