Exam 2 Chm 205 (Dr Mattson) 3 March 2014

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:

Circle: Section A or Section C **Folder group:**

H He Li Be B C N O F Ne Na Mg Al Si

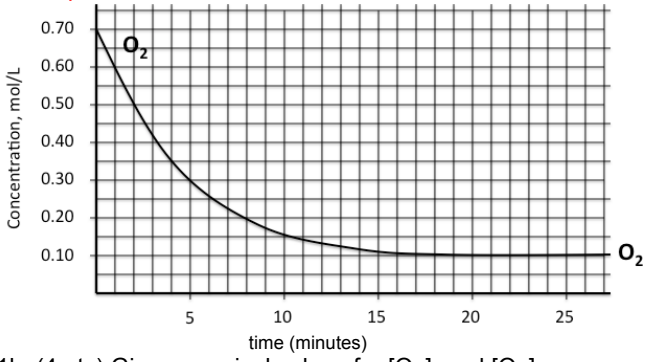
Instructions: Show all work whenever a calculation box is provided! Write legibly. Include units whenever appropriate. You will receive credit for **how** you worked each problem as well as for the correct answer. If you need more space, you may use the back of the data sheet provided — Write: "See attached"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

1a. (2 pt) Write the equilibrium expression, K_c, for the equilibrium:

$$2\ S(s) + 3\ O_2(g) \rightleftharpoons 2\ SO_3(g)$$

K_c =

Use this graph which pertains to the equilibrium given above. $[SO_3]_I$ = 0 M. **Note:** $[O_2]_I$ and $[SO_3]_I$ refer to initial concentrations. Similarly, $[O_2]_E$ and $[SO_3]_E$ refer to equilibrium concentrations.



1b. (4 pts) Give numerical values for $[O_2]_I$ and $[O_2]_E$.

$[O_2]_I$ = $[O_2]_E$ =

1c. (6 pts) Create a MICE table using the information provided in the graph and your answer to Question 1b.

$$2\ S(s) + 3\ O_2(g) \rightleftharpoons 2\ SO_3(g)$$

M	O_2	SO_3
I		
C		
E		

1d. (1 pt) How long does it take for the reaction to come to equilibrium? Units!

1e. (1 pt) Would $K_c = K_p$ for this reaction? **Yes No**

1f. (4 pts) What is the numerical value of K_c?

Answer:_____

1g. (1 pt) Would decreasing the volume cause this reaction to shift in order to reestablish equilibrium? If so, how?

A. Yes, to the right
B. Yes, to the left
C. No

1h. (1 pt) This reaction is known to be exothermic in the forward direction. Would K_c change if the temperature were raised?

A. Yes, K_c increases
B. Yes, K_c decreases
C. No, K_c is constant

1i. (1 pt) Given the reaction is exothermic, what happens to $[O_2]_E$ if the temperature is increased?

A. increase
B. It would decrease
C. It would stay the same

1j. (1 pt) What would happen to the time it takes to reach equilibrium if the temperature were increased? It would …

A. take less time
B. take more time
C. take the same time

2. Consider the equilibrium, for which K_c = 5.10 at 1000 K:

$$2\ BrCl(g) \rightleftharpoons Br_2(g) + Cl_2(g)$$

2a. (6 pts) Suppose 0.804 mol of BrCl(g) is placed in an empty 2.00 L vessel and allowed to come to equilibrium. Determine $[BrCl]_E$. $[Br_2]_E$, and $[Cl_2]_E$.

$[BrCl]_E$ =_____ $[Br_2]_E$ = _____ $[Cl_2]_E$ = _____

2b. (1 pt) Would this reaction shift in order to reestablish equilibrium if the container volume were decreased?

A. Yes, to the right
B. Yes, to the left
C. No

2c. (1 pt) Would this reaction shift in order to reestablish equilibrium if some BrCl(aq) were removed from a system at equilibrium?

A. Yes, to the right
B. Yes, to the left
C. No

2d. (1 pt) At 500 K, K_c = 32.0. Can we conclude that the reaction is exothermic or endothermic as written?

A. endothermic
B. exothermic
C. cannot make a conclusion

2e. (3 pt) Suppose $[Br_2]$ = 0.504 M, $[Cl_2]$ = 0.824 M and [BrCl] = 0.072 M at 1000 K. Is the system at equilibrium? If not, what will happen to reach equilibrium?

A. Yes, at equilibrium
B. No, must shift to the right
C. No, must shift to the left

3. Tying kinetics and equilibrium together…

3a. (3 pts) Circle all of the following equations that are true at equilibrium. (May be more than one answer.)

A. $k_{fwd} = k_{rev}$ B. $K_c = \frac{k_{fwd}}{k_{rev}}$ C. $rate_{fwd} = rate_{rev}$

3b. (3 pts) Consider the following reaction mechanism:

Step 1. $NO + O_2 \rightleftharpoons NO_3$ $K_c = [NO_3] / [NO][O_2]$

Step 2. $NO_3 + NO \rightarrow 2\ NO_2$ slow

What is the resulting rate expression from this mechanism?

A. rate = $k[NO][O_2]$ B. rate = $k[NO_2]^2$

C. rate = $k[NO_2]^2[NO_3][O_2]$ D. rate = $k[NO]^2[O_2]$

3c. (5 pts) T/F Adding a catalyst…

T F makes reactions more exothermic.

T F increases both $rate_{fwd}$ and $rate_{rev}$.

T F increases K_c.

T F increases k_{fwd} and k_{rev}.

T F changes the reaction pathway (storyline) by replacing a large E_{act} with smaller one(s).

4a. (3 pts) Write the equilibrium expression for HNO_3 in water. Use the correct arrows!

4b. (3 pts) What is the pH of 0.0027 M HNO_3(aq)?

Answer:_____

5. A solution of a weak acid HA, has an unknown K_a.

5a. (3 pts) Write the acid dissociation equilibrium expression for HA in water. Use the correct arrows!

5b. (4 pts) If a 0.160 M solution of HA had a pH of 4.11, what is the value of K_a?

Answer:_____

5c. (2 pts) What is the pK_a value for this weak acid?

6. (4 pts) Circle the weak base(s). (May be more than one answer.)

A. ClO_2^- B. Br^- C. $HC_7H_7O_2$ D. NH_3

7. Consider these weak acids and their K_a values to answer the remaining questions:

Nitrous acid, HNO_2	$K_a = 4.5 \times 10^{-4}$
Acetic acid, $HC_2H_3O_2$	$K_a = 1.8 \times 10^{-5}$
Hypochlorous acid, HOCl	$K_a = 3.5 \times 10^{-8}$
Hypoiodous acid, HOI	$K_a = 2.3 \times 10^{-11}$

7a. (4 pts). What is the pH of a 0.070 M HOCl solution?

Answer:_____

7b. (3 pts) What is the value of K_b for OCl^-?

Answer:_____

7c. (3 pts) Write the equilibrium expression for the hypochlorite ion in water. Use the correct arrows!

7d. (4 pt) What is the pH of a 0.500 M OCl^-(aq) solution?

Answer:_____

7e. (1 pt) Which of these acids, as a 1.0 M solution would produce the lowest pH? Circle:

A. nitrous acid B. acetic acid

C. hypochlorous acid D. hypoiodous acid

7f. (1 pt) Which of these has the largest K_b?

A. nitrite B. acetate C. hypochlorite D. hypoiodite

Subtotal from exam: _____

Folder work: (20 max) _____

Total:

Answers:

1a. $K_c = [SO_3]^2/[O_2]^3$

1b. $[O_2]_I = 0.70$ M $\quad\quad$ $[O_2]_E = 0.10$ M

1c.

M	O_2	SO_3
I	0.70	0
C	-3x	+2x
E	0.70-3x = 0.10	0+2x=0.40

1d. 16 – 18 min

1e. No

1f. $K_c = 160$

1g. A

1h. B

1i. A.

1j. A. take less time

2a. $[BrCl]_E = 0.073$ M; $[Br_2]_E = 0.165$ M; $[Cl_2]_E = 0.165$ M

2b. C; 2c. B; 2d. B; 2e. C

3a. B, C

3b. D

3c. F T F F T

4a. $HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$

4b. 2.57

5. A solution of a weak acid HA, has an unknown K_a.

5a. $HA + H_2O + \rightleftharpoons H_3O^+ + A^-$

5b. 3.8×10^{-8}

5c. 7.42

6. A and D

7a. 4.31

7b. 2.9×10^{-7}

7c. $OCl^- + H_2O + \rightleftharpoons OH^- + HOCl$

7d. 10.58

7e. A

7f. D