

US 111 Exam 1, Spring 2004

Name _____

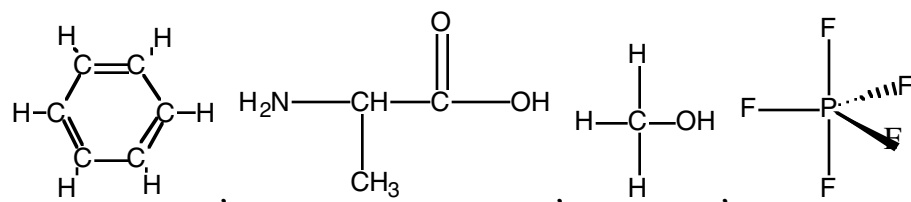
Useful information: $\ln \frac{[A]_t}{[A]_0} = -kt$, $\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$, $k = Ae^{-\frac{E_a}{RT}}$, $P_{\text{solution}} = P_A^0 \chi_A + P_B^0 \chi_B$,

$\Pi = MRT$, $R = 8.314 \frac{J}{\text{mol} \cdot K}$, $0.0821 \frac{l \cdot \text{atm}}{\text{mol} \cdot K}$, $\Delta T_b = K_b c_m$, $\Delta T_f = -K_f c_m$, $\text{solubility} = k \cdot P$,

$\ln P_{\text{vap}} = \frac{-\Delta H_{\text{vap}}}{RT} + C$, $\ln \frac{P_2}{P_1} = \frac{\Delta H_{\text{vap}}}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$

You must show work for credit.

(1) (4 points)



(a) Which of the following molecules would you expect to be soluble in fat?

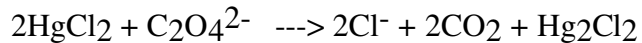
(b) Which would you expect to be soluble in water?

(2) (4 points) $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$

For the reaction above, relate the rate of the reaction expressed in terms of the appearance of CO_2 , appearance of H_2O , and the disappearance of $\text{C}_2\text{H}_5\text{OH}$. Make all three rates equal to

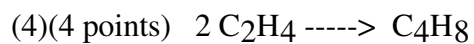
$$-\frac{d[\text{C}_2\text{H}_5\text{OH}]}{dt} =$$

(3)(6 points) From the following kinetic data, determine the form of the rate law.



Experiment	Initial Concentrations		Initial rate (in M/s)
	[HgCl ₂]	[C ₂ O ₄ ²⁻]	
1	0.105	0.15	1.8 x 10 ⁻⁵
2	0.105	0.30	7.1 x 10 ⁻⁵
3	0.052	0.30	3.5 x 10 ⁻⁵

Write out the rate law including the value of the rate constant k.



The reaction above is found to be first order in [C₂H₄]. If the rate constant k, is 4.91 x 10⁻³ 1/Ms and [C₂H₄]₀ = 0.158 M, (a) what is the half life of the reaction? and (b) What will [C₂H₄] be at t = 450 s?

(5)(5 points) $\text{H}_2 + \text{ICl} \rightarrow \text{HI} + \text{HCl}$ (slow step)

$\text{HI} + \text{ICl} \rightarrow \text{I}_2 + \text{HCl}$ (fast step)

(overall) $\text{H}_2 + 2\text{ICl} \rightarrow \text{I}_2 + 2\text{HCl}$

Using the information from the above reaction mechanism, answer the following questions

(a) Write the rate law for the reaction

(b) What is the molecularity of the reaction?

(c) List any catalysts or intermediates in the mechanism above.

(6)(4 pts) The solubility of O_2 in water is 1.38×10^{-3} M if $P_{\text{O}_2} = 25.0$ mm of Hg. What pressure of O_2 would be required to form a 0.100 M solution of O_2 ?

(7) (6 pts)

(a) Sketch a phase diagram using the information given below

- The triple point is at 25 °C and 2.25 atm
- The critical point is at 175 °C and 11.2 atm
- The solid is denser than the liquid

(b) What phase(s) is (are) present at 75 °C and 5 atm?

(8)(4 pts) If a compound has a vapor pressure of 75 mm Hg at 50 °C, and 275 mm H at 85 °C, what is its ΔH_{vap} ?

(9)(4 pts) What is the difference between a solution and a suspension?

(10)(4 pts) Convert a 0.25 mole fraction of sodium chloride in water to molality.

(11)(4 pts) The freezing point of nitrobenzene is $5.7\text{ }^{\circ}\text{C}$. When 5.23 g of an unknown molecular compound is added to 115 g of nitrobenzene, the freezing point of the solution is $-2.2\text{ }^{\circ}\text{C}$. What is the molecular weight of the unknown if $K_f = 5.24\text{ }^{\circ}\text{C}/\text{m}$?

(12)(4 pts) (a) What is the minimum pressure needed to get pure water from a 0.0200 M solution of CaCl_2 by reverse osmosis at 350 K ?

(b) Would it be easier or harder to get pure water from the above solution at room temperature? Explain why or why not

Extra Credit: (4 points)

The half life is the time it takes for the concentration to be reduced to 1/2 the initial amount. This is just a convenient amount. You could talk about a 1/3 (the time it takes for the concentration to be reduced to 1/3 of the original concentration) life or a 1/10 time. What would be the expression for the tenth life of a second order reaction?

