Physics 7B, Speliotopoulos
First Midterm, Fall 2012
Berkeley, CA

Rules: *This midterm is closed book and closed notes. You are allowed two sides of one-half sheet of 8.5" x 11" of paper on which you may write whatever notes you may need. You are also allowed to use scientific calculators in general, but not ones which can communicate with other calculators through any means.* ***Anyone who does use a wireless-capable device will automatically receive a zero for this midterm.*** *Cell phones must be turned off during the exam, and placed in your backpacks.* ***In particular, cell-phone-based calculators cannot be used.***

Please make sure that you do the following during the midterm:

- ***Show all your work in your blue book***
- *Write your name, discussion number, ID number on all documents you hand in.*
- *Make sure that the grader knows what s/he should grade by circling your final answer.*
- *Cross out any parts of your solutions that you do not want the grader to grade.*

Each problem is worth 20 points. We will give partial credit on this midterm*, so if you are not altogether sure how to do a problem, or if you do not have time to complete a problem, be sure to write down as much information as you can on the problem. This includes any or all of the following: Drawing a clear diagram of the problem, telling us how you would do the problem if you had the time, telling us why you believe (in terms of physics) the answer you got to a problem is incorrect, and telling us how you would mathematically solve an equation or set of equations once the physics is given and the equations have been derived. Don't get too bogged down in the mathematics; we are looking to see how much physics you know, not how well you can solve math problems.*

If at any point in the exam you have any questions, just raise your hand, and we will see if we are able to answer them.

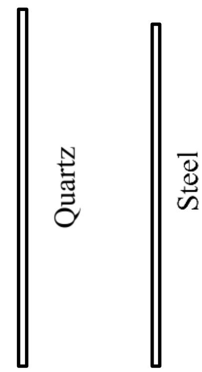
Copy and fill in the following information on the front of your bluebook:

Name: ______________________________ *Disc Sec Number:* ________________________

Signature: ___________________________ *Disc Sec GSI:* ___________________________

Student ID Number: ____________________

1. A rod made of quartz is placed side-by-side with a steel rod (see figure to the right). Suppose at $T_0 = 200$ °C the quartz rod is 100 cm long, and the steel rod is 98 cm long. The coefficient of linear expansion of quartz and steel are $\alpha_{quartz} = 0.4 \times 10^{-6}\ (C°)^{-1}$ and $\alpha_{Fe} = 12 \times 10^{-6}\ (C°)^{-1}$, respectively.

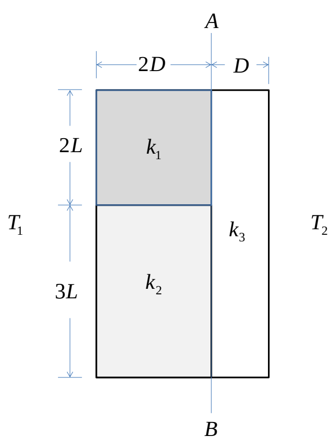


   a. What are the lengths of the quartz and steel rods at 1000 °C?
   b. The melting temperature of quartz is $T_{quartz}^{melt} = 1600\ C°$, while the melting point of the steel $T_{Fe}^{melt} = 1425C°$. It there a temperature at which the length of the *solid* quartz rod is the same as the *solid* steel rod? (You must justify your answer to receive credit.)

2. A piece of ice with mass, m_{ice}, and with a temperature, T_{ice}, is place in a container of water at a temperature, T_w. After the a while, all the water has frozen, and the system is at a temperature, $T > T_{ice}$. *All temperatures are given in* $C°$. What is the mass, m_w, of the water in the container? Express you answer in terms of m_{ice}, T_{ice}, T_w, T, the specific heat of ice, c_{ice}, the specific heat of water, c_w, and the latent heat of fusion for water, L_{ice}.

3. Two identical containers contain two different diatomic gasses. While the total mass of the gas in each container is the same, the total number of molecules in A is N_A, and the total number of molecules in B is N_B. The two gases are at the same temperature, *T*.

   a. What is the ratio of RMS velocities, v_{RMS}^A / v_{RMS}^B, of the gas in A and B?
   b. If P_A the pressure in A, and P_B is the pressure in what is B, P_A / P_B?
   c. If we want $v_{RMS}^A = v_{RMS}^B$, by what fraction, $(T_A - T)/T$, should the new temperature, T_A, in container A be changed from *T*?



4. The figure on the left shows a section of a wall (view from the top of the wall looking down) with height, *H*, made up of three substances having thermal conductivities, $k_1 = 0.84$ J/s m °C , $k_2 = 0.1$ J/s m °C , and $k_3 = 0.048$ J/s m °C. One side of the wall is held at a temperature $T_1 = 20$ °C, and the other side a temperature $T_2 = -20$ °C. Take the temperature, *T*, at along the interface labeled, *A* and *B* to be constant.

   a. What is the total rate of heat flow (d*Q*/d*t*) into the interface? Express your answer in terms of the *D*, *L*, *H*, *T*, .
   b. What is the total rate of heat flow out of the interface? Express your answer in terms of *D*, *L*, and *T*.
   c. What is *T*?

5. The cycle shown on the right is called a Brayton cycle, which is used in gas turbines. The processes $b \to c$ and $d \to a$ are adiabatic, while the processes $a \to b$ and $c \to d$ are isobaric.

   a. Find V_b/V_c in terms of P_1, P_2, and γ for the gas. Here, V_b and V_c are the volumes of the gas at points *b* and *c*, respectively.
   b. Find V_a/V_d in terms of P_1, P_2, and γ. Here, V_a and V_d are the volumes of the gas at points *a* and *d*, respectively.
   c. What is the efficiency, *e*, of the cycle? Express your answer in terms of P_1, P_2, and γ.