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

UNIVERSITY EXAMINATIONS

UNIVERSITEITSEKSAMENS

UNISA university of south africa

CHE1502 (494714) May/June 2015

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: 494714

The examination paper consists of 23 pages plus 5 pages for rough work (pp 24-28) plus instructions for completion of the mark reading sheet.

The examination paper consists of TWO parts:

SECTION A: 60 Marks
Consisting of 35 multiple choice questions which must be answered on a marking reading sheet. Each question is allocated TWO marks.
The multiple choice questions have four possible answers. In each case, provide only ONE answer to each question

SECTION B: 40 Marks
This section consists of written questions which must be answered in spaces provided on the examination paper.

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.**

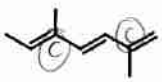
Answer ALL **the questions in this section on the MARK READING SHEET**

Unique Number **494714**

1 Which of the following compounds contains the greatest number of sp^2 hybridized carbon atoms?

(1) 

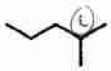
0 × sp^2 hybridized C's

(2) 

2 × sp^2 hybridized C's

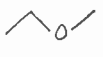
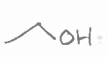
(3) 

1 × sp^2 hybridized C

(4) 

1 × sp^2 hybridized C

2 Which of the following pairs of compounds are structural / constitutional isomers?

(1)  

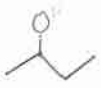
$CH_3CH_2OCH_3$ and CH_3CH_2CHO

H×8 H×6

(2)

$CH_3COCH_2CH_3$ and $CH_3CH_2COCH_3$

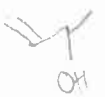
C_4H_8O C_4H_8O

(3)

$CH_2CHCH(OH)CH_3$ and $CH_3CH_2COCH_3$

C_4H_8O C_4H_8O



(4)

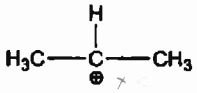
CH_3CH_2CHO and $CH_3CH_2CH_2OH$

C_3H_6O C_3H_8O

3 Which of the following compounds can easily donate a pair of electrons?

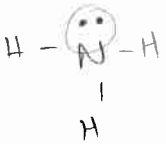
(1)

(2)



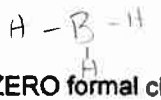
(3)

NH_3

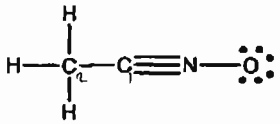


(4)

BH_3



4 In the structure below, the NON-ZERO formal charges present in the molecule are



(1) -1 on N and +1 on C

(2) +1 on N and -1 on C

(3) +1 on N and -1 on O

(4) +1 on C and -1 on O

5 Which of the following set of radicals represent AN ORDER OF INCREASING STABILITIES, i e from THE LEAST STABLE TO THE MOST STABLE

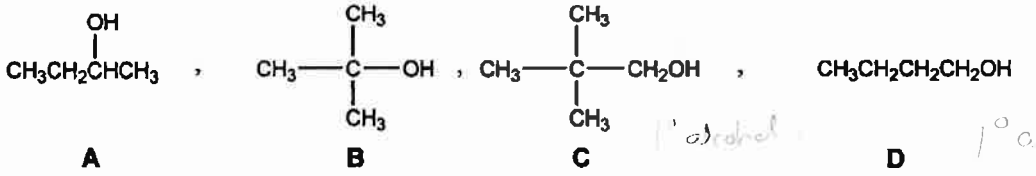
(1) $\dot{C}H_2CH_2CH(CH_3)_2 < CH_3CH_2\dot{C}(CH_3)_2 < CH_3\dot{C}HCH(CH_3)_2$

(2) $CH_3CH_2\dot{C}(CH_3)_2 < CH_3\dot{C}HCH(CH_3)_2 < \dot{C}H_2CH_2CH(CH_3)_2$

(3) $CH_3\dot{C}HCH(CH_3)_2 < CH_3CH_2\dot{C}(CH_3)_2 < \dot{C}H_2CH_2CH(CH_3)_2$

(4) $\dot{C}H_2CH_2CH(CH_3)_2 < CH_3\dot{C}HCH(CH_3)_2 < CH_3CH_2\dot{C}(CH_3)_2$

6 Consider the following compounds



A , **B** , **C** , **D**

Which statement regarding the above compounds is **INCORRECT**?

(1) **B** is a tertiary alcohol

(2) **C** and **D** are secondary alcohols

(3) All of the compounds contain a poor leaving group

(4) The compound, **A**, is chiral

7 The following compounds have similar molecular weights Which compound is capable of forming hydrogen bonding?

(1) CH_3CH_2OH

(2) $CH_3C(=O)H$

(3) $CH_3CH_2CH_3$

(4) CH_3OCH_3

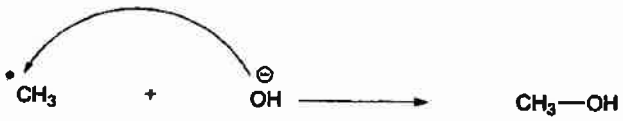
8 Which of the following processes is a CORRECT representation of HOMOLYTIC BOND FORMATION?

(1)

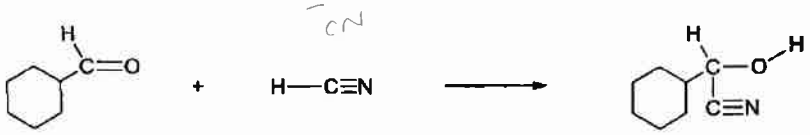
(2)

(3)

(4)



9 Classify the following reaction



(1) elimination reaction
(2) substitution reaction
(3) addition reaction
(4) rearrangement reaction

10 In order for a reagent to behave as an electrophile it **must** have

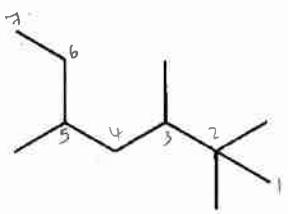
(1) an overall positive charge or an empty orbital

(2) a nitrogen or sulfur atom

(3) a non-bonding electron pair

(4) an overall negative charge

11 What is the IUPAC name of the molecule shown below?



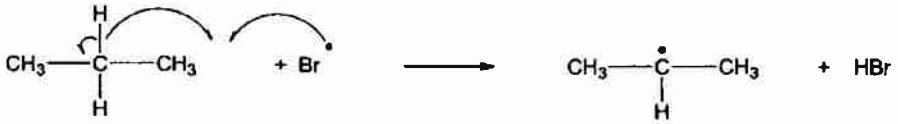
(1) 1,2,4-trimethylisoheptane
(2) 5-ethyl-2,2,3-trimethylhexane
(3) 2,2,3,5-tetramethylheptane
(4) 3,5,6,6-tetramethylheptane

12 Consider the following reaction

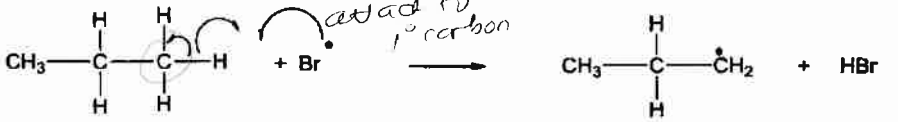
Which step is NOT relevant to the mechanism of the reaction?

(1)

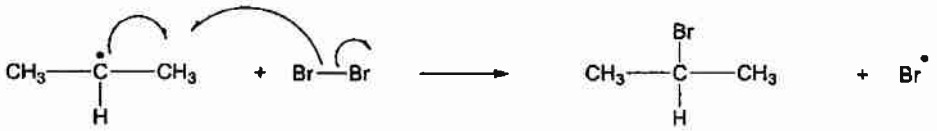
(2)



(3)



(4)



13 Which of the following compounds will be the BEST nucleophile to react in an S_N2-type reaction?

(1) $(CH_3)_2C=O$

(2) CH_3Cl

(3) CN^-

(4) CH_3OH

14 Consider the general reaction

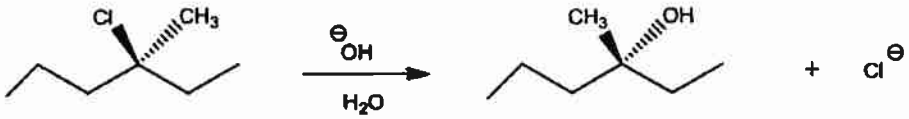
Which example below will take place the FASTEST?

(1)

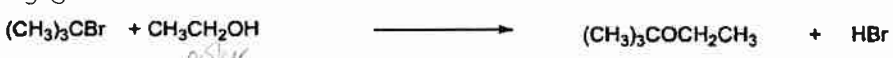
(2)

(3)

(4)



15 Ethanol reacts with *tert*-butyl bromide according to the reaction shown below

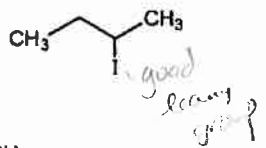


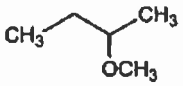
If the concentration of ethanol is doubled, by what factor will the rate of the reaction change?

Nothing. It is an SN1 reaction. The rate depends only on the concentration of t-Butyl bromide.

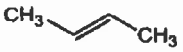
(1) Remain the same
(2) Increase by a factor of 2
(3) Increase by a factor of 4
(4) Decrease by a factor of 2

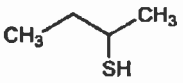
16 Alkyl halides may undergo nucleophilic substitution reactions. Which of the following reaction products is obtained in the following reaction?



(1)


(2)


(3)


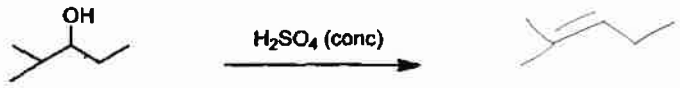
(4)


17 Which of the following compounds has cis-trans isomers?

(1) $BrHC=C(CH_3)_2$
(2) $CH_3C{\equiv}CH$
(3) $CH_3CH=CHCH_3$
(4) $H_2C=C(CH_3)_2$

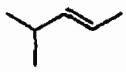
Dehydration of an alcohol

18 Consider the following reaction

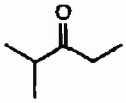


Which compound if the MAJOR PRODUCT of the reaction?

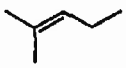
(1)



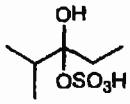
(2)



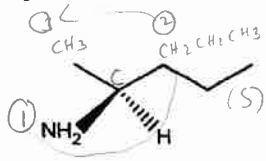
(3)



(4)



19 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?

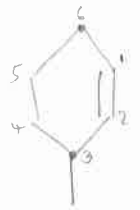


-pentane
(S) 2-aminopentane
counter-clockwise = (S)

Atomic no's
N = 5
C = 4.

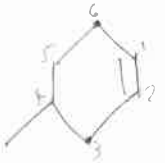
(1) (R)-2-aminopentane
(2) (S)-4-aminopentane
(3) (S)-2-aminopentane
(4) (S)-2-nitropentane

3-methylcyclohexene



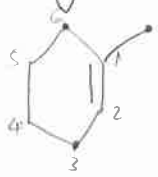
Disubstituted alkene

4-methylcyclohexene



Disubstituted alkene

1-methylcyclohexene



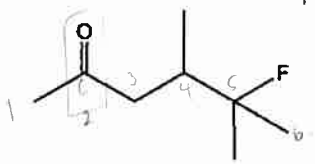
1 substituted = most stable

20 Using Zaitsev's rule, choose the most stable alkene among the following

Zaitsev) Most substituted = most stable

(1) 3-methylcyclohexene
(2) 4-methylcyclohexene
(3) They are all of equal stability
(4) 1-methylcyclohexene

21 What is the IUPAC name of the molecule shown below?



ketone

hexan-2-one

4,5-dimethyl

5 fluoro

5-fluoro-4,5-dimethylhexan-2-one.

(1) 5-fluoro-4,5-dimethylhexan-2-one
(2) 4-fluoro-4,5,5-trimethylpentan-2-one
(3) 1-fluoro-1,1,2-trimethylpentan-4-one
(4) 2-fluoro-2,3-dimethylhexan-5-one

—OH —NH$_2$

22 Consider the compounds, ethanol (CH_3CH_2OH) and ethanamine ($CH_3CH_2NH_2$)
Which statement below is INCORRECT?

OH NH$_2$
alcohol amine

(1) Ethanol has a higher boiling point than ethanamine ✓

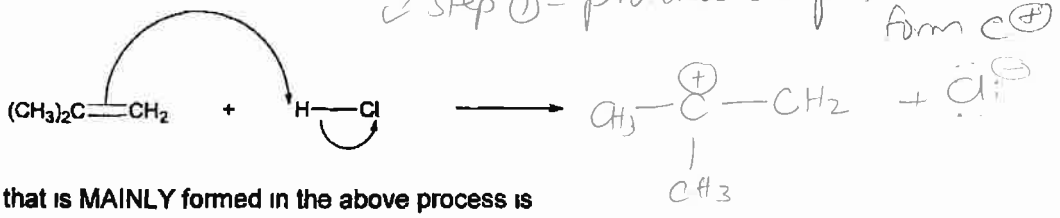
(2) The O-H bond is more polar than the N-H because oxygen is more electronegative than nitrogen ✓

(3) Alcohols form stronger hydrogen-bonds than amines and have higher boiling points ✓

(4) Ethanamine has a higher boiling point than ethanol ✗

Addition of hydrogen halides to alkenes

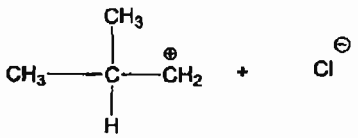
23 Consider the following process



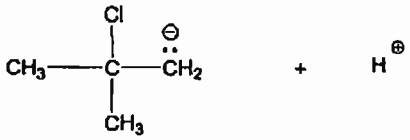
✓ Step ① - protonation of π bond to form C⊕

The correct species that is MAINLY formed in the above process is

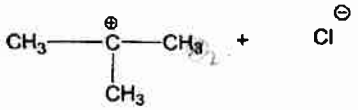
(1)



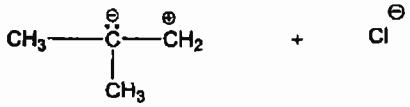
(2)



(3)

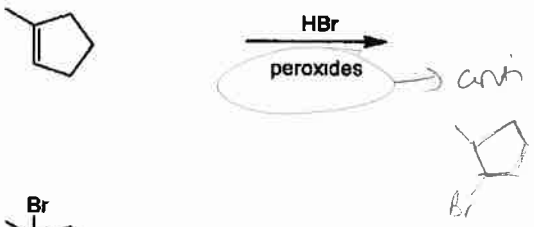


(4)



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

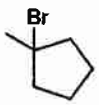
Hydrobromination with peroxides



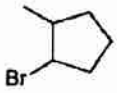
anti Markovnikov

Br adds to least substituted C of C=C

(1)



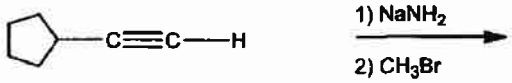
(2)



(3)

(4)

Consider the following reaction sequence TO ANSWER questions 25 and 26 below



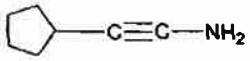
Deprotonation for
① Formation of acetylide ion
② Synthesis of Alkyne from acetylide

① 

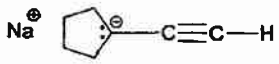
② 

25 What is the structure of the major organic species formed in STEP 1?

(1)



(2)



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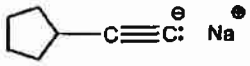

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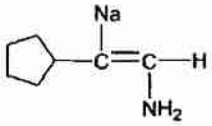
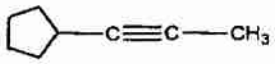


26 What is the structure of the major organic product in the reaction sequence?

(1)



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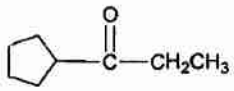
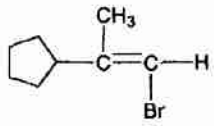
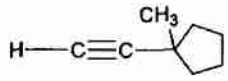


(3)

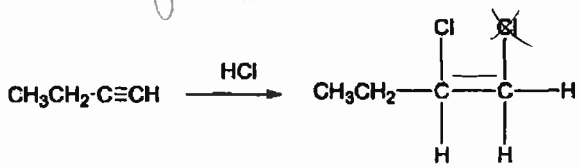


(4)

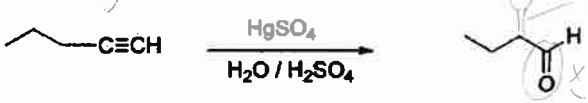


27 Alkynes undergo addition reactions because they contain weak π bonds Which of the following reactions will take place?

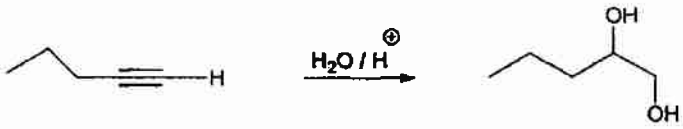
(1) Addition of Hydrogen Halide



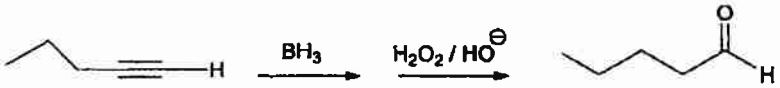
(2) Hydration of Alkynes



(3)



(4) Hydroboration - Oxidation (anti Markovnikov)



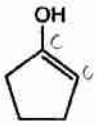
28 Which of the following structures would be considered an enol tautomer of cyclopentanone?

cyclopentanone

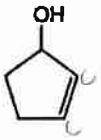
Contains a pair of C=C (double bonded carbons) next to a hydroxyl group

C=C
|
OH

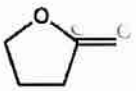
(1)



(2)

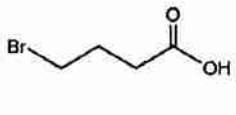


(3)

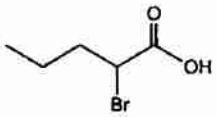


(4)

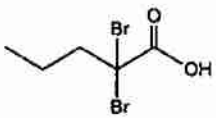
29 Identify the STRONGEST acid in the series below



A



B



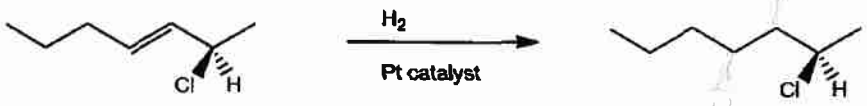
C

2 x e⁻ withdrawing groups on α carbon.

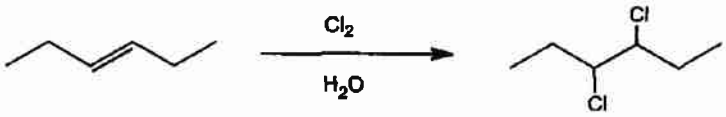
(1) A
(2) C
(3) B
(4) A and C

30 Which of the following reactions does NOT produce the MAJOR PRODUCT as shown?

(1) Catalytic hydrogenation of alkene



(2)



(3) Halogenation

anti-stereochemistry

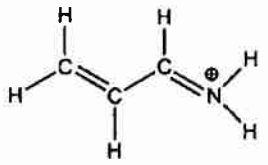
(4) oxymercuration - demercuration

SECTION B

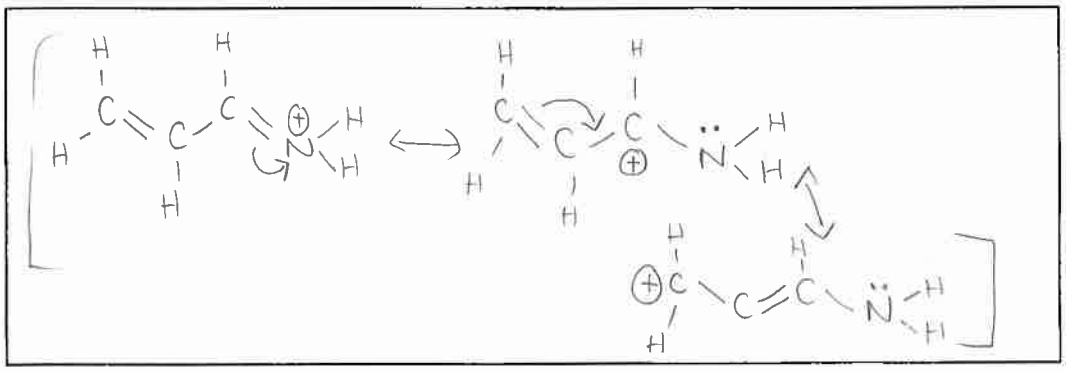
Answer ALL the questions this section in the SPACE PROVIDED AFTER EACH QUESTION.

Question 1 [20]

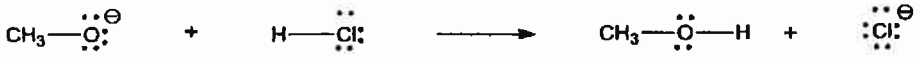
1 1 Draw the important resonance forms to show the delocalization of charge in the following species Indicate the movement of electrons with curved arrows



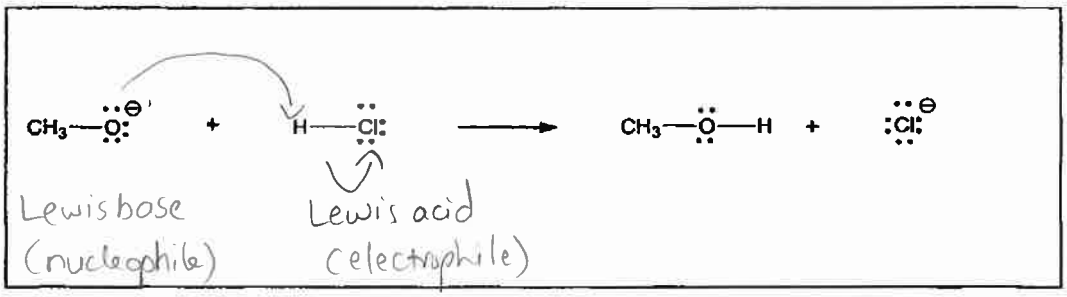
(4)



1 2 Use curved arrows to show the movement of electron pairs in the reaction shown below and label the reactants as a Lewis base (nucleophile) or a Lewis acid (electrophile)



(4)



1 3 (a) **Draw the structure of 6-chloro-3,6-dimethyl-2,3-diethylheptane**

(2)

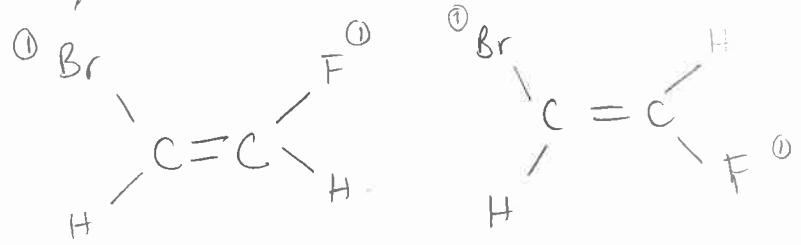
(b) **Explain what is wrong with the name provided in (a) and give the correct IUPAC name for compound**

(5)

- Carbon chain is numbered from the wrong direction by should start from the right, nearest the Cl and CH_3 (highest priority) substituents on carbon 2.
- alphabetical order of functional groups in name is incorrect (-ethyl, should be before -methyl groups)
- Longest carbon chain = 8 carbons ∴ octane not heptane

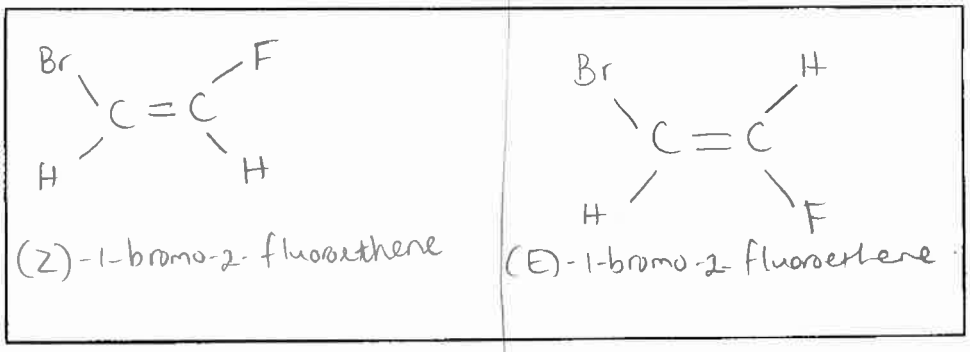
2-chloro-5-ethyl-2,6-dimethyl octane.

(Z)-1-bromo, 2-fluoroethene (E)-1-bromo, 2-fluoroethene



1 4 Draw the geometric isomers of BrCH=CHF

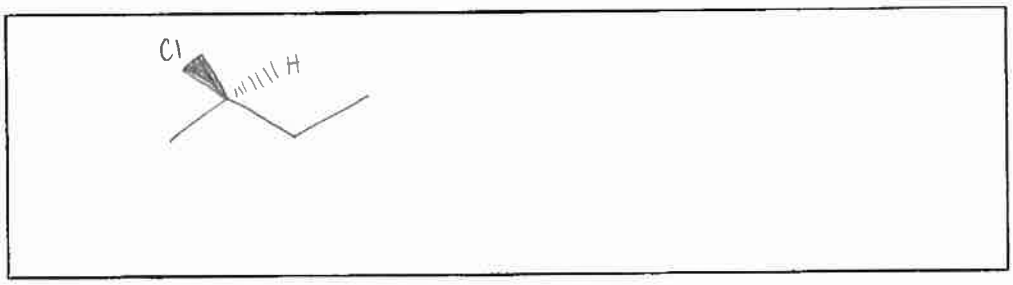
(2)



(Z)-1-bromo-2-fluoroethene (E)-1-bromo-2-fluoroethene

1 5 Draw the correct 3-dimensional structure of (R)-2-chlorobutane

(3)



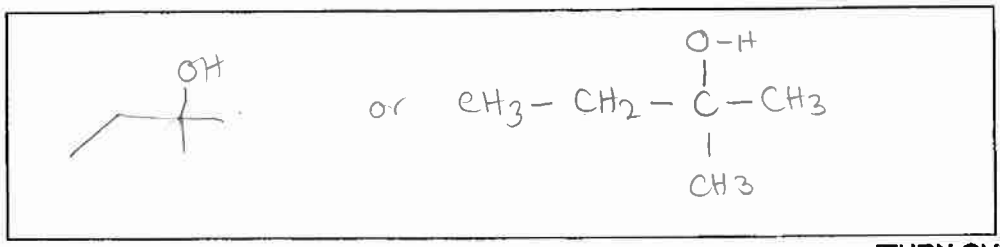
Question 2 [20]

Acid catalyzed hydration of an alcohol.

2 1 (a) Write the structure of the MAJOR PRODUCT formed in the reaction of

$CH_3CH=C(CH_3)_2$ with H_2O in the presence of an acid catalyst

(2)



or $CH_3-CH_2-C(OH)(CH_3)-CH_3$

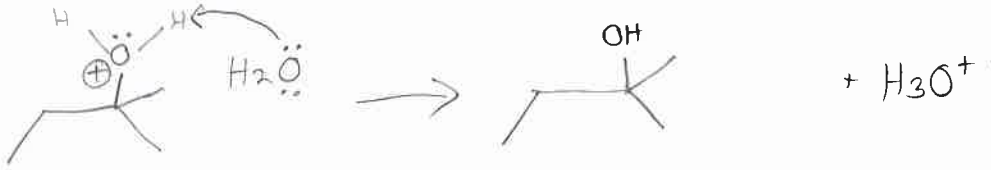
Mechanism:

(1) protonation of double bond to form carbocation:

(2) nucleophilic attack by H_2O to form a protonated alcohol:

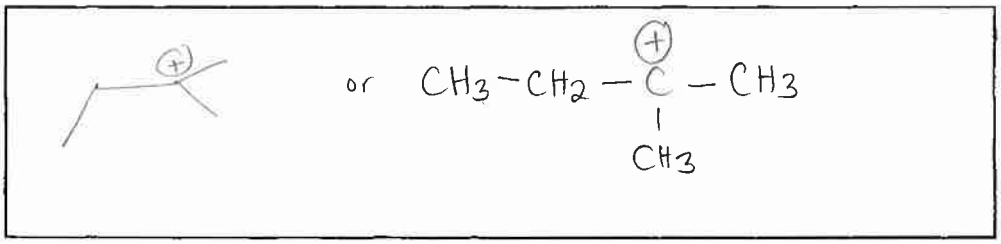
P.T.O. →

Step ③ Deprotonation by another H_2O to give alcohol



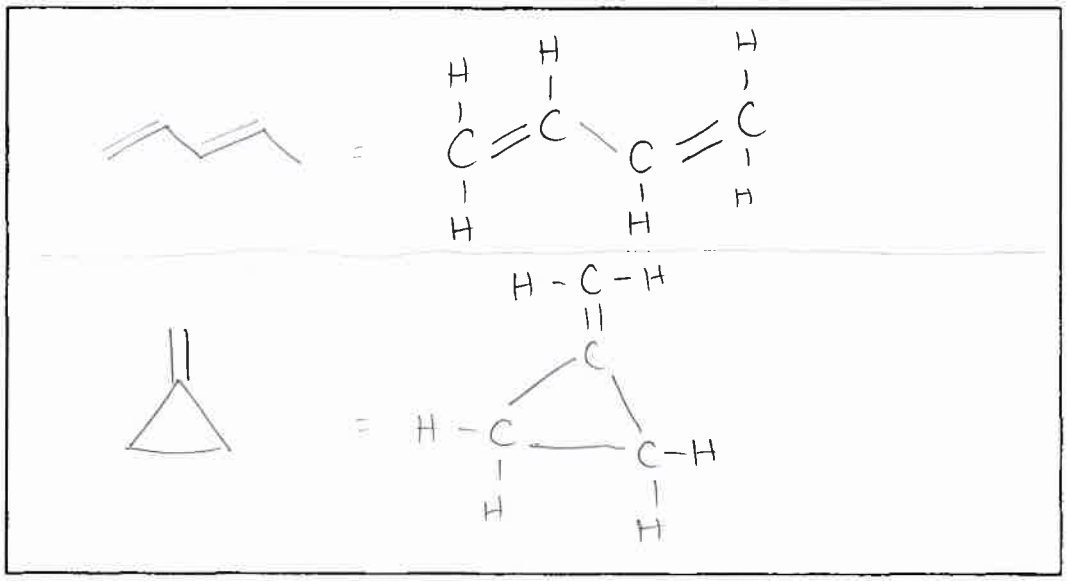
(b) Provide the structure of the intermediate formed in the reaction in (a)

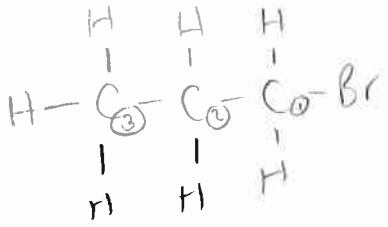
(2)



2.2 Draw the structural formulas for two constitutional / structural isomers for a compound having a molecular formula of C_4H_6

(4)





C① attaches to H, H, Br

C② attaches to H, H, CH_3

most stable ⊛ anti conformation $\theta = 180°$

eclipsed $\theta = 120°$ or $240°$

gauche $\theta = 60°$ or $300°$

least stable ⊛ totally eclipsed $\theta = 0°$

2 3 Draw the Newman projections of the most stable and least stable conformations of 1-bromopropane, $CH_3CH_2CH_2Br$, viewing along the C1-C2- bond Label the conformations accordingly

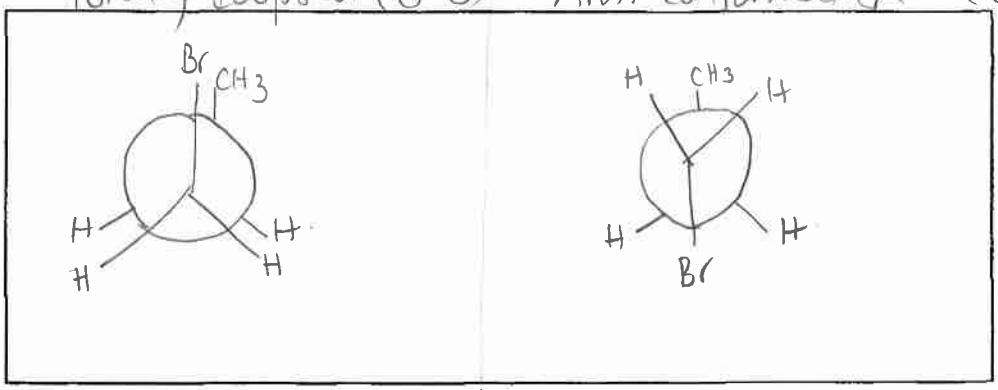
Least stable

Totally eclipsed ($\theta = 0°$)

Most stable

Anti conformation ($\theta = 180°$)

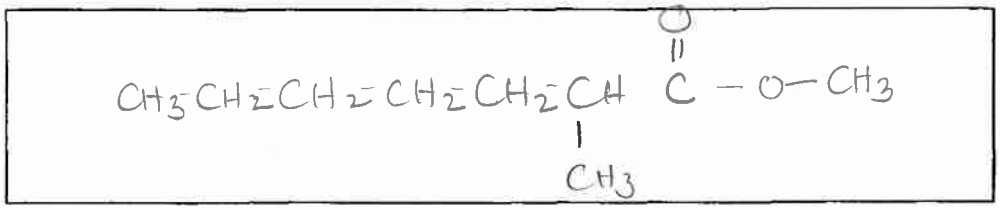
(4)



2 4 Draw the structure of methyl 2-methylheptanoate

ester → $R-\overset{O}{\overset{\|}{C}}-O-R$

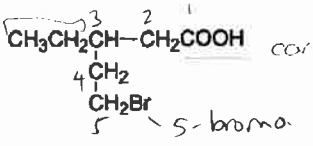
(2) carboxylic acid



2 5 Write the IUPAC name of the following compound

pentanoic acid

3-ethyl



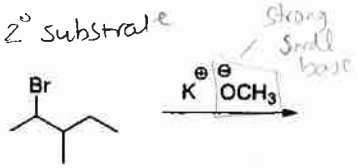
carboxylic acid (-oic acid)

5-bromo

(2)

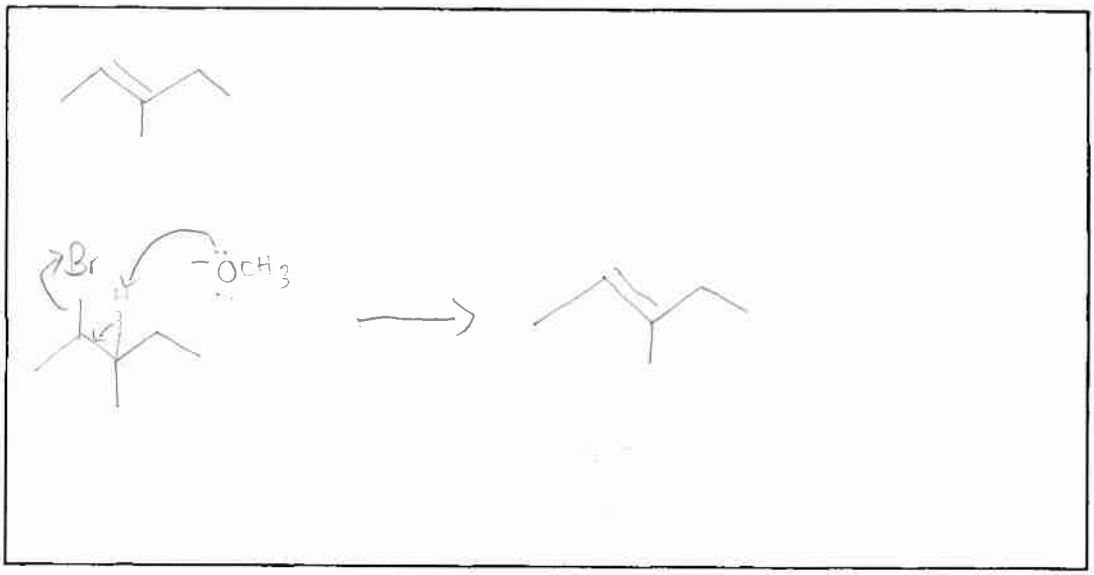
5-bromo-3-ethylpentanoic acid

2 6 Consider the following reaction



(i) What is the major organic product formed in the following reaction?
(ii) Write the reaction mechanism for the formation of the product given in (i)

(4)



TOTAL MARKS [100]

ROUGH WORK