



First Semester Examination
Academic Session 2020/2021

December 2020 / January 2021

KTE411 – Selected Topics in Inorganic Chemistry
(Tajuk-Tajuk Terpilih Dalam Kimia Tak Organik)

Duration: 2 hours
(Masa : 2 jam)

Please check that this examination paper consists of **SEVEN (7)** pages of printed material before you begin the examination.

Section A: Answer **ALL** questions.

Section B: Answer any **ONE** question.

Answer each question on a new page.

You may answer the question either in Bahasa Malaysia or in English.

If a candidate answers more than four questions, only the answers to the first four questions in the answer sheet will be graded.

In the event of any discrepancies, the English version shall be used.

SECTION A: Answer **ALL** questions.**[TIME: 2 HOURS]**

1. (a) Ethanol can be used as a fuel or can be converted into ethene by concentrated sulphuric acid as catalyst for catalysed dehydration.

(i) Define the meaning of dehydration.

(ii) Show the mechanism for this reaction.

(9 marks)

(b) Pyrolysis can be used as a method for the generation of renewable energy.

(i) Explain in details the pyrolysis of acetic acid steam reforming on Ni/La₂O₃ catalyst.

(ii) Sketch the reaction scheme of (i).

(9 marks)

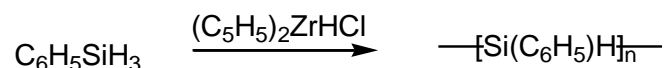
(c) Porous solid material such as activated carbon and oxides of metals (alumina, silica, zeolites) are commonly used as supports. Write two reasons why catalysts are supported.

(2 marks)

(d) Sketch the diagrams with label to show the reaction occurring on a surface and pores catalysed by a heterogenous catalyst.

(5 marks)

2. (a) Metallocene complexes such as (C₅H₅)₂ZrHCl can catalyse the conversion of arylsilanes to short chain polysilanes containing Si-H terminal groups. Describe in details the mechanism for the following reaction;



(10 marks)

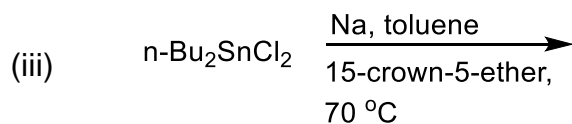
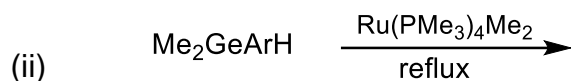
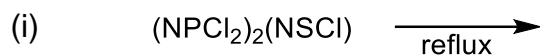
(b) Size exclusion chromatography can be used to determine the molecular weight distribution of a polymer.

(i) Explain the principle of the technique.

(ii) Sketch the size exclusion chromatogram that show the heavier and lighter molecular weight of polymer, and state how the number and weight average molecular weight can be obtained from the data.

(10 marks)

(c) Predict the product of the following reactions;



(5 marks)

3. (a) Figure 1 shows a methane, CH₄ gas uptake with and without the presence of copper(II)-benzene-1,3,5-tricarboxylate, Cu-BTC metal organic frameworks (MOFs).

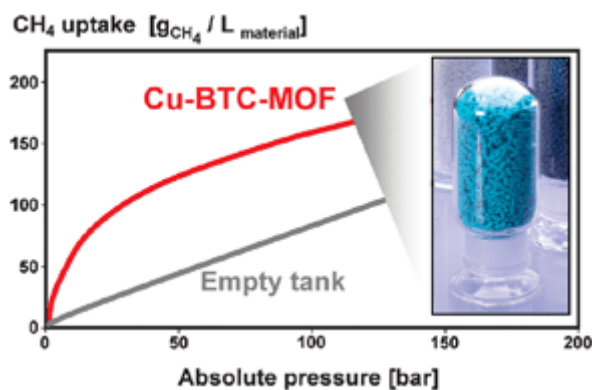


Figure 1

- (i) Sketch the structure of repeating unit in Cu-BTC MOFs.
- (ii) Explain the observation in gas intake from the graph in Figure 1.
- (iii) Explain on why the Cu-BTC MOFs can be useful as a material for gas storage and gas purification.

(10 marks)

- (b) Topology and nets are used to describe the types of coordination polymers. Name and sketch a diagram of 3 possible topologies for 2D coordination polymer.

(9 marks)

- (c) Derive mixed-valent polynuclear complexes with suitable example. Explain why mixed-valent cluster is not observed for complexes of main group elements.

(6 marks)

Section B. Answer any **ONE** question.

4. (a) Figure 2 shows a reaction has certain type of selectivity.

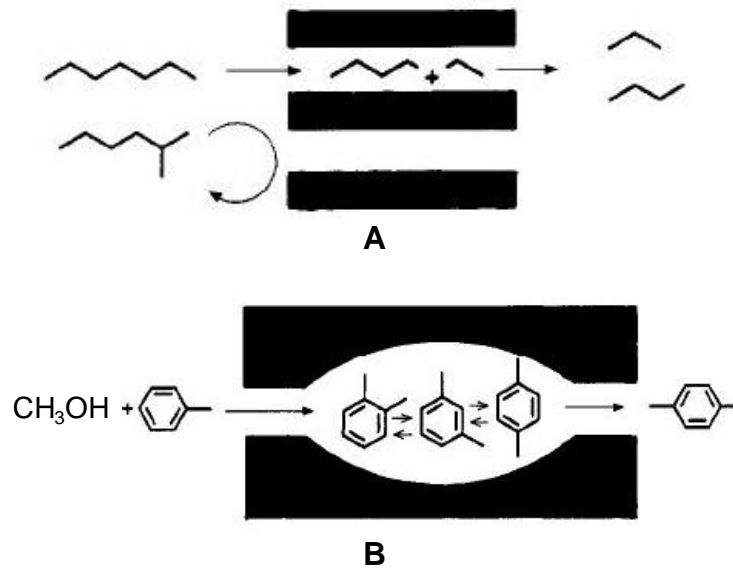


Figure 2

- (i) Define shape-selective catalysis of zeolite.
- (ii) Identify type of selectivity for reaction **A** and **B**.
- (ii) Explain the selectivity for the reaction of **A** and **B**.

(5 marks)

(b) Explain the multilayer formation for adsorption isotherm during the characterization using nitrogen adsorption-desorption analysis.

(4 marks)

(c) The following table shows T_g values for different polymers:

Polymer	T_g ($^{\circ}\text{C}$)
Poly(vinyl chloride)	81
$[\text{Me}_2\text{SiO}]_n$	-123
Natural Rubber	-72
Polypropylene	-20

(i) State the difference in the T_g values with respect to the polymers and explain why polydimethylsiloxane has a low T_g value compared to most organic polymers.

(ii) Relate the T_g values with the properties of the material

(8 marks)

(d) Define Porous Coordination Polymers (PCPs). Explain with examples, three non-covalent interactions that may involve in the formation of stable PCPs.

(8 marks)

5. (a) Photocatalysis is an advanced oxidation process and one of the examples for catalysis on metal oxides surface.

(i) Define photocatalyst and state the requirements of this process.

(ii) Sketch a diagram to show the photocatalysis process.

(iii) Write two applications of photocatalytic process.

(8 marks)

(b) Stannane or tin bridged ferrocenophanes can be polymerized simply by Thermal Ring Opening Method (Thermal ROP).

(i) Develop the mechanistic reaction pathway for the synthesis of organometallic polymer, $[\text{Fe}(\eta^5\text{-C}_5\text{H}_4)_2\text{SnMe}_2]_n$ using monomer of $[\text{Fe}(\eta^5\text{-C}_5\text{H}_4)_2\text{SnMe}_2]$ and methanol as the termination agent.

(ii) Give three uses of polystannane materials in our everyday life.

(9 marks)

(c) Metal-metal interactions are known to be important especially in the formation of polynuclear clusters. If the Van der Waals radius for silver atom is 172 ppm, calculate the ideal distance of the two adjacent silver atoms in order to form a significant argentophilic interaction. Explain your answer.

(4 marks)

(d) In 2016, Sir Fraser Stoddart won the Nobel Prize in Chemistry for his work in the syntheses of mechanically-interlocked molecular architectures or host-guest molecules. He has demonstrated that these host-guest molecules can be employed as sensors and molecular switches. Determine and explain the characteristics of the element that can be used to design a host for the target guest.

(4 marks)