

Name.....Student ID.....

**PRINCE OF SONGKLA UNIVERSITY  
FACULTY OF ENGINEERING**

Final Examination : Semester I

Academic year : 2009

Date : 29 September 2009

Time: 9.00 – 12.00 am

Subject : 230-620 Advance Kinetics and Reactor Design Room : R 300

**ทูลจรตในการสอบ โทษขั้้นต่ำปร้บตคในรายวชานั้้น แลลพ้กการเรยรึน**

**1 ภาคการศึทกษา โทษสูงสุด ให้ออก**

1. The exam are not allow to leave an exam room
2. All books, notes, and all computing devices (i.e., calculator and computer) are allowed
3. Do not discuss or ask any person during taking an exam
4. Do all problems, the mark of each problem is listed below

<b>Problem No.</b>	<b>Total Points</b>	<b>Point obtained</b>
1	15	
2	20	
3	15	
4	20	
5	30	
รวม	<b>100</b>	

**Please note that the exam must consist of 9 pages (including the cover page)**

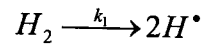
Good luck and do your best on the exam  
Assoc. Prof. Dr. Charun Bunyakan  
Sep. 25, 2009

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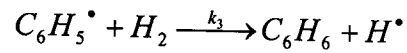
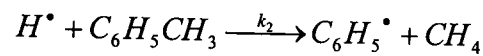
1. (15 points)

The hydrodealkylation of toluene from petroleum stocks to produce benzene and methane occurs in the gas phase at high temperature and involves free radical. The free radical mechanism is believed to proceed by the sequence

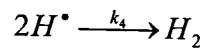
Initiation:



Propagation :



Termination:

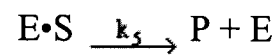
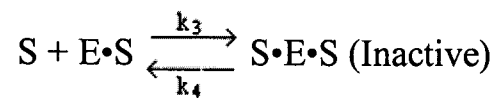
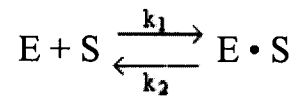


The specific reaction rates  $k_1$  and  $k_4$  are defined with respect to  $H_2$ . Derive the reaction rate law for the rate of formation of benzene based on this mechanism.

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2 (20 points)

Uncompetitive Substrate Inhibition, here the substrate ties up the enzyme-substrate complex by forming a substrate-enzyme-substrate complex, (S•E•S) which is inactive. The mechanisms are given below



Show that the rate law for substrate Inhibition is

$$r_p = \frac{V_{\max} S}{K_M + S \left( 1 + \frac{S}{K_I} \right)} = \frac{K_I V_{\max} S}{S^2 + K_I S + K_M K_I}$$

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3. (15 points)

The thinned starch was converted to glucose by enzyme glucoamylase at 15°C and pH of 5.1. The initial rates for each experiment are given below.

$C_s$ (mM)	5.5	8.33	11.11	13.89	16.66	22.22	27.77
$r_p$ (mM/min)	0.163	0.211	0.241	0.276	0.301	0.339	0.347

Determine the Michalis-Menten parameters  $V_{max}$  and  $K_M$ .

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4. (20 points)

From problem 3, if the total concentration of glucoamylase corresponding to the value of  $V_{\max}$  is 30 mM, calculate the initial concentration of thinned starch which gave 90% conversion in batch reactor within 2 hr. The glucoamylase concentration is 15 mM.

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5. (30 points)

The data below were obtained in a steady state continuous stirred tank fermenter (CSTF/CSTR) for an uninhibited bioreaction. A feed of pure substrate at a concentration of  $100 \text{ g/dm}^3$  enters the fermenter at a volumetric flow rate of  $10 \text{ dm}^3/\text{min}$ .

(a) What are the Monod rate law parameters?

(b) What fermenter volume is required to produce an effluent product rate of  $20 \text{ g}/(\text{dm}^3 \text{ min})$  with a cell concentration of  $20 \text{ g/dm}^3$ ?

Additional data

$r_g \text{ (g/h. dm}^3\text{)}$	$C_s \text{ (g/dm}^3\text{)}$	$C_C \text{ (g/dm}^3\text{)}$
1.10	100	1.0
0.71	50	1.0
0.40	20	1.0

and  $Y_{p/s} = 0.1 \text{ g/g}$

$Y'_{c/s} = 0.9 \text{ g/g}$