Exam 2 Chm 205 (Dr Mattson) 27 February 2019

Academic Integrity Pledge: *In keeping with Creighton University's ideals and with the Academic Integrity Code, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.*

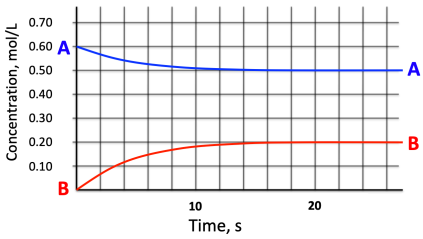
Signature:

Name:

Chemistry Student Number: _____

Instructions: **Show all work whenever a calculation box is provided!** Write legibly. Include units whenever appropriate. You will receive credit for **how** you worked each problem as well as for the correct answer. If you need more space, you may use the back of the data sheet provided — Write: "See data sheet" in the answer box – then write your name on the data sheet. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and purse-like items must be stored on the tables in the back of the room. Cell phones must be silent and placed in your backpack/bag/purse – not in your pocket.

1. Consider this chart of A going to B. We will build a MICE table from this chart. **Carefully check your work!**



1a. (3 pts) What are the initial concentrations of A, $[A]_I$ the change in the concentration of A, $[A]_C$ and the equilibrium concentration of A, $[A]_E$?

$[A]_I$=	$[A]_C$=	$[A]_E$=

1b. (3 pts) What are $[B]_I$, $[B]_C$, $[B]_E$?

$[B]_I$=	$[B]_C$=	$[B]_E$=

1c. (3 pts) Based on the changes in concentrations of A and B, balance the equation for A → B.

_____ A → _____ B

1d. (3 pts) Use the above information to carefully fill in this MICE table. Be sure you use the balanced equation.

M	→	
I		
C		
E		

1e. (3 pts) Write the equilibrium constant in terms of [A] and [B] **and** then solve for its numerical value.

1f. (1 pt) How many seconds does it take for the reaction to reach equilibrium?

1g. (1 pt) If more **A** was added to an equilibrium mixture, how would the reaction shift in order to return to equilibrium? Circle: **Shift left** **Shift right** **No Shift**

1h. (1 pt) Suppose the volume were decreased. How would the reaction shift to return to equilibrium? Circle your choice: **Shift left** **Shift right** **No Shift**

1i. (2 pts) The reaction is ***endothermic*** and the temperature is increased. What shift occurs to return equilibrium? Circle: **Shift left** **Shift right** **No Shift**

1j. (2 pts) The reaction is ***endothermic*** and the temperature is increased. How is K_c affected? Circle: **K_c increases** **K_c decreases** **K_c does not change**

1k. (1 pt) If a catalyst was used and the reaction repeated, how would the time to reach equilibrium change? Circle: **Increase** **Decrease** **No change**

1l. (2 pts) If a catalyst was used and the reaction repeated, how would K_c change? Circle your choice: **Increase** **Decrease** **No change**

1m. (1 pt) Is $K_c = K_p$ for this reaction? Circle: **Yes** **No**

1n. (2 pts) At t = 4 s, how does Q_c compare to K_c? Circle: **$Q_c > K_c$** **$Q_c < K_c$** **$Q_c = K_c$**

1o. (3 pts) Write the equilibrium expression for the reverse reaction from Question 1e and solve its numerical value.

2a. (4 pts) Consider this equilibrium at 1000 K. Suppose $[O_2]_E$ = 0.115 M. What are $[SO_2]_E$ and $[SO_3]_E$?

	$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g)$ ΔH_{rxn} = -99 kJ		
M			
I	0.200	0.200	0
C			
E		0.115	

2b. (4 pts) Write the K_c expression in terms of concentrations. Calculate K_c^{1000}.

Show work for credit.

2c. (2 pts) How will increasing the temperature affect K_c? Circle: **Increase** **Decrease** **No change**

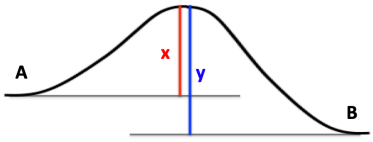
2c. (1 pt) Would decreasing the volume increase K_c? Circle: **Yes** **No**

2d. (1 pt) How would decreasing the volume shift the reaction? Circle: **Shift left** **Shift right** **No shift**

2e. (1 pt) Would adding some $SO_2(g)$ to an equilibrium mixture increase K_c? Circle: **Yes** **No**

2f. (1 pt) Would adding $SO_2(g)$ to an equilibrium mixture cause the reaction to shift right? Circle: **Yes** **No**

3. Consider the reaction profile for the A ⇌ B equilibrium. The fraction of molecules, **f**, with enough energy to overcome E_{act} is given by $f = e^{-E_{act}/RT}$. Note: Both **x** and **y** are positive.



3a. (1 pt) The reaction is **exothermic** or **endothermic**

3b. (1 pt) E_{act}^{fwd} is designated by… Circle **x** or **y**

3c. (2 pts) ΔH_{rxn} is equal to… Circle **x - y** or **y - x**

3d. (1 pt) Increasing temperature will result in a … Fill in your choice: ☐ smaller E_{act} or ☐ larger **f** values for both forward and reverse reactions or ☐ change in ΔH_{rxn}

3e. (1 pt) Increasing temperature will increase **f** for… Fill in your choice: ☐ the forward reaction more than the reverse reaction or ☐ the reverse reaction more than the forward reaction or ☐ both by the same factor

3f. (2 pts) Increasing temperature will… ☐ increase [A] or ☐ increase [B] or ☐ not change [A] or [B]

3g. (2 pts) K_c is most likely… ☐ <1 or ☐ >1 or ☐ = 1

4. (3 pts) Write the equilibrium expression for water into hydronium ions and hydroxide ions. Use appropriate equilibrium arrows (long/short) given that $K_w = 1 \times 10^{-14}$ at 298 K. *Include charges on ions for credit on this and all of the following questions.*

5. (3 pts) Select the three strong acids form these choices.

☐ $HNO_2(aq)$ ☐ $H_2CO_3(aq)$ ☐ $H_2SO_3(aq)$
☐ $HClO_4(aq)$ ☐ $KNO_3(aq)$ ☐ $HCl(aq)$
☐ $NH_3(aq)$ ☐ $NaBr(aq)$ ☐ $HI(aq)$

6. (3 pts) What is the pH of a 5.8×10^{-4} M solution of any monoprotic strong acid?

Answer with correct significant figures: _____

7. (4 pts) Write the conjugate base for each weak acid.

a. $HC_2H_3O_2$	b. HF	c. HSO_3^-	d. H_3PO_4

8. (4 pts) Write the conjugate acid for each weak base.

a. NO_2^-	b. NH_3	c. HCO_3^-	d. HPO_4^{2-}

9a. (3 pts) Write the equilibrium expression with long/short arrows for proprionic acid, $HC_3H_5O_2$, a weak acid that you may abbreviate HPr.

9b. (4 pts) What is the pH of a 0.400 M propionic acid solution given that its K_a value is 1.35×10^{-5}.

Show work for credit.

Answer with correct significant figures: _____

10. (3 pts) What is the pH of a 2.25×10^{-3} M KOH(aq)?

Answer with correct significant figures: _____

11a. (3 pts) A 0.0550 M solution of a weak acid has a pH of 3.94. What is its K_a?

Answer with correct significant figures: _____

11b. (2 pts) Convert your K_a value from the previous question into a pK_a value.

Answer with correct significant figures: _____

12a. (4 pts) What is the K_b value for the acetate ion given the $K_a = 1.82 \times 10^{-5}$ for acetic acid.

12b. (3 pts) Write the equilibrium expression with long/short arrows for the acetate ion, $C_2H_3O_2^-$ that you may abbreviate Ac^-.

12c. (4 pts) Calculate the pH of a 5.7×10^{-2} M $NaC_2H_3O_2$ solution. (Do not include Na^+ in your MICE table.)

Show work for credit.

Answer with correct significant figures: _____

13. (5 pts) Which if these salts are acidic, basic, or neutral? Circle your choice.

A. NH_4Cl **Acidic Basic Neutral**
B. KI **Acidic Basic Neutral**
C. LiBr **Acidic Basic Neutral**
D. $NaBrO_2$ **Acidic Basic Neutral**
E. Na_2SO_3 **Acidic Basic Neutral**

Answers:

1a. $[A]_I$= 0.60 M; $[A]_C$= 0.10 M; $[A]_E$= 0.10 M

1b.$[B]_I$= 0.0 M; $[B]_C$= 0.20 M; $[B]_E$= 0.20 M

1c. A → 2 B

1d.

M	A	→	2 B
I	0.60		0.0
C	-0.10		+0.20
E	0.50		0.20

1e. $K_c = [B]^2 / [A] = 0.080$

1f. ~15 s

1g. Right

1h. Left

1i. Right

1j. K_c increases

1k. Decrease

1l. No change

1m. No

1n. $Q_c < K_c$

1o. $K_c = [A] / [B]^2 = 12.5$

2a. $[SO_2]_E$ = 0.030 M and $[SO_3]_E$ = 0.170 M

2b. $K_c^{1000} = 279$

2c. Decrease

2c. No

2d. Shift right

2e. No

2f. Yes

3a. exothermic

3b. x

3c. x - y

3d. ☐ larger f values for both forward and reverse reactions

3e. ☐ the reverse reaction more than the forward reaction

3f. ☐ increase [A]

3g. ☐ >1

4. $2\ H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

5. ☐ $HClO_4(aq)$ ☐ HCl(aq) ☐ HI(aq)

6. 3.24

7.

a. $C_2H_3O_2^-$	b. F^-	c. SO_3^{2-}	d. $H_2PO_4^-$

8.

a. HNO_2	b. NH_4^+	c. H_2CO_3	d. $H_2PO_4^-$

9a. $HPr(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + Pr^-(aq)$

9b. 2.63

10. 11.35

11a. $K_a = 2.4 \times 10^{-7}$

11b. 6.62

12a. $K_b = 5.5 \times 10^{-10}$

12b. $Ac^-(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + HAc(aq)$

12c. 8.75

13. Acidic, Neutral, Neutral, Basic , Basic