EXAM TWO **CHM 205 (Dr. Mattson)** **23 FEBRUARY 2011**	***Print your name:*** ***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. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. BOX YOUR ANSWERS! Write legibly.

1. Question 1 (all parts, 1a – 1f) refers to the chart on the data sheet. The reaction involved is:

$$2\ A(g) \rightarrow B(g) + 3\ C(g)$$

1a. (2 pts) Write the equilibrium expression for K_c.

1b. (2 pts) At what point in time is equilibrium reached?

1c. (9 pts) Create an ICE table for the reaction and fill it in from data obtained from the chart.

	2 A(g)	→	B(g)	+	3 C(g)
I					
C					
E					

1d. (2 pts) Determine a numerical value for the equilibrium constant, K_c.

1e. (2 pts) What is the numerical value for K_c for:

$$B(g) + 3\ C(g) \rightarrow 2\ A(g)$$

1f. (2 pts) What would happen to [A] and [B] if some C(g) were added to the equilibrium mixture and allowed to re-equilibrate? Circle your choice.

(a) [A] would: increase decrease stay the same

(b) [B] would: increase decrease stay the same

2. (2 pts) Write a K_p expression for the equilibrium:

$$Al_2O_3(s) + 3\ CO(g) \rightleftharpoons 2\ Al(s) + 3\ CO_2(g)$$

3. (3 pts) Consider the equilibrium:

$$N_2(g) + O_2(g) \rightleftharpoons 2\ NO(g)$$

Suppose 0.72 mol NO(g) were placed into an empty 1.0 L container and allowed to come to equilibrium. At equilibrium the concentration of $O_2(g)$ was determined to be 0.11 M. Calculate K_c.

4. (3 pts) Consider the equilibrium:

$$2\ NO\ (g) + O_2(g) \rightleftharpoons 2\ NO_2(g) \qquad K_c = 0.413$$

Suppose the concentrations of all three gases were determined to be [NO] = 0.224 M, [O_2] = 0.913 M and [NO_2] = 0.205 M. Is the system at equilibrium? If not, which direction does it need to shift in order to attain equilibrium?

5. (11 pts) Write an arrow up to indicate increases, arrow down for decreases and a dash (-) to signify no change that occurs to the entities listed across the top row when the changes in the left column are applied to the exothermic reaction, known to follow first order kinetics:

$$2\ A(g) \rightarrow B(g) \quad \Delta H < 0 \text{ and rate} = k[A]$$

	Kinetics region		At equilibrium	
	k_{fwd}	Rate	K_c	[B]
Temp increased				
Volume increased				
Some B removed				

6. (4 pts) Circle all of the following equations that describe the relationship between kinetics and equilibrium

a. $k_{fwd} = k_{rev}$ b. $K_c = \frac{k_{fwd}}{k_{rev}}$

c. $rate_{fwd} = rate_{rev}$ d. $K_c = k[A]^{0,\ 1,\ or\ 2}$

7. (1 pt) Which solution is most acidic?

A. pH = 8.2 B. $[OH^-] = 9.2 \times 10^{-3}$

C. $[H_3O^+] = 4.0 \times 10^{-5}$ D. pOH = 11.88

8. (2 pts) What is $[OH^-]$ in a solution with pH = 9.77?

9. (3 pts) A 0.060 molar solution of a weak acid has a pH of 3.79. Calculate its K_a. (Write equilibrium!)

10. (1 pt) For which one of these acids would the quadratic equation be most needed to accurately determine the $[H_3O^+]$? Show work or explain.

A. 0.010 M HA $K_a = 5.0 \times 10^{-6}$

B. 0.010 M HB $K_a = 2.0 \times 10^{-4}$

C. 0.100 M HB $K_a = 2.0 \times 10^{-4}$

11. (3 pts) What is the pH of the a 0.0413 M solution of hydrochloric acid? (Significant figures!)

12a. (6 pts) Complete the following table:

Weak acid	pK_a	Weak base	pK_b
HA	3.50		
		B^-	8.70
HC			4.80

12b. (2 pts) Referring to the table, which weak acid would give the lowest pH as a 0.10 M solution?

12c. (2 pts) What is the value of K_a for HC?

12d. (2 pts) Referring to the table, which weak base would is the strongest of the three?

13. Acetic acid, $HC_2H_3O_2$ has a $K_a = 1.8 \times 10^{-5}$.

13a. (3 pts) Determine the pH of a 0.230 molar solution of acetic acid. Write equilibrium; you may use the abbreviation HA.)

13b. (3 pts) What is the percent dissociation of $HC_2H_3O_2$ acetic acid in the previous problem, 13a?

13c. (4 pts) Determine the pH of a 0.400 M solution of $NaC_2H_3O_2$? (Write equilibrium! Ok to abbreviate A^-.)

14. (6 pts) Identify each of the aqueous solutions below as strong acid, weak acid, strong base, weak base or neutral solution:

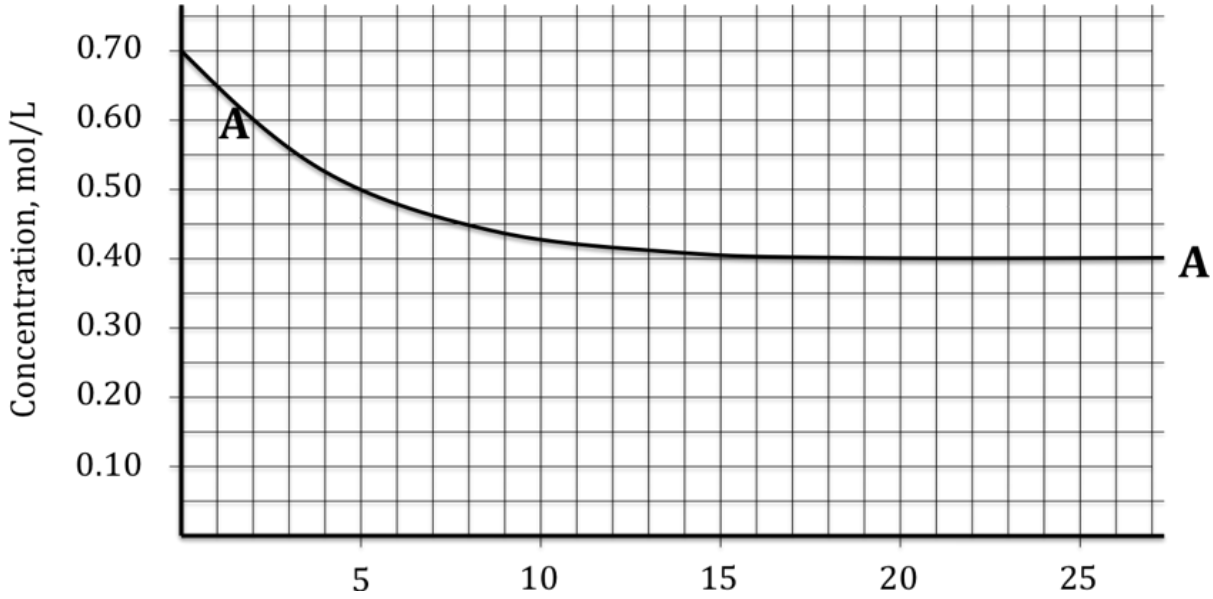
ammonium nitrate	SA WA SB WB N
perchloric acid	SA WA SB WB N
sodium hydroxide	SA WA SB WB N
hydrofluoric acid	SA WA SB WB N
sodium nitrate	SA WA SB WB N
potassium cyanide	SA WA SB WB N

Subtotal from exam: _____

Homework: _____

Total: _____

Use this figure to answer Question 16(c) and (d):



1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112		114		116		118

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Answers:

1a. $K_c = \frac{[B][C]^3}{[A]^2}$; 1b. 15 minutes

1c.

M	2 A	→	B	3 C
I	0.70		0	0
C	– 2x		+x	+3x
E	0.70 – 2x = 0.40		x = 0.15	3x = 0.45

1d. K_c = 0.085; 1e. K_c = 11.7; 1f. (a) [A] would: increase; (b) [B] would: decrease

2. $K_p = \frac{P_{CO_2}^3}{P_{CO}^3}$

3. K_c = 20.66

4. . Q_c = 0.917, therefore it shifts left in order to re-establish equilibrium

5.

	Kinetics region		At equilibrium	
	k_{fwd}	Rate	K_c	[B]
Temp increased	inc	inc	dec	dec
Volume increased	-	dec	-	dec
Some B removed	-	-	-	

6. b and c; 7. D; 8. 5.9 x 10^{-5}; 9. 4.37 x 10^{-7}

10. B; 11. 1.38

12a.

Weak acid	pK_a	Weak base	pK_b
HA	3.50	A^-	10.50
HB	5.30	B^-	8.70
HC	9.20	C^-	4.80

12b. HA; 12c. 6.31 x 10^{-10}; 12d. C^-

13a. 2.69; 13b. 0.88%; 13c. 9.17

14.

ammonium nitrate	WA
perchloric acid	SA
sodium hydroxide	SB
hydrofluoric acid	WA
sodium nitrate	N
potassium cyanide	WB