⊗ Not an official memo. Completed by a past student of the module.

UNIVERSITY EXAMINATIONS

UNIVERSITEITSEKSAMENS

UNISA university of south africa

CHE1502 (496566) May/June 2016

GENERAL CHEMISTRY IB

Duration 2 Hours 100 Marks

EXAMINERS
FIRST PROF CA SUMMERS
SECOND MR KGLL LESENYEHO

Use of a non-programmable pocket calculator is permissible

Closed book examination.

EXAMINATION PAPER UNIQUE NUMBER: 496566

The examination paper consists of 25 pages plus 5 pages for rough work (pp 26-30) plus instructions for completion of the mark reading sheet

The examination paper consists of two parts:

SECTION A: consists of 30 multiple choice questions- answer on a marking reading sheet.

SECTION B: Written questions - answer in spaces provided on the examination paper.

SECTION A: Each question is allocated TWO marks- 60 marks

SECTION B: 40 marks

The multiple choice questions have four possible answers. In each case, provide only ONE answer to each question

The use of molecular models is permissible

ANSWER ALL QUESTIONS IN SECTION A AND SECTION B

SECTION A

This section consists of **30 MULTIPLE CHOICE QUESTIONS.**

Answer ALL **the questions in this section on the MARK READING SHEET**

Unique Number **496566**

$Na^+ OH^-$ = ionic compound

1 What at type of bonding is present in the compound, sodium hydroxide (NaOH)?

(1) ionic
(2) a mixture of covalent and ionic
(3) polar covalent
(4) nonpolar covalent

and it has polar covalent bonds between atoms (O – H)
δ^- δ^+

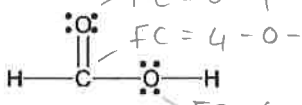
2. Which of the following is the correct Lewis structure for a molecule with molecular formula CH_2O_2?

C H O = 18 valence e^-
4 2 2

(1)

× 16 e^-

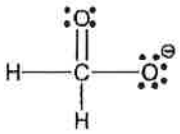
(2)



FC = 6 – 4 – 1/2(4) = 0
FC = 4 – 0 – 1/2(8) = 0
FC = 6 – 4 – 1/2(4) = 0

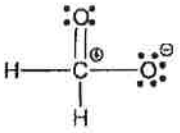
✓ . 18 e^-
. All formal charges = 0

(3)



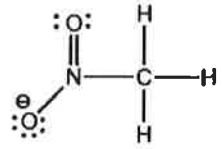
× 20 e^-

(4)



× 20 e^-

3 In the structure below, the formal charge on N is



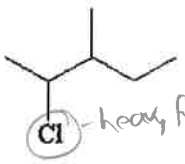
N FC = # valence e⁻ − # non-bonding e⁻ − ½(shared e⁻)
= 5 − 0 − ½(8) = 5 − 4 = (+1)

(1) +1
(2) -1
(3) 0
(4) +2

4 Which of the following has the lowest boiling point?

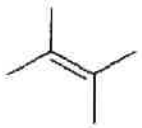
↑ molar mass = ↑ Boiling point
↑ Branching = ↓ Boiling point
↑ Polar functional groups = ↑ Boiling point
↑ possibility of forming H-bonds = ↑ Boiling point

(1)



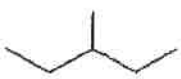
↑ mass = ↑ BP
Cl - heavy functional group

(2)



no polar functional groups
→ More branched
↓ BP

(3)



Linear molecule (↓branching) = ↓ BP
No double bonds
No polar functional groups ∴ lowest BP

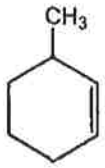
(4)

Polar functional group, capable of forming H bonds = highest BP

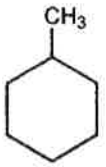
same no. of atoms
different bonding sequence

5 Which of the following pairs of compounds are constitutional isomers?

(1)



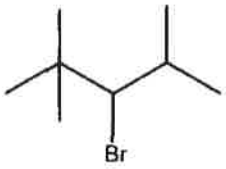
C_7H_{12}



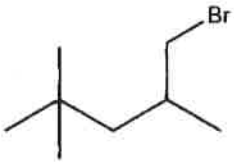
C_7H_{14}

× Diff. no. of H atoms

(2)

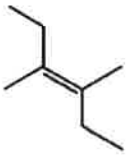


and

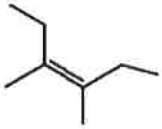


✓ Same no. of atoms
✓ Different bonding sequence.

(3)

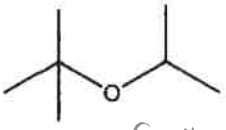


and



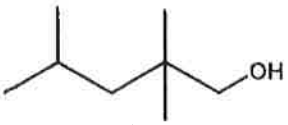
× geometric isomers

(4)



$C_7H_{16}O$

and

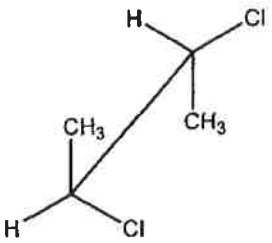


$C_8H_{18}O$

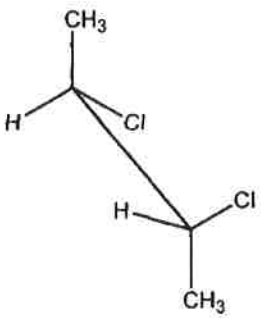
× Diff no. of Carbons + H atoms

6 Which of the following pairs of drawings represent eclipsed conformations?

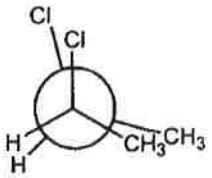
(1)



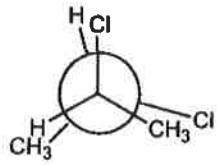
and



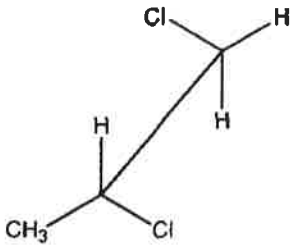
(2)



and



(3)



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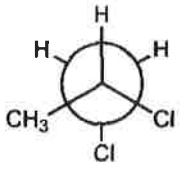
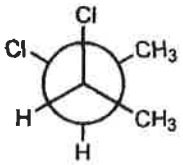
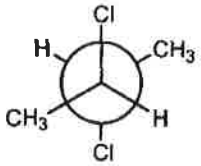


(4)

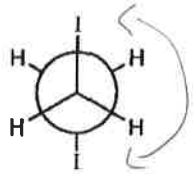


and



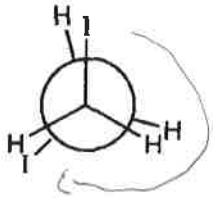
7 The most stable conformation of CH_2ICH_2I is

(1)



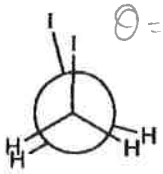
$\theta = 180^\circ$ = Anti (least torsional energy ∴ Most stable)

(2)



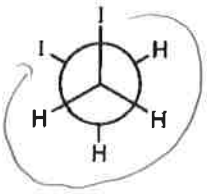
$\theta = 240^\circ$ = Eclipsed. ✗

(3)



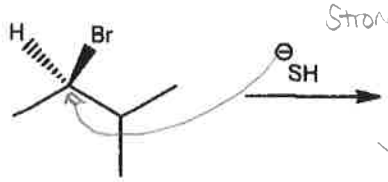
θ = 0° = Totally Eclipsed = least stable ✗

(4)



θ = 300° = Gauche/ Staggered ✗

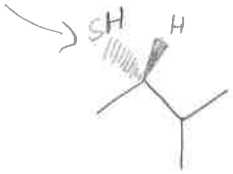
8. Which compound is the MAJOR product of the following reaction?



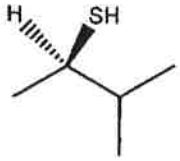
2° substrate

Strong nucleophile

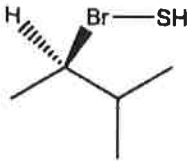
SN2 mechanism (+ inversion of stereochemistry)



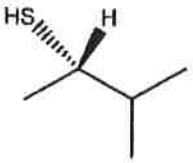
(1)



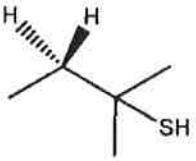
(2)



(3)



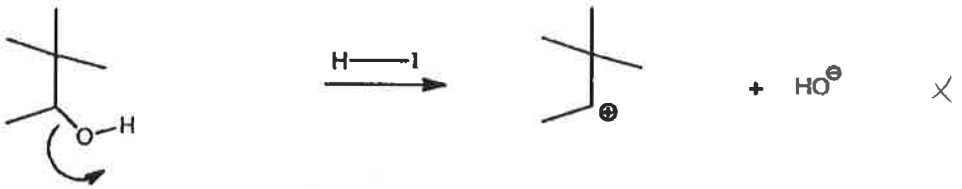
(4)



9 Consider the reactivity of the alcohol functional group and select the process that will take place

(1) protonation of hydrogen. ✓

(2)



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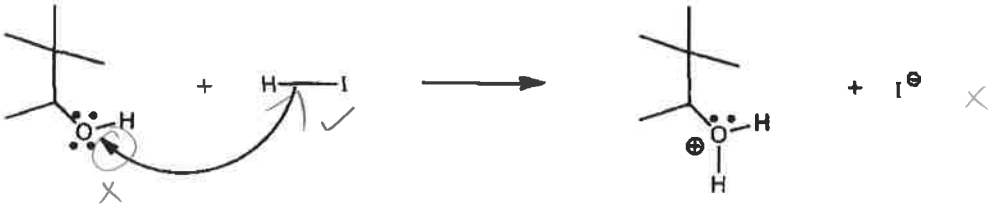
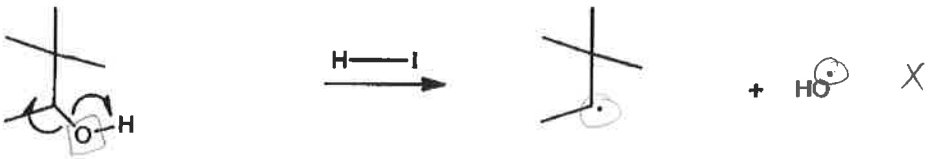


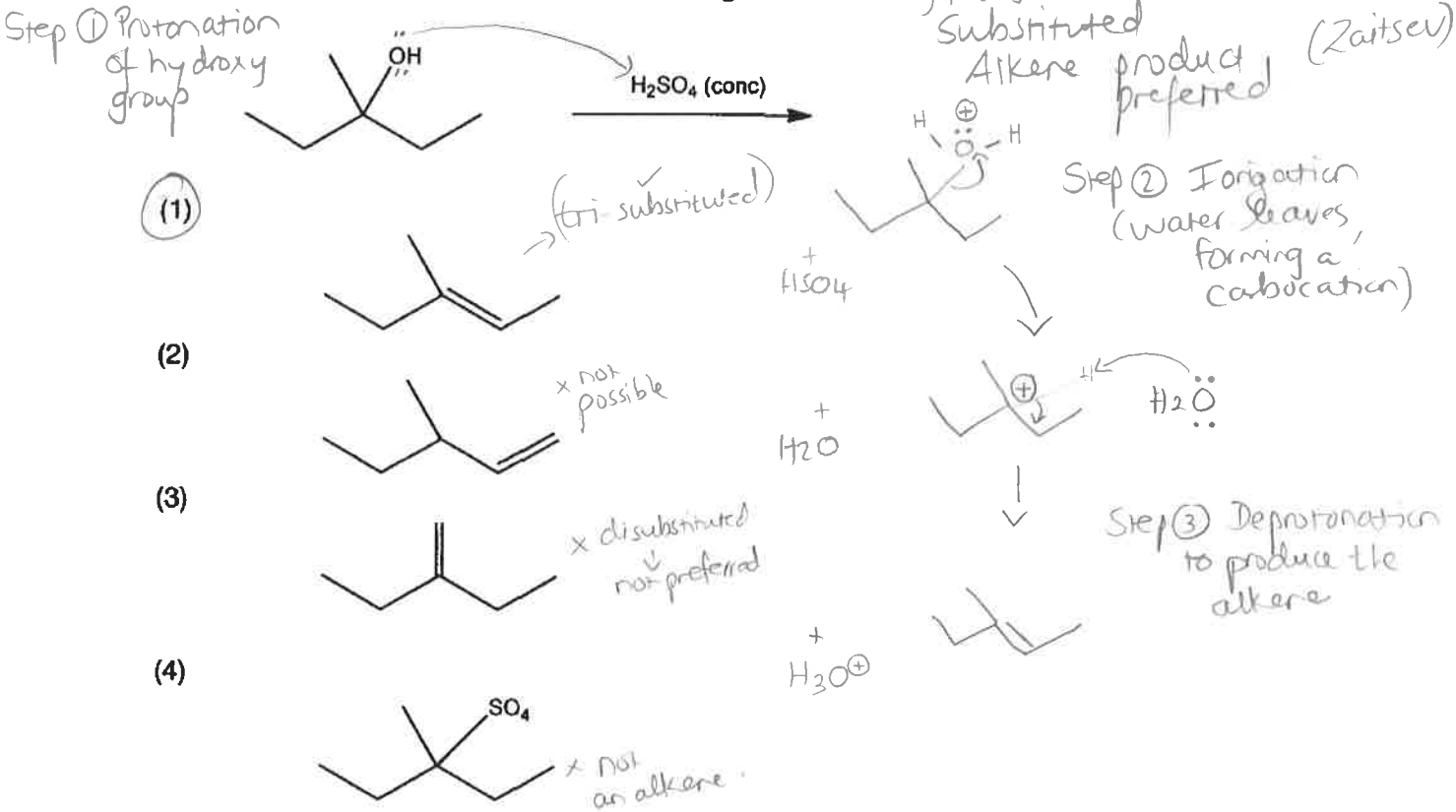
(4)



more electronegative than C; will not cleave homolytically.

Dehydration of an alcohol to form an alkene

10 Identify the product that will form in the following reaction.



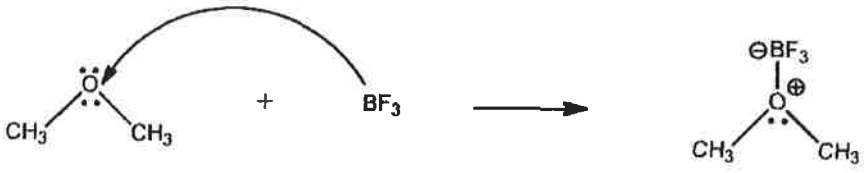
11 Consider the following ether molecule

Which of the following options is CORRECT?

(1) The hybridization state of the oxygen atom in the above compound is sp^3

surrounded by 4 regions of electron density
↳ 2 lone pairs
↳ 2 x bonds
∴ sp^3 hybridized.

(2) The reaction with boron trifluoride takes place as follows:

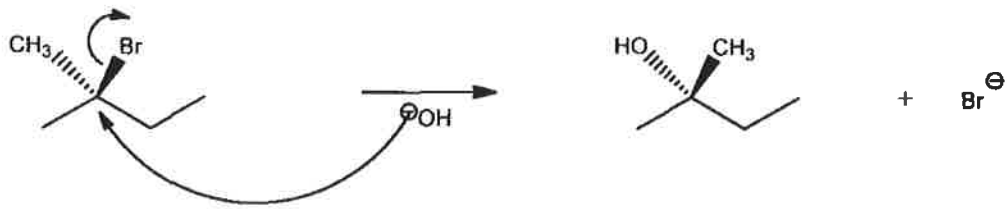


(3) The compound has a high boiling point. X

(4) It can form extensive hydrogen bonds with water X

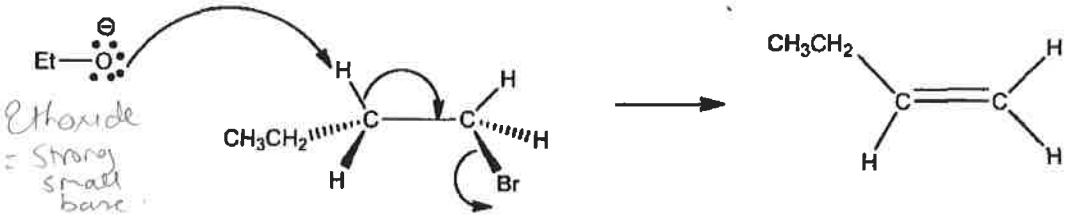
12. Which reaction proceeds via an E2 reaction mechanism?

(1)



X SN2 with inversion of chirality

(2)

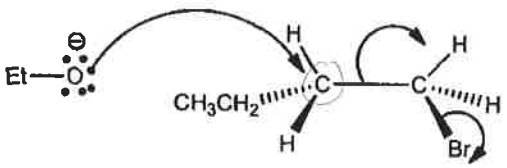


Ethoxide = strong small base

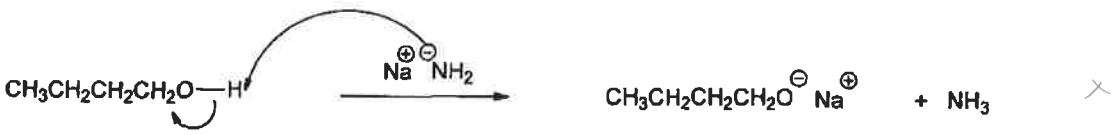
✓ E2 (Zaitsev product)

(3)

attacks the H, not the C



(4)



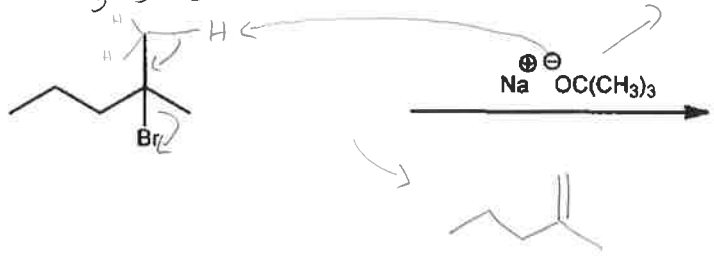
X

Base Attacks the least substituted β hydrogen pulling it off, causing the leaving group to be kicked off.

13 What is the major product formed in the following reaction?

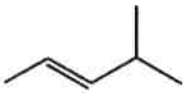
3° substrate

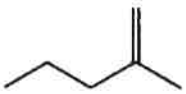
t-butoxide = strong, bulky base

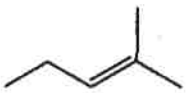


E2 (Hoffman product)

(1) 

(2) 

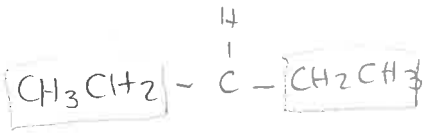
(3) 

(4) 

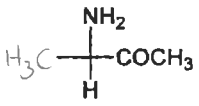
4 different groups attached to it

14 Which of the following molecules has a chiral (asymmetric) carbon atom?

(1) □ ×

(2) $CH_3CH_2CHFCH_2CH_3$ × 

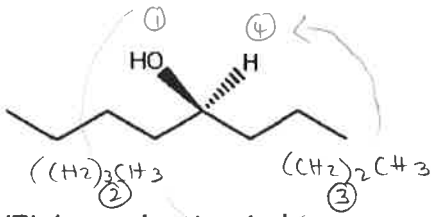
Not 4 different groups

(3) 

✓

(4) 

15 The absolute configuration of a chiral carbon is defined as R- or S- according to the Cahn-Ingold-Prelog rules What is the name for the following compound?



counter-clockwise = (S)

∴ (S) octan-4-ol

(1) (R)-1-propylpentan-1-ol

(2) (R) octan-4-ol

(3) (S) octan-4-ol

(4) (S)-4-hydroxyoctane

16 Identify the tertiary amine below

(1) $PhNHCH_2CH_3$ — Ph-NH-CH2CH3 (2° amine)

(2) $CH_3CH_2NH_2$ — CH2CH3-NH2 (1° amine)

(3) $CH_3CH_2CH_2NHCH_3$ — CH2CH2CH3-NH-CH3 (2° amine)

(4) $(CH_3CH_2)_3N$ — CH2CH3-N(CH2CH3)-CH2CH3 (3° amine)

17 The compounds shown below are described as

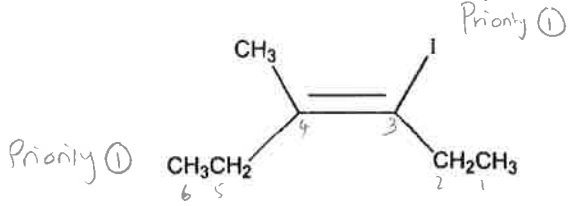
(1) structural isomers

(2) enantiomers

(3) geometric isomers

(4) conformers

18 Name the following compound according to the IUPAC rules



∴ (E)

(1) (Z)-3-iodo-4-methylhex-3-ene

(2) (E)-4-iodo-3-methylhex-3-ene

(3) (E)-3-iodo-4-methylhex-3-ene

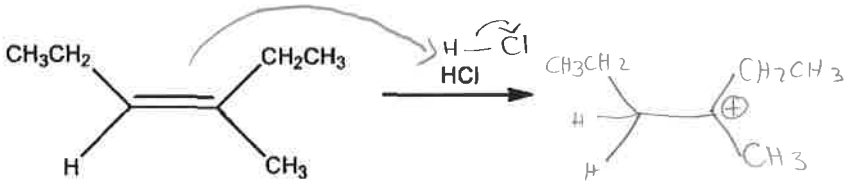
(4) (Z)-1-ethyl- 1-iodo-2-methylbut-1-ene

Use the information below to answer questions 19 and 20 below.

→ Markovnikov

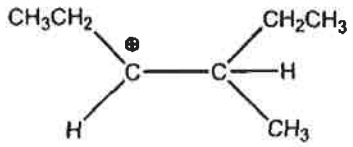
Addition of Hydrogen Halide to an alkene ∴ C⊕ forms on more substituted C. H adds to least substituted C.

Consider the reaction

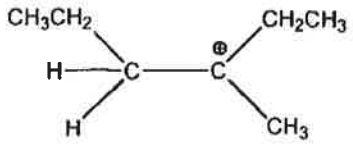


19 ~~18~~ Which of the following intermediates is predominantly formed during the reaction?

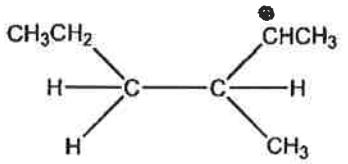
(1)



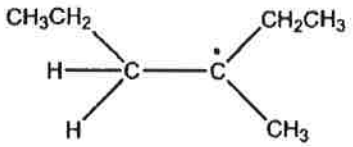
(2)



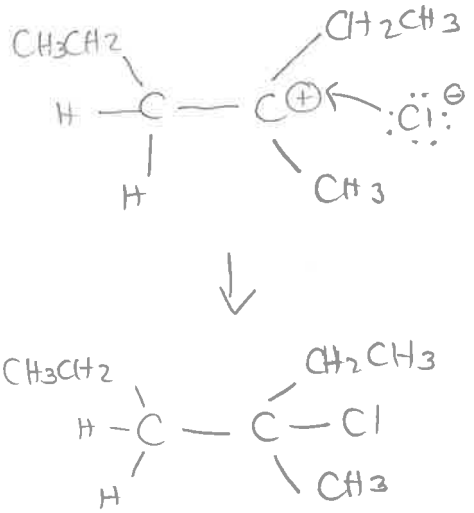
(3)



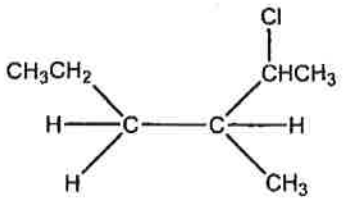
(4)



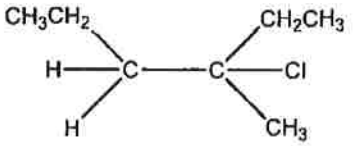
20 What is the MAJOR product of the reaction?



(1)



(2)



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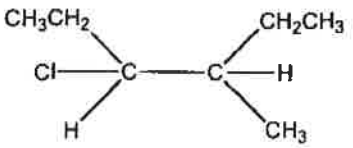
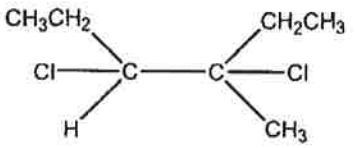
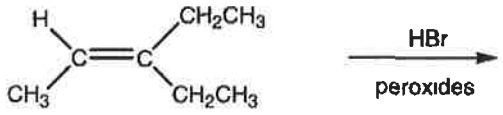


(4)

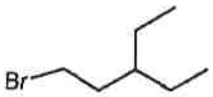


21. Alkenes react with hydrogen halides to give alkyl halides as products What is the MAJOR organic product formed in the following reaction?

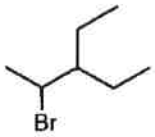
Hydrobromination with peroxides = anti-Markovnikov



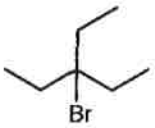
(1)



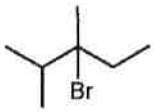
(2)

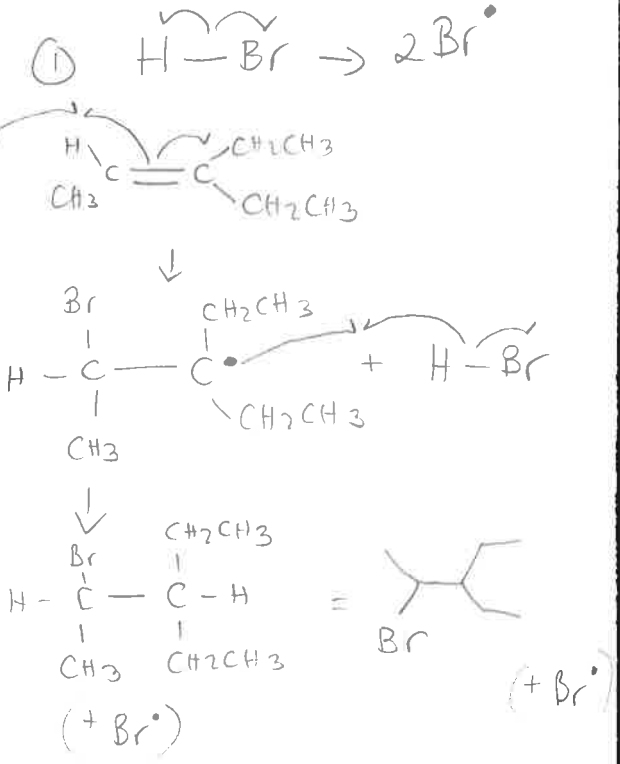


(3)



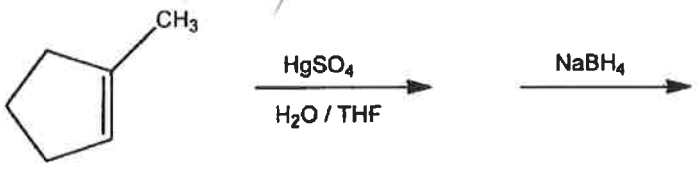
(4)



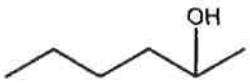


22 What is the major organic product formed in the following reaction?

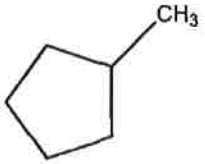
Hydration by oxymercuration - demercuration



(1)



(2)



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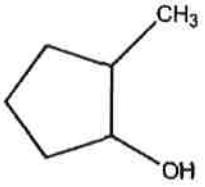
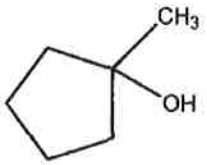
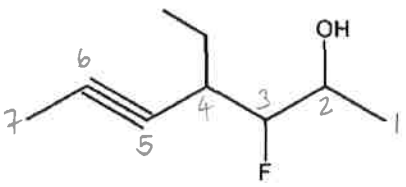


(4)



23 **Name the following compound according to the IUPAC rules.**



7-hept
2-ol
5-yne

4-ethyl
3-fluoro

(1) 4-ethyl-5-fluorohept-2-yn-6-ol

(2) 3-fluoro-4-ethylhept-5-yn-2-ol

(3) 4-ethyl-5-fluoro-6-hydroxyhept-2-yne

(4) 4-ethyl-3-fluorohept-5-yn-2-ol

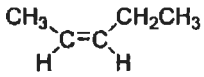
Metal-ammonia reduction to trans alkenes

24 What is the MAJOR product in the following reaction?

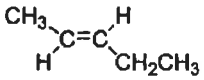
(anti-stereochemistry product)

$CH_3—C\equiv C—CH_2CH_3 \xrightarrow{Li\,/\,NH_3}$

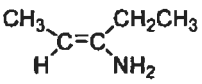
(1)



(2)



(3)



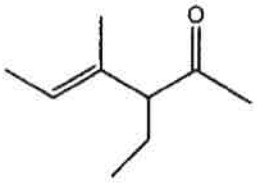
(4)

$CH_3CH_2CH_2CH_2CH_3$

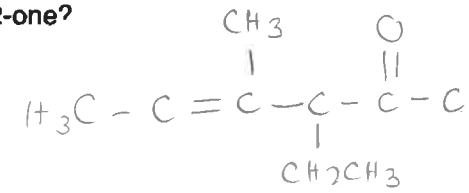
25 What is the correct structure of 3-ethyl-4-methylhex-4-en-2-one?

Two possible answers (1) or (4)

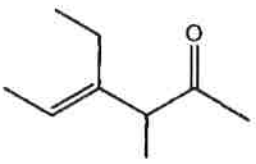
(1) or (4)



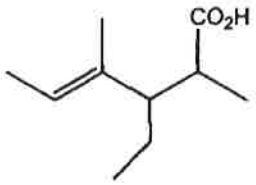
→ identical to option (4)



(2)

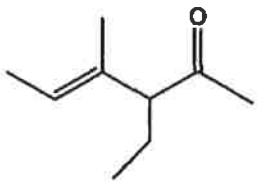


(3)



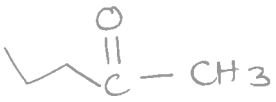
(4)

or (1)

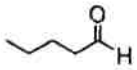


→ identical to option (1)

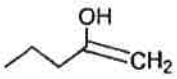
26. **What if the MAJOR product of the following reaction?** Hydration of alkynes to ketones/aldehydes



(1)



(2)



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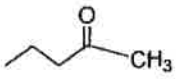
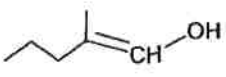


(4)



Lewis acid = e⁻ pair acceptor
Lewis base = e⁻ pair donor

27 The positively polarized carbon atom of a carbonyl group acts as

attracts e⁻ e⁻ pair acceptor

(1) an electrophile and a Lewis acid

(2) an electrophile and a Lewis base

(3) a nucleophile and a Lewis base

(4) a nucleophile and a Lewis acid

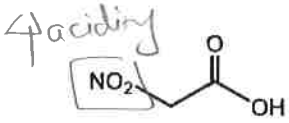
28 Which of the following compounds is the WEAKEST acid?

(eg NO_2 / Cl)

Electron-withdrawing groups on the α carbon increase strength of acid

Electron-donating groups on the α carbon decrease acid strength (eg CH_3O / CH_3)

(1)



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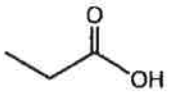
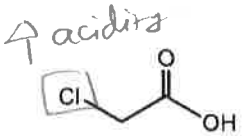
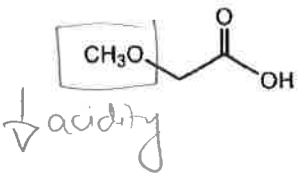


(3)

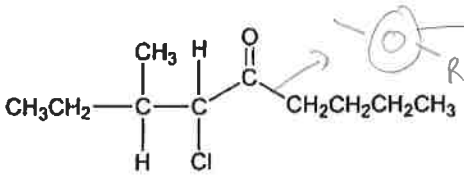


(4)

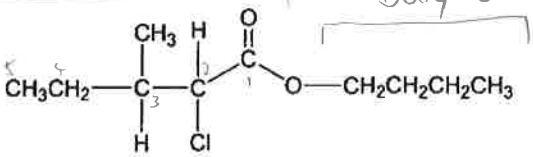


29 What is the correct structure of butyl -2-chloro-3-methylpentanoate?

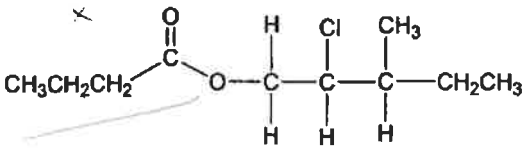
(1)



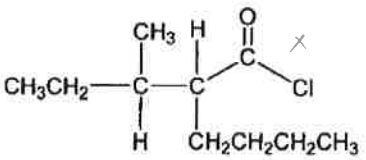
(2)



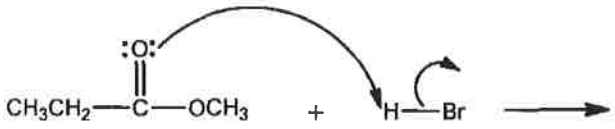
(3)



(4)

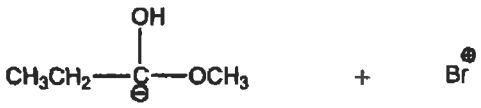


30 Consider the following process:

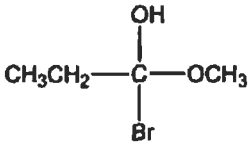


The species formed in the above step is

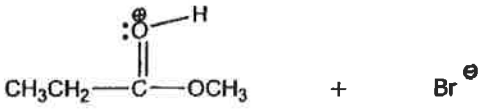
(1)



(2)



(3)



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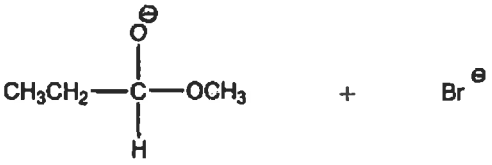


[60]

SECTION B

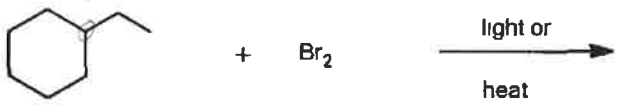
Answer ALL the questions in this section.

Answer this section in the SPACE PROVIDED AFTER EACH QUESTION.

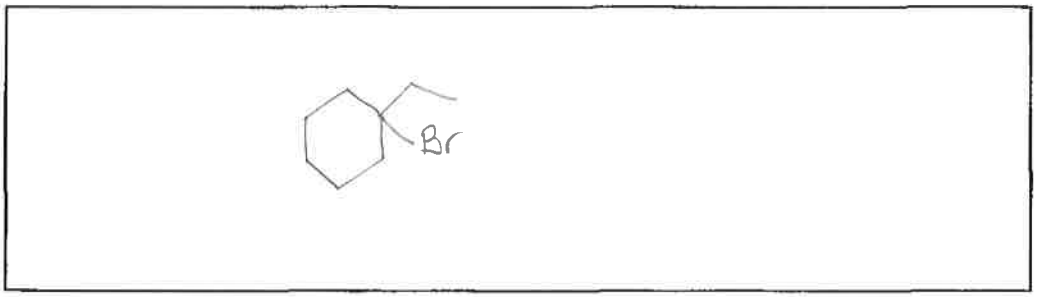
Question 1 [10]

(a) Draw the structure of the MAJOR monobrominated product formed in the following reaction

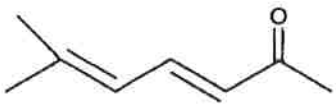
3° carbon = most substituted / most stable alkyl radical forms



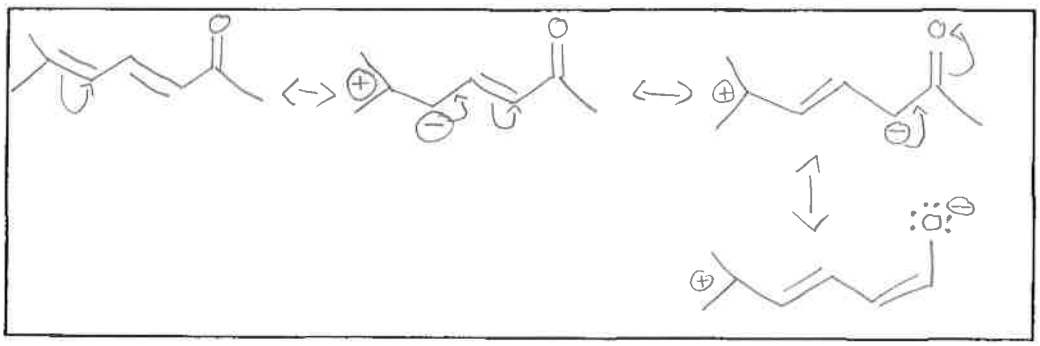
(2)



(b) Draw the different resonance forms of the ion shown below Indicate the movement of electrons with curved arrows



(6)



Halogenation of an Alkene (anti-stereochemistry product)

(c) Give the product and detailed mechanism of the following reaction

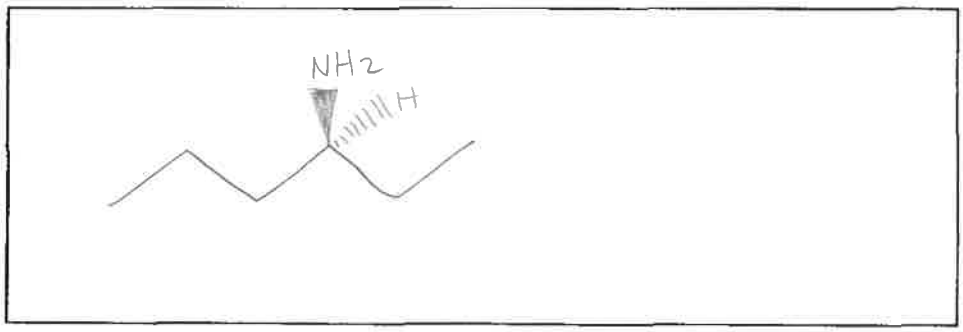
(6)

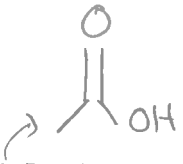
① Electrophilic attack forms Bromonium ion

② Bromide ion attacks to open Bromonium ion

(d) Draw the 3-dimensional structure of (S)-3-aminohexane

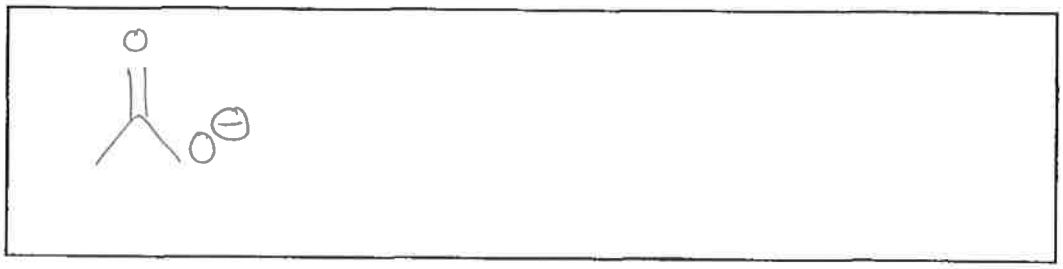
(3)





(e) Draw the structure of the conjugate base of the acid, CH_3COOH

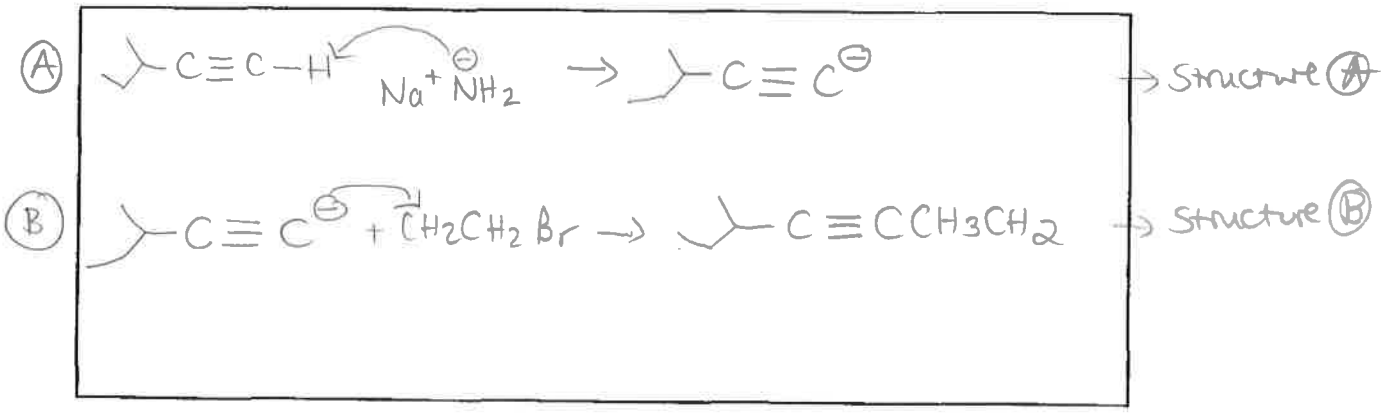
(3)



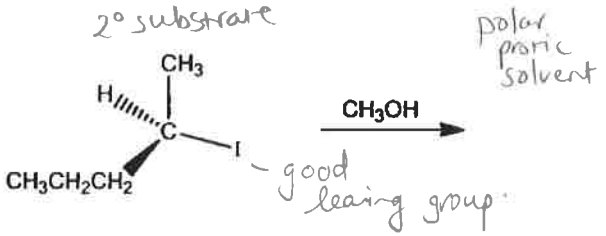
Question 2 [10]

(a) Provide the structures of A and B in the following reaction

(4)



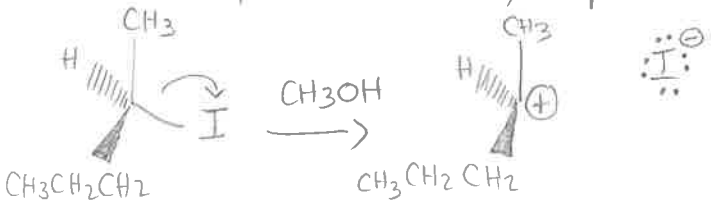
(b) **Give the product(s) and the detailed mechanism of the following nucleophilic substitution reaction**



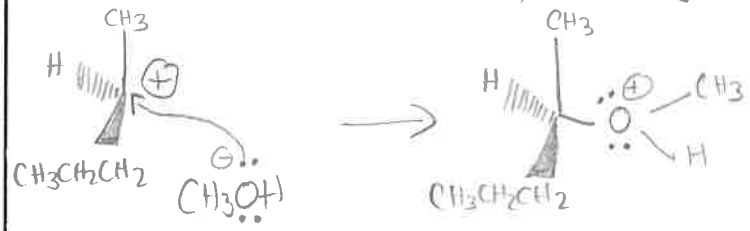
S_N1 (solvolysis) mechanism

(8)

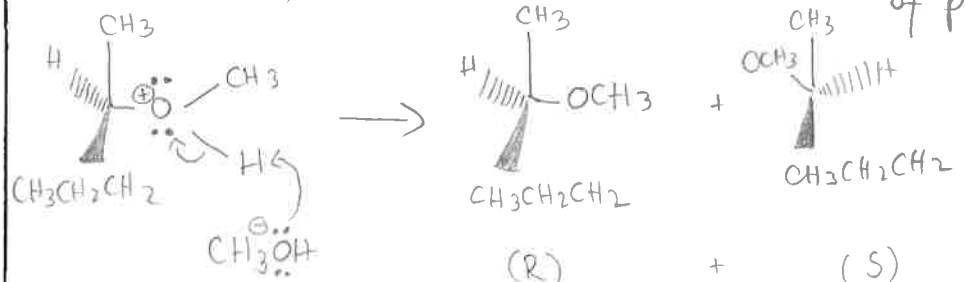
① Formation of carbocation by departure of leaving group



② Solvent (acting as nucleophile) uses its lone electrons to attack the carbocation, forming a bond



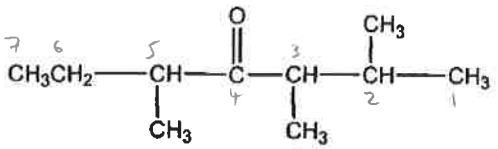
③ Another solvent molecule uses its electrons to deprotonate the oxygen by taking the lone hydrogen. Forms a racemic mixture of products



(R) + (S)

(Racemic mixture of products)

(c) Write the correct IUPAC name for the following compound

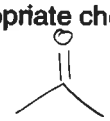


hept-
4-one
2,3,5-trimethyl

(2)

2,3,5-trimethylheptan-4-one

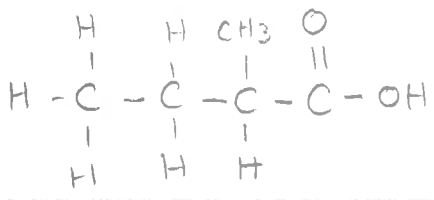
(d) Use an appropriate chemical equation to illustrate the keto-enol tautomerism in propanone



(4)

(e) Draw the correct structure of 2-methylbutanoic acid carboxylic acid $-\overset{O}{\overset{\|}{C}}-OH$

(2)



TOTAL MARKS [100]

ROUGH WORK