UNIVERSITI SAINS MALAYSIA

Final Examination
2016/2017 Academic Session

May/June 2017

JIK 410 – Advanced Inorganic Chemistry
[Kimia Takorganik Lanjutan]

Duration : 3 hours
[Masa : 3 jam]

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

Answer **FIVE** 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 **TUJUH** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*

*Jawab **LIMA** 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.

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1. Elaborate and discuss briefly the following organometalic reactions.
Huraikan dan bincangkan dengan ringkas jenis-jenis tindak balas organologam berikut.

   (a) Oxidative addition
   Penambahan oksidaan

   (b) Reductive elimination
   Penyingkiran reduktif

   (c) Insertion reaction
   Tindak balas penyelitan

   (d) Metallation reaction
   Tindak balas pelogaman.

   (20 marks/*markah*)

2. Both BASF and Monsanto have developed the methanol carbonylation reaction that produces acetic acid. Elaborate, compare and contrast the above processes. Explain the advantages of the Monsanto process.
BASF dan Monsanto telah membangunkan proses pengkarbonilan metanol untuk menghasilkan asid asetik. Huraikan, dengan mengambilkira persamaan dan perbezaan proses di atas. Jelaskan kelebihan proses Monsanto.

   (20 marks/*markah*)

3. Discuss the following:-

   (a) Cone angle of a tertiary phosphine ligand.

   (b) The use of CO stretching frequency (υ_{co}) in carbonyl chemistry.

   (c) Back bonding between an alkyne and a transition metal, M. (M–C≡CR)

   Bincangkan perkara-perkara berikut:-

   (a) Sudut kon ligan fosfin tertier.

   (b) Penggunaan frekuensi renggangan CO (υ_{co}) di dalam kimia karbonil.

   (c) Ikatan berbalik di antara logam peralihan, M dengan alkuna. (M–C≡CR)

   (20 marks/*markah*)

4. (a) What is the definition of an organometallic compounds.
   Apakah definisi sebatian organologam.

   (4 marks/*markah*)

   (b) Give four (4) examples of an organometallic compounds (two (2) from main group and two (2) from transition metal).
   Berikan empat (4) contoh sebatian organologam (dua (2) daripada logam kumpulan utama dan dua (2) daripada logam peralihan).

   (2 marks/*markah*)

(c) Define σ and π bonds in organometallic compounds. Explain the difference between the two (2) types of bonds.

Apakah definisi pengikatan σ dan π dalam sebatian organologam. Terangkan perbezaan antara dua (2) jenis ikatan.

(4 marks/*markah*)

(d) State and elaborate one method of preparation of a main group organometallic compound and one method of preparation of an organotransition metal compound.

Nyatakan dan huraikan satu cara penyediaan sebatian organologam kumpulam utama dan satu cara penyediaan sebatian organologam kumpulan peralihan.

(10 marks/*markah*)

5. Assuming the following organometallic complexes obey the 18 electron rule and adopt the 'closo' structure:

Andai gugusan organologam berikut mematuhi hukum 18 elektron dan membentuk struktur kloso:

(a) $[CpMo(CO)(PPh_3)]_2$ $(Cp \equiv \eta^5\text{-}C_5H_5)$

(b) $(\mu_2\text{-}H)_2Os_3(CO)_9(AsPh_3)$

(c) $Co_4(CO)_{10}(SbPh_3)(PMe_3)$

(d) $[Pt_3(CO)_5(PMe_3)]^{2-}$

(e) $[CpFe(\mu_2\text{-}CO)(CO)]_2$ $(Cp \equiv \eta^5\text{-}C_5H_5)$

(f) $(\mu_2\text{-}H)_4Ru_4(CO)_8(dppm)(dpam)$

dppm = $Ph_2PCH_2PPh_2$

dpam = $Ph_2AsCH_2AsPh_2$

(g) $(\mu\text{-}H)_2Ru_3(CO)_9(\mu_3\text{-}S)$

(i) Calculate the number of metal-metal bond(s) for complexes (a) to (g).

Kira bilangan ikatan logam-logam untuk sebatian-sebatian (a) hingga (g).

(ii) Draw the molecular structure for the following complexes (a) to (g).

Lukiskan struktur molekul untuk sebatian-sebatian (a) hingga (g) berikut.

[Method of calculation **MUST** be shown, marks will **NOT** be given if the method of calculation is not shown].

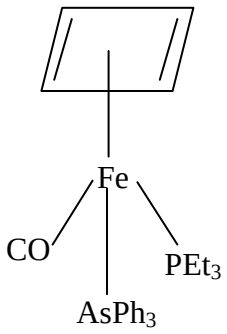
*[Cara pengiraan **MESTI** ditunjukkan, markah **TIDAK** akan diberikan sekiranya cara pengiraan tidak ditunjukkan]*.

(20 marks/*markah*)

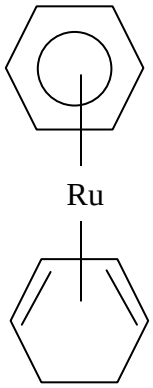
6. If the following organometallic complexes obey the 18 electron rule and adopt the *closo* structure,
Jika kompleks organologam berikut mematuhi hukum 18 elektron dan mempunyai struktur kloso,

(a) $(\mu\text{-H})_4Ru_4(CO)_9(ARPHOS)(AsPh_3)$
ARPHOS≡ $Ph_2\ As(CH_2)_2\ PPh_2$

(b)



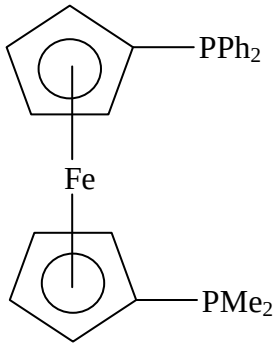
(c)



(d) $Ru_3(CO)_8(dpam)(dppe)$
dpam ≡ $Ph_2AsCH_2AsPh_2$

dppe ≡ $Ph_2P(CH_2)_2PPh_2$

(e)



(i) calculate the number of valence electrons per metal for complexes (a) to (e).

Kira bilangan elektron valens per logam untuk kompleks (a) hingga (e).

(ii) Name complexes (a) to (e) according to the IUPAC rule.

Namakan kompleks (a) hingga (e) mengikut peraturan IUPAC.

[Method of calculation **MUST** be shown. Marks will **NOT** be given if the method of calculation is not shown].

*[Anda dikehendaki menunjukkan cara pengiraan anda. Markah **TIDAK** akan diberikan sekiranya cara pengiraan tidak ditunjukkan]*.

(20 marks/*markah*)

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