

PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination: Semester II

Academic Year: 2007

Date: December 26, 2007

Time: 9:00-12:00

Subject: 230-592 Special topics (Catalysts)

Room: R300

อนุญาตให้นำเอกสารและเครื่องคำนวณทุกชนิดเข้าห้องสอบได้
ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริต
และพักการศึกษา 1 ภาคการศึกษา

Please do all 7 questions. Show all your work to receive full or partial credit.
Final score is 195. (Total page = 11, including first page)

Question #	Total Score	Score
1	60	
2	40	
3	15	
4	25	
5	15	
6	20	
7	20	
Total	195	

สุกฤทธิรา รัตนวิไล
ผู้ออกข้อสอบ

1. Explain the following words. (5 scores/each word, total 60 scores)

1.1 Sintering.....
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1.2 CVD.....
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1.3 Reducing process.....
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1.4 Langmuir Isotherm.....
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1.5 Turn over frequency.....
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1.6 Activity.....
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1.7 Adsorption Isotherms.....

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1.8 PSSH.....

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1.9 Heterogeneous catalyst.....

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1.10 Equilibrium.....

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1.11 Eley-Rideal mechanism.....

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1.12 Aluminosilicate.....

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2. Find the answer of each question. (10 scores/each, total 40 scores)

2.1 What is different between “Promoter”, “Carrier” and “Support”?

2.2 Calculate the amount of $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ required to make 10 grams of a $\text{Ni}/\text{Al}_2\text{O}_3$ catalyst containing 5 weight % nickel metal.

2.3 What are molecular sieve and zeolite, how different?

2.4 What is different between “Chemisorption” and “Absorption”?

3. What was in your view the greatest development in catalytic technology in the 20th Century and why? (15 scores)

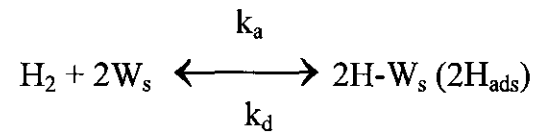
4. Congratulations, you have been promoted and transferred to the planning division of Cal's Catalyst Corp. Your first assignment is to make recommendations to the President (Cal) regarding the company's investment in R&D during the next 10 years. Specifically, the President wants you to give him a one-page summary which addresses the following questions: (25 scores)

4.1 Is the field of catalyst a mature technology area? Is there potential for breakthroughs, and if so in what process areas? How rapidly will the sales of catalyst grow in the next 10 years? Should the company expand its R&D? If so, how rapidly? Assume the company devotes about \$10 million per year or about 2% of its annual sales to R&D.

4.2 What kinds of new catalyst and reactor technologies could the company expect to research and developing the next 10 years? What are the most promising areas of new catalyst technology? Reactor technology? On what areas should the company focus its long term efforts?

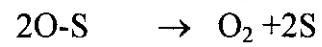
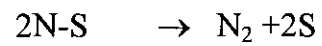
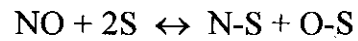
5. The non-catalytic oxidation of a hydrocarbon occurs at 650°C has an activation energy (E_a) of 167 kJ/mol . By using a catalyst the activation energy (E_a) can be reduced to 84 kJ/mol . What would be the temperature for the catalytic reaction in order to achieve the same conversion assuming all other rate parameters are the same? (15 scores)

6. H₂ gas adsorbs on the active sites, W_s of a tungsten surface according to the reaction:



Express the surface coverage of H_{ads} in terms of the equilibrium constant for adsorption and the concentration of H₂ gas and draw a sketch of the surface coverage against [H₂] (or [H₂]^{1/2}) for the cases of k_a >> k_d, k_a ≈ k_d, k_a << k_d. (20 scores)

7. NO decomposition at high temperature on Cu-ZSM-5 is thought to occur by the following mechanism where S is a surface site.



Derive a rate expression in terms of concentrations and rate/equilibrium constants for the disappearance of NO based on the above sequence. (20 scores)