

INSTRUCTIONS:

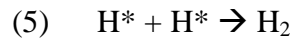
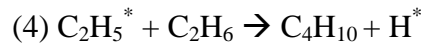
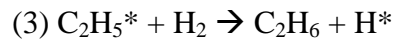
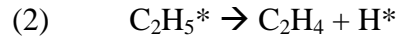
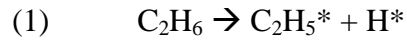
- 1. Read and Sign the Agreement Below.*
- 2. Write all answers in blue book provided.*
- 3. There are 5 questions; each are worth 20 points. Some are easier than others. Make sure you budget your time to maximize points.*
- 4. YOU MUST HAND YOUR BLUE BOOK AND THIS HANDOUT.*
- 5. If you have a minute left, enjoy the bonus questions at the end.*

I agree to abide by the University of Connecticut code of Academic Honesty, as stated in the Student Conduct Code, rev. May 10, 1996, and agree not to commit acts of academic misconduct, including providing or receiving assistance not authorized by the instructor in the creation of work to be submitted for academic evaluation including papers; projects and examinations. In keeping with the code of Academic Honesty, I agree to not discuss any aspect of this exam with my fellow students until after 4PM, Monday April 2nd, 2007.

Signed _____ *Date* _____

Q1. Dehydrogenation of Ethane [40 pts]

The following four-step mechanism is proposed for the overall homogeneous, gas-phase dehydrogenation of ethane, $C_2H_6 \rightarrow C_2H_4 + H_2$.



- [5 pts] Classify each reaction step as either: initiation, propagation or termination.
- [10 pts] Derive expressions for $[H^*]$ and $[C_2H_5^*]$, in terms of rate coefficients k_1, k_2, k_3, k_4, k_5 , hydrogen concentration $[H_2]$ and ethane concentration $[C_2H_6]$. DO NOT "LUMP" PARAMETERS.
- [5 pts] Derive expression for the rate of ethane disappearance ($-r_{C_2H_6}$), in terms of k_1, k_2, k_3, k_4, k_5 , $[H_2]$ and $[C_2H_6]$.
- [20 pts] A CSTR is to be designed for this reaction, with a target outlet conversion of 75%. Using a stoichiometric table, assuming ideal gas law, and assuming ideal mixing (CSTR design equation), **solve for the outlet concentrations of C_2H_6 , C_2H_4 and H_2** , and the **reactor volume** required to achieve this outlet conversion for the following kinetic data and operating conditions:

$$k_1 = 0.01 \text{ s}^{-1}$$

$$k_2 = 0.02 \text{ s}^{-1}$$

$$k_3 = 50 \text{ L}\cdot\text{mol}^{-1}\cdot\text{s}^{-1}$$

$$k_4 = 25 \text{ L}\cdot\text{mol}^{-1}\cdot\text{s}^{-1}$$

$$k_5 = 300 \text{ s}^{-1}$$

$$P = 1 \text{ atm}$$

$$T = 500^\circ\text{C}$$

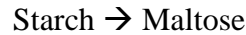
$$R = 0.0821 \text{ atm}\cdot\text{L}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$$

$$F_{AO} = 1 \text{ mol}\cdot\text{s}^{-1}$$

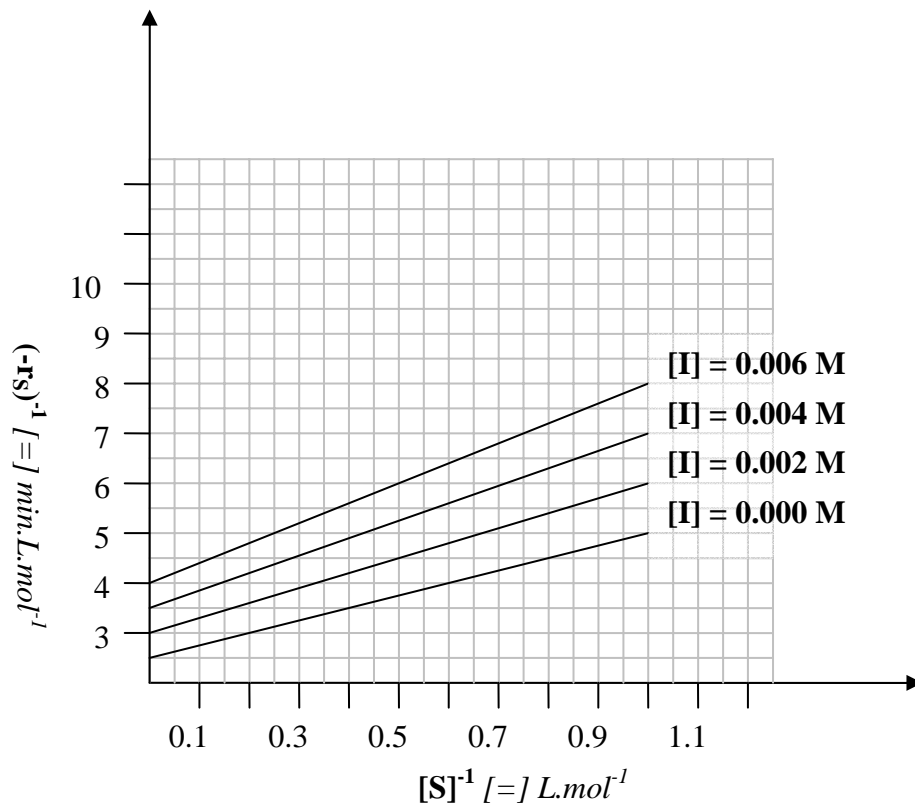
$$y_{AO} = 1 \text{ (pure A inlet)}$$

Q2. Enzymatic Hydrolysis of Starch [30 pts]:

An important step in the conversion of starches to sugars in human digestion is the hydrolysis of starch to maltose, which is catalyzed by the enzyme α -amylase.



Maltose product is a disaccharide which can be subsequently hydrolyzed to two glucose molecules. The presence of Phaseolamin has been found to reduce the rate of starch hydrolysis by α -amylase. Batchwise experiments monitoring starch concentrations vs. time in the presence of varying Phaseolamin concentrations are presented graphically below:



- [15 pts] Using the above data, propose a mechanism for inhibition of the above reaction by Phaseolamin, and determine values of V_{\max} , K_m and K_I for the corresponding rate expression. SHOW UNITS!
- [10 pts] One can crudely model the human stomach as a batch reactor, to view the effects of this inhibitor. If Phaseolamin concentration in the stomach is 0.01 mol/dm^3 , and the initial starch concentration is 2 mol/L in the food slurry entering at time $t=0$, how much starch is converted to maltose after 30 minutes (typical stomach residence time)?
- [5 pts] What method of data analysis (from Chapter 5) does this analysis represent? What is the popular name for this specific plot in enzyme chemistry?

Q3.Data Analysis and Linearization [30 pts]

Differential Method Analysis: Linearize the following, and identify the appropriate **y-axis**, **x-axis** for plotting the linearized form. Identify **slope** and **y-intercept**. The linearized form should allow determination of unknown coefficients (V_{\max} , K_m , k , n).

Example: $y = m \cdot x + b$

y-axis is y
x-axis is x
slope is m
y-intercept is b.

a) $-r_S = \frac{V_{\max} \cdot C_S}{K_m + C_S}$ [Michaelis-Menton]

b) $-r_A = k \cdot C_A^n$ [Power Law]

c) $-r_A = \frac{k \cdot C_A \cdot C_B \cdot [S]}{1 + K_A C_A + K_B C_B}$ [Langmuir-Hinshelwood Kinetics]

d) $-r_S = \frac{\mu_{\max} C_C}{1 + k C_S^{-\lambda}}$ [Moser Model]

Integral Method Analysis: Linearize the resulting concentration vs. time relationships, as above, indicating slope and y-intercept, for the following rate expressions:

e) $-r_A = k \cdot C_A^3$, in a batch reactor with perfect mixing.

f) $-r_S = \frac{\mu_{\max} C_C \cdot C_S}{K_S + C_S}$, in a semi-batch reactor where substrate is continuously added to

maintain a constant substrate concentration of $C_S = C_{SO}$.

BONUS QUESTIONS: 1 POINT EACH, MAXIMUM 3 POINTS PER STUDENT.

1. (SPORTS) Who made the game-winning dunk to beat Houston and win the 1983 Men's Basketball National Championship?
2. (THE ARTS) Who wrote "Das Kapital"?
3. (POP CULTURE) What is the name of Angelina Jolie's most recently adopted child?
4. (SCIENCE) What Mother and Daughter both won Nobel Prizes in Science?
5. (HISTORY) Who founded the Library of Congress?