# General Physics II: Tutorial Material 9

1) There are 20 kg of ice at −10˚C and 50 kg of water at 10˚C. (*)

   a) How much heat is needed to increase the temperature of the ice to 0˚C and how much heat is needed to melt all the ice at 0˚C? How much heat is needed to decrease the temperature of water to 0˚C?

   b) What is the thermal equilibrium state when the 20 kg of ice at −10˚C is put into the 50 kg of water at 10˚C?

   Note that the specific heats of water and ice are, 1 kcal/kg·C° and 0.5 kcal/kg·C°, respectively. Further more, heat of fusion for water is 80 kcal/kg with a melting point at 0˚C.

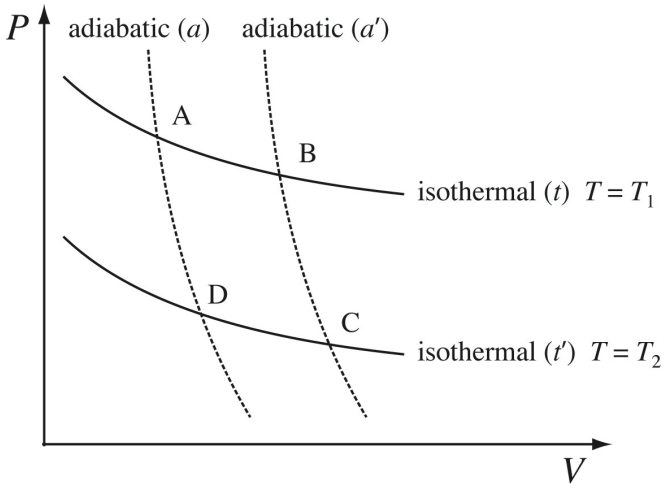
2) Suppose 2.60 mol of an ideal gas with a volume and temperature, $V_1 = 3.50\ \text{m}^3$ and $T_1 = 290\ \text{K}$, respectively, is allowed to expand isothermally to $V_2 = 7.00\ \text{m}^3$ at $T_2 = 290\ \text{K}$. Determine (a) the work done by the gas, (b) the heat into the gas, and (c) the change in the internal energy of the gas.

3) An audience of 1800 people fills a concert hall with a volume of $22000\ \text{m}^3$. In average, each person emits 70 W of energy due to metabolism. The concert hall is well isolated and the air can be considered as an ideal gas of diatomic molecules. At the beginning of the concert, the temperature and pressure of the air in the hall are 20° C and 1 atm, respectively. With no ventilation, by how much the temperature of the hall will raise after two hours?

4) An *n* mole of ideal gas expands adiabatically from a volume of $V_\text{i}$ to $V_\text{f}$. Initially, the pressure was $P_i$. Determine (a) the work of the gas, (b) the heat of the gas, (c) the change of internal energy from the first law of thermal dynamics and (d) show that the internal energy obtained in (c) is identical to $\Delta E_\text{int} = nC_V\Delta T$. (*)

5) An ideal gas is at the state A: $\left(V_\text{a}, P_\text{a}, T_0\right)$. By expanding the volume to $V_\text{b}$ through isothermal process, the state changes to B: $\left(V_\text{b}, P_\text{b}, T_0\right)$, while with the adiabatic process to C: $\left(V_\text{b}, P_\text{c}, T_\text{c}\right)$. Which pressure is higher, $P_\text{b}$ or $P_\text{c}$? Which temperature is higher, $T_0$ or $T_\text{c}$? Why the temperature changes in the adiabatic process? (*)

6) For an *n*-mole of ideal gas, two isothermal lines, *t* and *t'*, at temperatures $T_1$ and $T_2$ in Kelvin respectively, and two adiabatic lines, *a* and *a'*, are crossing at the four points, A, B, C and D, in the volume (*V*) versus pressure (*P*) diagram, as shown in the plot below. The heat in the process A→B is denoted by $Q_\text{ab}$ and in the process C→D, $Q_\text{cd}$. Show that the ratio, $Q_\text{ab}/Q_\text{cd}$, depends only on $T_1$ and $T_2$ .


P
adiabatic (a)
adiabatic (a′)
A
B
isothermal (t) T = T1
D
C
isothermal (t′) T = T2
V