HONORS TEAM ___________________________________ Schneider – Univ2 – Spring 2007

Honors TEAMWORK 03 "What's the screeching and wailing? … Oh Ashley is practicing." – 02/16/07

Author ____________________________ **Name** ____________________________________

Name _____________________________ **Name** ____________________________________

(It is strongly suggested that you try to adopt some of the roles indicated {such as Recorder, Taskmaster, Gatekeeper, Devil's Advocate} – if roles are used, please indicate next to the names.)

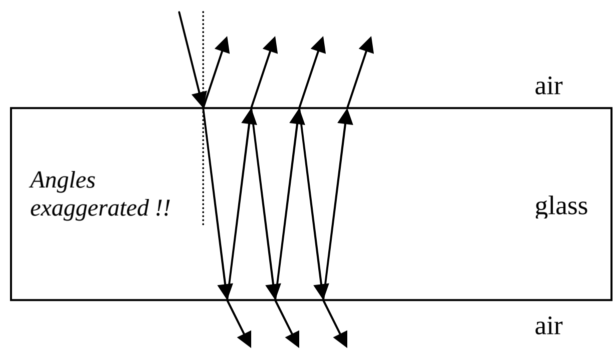
Preparation – read over team roles and read through entire team project (silently, individually) – *5 minutes*

Problem 1 – ***20*** *minutes – maximum*
Problem 2 – ***15*** *minutes – maximum* *[Papers turned in at 10:40 – in-class in-team survey at that point.]*

1) Ashley Simpson, after watching the Grammys®©™, realizes she'll never win one for singing (I mean, c'mon) – so, maybe she should try to invent a new musical instrument. But, being not to bright *(I mean, c'mon {this is called a "callback" and also a "shout out" to Arrested Development!})* – her invention appears to be just a straight pipe. If she blows air across the end, you notice that there is a set of frequencies that sound *really loud*. You notice **one** of Ashley's frequencies is **291 Hz** and another one is **874 Hz**. She might or might not have covered one of the ends of the tube, which has a length of **0.85 m**. And the speed of sound for this situation is a **reasonable** {but, as yet unknown} value.
a) Show that these **cannot** be consecutive frequencies.

b) Determine the speed of sound in this situation – also determine if Ashley has a tube with both ends open, or did she cover one – explain.

2) Consider the reflections of light inside a thin film of glass in air. In class, we consider only the primary reflection (from the top of the glass) and the second beam (that reflects from the bottom of the glass) – and decide how they interfere. This means we ignore any further reflections (when the second beam exits the top, it also reflects down to the lower surface, then back up and out {third beam}, but it also reflects from the top, then down off the bottom and then up and out {fourth beam}, etc. The initial beam of light is nearly perpendicular, and the index of refraction of the glass is 1.5. Remember that the intensity **reflected back** is : $I = I_o\left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2$



a) Assume that the down-and-back distance inside the film (2t) is a whole number of wavelengths for your film. With an initial intensity of I0, determine what the **intensity of the second beam** is, and what the **relative phase** (compared to beam 1) is when it comes out the top? [Remember, once the first beam reflects, the intensity that is left transmits through the glass to reflect off the bottom {letting some out the bottom} – what reflects off the bottom comes up to the top surface and reflects back down {to make the third beam} and also escapes to make the second beam come out – you need to keep track of those transmitted/reflected intesities as you go along!] [Hint, would it be useful to calculate the reflected "fraction" – and couldn't we be clever about how to use it?] Then calculate the same for Beam 3 – is it ok to ignore it (and further reflections)?

1) Ashley Simpson, after watching the Grammys®©™, realizes she'll never win one for singing (I mean, c'mon) – so, maybe she should try to invent a new musical instrument. But, being not to bright *(I mean, c'mon {this is called a "callback" and also a "shout out" to Arrested Development!})* – her invention appears to be just a straight pipe. If she blows air across the end, you notice that there is a set of frequencies that sound *really loud*. You notice **one** of Ashley's frequencies is **291 Hz** and another one is **874 Hz**. She might or might not have covered one of the ends of the tube, which has a length of **0.85 m**. And the speed of sound for this situation is a **reasonable** {but, as yet unknown} value.

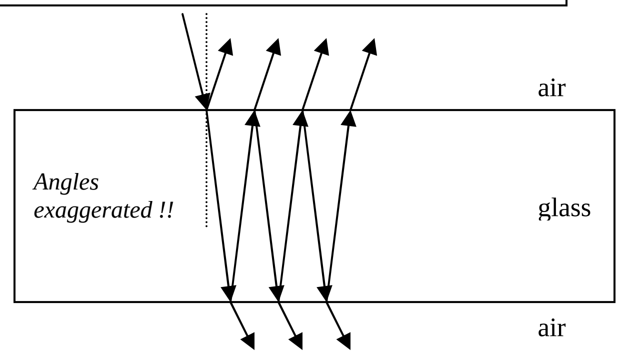
a) Show that these **cannot** be consecutive frequencies.

874-291 = 583 Hz … notice that 583 = 2(291) if they are consecutive, then it must be **open/closed** with f_1 being 291 then jump $2f_1$ to get to 874. But, if $f_1 = \frac{v}{4L}$ $v = 4(0.85)(291) = 989.4\ m/s$ not reasonable!

b) Determine the speed of sound in this situation – also determine if Ashley has a tube with both ends open, or did she cover one – explain.

Now we have to play a little … what if Δf = 583/2 = 291 (that is, one other frequency between 291 and 874) – this would mean it must be a both ends open – to have 291, then 583, then 874 … but then $v = 2(0.85)(291) = 494.7\ m/s$ - still unreasonable! … so, try 583/3 = 194.3 Hz = Δf ?? This looks promising .. f=291 – 194.3 ~ 97 Hz … and 291 = 3(97) and 874 = 9(97) … looks like an open/closed situation with $v = 2(0.85)(194.\overline{3}) = 330\ m/s$ **REASONABLE!**

2) Consider the reflections of light inside a thin film of glass in air. In class, we consider only the primary reflection (from the top of the glass) and the second beam (that reflects from the bottom of the glass) – and decide how they interfere. This means we ignore any further reflections (when the second beam exits the top, it also reflects down to the lower surface, then back up and out {third beam}, but it also reflects from the top, then down off the bottom and then up and out {fourth beam}, etc. The initial beam of light is nearly perpendicular, and the index of refraction of the glass is 1.5.



Remember that the intensity **reflected back** is : $I = I_o\left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2$

a) Assume that the down-and-back distance inside the film (2t) is a whole number of wavelengths for your film. With an initial intensity of I0, determine what the **intensity of the second beam** is, and what the **relative phase** (compared to beam 1) is when it comes out the top? [Remember, once the first beam reflects, the intensity that is left transmits through the glass to reflect off the bottom {letting some out the bottom} – what reflects off the bottom comes up to the top surface and reflects back down {to make the third beam} and also escapes to make the second beam come out – you need to keep track of those transmitted/reflected intesities as you go along!] [Hint, would it be useful to calculate the reflected "fraction" – and couldn't we be clever about how to use it?] Then calculate the same for Beam 3 – is it ok to ignore it (and further reflections)?

With light-heavy-light, and 2t=mλ - wave 2 will be 180 out of phase with wave 1.
The index factor gives us 4% reflection. So 96% transmits – 4 % becomes beam 1.
Of the 96% that goes to the bottom layer – 4% reflects back – so (96%)(4%) = 3.84% heads toward the top – but it refracts/reflects .. (96%)(3.84%) = 3.686 escapes as Beam 2 while (4%)(3.84%) = 0.1536% heads down to be beam 3 … it reflects/refracts from the bottom surface – we care about reflection - (4%)(0.1536%) = 0.006% reflects back, and only 96% of that gets out = 0.0058 % comes out for beam 3.

So, compare the beams .. beam 1 reflects back with 4% - beam 2 comes out with 3.686 % (180 out of phase with beam 1) – and beam 3 comes out with 0.0058% .. yes, it can easily be ignored (and future reflections would be worse!).
What about the phase for beam 3? The reflections from inside the glass (to air) don't add phase shifts .. so all further reflections beyond 2 are in phase with 2 (thus out of phase with respect to 1). So, even though all the further reflections have smaller intensities .. they are all in phase, so they could add together as one big "wave 2" which is out of phase with wave 1.