CYL 110: 2010-2011 Thermodynamics Tutorial 3

1. The molar Gibbs energy of a certain gas is given by $G_m = RT \ln p + A + Bp + \frac{1}{2}Cp^2 + \frac{1}{3}Dp^3$, where *A*, *B*, *C*, and *D* are constants. Obtain the equation of state of the gas.
2. Predict whether the oxidation reactions of α D-glucose and CH_4 at 298 K are spontaneous or not. Does your prediction agree with the fact that these substances can be kept in air for very long periods without any change? The overall reaction for metabolic breakdown of glucose in our bodies is the same as the combustion of glucose in air. Is this reaction more favored at 37 ℃.
3. Calculate the change in the chemical potential of a perfect gas when its pressure is increased isothermally from 1.8 atm to 29.5 atm at 40 ℃.
4. (a) Calculate $\Delta_{mix}G$ when (i) 2 mol H_2 at 2 atm and 4 mol N_2 at 3 atm are mixed at 25 ℃. Calculate also the entropy change (ii) if the initial pressures of the gases are identical and (iii) if the gases are identical.
5. Calculate the vapor pressure of water at 25 ℃. $\Delta_f H^0$(H2O, l) = −287 kJ mol^{-1} ; $\Delta_f H^0$(H2O, g) = −243 kJ mol^{-1};S^0 (H2O, g) = 189.5 J K^{-1} mol^{-1};S^0 (H2O, l) = 70.2 J K^{-1} mol^{-1} .
6. Consider the application of the van't Hoff equation to a two-phase equilibrium $\alpha \rightleftharpoons \beta$. Show that the van't Hoff equation leads to the Clapeyron equation in such a case.
7. Estimate the temperature at which $CuSO_4$.$5H_2$ 0 undergoes dehydration. ΔH^0 for the dehydration = -299 kJ mol^{-1} and the change in entropy at standard state is 752 J K^{-1} mol^{-1}.
8. The vapour pressure of a substance at 20.0°C is 58.0 kPa and its enthalpy of vaporization is 32.7 k} mol- J . Estimate the temperature at which its vapour pressure is 66.0 kPa.
9. On a cold, dry morning after a frost, the temperature was -5°C and the partial pressure of water in the atmosphere fell to 0.30 kPa. Will the frost sublime?
10. On the sea bottom at the Galapagos Rift, water heated to 350 °C gushes out of hydrothermal vents at a depth of 3000 m. Will this water boil or remain liquid at this depth? The vapor pressure of water is 163 atm at 350 °C.
11. An ideal gas reaction mixture is in a constant temperature bath. State whether each of the following will change the value of Kp. (a) Addition of a reactant, (b) Addition of an inert gas, (c) Change in pressure for a reaction with $\Delta n \neq 0$, (d) Change in temperature of the bath.
12. A new molecule (a drug), renol, has been synthesized and its phase diagram needs exploring. Near its triple point it is found that the vapor pressure over the liquid (p_ℓ) and over the solid (p_s) are given by $\ln p_l = -\frac{3.01\ K}{T} + 13.2 \quad and \quad \ln p_s = -\frac{3.82\ K}{T} + 16.1$ (a) Calculate the triple point temperature and pressure. (b) In which phase is renol at 1 bar, 298 K? (c) What is $\Delta\overline{H}_{sub}$?