Exam 1 Chm 205 (Dr Mattson) 6 February 2019

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:

Chemistry Student Number: _____

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 data sheet" in the answer box – then write your name on the data sheet. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and purse-like items must be stored on the tables in the back of the room. Cell phones must be silent and placed in your backpack/bag/purse – not in your pocket.

1. (4 pts) Which member of each pair is expected to be the most soluble in water? Circle your choice for each pair.

CH_3OH or $CH_3CH_2CH_3$	CH_3NH_2 or CCl_4
NH_4Cl or CH_3Cl	Br_2 or NH_4Br

2. A solution was prepared by dissolving 17.70 g sodium sulfate in 238.2 g water. Use this table if you wish.

	MM	mass, m	moles, n
Na_2SO_4	142.0 g mol^{-1}		
H_2O	18.0 g mol^{-1}		

2a. (4 pts) What is the mole fraction of Na_2SO_4?

Show work for credit.

Answer: _____

2b. (4 pts) What is the mass percent of Na_2SO_4?

Show work for credit.

Answer with units: _____

3. (4 pts) What is the molality of Na_2SO_4 in a solution that is known to have a mole fraction, $X_{Na_2SO_4}$ = 0.283?

Show work for credit.

Answer with units: _____

4. (4 pts) What *mass of solution* known to contain 0.500 molal sodium acetate contains 0.230 mol $NaC_2H_3O_2$?

	MM	m	n
$NaC_2H_3O_2$	82.03 g mol^{-1}		
H_2O	18.02 g mol^{-1}		
Solution			

Answer with units: _____

5. (4 pts) 0.200 mL of pure propanol ($d_{propanol}$ = 0.803 g/mL) is diluted with water to make 1.00 L. What is the concentration of propanol in ppm? (d_{water} = 1.00 g/mL)

Show work for credit.

Answer with units: _____

6. (5 pts) Sucrose, $C_{12}H_{22}O_{11}$ (MM = 342 g/mol) can be made as an aqueous solution that is 40% by mass sucrose with a density of 1.176 g/mL. What is the molarity of the sucrose in the solution?

	m	n	V
$C_{12}H_{22}O_{11}$			
H_2O			
Solution			

Answer with units: _____

7. (4 pts) What is the van't Hoff factor, **i**, for each of these aqueous solutions?

Methanol, CH_3OH	**i =**	$(NH_4)_2SO_4$	**i =**
K_2CO_3	**i =**	RbBr	**i =**

8. (4 pts) Water has a vapor pressure of 19.5 mmHg at 22.0 ^oC. Suppose 0.288 mol sucrose is dissolved in 64.0 g (3.55 mol) water. What is the vapor pressure of the solution at 22.0 ^oC?

Show work for credit.

Answer with units: _____

9a. (4 pts) Ethanol, C_2H_5OH is a liquid with a vapor pressure of 40.0 mmHg at 19.0 ^oC. Water's vapor pressure at that temperature is 16.5 mmHg. What is the vapor pressure of a solution that has $X_{ethanol}$ = 0.37?

Show work for credit.

Answer with units: _____

9b. (1 pt) Which liquid has the higher boiling point? **Ethanol Water**

9c. (1 pt) If the solution contained more ethanol, would $P_{sol'n}$ increase? **Yes No**

9d. (1 pt) If the solution contained more ethanol, would the molality of ethanol increase? **Yes No**

9e. (1 pt) For the solution described, does $X_{ethanol} + X_{water}$ always equal 1.00? **Yes No**

10. (5 pts) Biphenyl is used as a solvent for determining molar mass of unknowns by freezing point lowering. Biphenyl normally melts at 69.2 ^{o}C. Suppose 0.650 g of an unknown is dissolved in 27.8 g liquid biphenyl and allowed to cool. The resulting solution melts at 67.64 ^{o}C. Given K_f = 8.00 deg/molal for biphenyl, what is the MM of the unknown?

Show work for credit.

Answer with units: _____

11. The following initial concentration - initial rate data listed in the table were collected for the reaction of gas phase iodine atoms combining to form molecular iodine:

$2\ I(g) \rightarrow I_2(g)$

Expt.	$[\ I\ ]_o$	Initial rate = $-\Delta[\ I\ ]/\Delta t$
1	2.40×10^{-6} mol/L	4.03×10^{-2} mol L^{-1} s^{-1}
2	3.72×10^{-6} mol/L	9.69×10^{-2} mol L^{-1} s^{-1}
3	2.99×10^{-6} mol/L	6.26×10^{-2} mol L^{-1} s^{-1}

11a. (4 pts) What is the rate law?

Show work for credit.

Answer: rate =_____

11b. (4 pts) What is the value of the rate constant?

Watch the units.

Answer with units: _____

11c. (4 pts) What is the initial rate if $[I]_o = 5.10 \times 10^{-6}$ M?

Show work for credit.

Answer with units: _____

12. Refer to the data sheet for information related to this problem, collected for the reaction. Note: [A] = $[Br_2]$

$Br_2(aq) + HCOOH(aq) \rightarrow 2\ Br^-(aq) + 2\ H^+(aq)\_ + CO_2(g)$

12a. (3 pts) What is the order for the reaction? Write the rate expression in terms of $[Br_2]$. (Given: It is zero order in HCOOH.)

rate =

12b. (4 pts) What is the rate constant for the reaction?

Show work for credit.

Answer with units: _____

12c. (4 pts) What is the rate if $[Br_2]$ = 0.040 mol/L?

Show work for credit.

Answer with units: _____

12d. (4 pts) What is $[Br_2]$ after 70.0 seconds?

Show work for credit.

Answer with units: _____

12e. (4 pts) How long, **in seconds**, does it take for $[Br_2]$ to decrease **by** 20.0% from its original value?

Show work for credit.

Answer with units: _____

12f. (4 pts) What is the half-life for the reaction?

Show work for credit.

Answer with units: _____

13. Consider this proposed reaction mechanism:

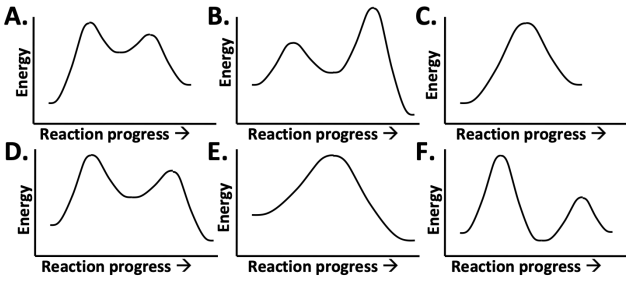
Step 1. $NO(g) + NO(g) \rightarrow N_2O_2(g)$ slow

Step 2. $N_2O_2(g) + O_2(g) \rightarrow 2\ NO_2(g)$ fast

13a. (3 pts) What is the rate law for this reaction?

13b. (3 pts) What is overall reaction?

13c. (3 pts) The reaction is known to be exothermic overall. Which energy profile best summarizes the mechanism?



13d (5 pts) True/False

T F Increasing the temperature will increase the rate.

T F Increasing the $[O_2]$ will increase the rate.

T F Increasing the [NO] will increase the rate.

T F $N_2O_2(g)$ is an intermediate.

T F Both steps of the mechanism are bimolecular.

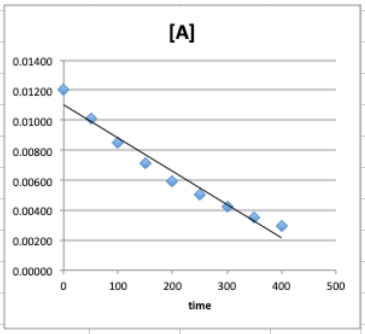
	Zero Order	First Order	Second Order
Rate Expression	rate = k	rate = k[A]	rate = $k[A]^2$
Test for order: Makes a straight-line Plot	$[A]_t$ vs t	$\ln[A]_t$ vs t	$1/[A]_t$ vs t
Time-Conc. Expression	$[A]_t = -kt + [A]_o$	$\ln([A]_o/[A]_t) = kt$	$1/[A]_t = kt + 1/[A]_o$
Half-life	$t_{1/2} = [A]_o/2k$	$t_{1/2} = 0.693/k$	$t_{1/2} = 1/k[A]_o$

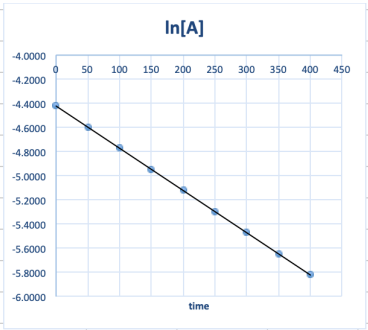
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	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
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 (97)	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
55 Cs 132.9	56 Ba 137.3	71 Lu 175.0	72 Hf 178.5	73 Ta 181.0	74 W 183.9	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)
87 Fr (223)	88 Ra (226)	103 Lr (262)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Uun (269)	111 Uuu (272)	112 Uub (277)		114 Uuq (289)		116 Uuh (289)		118 Uuo (293)

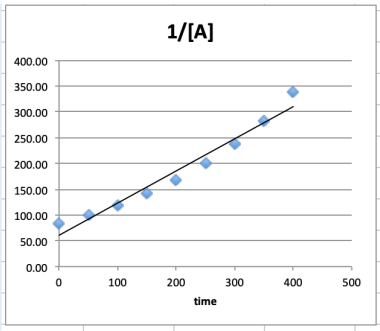
57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
89 Ac (227)	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Information for Problem 12. Note: [A] is $[Br_2]$

time (s)	[A]
0	0.01200
50	0.01010
100	0.00846
150	0.00710
200	0.00596
250	0.00500
300	0.00420
350	0.00353
400	0.00296







Answers.

1.

CH_3OH	**CH_3NH_2**
NH_4Cl	**NH_4Br**

2a. 0.00933

2b. 6.91%

3. 21.9 molal

4. 479 g

5. 161 ppm

6. 1.38 M

7.

Methanol, CH_3OH **i = 1**	$(NH_4)_2SO_4$ **i = 3**
K_2CO_3 **i = 3**	RbBr **i = 2**

8. 18.04 mmHg

9a - e. 9a. 25.20 mmHg; 9b. water; 9c. Yes; 9d. Yes; 9e. Yes

10. 119.9 g/mol

11a. rate = $k[\ I\ ]^2$

11b. $k = 7.00 \times 10^{+9}$ L mol^{-1} s^{-1}

11c. 0.182 mol/L s

12a. rate = $k\ [Br_2]$

12b. 3.5×10^{-3} s^{-1}

12c. 1.4×10^{-4} mol L^{-1} s^{-1}

12d. 9.4×10^{-3} mol/L

12e. 64 s

12f. 198 s

13a. rate = $k[\ NO\ ]^2$

13b. $2\ NO(g) + O_2(g) \rightarrow 2\ NO_2(g)$

13c. D (exothermic, first step slow, two steps)

13d. T F T T T