

Exam 1 Chm 205 (Dr Mattson) 31 January 2018

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. (6 pts) Which solvent, either **water** or **CCl₄**, is expected to be better at dissolving the following solutes? **Circle either H₂O or CCl₄ for each of these solutes.**

1a. ethanol, CH₃CH₂OH: Soluble in: **H₂O** or **CCl₄**

1b. chloromethane, CH₃Cl: Soluble in: **H₂O** or **CCl₄**

1c. ethanoic acid, CH₃COOH: Soluble in: **H₂O** or **CCl₄**

1d. ammonium acetate: Soluble in: **H₂O** or **CCl₄**

1e. benzene, C₆H₆: Soluble in: **H₂O** or **CCl₄**

1f. hexane, C₆H₁₄: Soluble in: **H₂O** or **CCl₄**

2. A solution was prepared by dissolving 75.0 g ammonium bromide in 250.0 g water. Use this table to organize your calculations.

	MM	mass, m	moles, n
NH ₄ Br	97.9 g mol ⁻¹		
H ₂ O	18.0 g mol ⁻¹		

2a. (4 pts) What is the mole fraction of NH₄Br?

Answer: _____

2b. (4 pts) What is the mass percent of NH₄Br?

Answer with units: _____

2c. (4 pts) What is the molality of NH₄Br?

Answer with units: _____

3. (5 pts) A 1.70 M NaCl(aq) solution has a density of 1.069 g/cm³. What is the molality of NaCl?

	MM	m	n	V
NaCl	58.5 g mol ⁻¹			
H ₂ O	18.0 g mol ⁻¹			
Solution				

4. (4 pts) What is the van't Hoff factor for each solution?

4a. 0.25 M KI(aq)	i = _____
4b. 0.15 molal CaCl ₂ (aq)	i = _____
4c. 12.9 mass percent C ₂ H ₅ OH(aq)	i = _____
4d. 0.10 mole fraction K ₃ PO ₄ (aq)	i = _____

5. (5 pts) Benzene, C₆H₆ (MM = 78.1 g mol⁻¹), is a liquid with a vapor pressure of 119.3 mmHg at 30.0 °C. Suppose 2.55 g naphthalene, a solid with formula C₁₀H₈ (MM = 128.2 g mol⁻¹), is dissolved in 40.0 g benzene. What is the vapor pressure of the solution?

Answer with units: _____

6a. (5 pts) Suppose 4.44 g m-xylene, C₈H₁₀ (MM = 106.2 g mol⁻¹), with a vapor pressure of 11.6 mmHg at 30.0 °C is mixed with 8.88 g benzene. What is the vapor pressure of the solution? **See Question 5 for C₆H₆ data.**

Answer with units: _____

6b. (2 pt) Are m-xylene and benzene miscible?

Yes or No

6c. (2 pt) What intermolecular forces best describes what is occurring with this solution? **Circle your choice**

London disp. H-bonding Ion-dipole dipole-dipole

7. (5 pts) Benzene has a normal freezing point of 5.50 °C. Suppose 1.53 g of an unknown are dissolved in 65.0 g benzene and the solution has a freezing point of 3.90 °C. What is the molar mass, MM, of the unknown? Given **K_f = 5.07 deg/molal** for benzene.

Answer with units: _____

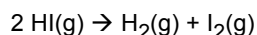
8. (5 pts) How much $\text{CaCl}_2(\text{s})$ (MM = 111 g/mol), in grams, should be added per kg H_2O in order to lower the freezing point to $-5\text{ }^\circ\text{C}$? Given: $K_f = 1.86\text{ deg/molal}$

Answer with units: _____

9. (4 pts) What is the osmotic pressure of a 0.023 M Na_2SO_4 solution at 300 K? $R = 0.0821\text{ L atm mol}^{-1}\text{K}^{-1}$

Answer with units: _____

10. At 700 K, the reaction of HI to form H_2 and I_2 is second order in [HI] with a measured rate constant at 700 K of $k = 1.8 \times 10^{-3}\text{ L/mol s}$. The reaction is:



- 10a. (3 pts) Write the rate law for this reaction.

- 10b. (4 pts) If the $[\text{HI}]_0$ were 0.400 mol/L, how long would it take for $[\text{HI}] = 0.250\text{ mol/L}$?

Answer with units of seconds: _____

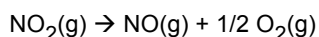
- 10c. (3 pts) What is the rate of the reaction at 700 K when $[\text{HI}] = 0.200\text{ M}$?

Answer with units: _____

- 10d. (3 pts) If, under certain conditions, the rate of the reaction, $-\Delta[\text{HI}]/\Delta t = 2.24 \times 10^{-4}\text{ mol L}^{-1}\text{ s}^{-1}$, what is the rate of appearance of I_2 , $\Delta[\text{I}_2]/\Delta t$?

Answer with units: _____

11. The following initial concentration - initial rate data listed in the table were collected for the reaction:



Expt.	$[\text{NO}_2]_0$	Initial rate = $-\Delta[\text{NO}_2]/\Delta t$
1	0.020 mol/L	$1.35 \times 10^{-2}\text{ mol L}^{-1}\text{ s}^{-1}$
2	0.030	3.03×10^{-2}
3	0.050	8.43×10^{-2}
4	0.080	?

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

Answer with units: _____

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

Answer with units: _____

- 11c. (4 pts) What is the initial rate if $[\text{NO}_2]_0 = 0.080\text{ M}$?

Answer with units: _____

12. Consider data collected for the hydrolysis reaction of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, to form glucose and fructose:
 $\text{sucrose}(\text{aq}) + \text{H}_2\text{O} \rightarrow \text{glucose}(\text{aq}) + \text{fructose}(\text{aq})$

Time (hr)	$[\text{C}_{12}\text{H}_{22}\text{O}_{11}]$ (mol/L)
0.0	0.900
2.0	0.594
4.0	0.392
6.0	0.258
8.0	0.170

- 12a. (4 pts) A graph of the $\ln[\text{C}_{12}\text{H}_{22}\text{O}_{11}]$ vs. time gives a straight-line. Determine the value of the rate constant.

Answer with units: _____

- 12b. (4 pts) Determine $[\text{C}_{12}\text{H}_{22}\text{O}_{11}]$ when $t = 5.3\text{ hr}$.

Answer with units: _____

- 12c. (4 pts) How long does it take until $[\text{C}_{12}\text{H}_{22}\text{O}_{11}] = 0.550\text{ M}$?

Answer with units: _____

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

Answer with units: _____

- 12e. (4 pts) How long does it take until $[\text{C}_{12}\text{H}_{22}\text{O}_{11}]$ drops to 70% of its original concentration?

Answer with units: _____

Total score (out of 100): _____

A+ > 95% A > 90% B+ > 85% B > 80% C+ > 75% C > 70% D > 60%

	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)

Answers

1a. H₂O, 1b. CCl₄, 1c. H₂O or CCl₄, 1d. H₂O or CCl₄, 1e.

CCl₄, 1f. CCl₄

2a. 0.0523

2b. 23.1%

2c. 3.06 molal

3. 1.75 M

4. 2, 3, 1, 4

5. 115 mmHg

6a. 90.4 mmHg

6b. Yes

6c. London disp.

7. 74.6 g/mol

8. 99.5 g

9. 1.7 atm

10a. rate = k[H]²

10b. 833 s

10c. 7.2 x 10⁻⁵ mol L⁻¹ s⁻¹

10d. 1.12 x 10⁻⁴ mol L⁻¹ s⁻¹

11a. rate = k[NO₂]²

11b. 33.7 L mol⁻¹ s⁻¹

11c. 0.216 mol L⁻¹ s⁻¹

12a. 0.208 hr⁻¹

12b. 0.299 mol/L

12c. 2.37 hr

12d. 3.33 hr

12e. 1.7 hr