



PAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH AND APPLIED SCIENCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	LEVEL: 7
COURSE CODE: OCH701S	COURSE NAME: ORGANIC CHEMISTRY 2
SESSION: JUNE 2019	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	DR. MARIUS MUTORWA
MODERATOR:	DR. RENATE HANS

<p style="text-align: center;">INSTRUCTIONS</p> <ol style="list-style-type: none">1. Answer ALL the questions.2. Write clearly and neatly.3. Number the answers clearly4. All written work must be done in blue or black ink and sketches must be done in pencil5. No book, notes and other additional aids are allowed
--

PERMISSIBLE MATERIALS

Non-programmable Calculators

ATTACHMENTS

Solvent Chart, pKa Chart and Periodic Table

THIS QUESTION PAPER CONSISTS OF 14 PAGES

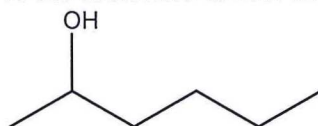
(Including this front page and attachments)

QUESTION 1: Multiple Choice Questions

[50]

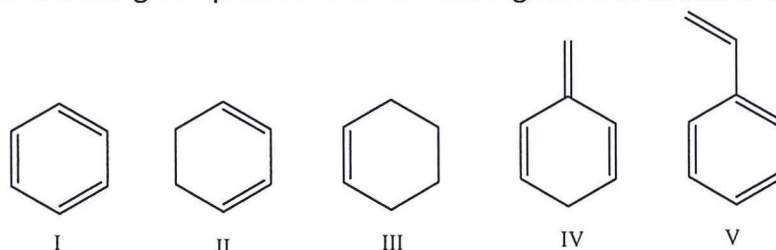
- There are 25 multiple choice questions and each question carries 2 marks.
- Answer ALL questions by selecting the letter of the correct answer.
- Choose the best possible answer for each question, even if you think there is another possible answer that is not given.

1.1 Which of the m/z values correspond to the molecular ion for the following compound?



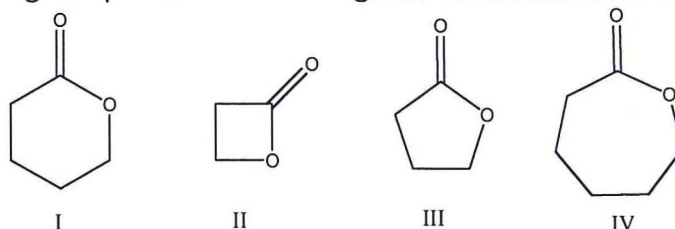
- A. 18
- B. 82
- C. 100
- D. 102
- E. 103

1.2 Which one of the following compounds will have the highest wavenumber for C=C absorption?



- A. I
- B. II
- C. III
- D. IV
- E. V

1.3 Which of the following compounds will have highest wavenumber for carbonyl absorption?



- A. I
- B. II
- C. III
- D. IV
- E. II and III

1.4 Which molecular formula is consistent with the following mass spectrum data?

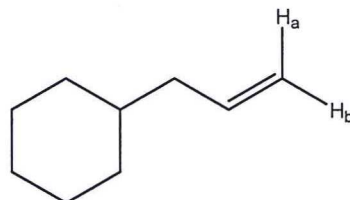
$M^{+\bullet}$ at $m/z = 84$, relative height=10.0%
 $(M+1)^{+\bullet}$ at $m/z = 85$, relative height=0.56%

- A. $C_5H_{10}O$
- B. C_5H_8O
- C. C_5H_{24}
- D. C_6H_{12}
- E. $C_4H_6O_2$

1.5 Which of the following is true about the relationship between the energy gap (ΔE) between the spin states for a 1H nucleus and the strength of the external magnetic field?

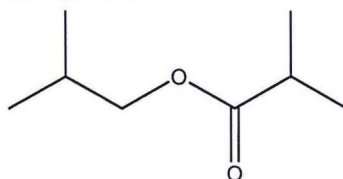
- A. They are inversely proportional
- B. They are directly proportional
- C. There is no relationship
- D. The magnetic field is slightly less
- E. None of the above

1.6 Protons H_a and H_b in the following compound are:



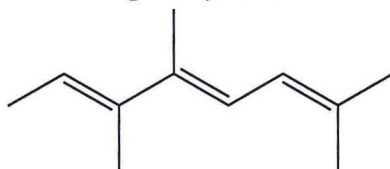
- A. homotopic
- B. Enantiotopic
- C. Diastereotopic
- D. mesotopic
- D. None of the above

1.7 How many signals would you expect to find in the 1H NMR spectrum of the compound below?



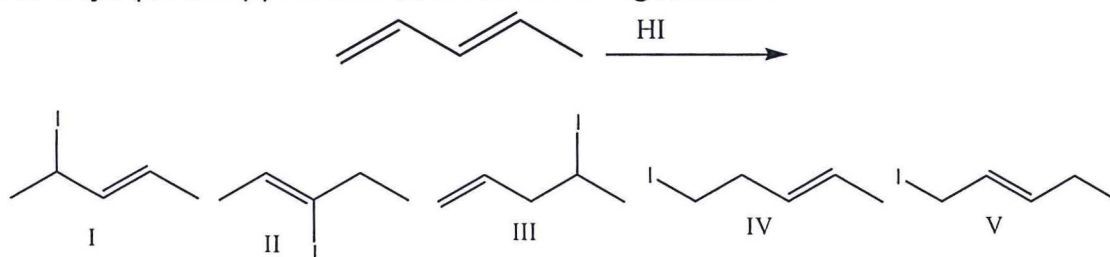
- A. 4
- B. 5
- C. 6
- D. 7
- E. 8

1.8 What is the IUPAC name for the following compound?



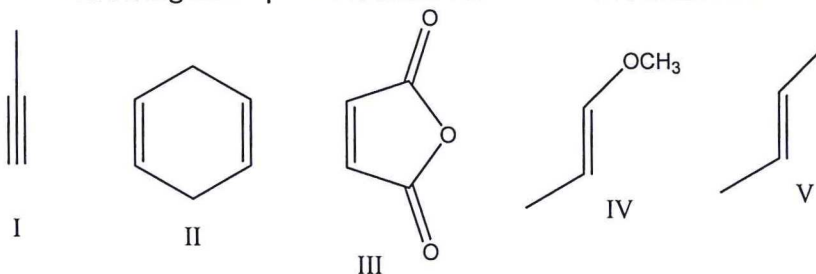
- A. (2E,4Z,6E)-3,4,7,8-tetramethyl-2,4,6-heptatriene
- B. (2Z,4E,)-3,4,7-trimethyl-2,4,6-octatriene
- C. (2E,4Z,6E)-2,5,6,7-tetramethyl-3,5,7-heptatriene
- D. (2E,4Z)-2,5,6-trimethyl-3,5,7-octatriene
- E. (2E,4E,6E)-2,5,6-trimethyl-2,4,6-octatriene

1.9 Which major product(s) are formed for the following reaction?



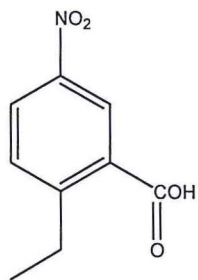
- A. I
- B. II
- C. III
- D. IV
- E. V

1.10 Which one of the following dienophiles is most reactive in the Diels-Alder reaction?



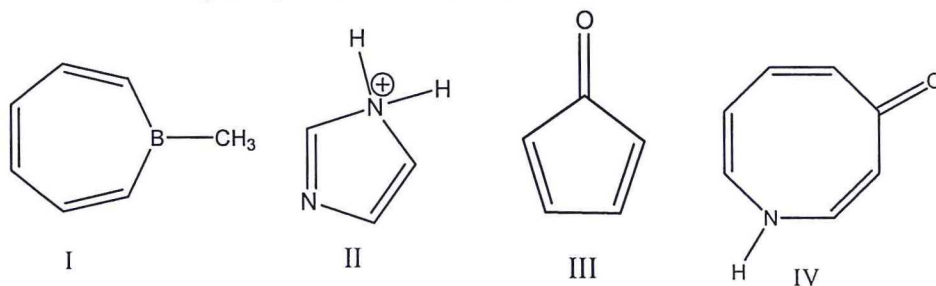
- A. I
- B. II
- C. III
- D. IV
- E. V

1.11 What is the IUPAC name for the following compound?



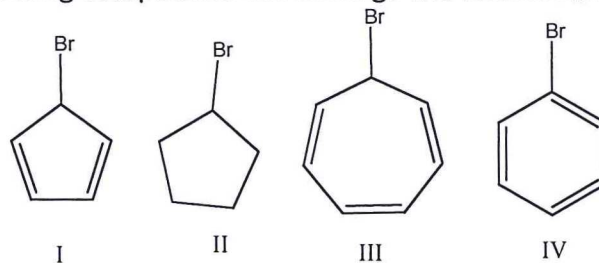
- A. 6-ethyl-3-nitrobenzoic acid
- B. 1-ethyl-4-nitrobenzoic acid
- C. 2-ethyl-5-nitrobenzoic acid
- D. 2-ethyl-5-nitrobenzaldehyde
- E. 4-nitro-3-carboxyethylbenzene

1.12 Which one of the following compounds is aromatic?



- A. I
- B. II
- C. III
- D. IV
- E. I and III

1.13 Which one of the following compounds will undergo the fastest S_N1 reaction?



- A. I
- B. II
- C. III
- D. IV
- E. III and IV

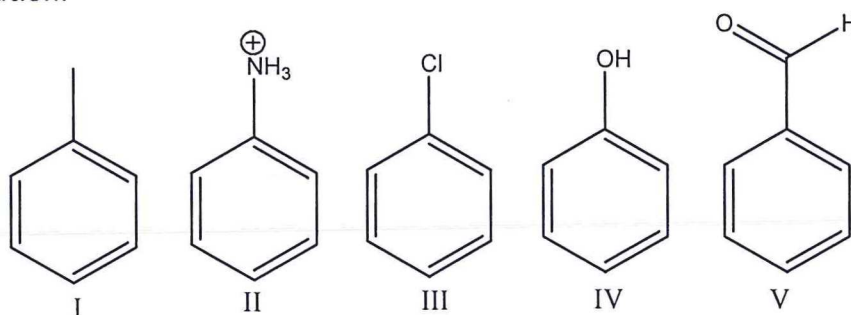
1.14 Which of these is the rate-determining step in the electrophilic aromatic substitution of benzene?

- A. Formation of an electrophile
- B. Formation of sigma complex.
- C. Loss of proton from sigma complex.
- D. Addition of electrophile & loss of proton
- E. None of the above

1.15 Predict the major product for the reaction between benzene and 2-chlorobutane in the presence of AlCl_3 .

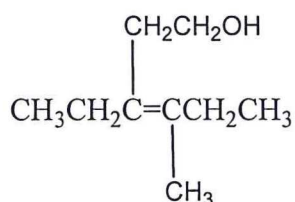
- A. Chlorobenzene
- B. sec-butylbenzene
- C. ethylbenzene
- D. isopropylbenzene
- E. tert-butylbenzene

1.16 Arrange the following compounds in order of decreasing reactivity towards electrophilic aromatic substitution.



- A. $\text{V} > \text{II} > \text{I} > \text{III} > \text{IV}$
- B. $\text{II} > \text{V} > \text{III} > \text{I} > \text{IV}$
- C. $\text{IV} > \text{I} > \text{III} > \text{V} > \text{II}$
- D. $\text{III} > \text{II} > \text{I} > \text{IV} > \text{V}$
- E. $\text{IV} > \text{V} > \text{II} > \text{I} > \text{III}$

1.17 What is the IUPAC name for the following compound?



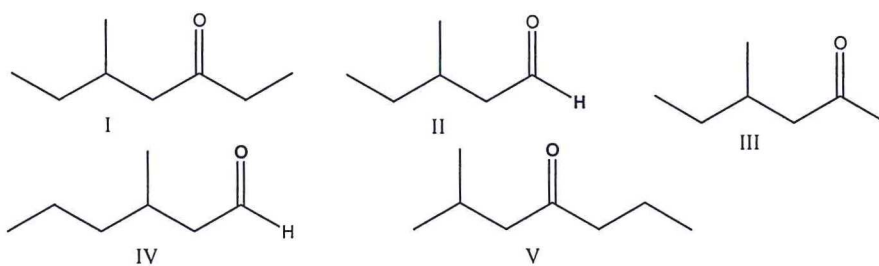
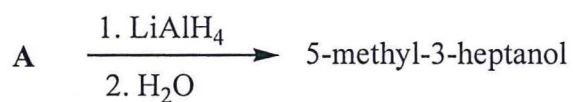
- A. 3-methyl-4-ethyl-3-hexen-6-ol
- B. 4-ethyl-3-methyl-3,6-hexenol
- C. 3-ethyl-4-methyl-3-hexen-1-ol
- D. 3-methyl-4-(2-hydroxyethyl)-3-hexene
- E. 3-(2-hydroxyethyl)-3-methyl-3-hexene

1.18 Provide the reagents necessary to carry out the following conversion.



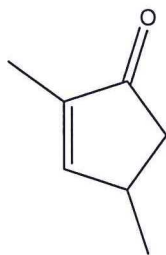
- A. NaOH/H₂O
- B. 1. NaOCH₃, 2. H₃O⁺
- C. 1. (CH₃)₃COK, 2. BH₃, 3. H₂O₂/NaOH/H₂O
- D. 1. (CH₃)₃COK, 2. H₃O⁺
- E. B and D are correct

1.19 Provide the reactant (A) for the following reaction.



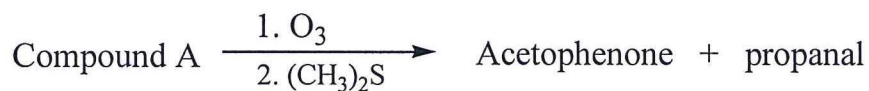
- A. I
- B. II
- C. III
- D. IV
- E. V

1.20 What is the IUPAC name for the following compound?



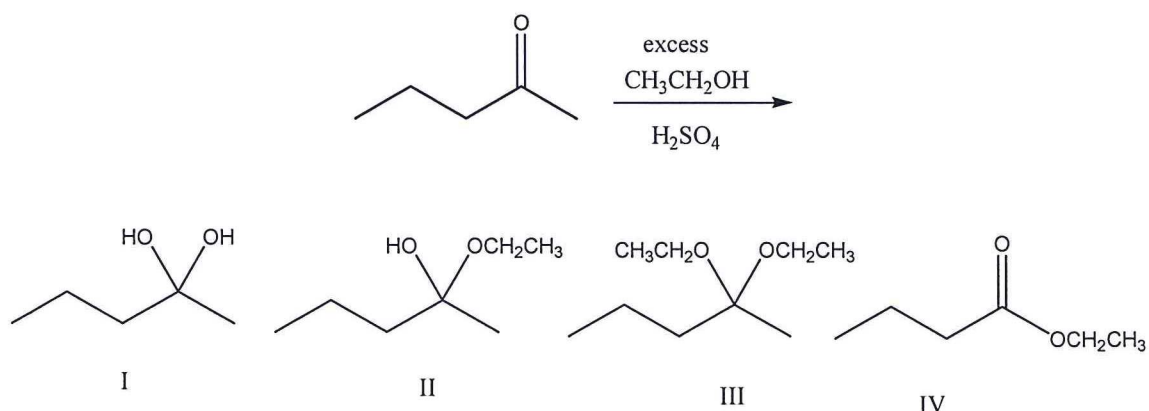
- A. 2,4-dimethyl-2-pentenone
- B. 2,5-dimethylcyclopent-3-one
- C. 2,4-dimethylcyclopent-2-enone
- D. 3,5-dimethylcyclopent-2-enone
- E. 2-methyl-5-methylcyclopent-2-enone

1.21 Compound A on ozonolysis yields acetophenone and propanal. What is the structure of compound A?



- A. 2-phenyl-2-pentene
- B. 1-phenyl-1-hexene
- C. 1-phenyl-2-pentene
- D. 2-phenyl-2-hexene
- E. None of the above

1.22 Predict the product for the following reaction.

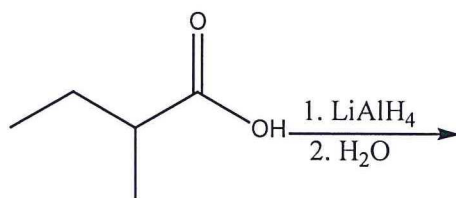


- A. I
- B. II
- C. III
- D. IV
- E. None of the above

1.23 Which one of the following is the strongest acid?

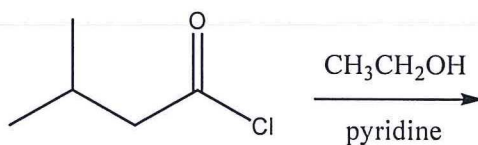
- A. benzoic acid
- B. 4-nitrobenzoic acid
- C. 4-ethylbenzoic acid
- D. 4-chlorobenzoic acid
- E. 4-hydroxybenzoic acid

1.24 Predict the product for the following reaction.



- A. 3-methyl-2-pentanone
- B. 3-methyl-1-propanol
- C. 2-methyl-1-butanol
- D. 3-methyl-2-pentanol
- E. None of the above

1.25 Predict the product for the following reaction.

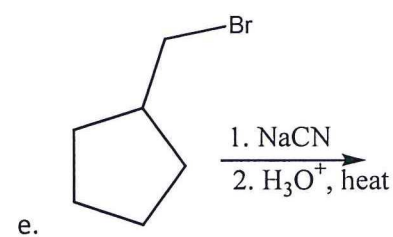
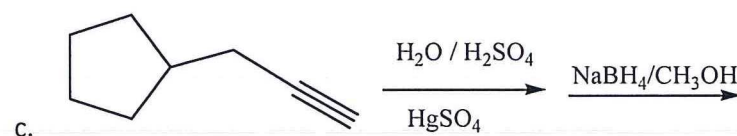
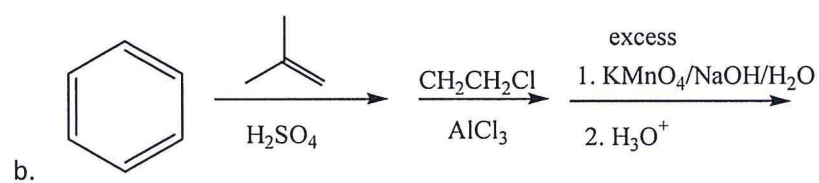
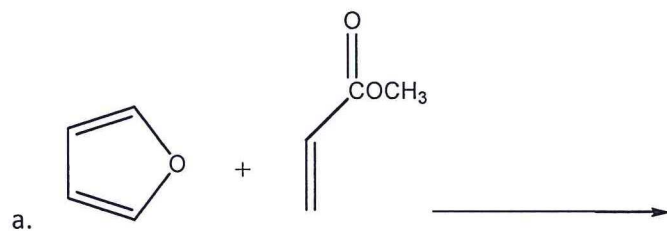


- A. ethyl-3-methylbutanoate
- B. ethyl-2-methylpropanoate
- C. isobutylethanoate
- D. 5-methyl-3-hexanone
- E. None of the above

QUESTION 2

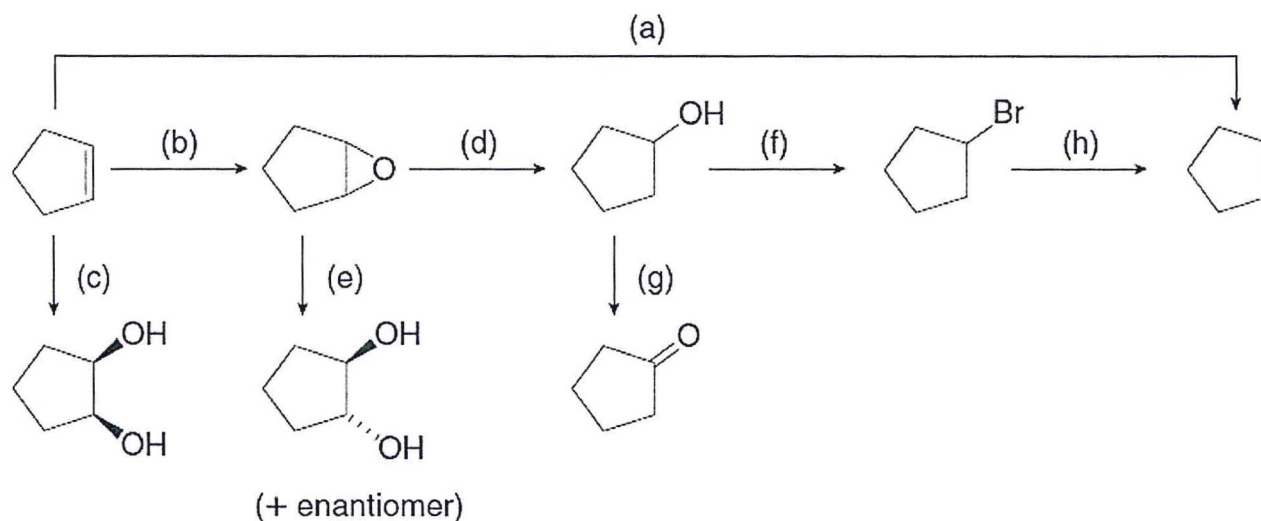
[10]

What is (are) the product(s) of the following reactions?

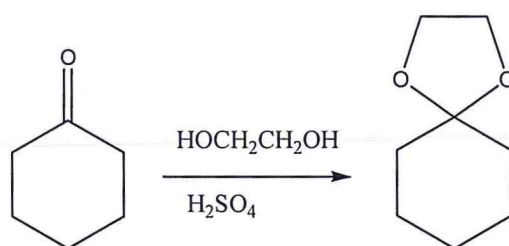
Note: Each question carries 2 marks.

QUESTION 3**[16]**

Identify the reagents (a – h) needed to carry out each organic transformation.

**QUESTION 4****[14]**

Draw a stepwise detailed reaction mechanism for the transformation below. In order to receive full marks, show the flow of electrons using appropriate arrows and all the intermediates.

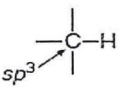
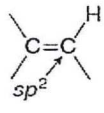
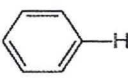
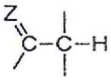


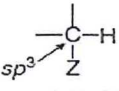
**QUESTION 5****[10]**

A compound with molecular formula $\text{C}_9\text{H}_{10}\text{O}_2$ exhibits a triplet at δ 1.2 ($I=3$), a quartet at δ 2.6 ($I=2$), a doublet at δ 7.3 ($I=2$), a doublet at δ 8.0 ($I=2$) and a singlet at δ 11 ($I=1$) in its ^1H NMR spectrum. The IR spectrum shows a strong absorption band at 3280 cm^{-1} . What is the structure for this compound?


THE END**GOOD LUCK**

^1H NMR SPECTRAL DATA

Characteristic Chemical Shifts of Common Types of Protons

Type of proton	Chemical shift (ppm)	Type of proton	Chemical shift (ppm)
 <ul style="list-style-type: none"> • RCH_3 ~0.9 • R_2CH_2 ~1.3 • R_3CH ~1.7 	0.9–2	 	4.5–6 6.5–8
 $\text{Z} = \text{C}, \text{O}, \text{N}$	1.5–2.5		9–10
$\text{—C}\equiv\text{C—H}$	~2.5		10–12
 $\text{Z} = \text{N}, \text{O}, \text{X}$	2.5–4	RO—H or R—N—H	1–5

Important IR Absorptions

Bond type	Approximate $\bar{\nu}$ (cm^{-1})	Intensity
O—H	3600–3200	strong, broad
N—H	3500–3200	medium
C—H	~3000	
<ul style="list-style-type: none"> • $\text{C}_{\text{sp}^3}\text{—H}$ 3000–2850 strong • $\text{C}_{\text{sp}^2}\text{—H}$ 3150–3000 medium • $\text{C}_{\text{sp}}\text{—H}$ 3300 medium 		
$\text{C}\equiv\text{C}$	2250	medium
$\text{C}\equiv\text{N}$	2250	medium
C=O	1800–1650 (often ~1700)	strong
C=C	1650	medium
	1600, 1500	medium

