Exam 3 – Spring 2019

BCH 341 - Physical Chemistry with a Biological Focus

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February 20-21, 2019

DUE Thursday, Feb. 21, 2019 by 11:59 PM (UTC-7). Turn in completed exam as a single PDF document into the assignment link on ASU Canvas. Please make sure the completed exam is organized, self-contained and legible (preferably electronically typed and not handwritten).

Initials: _____ Email: _____

To aid in the anonymous peer review process, you do NOT need to include your full name, just your first and last initials, and an email address for contact purposes. The exam consists of 8 numerical problems. The first 4 problems are worth 10 pts each and the last 4 problems are worth 15 pts each. Hence, the exam is worth a total of 100 points. You are required to explicitly show all equations, numerical calculations and associated units. All assumptions need to be clearly and concisely stated. If thermodynamic parameters are used, the citation, reference or link to where this thermodynamics data came from must be stated.

1. Calculate the potential of the electrochemical cell (express your answer in units of Volts, V):

$$Ag(s) \mid AgCl(s) \mid KCl\ (aq, 0.025\ mol/kg) \parallel AgNO_3\ (aq, 0.01\ mol/kg) \mid Ag(s)$$

2. Is the conversion of pyruvate ion to lactate ion

$$\text{Pyruvate}^- (aq) + \text{NADH} (aq) + \text{H}^+ (aq) \rightarrow \text{Lactate}^- (aq) + \text{NAD}^+ (aq)$$

A redox reaction (1 pt)? Explain or justify your answer (9 pts).

3. Calculate the masses of **(a)** $Ca(NO_3)_2$ and, separately, **(b)** NaCl to add to a 0.150 mol/kg solution of KNO_3 (aq) containing 500.0 g of solvent to raise its ionic strength to 0.20.

4. Estimate the mean ionic activity coefficient and activity of a solution that is 10.0 mM $CaCl_2$ (aq) and 20 mM NaCl (aq).

5. (a) Calculate the standard potential of the cell

$$\text{Pt (s) | cysteine (aq) , cystine (aq) || } H^+ \text{ (aq) | } O_2 \text{ (g) | Pt (s)}$$

(b) Calculate the standard Gibbs energy and enthalpy of the cell reaction at 25°C.

(c) Estimate the value of the Gibbs energy of the cell reaction at 35°C.

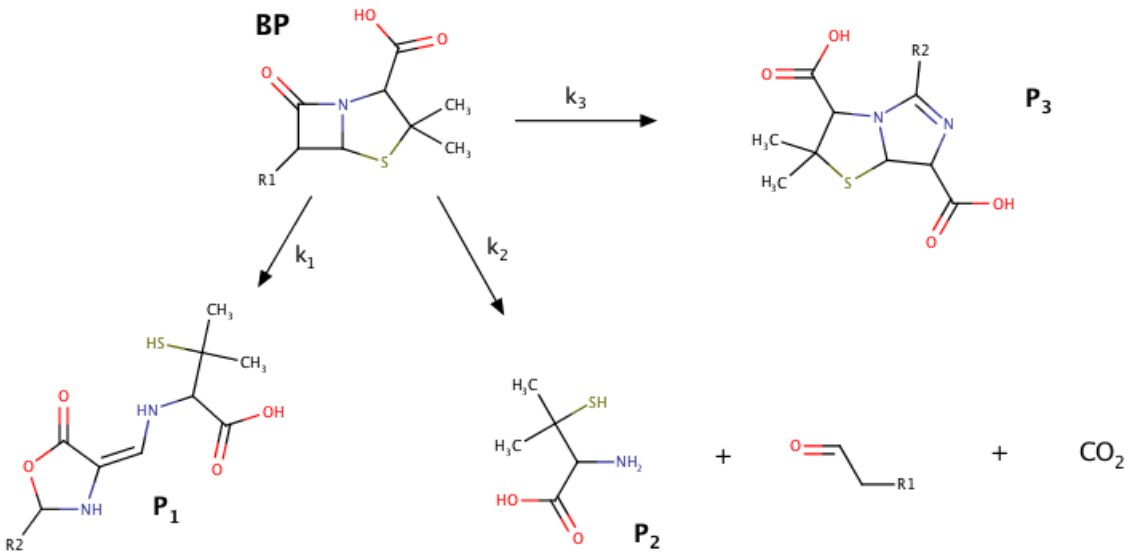
6. Calculate the standard Gibbs free energy change and the equilibrium constant for the oxidation of a formate ion to carbon dioxide at pH=7 and room temperature.

7. The important biochemical intermediate, acetyl CoA, may be prepared by reacting CoASH with acetyl chloride. The following data was obtained for this reaction when CoASH and acetyl chloride were mixed in a 1:1 ratio:

Time (min)	0	1.0	2.0	3.0	4.0	5.0
[CoASH] (mM)	10.0	6.7	5.1	4.2	3.5	3.0

Determine the order of the overall reaction and the associated rate constant (remember to include the units on the rate constant).

8. In acidic conditions, benzyl penicillin (BP) undergoes the following parallel reaction:



In the molecular structures, R_1 and R_2 indicate alkyl substituents. In a solution where pH=4, the rate constants for the processes at 22°C are $k_1 = 0.070\ s^{-1}$, $k_2 = 0.210\ s^{-1}$, $k_3 = 0.230\ s^{-1}$. **(a)** What are the percent yields for P_1, P_2, and P_3 formation?

8(b) The temperature dependence of the acid-catalyzed hydrolysis of penicillin is investigated, and the dependence of k_1 on temperature is given in the following table:

Temperature (°C)	**k_1 (s^{-1})**
22.0	0.070
29.3	0.110
35.6	0.250
46.4	0.580
55.2	0.980

What is the activation energy (E_a) and Arrhenius pre-exponential factor (A) for this branch (P_1) of the hydrolysis reaction? [Put a box around your final answers. Express your answer for E_a in units of kJ/mol and your answer for A in units of s^{-1}]