Notre Dame University
Faculty of Natural and Applied Sciences
Department of Sciences
Spring 2008-2009

May 14, 2009

PHS 203
Exam II

NAME: _____ ID: _____

Section or Name of your instructor: _____

Only calculators are allowed.

Not allowed: mobile phones, any written material, borrowing calculators or pens during the exam.

Write in detail the solutions of the exercises in Part I. Failing to do so will deny you any credit, even if the selected solution happens to be correct. Write in detail the solutions of the problems in Part II.

GRADING

Part I: 10x6 = 60 marks	
Part II Problem 1 :	20 marks
Part II Problem 2:	20 marks
Total :	100 marks

PART I:

1. As an ambulance travels east down a highway at a speed of 33.5 m/s, its siren emits sound at a frequency of 400 Hz. A person in a car traveling west at 24.6 m/s and approaching the ambulance will hear a frequency of:
   a. 338 Hz
   b. 443 Hz
   c. 364 Hz
   d. 475 Hz
   e. None of the above, my answer is_____

2. A point source emits sound waves with an average power output of 80.0 W. The distance at which the sound level is 40 dB is:
   a. 25.2 km
   b. 25.2 m
   c. 2.52 km
   d. 252 m
   e. None of the above, my answer is_____

3. If sunlight is reflected fully polarized from the smooth surface of water in a lake (the index of refraction of water is 1.33), then the refraction angle is:
   a. 53.1°
   b. 36.9°
   c. 90°
   d. 0°
   e. None of the above, my answer is_____

4. A tuning fork produces a steady 400 Hz tone. When this tuning fork is struck and held near a vibrating guitar string, twenty beats are counted in five seconds. The possible frequency produced by the guitar string is:
   a. 404 Hz
   b. 396 Hz
   c. 400 Hz
   d. 404 Hz or 396 Hz
   e. None of the above, my answer is_____

5. Un-polarized light falls on two crossed Polaroids. A third Polaroid, with axis at 45° to each of the other two, is placed between them. Then,

   a. No light passes through.
   b. 1/8 of the original intensity gets transmitted.
   c. 1/2 of the original intensity gets transmitted.
   d. 1/4 of the original intensity gets transmitted.
   e. None of the above.

6. Two loudspeakers are 1.00 m apart. A person stands 4.00 m from one speaker. How far must this person be from the second speaker in order to detect destructive interference when the speakers emit an 1150 Hz sound? The speed of sound is 343 m/s.

   a. 4.15 m
   b. 3.85 m
   c. 0.30 m
   d. 4.15 m or 3.85 m
   e. None of the above, my answer is _____

7. You can hear a distant train approaching by putting your ear to the track. How long does it take for the wave to travel down the steel track if the train is 1.0 km away? The elastic modulus of steel is $2.0\times10^{11}\,N/m^2$ and the density of steel is $7.8\times10^{3}\,kg/m^3$.

   a. 2 s.
   b. 20 s.
   c. 0.20 s
   d. Cannot be determined because we do not know the speed of the train.
   e. None of the above

8. The pressure amplitude for the faintest sounds the human ear can detect at a frequency of 1000 Hz is $2.87\times10^{-5}\,N/m^2$. If the density of air is $1.20\ kg/m^3$ and the speed of sound in air is 343 m/s, then the corresponding displacement amplitude is:

   a. $1.11\times10^{-10}\,m$
   b. $1.11\times10^{-12}\,m$
   c. $1.11\times10^{-5}\,m$
   d. $1.11\times10^{-11}\,m$
   e. None of the above, my answer is_____

9. What are the estimated maximum amplitudes of the electric and magnetic fields of the light that is incident on this page because of the visible light coming from your desk lamp? The distance from the bulb (treated as a point source) is 0.30 m. The output of the bulb in the form of visible light is 3.0 W. $\mu_o = 4\pi\times10^{-7}\,T.m/A$ and $c = 3.00\times10^8\,m/s$:

   a. 45 V/m and $1.5\times10^{-7}\,T$
   b. 45 V/m and $1.5\times10^{-5}\,T$
   c. 4.5 V/m and $1.5\times10^{-7}\,T$
   d. 450 V/m and $1.5\times10^{-7}\,T$
   e. None of the above, my answer is_____

10. The Sun delivers about $1000W/m^2$ of energy to the Earth's surface via electromagnetic radiation. The total power that is incident on a roof of dimensions 8.00 m × 20.0 m is:

   a. $1.6\times10^{7}\,W$
   b. $1.6\times10^{4}\,W$
   c. $1.6\times10^{5}\,W$
   d. $1.6\times10^{3}\,W$
   e. None of the above, my answer is_____

PART II

Problem 1

A layer of water (n = 1.333) floats on the surface of glycerine (n = 1.473) in a bucket. A ray of light from the bottom of the bucket travels upward through the glycerine. What is the largest angle with respect to the normal that the ray can make at the glycerine-water interface and still pass out into the air above the water?

$\theta_c = \sin^{-1}\left(\frac{1,33}{1,473}\right) = 64,81.$

~~The part out of water the angle must be~~

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Problem 2

A small loudspeaker driven by an audio oscillator and amplifier is adjustable in frequency between 500 Hz and 1000 Hz sends sound waves into a cylindrical tube 1.0 m long and closed at both ends. The speed of sound in air is 343 m/s. At what frequencies will resonance occur in the pipe when the frequency emitted by the speaker is varied from 500 to 1000 Hz?

The Tube is closed at both ends ⇒:

$f = \frac{n \cdot v}{8}$; $500 < f < 1000$

$500 < \frac{n \times 343}{8} < 1000$

$11,66 < n < 23,32$

$n = 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23$

$f_1 = \frac{12 \times 343}{8} = 514,5\ Hz$

$f_2 = \frac{13 \times 343}{8} = 557,37\ Hz$

$f_3 = \frac{14 \times 343}{8} = 600,25\ Hz$

$f_4 = \frac{15 \times 343}{8} = 643,125\ Hz$

$f_5 = \frac{16 \times 343}{8} = 686\ Hz$

$f_6 = \frac{17 \times 343}{8} = 728,875\ Hz$

$f_7 = \frac{16 \times 343}{8} = 771,75\ Hz$

$f_8 = \frac{19 \times 343}{8} = 814,625\ Hz$

$f_9 = \frac{20 \times 343}{8} = 857,5\ Hz$

$f_{10} = \frac{21 \times 343}{8} = 900,375\ Hz$

$f_{11} = \frac{22 \times 343}{8} = 943,25\ Hz$

$f_{12} = \frac{23 \times 343}{8} = 986,125\ Hz$

3.