Exam One CHM 205 (Dr. Mattson) 31 January 2012	***Print your name:*** ***Signature:***	***Circle your section:*** ***8:30 9:30***

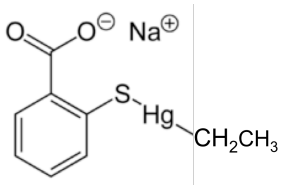
Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. If you need more space, you may use the back of your data sheet — Write: "See data sheet" in box and then attach the data sheet. BOX YOUR ANSWERS! Write legibly.

1. (4 pts) Which of these formulas for concentration are correct? Circle all that are correct.

A. $X_{solute} = \frac{n_{solute}}{n_{solute} + n_{solvent}}$ B. $M = \frac{n_{solute}}{V_{solvent}}$

C. $m = \frac{n_{solute}}{m_{solvent}(kg)}$ D. $mass\% = \frac{m_{solute}}{m_{solution}} \times 100$

2. Aqueous solutions of merthiolate, $NaC_9H_9HgO_2S$, MM = 404.81 g/mol, were used for antiseptic purposes for many years. Merthiolate was also used as an internal antiseptic in childhood immunizations to prevent the staphylococcus infections. The compound is no longer used for this purpose and continues to be at the heart of the controversy associated with the onset of autism in children.



(a) (2 pts) Would you expect merthiolate to be soluble in water? Circle: YES or NO

(b) (2 pts) Would you expect merthiolate to be soluble in $C_6H_6(l)$? Circle: YES or NO

(c) (4 pts) Consider an aqueous solution that is 0.10 mass % merthiolate. What is its molality?

(d) (3 pts) What is the concentration of 0.10 mass % merthiolate in ppm?

3. (4 pts) Consider a solution of rubbing alcohol which contains 55.0 g C_3H_7OH (MM = 60 g/mol) and 30.0 g H_2O (MM = 18 g/mol). What is the mole fraction of the alcohol in the solution? (Answer box top of next column.)

Answer Question 3 here.

4. (4 pts)The density of a 0.500 molal solution of acetic acid, $HC_2H_3O_2$ (MM = 60.05 g/mol) is 1.0042 g/mL. What is its molarity?

5. (1 pt) Which of these aqueous solutions would have the lowest vapor pressure?
A. pure H_2O B. 1.5 M $C_{12}H_{22}O_{11}$ C. 1.0 M KBr

6. (4 pts) Suppose a solution contained 2.0 mol a non-volatile, non-electrolytic solute and 100.0 g water. Given that pure water has a vapor pressure of 24.02 mmHg at 25 ^oC, what is the vapor pressure of the solution at this temperature?

7a. (4 pts) Suppose 9.744 g of an unknown solute was dissolved in 60.0 g water and the solution was found to freeze at -2.21 ^oC. In a separate experiment, the solution was found to not conduct electricity. What is the molar mass of the solute? [Given: K_f = 1.86 deg/molal]

7b. (4 pts) What can you conclude about the solute described in Question 7a? Circle all that apply.

A. It is covalent molecular B. It is polar

C. It is ionic D. It is non-polar

8. (4 pts) Suppose in lab, you determined that pure water had a boiling point of 97.9 ^{o}C on a particular day. If you dissolved 2.066 g calcium acetate, $Ca(C_2H_3O_2)_2$, MM = 158.17 g/mol, into 100.0 g water, what would you predict for the boiling point? [Given: K_b = 0.52 deg/molal]

9. Cyclopropane, is converted into propene at high temperatures. Time-concentration data and three useful graphs are given on the data sheet.

9a. (2 pts) Inspect the three charts and determine the reaction order. Circle one choice.

A. zero order B. first order C. second order

9b. (4 pts) Use the data to determine the value of the rate constant, with proper units.

9c. (4 pts) How long (in minutes) would it take for the [Cyclopropane] to go from 0.098 M to 0.050 M?

9d. (4 pts) What is [Cyclopropane] after 8.0 min?

9e. (4 pts) What is the half-life in minutes?

10. (4 pts) Consider the following gas-phase reaction and experimental data:

$NO_2 + CO \rightarrow NO + CO_2$

Trial	$[NO_2]$, M	[CO], M	Initial rate*
1	0.240	0.173	0.0117
2	0.240	0.501	0.0117
3	0.445	0.173	0.0402
4	0.445	0.501	0.0402

*rate = Δ[NO]/Δt, mol/L min

10a. (4 pts) What is the order of the reaction with respect to NO_2?

10a. (4 pts) What is the order of the reaction with respect to CO?

10c. (3 pts) What is the value of the rate constant? Include proper units.

11. (4 pts) Consider the reaction A $\rightarrow$ B, known to be second order in A with k = 0.040 L/mol s. If the initial $[A]_0$ = 0.0170 M, what is $[A]_t$ after 400 s?

12. (3 pts) We learned that the mechanism for the reaction shown in Question 10 is:

Step 1. $NO_2 + NO_2 \rightarrow NO + NO_3$ slow step

Step 2. $NO_3 + CO \rightarrow NO_2 + CO_2$

Given this mechanism, what is the rate law?

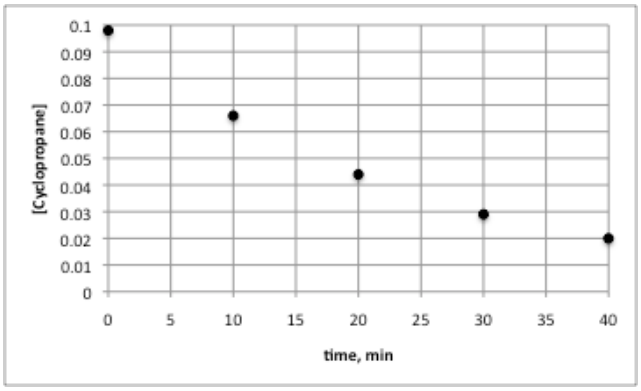
Useful kinetics equations

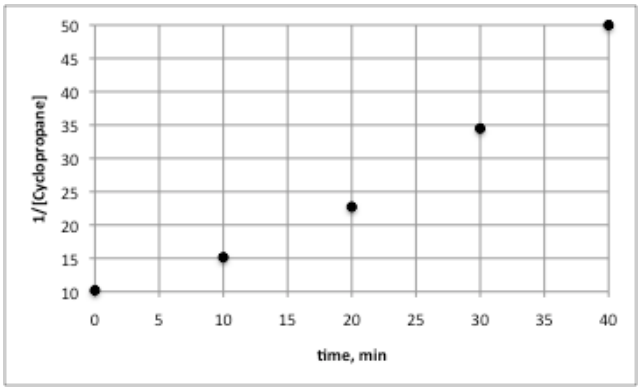
	Zero Order	First Order	Second Order
Rate Expression	rate = k	rate = k[A]	rate = $k[A]^2$
Time-Conc. Expression	$[A]_t = -kt + [A]_o$	$\ln([A]_o/[A]_t) = kt$	$^1/_{[A]_t} = kt + {}^1/_{[A]_o}$
Linear Plot	$[A]_t$ vs t	$\ln[A]_t$ vs t	$^1/_{[A]_t}$ vs t
Half-life	$t_{1/2} = [A]_o/2k$	$t_{1/2} = {}^{0.693}/_k$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

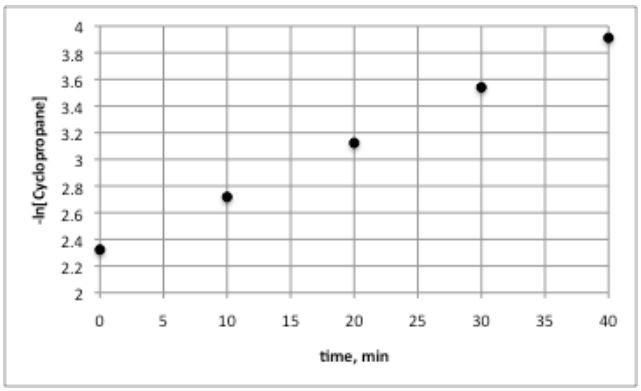
Use these data and graphs to answer Question 9:

Cyclopropane → propene

Time (min)	[Cyclopropane]
0.00	0.098
10.0	0.066
20.0	0.044
30.0	0.029
40.0	0.020







Answers

1. A, C, D

2. (a) YES; (b) I accepted either answer – there is plenty of non-polar parts of the molecule to make it soiluble in non-polar solvents providing the sodium cation binds tightly to the anion.

(c) 2.47×10^{-3} molal

(d) 1000 ppm

3. 0.354

4. 0.487 M

5. C

6. 17.65 mmHg

7a. 136.7 g/mol

7b. A and B

8. 98.1 ^{o}C

9a. B. first order

9b. 0.0400 min^{-1}

9c. 16.8 min

9d. [Cyclopropane] = 0.071 mol/L

9e. 17 min

10a. second order with respect to NO_2

10a. zero order with respect to CO

10c. 0.203 L mol^{-1} min^{-1}

11. 0.0134 M

12. rate = $k[NO_2]^2$