

Exam One
CHM 205 (Dr. Mattson)
30 January 2006

Academic Integrity Pledge:

In keeping with Creighton University's ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.

Signature:

Instructions: Show all work whenever a calculation is required! You will receive credit for **how** you worked each problem as well as for the correct answer. This exam is worth 50 points. **BOX YOUR ANSWERS!** Questions worth ONE point, unless noted.

Note: Assume the density of water = 1.00 g/mL.

1. (3 pts) Suppose 17.5 g $\text{Ca}(\text{NO}_3)_2$ were dissolved in 100.0 mL water. What is the molality of the solution? [MM: $\text{Ca}(\text{NO}_3)_2 = 164.1 \text{ g/mol}$]

2. (3 pts) What is the molarity of a solution of 60.5 g sodium nitrate in enough water to make 250.00 mL solution? [MM: $\text{NaNO}_3 = 85.0 \text{ g/mol}$]

3. (3 pts) Consider a solution of aqueous ammonium acetate that has a mole fraction of 0.15 $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$. What is the mass percent of the solution? [MM: $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2 = 77.1 \text{ g/mol}$]

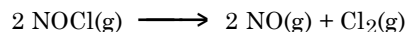
4. (3 pts) Concentrated perchloric acid is 11.7 M and has a density of 1.67 g/cm^3 . What is the molality of this acid? [MM: $\text{HClO}_4 = 100.5 \text{ g/mol}$]

5. (3 pts) Ethanol normally boils at $78.5 \text{ }^\circ\text{C}$. What is the boiling point of a 2.45 molal solution of urea, a non-volatile solute in ethanol? [$K_b = 1.22 \text{ deg/molal}$]

6. (3 pts) A 13.45 g sample of an unknown, non-electrolyte is dissolved in 85 g water and the freezing point of the solution drops by 3.2 degrees. What is the MM of the unknown? [$K_f = 1.86 \text{ deg/molal}$]

7. (3 points) Pure water has a vapor pressure of 17.5 mmHg at $20 \text{ }^\circ\text{C}$. What is the vapor pressure of a solution of 1.95 mol sugar in 400 g water?

8. (3 pts) What is the order of the following reaction?



[NOCl]	Rate, $-\Delta[\text{NOCl}]/\Delta t$
0.30 mol L^{-1}	$3.60 \times 10^{-9} \text{ mol L}^{-1} \text{ s}^{-1}$
0.60	14.4×10^{-9}
0.90	3.24×10^{-9}

Answer with explanation:

9. (2 pts) Refer again to Question 8. In the first experiment, the rate of disappearance of NOCl, $-\Delta[\text{NOCl}]/\Delta t$, was listed as $3.60 \times 10^{-9} \text{ mol L}^{-1} \text{ s}^{-1}$. What is the rate of formation of Cl_2 , $\Delta[\text{Cl}_2]/\Delta t$, at that same point in time?

- 10 – 14. Sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, slowly undergoes hydrolysis to form fructose and glucose. The candy industry uses this reaction because fructose is sweeter than sucrose so less sugar can be used to achieve the same sweetness. Consider these data for the reaction:

Time, hr	$[\text{C}_{12}\text{H}_{22}\text{O}_{11}]$
0.0	0.500 M
1.00	0.400
2.00	0.321
3.00	0.257

10. (3 pts) In the space to the right of the data, determine the order of the reaction. The order is:

11. (3 pts) What is the value for the rate constant?

12. (3 pts) What is $[\text{C}_{12}\text{H}_{22}\text{O}_{11}]$ after 5.5 hours?

13. (3 pts) How long will it take for $[\text{C}_{12}\text{H}_{22}\text{O}_{11}] = 0.040 \text{ M}$?

14. (3 pts) Circle all the things that would happen if the temperature were increased:

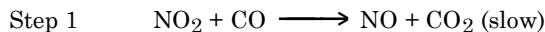
- A. The rate constant would increase.
 B. The rate would increase
 C. The activation energy would increase.

- 15 – 17. The rate law for the following reaction is $\text{rate} = k[\text{NO}_2]^2$:

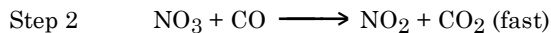
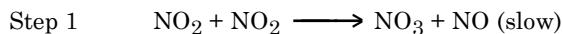


15. (2 pts) Which of the following mechanisms is consistent with the observed rate expression? Circle your choice(s) here: **I II III IV**

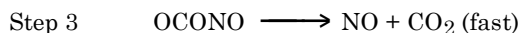
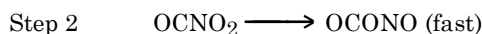
Mechanism I



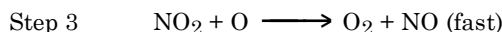
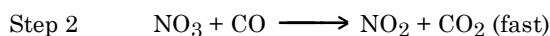
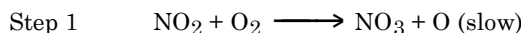
Mechanism II



Mechanism III



Mechanism IV



16. (2 pts) Which of the mechanisms shown features one or more intermediates? Circle your choice(s) here: **I II III IV**

17. (2 pts) Which of the mechanisms uses a catalyst? Circle your choice(s) here: **I II III IV**

18. (3 pts) Sketch the reaction profile for Mechanism I. Label E_{act} and ΔH .

19. (BONUS 1 point) Print your name here:

Your exam score (50 possible): _____

Determine your grade:

$A \geq 46.5$; $B+ \geq 43.2$; $B \geq 41.0$; $C+ \geq 37.5$; $C \geq 34.00$; $D \geq 30.00$

Answers:

1. 1.07 mol/kg
2. 2.85 M
3. 43%
4. 23.7 mol/kg
5. 81.5 °C
6. 92.0 g/mol
7. 16.1 mmHg
8. second order
9. 1.80×10^{-9} mol/L s
10. first order
11. $k = 0.225 \text{ hr}^{-1}$
12. 0.147 mol/L
13. 11.3 hr
14. A and B
15. II
16. II, III, and IV
17. IV
18. one hump; Energy change between reactants (left) and hill top is $E_{\text{activation}}$.
Energy change between reactants and products (right) is ΔH_{rxn} .