

ORGANIC REACTION MECHANISMS-IV

CONTENTS

Particular	Page No.
Theory	01 – 06
Exercise - 1	07 – 11
Part - I : Subjective Questions	
Part - II : Only One Option Correct Type	
Part - III : Match the Columns	
Exercise - 2	12 – 17
Part - I : Only One Option Correct Type	
Part - II : Single or Double Digit Integer Type Questions	
Part - III : One or More Than One Options Correct Type	
Part - IV : Comprehensions	
Exercise - 3	18 – 25
Part - I : JEE(ADVANCED) / IIT-JEE Problems (Previous Years)	
Part - II : JEE(MAIN) / AIEEE Problems (Previous Years)	
Answers	26 – 28
Additional Problems for Self Practice (APSP)	29 – 41
Part - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))	
Part - II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I	
Part - III : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))	
APSP Answers	42
APSP Solutions	43 – 46

JEE(Advanced) Syllabus

Alkyl Halide : Nucleophilic substitution reactions of alkyl halides; Rearrangement reactions of alkyl carbocation, Preparation of alkenes and alkynes by elimination reactions.

Haloarenes : Nucleophilic aromatic substitution in haloarenes and substituted haloarenes (excluding Benzyne mechanism and Cine substitution).

Alcohols: Esterification, dehydration, reaction with sodium, phosphorus halides, ZnCl_2 /concentrated HCl.

Ethers : Preparation by Williamson's Synthesis.

JEE(Main) Syllabus

Organic Reaction Mechanisms : Organic Compounds with functional groups Containing Halogens (x).

Alkyl Halides : Nature of C–X bond in haloalkanes, physical and chemical properties, mechanism of substitution reactions, elimination reactions and rearrangement reactions, reactivity of C–X bond in haloalkanes.

Some commercially important compounds : Dichloro, trichloro and tetrachloromethanes; freons, BHC, DDT, their uses and important reactions.

Organic compounds with functional groups containing oxygen

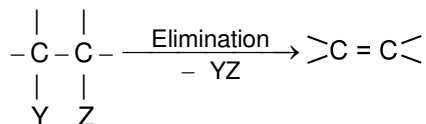
Alcohols & Ethers : Methods of preparation, physical and chemical properties; Electronic structure, Structure of functional group, some commercially important compounds.



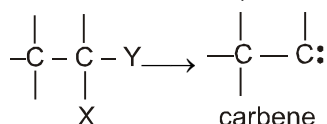
Organic Reaction Mechanisms-IV

Elimination reactions:

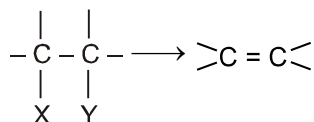
In an elimination reaction two atoms or groups (YZ) are removed from the substrate and generally resulting into formation of π bond.



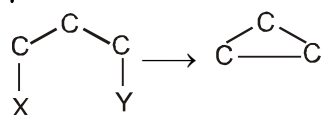
α -elimination : When two groups are lost from the same carbon atom to give a carbene (or nitrene). This is also called 1,1-elimination.



β -elimination : When two groups are lost from adjacent atoms so that a new π bond is formed. This is also called 1,2-elimination.



γ -elimination : It is also called 1,3-elimination, In this a three membered ring is formed.



Type of β -elimination reactions : There are three types of elimination reactions

(I) E1

(II) E2

(III) E1cB

Section (A) : Unimolecular eliminaiton reaction (E1)

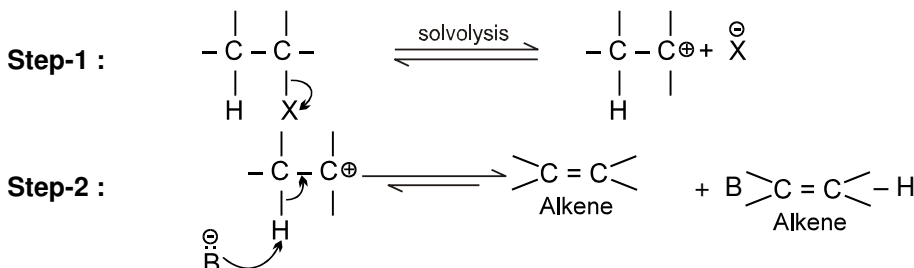
Proton and leaving group depart in two different step.

(a) **First step** : Slow step involves ionisation to form carbocation

(b) **Second step** : Abstraction of proton

(1) E1 Reaction of Alkyl halides :

Mechanism :



**Characteristics of E1 reaction :**

- (i) It is unimolecular, two step process.
- (ii) It is a first order reaction.
- (iii) Reaction intermediate is carbocation, so rearrangement is possible
- (iv) In the second step, a base abstracts a proton from the carbon atom adjacent to the carbocation, and forms alkene.

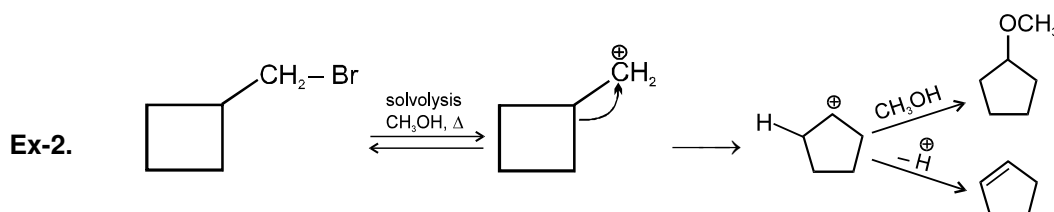
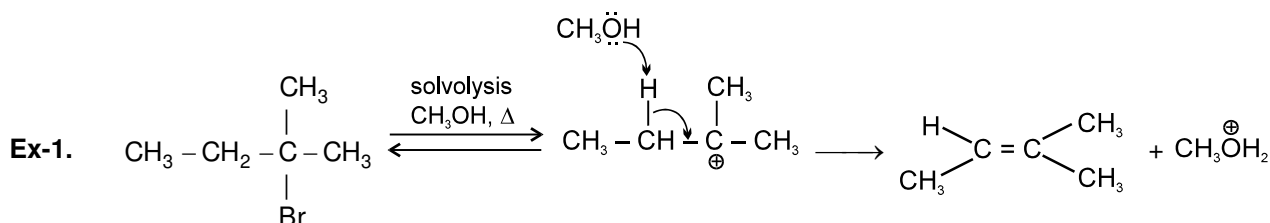
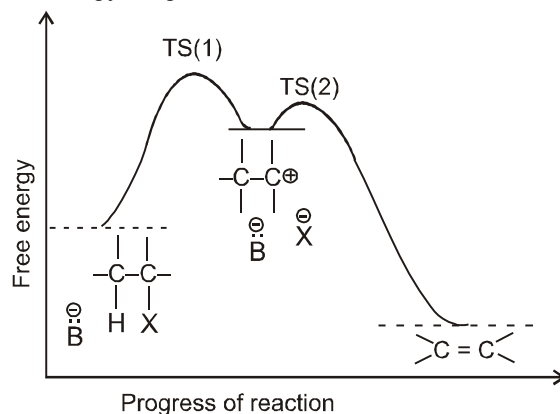
Rate of E1 = 3° Alcohol > 2° Alcohol > 1° Alcohol.

Rate of reaction \propto stability of carbocation

(v) Kinetics : Rate \propto [Alkyl halide]

Rate = k [Alkyl halide]

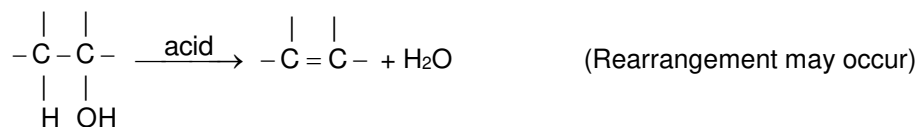
(vi) Energetics : The free energy diagram for the E1 reaction is similar to that for the S_N1 reaction.

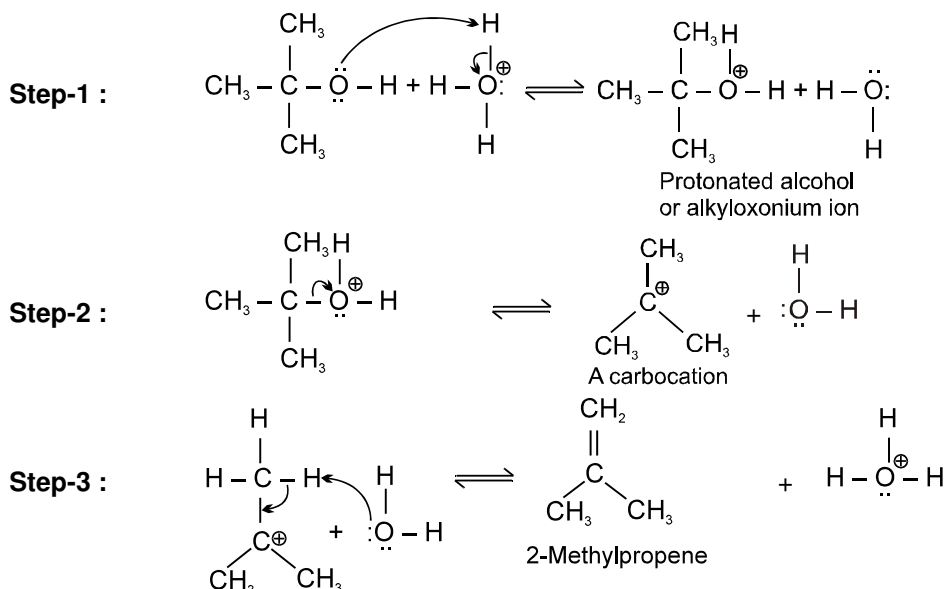
**(2) E1 Reaction of Alcohols :**

Dehydration requires an acidic catalyst to protonate the hydroxyl group of the alcohol and convert it to a good leaving group. Loss of water, followed by loss of proton, gives the alkene. An equilibrium is established between reactants and products. For E1 mechanism reagents are :

(i) H₃PO₄ / Δ

(ii) H₂SO₄ / 160°



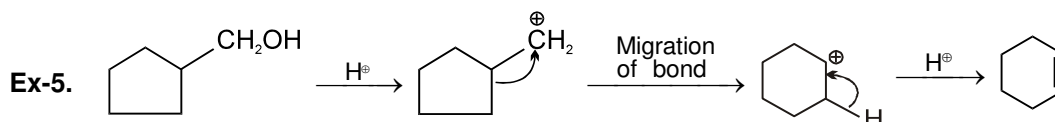
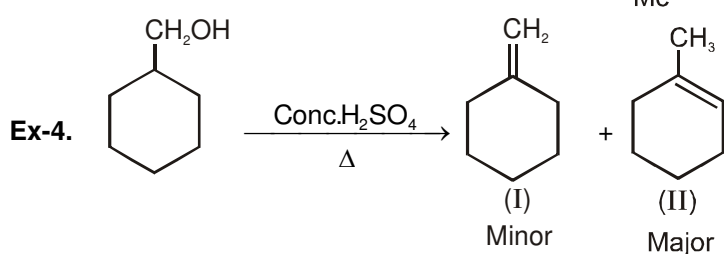
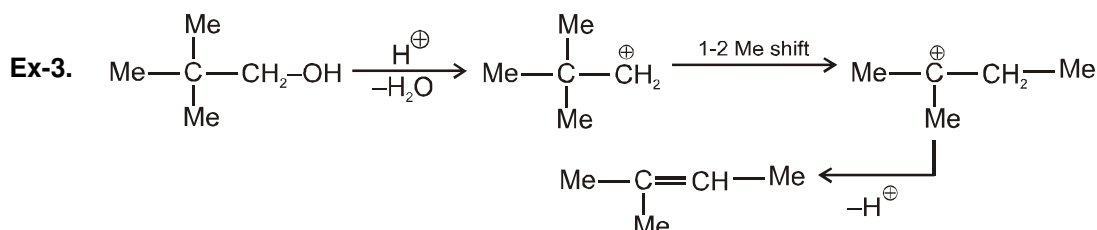
**Mechanism :****Remarks :**

In first step, an acid-base reaction a proton is rapidly transferred from the acid to one of the unshared electron pairs of the alcohol.

In second step the carbon oxygen bond breaks. The leaving group is water molecule.

Finally, in third step the carbocation transfers a proton to a molecule of water. The result is the formation of a hydronium ion and an alkene.

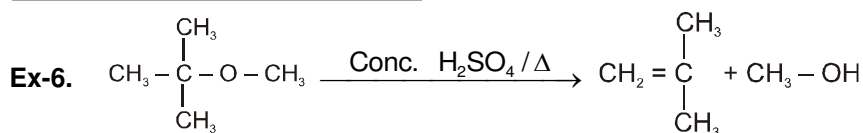
Reactivity of ROH : $3^\circ > 2^\circ > 1^\circ$

**(3) E1 Reaction of Ether :**

Elimination is not a favourable reaction for ether, but however few reactions have been observed.

E1 Elimination takes place via formation of stable carbocation.

Ether undergoes dehydration reaction in the presence of conc. $\text{H}_2\text{SO}_4 / \Delta$.



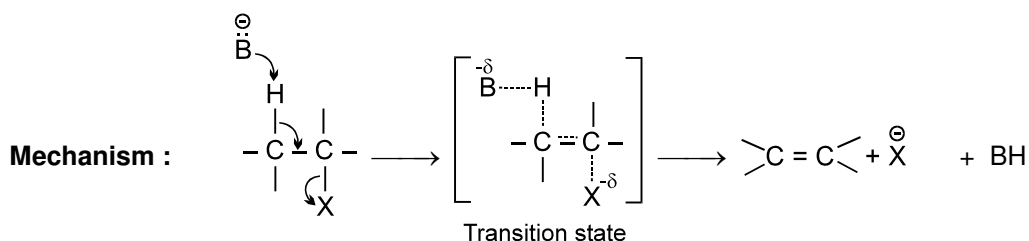
Section (B) : Bimolecular elimination reaction (E2)

(1) E2 Reaction of Alkyl halide :

Dehydrohalogenation is the elimination of a hydrogen and a halogen from an alkyl halide to form an alkene. Dehydrohalogenation can take place by E1 and E2 mechanism.

Reagent

- (i) Hot alcoholic solution of KOH or $\text{EtO}^- / \text{EtOH}$ (ii) NaNH_2 (iii) $\text{t-BuO}^- \text{K}^+$ in t-BuOH



Characteristics of E2 reaction :

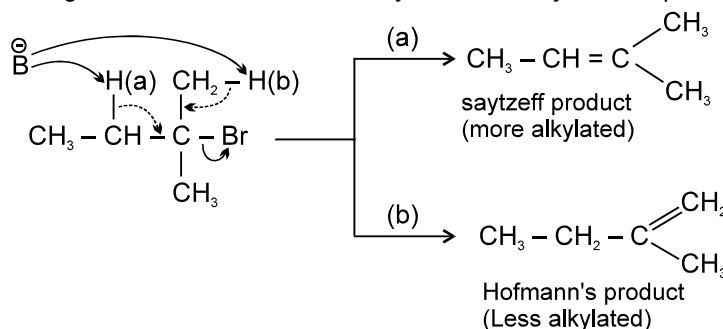
1. This is a single step, bimolecular reaction
2. It is a second order reaction
3. Kinetics \rightarrow Rate $\propto [\text{R-X}] [\text{Base}]$

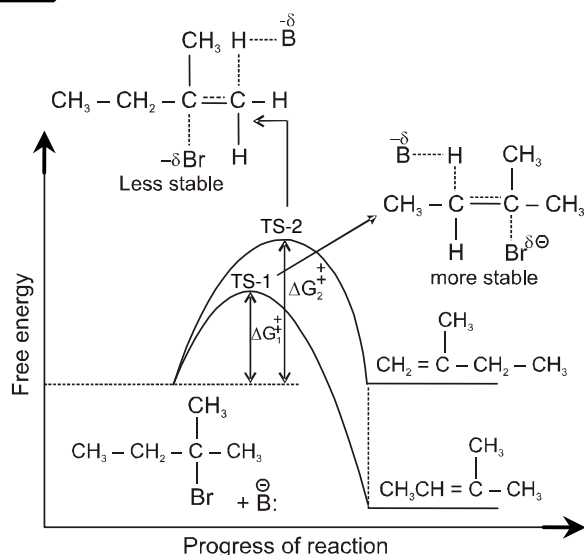
$$\text{Rate} = k [\text{R-X}] [\text{B}^-]$$
4. Rearrangement is not possible
5. For the lower energy of activation, transition state must be stable
6. E2 follows a concerted mechanism
7. The orientation of proton & leaving group should be antiperiplanar.
8. Here $\beta\text{-H}$ is eliminated by base hence called **β elimination**
9. Positional orientation of elimination \rightarrow In most E1 and E2 eliminations where there are two or more possible elimination products, the product with the most highly substituted double bond will predominate. This rule is called the saytzeff or zaitsev rule.

Reactivity towards E2 \rightarrow $\text{R-I} > \text{R-Br} > \text{R-Cl} > \text{R-F}$

Rate of E2 reaction = 3° Alkylhalide $>$ 2° Alkylhalide $>$ 1° Alkylhalide

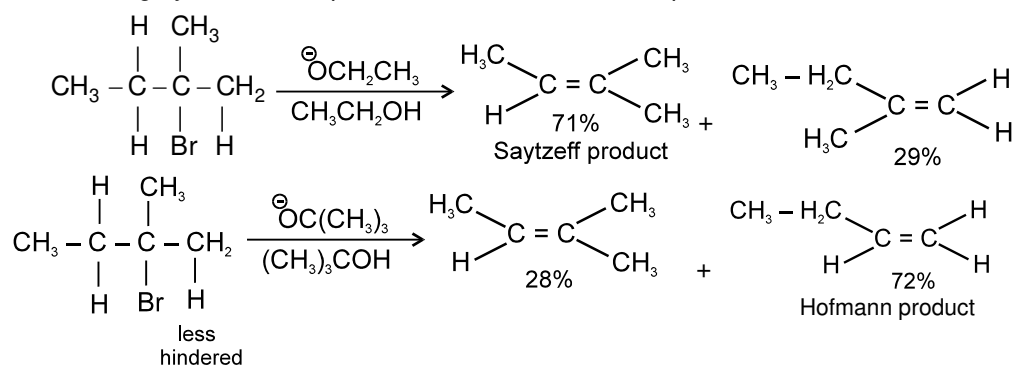
Ex-7. Dehydrohalogenation of 2-bromo-2-methylbutane can yield two products.



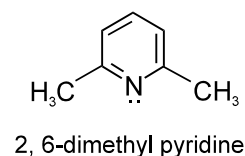
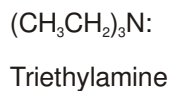
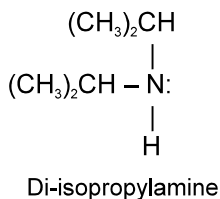
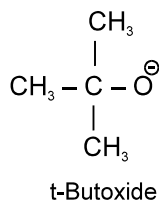


Formation of the Hoffmann product

Bulky bases can also accomplish dehydrohalogenations that do not follow the Saytzeff rule. Due to steric hindrance, a bulky base abstracts a less hindered proton, often the one that leads to formation of the least highly substituted product, called the Hoffmann product.

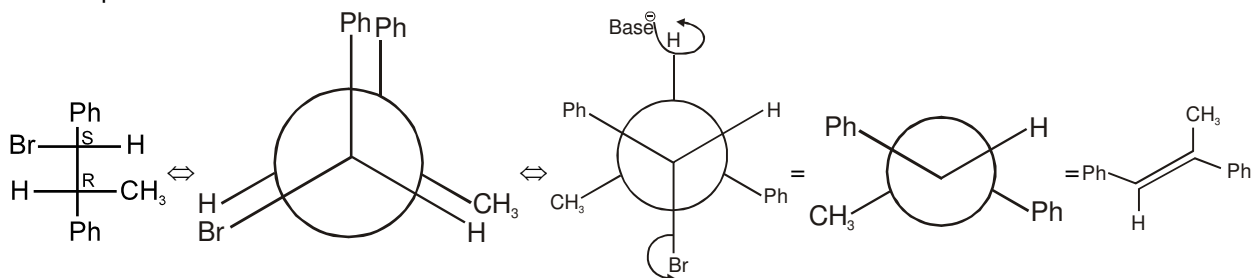


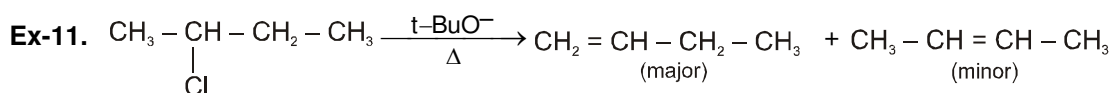
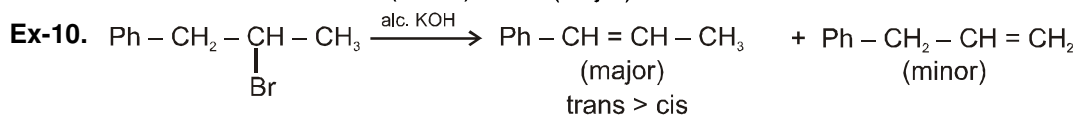
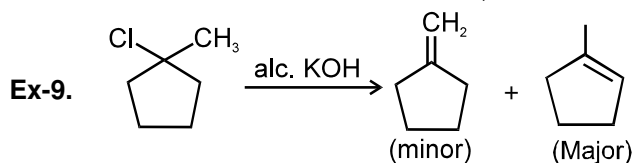
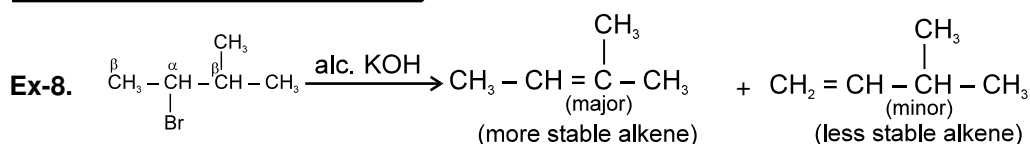
Bulky base :



Stereospecific E2 reactions

The E2 is stereospecific because it normally goes through an anti periplanar transition state. The products are alkenes.

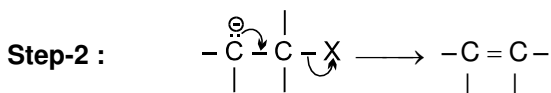
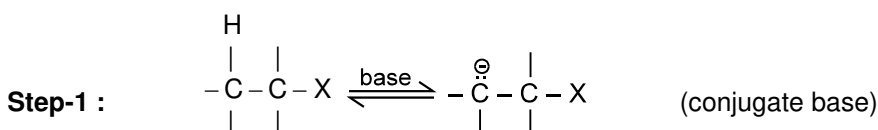




Section (C) : Unimolecular elimination by conjugate base (E1cB)

In the E1cB, H leaves first and then the X. This is a two step process, the intermediate is a carbanion.

Mechanism :

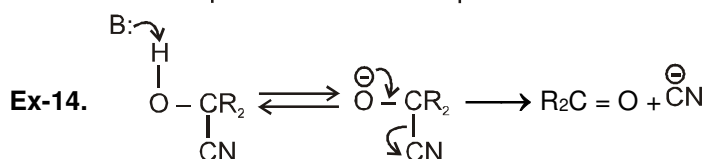
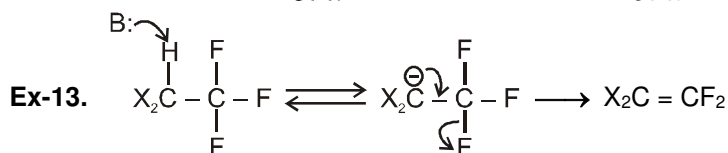
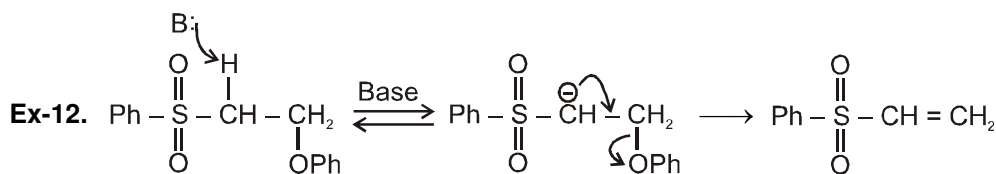


Remarks :

First step consists of the removal of a proton (H^+) by a base generating a carbanion.

In second step carbanion loses a leaving group to form alkene.

Condition: For the E1cB, (i) substrate must be containing acidic hydrogens and (ii) poor leaving groups.





Exercise-1

Marked questions are recommended for Revision.

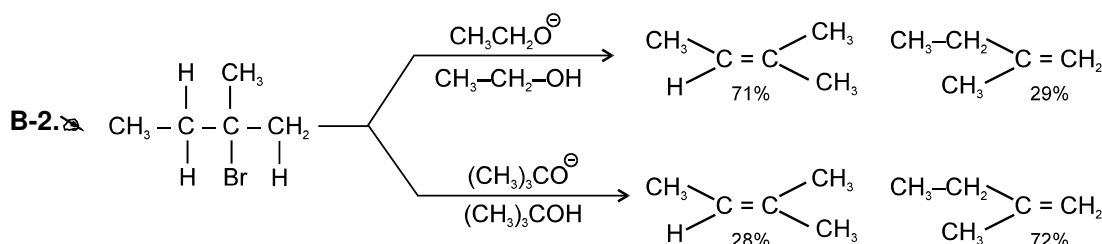
PART - I : SUBJECTIVE QUESTIONS

Section (A) : Unimolecular elimination reaction (E1)

- A-1.** Why dehydration of alcohol takes place in acidic medium generally but not in basic medium.
- A-2.** 1° alcohols are poor starting material for synthesis of 1-Alkene. Explain ?
- A-3.** Predict the major product of the acid catalysed dehydration of the following alcohols :
 (a) $(\text{CH}_3)_2\text{C}(\text{OH})\text{CH}_2\text{CH}_3$ (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
 (c) $(\text{CH}_3)_2\text{C}(\text{OH})\text{CH}(\text{CH}_3)_2$ (d) $(\text{CH}_3)_3\text{CCH}_2\text{OH}$
- A-4.** When 1-Bromo-1-methylcyclohexane is heated in ethanol for an extended period of time, three products result: one ether and two alkenes. Predict the products of this reaction, and propose a mechanism for their formation. Also, mention the major elimination product.

Section (B) : Bimolecular elimination reaction (E2)

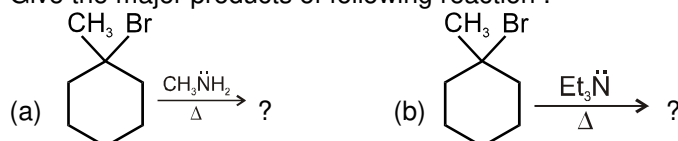
- B-1.** A halide with formula $\text{C}_6\text{H}_{13}\text{I}$ is found to give two isomeric alkenes 2-methyl-2-pentene and 4-methyl-2-pentene on dehydrohalogenation with alcoholic KOH. Suggest its structure.



Explain why more alkylated alkene is formed predominantly if base is $\text{CH}_3\text{CH}_2\text{O}^-$, while less alkylated alkene is obtained majorly when $t\text{-BuO}^-$ base is used.

- B-3.** Bromocyclodecane on heating with ethanolic KOH, produces two alkenes. Write the two products also mention the major one.
- B-4.** Which alkyl chloride would yield following pure alkene on reaction with alcoholic KOH ?
- (i) $\text{CH}_3 - \text{C}(\text{CH}_3) = \text{CH}_2$ (ii) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH} = \text{CH}_2$ (iii) $\text{CH}_3 - \text{CH}_2 - \text{C}(\text{CH}_3) = \text{CH}_2$
- B-5.** Predict all the alkenes that would be formed by dehydrohalogenation of the following alkyl halides with sodium ethoxide in ethanol and identify the major alkene :
- (i) 1-Bromo-1-methylcyclohexane (ii) 2-Chloro-2-methylbutane
- (iii) 2, 2, 3-Trimethyl-3-bromopentane.
-

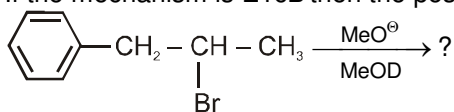
- B-6.** Give the major products of following reaction :





Section (C) : Unimolecular elimination by conjugate base (E1cB)

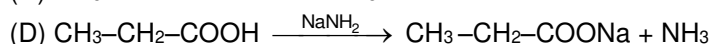
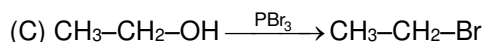
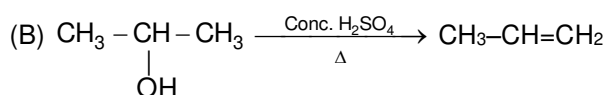
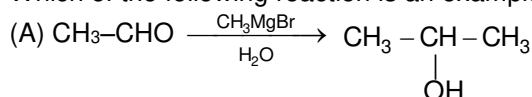
- C-1.** What are the essential conditions for any reaction to show E1cB mechanism ?
- C-2.** If ethanol containing EtOD is used as solvent, then deuterium exchange take place in E1cB mechanism. Why ?
- C-3.** If the mechanism is E1cB then the possible products will be :



PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Unimolecular elimination reaction (E1)

- A-1.** Which of the following reaction is an example of elimination reaction :



- A-2.** Correct statement for E1 Reaction is :

- (A) It is a two step process. (B) Rearrangement is possible.
(C) Good leaving group favours (D) All of these

- A-3.** Intermediate formed during E1 reaction is –

- (A) Carbocation (B) Carbanion (C) Free radical (D) Carbene

- A-4.** $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{Cl})\text{CH}_3 \xrightarrow{\text{EtOH}/\Delta}$ Major elimination product X.

X is :

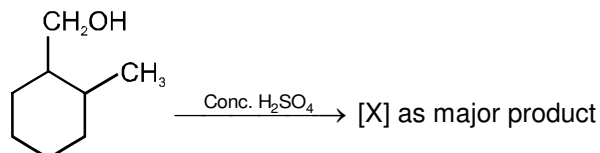
- (A) $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}=\text{CH}_2$ (B) $\text{CH}_3\text{C}(\text{CH}_3)=\text{CHCH}_3$ (C) $\text{CH}_3\text{C}(\text{C}_2\text{H}_5)=\text{CH}_2$ (D) $\text{CH}_3\text{C}(\text{CH}_3)_2=\text{CHCH}_3$

- A-5.** $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{CH}_3 \xrightarrow[\Delta]{\text{Conc. H}_2\text{SO}_4}$ Major Product

Major product is :

- (A) (B) (C) (D)

- A-6.** In the given reaction :

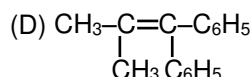
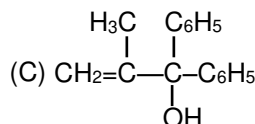
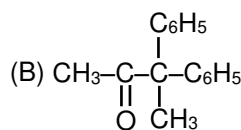
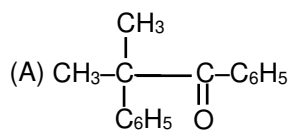
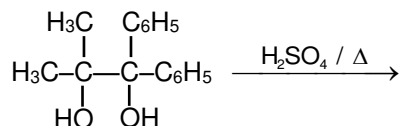


[X] will be :

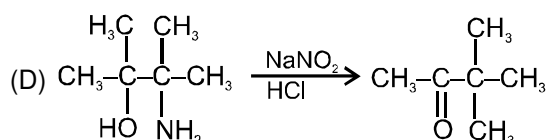
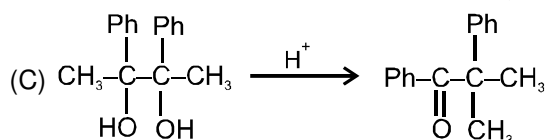
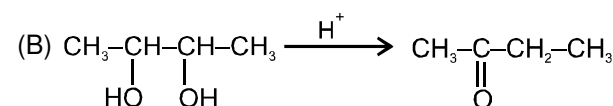
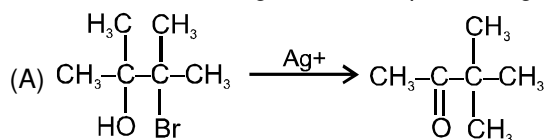
- (A) (B) (C) (D)



A-7. Identify the major product formed in the following reaction



A-8. Which of the following does not representing the correct product



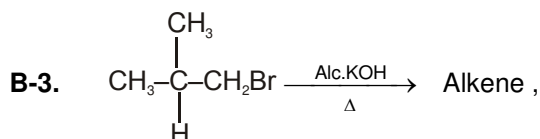
Section (B) : Bimolecular elimination reaction (E2)

B-1. Correct statement for E2 Reaction is :

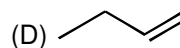
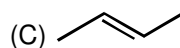
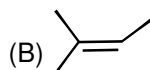
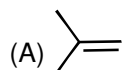
- (A) It is a two step process. (B) It is an unimolecular reaction
(C) Strong base favours (D) Carbanion is formed during the reaction

B-2. Intermediate of E2 reaction is –

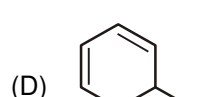
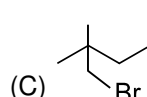
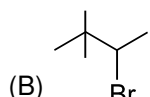
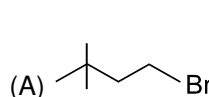
- (A) Carbocation (B) Carbanion
(C) Free radical (D) Intermediate is not Formed



Alkene is –

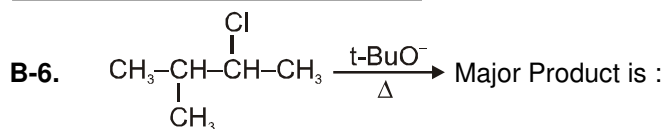


B-4. Which of the following cannot undergo E2 reaction ?

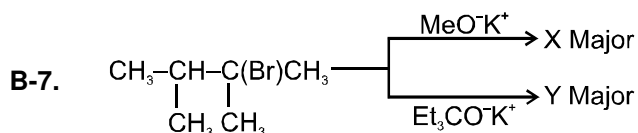


B-5. 2-Chlorobutane on treatment with alcoholic KOH/ Δ gives major product :

- (A) 2-Butene (B) 1-Butene (C) 2-Butanol (D) 1-Butyne



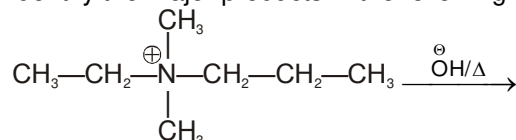
- (A) $\text{CH}_3-\underset{\text{CH}_3}{\text{C}}=\text{CH}-\text{CH}_3$ (B) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}=\text{CH}_2$ (C) $\text{CH}_2=\underset{\text{CH}_3}{\text{C}}-\text{CH}_2-\text{CH}_3$ (D) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\overset{\text{OH}}{\text{CH}}-\text{CH}_3$



X and Y are respectively :

- (A) $\text{CH}_3-\text{C}(\text{CH}_3)=\text{C}(\text{CH}_3)_2$ and $(\text{CH}_3)_2\text{CH}-\text{C}(\text{CH}_3)=\text{CH}_2$
 (B) $(\text{CH}_3)_2\text{CH}-\text{C}(\text{CH}_3)=\text{CH}_2$ and $\text{CH}_3-\text{C}(\text{CH}_3)=\text{C}(\text{CH}_3)_2$
 (C) Both $\text{CH}_3-\text{C}(\text{CH}_3)=\text{C}(\text{CH}_3)_2$ and $(\text{CH}_3)_2\text{CH}-\text{C}(\text{CH}_3)=\text{CH}_2$
 (D) Both $\text{H}_2\text{C}=\text{C}(\text{CH}_3)_2$ and $\text{H}_2\text{C}=\text{C}(\text{CH}_3)_2$

B-8. Identify the major products in the following reaction ?



- (A) $\text{CH}_3-\text{CH}=\text{CH}_2$ (B) $\text{CH}_2=\text{CH}_2$ (C) $\text{CH}_3\text{CH}_2-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\underset{|}{\text{N}}^+}}-\text{OH}$ (D) $\text{C}_2\text{H}_5-\text{OH}$

Section (C) : Unimolecular elimination by conjugate base (E1cB)

C-1. Reaction intermediate of E1cB reaction is :

- (A) Carbocation (B) Carbanion (C) Benzyne (D) Free radical

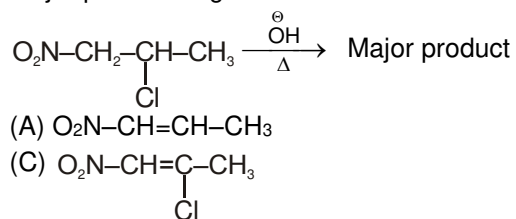
C-2. D-exchange is observed in :

- (A) E1 (B) E2 (C) E1cB (D) none of these



- (A) $\text{CH}_3\text{COCH}_2\text{CH}_2\text{OH}$ (B) $\text{CH}_3\text{COCH}=\text{CH}_2$ (C) $\text{CH}_3\text{COCH}_2\text{CH}=\text{CH}_2$ (D) $\text{CH}_3\text{COCH}_2\text{CHF}_2$

C-4. Major product of given reaction is-





PART - III : MATCH THE COLUMN

1. Match List I (Reaction) with List II (Type of reaction) and select the correct answer using the code given below the lists :

	List I		List II
(P)		(1)	S _N 1
(Q)		(2)	S _N 2
(R)		(3)	E1
(S)		(4)	E2

Codes :

	P	Q	R	S		P	Q	R	S
(A)	4	2	1	3	(B)	2	4	3	1
(C)	3	1	2	4	(D)	2	1	4	3

2. Match reactions written in **List-I** with their mechanism in **List-II**.

	List-I		List-II
(A)	$\text{Ph-CH}_2\text{-CH}_2\text{-Br} \xrightarrow{\text{aq. KOH}} \text{Ph-CH(OH)-CH}_3 + \text{Ph-CH=CH}_2$	(p)	S _N 1
(B)	$\text{Ph-CH}_2\text{-CH}_2\text{-Br} \xrightarrow[\Delta]{\text{EtONa}} \text{Ph-CH}_2\text{-CH}_2\text{-OEt} + \text{Ph-CH=CH}_2$	(q)	S _N 2
(C)	$\text{Ph-CH}_2\text{-CH}_2\text{-Br} \xrightarrow[\Delta]{\text{EtO}^-/\text{EtOD}} \text{Ph-CH=CH}_2$	(r)	E1
(D)	$\text{Ph-CH}_2\text{-CH}_2\text{-Br} \xrightarrow[\Delta]{\text{EtO}^-/\text{EtOD}} \text{Ph-CH=CH}_2 + \text{Ph-CD}_2\text{-CH}_2\text{Br}$	(s)	E2
		(t)	E1cB

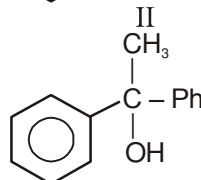
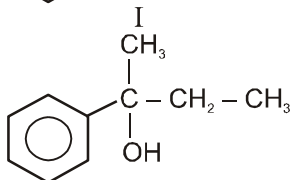
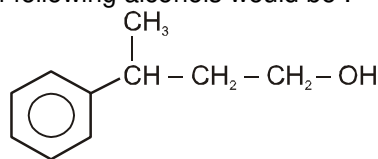
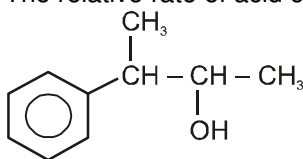


Exercise-2

Marked questions are recommended for Revision.

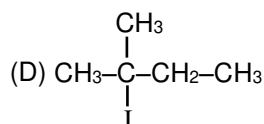
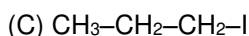
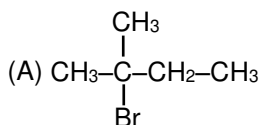
PART - I : ONLY ONE OPTION CORRECT TYPE

1. The relative rate of acid catalysed dehydration of following alcohols would be :



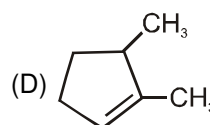
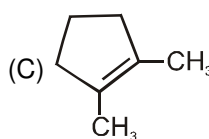
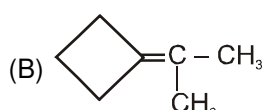
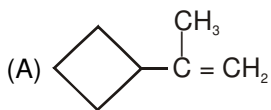
- (A) III > I > IV > II (B) III > IV > I > II (C) I > III > IV > II (D) IV > III > I > II

2. Which one of the following compound undergoes E1 reaction most readily ?



3. In the given reaction, [X]

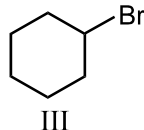
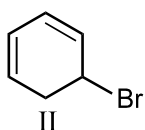
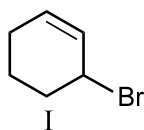
[X] as the major product among the elimination products is :



4. Product

Intermediates for both the steps are respectively ?

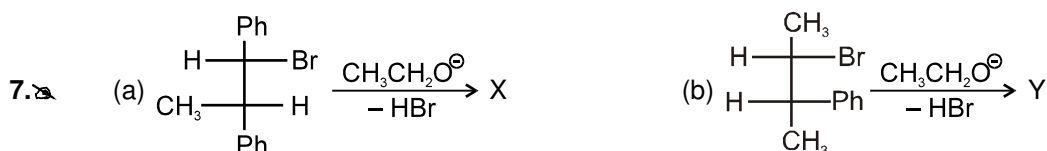
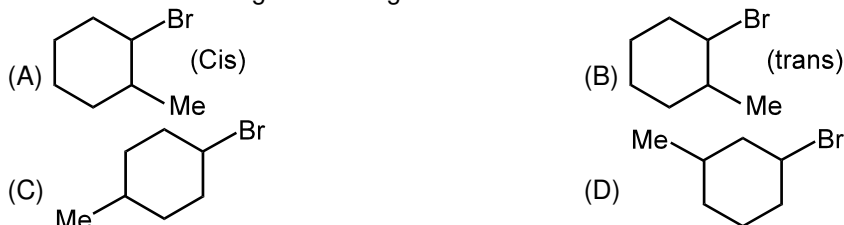
- (A) Carbocation & No intermediate (B) No intermediate & carbocation
(C) Carbocation & carbanion (D) Carbocation & carbocation
5. Arrange the following in decreasing order of stability of their transition state during elimination by strong base



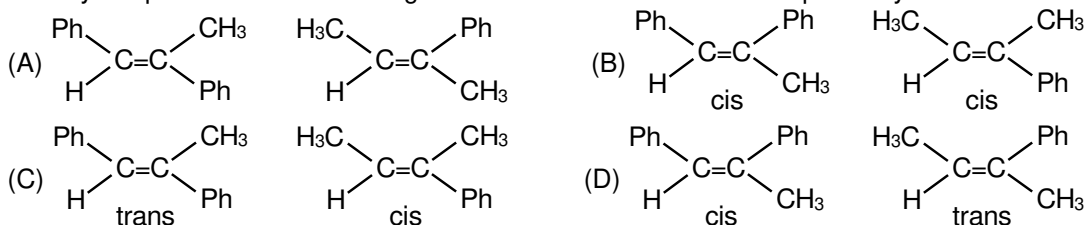
- (A) II > I > III (B) II > III > I (C) I > III > II (D) I > II > III



6. Which of the following will undergo fastest elimination reaction with alcoholic KOH.



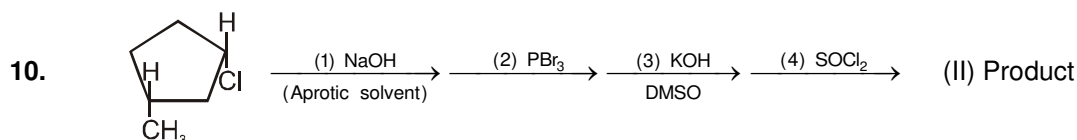
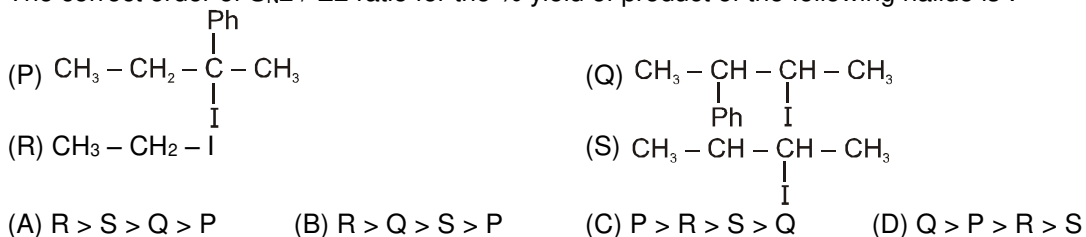
Identify the product of the following elimination reaction X and Y respectively with stereochemistry :



8. Which mechanism has different reactivity order of alkyl halides (1° , 2° , 3°) than others :

(A) S_N1 (B) S_N2 (C) E1 (D) E2

9. The correct order of S_N2 / E2 ratio for the % yield of product of the following halide is :



(I) (Reactant)

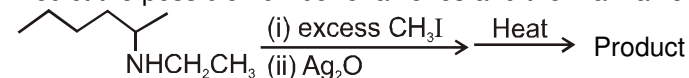
In this reaction I and II are,

- (A) Enantiomers (B) Structure isomers
 (C) Geometrical isomers (D) Identical compounds

11. Select the incorrect option for the following statements.

- (A) Bimolecular elimination of alkyl halides is a stereospecific reaction.
 (B) In S_N2 reaction a single isomer is the only product.
 (C) Alcohol dehydrate in strongly basic conditions by E1 mechanism.
 (D) 3-hydroxypropanal dehydrates in strong basic condition by E1cb mechanism.

12. Predict the possible number of alkenes and the main alkene in the following reaction.



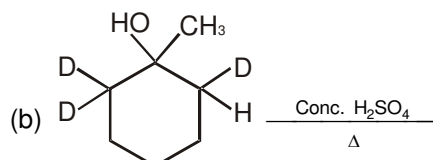
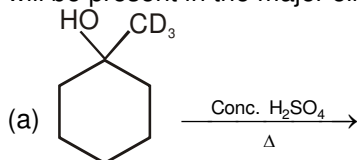
- (A) 2 and (B) 2 and
 (C) 4 and $\text{H}_2\text{C}=\text{CH}_2$ (D) 3 and $\text{H}_2\text{C}=\text{CH}_2$



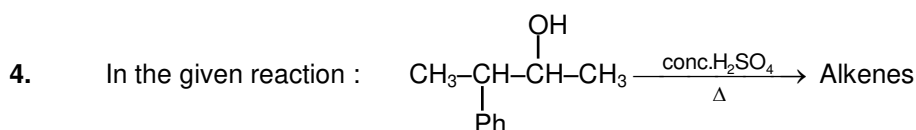
PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

1. 'X' is a smallest optically active alkanol. On dehydration it can form Y number of alkenes (including stereoisomers). On reaction with Lucas reagent it forms Z number of alkyl halides (including stereoisomers). Report your answer as Z Y.

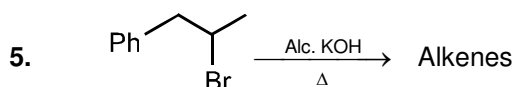
2. If the starting material is labelled with deuterium as indicated, predict how many total deuterium atoms will be present in the major elimination product ?



3. The total number of alkenes possible by dehydrobromination of 3-bromo-3-methylhexane using alcoholic KOH is :

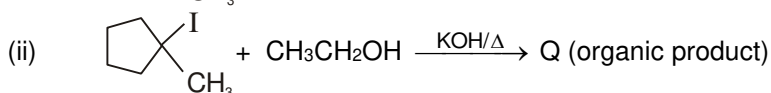
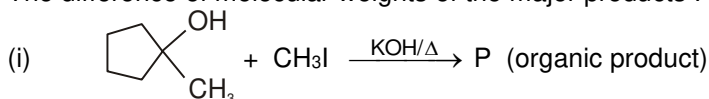


Total number of alkenes (Including stereo isomers) formed will be

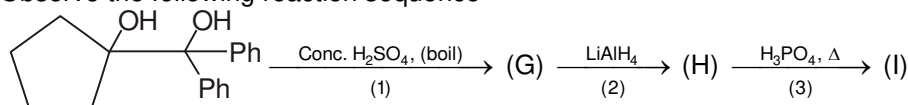


the total number of possible alkenes in this elimination reaction is.

6. The difference of molecular weights of the major products P and Q from the following reactions is



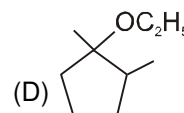
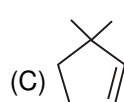
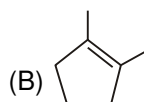
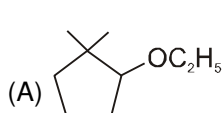
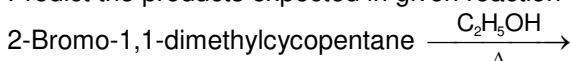
7. Observe the following reaction sequence



Calculate molecular mass [W] of product I and report your answer as N, where $N = W \div 3$.

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Predict the products expected in given reaction

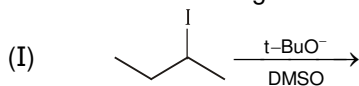


2. Which of the following order is/are correct for the rate of E2 reaction ?

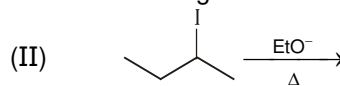
- (A) 5-Bromocycloheptene > 4-Bromocycloheptene
 (B) 2-Bromo-1-phenylbutane > 3-Bromo-1-phenylbutane
 (C) 3-Bromocyclohexene > Bromocyclohexane
 (D) 3-Bromo-2-methylpentane > 2-Bromo-4-methylpentane



3. Which of the following statement (s) is/are true about the following eliminations ?

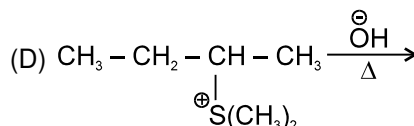
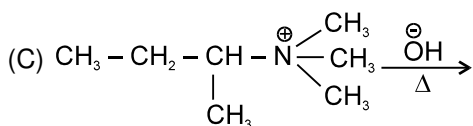
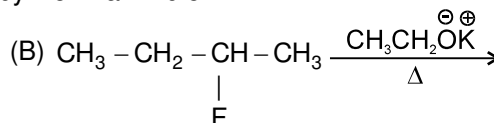
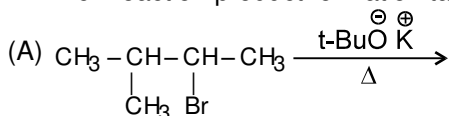


- (A) Hoffmann product is major product in I.
(C) Hoffmann product is major product in II.

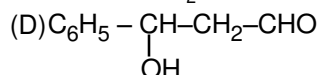
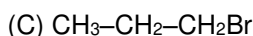
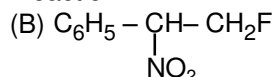
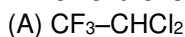


- (B) Saytzeff product is major product in I
(D) Saytzeff product is major product in II

4. In which reaction product formation takes place by Hoffmann rule ?



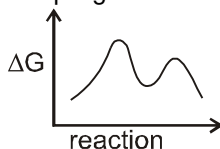
5. Which of the following compounds can give E1cB reaction ?



6. Which of the following statement (s) is/are correct

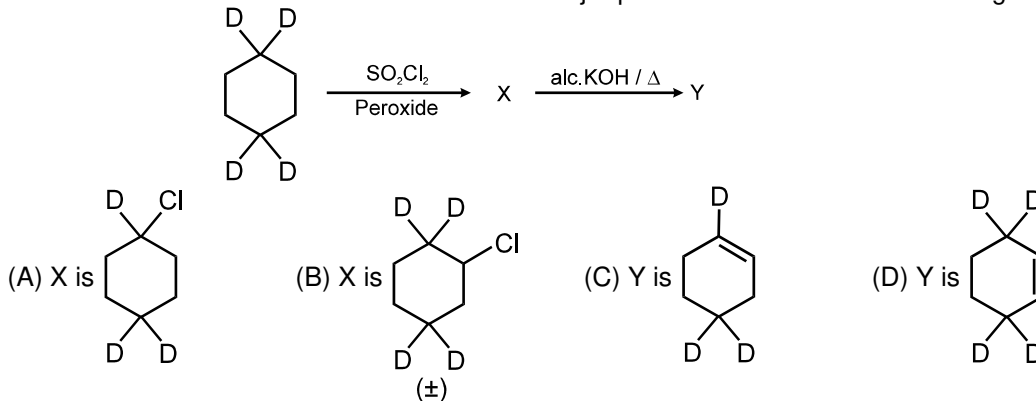
- (A) E2 is a concerted reaction in which bonds break and new bonds form at the same time in a single step.
(B) Order of reactivity of alkyl halides towards E2 dehydrohalogenation is found to be $3^\circ > 2^\circ > 1^\circ$
(C) In E2 reaction both β hydrogen and leaving group should be antiperiplanar.
(D) In E2 elimination different stereoisomer (diastereomer) converts into different stereo product.

7. Following graph between ΔG and reaction progress in for/can be :



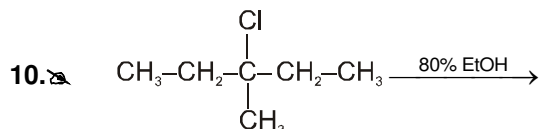
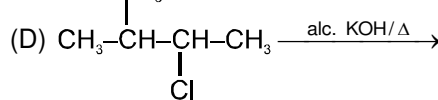
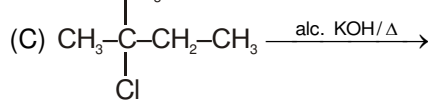
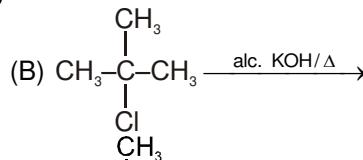
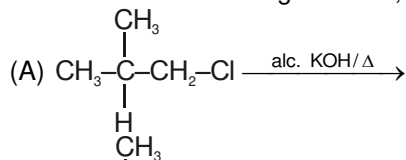
- (A) $\text{S}_\text{N}1$ reaction
(B) E_1 reaction
(C) Aromatic electrophilic substitution
(D) Electrophilic addition reaction

8. Which observation/s will be correct about the major products X and Y of the following reaction.





9. In which of the following reaction, regioselectivity can be observed.



What is / are true about above reaction ?

- (A) Major product is given by $\text{S}_{\text{N}}1$ reaction.
 (B) Through $\text{E}1$ mechanism 3 alkenes are formed.
 (C) 3-Methylpentan-3-ol is also formed as one of the product.
 (D) Fractional distillation of elimination products will give two fractions.

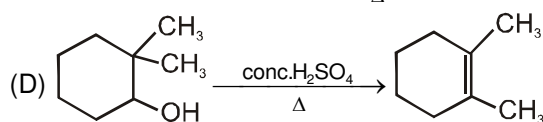
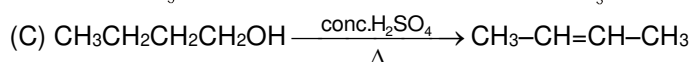
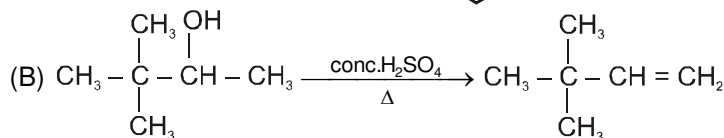
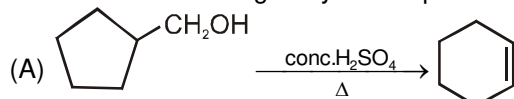
PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

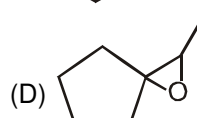
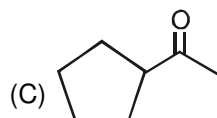
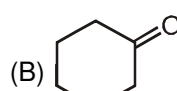
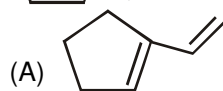
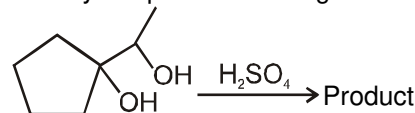
Comprehension # 1

Alcohols undergo acid catalysed elimination reactions to produce alkenes. Because water is lost in the elimination, this reaction is called dehydration reaction. Secondary and tertiary alcohols always give $\text{E}1$ reaction in dehydration. Primary alcohols whose β -carbon is branched also give $\text{E}1$ reaction. The reactivity of alcohol for elimination reaction is tertiary alcohol > Secondary alcohol > Primary alcohol.

1. Which of the following dehydration product (major) is incorrect ?

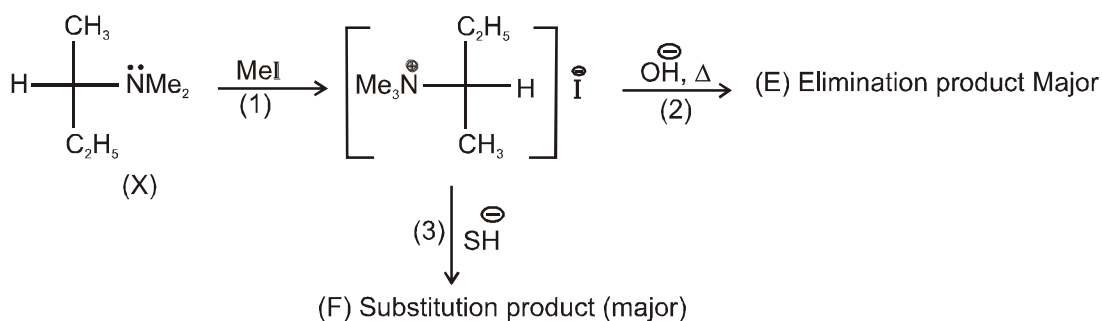


2. Identify the product in the given reaction :





Comprehension # 2



3. The incorrect statement about step-1 is :
 (A) It is $\text{S}_{\text{N}}2$ reaction
 (B) Only one transition state is formed in this reaction
 (C) Walden inversion has occurred at reactant 'X'
 (D) The reaction has molecularity two
4. The product 'E' is :
 (A) $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}_2$ (B) $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$ (C) $\text{CH}_2=\text{CH}_2$ (D) $\text{CH}_3-\text{CH}=\text{CH}_2$
5. The product 'F' is :
 (A) $\text{C}_2\text{H}_5\text{SH}$ (B) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}-\text{C}-\text{SH} \\ | \\ \text{C}_2\text{H}_5 \end{array}$ (C) CH_3SH (D) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{HS}-\text{C}-\text{H} \\ | \\ \text{C}_2\text{H}_5 \end{array}$

Comprehension # 3

Answer Q.6, Q.7 and Q.8 by appropriately matching the information given in the three columns of the following table.

Column-1		Column-2		Column-3	
(I)		(i)	Zn dust / Δ	(P)	
(II)		(ii)	Conc. H_2SO_4	(Q)	
(III)		(iii)	HCl/ZnCl_2	(R)	
(IV)		(iv)	Aqueous AgNO_3	(S)	

6. The bimolecular reaction is represented by :
 (A) (IV), (iii), (Q) (B) (I), (ii), (S) (C) (III), (ii), (P) (D) (II), (i), (R)
7. The dehydration reaction is represented by :
 (A) (III), (ii), (R) (B) (III), (iv), (P) (C) (I), (ii), (S) (D) (IV), (iii), (R)
8. The unimolecular nucleophilic substitution is represented by :
 (A) (II), (iii), (Q) (B) (I), (iv), (S) (C) (IV), (iv), (Q) (D) (IV), (iii), (Q)

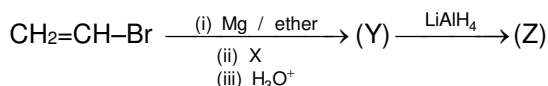
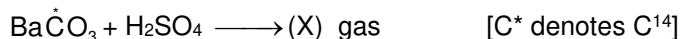


Exercise-3

* Marked Questions may have more than one correct option.

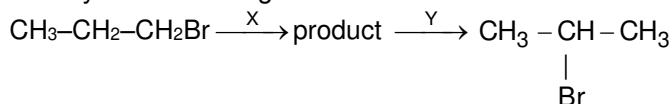
PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. Identify (X), (Y) and (Z) in the following synthetic scheme and write their structures. Explain the formation of labelled formaldehyde ($\text{H}_2\text{C}^*\text{O}$) as one of the products when compound (Z) is treated with HBr and subsequently ozonolysed. Mark the C^* carbon in the entire scheme.



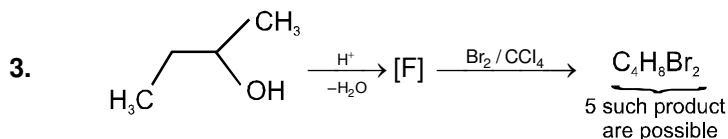
[IIT-JEE 2001(M), 5/135]

2. Identify the set of reagents/reaction conditions 'X' and 'Y' in the following set of transformations.



[IIT-JEE 2002(S), 3/150]

- (A) X = concentrated alcoholic NaOH, 80°C ; Y = HBr acetic acid, 20°C
 (B) X = dil. aq. NaOH, 20°C , Y = HBr / acetic acid, 20°C
 (C) X = dil. aq. NaOH, 20°C , Y = Br_2 / CHCl_3 , 0°C
 (D) X = conc. alc. NaOH, 80°C , Y = Br_2 / CHCl_3 , 0°C



How many structures of F is possible?

(A) 2

(B) 5

(C) 6

(D) 3

[IIT-JEE 2003(S), 4/144]

4. Which is the best reagent to convert cyclohexanol into cyclohexene.

(A) conc. HCl

(B) conc. HBr

(C) conc. H_3PO_4

(D) HCl + ZnCl_2

[JEE-2005, 3/144]

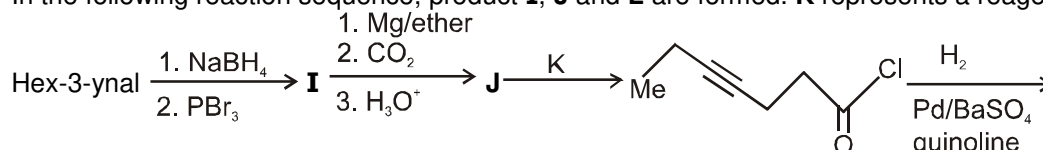
5. Match the following (one term in column-I may match with more than one terms in column-II)

[JEE-2006, 6/184]

	Column I		Column II
(A)	$\text{CH}_3-\underset{\text{Br}}{\text{CH}}-\text{CD}_3$ on reaction with $\text{C}_2\text{H}_5\text{O}^-$ gives $\text{CH}_2=\text{CH}-\text{CD}_3$	(p)	The reaction is E1
(B)	$\text{PhCH}_2\text{CH}_2\text{Br}$ gives elimination faster than $\text{PhCD}_2\text{CH}_2\text{Br}$. The mechanism is	(q)	The reaction is E2
(C)	$\text{PhCH}_2\text{CH}_2\text{Br}$ in presence of $\text{C}_2\text{H}_5\text{OD}/\text{C}_2\text{H}_5\text{O}^-$ gives good yield of $\text{PhCD}_2\text{CH}_2\text{Br}$ along with alkene	(r)	The reaction is E1 cB
(D)	$\text{Ph}-\underset{\text{Br}}{\text{CH}}-\text{CD}_3$ and $\text{Ph}-\underset{\text{Br}}{\text{CH}}-\text{CH}_3$ on elimination, yield alkene at the same rate	(s)	The reaction is unimolecular

Comprehension # 1

In the following reaction sequence, product I, J and L are formed. K represents a reagent.

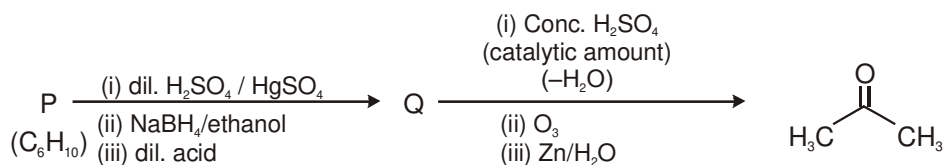




6. The structure of the product **I** is [IIT-JEE 2008, 4/162]
 (A) (B)
 (C) (D)
7. The structures of compound **J** and **K**, respectively, are [IIT-JEE 2008, 4/162]
 (A) and SOCl_2 (B) and SOCl_2
 (C) (D) and $\text{CH}_3\text{SO}_2\text{Cl}$
8. The structure of product **L** is [IIT-JEE 2008, 4/162]
 (A) (B)
 (C) (D)
9. The total number of alkenes possible by dehydrobromination of 3-bromo-3-cyclopentylhexane using alcoholic KOH is [JEE-2011, 4/160]

Comprehension # 2

An acyclic hydrocarbon **P**, having molecular formula C_6H_{10} , gave acetone as the only organic product through the following sequence of reactions, in which **Q** is an intermediate organic compound.

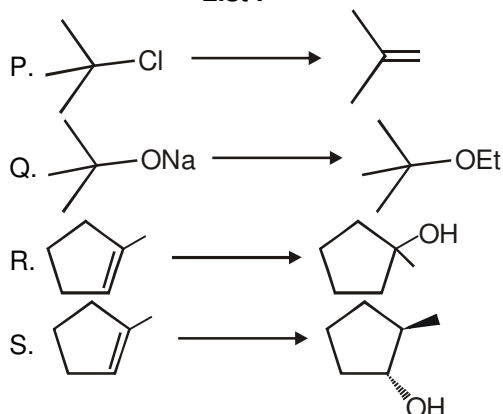


10. The structure of compound **P** is [JEE 2011, 3/160]
 (A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2-\text{C}\equiv\text{C}-\text{H}$ (B) $\text{H}_3\text{CH}_2\text{C}-\text{C}\equiv\text{C}-\text{CH}_2\text{CH}_3$
 (C) (D)
11. The structure of the compound **Q** is [JEE 2011, 3/160]
 (A) (B)
 (C) (D)
12. The major product (**H**) in the given reaction sequence is : [IIT-JEE 2012, 3/136]
 $\text{CH}_3-\text{CH}_2-\text{CO}-\text{CH}_3 \xrightarrow{\text{CN}^-} \text{G} \xrightarrow[\text{Heat}]{95\% \text{ H}_2\text{SO}_4} \text{H}$
 (A) (B)
 (C) (D)



13. Match the chemical conversions in List I with the appropriate reagents in List II and select the correct answer using the code given below the lists : [IIT-JEE-2013, 3/120]

List I



List II

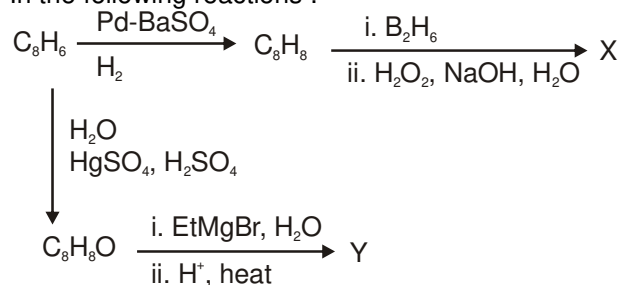
- (i) $\text{Hg}(\text{OAc})_2$; (ii) NaBH_4
- NaOEt
- Et-Br
- (i) BH_3 ; (ii) $\text{H}_2\text{O}_2/\text{NaOH}$

Codes :

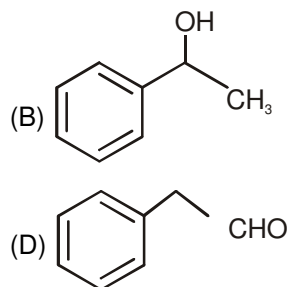
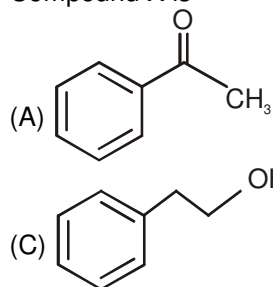
	P	Q	R	S		P	Q	R	S
(A)	2	3	1	4	(B)	3	2	1	4
(C)	2	3	4	1	(D)	3	2	4	1

Comprehension # 3

In the following reactions :

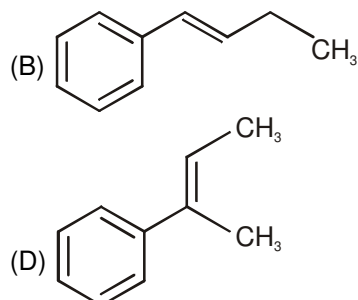
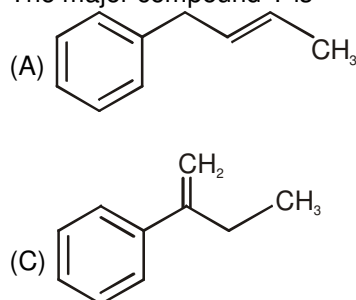


14. Compound X is



[IIT-JEE-2015, 4/168]

15. The major compound Y is



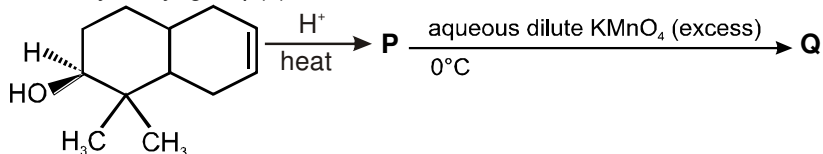
[IIT-JEE-2015, 4/168]





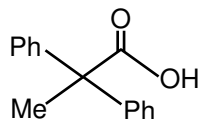
16. The number of hydroxyl group(s) in **Q** is :

[IIT-JEE-2015, 4/168]



17. The desired product **X** can be prepared by reacting the major product of the reactions in LIST-I with one or more appropriate reagents in LIST-II. (Given, order of migratory aptitude: aryl > alkyl > hydrogen)

[JEE(Advanced) 2018, 3/120]



X

LIST-I		LIST-II	
(P)		(1)	I ₂ , NaOH
(Q)		(2)	[Ag(NH ₃) ₂]OH
(R)		(3)	Fehling solution
(S)		(4)	HCHO, NaOH
		(5)	NaOBr

The correct option is

(A) P → 1 ; Q → 2, 3 ; R → 1, 4 ; S → 2, 4
(C) P → 1, 5 ; Q → 3, 4 ; R → 5 ; S → 2, 4

(B) P → 1, 5 ; Q → 3, 4 ; R → 4, 5 ; S → 3
(D) P → 1, 5 ; Q → 2, 3 ; R → 1, 5 ; S → 2, 3

18. LIST-I contains reactions and LIST-II contains major products.

[JEE(Advanced) 2018, 3/120]

LIST-I		LIST-II	
(P)		(1)	
(Q)		(2)	
(R)		(3)	
(S)		(4)	
		(5)	





Match each reaction in LIST-I with one or more products in LIST-II and choose the correct option.

(A) P → 1, 5 ; Q → 2 ; R → 3 ; S → 4

(B) P → 1, 4 ; Q → 2 ; R → 4 ; S → 3

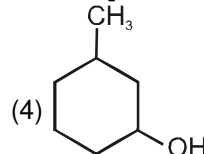
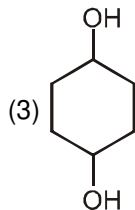
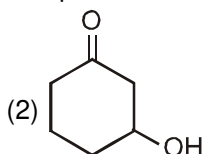
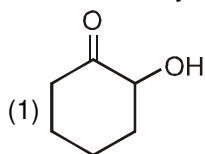
(C) P → 1, 4 ; Q → 1, 2 ; R → 3, 4 ; S → 4

(D) P → 4, 5 ; Q → 4 ; R → 4 ; S → 3, 4

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

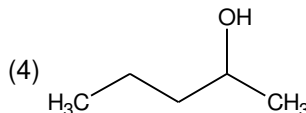
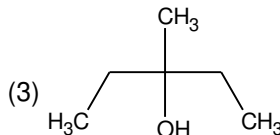
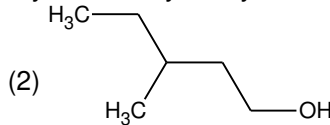
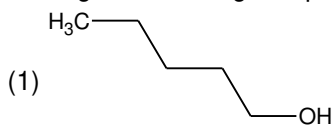
JEE(MAIN) OFFLINE PROBLEMS

1. Maximum dehydration takes place that of : [AIEEE-2002, 3/225]



2. During dehydration of alcohols to alkenes by heating with concentrated H_2SO_4 the initiation step is
 (1) Protonation of alcohol molecule (2) Formation of carbocation [AIEEE-2003, 3/225]
 (3) Elimination of water (4) Formation of an ester

3. Among the following compounds which can be dehydrated very easily : [AIEEE-2004, 3/225]

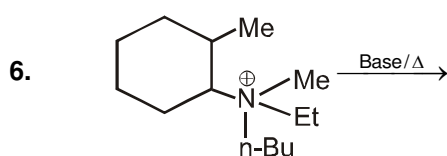


4. Elimination of HBr from 2-bromobutane result in the formation of : [AIEEE-2005, 3/225]
 (1) Predominantly 2-butyne (2) Predominantly 1-butene
 (3) Predominantly 2-butene (4) Equimolar mixture of 1 and 2-butene

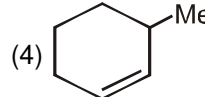
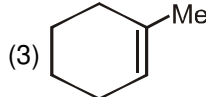
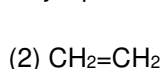
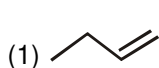
5. Reaction of trans 2-phenyl-1-bromocyclopentane on reaction with alcoholic KOH produces: [AIEEE-2006, 3/165]

(1) 2-phenylcyclopentene
 (3) 3-phenylcyclopentene

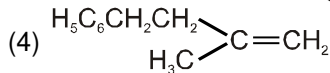
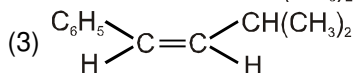
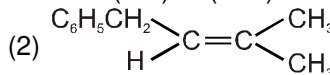
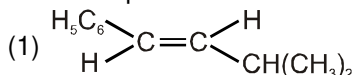
(2) 1-phenylcyclopentene
 (4) 4-phenylcyclopentene



The alkene formed as a major product in the above elimination reaction is : [AIEEE-2006, 3/165]

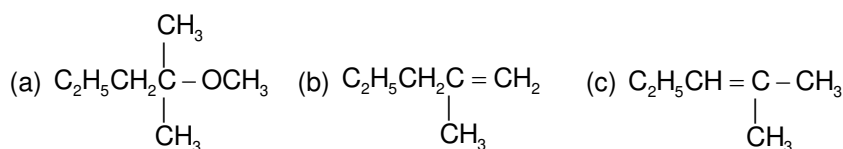


7. The main product of the following reaction is, $\text{C}_6\text{H}_5\text{CH}_2\text{CH}(\text{OH})\text{CH}(\text{CH}_3)_2 \xrightarrow{\text{conc. H}_2\text{SO}_4}$ [AIEEE-2010, 4/144]

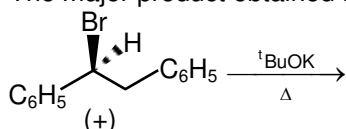




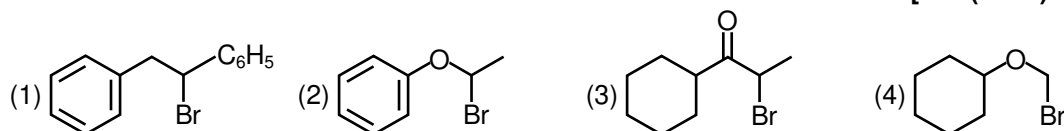
8. Consider the following reaction: $\text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{SO}_4 \rightarrow \text{Product}$
Among the following, which one cannot be formed as a product under any conditions ?
[JEE(Main) 2011, 4/120]
- (1) Ethylene (2) Acetylene (3) Diethyl ether (4) Ethyl-hydrogen sulphate
9. In the reaction, $\text{CH}_3\text{COOH} \xrightarrow{\text{LiAlH}_4} \text{A} \xrightarrow{\text{PCl}_5} \text{B} \xrightarrow{\text{Alc. KOH}} \text{C}$,
the product C is :
[JEE(Main) 2014, 4/120]
- (1) Acetaldehyde (2) Acetylene (3) Ethylene (4) Acetyl chloride
10. 2-Chloro-2-methylpentane on reaction with sodium methoxide in methanol yields :
[JEE(Main) 2016, 4/120]



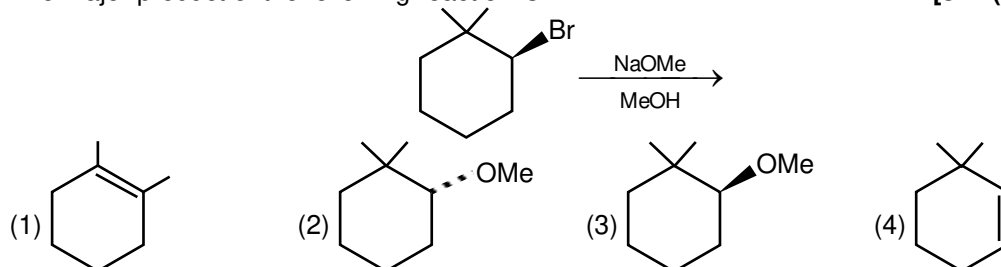
- (1) (a) and (c) (2) (c) only (3) (a) and (b) (4) All of these
11. The major product obtained in the following reaction is :
[JEE(Main) 2017, 4/120]



- (1) $\text{C}_6\text{H}_5\text{CH}=\text{CHC}_6\text{H}_5$ (2) $(+)\text{C}_6\text{H}_5\text{CH}(\text{O}^t\text{Bu})\text{CH}_2\text{C}_6\text{H}_5$
(3) $(-)\text{C}_6\text{H}_5\text{CH}(\text{O}^t\text{Bu})\text{CH}_2\text{C}_6\text{H}_5$ (4) $(\pm)\text{C}_6\text{H}_5\text{CH}(\text{O}^t\text{Bu})\text{CH}_2\text{C}_6\text{H}_5$
12. Which of the following, upon treatment with tert-BuONa followed by addition of bromine water, fails to decolourize the colour of bromine ?
[JEE(Main) 2017, 4/120]

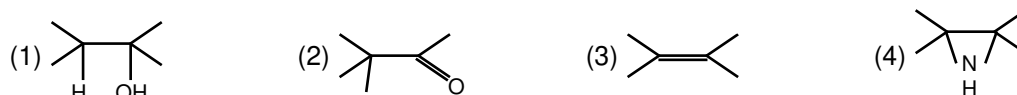


13. The major product of the following reaction is :
[JEE(Main) 2018, 4/120]

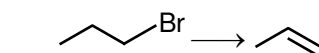


JEE(MAIN) ONLINE PROBLEMS

1. The major product of the reaction
 $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}(\text{NH}_2)\text{CH}_2\text{OH} \xrightarrow{\text{NaNO}_2/\text{H}_2\text{SO}_4}$ is :
[JEE(Main) 2014 Online (09-04-14), 4/120]



2. Which one of the following reagents is not suitable for the elimination reaction ?
[JEE(Main) 2016 Online (10-04-16), 4/120]

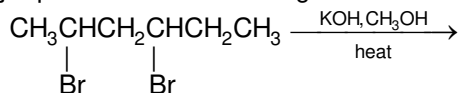


- (1) NaI (2) NaOH / H_2O -EtOH
(3) NaOH / H_2O (4) NaOEt / EtOH



3. The major product of the following reaction is :

[JEE(Main) 2017 Online (08-04-17), 4/120]

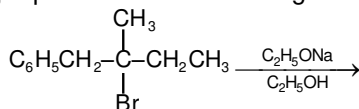


- (1) $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$
(3) $\text{CH}_3\text{CH}=\text{CH}-\text{CH}=\text{CHCH}_3$

- (2) $\text{CH}_2=\text{CHCH}=\text{CHCH}_2\text{CH}_3$
(4) $\text{CH}_2=\text{CHCH}_2\text{CH}=\text{CHCH}_3$

4. The major product of the following reaction is :

[JEE(Main) 2017 Online (08-04-17), 4/120]



- (1) $\text{C}_6\text{H}_5\text{CH}_2-\text{C}(\text{CH}_3)=\text{CHCH}_3$

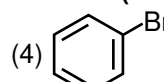
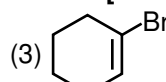
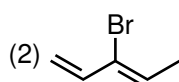
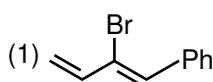
- (2) $\text{C}_6\text{H}_5\text{CH}_2-\text{C}(\text{CH}_2\text{CH}_3)=\text{CH}_2$

- (3) $\text{C}_6\text{H}_5\text{CH}_2-\text{C}(\text{CH}_3)(\text{OC}_2\text{H}_5)-\text{CH}_2\text{CH}_3$

- (4) $\text{C}_6\text{H}_5\text{CH}(\text{CH}_3)-\text{CH}=\text{CH}_2$

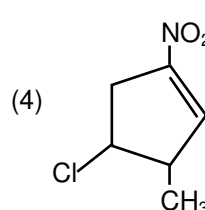
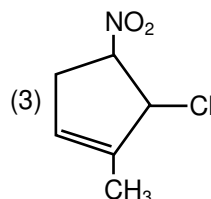
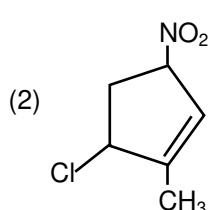
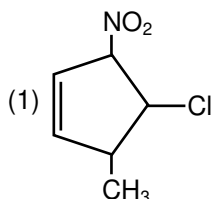
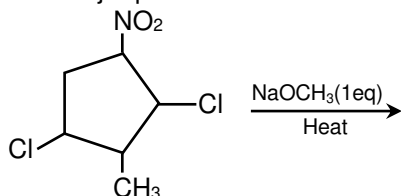
5. Which of the following will most readily give the dehydrohalogenation product ?

[JEE(Main) 2018 Online (15-04-18), 4/120]



6. The major product formed in the following reaction is :

[JEE(Main) 2018 Online (15-04-18), 4/120]



7. Which of the following compounds will most readily be dehydrated to give alkene under acidic condition?

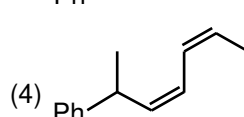
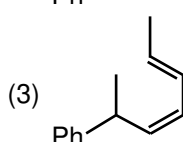
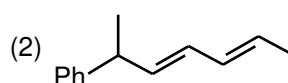
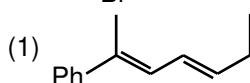
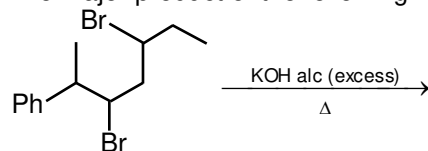
[JEE(Main) 2018 Online (16-04-18), 4/120]

- (1) 4-Hydroxypentan-2-one
(3) 1-Pentanol

- (2) 3-Hydroxypentan-2-one
(4) 2-Hydroxycyclopentanone

8. The major product of the following reaction is :

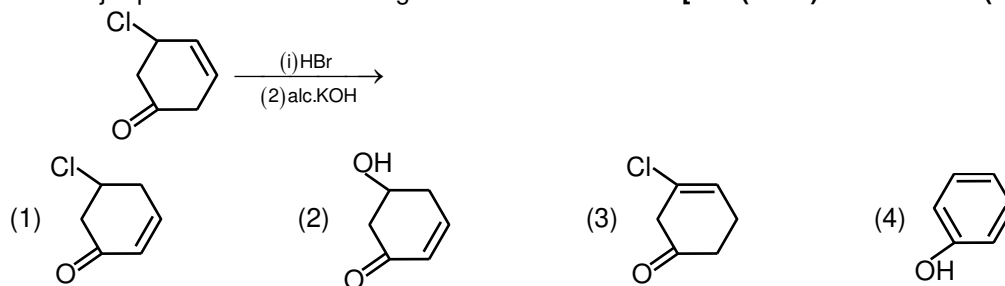
[JEE(Main) 2019 Online (10-01-19), 4/120]





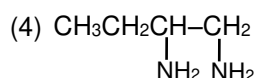
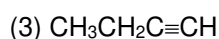
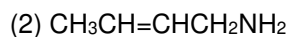
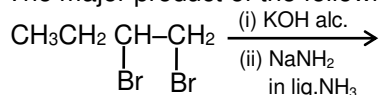
9. The major product of the following reaction is

[JEE(Main) 2019 Online (11-01-19), 4/120]



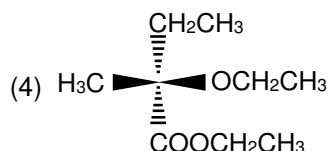
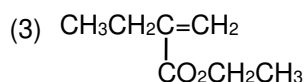
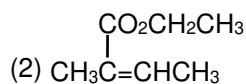
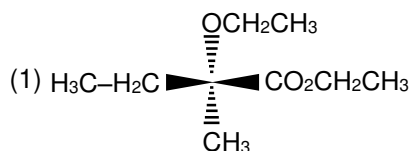
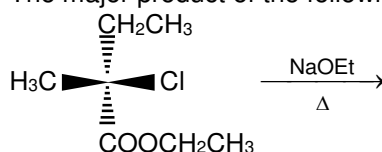
10. The major product of the following reaction is :

[JEE(Main) 2019 Online (12-01-19), 4/120]



11. The major product of the following reaction is:

[JEE(Main) 2019 Online (12-01-19), 4/120]





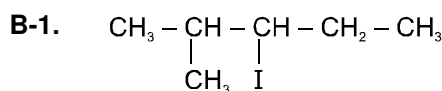
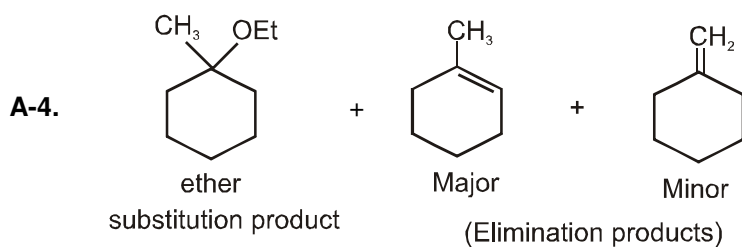
Answers

EXERCISE – 1

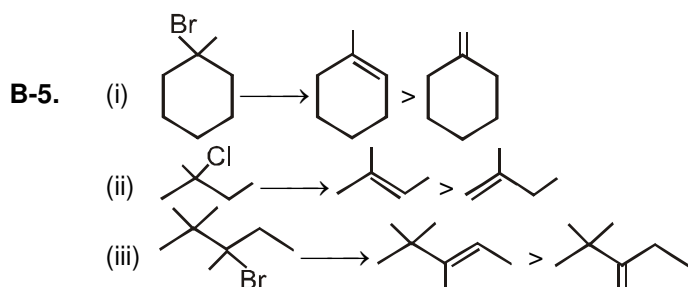
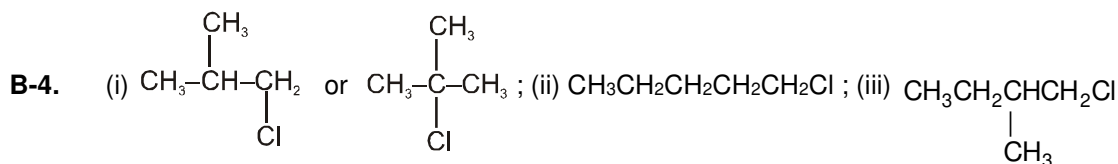
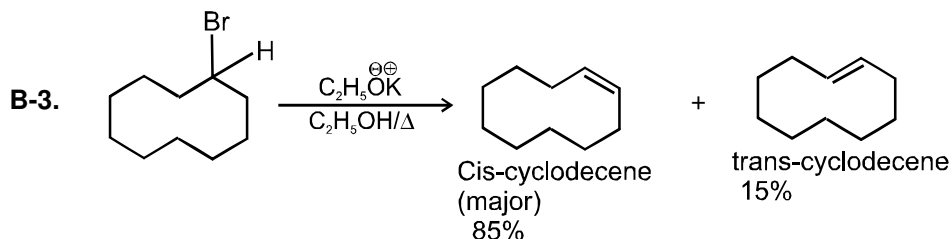
PART - I

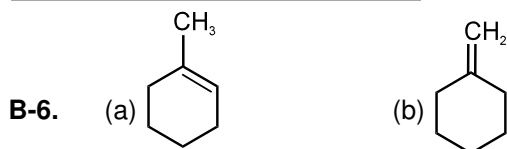
A-1. In basic condition very poor leaving group -OH will eliminate but in acidic medium -OH will be converted into -OH_2^+ which is very good leaving group.

A-2. 1° carbocation R-CH_2^+ would rearrange and 2-alkene would result. Even if 1-alkene is also formed but, it would tend to rearrange in acidic medium to 2-alkene.



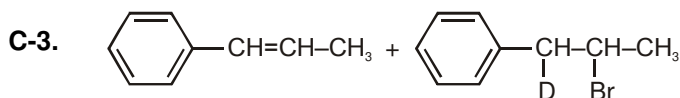
B-2. t-BuO^- is bulky base so Hoffmann product is formed as major product.





C-1. The compound must have acidic β -hydrogen and a relatively poor leaving group.

C-2. In E1cB mechanism carbanion is formed as intermediate and 1st step is reversible.



PART - II

- | | | | | |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| A-1. (B) | A-2. (D) | A-3. (A) | A-4. (B) | A-5. (A) |
| A-6. (B) | A-7. (B) | A-8. (C) | B-1. (C) | B-2. (D) |
| B-3. (A) | B-4. (C) | B-5. (A) | B-6. (B) | B-7. (A) |
| B-8. (B) | C-1. (B) | C-2. (C) | C-3. (B) | C-4. (A) |

PART - III

1. (B) 2. (A \rightarrow p,r) ; (B \rightarrow q,s) ; (C \rightarrow s) ; (D \rightarrow t)

EXERCISE – 2

PART - I

- | | | | | |
|---------|---------|--------|--------|---------|
| 1. (D) | 2. (D) | 3. (C) | 4. (D) | 5. (A) |
| 6. (A) | 7. (C) | 8. (B) | 9. (A) | 10. (C) |
| 11. (C) | 12. (C) | | | |

PART - II

- | | | | | |
|---|-------|------|------|------|
| 1. 23 | 2. 6 | 3. 5 | 4. 5 | 5. 3 |
| 6. 32 [Molecular Weights (P – Q) = 114 – 82 = 32] | 7. 78 | | | |

PART – III

- | | | | | |
|-----------|-----------|---------|-----------|-----------|
| 1. (ABCD) | 2. (BCD) | 3. (AD) | 4. (ABCD) | 5. (ABD) |
| 6. (ABCD) | 7. (ABCD) | 8. (BD) | 9. (CD) | 10. (ABC) |

PART - IV

- | | | | | |
|--------|--------|--------|--------|--------|
| 1. (B) | 2. (C) | 3. (C) | 4. (A) | 5. (C) |
| 6. (D) | 7. (C) | 8. (D) | | |

EXERCISE – 3

PART - I

1. (X) = $\dot{\text{C}}\text{O}_2$; (Y) = $\text{CH}_2 = \text{CH} - \dot{\text{C}}(\text{O}) - \text{O} - \text{H}$; (Z) = $\text{CH}_2 = \text{CH} - \dot{\text{C}}\text{H}_2 - \text{OH} + \text{H}_2\text{O}$ 2. (A)
- | | | | |
|---------|---------|--|---------|
| 3. (D) | 4. (C) | 5. (A) - q ; (B) - q ; (C) - r, s ; (D) - p, s | 6. (D) |
| 7. (A) | 8. (C) | 9. 5 | 10. (D) |
| 12. (A) | 13. (A) | 14. (C) | 15. (D) |
| 17. (D) | 18. (B) | | 16. (4) |



**PART - II****JEE(MAIN) OFFLINE PROBLEMS**

1.	(2)	2.	(1)	3.	(3)	4.	(3)	5.	(3)
6.	(2)	7.	(1)	8.	(2)	9.	(3)	10.	(4)
11.	(1)	12.	(4)	13.	(4)				

JEE(MAIN) ONLINE PROBLEMS

1.	(2)	2.	(1)	3.	(3)	4.	(4)	5.	(1)
6.	(4)	7.	(1)	8.	(1)	9.	(4)	10.	(3)
11.	(2)								



Additional Problems for Self Practice (APSP)

This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.

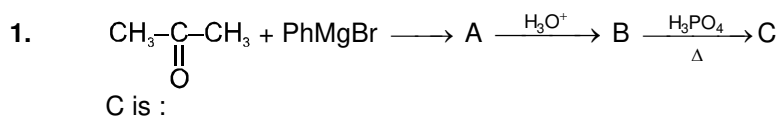
PART - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))

Max. Time : 1 Hr.

Max. Marks : 120

Important Instructions

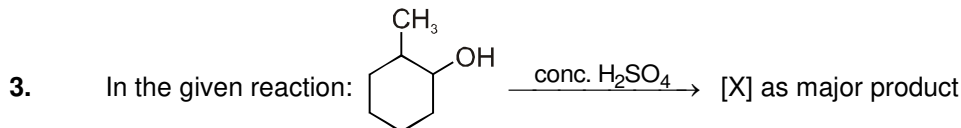
- The test is of **1 hour** duration.
- The Test Booklet consists of **30** questions. The maximum marks are **120**.
- Each question is allotted **4 (four)** marks for correct response.
- Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question. $\frac{1}{4}$ (**one fourth**) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
- There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 4 above.



- (1) $\text{Ph}-\overset{\text{O}}{\underset{\text{||}}{\text{C}}}-\text{CH}_3$ (2) $\text{Ph}-\overset{\text{CH}_3}{\underset{\text{OH}}{\text{C}}}-\text{CH}_3$ (3) $\text{Ph}-\overset{\text{CH}_3}{\underset{\text{||}}{\text{C}}}=\text{CH}_2$ (4) $\text{Ph}-\underset{\text{CH}_3}{\underset{|}{\text{CH}}}-\text{CH}_3$

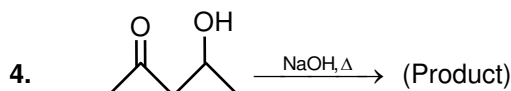
2. The correct increasing order of reactivity for following alkyl halides towards elimination reaction with alcoholic KOH is :

- (I) $\text{CH}_3-\underset{\text{Cl}}{\underset{|}{\text{CH}}}-\text{CH}_3$ (II) $\text{CH}_3-\overset{\text{CH}_3}{\underset{\text{Br}}{\underset{|}{\text{C}}}}-\text{CH}_2\text{CH}_3$ (III) $\text{CH}_3-\overset{\text{CH}_3}{\underset{\text{Cl}}{\underset{|}{\text{C}}}}-\text{CH}_2\text{CH}_3$
(1) II > I > III (2) I > II > III (3) II > III > I (4) III > II > I



[X] will be :

- (1) $\text{Cyclohexyl-CH=CH}_2$ (2) $\text{Cyclohexyl-CH=CH-CH}_3$ (3) $\text{Cyclohexyl-CH=CH-CH}_3$ (4) $\text{Cyclohexyl-CH=CH-CH}_3$



The major product of the above reaction is obtained by mechanism

- (1) $\text{S}_{\text{N}}2$ (2) E2 (3) E1cB (4) $\text{S}_{\text{N}}1$
5. Select the incorrect option for the following statements.
 (1) Bimolecular elimination of alkyl halides is a stereospecific reaction.
 (2) In $\text{S}_{\text{N}}2$ reaction a single isomer is the only product.
 (3) Alcohol dehydrate in strongly basic conditions by E1 mechanism.
 (4) 3-hydroxypropanal dehydrates in strong basic condition by E1cb mechanism.

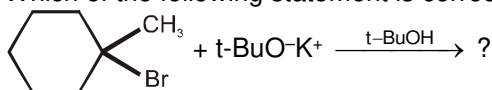


6. Major product is :
 (1) (2) (3) (4)
7. Which of the following conformations of meso 2,3-dibromobutane will give bromoalkene with alcoholic KOH ?
 (1) Gauche form (2) Anti form
 (3) Partial eclipsed form (4) Fully eclipsed form
8. 2-Bromopentane is heated with potassium ethoxide in ethanol. The major product obtained is
 (1) 2-Ethoxypentane (2) pent-1-ene
 (3) cis-pent-2-ene (4) trans-pent-2-ene
9. R is :
 (1) But-1-ene (2) 2-methylbut-1-ene
 (3) 2-methylbut-2-ene (4) 2-methyl propene
10. Major product is :
 (1) (2) (3) (4)
11. The most probable product in the following reaction is :

 (1) (2) (3) (4)
12. Product P is :
 (1) (2) (3) (4) None
13. Which statement is false for elimination reaction.
 (1) β -elimination is more common than α & γ elimination
 (2) In β -elimination, formation of multiple bond occur.
 (3) β -elimination may be E1, E2 or E1cB.
 (4) E1 & E2 requires presence of poor leaving group but E1cB requires presence of good leaving group.



14. Which of the following statement is correct regarding following reaction ?

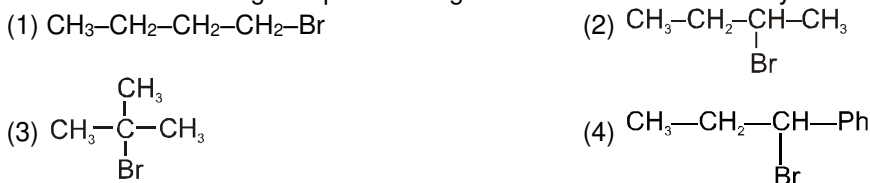


- (1) Major product is endocyclic alkene formed according to Saytzeff.
- (2) Major product is exocyclic alkene formed according to Saytzeff.
- (3) Major product is exocyclic alkene formed according to Hoffmann.
- (4) Major product is endocyclic alkene formed according to Hoffmann.

15. Substrate that show E1 reaction



16. Which of the following compound will give three alkenes after dehydrohalogenation.



17. $\text{PhSO}_2\text{CH}_2\text{CH}_2\text{OMe} \xrightarrow[\text{EtOD}]{\text{EtO}^\ominus} \text{product} + \text{PhSO}_2\text{CH}(\text{D})\text{CH}_2\text{OMe}$
(recovered reactant)

The product is :

- (1) $\text{PhSO}_2\text{CH}=\text{CH}_2$
- (2) $\text{CH}_2=\text{CH}-\text{OMe}$
- (3) $\text{PhSO}_2\text{CH}_2\text{CD}_2\text{OMe}$
- (4) $\text{CD}_2=\text{CH}_2$

18. A. The product A is :



19. Typical features of E2 involve :

- (1) Two step reaction
- (2) Second step is the rate determining step
- (3) Anti-periplanar transition state
- (4) Formation of a carbanion intermediate, stabilized by conjugation with a strong -M group

20. An alkyl chloride produces a single alkene on reaction with sodium ethoxide and ethanol. The alkene further undergoes hydrogenation to yield-2-methylbutane. Identify the alkyl chloride from amongst the following :

- (1) $\text{ClCH}_2\text{C}(\text{CH}_3)_2\text{CH}_3$
- (2) $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- (3) $\text{ClCH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- (4) $\text{CH}_3\text{C}(\text{Cl})(\text{CH}_3)\text{CH}_2\text{CH}_3$

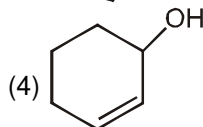
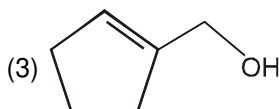
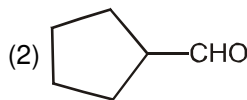
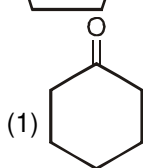
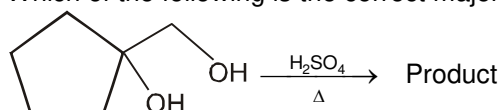
21. Relative ease of dehydration of alcohol follows which general order

- (1) $3^\circ > 2^\circ > 1^\circ$ alc.
- (2) $1^\circ > 2^\circ > 3^\circ$ alc
- (3) $2^\circ > 3^\circ > 1^\circ$ alc
- (4) $3^\circ > 1^\circ > 2^\circ$ alc

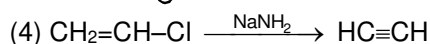
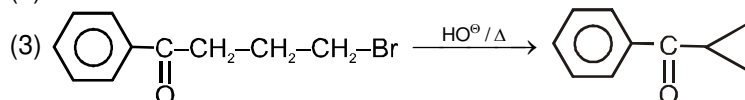
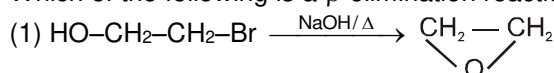




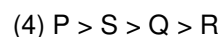
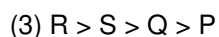
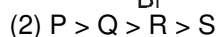
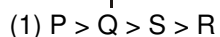
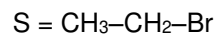
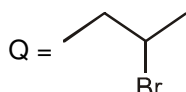
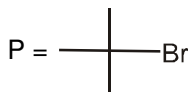
22. Which of the following is the correct major product for given reaction ?



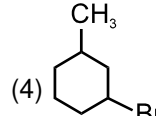
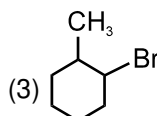
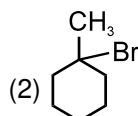
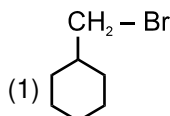
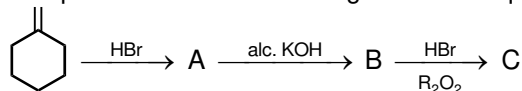
23. Which of the following is a β -elimination reaction ?



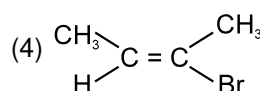
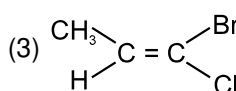
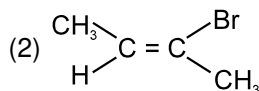
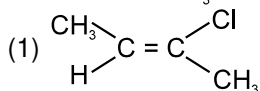
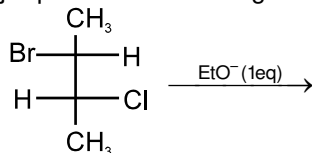
24. Correct order of $\text{E}_2/\text{S}_{\text{N}}2$ ratio is :



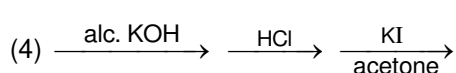
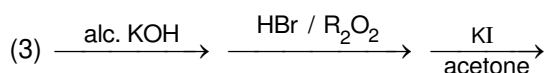
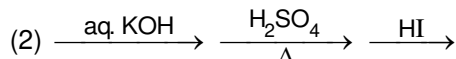
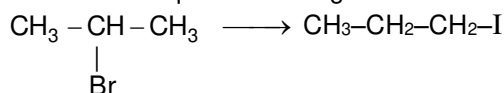
25. The product C of the following reaction sequence is :



26. The major product of following reaction is

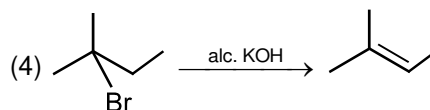
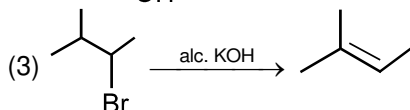
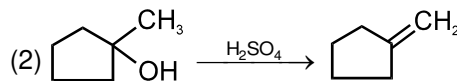
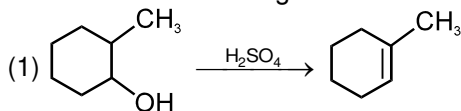


27. What is the correct sequence of reagent/s for the following conversion:

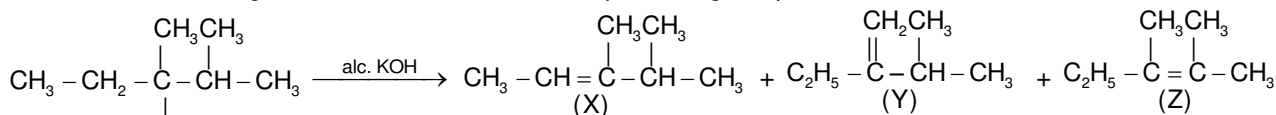




28. In which of the following reaction the single product formed is not the saytzeff's product



29. In the following reaction the correct order of percentage of products X, Y and Z is



(1) $X > Y > Z$

(2) $Z > Y > X$

(3) $Z > X > Y$

(4) $Y > Z > X$

30. The rate of elimination is fastest in

(1) $\text{Ph}-\text{CH}_2-\text{CH}_2-\text{F}$

(2) $\text{Ph}-\text{C}(=\text{O})-\text{CH}_2-\text{CH}_2-\text{F}$

(3) $\text{Ph}-\text{O}-\text{CH}_2-\text{CH}_2-\text{F}$

(4) $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{F}$

Practice Test-1 ((IIT-JEE (Main Pattern)))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25	26	27	28	29	30
Ans.										

PART - II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I

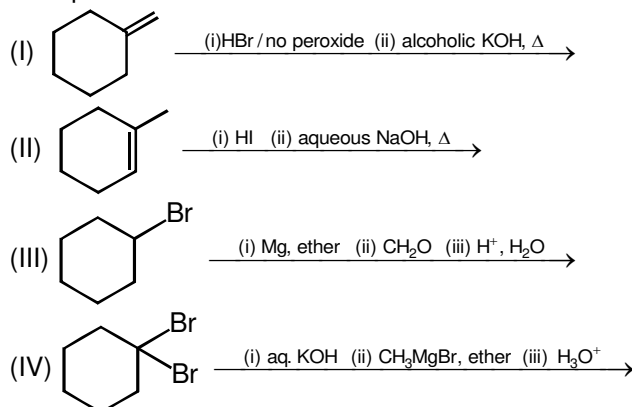
- An alkyl bromide produces a single alkene when it reacts with sodium ethoxide and ethanol. This alkene undergoes hydrogenation and produces 2-methylbutane. What is the identity of the alkylbromide? [NSEC-2000]
 (A) 1-bromo-2-methylbutane (B) 1-bromobutane
 (C) 1-bromo-2, 2-dimethylpropane (D) 2-bromo-2-methylbutane
- Which of the following most readily undergoes E2 elimination with a strong base ? [NSEC-2000]
 (A) 2-bromopentane (B) 2-bromo-2-methylbutane
 (C) 1-bromo-2, 2-dimethylpropane (D) 2-bromo-3-methylbutane
- An alkyl chloride produces a single alkene on reaction with sodium ethoxide and ethanol. The alkene further undergoes hydrogenation to yield 2-methylbutane. Identify the alkyl chloride from amongst the following : [NSEC-2001]
 (A) $\text{ClCH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ (B) $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
 (C) $\text{ClCH}(\text{CH}_3)_2\text{CH}_3$ (D) $\text{CH}_3\text{C}(\text{Cl})(\text{CH}_3)\text{CH}_2\text{CH}_3$
- On heating glycerol with conc. H_2SO_4 , a compound obtained which has an unpleasant odour. This compound is : [NSEC-2001, 2004]
 (A) ethylene glycol (B) allyl alcohol (C) acrolein (D) glycerol sulphate



5. n-Propylbromide and ethanolic potassium hydroxide react to give : [NSEC-2001]
 (A) propyne (B) propene (C) propane (D) propanol
6. The peroxide effect occurs by : [NSEC-2001]
 (A) ionic mechanism (B) heterolytic fission of double bond
 (C) homolytic fission of double bond (D) free radical mechanism
7. Acid catalysed dehydration of 2-pentanol would give [NSEC-2006]
 (A) 1-pentene as a major product (B) cis 2-pentene as a major product
 (C) trans-2-pentene as a major product (D) cis- and trans-2-pentene in equal amount.
8. The major product formed in the following reaction is : [NSEC-2007]
-
- (A) (B) (C) (D)
9. Arrange the following compounds in order of decreasing reactivity in the elimination (bimolecular) reaction with C_2H_5ONa [NSEC-2007]
- (i) (ii) (iii) (iv)
- (A) II > I > III > IV (B) IV > III > I > II (C) III > I > II > IV (D) I > III > IV > II
10. Compound X on treatment with HI gives Y. Y on treatment with ethanolic KOH gives Z (an isomer of X). Ozonolysis of Z (with H_2O_2 workup) gives a two-carbon carboxylic acid and four carbon ketone. Hence, X is : [NSEC-2009]
 (A) 2-methyl-2-pentene (B) 4-methyl-1-pentene
 (C) 2, 3-dimethyl-2-butene (D) 3-methyl-1-pentene
11. The major product of the following reaction is : [NSEC-2009]
-
- (A) (B) (C) (D)
12. [NSEC-2013]
 The carbanion expels a leaving group LG to yield an alkene as shown above by
 (A) E1cB mechanism (B) E1 mechanism
 (C) E2 mechanism (D) Such a reaction does not take place
13. The compound that is most reactive with alcoholic KOH is [NSEC-2014]
 (A) $CH_2=CH-Br$ (B) CH_3CH_2Br (C) $(CH_3)_2CH-Br$ (D) $CH_3COCH_2CH_2Br$



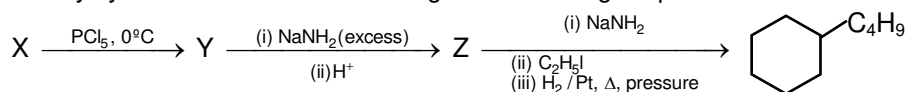
14. Four processes are indicated below :



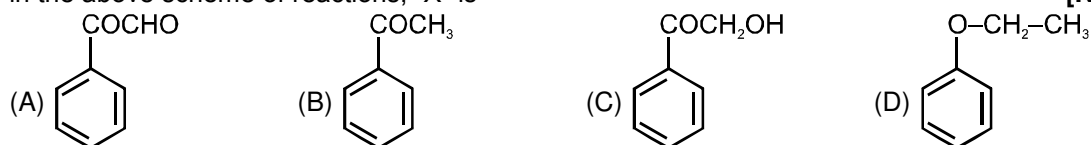
The processes that do not produce 1-methylcyclohexanol are

- (A) II, IV (B) I, II (C) III, IV (D) I, III

15. n-Butylcyclohexane is formed through the following sequence of reactions.

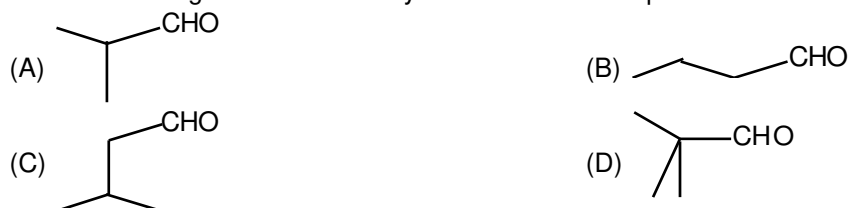


In the above scheme of reactions, "X" is –

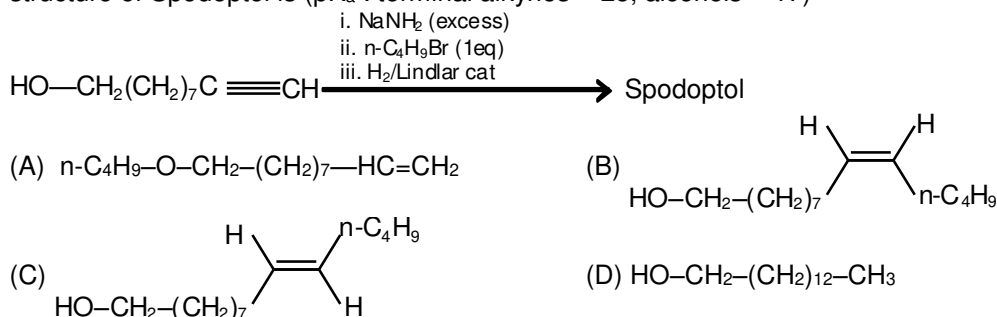


[NSEC-2015]

16. An alkyl halide (X) on reaction with ethanolic sodium hydroxide forms an alkene (Y) which on further reaction with HBr gives the same alkyl halide. The alkene (Y) on reaction with HBr/peroxide followed by reaction with Mg metal followed by reaction with HCN produces an aldehyde (Z). Z is : [NSEC-2016]



17. Spodoptol, a sex attractant, produced by a female fall armyworm moth, can be prepared as follows. The structure of Spodoptol is (pK_a : terminal alkynes ~ 25 , alcohols ~ 17) [NSEC-2016]





PART - III : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))

Max. Time : 1 Hr.

Max. Marks : 66

Important Instructions

A. General :

- The test is of 1 hour duration.
- The Test Booklet consists of 22 questions. The maximum marks are 66.

B. Question Paper Format :

- Each part consists of five sections.
- Section 1 contains 8 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE is correct.
- Section 2 contains 6 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE OR MORE THAN ONE are correct.
- Section 3 contains 4 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9 (both inclusive).
- Section 4 contains 1 paragraphs each describing theory, experiment and data etc. 3 questions relate to paragraph. Each question pertaining to a particular passage should have only one correct answer among the four given choices (A), (B), (C) and (D).
- Section 5 contains 1 multiple choice questions. Question has two lists (list-1 : P, Q, R and S; List-2 : 1, 2, 3 and 4). The options for the correct match are provided as (A), (B), (C) and (D) out of which ONLY ONE is correct.

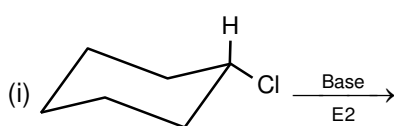
C. Marking Scheme

- For each question in Section 1, 4 and 5 you will be awarded 3 marks if you darken the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (–1) mark will be awarded.
- For each question in Section 2, you will be awarded 3 marks. If you darken all the bubble(s) corresponding to the correct answer(s) and zero mark. If no bubbles are darkened. No negative marks will be answered for incorrect answer in this section.
- For each question in Section 3, you will be awarded 3 marks if you darken only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for incorrect answer in this section.

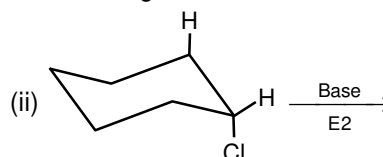
SECTION-1 : (Only One option correct Type)

This section contains 8 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which Only ONE option is correct.

1. Rate of Bimolecular elimination (E2) reaction for the following :



- (A) Same for both conformers
(C) ii > i

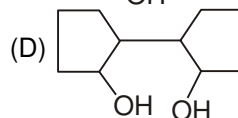
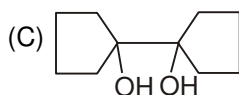
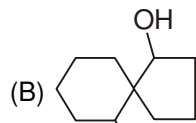
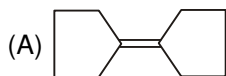
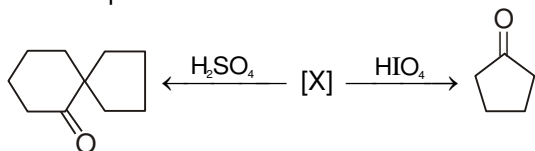


- (B) i > ii
(D) Can't say anything about rate of E-2 reaction

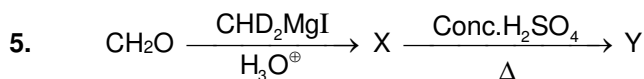
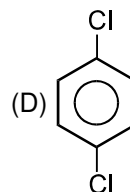
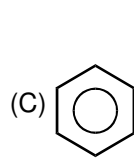
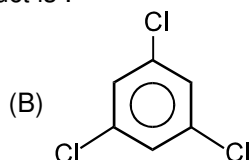
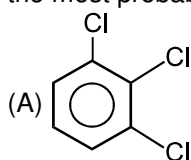
2. Which is incorrect about alkyl bromide having molecular formula $C_5H_{11}Br$
- (A) One isomeric alkyl bromide undergoes E1 elimination at the fastest rate
(B) Only one is incapable of reacting by the E2 mechanism
(C) Only one isomer gives a single alkene on E2 elimination
(D) 2-Bromopentane gives the most complex mixture of alkenes on E2 elimination



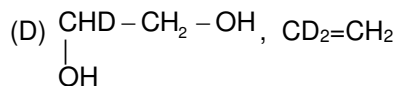
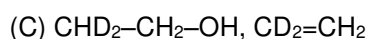
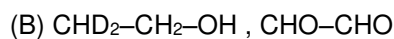
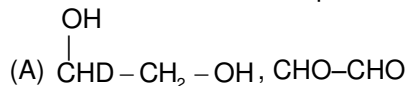
3. The compound 'X' is



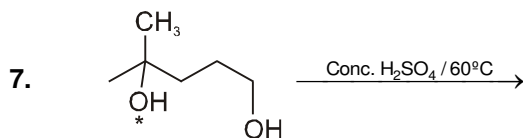
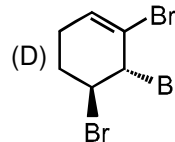
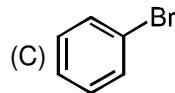
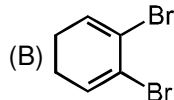
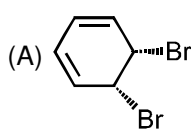
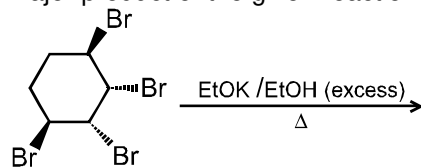
4. When the all-cis isomer of $C_6H_6Cl_6$ (1, 2, 3, 4, 5, 6-Hexachlorocyclohexane) is heated with alc. KOH, the most probable product is :



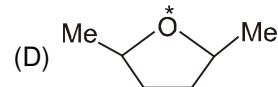
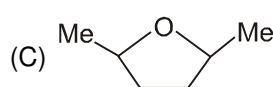
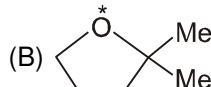
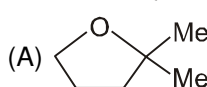
In the above reaction compound X & Y respectively will be



6. Major product of the given reaction is :

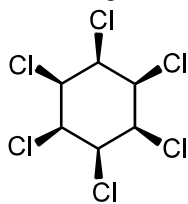


The product is –

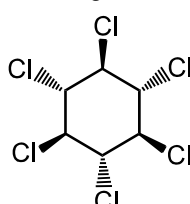




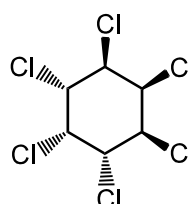
8. Which one of the following hexachlorocyclohexane is least reactive and which one is most reactive for E2 reactions with a strong base for dehydrohalogenation.



I



II



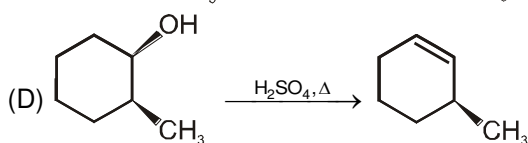
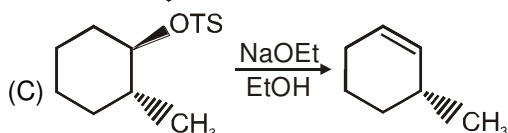
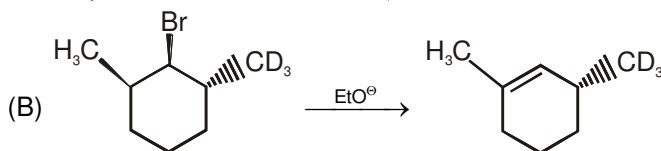
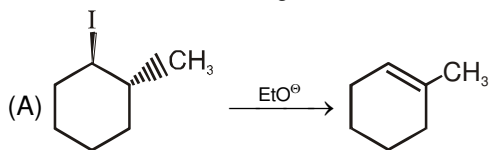
III

- (A) I least & II most (B) II least & I most (C) III least & I most (D) III least & II most

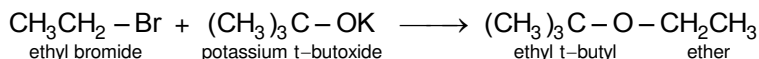
Section-2 : (One or More than one options correct Type)

This section contains 6 multipole choice questions. Each questions has four choices (A), (B), (C) and (D) out of which ONE or MORE THAN ONE are correct.

9. In which of the following reactions the correct major products are mentioned



10. When ethyl bromide is added to potassium t-butoxide, the product is ethyl t-butyl ether.

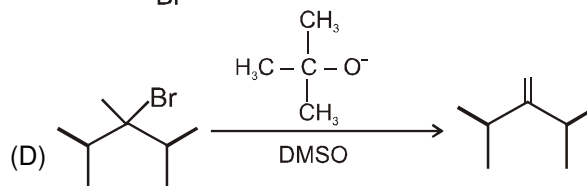
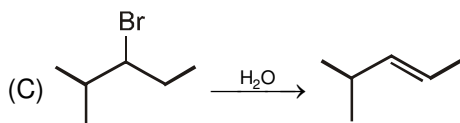
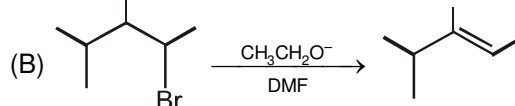
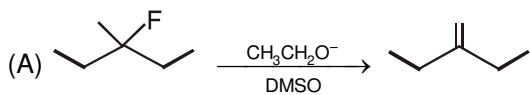


Which of the following statement(s) is/are correct ?

- (A) when the concentration of Ethyl bromide is doubled rate is also doubled.
 (B) when the concentration of potassium t-butoxide is tripled and the concentration of ethyl bromide is doubled rate will increase six times.
 (C) Elimination product dominates when temperature is raised.
 (D) when the concentration of potassium t-butoxide is tripled and the concentration of ethyl bromide is doubled rate will increase three times.
11. Which of the following statement are true ?
 (A) Bridgehead halide are inert for both $\text{S}_{\text{N}}1$ and $\text{S}_{\text{N}}2$ reaction.
 (B) The first step in both $\text{S}_{\text{N}}1$ and $\text{E}1$ reaction is same.
 (C) $\text{S}_{\text{N}}2$ reaction proceed with total retention of configuration.
 (D) $\text{E}2$ elimination are favoured by weak base



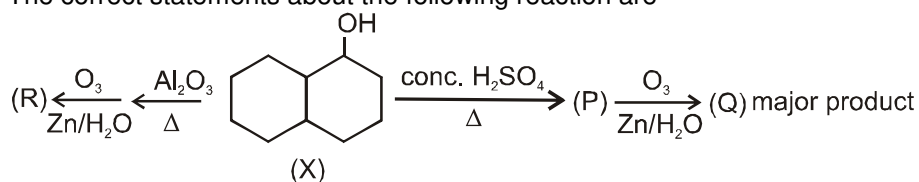
12. Which of the following reactions represent the major product.



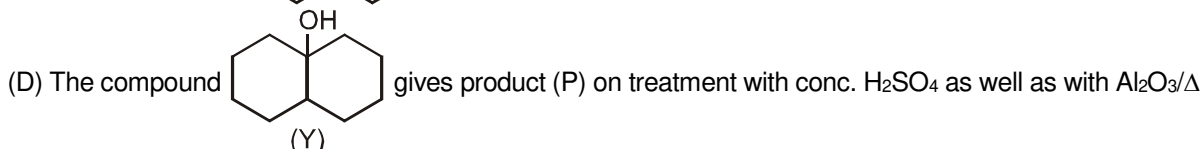
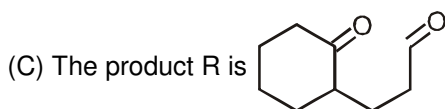
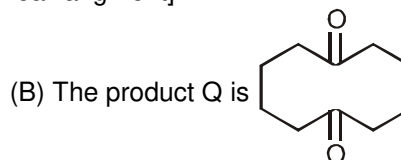
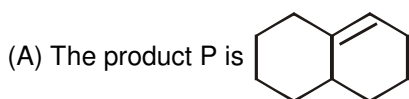
13. Which of the following statements is/are correct for alkyl halide ?

- (A) In most unimolecular reactions of alkyl halide S_N1 reaction is favoured over $E1$ reaction.
 (B) $E1$ mechanism is favoured as compared to S_N1 mechanism by branching at β carbon
 (C) In unimolecular reaction, increasing the temperature favours $E1$ mechanism
 (D) $E1$ reactions are favoured by the use of weak bases and by the use of polar solvents.

14. The correct statements about the following reaction are



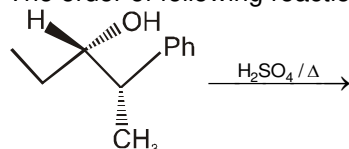
[Hint : Al_2O_3 gives saytzeff's product without any rearrangement]



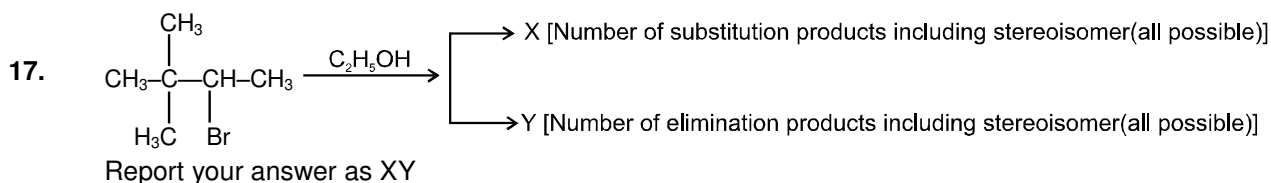
Section-3 : (One Integer Value Correct Type.)

This section contains 4 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive)

15. The order of following reaction is :

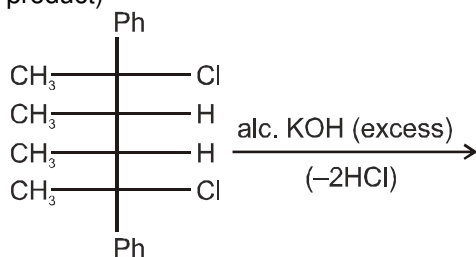


16. Total number of alkenes obtained by dehydration of 3,4-diethylhexan-2-ol in acidic medium ?





18. The number of products (stereoisomers) formed in the following reaction is (consider only major product)

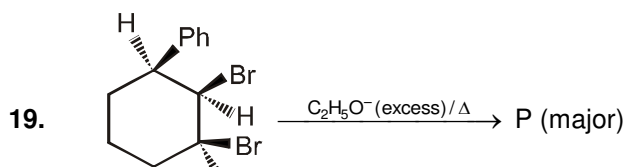


SECTION-4 : Comprehension Type (Only One options correct)

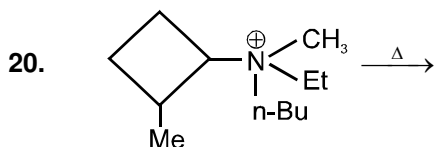
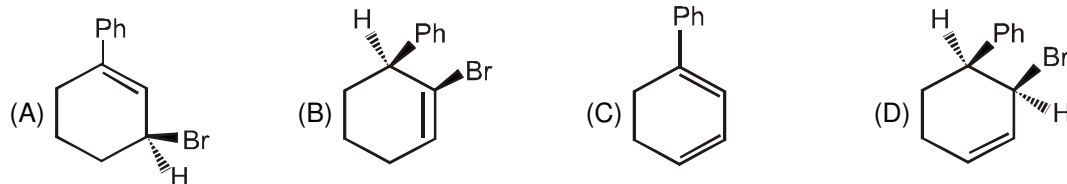
This section contains 1 paragraphs, each describing theory, experiments, data etc. 3 questions relate to the paragraph. Each question has only one correct answer among the four given options (A), (B), (C) and (D)

Paragraph for Questions 19 to 21

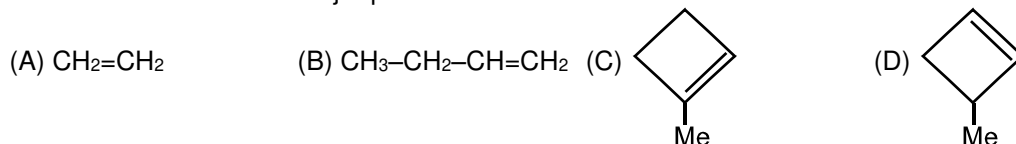
The elimination reactions mainly involve three mechanism E1, E2, E1cB. If the leaving group departs before β -proton (H^\oplus ion) then it is E1 mechanism, If proton is taken off first before leaving group it is E1cB mechanism. The pure E2 involves both β -Hydrogen and leaving group departing simultaneously. If acidity of β -Hydrogen increases and leaving group ability decreases then E1cB mechanism increases.



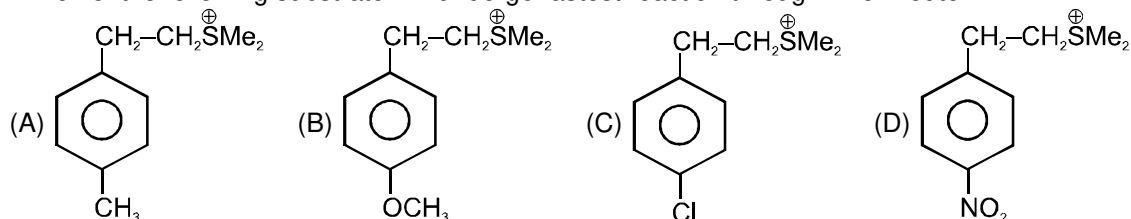
Product P is



The alkene formed as a major product in the above elimination reaction is



21. Which of the following substrate will undergo fastest reaction through E1cB route





SECTION-5 : Matching List Type (Only One options correct)

This section contains 1 questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (A), (B), (C) and (D) out of which one is correct

22. Match List I (Reaction) with List II (Type of reaction) and select the correct answer using the code given below the lists :

	List I		List II
(P)		(1)	E1
(Q)		(2)	E2
(R)		(3)	E1cB
(S)		(4)	S _N 1

Codes :

	P	Q	R	S		P	Q	R	S
(A)	1	3	4	2	(B)	3	4	2	1
(C)	1	3	2	4	(D)	2	3	4	1

Practice Test-2 ((IIT-JEE (ADVANCED Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22								
Ans.										



APSP Answers

PART - I

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (3) | 2. (3) | 3. (2) | 4. (3) | 5. (3) |
| 6. (3) | 7. (1) | 8. (4) | 9. (3) | 10. (4) |
| 11. (3) | 12. (2) | 13. (4) | 14. (3) | 15. (3) |
| 16. (2) | 17. (1) | 18. (3) | 19. (3) | 20. (3) |
| 21. (1) | 22. (2) | 23. (4) | 24. (1) | 25. (3) |
| 26. (1) | 27. (3) | 28. (2) | 29. (3) | 30. (2) |

PART - II

- | | | | | |
|----------|---------|---------|---------|---------|
| 1. (A) | 2. (B) | 3. (A) | 4. (C) | 5. (B) |
| 6. (D) | 7. (C) | 8. (C) | 9. (A) | 10. (D) |
| 11. (A) | 12. (A) | 13. (D) | 14. (D) | 15. (B) |
| 16. (BC) | 17. (B) | | | |

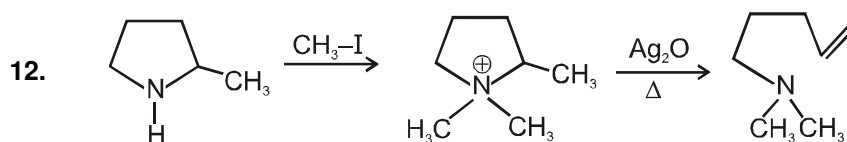
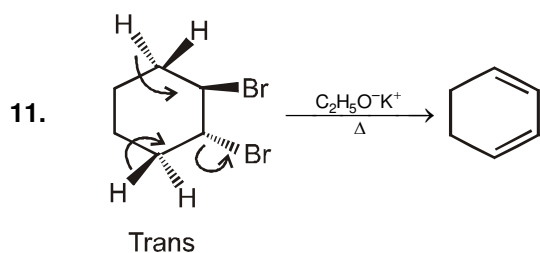
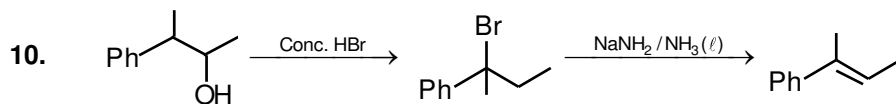
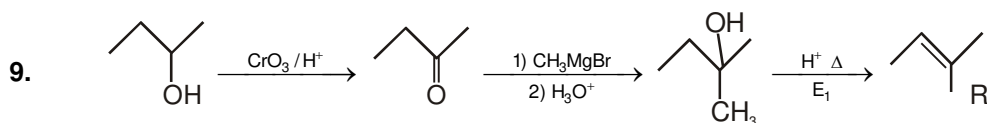
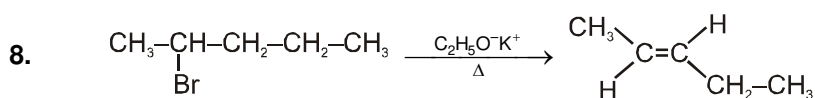
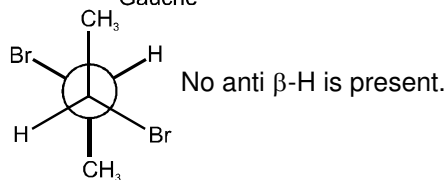
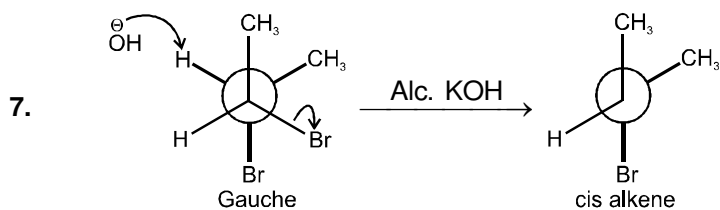
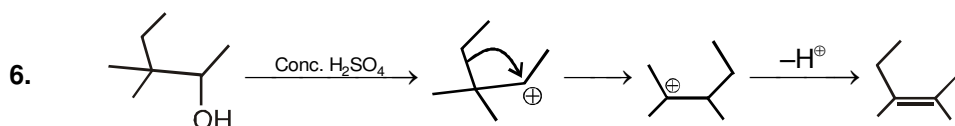
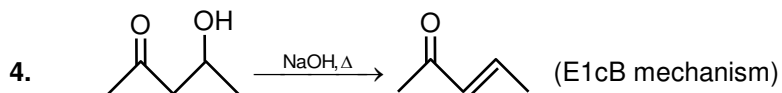
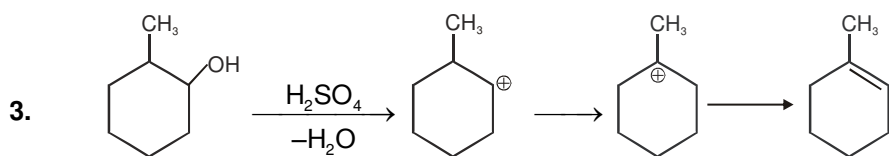
PART - III

- | | | | | |
|----------|-----------|------------|----------|-----------|
| 1. (C) | 2. (C) | 3. (C) | 4. (B) | 5. (C) |
| 6. (C) | 7. (A) | 8. (B) | 9. (BC) | 10. (ABC) |
| 11. (AB) | 12. (ABD) | 13. (ABCD) | 14. (BD) | 15. 1 |
| 16. 5 | 17. 33 | 18. 1 | 19. (C) | 20. (A) |
| 21. (D) | 22. (D) | | | |



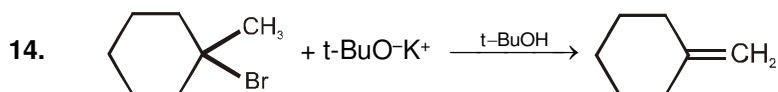
APSP Solutions

PART - I

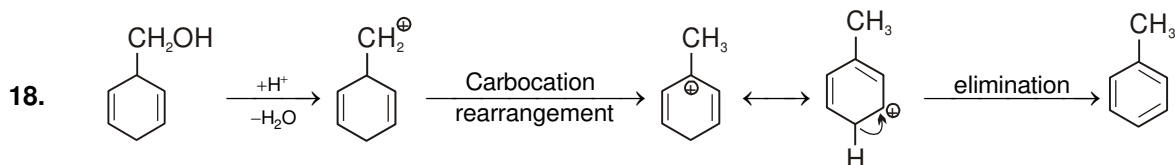




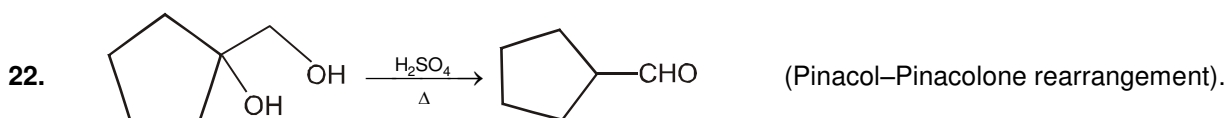
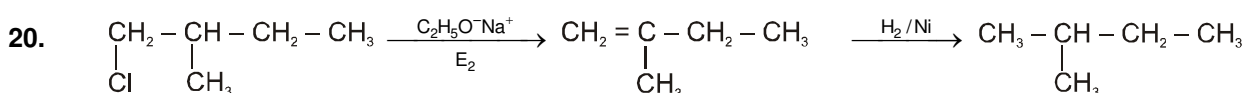
13. Self understood



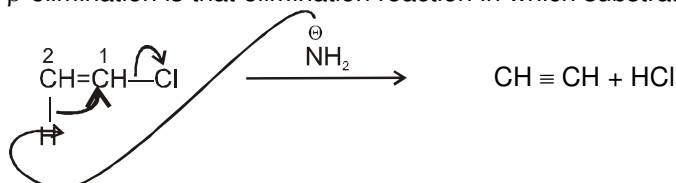
17. The reaction follows E1cb mechanism in which reactant undergoes D exchange along with an elimination product.



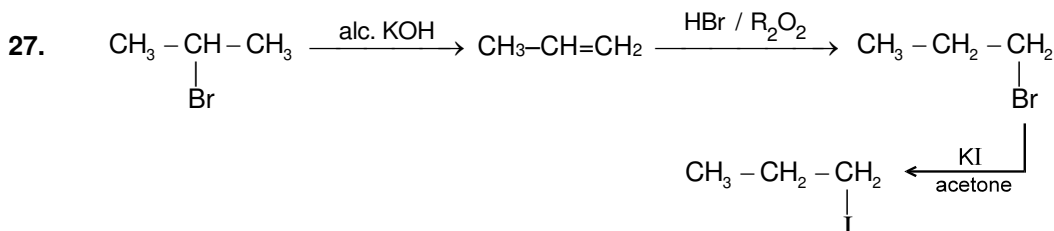
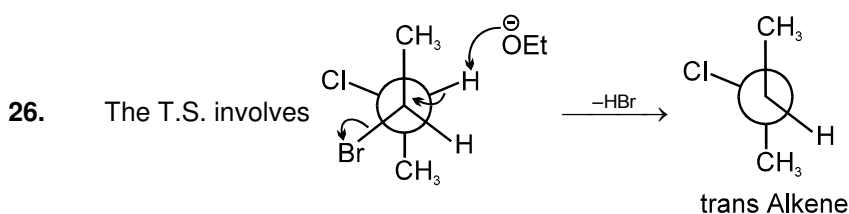
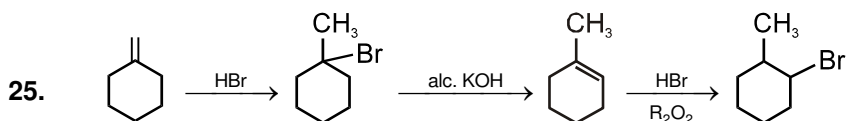
19. It is a basic fact.



23. β -elimination is that elimination reaction in which substrate loses two atoms from 1 & 2 position.



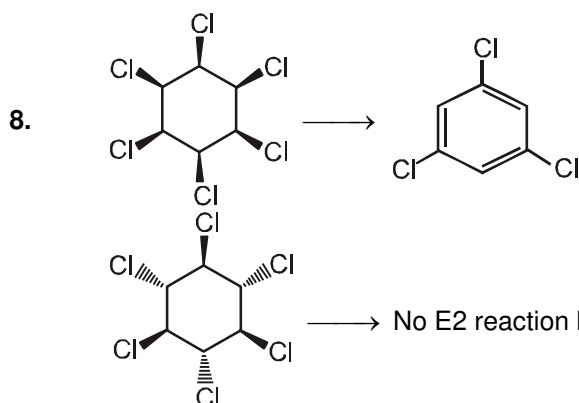
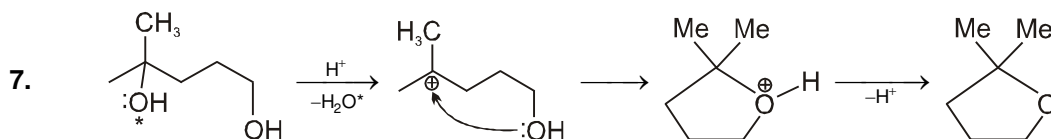
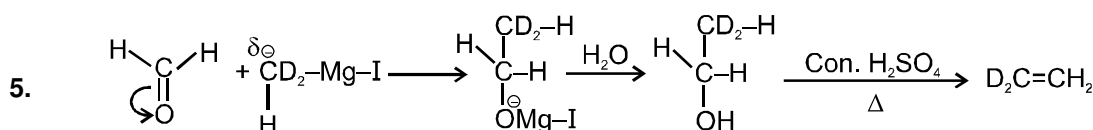
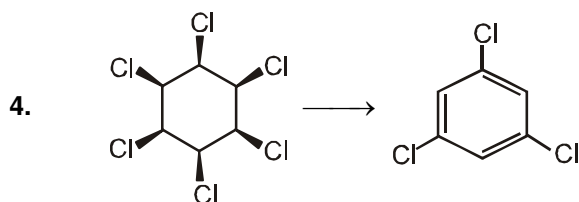
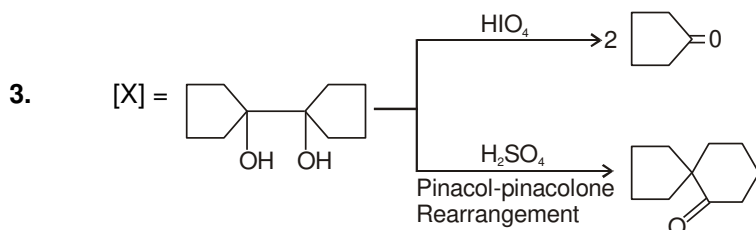
NaNH_2 is strong base so give β -elimination reaction.



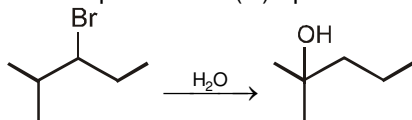


PART - III

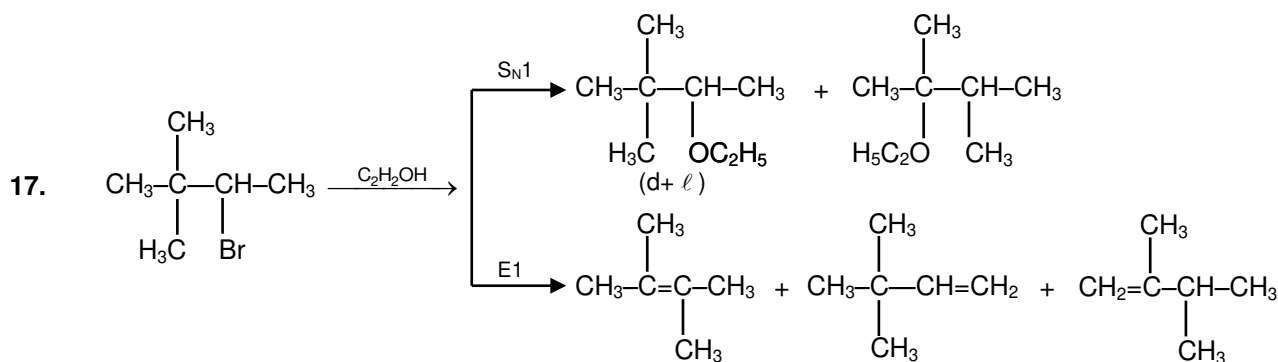
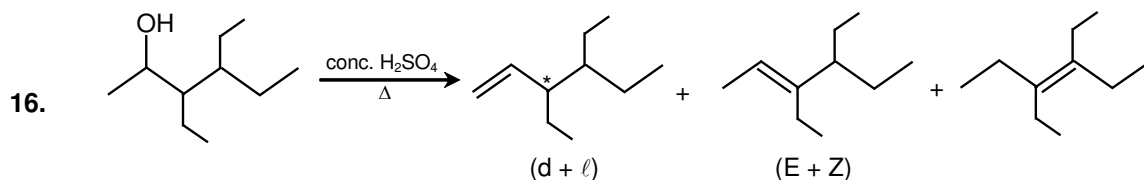
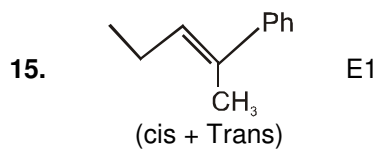
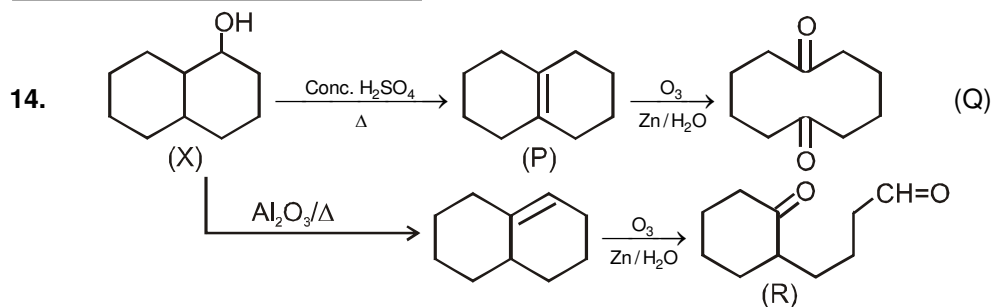
- The more stable conformation of chlorocyclohexane does not undergo an E-2 elimination easily while the less stable conformer, with the chloro group in the axial position, readily undergoes an E-2 reaction.
- [C] is incorrect because more than one isomer gives a single alkene on E2 elimination.



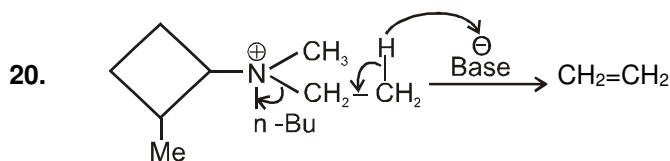
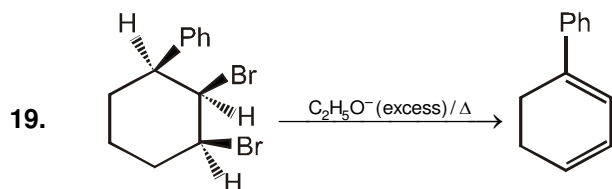
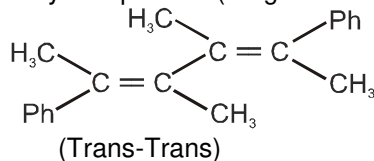
- In $\text{S}_{\text{N}}2$ reaction inversion takes place.
- Correct product for (C) option.



- All statement are correct.



18. Only one product (Single stereoisomer)



21. -I and -M group increases acidic strength.