Physics 380H - Wave Theory **Homework #06**

Fall 2004 Due 12:01 PM, Monday 2004/11/01

[60 points total]

"Journal" questions:
– Approximately how much time per week are you spending on the various aspects of this course, outside of scheduled class times? (ie: lab, assignments, non-assignment pre-reading, general studying, any other categories?) About how much time do you think that you SHOULD be spending on the various aspects of this course? Assuming that you would prefer to reduce your workload, do you have any suggestions on how the course could be arranged to reduce the course workload without significantly reducing the amount and depth of material covered?
– Any comments about this week's activities? Course content? Assignment? Lab?

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1. (From Towne P1-8, pg 17) Given $y(x,t) = \Re\{\mathbf{A}e^{i(\omega t - kx)}\}$, where $\mathbf{A} = Ae^{i\theta}$ is a complex constant. Verify by direct substitution that this function is a solution of the one-dimensional wave equation. What kind of wave is this? Verify that this function conforms with the appropriate relation asserted in (Towne 1-14). [10]

$$\frac{\partial y_\pm}{\partial t} = \mp c \frac{\partial y_\pm}{\partial x} \qquad \text{(Towne 1-14)}$$

2. (From Towne P2-4, pg 36) If the gas filling an organ pipe is changed from air to helium, find the change in pitch of the fundamental vibration. Express the result as a frequency ratio and give the nearest musical interval to which this corresponds. [10]

3. (From Towne P4-14, pg 82) The fundamental vibration of a viloin string is a standing wave having nodes at the two fixed ends, and is described by the fundtion $y(x,t) = A\sin(kx)\cos(\omega t)$, where $k = \pi/l$, l being the length of the string. Find the total instantaneous kinetic and potential energies (integrated over the length of the string) and show that their sum is constant. [10]

4. What surprising consequence did Maxwell's equations provide? How are the permittivity and permeability of free space related to light? Limit your discussion to about 50 words or so. [10]

5. Why does monochromatic "natural light" not exhibit the phenomenon of polarization while all sinusoidal waves are intrinsically polarized? Limit your discussion to about 50 words or so. [10]

6. (From Towne P7-14, pg 133) The channeled spectrum obtained by reflection from a thin film surrounded by air contains only two dark bands, centered at 4500 Å and 6000 Å. What is the optical thickness of the film? ("Optical thickness" is a term used for the product of the index of refraction and the geometrical thickness. Neglect the dependence of index of refraction on wavelength.) [10]

Headstart for next week, Week 07, starting Monday 2004/11/01:
– Read Chapter 11 "Interference Pattern from a Pair of Point Sources" in Towne, omit 11-8 through 11-15
– – Section 11-1 "Introduction"
– – Section 11-2 "Sources close together compared with a wavelength; the dipole source"
– – Section 11-3 "Various interference patters for $d \sim \lambda$"
– – Section 11-4 "Total power radiated from a pair of point sources"
– – Section 11-5 "The phenomenon of beats"
– – Section 11-6 "Interference patterns when $kd \gg 1$"
– – Section 11-7 "Young's experiment"