Final Examination
2017/2018 Academic Session

May/June 2018

JIK410 – Advanced Inorganic Chemistry
[Kimia Takorganik Lanjutan]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **SIX** printed pages before you begin the examination.

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.

All answers must be written in the answer booklet provided.

Each question is worth 20 marks and the mark for each sub question is given at the end of that question.

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

*Sila pastikan bahawa kertas peperiksaan ini mengandungi **ENAM** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*

*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.*

Setiap jawapan mesti dijawab di dalam buku jawapan yang disediakan.

Setiap soalan bernilai 20 markah dan markah subsoalan diperlihatkan di penghujung subsoalan itu.

Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.

…2/-

1. (a). Define organometallic compound and give **TWO (2)** examples each of organo main group compounds and organotransition metal compounds. You are required to give the exemption to the common rules.

*Takrif sebatian organologam dan berikan **DUA (2)** contoh bagi setiap sebatian-sebatian organo kumpulan utama dan logam organo-peralihan. Anda dikehendaki untuk memberi pengecualian kepada peraturan am.*

[10 marks/*markah*]

(b). Give an example of a synthesis of an organotransition metal compound. Elaborate the various steps in the synthesis of that compound. You are required to explain step by step the synthesis and give the relevant chemical equations. You are also required to explain the method used to obtain the pure compound.

Berikan suatu contoh sintesis sebatian logam organo-peralihan. Huraikan pelbagai langkah penyediaan dalam sintesis sebatian tersebut. Anda dikehendaki untuk menjelaskan satu persatu langkah penyediaan dan memberikan persamaan kimia yang bersesuaian. Anda juga dikehendaki untuk menjelaskan kaedah yang digunakan untuk memperolehi sebatian tulen.

[10 marks/*markah*]

2. For the following organometallic compounds, calculate the number of valence electrons per metal. You are required to show the method of calculation. Marks will not be given if the method of calculation is not shown.
Untuk sebatian-sebatian organologam berikut, kira bilangan elektron per logam. Anda dikehendaki menunjukkan cara pengiraan. Markah tidak akan diberi jika cara pengiraan tidak ditunjukkan.

(a). $(\eta^5\text{-Cp})Ni(NO)$

(b). $[V(CO)_6]^-$

(c). $H_4Ru_4(CO)_{11}(SbPh_3)$

(d). $H_2Ru_3(CO)_9(\eta^1, 2\eta^2\text{-}C_2Bu^t)$

(e). $HRhRu_3(CO)_{13}$

(f). $W(CO)_5(AsMe_3)$

(g). $Re_2(CO)_{10}$

(h). $(\eta^5\text{-Cp})Mn(CO)_3$

(i). $Co_4(CO)_{12}$

(j). $H_2Ru_6(CO)_{18}$

*Note/*nota*: [Cp = cyclopentadienyl/*siklopentadienil*, Bu^t = tertiary-butyl/*butil- tertier*]

[20 marks/*markah*]

3. (a). Assume the following compounds obey the 18 electron rule and has the *closo* structure, calculate the number of metal-metal (M-M) bond(s). You are required to show the method of calculation. Marks will not be given if the method of calculation is not shown.

Andaikan sebatian-sebatian berikut mematuhi hukum 18 elektron dan mempunyai struktur kloso, kira bilangan ikatan(-ikatan) logam-logam (M-M). Anda dikehendaki menunjukkan cara pengiraan. Markah tidak akan diberi jika cara pengiraan tidak ditunjukkan.

(i). $Fe_3(CO)_{10}(\mu\text{-}CO)_2$

(ii). $[Cp(CO)_2Mo]_2$

(iii). $(\mu\text{-}H)_2Os_3(CO)_8(dppm)$

(iv). $(\mu\text{-}H)_2\,[Cp(NO)W(H)]_2$

(v). $[Mn(CO)_4]_2(\mu\text{-}Br)_2$

*Note/*nota*: [Cp = cyclopentadienyl/*siklopentadienil*;
dppm = bis(diphenylphosphino)methane/*bis(difenilfosfino)metana*]

[10 marks/*markah*]

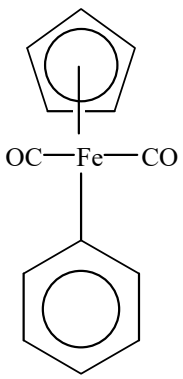
(b). Name the following organometallic complexes according to the IUPAC system.

Namakan kompleks-kompleks organologam berikut mengikut sistem IUPAC.

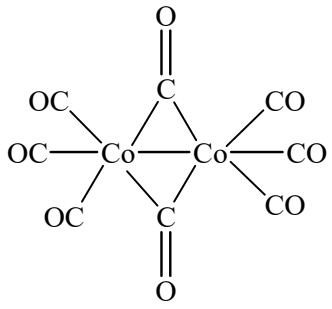
(i). Et_2Me_2Sn

(ii). $(CH_3)_2Hg$

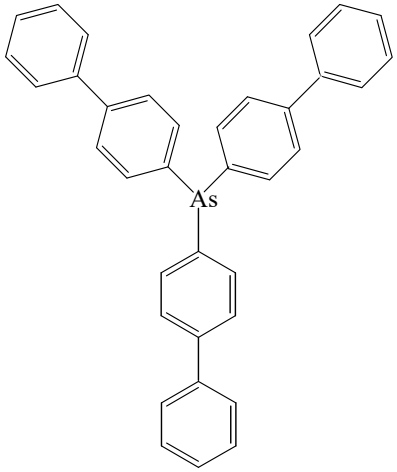
(iii).



(iv).



(v).



[10 marks/*markah*]

4. (a). State and elaborate why organotransition metal complexes are good catalyst for many chemical reactions. You are required to include suitable examples and also discuss the properties that are relevant to catalysis.

Nyatakan dan huraikan mengapa kompleks-kompleks logam organo-peralihan adalah mangkin yang baik untuk kebanyakan tindak balas kimia. Anda dikehendaki memberi contoh-contoh yang bersesuaian dan juga bincangkan sifat-sifat yang berkaitan terhadap pemangkinan.

[14 marks/*markah*]

(b). Briefly discuss the advantages and disadvantages of homogenous catalyst and heterogeneous catalyst.

Huraikan secara ringkas kelebihan dan kekurangan mangkin homogen dan mangkin heterogen.

[6 marks/*markah*]

…6/-

5. Industrial carbonylation of methanol uses **TWO (2)** types of catalysts namely rhodium (Rh) and cobalt (Co). Use the relevant catalytic cycle to compare and contrast the two processes.

*Proses pengkarbonilan metanol pada skala industri menggunakan **DUA (2)** jenis mangkin iaitu rodium (Rh) dan kobalt (Co). Dengan menggunakan kitar pemangkinan yang sesuai, bandingkan dan bezakan kedua-dua proses ini.*

[20 marks/*markah*]

6. Describe and discuss the following types of organometallic reactions:

(a). reductive elimination

(b). insertion reaction

(c). **THREE (3)** types of hydrogenation reactions between hydrogen molecule and organometallic complexes

Nyatakan dan huraikan jenis tindak balas-tindak balas organologam berikut:

(a). penyingkiran reduktif

(b). tindak balas penyelitan

*(c). **TIGA (3)** jenis tindak balas hidrogenasi antara molekul hidrogen dan kompleks-kompleks organologam*

[20 marks/*markah*]

- oooOooo -