CHEM 1515
Exam II
John II. Gelder
October 14, 1993

Name ______________________

TA's Name ______________________

Lab Section ______________________

INSTRUCTIONS:

1. This examination consists of a total of 8 different pages. The last two pages include a periodic table, a solubility table and some useful equations. All work should be done in this booklet.
2. PRINT your name, TA's name and your lab section number now in the space at the top of this sheet. DO NOT SEPARATE THESE PAGES.
3. Answer all questions that you can and whenever called for show your work clearly. Your method of solving problems should pattern the approach used in lecture. You do not have to show your work for the multiple choice or short answer questions.
4. No credit will be awarded if your work is not shown in problems 2 – 5.
5. Point values are shown next to the problem number.
6. Budget your time for each of the questions. Some problems may have a low point value yet be very challenging. If you do not recognize the solution to a question quickly, skip it, and return to the question after completing the easier problems.
7. Look through the exam before beginning; plan your work; then begin.
8. Relax and do well.

	Page 2	Page 3	Page 4	Page 5	Page 6	TOTAL
SCORES	______ (33)	______ (20)	______ (23)	______ (12)	______ (12)	______ (100)

(12) 1. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify the phase of each product as either (g)as, (l)iquid, (s)olid or (aq)ueous. Soluble ionic compounds should be written in the form of their component ions.

a) $MgO\textit{(s)} + CO_2\textit{(g)} \rightarrow$

b) $Al\textit{(s)} + Fe_2O_3\textit{(s)} \rightarrow$

c) $Na_2CO_3\textit{(aq)} + Ca(NO_3)_2\textit{(aq)} \rightarrow$

(21) 2. The rate constant for the second order decomposition of NOBr

$$2NOBr\textit{(g)} \rightarrow 2NO\textit{(g)} + Br_2\textit{(g)}$$

is 0.80 $M^{-1} \cdot s^{-1}$ at 10 ˚C.

a) If the concentration of NOBr is initially 0.0289 M, calculate the concentration of NOBr after 75.0 seconds.

b) Calculate the half-life for this reaction under the same set of conditions as described in part a).

c) How long would it take for 90.0% of the NOBr to react? Assume the same initial conditions as described in part a).

(20) 3. The half-life for the first order decomposition of N_2O

$$2N_2O(g) \rightarrow 2N_2(g) + O_2(g)$$

is 3.58×10^3 min at 730 ˚C. A sample of N_2O is placed in a flask at this temperature and sealed.

a) What will be the pressure of N_2O in the flask after 5.50×10^2 minutes, given that the initial pressure of N_2O is 2.30 atm?

b) Assuming the initial pressure of N_2 is zero, what is the pressure of N_2 after 5.50×10^2 minutes?

c) Calculate the total pressure exerted in the flask after one half-life (3.58×10^3 min).

d) Suggest a two step mechanism which is consistent with the rate law.

(11) 4. At 200 ˚C, 0.500 mol of H_2, 0.500 mol of N_2 and 0.500 mol of NH_3 are introduced into a 1.00 liter container and allowed to react according to the equation,

$$N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$$

At equilibrium the concentration of NH_3 is 0.384 M. Calculate K_c for the reaction.

(12) 5. The magnitude of the equilibrium constant for the reaction,

$$H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)}$$

is 54.7 at 700 K. If the initial concentrations of H_2 and I_2 are 0.0714 M and the initial concentration of HI is 0.800 M at 700 K, calculate the concentrations of all species when the reaction reaches equilibrium.

Short Answer:

(12) 6. Consider the reaction

$$CS_{2(g)} + 4H_{2(g)} \rightleftarrows CH_{4(g)} + 2H_2S_{(g)}$$

for which ΔH_{rxn} = –233 kJ. Assume a 1.00 L vessel containing an equilibrium mixture, predict how the $[CH_4]$ will change when the equilibrium is disturbed by,

a) addition of H_2

b) removal of CS_2

c) increase in temperature

d) decrease in the volume of the reaction container

Multiple Choice:

Print the letter (A, B, C, D, E) which corresponds to the answer selected.

7. ________ 8. ________ 9. ________ 10. ________

ONLY THE ANSWERS IN THE AREA ABOVE WILL BE GRADED. Select the most correct answer for each question. Each question is worth 3 points.

7. How does a catalyst increase the rate of a reaction?
A) by changing the mechanism of the reaction.
B) by increasing the activation energy of the reaction.
C) by increasing the concentration of one of the reactants.
D) by decreasing the difference in relative energy of the reactants and the products.

8. The activation energy for a given reaction is 83.1 $\frac{\text{kJ}}{\text{mol}}$. By what factor will the rate constant increase for a 10.0 ˚ temperature change when the initial temperature is 50.0 ˚C?
A) 0.395
B) 0.929
C) 2.53
D) 10

9. The bromination of acetone is acid-catalyzed as shown in the equation below:

$$CH_3COCH_3(aq) + Br_2(aq) \xrightarrow{H^+} \text{products}$$

The following initial rate data was obtained for the several experiments;

Exp. #	$[CH_3COCH_3]$	$[Br_2]$	$[H^+]$	initial rate $\left(\frac{M}{s}\right)$
1	0.30 M	0.050 M	0.050 M	5.7×10^{-5}
2	0.30 M	0.100 M	0.050 M	5.7×10^{-5}
3	0.30 M	0.050 M	0.100 M	1.2×10^{-4}
4	0.40 M	0.050 M	0.200 M	3.1×10^{-4}

The experimental rate is;
A) rate = $k[CH_3COCH_3]^1[Br_2]^1[H^+]^1$
B) rate = $k[CH_3COCH_3]^1[Br_2]^0[H^+]^1$
C) rate = $k[CH_3COCH_3]^0[Br_2]^1[H^+]^1$
D) rate = $k[CH_3COCH_3]^1[Br_2]^1[H^+]^0$

10. What conditions of temperature and pressure favor the formation of products in the reaction,

A) high temperature and low pressure.
B) high temperature and high pressure
C) low temperature and low pressure
D) low temperature and high pressure

Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1 **H** 1.008																	2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
6	55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** 226.0	89 **Ac** 227.0	104 (261)	105 (262)	106 (263)												

Lanthanides	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.2	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
Actinides	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** 237.0	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

Useful Information

$PV = nRT$

$R = 0.0821 \frac{L\cdot atm}{mol\cdot K}$

$\ln\left(\frac{k_1}{k_2}\right) = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

$R = 8.314 \frac{J}{K\cdot mol}$

$\ln\left(\frac{[A]_t}{[A]_o}\right) = -kt$

$\frac{1}{[A]_t} - \frac{1}{[A]_o} = kt$

$K_p = K_c(RT)^{\Delta n}$

$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ for $ax^2 + bx + c = 0$

$\ln\left(\frac{K_1}{K_2}\right) = \frac{\Delta H_{rxn}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

Solubility Table

Ion	Solubility	Exceptions
NO_3^-	soluble	none
ClO_4^-	soluble	none
Cl^-	soluble	except Ag^+, Hg_2^{2+}, *Pb^{2+}
I^-	soluble	except Ag^+, Hg_2^{2+}, Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+}, Ba^{2+}, Sr^{2+}, Hg^{2+}, Pb^{2+}, Ag^+
CO_3^{2-}	insoluble	except Group IA and NH_4^+
PO_4^{3-}	insoluble	except Group IA and NH_4^+
^-OH	insoluble	except Group IA, *Ca^{2+}, Ba^{2+}, Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^+
Na^+	soluble	none
NH_4^+	soluble	none
K^+	soluble	none

*slightly soluble