Physics 380H - Wave Theory **Example Midterm Test**

Fall 2004 **Name:** _____

Friday 2004/10/22 **Student Number:** _____

The following are the types of questions that you can expect to see on the midterm test. Typically you would be asked to answer all of the first question and then choose three or four of the other questions to answer. The first question would be worth about 20 points with the other questions worth about 10 points each.

Please let me know of any typos or similar errors.

This examination paper includes 2 pages and 6 questions. You are responsible for ensuring that your copy of the paper is complete. Bring any discrepancy to the attention of your invigilator.

Special Instructions:

The only aids allowed are: a one (1) page single-sided hand-written formula sheet, and a calculator. When completed, turn in all exam booklets, the test paper, and the formula sheet.

Write your name and student number on the top of this paper AND on the front of your answer booklet AND on your formula sheet. Be prepared to present your student ID for verification.

Portable communications devices of all types (e.g. pagers, cellular phones, communicating calculators) are prohibited in the examination room. All such devices must be turned off prior to the start of the examination. A penalty of 5% of the exam mark may be assessed to anyone who fails to prevent a call from interrupting the examination.

Giving or receiving aid during an exam is a violation of university rules and may result in a failing grade and/or expulsion from the university.

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1. In 100 words or less or using algebraic formulae where all of the symbols are defined, or annotated diagrams where appropriate, explain or define each of the following terms of wave phenomena:
   (a) radiative acoustic intensity
   (b) D'Alembertain operator
   (c) acoustic impedance
   (d) adiabatic bulk modulus
   (e) why optical lenses are "multicoated"
   (f) sound decibel level
   (g) energy density in a plane sound wave
2. Velocity of sound waves
   (a) Explain why the adiabitic form of the bulk modulus (and not the isothermal form) is needed to obtain an accurate model for the velocity of sound waves in a medium.
   (b) Show that the velocity of sound varies as the square root of the ratio γ/M where γ is the ratio of specific heat at constant pressure to the specific heat at constant volume.

3. Convective and radiative sound intensity.
   (a) Discuss how sound intensity can be broken down into convective and radiative parts.
   (b) Describe the differences in these two components and point out physical situations where one of these terms is dominant.

4. Sonar detection of icebergs. Assume a plane sonar wave is normally incident on the plane underwater surface of an iceberg. What is the decibel level of the reflected wave relative to that of the incident wave? ice has the acoustic properties of a fluid medium of impedance $Z = 1.9 \times 10^6\,\mathrm{kg/m^2 \cdot sec}$, and Z for seawater is $1.56 \times 10^6\,\mathrm{kg/m^2 \cdot sec}$.

5. Velocity of sound varying with temperature.
   (a) Explain how/why the velocity of sound in air varies with the temperature of the air.
   (b) Discuss two brief applications of this principle.

6. The one dimensional wave equation. Show how the one dimensional wave equation for transverse waves on a string can be developed.