Physics 380H - Wave Theory **Homework #02**

Fall 2004 Due 12:01 PM, Monday 2004/09/27

[50 points total]

"Journal" questions:
– What is your major/minor/etc.? What are you planning on doing after you finish your degree?
– Any comments about this week's activities? Course content? Assignment? Lab?

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1. (From Towne P1-2. pg 17) If $h(u)$ is an arbitrary twice-differentiable function of u, show by direct calculation that $y(x,t) = h(t + x/c)$ satisfies the one-dimensional wave equation. What relation does this solution have to the most general form of solution to the one-dimensional wave equation $y(x,t) = f(x - ct) + g(x + ct)$? [10]

2. (From Towne PI-2. pg 436) In general, the sum of two sinusoidal functions of equal amplitude but different phase has an amplitude different from that of the original functions. Find the exception. That is, find the value of θ which will allow $A\cos x + A\cos(x + \theta) = A\cos(x + \theta')$. Find also θ', the phase of the resultant. [10]

3. (From Towne Appendix I. pg 433) Prove the identity: $\cos\alpha - \cos\beta = 2\sin\left(\frac{\alpha+\beta}{2}\right)\sin\left(\frac{\beta-\alpha}{2}\right)$, by using the representation of sin and cos as complex functions. Of possible use are the identities: $e^{i\theta} = \cos\theta + i\sin\theta$, $\cos\theta = \Re e^{i\theta} = \frac{1}{2}\left(e^{i\theta} + e^{-i\theta}\right)$, and $\sin\theta = \Im e^{i\theta} = \frac{1}{2i}\left(e^{i\theta} - e^{-i\theta}\right)$. [10]

4. (From Towne P2-3. pg 36) When a tin flute is attached to a source of illuminating gas it is found that the pitch is approximately a musical third lower than the corresponding pitch in air. What does this mean in terms of the frequency of the sound? Estimate the molecular weight of the gas. [10]

5. (From Towne P2-5. pg 36) An organ pipe is tuned to a pitch of 440 Hz when the temperature is 25°C. What will the pitch be at a temperature of 0°C? [10]

Headstart for next week, Week 03, starting Monday 2004/09/27:
– Read Chapter 2 "The Acoustic Plane Wave" in "Wave Phenomena" by Towne, omit 2-6
– – Section 2-4 "Simplified form of the equation for acoustic waves"
– – Section 2-5 "Detailed description of a progressive sinusoidal wave"
– Read Chapter 3 "Boundary value problems" in "Wave Phenomena" by Towne, omit 3-9
– – Section 3-1 "Reflection at a fixed end of transverse waves on a string"
– – Section 3-2 "Reflection of acoustic waves at a rigid surface"
– – Section 3-3 "Waves produced by the specified motion of a boundary surface"