Exam 1 Chm 205 (Dr Mattson) 6 February 2015

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:

Circle your section: Section A or Section C

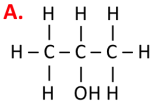
Circle your Folder group:

H He Li Be B C N O F Ne Na Mg Al Si

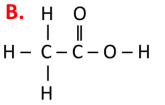
Instructions: Show all work whenever a calculation box is provided! Write legibly. Include units whenever appropriate. You will receive credit for **how** you worked each problem as well as for the correct answer. If you need more space, you may use the back of the data sheet provided — Write: "See Data Sheet" in the answer box and then submit data sheet with your exam. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks and bags must be closed and on the floor under the table. Cell phones must be OFF and placed in your backpack/bag – not in your pocket.

1. Use these structures to answer all parts of Question 1. (Note: Electron pairs are not shown.)

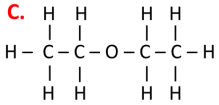
A.



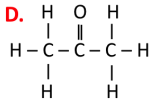
B.



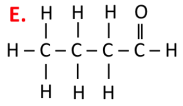
C.



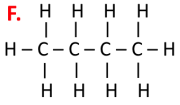
D.



E.



F.



1a. (5 pts) Which molecule is:

an ether	A	B	C	D	E	F	none
an alcohol	A	B	C	D	E	F	none
a carboxylic acid	A	B	C	D	E	F	none
a ketone	A	B	C	D	E	F	none
an aldehyde	A	B	C	D	E	F	none

1b. (3 pts) Which of these molecules exhibit… (Note: May be more than one. Circle all that apply.)

hydrogen bonding?	A	B	C	D	E	F
only London dispersion forces?	A	B	C	D	E	F
dipole forces, but not H-bonding?	A	B	C	D	E	F

2. (1 pt) Which ONE of these definitions is correct?

A. molarity = $n_{solute}/(m_{solute} + m_{solvent})$

B. molality = $n_{solute}/m_{solvent}$

C. mole fraction = $n_{solute}/n_{solvent}$

D. mass percent = $m_{solute}/m_{solvent}$

3. (4 pts) What is the mass percent of potassium nitrate (MM = 101.1 g/mol) in a 3.55 molal aqueous solution?

Answer with units: _____

4. (4 pts) What is the mole fraction of potassium nitrate in the previous problem?

Answer: _____

5. (4 pts) What is the molality of ammonium nitrate in an aqueous solution that is 3.20 M NH_4NO_3 (MM = 80.1 g/mol) and has a density of 1.15 g/cm^3?

Answer with units: _____

6. (5 pts) True or False

T F The solubility of gases in liquids decreases with increasing temperature.

T F The solubility of solids in liquids usually increases with increasing temperature.

T F The solubility of gases in liquids decreases with increasing pressure.

T F Effects caused by colligative properties increase as the amount of solute increases.

T F Ionic solutes exhibit larger colligative property effects than equal molar amounts of covalent-molecular solutes.

7. (4 pts) What is the vapor pressure in mmHg of a solution prepared by dissolving 8.5 g benzoic acid (MM = 122.1 g/mol) in 100.0 g 1-propanol (MM = 60.1 g/mol) at 40 ^oC. The vapor pressure of 1-propanol at 40 ^oC is 36.4 mmHg.

Answer with units: _____

8. (4 pts) Trichloromethane has a normal boiling point of 61.2 ^oC. What is ΔT_b and the new boiling point of a solution prepared by dissolving 7.00 g naphthalene, a non-volatile, non-electrolytic solid (MM = 128.2 g/mol) in 50.0 g $CHCl_3$? Given: K_b = 3.63 deg/molal.

The new boiling point is: _____

9. (2 pts) Pentane and hexane both have significant vapor pressures at 25 ^{o}C. Write the formula you would use to calculate the vapor pressure of a mixture of these miscible substances.

10. (4 pts) A solution is prepared by dissolving 10.00 g glycine, an amino acid, in 50.0 g water. What is the molar mass of glycine if the solution freezes at -4.96 ^{o}C? Given: K_f = 1.86 deg/molal for H_2O.

Answer with units: _____

11. Consider the time and concentration table and graphs on the data page, describing the following reaction, which takes place at an elevated temperature:

$$2\ HI(g) \rightarrow H_2(g) + I_2(g)$$

11a. (4 pts) What is the order of the reaction? CAUTION! No partial credit!

11b. (2 pts) What is the rate expression?

11c. (4 pts) What is the rate constant, with proper units?

Answer with units:_____

12. Consider the data for the first order reaction and with a rate constant, k = 0.0112 s^{-1} at a certain temperature:

$$C_4H_8 \rightarrow 2\ C_2H_4$$

Time (s)	$[C_4H_8]$
0	1.000
10	0.894
20	0.799
30	0.714
40	0.638

12a. (4 pts) What is $[C_4H_8]$ after 70 s?

Answer with units:_____

12b. (4 pts) How long does it take until $[C_4H_8]$ = 0.500 M?

Answer with units:_____

12c. (3 pts) What is the half-life for the reaction?

Answer with units:_____

13. Consider this proposed mechanism for a gas phase reaction:

Step 1. $NO_2 + Cl_2 \rightarrow ClNO_2 + Cl$ slow step

Step 2. $NO_2 + Cl \rightarrow ClNO_2$ fast step

13a. (3 pts) What is the overall reaction?

13b. (3 pts) What is the rate law?

13c. (2 pts) Is there an intermediate or catalyst?

Intermediate?	Yes	No	If yes, identify:
Catalyst?	Yes	No	If yes, identify:

13d. (2 pts) Steps 1 and 2 could each be described as…

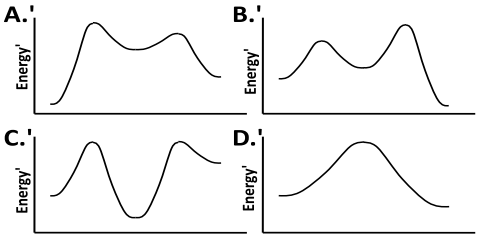
Step 1	Unimolecular	Bimolecular	Termolecular
Step 2	Unimolecular	Bimolecular	Termolecular

13e. (3 pts) Suppose rate = $-\Delta[NO_2]/\Delta t$ = 0.00203 mol/L min. What is the value for rate in terms of $\Delta[ClNO_2]/\Delta t$?

13f. (1 pt) What would happen to the rate constant if one increased the temperature?

A. increases B. decreases C. remains unchanged

13g. (1 pt) Which reaction profile best represents the mechanism? **Circle one: A B C D**



13h. (1 pt) The profile you selected in Question 13g is…

Circle: Exothermic or **Endothermic**

13i. (1 pt) Suppose the laboratory results determined that the rate law was actually rate = $k[NO_2]^2$. What can you conclude?

A. The laboratory work supports the mechanism.
B. The laboratory work is in error.
C. The proposed mechanism is in error.
D. The rate law may be different, but the rate constant must be the same.

14. (1 pt) Which reaction profile (Question 13g) represents an single-step mechanism? **Circle one: A B C D**

15. (1 pt) Which reaction profile (Question 13g) represents a situation with a stable intermediate? **A B C D**

Subtotal from exam: _____

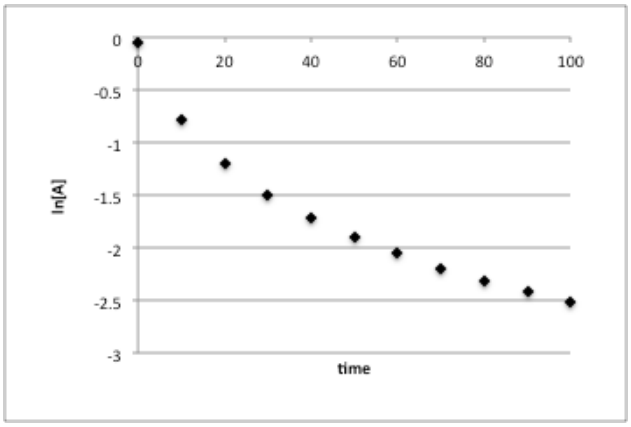
Folder work: (20 max) _____

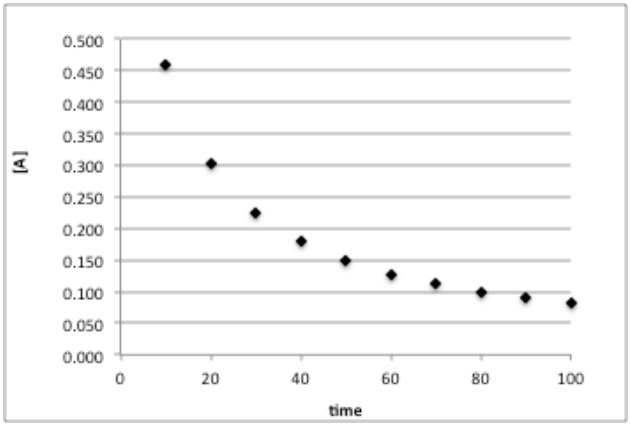
Total:

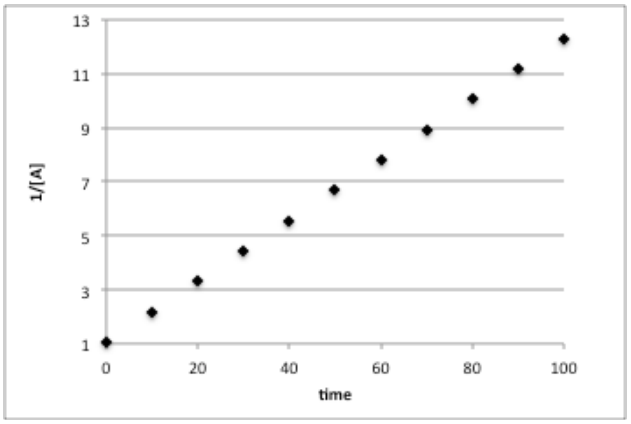
	Zero Order	First Order	Second Order
Rate Expression	rate = k	rate = k[A]	rate = $k[A]^2$
Time-Conc. Expression	$[A]_t = -kt + [A]_o$	$\ln([A]_o/[A]_t) = kt$	$^1/_{[A]_t} = kt + {}^1/_{[A]_o}$
Linear Plot	$[A]_t$ vs t	$\ln[A]_t$ vs t	$^1/_{[A]_t}$ vs t
Half-life	$t_{1/2} = [A]_o/2k$	$t_{1/2} = {}^{0.693}/_k$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

Use these data and three graphs to answer Question 11 for the reaction: 2 HI(g) → $H_2(g)$ + $I_2(g)$

time (min)	[A], mol/L
0	0.950
20	0.459
40	0.302
60	0.225
80	0.180
100	0.149
120	0.128
140	0.112
160	0.099
180	0.089
200	0.081







Answers

1a. C, A, B, D, E

1b.

hydrogen bonding?	A B
only London dispersion forces?	F
dipole forces, but not H-bonding?	C D E

2. B

3. 26.4%

4. 0.060

5. 3.58 molal

6. T T F T T

7. 34.9 mmHg

8. 65.2 ^{o}C

9. $P_{solution} = X_{solvent\ A} \times P_{solvent\ A} + X_{solvent\ B} \times P_{solvent\ B}$

10. 75 g/mol

11a. second order; 11b. rate = $k[NO_2]^2$

11c. k = 0.0563 L/mol min

12a. 0.457 M

12b. 61.9 s

12c. 61.9 s

13a. $2\ NO_2 + Cl_2 \rightarrow 2\ ClNO_2$

13b. rate = $k\ [NO_2][\ Cl_2]$

13c. Intermediate? Yes: Cl; no catalyst

13d. both steps are bimolecular

13e. rate = $\Delta[ClNO_2]/\ \Delta t$ = 0.00203 mol/L min.

13f. increase

13g. Either A or B – both look about the same.

13h. A is endothermic and B is exothermic

13i. C

14. D

15. C