



Final Examination  
2018/2019 Academic Session

June 2019

**JIK410 – Advanced Inorganic Chemistry  
(Kimia Takorganik Lanjutan)**

Duration : 3 hours  
(Masa : 3 jam)

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

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **TUJUH (7)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini].*

**Instructions** : Answer **FIVE (5)** questions. Answer the questions in English. You may also answer the questions in Bahasa Malaysia, but not a mix of both languages.

**[Arahan** : Jawab **LIMA (5)** soalan. Jawab soalan-soalan dalam Bahasa Inggeris. Anda juga dibenarkan menjawab soalan dalam Bahasa Malaysia, tetapi campuran antara kedua-dua bahasa ini tidak dibenarkan].

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

*[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunakan].*

1. (a). Define what is an organometallic complex. Give **TWO (2)** examples of organotransition metal complexes and **TWO (2)** examples of organomain group complexes. You are required to give the exemptions to the common rules.

*Takrifkan kompleks organologam. Berikan **DUA (2)** contoh kompleks logam organoperalihan dan **DUA (2)** contoh kompleks logam organo golongan utama. Anda perlu memberi pengecualian kepada peraturan am.*

(8 marks/markah)

- (b). Describe briefly the synthesis of an organotransition metal complex. You are also required to describe the experimental conditions and solvents.

*Huraikan dengan ringkas sintesis kompleks logam organoperalihan. Anda juga perlu menjelaskan keadaan eksperimen dan pelarut.*

(6 marks/markah)

- (c). Describe briefly the synthesis of an organomain group metal complex. You are also required to describe the experimental conditions and solvents.

*Huraikan dengan ringkas sintesis kompleks logam organo golongan utama. Anda juga perlu menjelaskan keadaan eksperimen dan pelarut.*

(6 marks/markah)

2. Calculate the number of valence electron per metal for the following complexes. Assume all the complexes adopt the *closo* structure. You are required to show the method of calculation. Marks will not be given if the method is not shown.

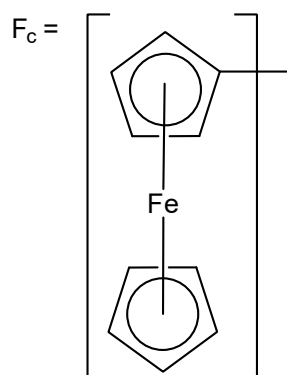
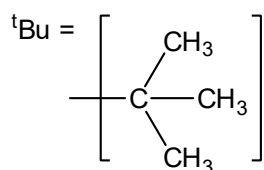
*Kira bilangan elektron valens per logam untuk kompleks berikut. Andaikan semua kompleks mengadaptasi struktur kloso. Anda dikehendaki menunjukkan cara pengiraan. Markah tidak akan diberikan jika cara pengiraan tidak ditunjukkan.*

- (a).  $\text{VCO}_6$   
 (b).  $(\eta^5\text{-C}_5\text{F}_5)_2\text{Fe}$   
 (c).  $\text{Ru}_3(\text{CO})_9(\text{dppm})(\text{AsPh}_3)$   
 (d).  $\text{Mn}_2(\text{CO})_9(\text{SbPh}_3)$   
 (e).  $\text{W}(\text{CO})_5(\text{AsMe}_3)$   
 (f).  $\text{H}_2\text{Os}_3(\text{CO})_{10}(\text{PEt}_3)$   
 (g).  $(\mu\text{-H})\text{Ru}_3(\text{CO})_9(2\eta^2, \eta^1\text{-C}_2\text{Bu}^t)$   
 (h).  $\text{H}_4\text{Ru}_4(\text{CO})_{11}(\text{PF}_6)_3$   
 (i).  $\text{Co}_4(\text{CO})_{12}$   
 (j).  $\text{H}_2\text{Ru}_6(\text{CO})_{18}$

Note:

Nota:

dppm =  $\text{Ph}_2\text{P}(\text{CH}_2)\text{PPh}_2$



(20 marks/markah)

...4/-

3. Briefly describe the following organometallic reactions. You are required to give suitable examples for each reaction.

*Jelaskan dengan ringkas tindak balas organologam berikut. Anda perlu memberi contoh yang sesuai untuk setiap tindak balas.*

- (a). oxidative addition reaction  
*tindak balas penambahan oksidaan*
- (b). insertion reaction  
*tindak balas penyelitan*
- (c). reductive elimination reaction  
*tindak balas penyingkiran reduktif*
- (d). heterolytic hydrogenation reaction  
*tindak balas penghidrogenan heterolitik*

(20 marks/markah)

4. Both BASF and Monsanto have developed the methanol carbonylation reaction that produces an acetic acid. Describe, elaborate, compare and contrast the above processes in term of reaction conditions and the catalyst involved in the reaction. Then, explain the advantages of the Monsanto process.

*Kedua-dua BASF dan Monsanto telah membangunkan tindak balas pengkarbonian metanol yang menghasilkan asid asetik. Nyatakan, huraikan, beza dan bandingkan proses di atas dari segi keadaan tindak balas dan pemangkin yang terlibat dalam tindak balas. Kemudian, jelaskan kelebihan proses Monsanto.*

(20 marks/markah)

5. Discuss the following statement:

*Bincangkan pernyataan berikut:*

(a). CO stretching frequency as a tool to differentiate the type of bonding of CO ligand to the transition metal.

*Frekuensi regangan CO sebagai peranti untuk membezakan jenis ikatan ligan CO kepada logam peralihan.*

(6 marks/markah)

(b). Back bonding between a transition metal and an olefin ligand.

*Ikatan berbalik antara logam peralihan dan ligan olefin.*

(6 marks/markah)

(c). The electronic and steric effect of phosphine ligand is observed when bonded to a metal centre. You are required to give suitable examples.

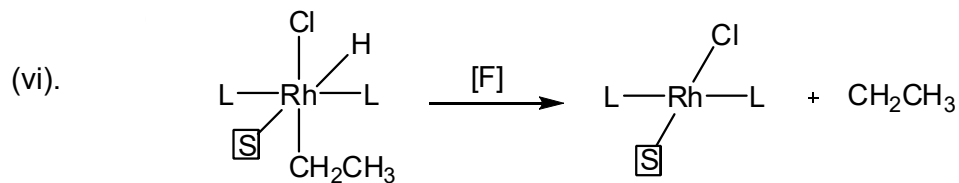
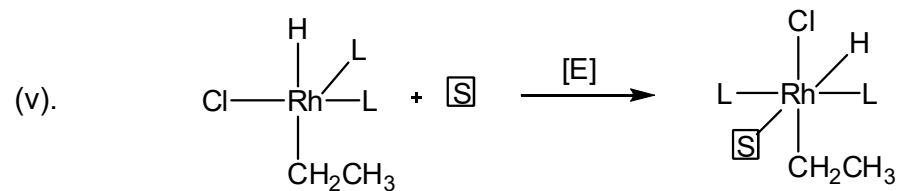
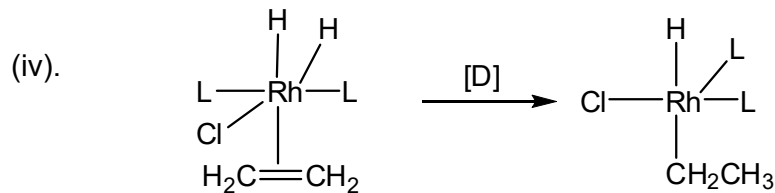
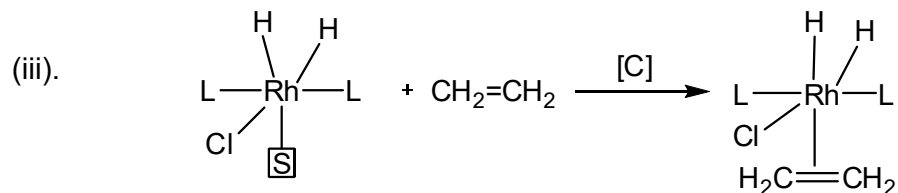
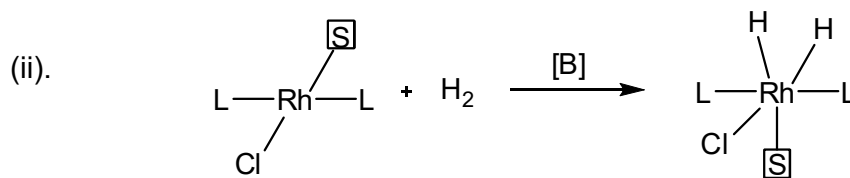
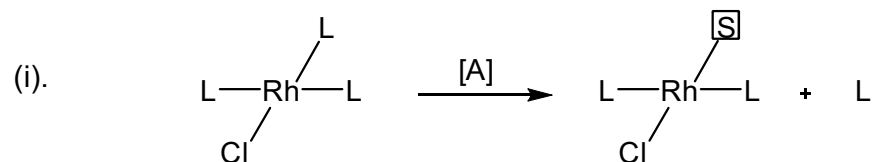
*Kesan elektronik dan sterik ligan fosfin apabila terikat pada logam pusat. Anda perlu memberi contoh-contoh yang sesuai.*

(8 marks/markah)

6. Olefin hydrogenation reaction using Wilkinson's catalyst is postulated to involve the following steps (step (i). to (vi).).

*Tindak balas penghidrogen olefin menggunakan mangkin Wilkinson melibatkan langkah-langkah berikut (langkah (i). hingga (vi).).*

(L = PPh<sub>3</sub> ; S = solvent/pelarut)



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- (a). State and elaborate the types of reaction (i). to (vi).

*Nyatakan dan huraikan jenis tindak balas (i). hingga (vi).*

(12 marks/markah)

- (b). Count and state the number of valence electrons for all the complexes in reactions (i). to (vi). involved in the catalytic process above.

*Kira dan nyatakan bilangan elektron valens untuk setiap kompleks dalam tindak balas (i). hingga (vi). yang terlibat dalam proses pemangkinan di atas.*

(8 marks/markah)

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