KWANTLEN COLLEGE
CHEMISTRY 1105 R-10
EXAM No. 2
August 11, 1994

NAME: _____

Instructions: This exam contains **8 + 1 bonus** questions. Read the exam carefully and judge your time accordingly. **ALL CALCULATIONS MUST BE SHOWN AND REPORT ALL NUMERICAL ANSWERS WITH THE CORRECT NUMBER OF SIGNIFICANT FIGURES TO RECEIVE FULL CREDIT !** If you need extra space, use the back of a preceding page and clearly indicate the question number. A periodic chart is included with this exam.
Maximum Score: 66 points + **4** bonus points

USEFUL INFORMATION

$\Delta H^{o} = \Sigma\, n\, \Delta H_f^{o}$ products $- \Sigma\, n\, \Delta H_f^{o}$ reactants

K_w for water at 25 ^{o}C = 1.0×10^{-14}

1	
2	
3	
4	
5	
6	
7	
8	
Bonus	
Total	

Question One: (4 MARKS)
A gaseous mixture containing 59.9 g of argon and 154 g of CO_2 has a total pressure of 7.00 atm. What are the partial pressures of Ar and CO_2?

Question Two: (5 MARKS)
The burning of 2.051 g of glucose, $C_6H_{12}O_6$ (molar mass = 180.2 g/mol), in a bomb calorimeter causes the temperature to rise from 24.92 to 31.41 ^oC. The bomb calorimeter has a heat capacity (calorimeter constant) of 4.921 kJ/^oC. (Note: the calorimeter constant includes the water in the water jacket.)

a) What is the heat of combustion of glucose in kJ/mol $C_6H_{12}O_6$?

b) Determine ΔH for the combustion of glucose based on the following equation:

$$2\ C_6H_{12}O_6(s) + 12\ O_2(g) \text{ ---> } 12\ CO_2(g) + 12\ H_2O(l)$$

Note: $\Delta H = \Delta U$ for this reaction.

Question Three: (8 MARKS)

a) Calculate ΔH^{o} for the reaction,

$C_2H_2(g) + 2\ H_2(g) \text{ ---> } C_2H_6(g)$

from the following combustion data: **(4)**

	ΔH^{o}
$C_2H_2(g) + 5/2\ O_2(g) \text{ ---> } 2\ CO_2(g) + H_2O(l)$	-1300 kJ
$H_2(g) + 1/2\ O_2 \text{ ---> } H_2O(l)$	-286 kJ
$C_2H_6(g) + 7/2\ O_2(g) \text{ ---> } 2\ CO_2(g) + 3\ H_2O(l)$	-1560 kJ

b) Calculate ΔH^{o} for the reaction,

$4\ N_2(g) + 3\ H_2O(l) \text{ ---> } 2\ NH_3(g) + 3\ N_2O(g)$

given the following standard enthalpies of formation: **(3)**

$\Delta H_f^{o}\ (H_2O(l)) = -285.8$ kJ $\qquad \Delta H_f^{o}\ (NH_3(g)) = -45.9$ kJ

$\Delta H_f^{o}\ (N_2O(g)) = +81.6$ kJ

i) Is the reaction endothermic or exothermic? **(½)**

ii) Is heat absorbed or released during the course of this reaction? **(½)**

Question Four: (9 MARKS)

a) Determine the oxidation number of the underlined element in each of the following: **(2)**

i) $\underline{N}_2H_4$ _____ **ii)** $\underline{S}_2O_3^{2-}$ _____

iii) $Na_2\underline{O}_2$ _____ **iv)** $\underline{W}_2O_{11}^{2-}$ _____

b) The following reaction takes place in acid solution:

$$Cr_2O_7^{2-}(aq) + Cl^-(aq) \text{ ---> } Cr^{3+}(aq) + Cl_2(g)$$

i) Write the balanced equations for each half reaction, identifying the oxidation and reduction half reactions. **(4)**

ii) Write the balanced equation for the overall reaction. **(2)**

iii) Identify the oxidizing agent in this reaction. **(1)**

Question Five: (17 MARKS)

a) Write the proper expression for K_c for each of the following equilibria: **(2)**

i) $4\ NH_3(g) + 3\ O_2(g) \rightleftarrows 2\ N_2(g) + 6\ H_2O(g)$

ii) $2\ Pb(s) + 3\ O_2(g) \rightleftarrows 2\ PbO(s) + 2\ SO_2(g)$

b) Give the balanced equation for the equilibrium system which would have the following expression for K_c: (Indicate the physical state of all species in your equation) **(3)**

$$K_c = \frac{[SO_2(g)]^2}{[H_2S(g)]^2\,[O_2(g)]^3}$$

c) Given the following equilibrium system at 300 ^oC:

$3\ H_2(g) + N_2(g) \rightleftarrows 2\ NH_3(g)$ $\qquad K_c = 9.5$

What is the value of K_c for the following reactions at 300 ^oC? **(3)**

i) $6\ H_2(g) + 2\ N_2(g) \rightleftarrows 4\ NH_3(g)$

ii) $2\ NH_3(g) \rightleftarrows 3\ H_2(g) + N_2(g)$

d) Consider the following equilibrium process:

$2\ N_2(g) + 6\ H_2O(l) \rightleftarrows 4\ NH_3(g) + 3\ O_2(g)$ $\qquad \Delta H^o = +1530.4$ kJ

i) Indicate the effect on the mass of NH_3 and the value of K_c by each of the following: (**I** = increase, **D** = decrease, **NC** = no change) **(8)**

ACTION TAKEN:	Mass of NH_3	K_c
Some N_2 is removed	_____	_____
Some H_2O is added	_____	_____
Volume of Container is increased	_____	_____
Temperature is decreased	_____	_____

ii) What is more stable the **reactants** or **products**? **(1)**

Question Six: (5 MARKS)
When 0.0930 moles of nitrogen monoxide gas and 0.0652 moles of bromine gas are sealed in a 1.00 L container at 77 ^{o}C, the following equilibrium is established:

$$2\ NO(g) + Br_2(g) \rightleftarrows 2\ NOBr(g)$$

At equilibrium the concentration of NOBr was measured to be 0.0612 M. Determine the following:

a) the equilibrium concentration of NO(g) and $Br_2(g)$.

b) the numerical value of K_c.

Question Seven: (6 MARKS)
The equilibrium constant, K_c, for the reaction

$$H_2O(g) + Cl_2O(g) \rightleftarrows 2\ HOCl(g)$$

is 0.090 at a given temperature. Initially 0.80 mol of H_2O and 0.80 mol of Cl_2O are injected into a 5.00 L reaction vessel at this temperature. Calculate the concentrations of H_2O, Cl_2O, and HOCl at equilibrium.

Question Eight: (12 MARKS)

a) Give the **conjugate acids** for **(2)**

i) NH_3 ii) CO_3^{2-}

b) Give the **conjugate bases** for **(2)**

i) NH_3 ii) OH^-

c) Given the acid / base equilibrium system:

$SO_4^{2-}(aq) + HCN(aq) \rightleftharpoons HSO_4^-(aq) + CN^-(aq)$

indicate the following: **(2)**

i) Stronger acid: _____ ii) Stronger base: _____

iii) Weaker acid: _____ iv) Weaker base: _____

d) Complete the following table: **(6)**

$[H_3O^+]$	$[OH^-]$	pH	pOH
3.3×10^{-4}	_____	_____	_____
_____	_____	8.57	_____

Bonus: (4 MARKS)

Determine the pH of a solution prepared by adding 0.315 g of $Ca(OH)_2(s)$ to 75.0 mL of a 0.162 M HNO_3 solution. Assume that the volume of the solution does not change upon the addition of $Ca(OH)_2$. The reaction is

$$2\ HNO_3(aq) + Ca(OH)_2 \text{ ---> } Ca(NO_3)_2(aq) + 2H_2O(l)$$