

INDEX NO:- .....

---

UNIVERSITI SAINS MALAYSIA

First Semester Examination  
2010/2011 Academic Session

November 2010

**KOT 121 – Organic Chemistry I**  
*[Kimia Organik I]*

Duration: 3 hours  
*[Masa : 3 jam]*

---

Please check that this examination paper consists of FORTY SIX pages of printed materials before you begin the examination.

**Instructions:**

**PART A** (40 marks), comprising 40 multiple-choice questions (MCQ), **has to be answered within the first hour of the examination on the OMR forms provided. The completed OMR forms will be collected one hour after the commencement of the examination.**

**PART B** (60 marks) consists of essay-type questions. Answer any **THREE (3)** questions.

Answer each question on a new page.

You may answer either in Bahasa Malaysia or in English.

Ensure that your OMR form is complete [with your index number, course code, answers to the questions]. Use only a 2B pencil on your OMR form.

Submit the answer scripts and question paper to the Invigilator before you leave the Examination Hall at the end of the examination.

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

## **SECTION B (60 MARKS)**

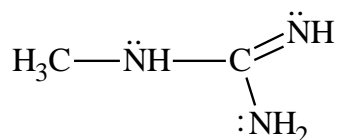
**Answer THREE questions.**

Only the first THREE questions answered in the answer book will be marked.

You must start each question on a new page.

**This section contains FOUR questions.**

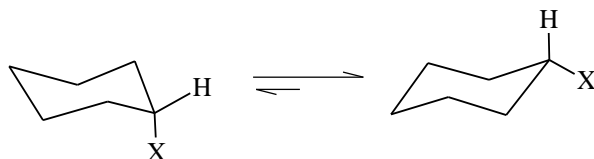
1. (a) The following compound can become protonated on any of the nitrogen atoms. However, one of these nitrogen atoms is much more basic than the others.



- (i) Draw the important resonance forms of the products of protonation on EACH of the three nitrogen atoms (include the formal charge).
- (ii) Determine which nitrogen atom is the most basic. Give reasons for your choice.

(8 marks)

(b)



X	$\Delta G$ (axial-equatorial)
	(kJ/mol)
-CH <sub>3</sub>	7.6
-CH <sub>2</sub> CH <sub>3</sub>	7.9
-CH(CH <sub>3</sub> ) <sub>2</sub>	8.8
-C(CH <sub>3</sub> ) <sub>3</sub>	23.0

From the data provided, the axial-equatorial energy difference for methyl, ethyl, and isopropyl groups increases gradually. The *t*-butyl group jumps to an energy difference of over twice the value for isopropyl group.

- (i) Draw chair conformers of the axial conformations of isopropylcyclohexane and *t*-butylcyclohexane.
- (ii) Explain why cyclohexane bearing the *t*-butyl substituent experiences such a large increase in axial energy over the isopropyl group.

(8 marks)

(c) Name the following compounds:

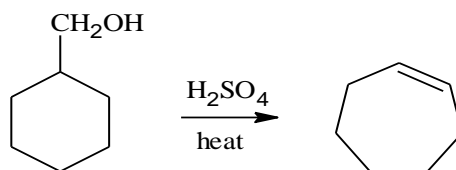
(i)

(ii)

(4 marks)

2. (a) Write a step-by-step mechanism for the reactions below:

(i)



(ii)

(6 marks)

- (b) One of the constituents of turpentine is  $\alpha$ -pinene,  $C_{10}H_{16}$ . The following scheme gives some reactions of  $\alpha$ -pinene. Draw the structure of  $\alpha$ -pinene and the organic products generated in the reactions, **A** through **E**.

(6 marks)

- (c) Show how you would synthesize each of the following compounds using 3,3-dimethylbut-1-ene as your starting material.

(i)

(iii)

(ii)

(iv)

(8 marks)

3. (a) Consider the following reaction:

- (I) Draw the mechanism for this reaction using curved arrows.
- (II) What happens to the reaction rate in each of the following instances?
- (i) The leaving group is changed from I<sup>-</sup> to Cl<sup>-</sup>.
  - (ii) The solvent is changed from H<sub>2</sub>O to DMF.
  - (iii) The alkyl halide is changed from (CH<sub>3</sub>)<sub>2</sub>C(I)CH<sub>2</sub>CH<sub>3</sub> to (CH<sub>3</sub>)<sub>2</sub>CHCH(I)CH<sub>3</sub>.

(6 marks)

- (b) Draw a stepwise, detailed mechanism (using curved arrows) for the following reaction.

(4 marks)

- (c) Draw the organic product of each of the following reactions and indicate the stereochemistry of any chiral centers.

(i)

(ii)

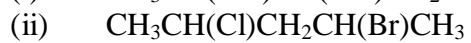
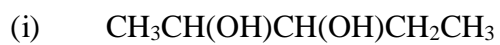
(6 marks)

(d) Identify the organic products **A** and **B** in the following reaction sequence.



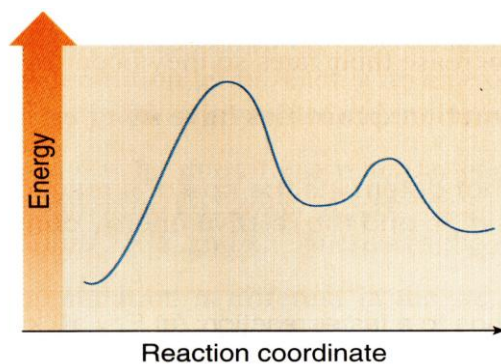
(4 marks)

4. (a) Draw all possible stereoisomers for the following compounds. Label pairs of enantiomers and diastereomers.



(4 marks)

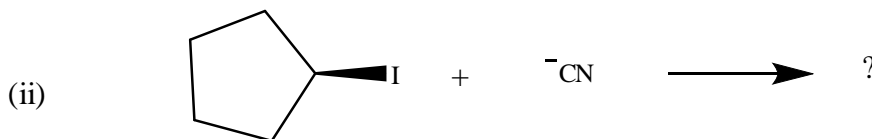
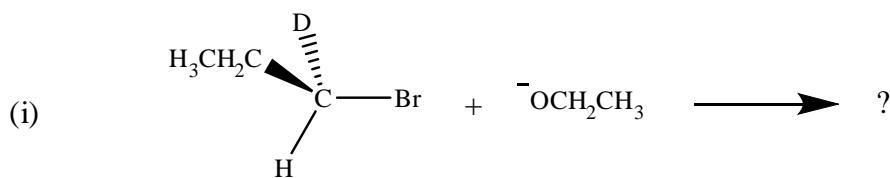
(b) Consider the following energy diagram.



- (i) How many steps are involved in this reaction?
- (ii) Label  $\Delta H^\circ$  and  $E_a$  for each step.
- (iii) Label the overall  $\Delta H^\circ$ .
- (iv) Label each transition state.
- (v) Which point on the graph corresponds to a reactive intermediate?
- (vi) Which step is rate-determining?
- (vii) Is the overall reaction endothermic or exothermic?

(6 marks)

- (c) Give the organic product for each of the following reactions. Predict the mechanism, which accounts for its formation.



(4 marks)

- (d) Identify the organic products **A-F** in the following reaction sequence.

(6 marks)



## TERJEMAHAN

---

### Arahan:

**BAHAGIAN A** (40 markah, mengandungi 40 soalan objektif (MCQ), **perlu dijawab dalam masa 1 jam pertama di dalam borang jawapan OMR yang disediakan. Borang OMR akan dikutip 1 jam selepas peperiksaan bermula.**

**BAHAGIAN B** (60 markah), mengandungi soalan bertulis. Jawab **TIGA** (3) soalan sahaja. Jawab setiap soalan di muka surat yang baru.

Anda dibenarkan menjawab soalan ini sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.

Pastikan borang OMR diisi dengan lengkap [nombor angka giliran, kod kursus, jawapan]. Gunakan hanya pensil 2B bagi borang OMR.

Sila serahkan buku jawapan dan kertas soalan ini kepada pengawas sebelum anda keluar dari dewan peperiksaan.

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

**BAHAGIAN B** (60 MARKAH)

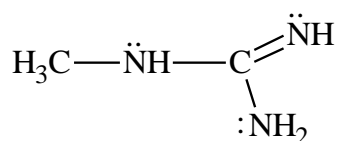
**Jawab sebarang TIGA soalan.**

Hanya TIGA jawapan yang pertama akan diperiksa.

Jawab tiap-tiap soalan pada muka surat yang baru.

**Bahagian ini mengandungi EMPAT soalan.**

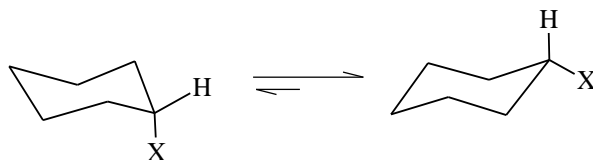
- 1 (a) Setiap atom nitrogen bagi sebatian di bawah dapat diprotonkan. Walau bagaimanapun, salah satu daripada atom nitrogen tersebut lebih berbes berbanding atom nitrogen yang lain



- (i) Lukiskan struktur resonans yang penting (termasuk cas formal) bagi hasil pemprotonan bagi setiap atom nitrogen.
- (ii) Tentukan atom nitrogen yang paling berbes. Berikan sebab bagi pilihan anda.

(8 markah)

(b)



X	$\Delta G$ (aksial-khatulistiwa) (kJ/mol)
-CH <sub>3</sub>	7.6
-CH <sub>2</sub> CH <sub>3</sub>	7.9
-CH(CH <sub>3</sub> ) <sub>2</sub>	8.8
-C(CH <sub>3</sub> ) <sub>3</sub>	23.0

Menurut data yang diberikan, perbezaan tenaga pertukaran antara aksial-khatulistiwa bagi kumpulan metil, etil dan isopropil meningkat secara beransur. Perbezaan tenaga antara pertukaran aksial-khatulistiwa bagi kumpulan *t*-butil meningkat secara mendadak, lebih daripada dua kali perbezaan tenaga pertukaran bagi kumpulan isopropil.

- (i) Lukiskan konformasi aksial bagi isopropilsikloheksana dan *t*-butilsikloheksana.
- (ii) Terangkan kenapa perbezaan tenaga pertukaran antara aksial-khatulistiwa bagi kumpulan penukarganti *t*-butil meningkat secara mendadak dibandingkan dengan perbezaan tenaga pertukaran antara aksial-khatulistiwa bagi kumpulan isopropil

(8 markah)

(c) Berikan nama bagi sebatian berikut:

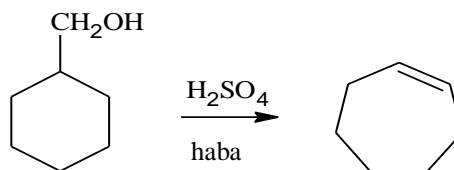
(i)

(ii)

(4 markah)

2. (a) Tuliskan suatu mekanisme langkah demi langkah bagi tindak balas di bawah:

(i)



(ii)

(6 markah)

- (b) Salah satu unsur bagi turpentin ialah  $\alpha$ -pinena,  $C_{10}H_{16}$ . Skema berikut memberikan beberapa tindak balas bagi  $\alpha$ -pinena. Lukiskan struktur bagi  $\alpha$ -pinena dan hasil organik **A** hingga **E** yang terbentuk bagi tindak balas tersebut.

(6 markah)

- (c) Tunjukkan bagaimana anda mensintesiskan setiap sebatian berikut dengan menggunakan 3,3-dimetilbut-1-ena sebagai bahan pemula.

(i)

(iii)

(ii)

(iv)

(8 markah)

3. (a) Pertimbangkan tindak balas berikut:

(I) Lukiskan mekanisme bagi tindak balas ini dengan menggunakan anak panah melengkung.

(II) Apakah yang terjadi kepada kadar tindak balas bagi setiap keadaan berikut ?

- i. Kumpulan peninggal ditukarkan daripada  $\Gamma$  kepada  $\text{Cl}$ .
- ii. Pelarut ditukarkan daripada  $\text{H}_2\text{O}$  kepada  $\text{DMF}$ .
- iii. Alkil halida ditukarkan daripada  $(\text{CH}_3)_2\text{C}(\text{I})\text{CH}_2\text{CH}_3$  kepada  $(\text{CH}_3)_2\text{CHCH}(\text{I})\text{CH}_3$ .

(6 markah)

(b) Lukiskan suatu mekanisme langkah demi langkah dan terperinci (menggunkan anak panah melengkung) bagi tindak balas berikut:

(4 markah)

- (c) Lukiskan hasil organik bagi tindak balas berikut dan tunjukkan stereokimia bagi mana-mana pusat kiral.

(i)

(ii)

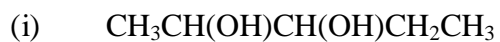
(6 markah)

- (d) Kenalpastikan hasil organik **A** dan **B** bagi urutan tindak balas berikut:



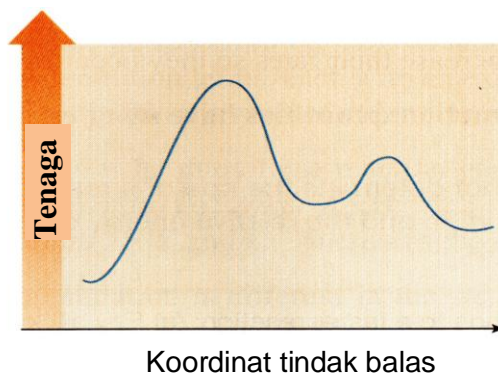
(4 markah)

4. (a) Lukiskan kesemua stereoisomer yang berkemungkinan bagi sebatian berikut. Labelkan pasangan enantiomer dan diastereomer.



(4 markah)

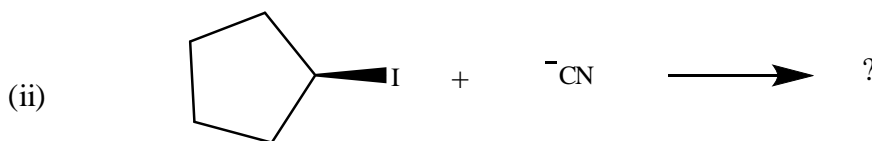
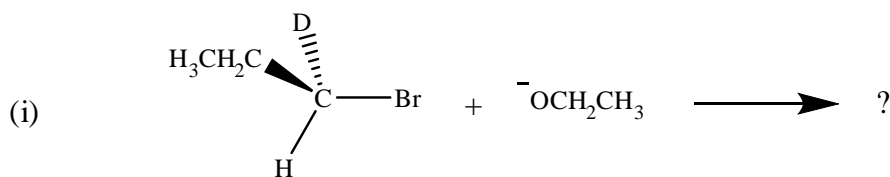
- (b) Pertimbangkan gambar rajah tenaga di bawah.



- (i) Berapakah langkah yang terlibat dalam tindak balas ini?
- (ii) Labelkan  $\Delta H^\circ$  dan  $E_a$  bagi setiap langkah.
- (iii) Labelkan  $\Delta H^\circ$  bagi tindak balas keseluruhan.
- (iv) Labelkan setiap keadaan peralihan.
- (v) Titik manakah pada graf bersesuaian dengan suatu bahan perantaraan yang reaktif?
- (vi) Langkah manakah merupakan langkah penentuan kadar?
- (vii) Adakah tindak balas ini endotermik atau eksotermik pada keseluruhannya?

(6 markah)

- (c) Lukiskan hasil organik bagi setiap tindak balas berikut. Ramalkan mekanisme yang menyumbang kepada pembentukan hasil organik tersebut.



(4 markah)

(d) Kenalpastikan hasil organik **A-F** bagi urutan tindak balas berikut.

(6 markah)