Exam 1 Chm 205 (Dr Mattson) 5 February 2013

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.

(1 pt) Signature:

Instructions: Show all work whenever a calculation box is provided! Write legibly. Include units whenever appropriate. BOX YOUR ANSWERS! You will receive credit for <u>how</u> you worked each problem as well as for the correct answer. If you need more space, you may use the back of your data sheet — Write: "See data sheet" in the answer box and then hand the data sheet in with your exam. At 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 stored in the front of the room. Cell phones must be OFF and placed at the front of the room.

Questions 1 - 4. A solution was prepared by dissolving 33.9 g NaCl(s) in 100.0 g water. The density of this solution at 25 °C was measured to be 1.193 g/cm³. You may use this chart if you find it useful.

	MM (g/mol)	Mass (g)	moles	Volume (mL)
NaCl	58.44			
н ₂ о	18.02			
Solution				

1. (4 pts) What is the molality of NaCl in the solution?

Answer with units:

2. (4 pts) What is the mass percent of NaCl in solution?

Answer with units:

3. (4 pts) What is the mole fraction of NaCl in the solution?

Answer:

4. (4 pts) What is the molarity of NaCl in the solution?

Answer with units:__

- 5. (4 pts) What is the mass percent of KBr (MM = 119 g/mol) in an aqueous solution that is 2.45 molal KBr?
 - Answer with units:

6. (5 pts) What is the molality of a 14.8 M H₃PO₄(aq) solution with a density of 1.70 g/mL? (MM for H₃PO₄ = 98.0 g/mol)

50.0 g/mor)	
	Answer with units:

7. (4 pts) In each case, circle the one member that is expected to be soluble in water.

7a. CCl ₄ or CH ₃ OH	7b. KCl or C ₈ H ₁₈	

- 7c. NH_3 or Ca_3P_2 7d. CH_4 or $Mg(NO_3)_2$
- 8 (5 pts) Benzene, C₆H₆, has a normal vapor pressure of

95 mmHg at 25 °C. What is the vapor pressure of a solution prepared by dissolving 0.400 mol naphthalene, a non-volatile substance with formula $C_{10}H_8$ in 1.450 mol benzene?

Answer with units:

9 (5 pts) Water has a normal vapor pressure of 23.76 mmHg at 25 °C. How many moles of urea, a non-volatile, water soluble non-electrolyte, should be added to 180 g water in order to reduce the vapor pressure to 20.0 mmHg at 25 °C?

Answer with units:

10. (5 pts) Assuming CaCl₂ (MM = 111 g/mol) dissociates 100% in solution, what mass of CaCl₂ is required to lower the freezing point of 500.0 g water to -5.0 °C? [K_f = 1.86 deg/molal]



11. (5 pts) A non-volatile, non-electrolytic solid unknown dissolves readily in water. A 5.25 g sample of the unknown was dissolved in 60.0 g water, and the freezing point of the solution was determined to be -1.23 °C. What is the molar mass of the unknown? [K_f = 1.86 deg/molal]

Answer with units:____

12. (4 pts) An organic molecule, A, is known to rearrange at 60 °C to form a more stable substance. The following data were obtained. (a) Determine the order of the reaction and (b) write the rate expression.

	/	
Expt	[A]	rate = -∆[A]/∆t
1	0.0350 M	3.68 x 10 ⁻⁵ mol/L s
2	0.0510 M	7.80 x 10 ⁻⁵ mol/L s
3	0.0630 M	1.19 x 10 ⁻⁴ mol/L s

Answers: Order: Circle: 0 1 or 2 and rate =

13. (4 pts) The following reaction was shown to be first order in NOBr(g):

$2 \operatorname{NOBr}(g) \rightarrow 2 \operatorname{NO}(g) + \operatorname{Br}_2(g)$

Given the following data, predict the rate of the reaction for Experiment 2.

Expt	[NOBr]	rate = -∆[NOBr]/∆t
1	0.0390 M	8.33 x 10 ⁻⁴ mol/L s
2	0.0510 M	?

Answer with units:

14. Consider the following data for the reaction:

$CH_3NC(g) \rightarrow CH_3CN(g)$

time, min	0	50	100	150	200
[CH ₃ NC]	0.0470	0.0364	0.0282	0.0218	0.0169

These data are plotted on the data sheet. From left to right: $[CH_3NC]$ vs time, $ln[CH_3NC]$ vs time, and $1/[CH_3NC]$ vs time.

14a. (2 pts) What is the order of the reaction? Circle: 0 1 2

14b. (4 pts) What is the value of the rate constant, with proper units?

Answer with units:

Answer with units:

14d. (4 pts) What is the half-life for the reaction?

14c. (4 pts) What is the [CH₃NC] at t = 300 min?

Answer with units:

14e. (4 pts) How long does it take for the reaction to decrease to 0.0300 M?

Answer with units:

15. (4 pts) The reaction A → B has a rate constant of 0.00377 L/mol s. What is the rate of the reaction if [A] = 0.080 M? Hint: the units on k will help you identify the order.

Answer with units:_

For DocM to complete:
Subtotal from exam:
Folder work: (20 max)
Total:

	Zero Order	First Order	Second Order
Rate Expression	rate = k	rate = k[A]	rate = k[A] ²
Time-Conc. Expression	$[A]_t = -kt + [A]_o$	ln([A] _o /[A] _t) = kt	$1/[A]_t = kt + 1/[A]_o$
Linear Plot	[A] _t vs t	ln[A] _t vs t	¹ /[A] _t vs t
Half-life	$t_{1/2} = [A]_0/2k$	$t_{1/2} = 0.693/k$	$t_{1/2} = 1/k[A]_0$

For Problem 14. Note [A] is the same as $[CH_3NC]$



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1					-											1	2
I H																н	He
1.01																1.01	4.00
3	4											5	6	7	8	9	10
111	Be											R	C	N	0	F	Ne
6.94	901											10.81	12.01	14.01	16.00	19.00	20.18
11	12											13	14	15	16	17	18
Na	Ma											ΔΙ	Si	D	S	CL	Δr
22.00												26.09	28.00	20.97	32.06	25.45	20.05
19	24.31	21	22	23	24	25	26	27	28	29	30	31	32	33	32.00	35	39.95
V		<u> </u>	T:	Ň		Mn	E		NI		7 n	Č	Č-	Å _	Š	D۳	<u>V</u> r
	Ca	30		V			ге			Cu	211	Ga	Ge	AS	36	DI	
1 00 10	10.00	44.00	47.00	50.04	FO 00	E 4 0 4			E 0 70							70 00	
39.10	40.08	44.96	47.90	50.94	52.00	54.94	55.85	58.93	58.70	63.55	65.38	69.72	72.59	74.92	78.96	79.90	5.00
39.10 37	40.08 38	44.96 39	47.90	50.94 41	52.00 42	54.94 43	55.85 44	58.93 45	58.70 46	63.55 47	65.38 48	69.72 49	72.59 50	74.92 51	52	79.90 53	54
39.10 37 Rb	^{40.08} 38 Sr	^{44.96} 39 Y	47.90 40 Zr	50.94 41 Nb	42 MO	^{54.94} 43 TC	44 Ru	45 Rh	^{58.70} 46 Pd	63.55 47 Ag	48 Cd	^{69.72} 49 In	^{72.59} 50 Sn	^{74.92} 51 Sb	52 Te	^{79.90} 53	54 Xe
39.10 37 Rb 85.47	40.08 38 Sr 87.62	44.96 39 Y 88.91	47.90 40 Zr 91.22	50.94 41 Nb 92.91	52.00 42 MO 95.94	54.94 43 TC 97	55.85 44 Ru 101.07	45 Rh 102.91	58.70 46 Pd 106.4	63.55 47 Ag 107.87	65.38 48 Cd 112.41	69.72 49 In 114.82	72.59 50 Sn 118.69	^{74.92} 51 Sb 121.75	52 Te 127.60	79.90 53 126.90	54 Xe 131.30
39.10 37 Rb 85.47 55	40.08 38 Sr 87.62 56	44.96 39 Y 88.91 57	47.90 40 Zr 91.22 72	50.94 41 Nb 92.91 73	52.00 42 MO 95.94 74	54.94 43 T C 97 75	55.85 44 Ru 101.07 76	58.93 45 Rh 102.91 77	58.70 46 Pd 106.4 78	63.55 47 Ag 107.87 79	65.38 48 Cd 112.41 80	69.72 49 In 114.82 81	72.59 50 Sn 118.69 82	51 Sb 121.75 83	78.96 52 T e 127.60 84	79.90 53 126.90 85	54 Xe 131.30 86
39.10 37 Rb 85.47 55 Cs	 40.08 38 Sr 87.62 56 Ba 	44.96 39 Y 88.91 57 La	47.90 40 Zr 91.22 72 Hf	50.94 41 Nb 92.91 73 Ta	52.00 42 Mo 95.94 74 W	^{54.94} 43 T C ⁹⁷ 75 R e	55.85 44 Ru 101.07 76 Os	45 Rh 102.91 77 Ir	58.70 46 Pd 106.4 78 Pt	63.55 47 Ag 107.87 79 Au	65.38 48 Cd 112.41 80 Hg	69.72 49 114.82 81 Ti	72.59 50 Sn 118.69 82 Pb	51 Sb 121.75 83 Bi	78.96 52 Te 127.60 84 Po	79.90 53 1 126.90 85 At	54 Xe ^{131.30} 86 Rn
39.10 37 Rb 85.47 55 Cs 132.9	40.08 38 Sr 87.62 56 Ba 137.33	44.96 39 Y 88.91 57 La 138.91	47.90 40 Zr 91.22 72 Hf 178.49	50.94 41 Nb 92.91 73 Ta 180.95	52.00 42 Mo 95.94 74 W 183.85	54.94 43 T C 97 75 R e 186.21	55.85 44 Ru 101.07 76 Os 190.2	58.93 45 Rh 102.91 77 Ir 192.22	58.70 46 Pd 106.4 78 Pt 195.09	63.55 47 Ag 107.87 79 Au 196.97	65.38 48 Cd 112.41 80 Hg 200.59	69.72 49 114.82 81 Ti 204.37	72.59 50 Sn 118.69 82 Pb 207.2	74.92 51 Sb 121.75 83 Bi 208.98	78.96 52 Te 127.60 84 Po 209	79.90 53 I 126.90 85 At 210	54 Xe 131.30 86 Rn 222
39.10 37 Rb 85.47 55 Cs 132.91 87	 40.08 38 Sr 87.62 56 Ba 137.33 88 	44.96 39 ✔ 88.91 57 La 138.91 89	47.90 40 Zr 91.22 72 Hf 178.49	50.94 41 Nb 92.91 73 Ta 180.95	52.00 42 Mo 95.94 74 W 183.85	54.94 43 T C 97 7 5 R e 186.21	55.85 44 Ru 101.07 76 O S 190.2	58.93 45 Rh 102.91 77 Ir 192.22	58.70 46 Pd 106.4 78 Pt 195.09	63.55 47 Ag 107.87 79 Au 196.97	65.38 48 Cd 112.41 80 Hg 200.59	69.72 49 114.82 81 Ti 204.37	72.59 50 Sn 118.69 82 Pb 207.2	74.92 51 Sb 121.75 83 Bi 208.98	78.96 52 Te 127.60 84 Po 209	79.90 53 I 126.90 85 At 210	54 Xe 131.30 86 Rn 222
39.10 37 Rb 85.47 55 Cs 132.97 87 Fr	 40.08 38 Sr 87.62 56 Baa 137.33 88 Ra 	44.96 39 Y 88.91 57 La 138.91 89 AC	47.90 40 Zr 91.22 72 Hf 178.49	50.94 41 Nb 92.91 73 Ta 180.95	52.00 42 Mo 95.94 74 W 183.85	54.94 43 T C 97 75 R e 186.21	55.85 44 Ru 101.07 76 Os 190.2	58.93 45 Rh 102.91 77 Ir 192.22	58.70 46 Pd 106.4 78 Pt 195.09	63.55 47 Ag 107.87 79 Au 196.97	65.38 48 Cd 112.41 80 Hg 200.59	69.72 49 In 114.82 81 Ti 204.37	72.59 50 Sn 118.69 82 Pb 207.2	74.92 51 Sb 121.75 83 Bi 208.98	78.96 52 Te 127.60 84 Po 209	79.90 53 I 126.90 85 At 210	54 Xe 131.30 86 Rn 222

Answers:

Questions 1 – 4.

	MM (g/mol)	Mass (g)	moles	Volume (mL)
NaCl	58.44	33.9	0.580	
H ₂ O	18.02	100.0	5.56	
Solution		133.9		112

1. 5.8 mol NaCl/kg H₂O

2. 25.3% NaCl

3. mole fraction NaCl = 0.0946

4. 5.15 mol NaCl /L solution

5. 22.6 mass% KBr

6. 59.2 molal H₃PO₄(aq)

7. 7a. CH₃OH; 7b. KCl; 7c. NH₃; 7d. Mg(NO₃)₂

8 74.5 mmHg

9 1.88 mol

10. 49.7 g

11. 132 g/mol

12. (a) second order; (b) rate = $k[A]^2$

13. rate = 1.09 x 10⁻³ mol/L s

14a. first order

14b. 5.11 x 10⁻³ min⁻¹

14c. [CH₃NC] = 0.0101 M

14d. half-life = 136 min

14e. 88 min

15. 2.41 x 10⁻⁵ mol/L s