Birla Institute of Technology & Science Pilani, Pilani Campus, Rajasthan 333 031

MIDSEM Examination, First Semester 2022-2023

Course Number: CHEM F337 **Course Title: Green Chemistry and Catalysis**

Max. Marks: 35 **Date: 02 Nov 2022** **OPEN BOOK** **Time: 60 min**

Important Instructions

- **There are THREE questions printed using both sides of the question paper**
- **Answer all questions in the answer booklet only**
- **DO NOT use pencils for answering any part, even graphics**
- **Start answering each question from a fresh page, all sub-sections together**

Q.1.(a) What is the idea behind "alternative catalysts" concept, when use of catalysts is considered as a green chemistry implementation already? **[2M]**

(b) Supercritical fluids can be used as green alternative solvents for extraction processes – describe the basis of SCF extraction processes? Name an industrial process where such a SCF-based extraction is is practice. **[2M]**

(c) How is cavitation created by ultrasound helps as alternative mode of activation? **[3M]**

(d) How is adipic acid synthesized from green bio-based raw materials? **[2M]**

Q.2. (a) Synthesis of ibuprofen by Hoechst-Celanese won the Kirkpatrick Award for implementation of green chemistry principles is 1991

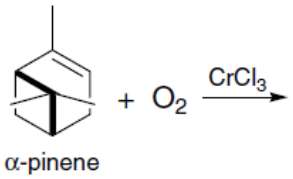
(i) Describe the green process briefly mentioning the reactions involved,

(ii) State FOUR advantageous aspects of the new route from green chemistry perspective. **[3+2=5M]**

(b) Explain the basis of classification of reactions as 'diffusion controlled' and 'chemically (kinetic) controlled', **[2M]**

(c) Complete the given reaction in Figure 1. Mention the type(s) of selectivity exhibited therein. **[2M]**

Figure 1



(d) Explain how biocatalysis resembles for both homogeneous and heterogeneous catalysis. **[2M]**

Q.3. (a) Explain in brief how creating a pseudo-order reaction helps to understand the kinetics of a catalytic reaction. **[2M]**

(b) Discuss the different processes involved in sintering in heterogeneous catalysts. **[3M]**

(c) Complete the catalytic cycle given in Figure 2, by filling up the required information. **[2M]**

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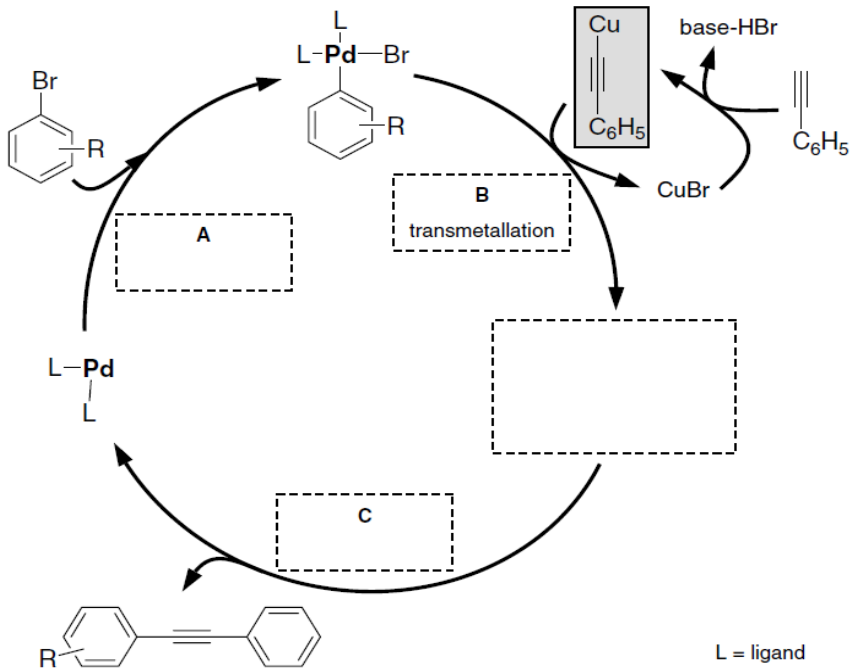
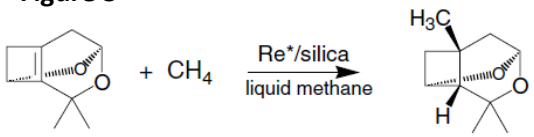
Figure 2



(d) The synthesis of lineatin, a pheromone involves the enantioselective addition of methane to the double bond of alkene A in the presence of a chiral rhenium catalyst on silica (Re/silica) as seen in Figure 3. Michael performed eight separate experiments for this reaction in a 500mL high pressure stirred autoclave reactor using liquid methane as a solvent and 0.05 mmol catalyst. The results are shown in the following table.

Figure 3



alkene **A** lineatin

Experiment	Time/min	[A]/mM	Time/min	[A]/mM
1	0.0	0.500	120.0	0.248
2	0.0	1.000	120.0	0.503
3	0.0	1.200	120.0	0.611
4	0.0	1.600	120.0	0.788
5	0.0	2.000	120.0	0.986
6	0.0	3.200	120.0	1.603
7	0.0	4.400	120.0	1.566
8	0.0	6.000	120.0	2.989

In a second study, Abdel performed five experiments in a 500mL stirred tank reactor at 20 C, using an inert organic solvent, 0.05 mmol catalyst, 1.000 mM alkene A and 1 atm of methane. It was found that the reaction fitted a second-order rate law.

(i) Write out the rate equation that fits Michael's results.

(ii) Calculate the value of the rate constant that Michael found.

(iii) Write out the rate equation fits Abdel's results.

(iv) What is the reason for the different results observed by Michael and Abdel? **[1+2+1+1=5M]**

(e) Write the any four salient features of Wacker Catalytic Oxidation process. **[2M]**

(f) Why is 'nucleophilic attack on a coordinated species' is common for carbonmonoxide? **[1M]**

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