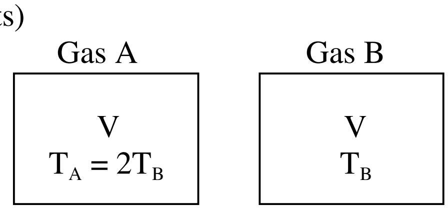
PHYSICS 4B QUIZ 3 SPRING QUARTER 2013
PROF. HIRSCH 3 Problems MAY 6TH

Please write in pen rather than in pencil. No regrading for quizzes written in pencil.

Problem 1 (10 pts + 5 pts extra credit)
A string of a guitar has mass 0.5 g and fundamental frequency 400 Hz, and the tension on the string is100 N. The guitar body is made of brass and the string is made of steel. The coefficients of linear thermal expansion of brass and steel are $19\text{x}10^{-6}$ / ºC and $12\text{x}10^{-6}$ / ºC respectively, the Young (elastic) modulus of steel is $200\text{x}10^{9}\text{N/m}^2$, and the cross-sectional area of the string is 1 mm^2.
(a) What is the fundamental frequency of this string if the tension is increased to 150 N?
(b) What is the length of this string, in cm?
(c) On a hot day, will the fundamental frequency of this string be slightly higher or slightly lower than on a cold day? Explain qualitatively.
(d) If on a normal day the tension on this guitar string is 100N, what will the tension be on a hot day when the temperature is 20 ºC higher?
(e) What will the fundamental frequency be on such a hot day, if it is 400Hz on a normal day? You may neglect the change in the length of the string for this calculation.
(f) Verify that neglecting the change in the length of the string in (e) is reasonable.

Problem 2 (10 pts)
Bat Richard is at rest, and is calling his friend bat Molly who is 1000 m away, by emitting an ultrasonic sound wave of frequency 24,000 Hz. Molly hears it and starts flying towards Richard, emitting an ultrasonic wave of frequency 23,510 Hz to signal she is coming. Richard hears Molly's sound with no beats, i.e. the combination of his and Molly's sounds has an amplitude that is constant in time.
(a) How fast is Molly flying towards Richard? Answer in m/s.
(b) Molly does hear beats. What is the beat frequency that Molly hears, in Hz? What is the time interval between two amplitude maxima (in seconds)?
<u>**Assume**</u> the speed of sound is 343m/s, and that beating occurs for waves of different amplitude the same way it occurs for waves of the same amplitude.

Problem 3 (10 pts)



Gases A and B are ideal, both are in sealed containers. Assume throughout this problem that the volume V is the same, and that the temperatures are T_A, T_B, with $T_A=2T_B$.
(a) If A has N atoms of hydrogen and B has N/2 atoms of helium, what can you conclude about P_A/P_B?
(b) If $P_A=P_B$ and gas A is hydrogen and gas B is helium, what can you conclude about the ratio of the total mass of the gases A and B, m_A/m_B?
(c) If $P_A=P_B$ and the bulk moduli of gases A and B are the same, what can you conclude about the ratio of sound velocities v_A/v_B if (i) gas A is hydrogen and gas B is helium, and if (ii) gas A and gas B are both hydrogen?
<u>Hint:</u> assume the atomic weight of He is 4 times the atomic weight of hydrogen.