2019 CHEM2C: Assignment 2

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Due date: April 18 2019 (in class). Keep everything brief.

1. According to thermodynamics, the transformation from diamond to graphite is spontaneous with $\Delta G^\circ = -2.90\,\text{kJ mol}^{-1}$. However, your diamond ring hasn't turned into graphite because of the kinetics of the reaction. Estimate the rate constant and half-life (assuming first-order) of this reaction is the preexponential factor is $A = 1\,\text{s}^{-1}$ and $E_a = 540\,\text{kJ mol}^{-1}$ at $T = 298\,\text{K}$. NB: The approximate age of the sun is 1.4×10^{17} s and approximate age of the universe 4.3×10^{17} s).

2. The rate constant k for the reaction $H_2 + I_2 \longrightarrow 2\,HI$ has been determined at two temperatures:

T (K)	k ($M^{-1}\,s^{-1}$)
599	5.4×10^{-4}
683	2.8×10^{-2}

   (a) Calculate the activation energy for the reaction.

   (b) At what temperature will the rate constant for the reaction have the value $k = 5.0\times10^{-3}\,M^{-1}\,s^{-1}$?

3. Derive the rate law for the following iodide-hypochlorite reaction in aqueous solution.

   $OCl^- + H_2O \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} HOCl + OH^-$ *Fast* [rxn. 1]

   $I^- + HOCl \xrightarrow{k_2} HOI + Cl^-$ *Slow* [rxn. 2]

   $HOI + OH^- \underset{k_{-3}}{\overset{k_3}{\rightleftharpoons}} H_2O + OI^-$ *Fast* [rxn. 3]

4. One proposed mechanism for the formation of a double helix in DNA is given by the following reactions. Where S_1 and S_2 represent strand 1 and 2, and $(S_1-S_2)^*$ represents an unstable helix. Write the rate of reaction expression for the formation of the double helix.

   1. $S_1 + S_2 \underset{\text{k-1}}{\overset{k_1}{\rightleftharpoons}} (S_1-S_2)^*$

   2. $(S_1-S_2)^* \xrightarrow{k_2} S_1-S_2$