Exam 1 Chm 205 (Dr Mattson) 5 February 2020

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 and writing "See Attached" in the answer box. Write your name on the data sheet if it contains work to be graded. On your desk you may have pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and similar items must be stored on the tables in the back of the room. Cell phones must be silent and placed in your backpack/bag – not with you.

1. (5 pts) Which of these solutes would you expect to be soluble in water? Circle all that are soluble in water. Sketch Lewis structures on data sheet if uncertain.

   CH_3OH KNO_3 C_2Cl_6 CH_3NH_2 $(NH_4)_2SO_4$

2. The compound *p*-dibromobenzene, $C_6H_4Br_2$, is solid that is soluble in diethyl ether, $C_2H_5O_2$, (a liquid with a density of 0.713 g mL^{-1}). Suppose 4.00 g $C_6H_4Br_2$ is dissolved in 50.0 mL of $C_2H_5O_2$. Use this table to organize your work and answer Questions 2a, 2b, 2c

MM		Mass	Moles
235.9 g/mol	$C_6H_4Br_2$	4.00 g	
74.1 g/mol	$C_2H_5O_2$		

2a (4 pts) What is the mass percent $C_6H_4Br_2$?

Show work for credit.

Answer (3 sig figs) with units: _____

2b (4 pts) What is the mole fraction of $C_6H_4Br_2$?

Show work for credit.

Answer (3 sig figs): _____

2c (4 pts) What is the molality of $C_6H_4Br_2$

Show work for credit.

Answer (3 sig fig) with units: _____

3. (4 pts) The Dead Sea is 31.5 mass percent NaCl and has a density of 1.24 g mL^{-1}. What is the molarity of the NaCl (MM = 58.44 g mol^{-1})?

Show work for credit.

Answer (3 sig fig) with units: _____

4. (4 pts) Sugar, like most solids, can be considered non-volatile. What is the vapor pressure of a solution of 0.100 mol sugar in 80.0 g water (MM = 18.01 g/mol) given water's vapor pressure at 25 ^oC is 23.77 mmHg?

Show work for credit.

Answer (2 decimal places) with units: _____

5. (4 pts) At 25 ^oC the vapor pressure of methanol is 97.7 mmHg and that of propanone is 230 mmHg. What is the vapor pressure of a solution that contains 3.50 mol methanol and 7.10 mol propanone?

Show work for credit.

Answer (3 sig fig) with units: _____

6. (4 pts) What is the freezing point of a 0.25 *m* K_2S(aq) solution? Given: T_f = 0 ^oC for H_2O. K_f = 1.86 deg/molal.

Show work for credit.

Answer (2 decimal places) with units: _____

7. (4 pts) What is the osmotic pressure of 0.130 M KNO_3(aq) at 22 ^oC? Given: R = 0.0821 L atm mol^{-1} K^{-1}

Show work for credit.

Answer (3 sig fig) with units: _____

8. (4 pts) Suppose 7.577 g of an unknown non-volatile, non-electrolytic solid is dissolved in 50.0 g water and the solution freezes at -2.22 ^oC. What is the MM of solid?

See Question 6 for data. Show work for credit.

Answer (3 sig fig) with units: _____

9. (4 pts) What is the molality of 17 ppm Hg^{2+}(aq)?

Show work for credit.

Answer in scientific notation, 2 sig fig, with units: _____

10a. (4 pts) What is the rate expression for this reaction?

$NOBr(g) \rightarrow NO(g) + Br(g)$

Trial	[NOBr]	rate = $-\Delta[NOBr]/\Delta t$
1	0.0390 mol L^{-1}	1.14 x 10^{-3} mol L^{-1} s^{-1}
2	0.0220	3.64 x 10^{-4}
3	0.0500	1.88 x 10^{-3}

Show work for credit.

Answer: rate = _____

10b. (4 pts) What is the rate constant for this reaction?

Show work for credit.

Answer (3 sig fig) with units: _____

11a (4 pts) We began Chapter 14 by studying this reaction and data. We determined the reaction was first order in $[N_2O_5]$. What is the rate constant for this reaction?

$2\ N_2O_5(g) \rightarrow 4\ NO_4(g) + O_2(g)$

Time (s)	$[N_2O_5]$ (mol/L)
0	2.330
1000	1.260
2000	0.681
3000	0.369

Show work for credit.

Answer with units: _____

11b. (4 pts) What is the half-life in seconds?

Show work for credit.

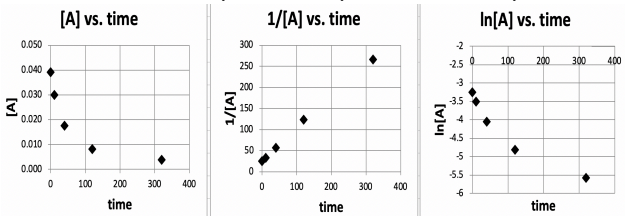
Answer (3 sig fig) with units: _____

11c. (4 pts) What is the rate if $[N_2O_5]$ = 3.00 mol/L?

Show work for credit.

Answer (3 sig fig) with units: _____

12. A time vs. concentration study for the reaction of A → Products was completed and produced these plots.



12a. (3 pts) What is the order of the reaction? **0 1 2**

12b. (3 pts) Write the rate expression.

rate =

13. At 500 °C cyclopropane, C_3H_6, rearranges to propene. The reaction is first order with k = 0.0402 min^{-1}. The initial $[C_3H_6]$ is 0.0500 mol/L

13a. (4 pts) What is $[C_3H_6]$ after 30.0 min?

Show work for credit.

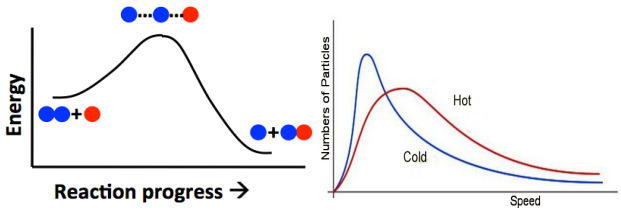
Answer (2 sig fig) with units: _____

13b. (4 pts) How many minutes does it take for $[C_3H_6]$ to drop to 0.0100 mol/L?

Show work for credit.

Answer (2 sig fig) with units: _____

14. Let **R = red circles** and **B = blue circles**. Use these two charts to answer the questions that follow.



14a. (3 pts) Left figure: Carefully label E_{act}^{fwd}, E_{act}^{rev}, ΔH_{rxn}.

14b. (1 pt) Circle the transition state.

14c. (3 pts) Draw two vertical lines and label them, on the right figure to represent E_{act}^{fwd} and E_{act}^{rev} for this reaction. Note that "speed" is related to collision energy.

14d. (2 pts) Write a balanced chemical reaction for this reaction using **R**s and **B**s.

14e. (2 pts) How many steps are in this mechanism?

14f. (3 pts) Write the rate expression for this mechanism.

rate =

14g. (2 pts) Is this reaction exothermic or endothermic?

Exothermic
Endothermic

14h. (3 pts) Considering the Arrhenius equation, $k = A \times e^{-Eact/RT}$, will the forward and/or reverse reaction rates increase if the temperature is raised?

Forward
Reverse
Both

14i. (2 pts) How will the rate constants for the forward and reverse reactions compare?

$k^{fwd} > k^{rev}$
$k^{fwd} = k^{rev}$
$k^{fwd} < k^{rev}$

Answers:

1. CH_3OH (yes, H-bonding) KNO_3 (yes, soluble ionic) C_2Cl_6 (no, non-polar) CH_3NH_2 (yes, H-bonding) $(NH_4)_2SO_4$ (yes, soluble ionic)

2.

MM		Mass	Moles
235.9 g/mol	$C_6H_4Br_2$	4.00 g	0.0169 mol
74.1 g/mol	$C_2H_5O_2$	35.65 g	0.481 mol

2a 10.1 %

2b 0.0340

2c 0.476 mol/kg or 0.476 molal

3. 6.69 M

4. 23.00 mmHg

5. 186 mmHg

6. T_f = -1.40 ^oC

7. 6.30 atm

8. MM = 127 g/mol

9. 8.5 x 10^{-5} molal

10a. rate = k[NOBr]^2

10b. 0.749 L mol^{-1} s^{-1}

11a 6.15 x 10^{-4} s^{-1}

11b. 1130 s

11c. 1.85 x 10^{-3} s^{-1} mol/L s?

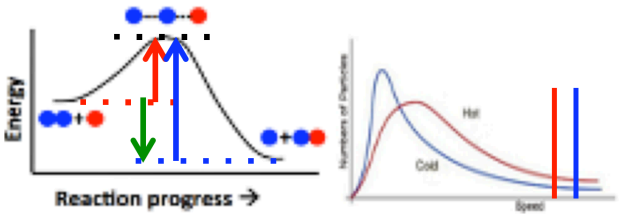
12a. second order

12b. rate = k[A]^2

13a. 0.015 mol/L

13b. 40 min

14. Let **R = red circles** and **B = blue circles**. Use these two charts to answer the questions that follow.



14a. E_{act}^{fwd}, E_{act}^{rev}, ΔH_{rxn}

14b. The transition state is the top of the "hill"

14c. E_{act}^{fwd} red line and E_{act}^{rev} blue line

14d. B_2 + R → B + BR

14e. one

14f. rate = k[B_2][R]

14g. exothermic

14h. both

14i. $k^{fwd} > k^{rev}$

General Chemistry with Dr. Mattson
Course website: http://mattson.creighton.edu

1 H 1.0079																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.941	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.409	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.06	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	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 Ds (269)	111 Rg (272)	112 Cn (277)	113 Nh (unknown)	114 Fl (289)	115 Mc (unknown)	116 Lv (289)	117 Ts (unknown)	118 Og (293)

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	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)

A → Products	**Zero Order**	**First Order**	**Second Order**
Rate Expression	rate = k	rate = k [A]	rate = k $[A]^2$
Units on k, the rate constant	mol L^{-1} s^{-1} or mol / L s	1 / s or s^{-1}	L mol^{-1} s^{-1} or L / mol s
Test for order: straight-line Plot	$[A]_t$ vs t	$\ln[A]_t$ vs t	1 / $[A]_t$ vs t
Time-Conc. Expression	$[A]_t = -k\,t + [A]_0$	$\ln([A]_0 / [A]_t) = k\,t$	$1/[A]_t = k\,t + 1/[A]_0$
Half-life	$t_{1/2} = [A]_0 / 2k$	$t_{1/2} = 0.693 / k$	$t_{1/2} = 1 / k\,[A]_0$