Physical chemistry
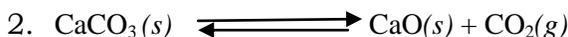
Tutorial 2 (08-10-2013)

1. Chloroform boils at 61.7 °C. Applying trouton's rule, estimate the vapor pressure of $CHCl_3$ at 50 °C.
   (Text book of Physical chemistry, **Robert G. Mortimer,** Edition 3, Chapter 5, page 212, example 5.6)

2. $CaCO_3 (s) \rightleftharpoons CaO(s) + CO_2(g)$
   By using equilibrium constant quotient (K) and $\Delta_f G°$ values for the above reaction, estimate its equlibrium constant (K_a) and P_{eq} (CO_2) at 298.15 K.
   [$\Delta_f G°$ (CO_2) = −394.389 KJ mol^{-1}; $\Delta_f G°$ (CaO) = −603.501 KJ mol^{-1}; $\Delta_f G°$ ($CaCO_3$) = −1128.79 KJ mol^{-1}]
   (Text book of Physical chemistry, **Robert G. Mortimer,** Edition 3, Chapter 7, page 312, example 7.4)

3. Show that the change
   2 mol of an ideal gas (2 bar, 273 K) $\longrightarrow$ 2 mol of gas (1 bar, 273 K) carried out irreversibly against an external pressure of 1 bar is spontaneous.

   (Text book of Physical chemistry, **K. L Kapoor,** Edition 3, *Vol 2,* Chapter 5, page 306, example 2)

4. A 50 g mass of Cu at a temperature of 393 K is placed in contact with 100 g mass of copper at a temperature of 303 K in a thermally insulated container. Calculate q and ΔS_{total} for the reversible process. Use a value of 0.4184 $Jg^{-1}K^{-1}$ for the specific heat capacity of Cu.

   (Text book of Physical chemistry, **K. L Kapoor,** Edition 3, *Vol 2,* Chapter 4, page 161, example 4)

5. Calculate the change in the entropies of the system and the surroundings, and the total change in entropy, when the volume of a sample of argon gas of mass 21 gat 298 K and 1.50 bar increases from 1.20 dm3 to 4.60 dm3 in (a) an isothermal reversible expansion, (b) an isothermal irreversible expansion against $p_{ex} = 0$, and (c) an adiabatic reversible expansion.

   (Physical Chemistry, **Atkins, P.W.; Paula, J. D.**, 8th ed.; Oxford: New York, 2006; Chapter 3, pp 113, Problem No: 3.13b)

6. A certain heat engine operates between 1000 K and 500 K. (a) What is the maximum efficiency of the engine? (b) Calculate the maximum work that can be done by for each 1.0 kJ of heat supplied by the hot source. (c) How much heat is discharged into the cold sink in a reversible process for each 1.0 kJ supplied by the hot source?

   (Physical Chemistry, **Atkins, P.W.; Paula, J. D**. 8th ed.; Oxford: New York, 2006; Chapter 3, pp 114, Problem No: 3.15b)

7. What is the change in the boiling point of water at a 100^{0}C per Pascal change in atmospheric pressure?
   The Molar enthalpy of vaporization is 40.69 kJ mol^{-1}, the molar volume of liquid water is 0.019×10^{-3} m^3 mol^{-1}, and the molar volume of steam is 30.199×10^{-3} m^3 mol^{-1}, all at 100^{0}C and 1.01325 bar

   (Physical Chemistry, *Silbey, Alberty, Bawendi*. Fourth Edition; Wiley India, Chapter 6, pp 182, example 6.1)

8. Label the regions of the phase diagram given below. State what substances (if compounds give their formnlas) exist in each region. Label each substance in each region as solid, liquid, or gas.

   (Physical Chemistry, *Atkins, P.W.; Paula, J. D*. 8th ed.; Oxford: New York, 2006; Chapter 6, pp 195, problem 6.6)