# Trent University
## Physics 380H
### 2001/2002

1.    **Explanation/definitions.** [20 marks, 4 each part]

In 200 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 as it pertains to the study of the physics of wave phenomena:

a)  Fraunhofer pattern

b)  What causes the phenomenon of beats?

c)  The polarizing angle (where the light reflected is perfectly linearly polarized).

d)  Maxwell's Relation (the relationship among the dielectric constant of a medium and its permittivity and permeability)

e)  the instantaneous kinetic energy for an acoustic plane wave.

**2.** [10 marks]  **Stereo speakers**

Discuss the wave physics of the acoustics associated with the design of a high quality speaker for a home stereo system. Include an analysis of the speaker size and shape as well as its enclosure.
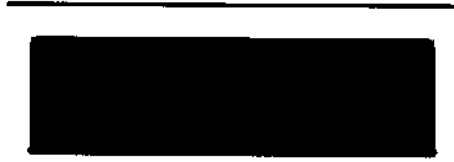
## 3. [10 marks] Velocity of Sound in Water

   Given that the value of  g  (the ratio of specific heat at constant pressure to the specific heat at constant volume) is close to 1.0 for most fluids (it is 1.004 for water) and that the bulk modulus $B_{isothermal}$ for water is $2.18 \times 10^{19}$ $N/m^2$ and that the density of water at STP is $0.998 \times 10^3$ $kg/m^3$, what is the velocity of sound in water at STP?  How does this depend on the temperature T?


## 4. [10 marks] Reflection of Sound

 Discuss the reflection of an acoustic wave from a hard surface. Describe, for a sound wave of frequency 331 Hz, where one might find the first node of "silence" as detected by the human ear?  What applications might this physics have?


## 5. [10 marks]  Sound level Intensity

   a) [4 marks] discuss the difference between the radiative intensity and the convective intensity of a sound wave
   b) [3 marks] describe the transmission of sound intensity at an air/water surface where $Z_{12} \ll 1$. What is the value of $T_i$ in terms of $Z_{12}$ ?
   c) [2 marks]  for sinusoidal waves, how are the average value and the RMS value of the radiative intensity calculated?
   d) [1 mark]  if you were now wearing hearing-protection "earmuffs" which reduce the decibel level by 20 db and the ambient noise in this exam room is 50 db,  what is the intensity level of sound entering your ears in units of watts/ $m^2$?

## 6. [10 marks] Polarization of Electromagnetic Waves

   Discuss EM wave polarization with respect to the following topics:
        -linear polarization and the use of polarizers and analysers
        -circular polarization
        -elliptical polarization
        -types of polarizing materials
        -polarization by reflection from a surface of a dielectric material

## 7 [10 marks] Interference of Two Wave Sources

   Discuss the interference pattern seen at some point for two sources which are separated by a distance **d** and have the same wavelength λ. Assume that the distance from the point is large with respect to d. Assume further that kd $\ll$ 1 and that the sources are exactly "out of phase". Is this an efficient way to transmit wave energy to point P?