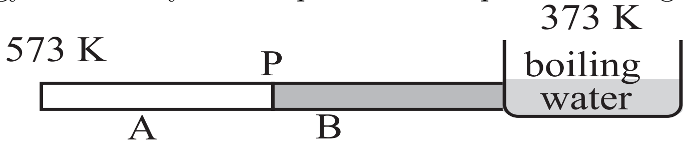
Name: ____________________ **Section:** __________ **Score:** __________**/20**

1. Let $\rho(T)$ be the density of a substance at T (K). It is found that $\rho(600)/\rho(300) = 1.038$. What is the linear thermal expansion coefficient α of this substance? [5]

2. In a rigid container is an ideal gas consisting of a mixture of equal number of molecules of chemical species B and C at temperature $T_0 = 200$ K. Its pressure is P_0. After the completion of the reaction $B + C \to A$ (i.e., after the total number of particles is halved), the temperature goes up to $T = 350$ K and the pressure is P. What is P/P_0? [5]

(**3** on the next page)

3. Two heat conducting rods A and B are connected at P and attached to a container C with boiling water at 100°C as shown in the figure. The left end of rod A is maintained at 573 K. The thermal conductivity of rod A is κ_A and that of rod B is κ_B. Their lengths and cross sections are the same. You may assume that the temperatures are all constant. (You assume there is no exchange of heat between the rods and its surroundings except at their ends. Thermal energy is lost only with vapor from the pan on the right.)

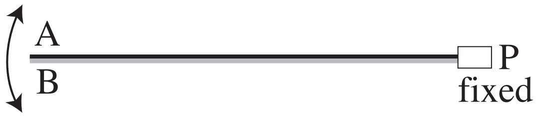


(a) $\kappa_A/\kappa_B = 3$. What is the temperature at P? [5]

(b) In 10 minutes 120 g of water evaporates. What is the rate of energy flow through the the cross section at P (in W or in kW)? The latent heat of evaporation of water at 373K is 2260 kJ/kg. [5]

Name: __________________ **Section:** __________ **Score:** __________/20

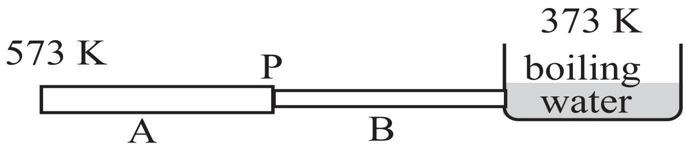
1. A bimetallic strip (bimetal) made of two metal strips A and B is horizontally fixed at its one end P as shown in the following figure. The linear thermal expansion coefficient of metal A is $\alpha_A = 1.4 \times 10^{-5}$ K^{-1}, and that of metal B is $\alpha_B = 2.3 \times 10^{-5}$ K^{-1}. The figure shows the state of the bimetal at 310 K. At 290 K which way does it bend, upward or downward? You must justify your answer. [5]



2. In a container is an ideal gas mixture consisting of equal numbers of molecules of chemical species B and C at temperature $T_0 = 200$ K. The ratio $v_B/v_C = 1.3$, where v_B (resp., v_C) is the root-mean-square velocity of molecule B (resp., C). What is the ratio of the molecular weights M_B/M_C, where M_B (resp., M_C) is the molecular mass of molecule B (resp., C). [5]

(**3** and **4** on the next page)

3. Two heat conducting rods A and B are connected at P and attached to a container C with boiling water at 100°C as shown in the figure. The left end of rod A is maintained at 300°C. Both the rods are made of the same material and of the same lengths, but the cross section of A is twice as large as that of B. (We assume there is no exchange of heat between the system under consideration and its surroundings except at the left end of A and due to evaporation from the pan. Also you may assume that the rods are far longer than their widths.)



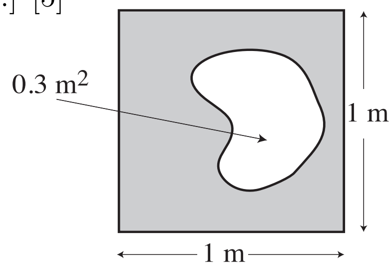
(a) What is the temperature at P (in the stationary state)? [5]

(b) In 3 minutes 20 g of water evaporates under the current condition. If the temperature at the left end of A is changed to 473 K how long does it take to evaporate 20 g (i.e., the same amount) of water? [5]

Physics 101 (F11) **Q11C**

Name: ____________________ **Section:** __________ **Score:** __________/20

1. A square is made of a material whose linear thermal expansion coefficient is $\alpha = 3.8 \times 10^{-4}$ K^{-1}. The square has a hole as shown in the figure below. Its area is 0.3 m^2 at $T = 210$ K. What is the area of the hole at $T = 450$ K? [Of course, you must assume that the material stays solid at this temperature.] [5]



2. A large enough ice chest has 1 kg of liquid water and 0.5 kg of ice and is at 0°C initially. Into this ice chest you put 7 soda cans at 25 °C whose heat capacity is 980 J/K per can. When the temperature reaches a new equilibrium, is there ice remaining in the ice chest? The latent heat of fusion of ice is 333 kJ/kg. You may ignore the heat capacity of the ice chest. [5]

(**3** and **4** on the next page)

3. The molar heat capacity of an ideal gas is $5R/2$. One mole of this gas is in a rigid container of volume V and is initially at 190 K and pressure 2300 Pa. Now, the heat is added and the pressure reaches 8500 Pa.

(a) Is the root-mean square velocity of the gas more than doubled? You must justify your answer. [5]

(b) What is the total amount of heat added to the ideal gas to raise its temperature? [5]

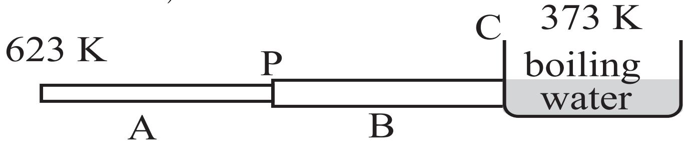
Name: ____________ **Section:** ________ **Score:** ________/20

1. At $T = 250$ K a cubic container of volume 0.8 m^3 made of a metal of linear thermal expansion coefficient $\alpha = 3.5 \times 10^{-5}$ K^{-1} contains brimful of liquid whose linear thermal expansion coefficient is $\alpha = 4.5 \times 10^{-5}$ K^{-1}. Now the temperature of the system is raised to 330 K. What is the volume of the spilt liquid (at 330 K)? [5]

2. In a rigid container is an ideal gas of pressure P_0. What is the pressure P of the ideal gas, if you wish to double the average kinetic energy of the gas molecules? Give P/P_0. you may assume that the container volume does not change. [5]

(**3** on the next page)

3. Two heat conducting rods A and B are connected at P and attached to a container C with boiling water at 100°C as shown in the figure. The left end of rod A is maintained at 350 °C. Both the rods are made of the same material and of the same lengths, but the cross section of B is twice as large as that of A. (We assume there is no exchange of heat between the system under consideration and its surroundings. Also you may assume that the rods are far longer than their widths.)



(a) What is the temperature at P (in the stationary state)? [5]

(b) It takes 3 minutes to evaporate 10 g of water. Suppose the thickness of the rod A is just the same as B (that is, both have the same cross sections). How many minutes does it take 10g of water to evaporate? [Hint: What is the temperature at P now? Then, concentrate your attention to the heat through B.] [5]