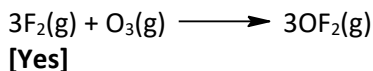
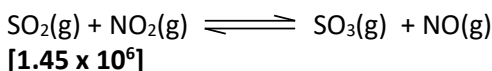


SURREY SUPPLEMENT: THERMODYNAMICS

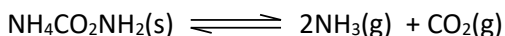
- 1) For oxygen difluoride,  $\text{OF}_2(\text{g})$ , the Gibbs free energy of formation is +40.6 kJ/mol.
- Is the preparation of  $\text{OF}_2(\text{g})$  from its elements at 25°C a spontaneous process? **[No]**
  - For ozone,  $\text{O}_3(\text{g})$ , the Gibbs free energy of formation is +163.43 kJ/mol. Is it theoretically possible to prepare  $\text{OF}_2(\text{g})$  at 25°C by the reaction:



- 2) The standard enthalpy of formation of  $\text{CS}_2(\text{l})$  is +87.9 kJ/mol. The absolute molar entropy of C(graphite) is 5.69 J/mol·K, of S(rhombic) is 31.9 J/mol·K, and of  $\text{CS}_2(\text{l})$  is 151.0 J/mol·K. Calculate the standard Gibbs free energy of formation of  $\text{CS}_2(\text{l})$ . **[63.7 kJ/mol]**
- 3) Look up the necessary data in the appendices of your textbook or online to determine the  $K_{p,298}$  value for the reaction:

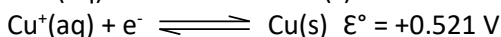
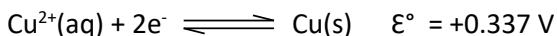


- 4) For the reaction:



$$\Delta G^\circ_{298} = +31.00 \text{ kJ and } \Delta H^\circ_{298} = +159.95 \text{ kJ}$$

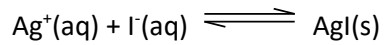
- Calculate the value of  $K_p$  at 298 K **[3.67 x 10<sup>-6</sup>]**
  - Calculate the pressure of  $\text{NH}_3$  and  $\text{CO}_2$  at equilibrium at 298 K **[ $P_{\text{CO}_2} = 9.7 \times 10^{-3}$  bar and  $P_{\text{NH}_3} = 1.94 \times 10^{-2}$  bar]**
  - Calculate the value of  $K_p$  at 500 K **[7.8 x 10<sup>-5</sup>]**
  - Calculate the absolute molar entropy of  $\text{NH}_3$  at 298 K given the following absolute molar entropies:  $\text{CO}_2(\text{g}) = 213.60 \text{ J/mol}\cdot\text{K}$  and  $\text{NH}_4\text{CO}_2\text{NH}_2(\text{s}) = 166.10 \text{ J/mol}\cdot\text{K}$  **[192.6 J/mol·K]**
- 5) Given the following standard electrode potentials and Gibbs free energies of formation at 298 K:



$$\Delta G^\circ_{f,298}(\text{Cu}(\text{OH})_2(\text{s})) = -356 \text{ kJ/mol}$$

- Calculate  $\mathcal{E}^\circ$  for the reaction:  $\text{Cu}^{2+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{Cu}^+(\text{aq})$  **[0.152 V]**
- Calculate  $\Delta G^\circ$  and  $K_c$  at 298 K for the reaction:  $2\text{Cu}^+(\text{aq}) \rightleftharpoons \text{Cu}^{2+}(\text{aq}) + \text{Cu}(\text{s})$  **[0.184 V]**
- Given the  $K_{sp}$  of  $\text{Cu}(\text{OH})_2 = 1.6 \times 10^{-19}$ , calculate  $\Delta G^\circ_{f,298}$  for  $\text{OH}^-(\text{aq})$ . **[-156.9 kJ/mol]**
- Using the Gibbs free energies of formation at 298 K for the  $\text{OH}^-$  and  $\text{H}^+$  ions along with the  $\Delta G^\circ_{f,298}$  for  $\text{H}_2\text{O}(\text{l}) = -237 \text{ kJ/mol}$ , calculate the  $K_w$  for water at 25°C. **[9.1 x 10<sup>-15</sup>]**

6) For the reaction:



$$\mathcal{E}^\circ = +0.951 \text{ V at } 25^\circ\text{C and } K_{328} = 1.88 \times 10^{14}$$

- Calculate  $\Delta G^\circ$  for the above reaction at 298 K **[-91.8 kJ]**
- Calculate  $\Delta H^\circ$  and  $\Delta S^\circ$  for this reaction at 298 K. Assume that  $\Delta H^\circ$  and  $\Delta S^\circ$  are independent of temperature. **[\Delta H^\circ = -113.6 kJ and \Delta S^\circ = -73.3 J/K]**
- Given that the Gibbs free energy of formation of  $\text{Ag}^+(\text{aq})$  at 298 K is +77.11 kJ/mol, calculate  $\mathcal{E}^\circ_{298}$  for the half reaction:  $\text{Ag}(\text{s}) + \text{I}^-(\text{aq}) \rightleftharpoons \text{AgI}(\text{s}) + \text{e}^-$  **[0.152 V]**