Exercise # 1 [Single Correct Choice Type Questions]

1. Consider the chemical reaction,

$$2A(g) \longrightarrow B(g) + 3C(g)$$

The rate of this reaction can be expressed in terms of time derivatives of conc. of A(g) , B(g) or C(g). Identify the correct relationship amongst rate expressions :

(A) $\text{Rate} = -\frac{d[A]}{dt} = \frac{d[B]}{dt} = \frac{d[C]}{dt}$ **(B)** $\text{Rate} = \frac{1}{2}\frac{d[A]}{dt} = \frac{d[B]}{dt} = \frac{1}{3}\frac{d[C]}{dt}$

(C) $\text{Rate} = -\frac{1}{2}\frac{d[A]}{dt} = \frac{d[B]}{dt} = \frac{1}{3}\frac{d[C]}{dt}$ **(D)** $\text{Rate} = \frac{1}{2}\frac{d[A]}{dt} = -\frac{d[B]}{dt} = -\frac{1}{3}\frac{d[C]}{dt}$

2. The differential rate law equation for the elementary reaction $A + 2B \xrightarrow{K} 3C$, is :

(A) $-\frac{d[A]}{dt} = -\frac{d[B]}{dt} = \frac{d[C]}{dt} = k[A][B]^2$ **(B)** $-\frac{d[A]}{dt} = -\frac{1}{2}\frac{d[B]}{dt} = \frac{1}{3}\frac{d[C]}{dt} = k[A]^2[B]$

(C) $-\frac{d[A]}{dt} = -\frac{1}{2}\frac{d[B]}{dt} = \frac{1}{3}\frac{d[C]}{dt} = k[A][B]^2$ **(D)** None of these

3. The minimum energy for molecules to enter into chemical reaction is called.

(A) Kinetic energy **(B)** Potential energy

(C) Threshold energy **(D)** Activation energy

4. For an elementary process $2X + Y \rightarrow Z + W$, the molecularity is :

(A) 2 **(B)** 1 **(C)** 3 **(D)** Unpredictable

5. What is the order of a reaction which has a rate expression rate = $k[A]^{3/2}[B]^{-1}$?

(A) 3/2 **(B)** 1/2 **(C)** 0 **(D)** None of these

6. Following mechanism has been proposed for a reaction.

$$2A + B \rightarrow D + E$$

Step -1 $A + B \rightarrow C + D$ – (slow)

Step -2 $A + C \rightarrow E$ – (fast)

The rate law expression for the reaction is :

(A) rate = $K[A]^2[B]$ **(B)** rate = $K[A][B]$

(C) rate = $K[A]^2$ **(D)** rate = $K[A][C]$

7. Activation energy of a reaction is :

(A) The energy released during the reaction

(B) The energy evolved when activated complex is formed

(C) Minimum amount of energy needed to overcome the potential barrier of reaction

(D) The energy needed to form one mole of the product.

8. Catalyst increases the rate of reaction because :

(A) it decreases ΔH **(B)** it increases ΔH

(C) it decreases activation energy **(D)** it increases activation energy

9. Which of the following is not a Nucleophile ?

(A) $AlCl_3$ **(B)** $(CH_3)_2NH$ **(C)** C_2H_5OH **(D)** H_2O

10. Which one of the following has maximum nucleophilicity ?

(A) $CH_3S^{\ominus}$ **(B)** $C_6H_5\text{–}\overset{\ominus}{O}$ **(C)** Et_3N **(D)** $F^{\ominus}$

11. Which one of the following has minimum nucleophilicity ?

(A) $(CH_3)_3CLi$ **(B)** $NaNH_2$ **(C)** CH_3ONa **(D)** NaOH

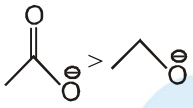
12. Which of the following is an electrophilic reagent ?

(A) H_2O **(B)** OH^- **(C)** NO_2^+ **(D)** None

13. Best leaving group is :

(A) F^- **(B)** Cl^- **(C)** Br^- **(D)** I^-

14. The correct order of leaving ability is :

(A) $\overset{\ominus}{O}H > H_2O$ **(B)** $\overset{\ominus}{O}H > \overset{\ominus}{S}H$ **(C)**  **(D)** $\overset{\ominus}{Cl} > \overset{\ominus}{I}$

15. Substitution reactions involve :

(A) Cleavage of a s–bond and formation of a new s–bond

(B) Cleavage of two s–bond and formation of a new p –bond

(C) Cleavage of a p–bond and formation of two new s –bond

(D) None of these

16. Which of the following reaction is a substitution reaction ?

(A) $CH_2=CH_2 \xrightarrow{Ni/H_2} CH_3-CH_3$ **(B)** $\underset{Br}{\overset{|}{CH_2}}-\underset{Br}{\overset{|}{CH_2}} \xrightarrow{Zn} CH_2=CH_2+ZnBr_2$

(C) $CH_3-I+\overset{\Theta}{O}H \longrightarrow CH_3OH+\overset{\Theta}{I}$ **(D)** $CH_3-CHO \xrightarrow[H^{\oplus}]{KCN} CH_3-\underset{CN}{\overset{H}{\overset{|}{C}}}-OH$

17. S_N1 reactions occur through the formation of intermediate :

(A) Carbocation **(B)** Carbanion **(C)** Free radical **(D)** None of these

18. Which of the following is protic solvent ?

(A) Acetone **(B)** Ethanol **(C)** DMF **(D)** Ether

19. Which of the following is aprotic solvent ?

(A) DMSO **(B)** NH_3 **(C)** H_2O **(D)** CH_3COOH

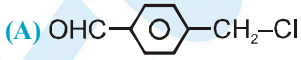
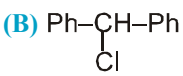
20. Which solvent is non-polar solvent ?

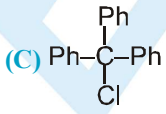
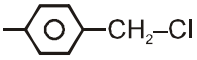
(A) $CH_3-CO-CH_3$ **(B)** $CH_3-SO-CH_3$ **(C)** CH_3COOH **(D)** Cyclohexane

21. In an S_N1 reaction, the configuration of the product undergoes :

(A) inversion **(B)** racemization **(C)** retention **(D)** difficult to predict

22. Which of the following alkyl halide is most reactive towards H_2O ?

(A)  **(B)** 

(C)  **(D)** 

23. $CH_3-CH_2-\underset{\underset{OH}{|}}{CH}-CH_3 \xrightarrow{HCl/ZnCl_2} [X]$

Identify X and the mechanism of the reaction.

(A) $CH_3-CH_2-CH_2-CH_2-Cl$ & S_N1

(B) $CH_3-CH_2-CH_2-CH_2-Cl$ & S_N2

(C) $CH_3-\underset{\underset{Cl}{|}}{CH}-CH_2-CH_3$ & S_N1

(D) $CH_3-\underset{\underset{Cl}{|}}{CH}-CH_2-CH_3$ & S_N2

24. $CH_3(CH_2)_2CH_2OH \xrightarrow{HBr} X,$

1-butanol

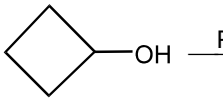
Identify X and the mechanism of the reaction

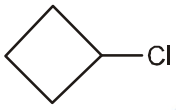
(A) $CH_3-CH_2-CH_2-CH_2-Br$ & S_N1

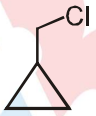
(B) $CH_3-CH_2-CH_2-CH_2-Br$ & S_N2

(C) $CH_3-\underset{\underset{Br}{|}}{CH}-CH_2-CH_3$ & S_N1

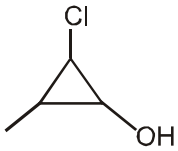
(D) $CH_3-\underset{\underset{Br}{|}}{CH}-CH_2-CH_3$ & S_N2

25.  $\xrightarrow{PCl_5}$ (X), X is :

(A) 

(B) 

(C) 

(D) 

26. What is the final product of reaction.

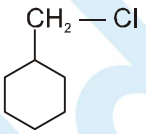
$CH_3-C\equiv CH \xrightarrow{Na} \xrightarrow{CH_3-CH_2-I}$ Product

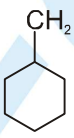
(A) $CH_2=CH-CH_2-CH_3$

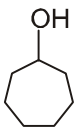
(B) $CH_3-CH_2-C\equiv C-CH_2-CH_3$

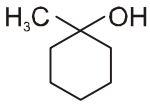
(C) $CH\equiv C-CH_2-CH_2-CH_3$

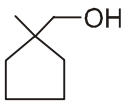
(D) $CH_3-C\equiv C-CH_2-CH_3$

27.  $\xrightarrow[AgNO_3]{H_2O}$ 'Y' Product :

(A) 

(B) 

(C) 

(D) 

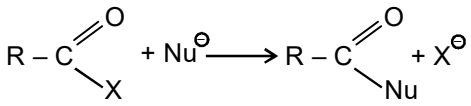
28. S_N2 mechanism proceeds through intervention of :

(A) Carbonium ion **(B)** Transition state **(C)** Free radical **(D)** Carbanion

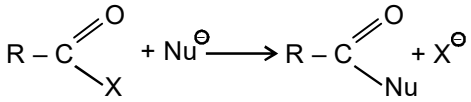
29. When the concentration of alkyl halide is tripled and the concentration of $\overset{\ominus}{OH}$ ion is reduced to half, the rate of S_N2 reaction increases by:

(A) 3 times **(B)** 2 times **(C)** 1.5 times **(D)** 6 times

30. The reaction



is slowest when X is :



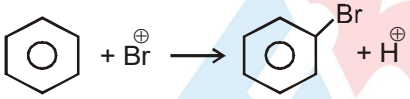
(A) Cl **(B)** NH_2 **(C)** OC_2H_5 **(D)** $OCOCH_3$

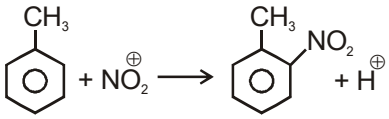
31. $CH_3–CH_2–\overset{O}{\overset{\|}{C}}–OCH_3 \xrightarrow[\Delta]{NaNH_2}$ X, X is

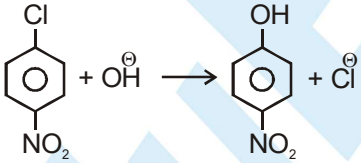
(A) $CH_3–CH_2–\overset{O}{\overset{\|}{C}}–ONa$ **(B)** $CH_3–CH_2–\overset{O}{\overset{\|}{C}}–NH_2$

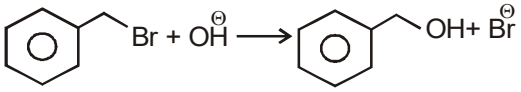
(C) $CH_3–\overset{O}{\overset{\|}{C}}–NH–CH_3$ **(D)** $CH_3–CH_2–NH_2$

32. Which of the following reaction is S_N2Ar reaction ?

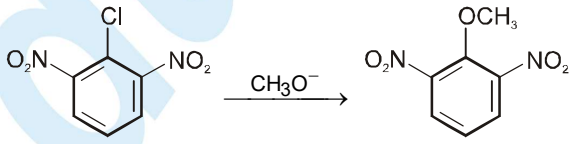
(A) 

(B) 

(C) 

(D) 

33. The given reaction most likely occurs by which of the following mechanism ?

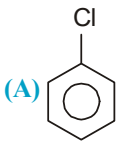


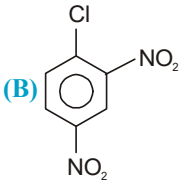
(A) S_N1 **(B)** S_N2 **(C)** S_N2Th **(D)** S_N2Ar

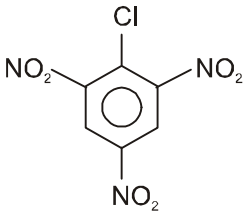
34. Electrophilic substitution reaction is characterstics reaction of

(A) Alkane **(B)** Alkyl halide **(C)** Alkene **(D)** Aromatic compound

35. Which of the following compound gives fastest S_N2 Ar reaction ?

(A) 

(B) 

(C) 

(D) 

36. Which of the following compounds is least reactive in the nucleophilic aromatic substitution reaction with NaOH?

(A) p-nitrofluorobenzene **(B)** p-nitrochlorobenzene

(C) p-nitrobromobenzene **(D)** p-nitroiodobenzene

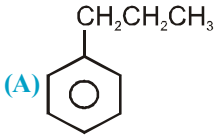
37. The following reaction is :

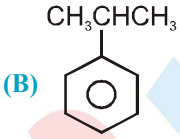
$$C_6H_6 + Br_2 \xrightarrow{FeBr_3} C_6H_5Br + HBr$$

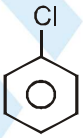
(A) An electrophilic addition reaction **(B)** A nucleophilic substitution reaction

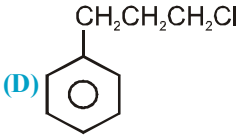
(C) An electrophilic substitution reaction **(D)** A free radical substitution reaction

38.  $+ CH_3CH_2CH_2Cl \xrightarrow{AlCl_3}$ Product

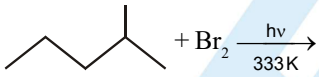
(A) 

(B) 

(C) 

(D) 

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



(A) 2-Bromo-2-methylpentane **(B)** 1-Bromo-2-methylpentane

(C) 4-Bromo-2-methylpentane **(D)** 3-Bromo-2-methylpentane

40. Addition reactions involve

(A) Cleavage of a σ-bond and formation of a new σ-bond

(B) Cleavage of two σ-bond and formation of a new π-bond

(C) Cleavage of a π-bond and formation of two new σ-bond

(D) None of these

41. Which is the correct decreasing order of reactivity in the following ?

(I) $CH_2=CH_2$ (II) $CH_3-CH=CH_2$ (III) $(CH_3)_2C=CH_2$

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

42. Which type of substitution in the given reaction occurs R–H $\xrightarrow{Cl_2/hv}$ R–Cl

(A) Free radical substitution **(B)** Electrophilic substitution

(C) Nucleophilic substitution **(D)** All of these

43. Which is the most reactive alkane towards bromination in presence of sunlight ?

(A) CH_3CH_3 **(B)** CH_4 **(C)** $CH_3CH_2CH_3$ **(D)** $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$

44. $CH_3-CH_2-CH_2-CH_3 + Cl_2 \xrightarrow{h\nu}$ Major product :

(A) $CH_3-CH_2-CH_2-CH_2-Cl$

(B) $CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_2-CH_3$

(C) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-Cl$

(D) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle Cl}{\overset{|}{\underset{|}{C}}}}-CH_3$

45. $Ph-CH_2-CH=CH_2 \xrightarrow{\text{dil. } H_2SO_4} X,$

Identify product 'X' is :

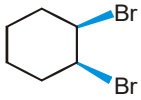
(A) $Ph-CH_2-CH_2-CH_2-OH$

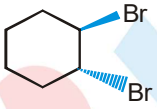
(B) $Ph-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(C) $Ph-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-CH_3$

(D) $Ph-CH_2-OH$

46.  $+ Br_2 \longrightarrow$ P, P will have configuration :

(A) 

(B) 

(C) both are true **(D)** none is true

47. $CH_3CH_2CH=CH_2 \xrightarrow{HOCl}$ Product, Product is :

(A) $CH_3-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-\underset{\displaystyle Cl}{\underset{|}{CH_2}}$

(B) $CH_3-CH_2-\underset{\displaystyle Cl}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH_2}}$

(C) $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-\underset{\displaystyle Cl}{\underset{|}{CH_2}}$

(D) $CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

48. $CH_3-CH_2-\overset{\displaystyle O}{\overset{\|}{C}}-CH_3 \xrightarrow[\text{(ii) } H_2O]{\text{(i) } CH_3MgBr}$ Product is :

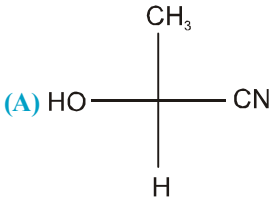
(A) $CH_3-CH_2-\underset{\displaystyle OH}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-CH_3$

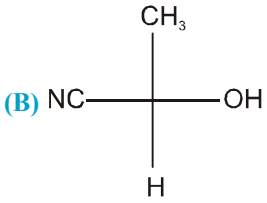
(B) $CH_3-CH_2-\underset{\displaystyle OH}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{CH}}}}-CH_2$

(C) $CH_3-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(D) $CH_3-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$

49. $CH_3CHO \xrightarrow{HCN}$ Product is :

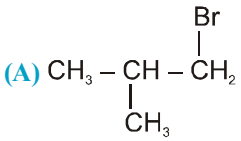
(A) 

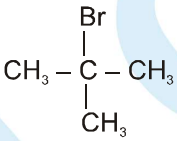
(B) 

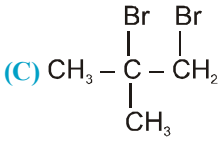
(C) Both **(A)** and **(B)**

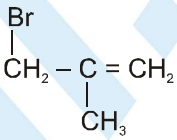
(D) None of these

50. $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}=CH_2 + HBr \xrightarrow{R_2O_2}$ Product is :

(A) 

(B) 

(C) 

(D) 

51. What is the product when one mole of pent-1-yne treated with two moles of HCl ?

(A) 1,2-Dichloropentane **(B)** 2,3-Dichloropentane

(C) 1,1-Dichloropentane **(D)** 2,2-Dichloropentane

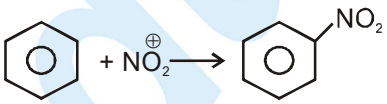
52. The correct order of reactivity of CH_3MgBr with following compounds will be :

CH_3–CHO, HCHO, Ph–CHO, $Ph-\overset{\displaystyle O}{\overset{\|}{C}}-CH_3$

(1) (2) (3) (4)

(A) 2 > 1 > 4 > 3 **(B)** 4 > 3 > 1 > 2 **(C)** 2 > 1 > 3 > 4 **(D)** 1 > 3 > 2 > 4

53. Which of the following is free radical addition reaction ?

(A) 

(B) $CH_2=CH_2 + HBr \longrightarrow CH_3-CH_2-Br$

(C) $CH_3-CH=CH_2 + HBr \xrightarrow{R_2O_2} CH_3-CH_2-CH_2-Br$

(D) $CH_3-CH=CH_2 + HCl \longrightarrow CH_3-\underset{\displaystyle Cl}{\overset{|}{CH}}-CH_3$

54. Which of the following reaction is an elimination reaction ?

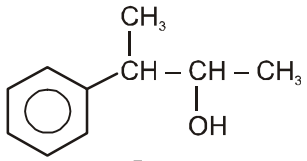
(A) $CH_3-CH_2-CH_2-OH \xrightarrow{PCl_5} CH_3-CH_2-CH_2-Cl$

(B) $CH_3-CH=CH_2 \xrightarrow{HCl} CH_3-\underset{Cl}{\underset{|}{CH}}-CH_3$

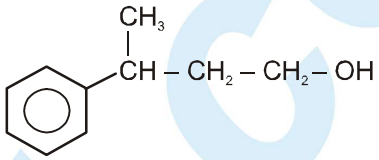
(C) $CH_3-\underset{Cl}{\underset{|}{CH}}-CH_3 \xrightarrow{Alc.KOH} CH_3-CH=CH_2$

(D) $CH_3-\underset{O}{\overset{\|}{C}}-OH \xrightarrow{CH_3OH} CH_3-\underset{O}{\overset{\|}{C}}-OCH_3$

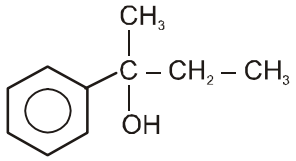
55. The relative rate of acid catalysed dehydration of following alcohols would be :



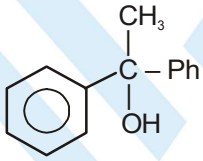
I



II



III



IV

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

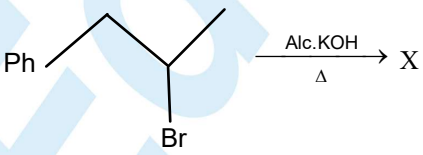
56. 2-Chlorobutane on treatment with alcoholic KOH/Δ gives mainly

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

57. $CH_3-\underset{CH_3}{\underset{|}{CH}}-\underset{Cl}{\underset{|}{CH}}-CH_3 \xrightarrow[\Delta]{t\text{-}BuO^-}$ Major Product is :

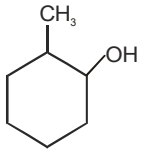
(A) $CH_3-\underset{CH_3}{\underset{|}{C}}=CH-CH_3$ **(B)** $CH_3-\underset{CH_3}{\underset{|}{CH}}-CH=CH_2$

(C) $CH_2=\underset{CH_3}{\underset{|}{C}}-CH_2-CH_3$ **(D)** $CH_3-\underset{CH_3}{\underset{|}{\overset{OH}{\overset{|}{CH}}}}-CH-CH_3$

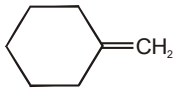
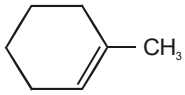
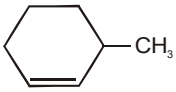
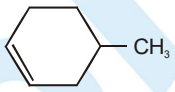
58. 

X is the total number of possible products in this elimination reaction :

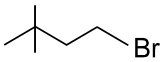
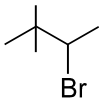
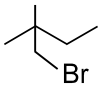
(A) 01 **(B)** 03 **(C)** 02 **(D)** 04

59. In the given reaction :  $\xrightarrow{\text{Conc.}H_2SO_4}$ [X] as major product

[X] will be :

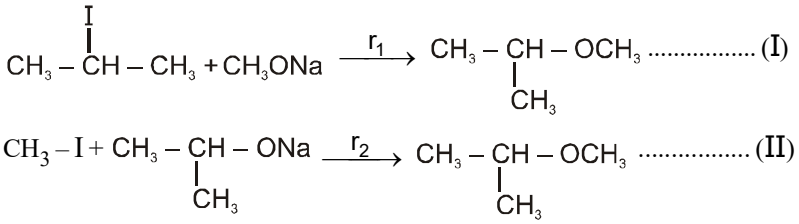
(A)  **(B)**  **(C)**  **(D)** 

60. Which of the following cannot undergo E2 reaction ?

(A)  **(B)**  **(C)**  **(D)** none of these

Exercise # 2 Part # I [Multiple Correct Choice Type Questions]

1. Observe the following reaction and tick correct option (s)



(I)

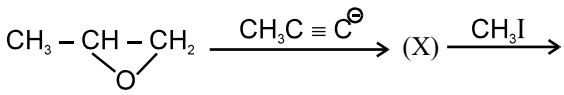
(II)

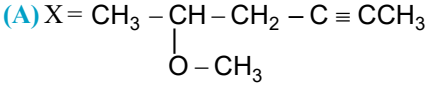
(A) $r_1 < r_2$

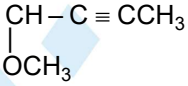
(B) Transition state in reaction (I) is less stable then transition state in reaction (II)

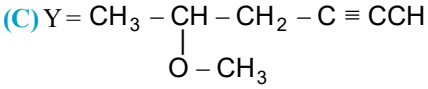
(C) Substrate of both the reactions are equally reactive to a particular nucleophile

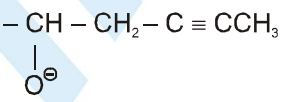
(D) r_1 and r_2 both are directly proportional to the concentration of nucleophile CH_3ONa

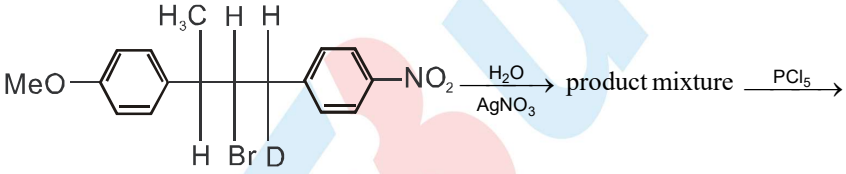
2.  (X) (Y). Identify X & Y :

(A) X = 

(B) Y = 

(C) Y = 

(D) X = 

3. 

No of product 'm' (Total isomers) $\xrightarrow[\text{distillation}]{\text{Fractional}}$ No. of Fractions 'n'.

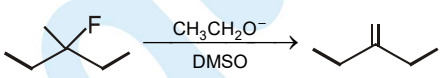
(A) Value of m & n are 4,2 respectively.

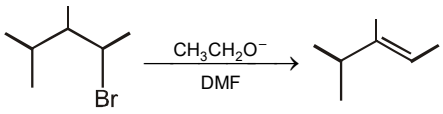
(B) Product mixture, and all fractions are optically active.

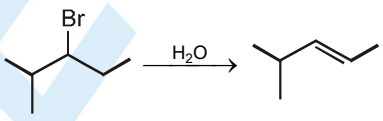
(C) Value of m & n are 4,4 respectively.

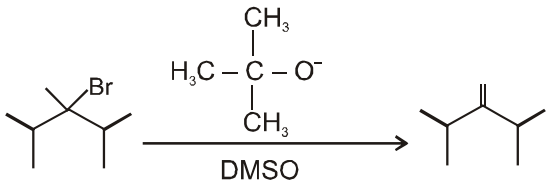
(D) Reaction of product mixture with PCl_5 is S_N2 mechanism.

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

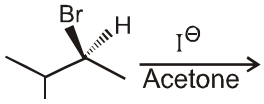
(A) 

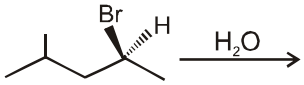
(B) 

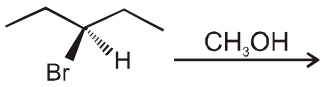
(C) 

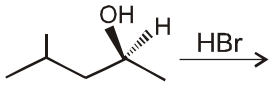
(D) 

5. Which reaction results in the formation of a pair of enantiomers ?

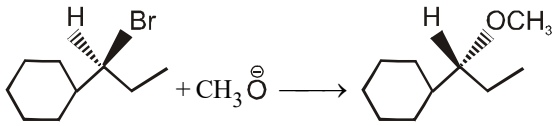
(A) 

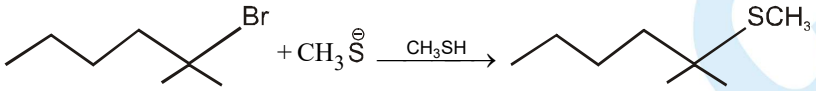
(B) 

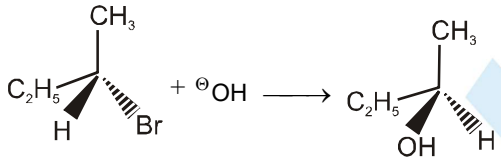
(C) 

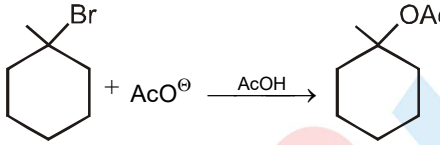
(D) 

6. Which of the following reaction will go faster if the concentration of the nucleophile is increased ?

(A) 

(B) 

(C) 

(D) 

7. Which is/are correct about alkyl bromide having molecular formula $C_5H_{11}Br$

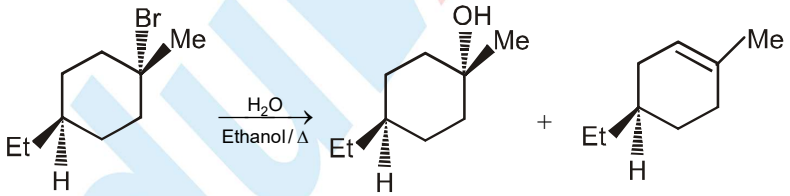
(A) One isomeric alkyl bromide undergoes E1 elimination at the fastest rate

(B) Only one is incapable of reacting by the E2 mechanism

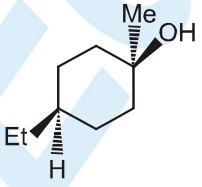
(C) Only one isomer gives a single alkene on E2 elimination

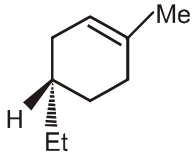
(D) 2-Bromopentane gives the most complex mixture of alkenes on E2 elimination

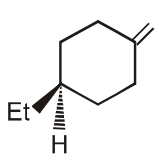
8. Consider the following $E1/S_N1$ reaction :

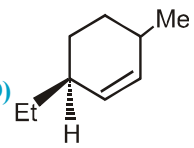


The missing product (s) is (are) :

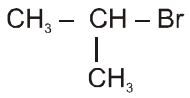
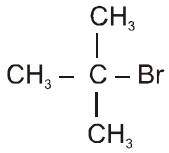
(A) 

(B) 

(C) 

(D) 

9. Account for the trend in relative rate observed for the formation of alcohol from the alkyl halide in H_2O / EtOH at 25°C.

	Alkyl Halide	Relative rate
(i)	CH_3-Br	2140
(ii)	CH_3-CH_2-Br	171
(iii)		4.99
(iv)		1010

Which of the following statements are true.

(A) The first two alkyl halide react mainly by the S_N2 pathway

(B) The fourth alkyl halide react mainly by the S_N1 pathway

(C) Water is a poor solvent for alkyl halide so EtOH is added in their solvation

(D) Rate of last two can be explain by steric hindrance.

10. Electrophiles are

(A) Electron deficent species **(B)** having atleast one pair of electron

(C) Electron rich species **(D)** having vacant p or d-orbital

11. Which of the followings are nucleophile ?

(A) BF_3 **(B)** CN^- **(C)** OH^- **(D)** NH_3

12. The correct nucleophilicity order is/are :

(A) $CH_3O^{\ominus} > CH_3^{\ominus}$ **(B)** $CH_3S^{\ominus} > CH_3SH$

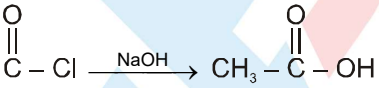
(C) $NH_3 > H_2O$ **(D)** $(CH_3CH_2)_3N > (CH_3CH_2)_3P$

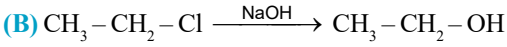
13. The correct order/s of decreasing reactivity of the given compound towards hydrolysis under identical condition is/are:

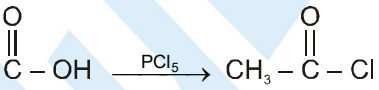
(A) $CH_3COCl > CH_3CONH_2$ **(B)** $CH_3COCl > (CH_3CO)_2O$

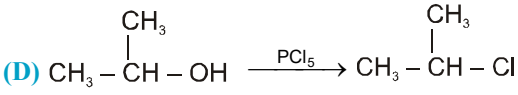
(C) $CH_3COOCH_3 > CH_3COCl$ **(D)** $(CH_3CO)_2O > CH_3CONH_2$

14. Which of the followings give product by S_N2 Th mechanism ?

(A) 

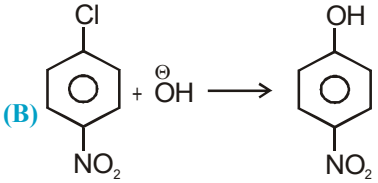
(B) 

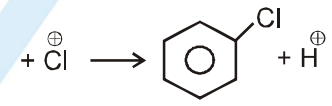
(C) 

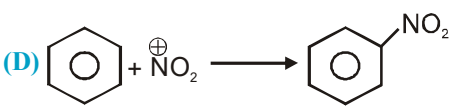
(D) 

15. Which of the following reactions is an electrophilic substitution ?

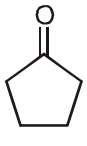
(A) 

(B) 

(C) 

(D) 

16. Which of the followings give nucleophilic addition reaction with CH_3MgBr :

(A) C_2H_5CHO **(B)** $CH_3-CH_2-\underset{\underset{O}{\|}}{C}-Cl$ **(C)**  **(D)** CH_3COOCH_3

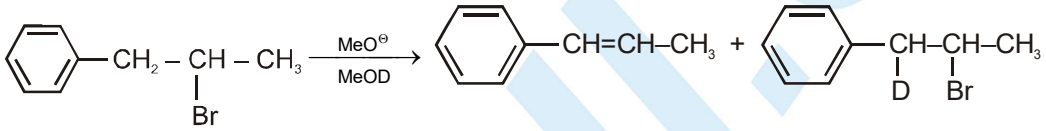
17. In which of the following reactions is there a possibility of rearrangement ?

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

18. E1 cB reaction is given by which of the following in presence of strong base :

(A) CF_3-CHCl_2 **(B)** $C_6H_5-\underset{\underset{NO_2}{|}}{CH}-CH_2Br$

(C) $CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-CH=O$ **(D)** All of these

19. 

This is an example of which type of elimination reaction ?

(A) E1 **(B)** E1cB **(C)** E2 **(D)** S_N2

20. Reaction intermediate of E1cB reaction is :

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

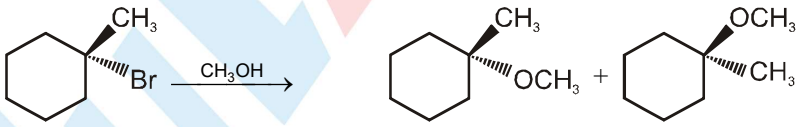
21. D-exchange is observed in :

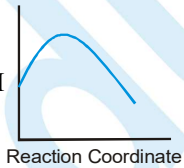
(A) E1 **(B)** E2 **(C)** E1cB` **(D)** none of these

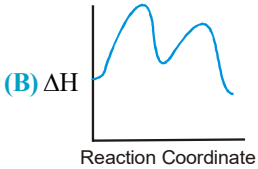
22. Number of fractions on fractional distillation of solvolysis in ethanol of 1-chlorobut-2-ene is

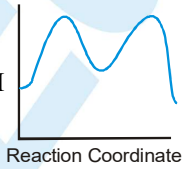
(A) 1 **(B)** 2 **(C)** 3 **(D)** 4

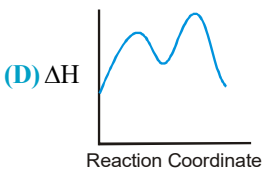
23. Which is the correct reaction coordinate diagram for the following solvolysis reaction ?

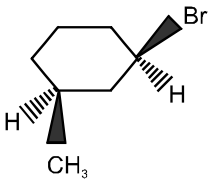


(A) 

(B) 

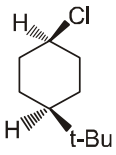
(C) 

(D) 

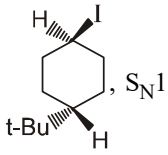
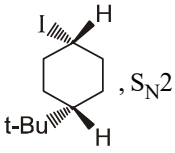
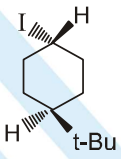
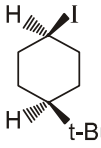
24.  + KOH $\xrightarrow{\text{acetone}}$ Product

(1R, 3S)–Cis–1–Bromo–3–methylcyclohexane.
The product formed in the reaction is

(A) (1R, 3S)–Cis–3–methyl cyclohexanol
(B) (1S, 3S)–Cis–3– methyl cyclohexanol
(C) (1S, 3S)–Trans–3–methyl cyclohexanol
(D) (1R, 3R)–Trans–3–methyl cyclohexanol

25.  $\xrightarrow[50°C]{\text{NaI / Acetone}}$ Product

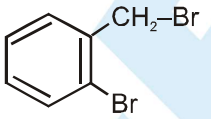
Product and mechanism are respectively

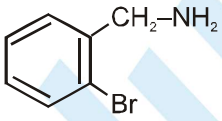
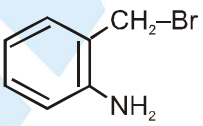
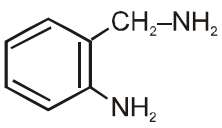
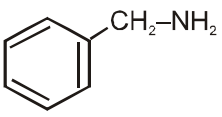
(A)  , S_N1
(B)  , S_N2
(C)  , S_N2
(D)  , S_N1

26. $CH_3-CH_2-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-\underset{\underset{OH}{|}}{CH}-CD_3 \xrightarrow[\Delta]{H_3PO_4}$ Total no. of alkenes (X) $\xrightarrow[\text{distilation}]{\text{Fractional}}$ No. of Fractions obtained (Y)

X and Y are :
(A) 6 ,6
(B) 9, 5
(C) 9, 6
(D) 6, 4

27. What is the major product obtained in the following reaction ?

 $\xrightarrow{NH_3}$ product

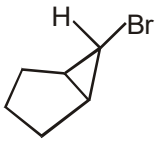
(A) 
(B) 
(C) 
(D) 

28. Consider the following reactions, which are carried out at the same temperature.

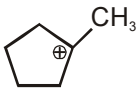
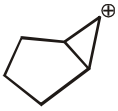
$$CH_3-Br+OH^{\ominus} \xrightarrow{EtOH} CH_3-OH+Br^{\ominus} \quad \text{....(i)}$$

$$CH_3-Br+OH^{\ominus} \xrightarrow{DMSO} CH_3-OH+Br^{\ominus} \quad \text{....(ii)}$$

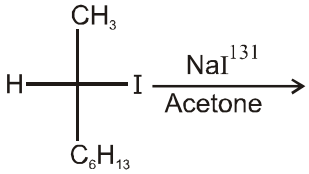
Which of the following statement is correct about these reactions.
(A) Both the reactions take place at the same rate
(B) The first reaction takes place faster than second reaction.
(C) The second reaction takes place faster than first reaction.
(D) Both the reactions take place by S_N1 mechanism

29.  $\xrightarrow{Ag^{\oplus}}$ Rearranged Carbocation + AgBr

Rearranged carbocation is :

(A)  **(B)**  **(C)**  **(D)** 

30. Which statement is incorrect about the following reaction :

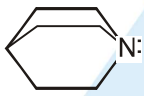


(A) Only one product is formed
(B) The product will have walden inversion
(C) The reaction mixture will have optical rotation zero
(D) The product is a mixture of d + ● isomers

31. Which of the following statements are correct for the given alcohol ?

$$R-OH \xrightarrow{X^{\Theta}} R-X + \overset{\ominus}{O}H$$

(A) Reaction will not take place because $\overset{\ominus}{O}H$ is poor leaving group ; $X^{\ominus}$ is weak base and $\overset{\ominus}{O}H$ is strong base
(B) Reaction will not take place because $\overset{\ominus}{O}H$ is poor leaving group ; $X^{\ominus}$ is strong base and $\overset{\ominus}{O}H$ is weak base.
(C) Reaction will not take place because $\overset{\ominus}{O}H$ is strong leaving group ; $X^{\ominus}$ is strong base and $\overset{\ominus}{O}H$ is weak base.
(D) Reaction will not take place because $\overset{\ominus}{O}H$ is good leaving group ; $X^{\ominus}$ is weak base and $\overset{\ominus}{O}H$ is strong base.

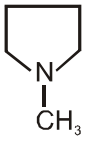
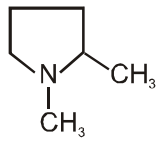
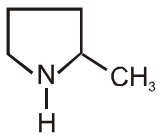
32. CH_3-I +  $\xrightarrow{K_1}$ (Reaction. I)

$$CH_3-I + CH_3-CH_2-\underset{\displaystyle CH_2-CH_3}{\overset{\displaystyle |}{\underset{\displaystyle |}{N}}}-CH_2-CH_3 \xrightarrow{K_2} \text{(Reaction.II)}$$

Which of the following statement is correct. ?
(A) Rate of reaction in I is less than reaction II.
(B) Rate of reaction in I is more than reaction II.
(C) Rate of reaction is equal in both reaction.
(D) Rate does not depend upon concentration of nucleophile.

33. $Br-CH_2-(CH_2)_2-\underset{\displaystyle CH_3}{\overset{\displaystyle |}{CH}}-Br + CH_3NH_2 \longrightarrow$ Product

Poduct of the reaction is :

(A)  **(B)**  **(C)**  **(D)** 

34. $CH_3CH_2OH + HCl \xrightarrow{ZnCl_2} CH_3CH_2Cl + H_2O$

In the above reaction, the leaving group is :

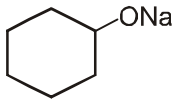
(A) $HO^{\ominus}$ **(B)** H_2O **(C)** $HOZnCl_2^{\ominus}$ **(D)** $H_3O^{\oplus}$

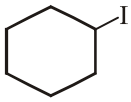
35. The decreasing order of rate of S_N2 is :

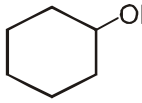
$Cl-CH_2-CH_2-Br$ (I) $\quad N\equiv C-CH_2-Br$ (II) $\quad CH_3-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3$ (III) $\quad CH_3-CH_2-Br$ (IV)

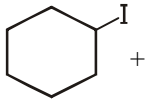
(A) II > I > IV > III **(B)** II > III > I > IV **(C)** II > I > III > IV **(D)** IV > I > II > III

36. Which of the following reactions is the best choice for preparing methyl cyclohexyl ether ?

(A)  $+ CH_3I \longrightarrow$

(B)  $+ CH_3ONa \longrightarrow$

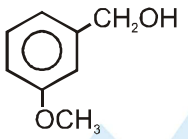
(C)  $+ CH_3I \longrightarrow$

(D)  $+ CH_3OH \longrightarrow$

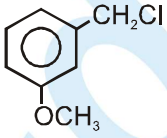
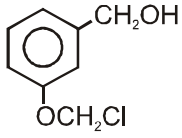
37. Which of the following chloride will exclusively give 2-Methyl but-2-ene on dehydrochlorination by a strong base?

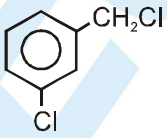
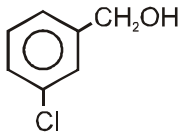
(A) 2-Chloro-2-methyl butane **(B)** 2-Chloro-3-methyl butane

(C) 1-Chloro-2-methyl butane **(D)** None of these

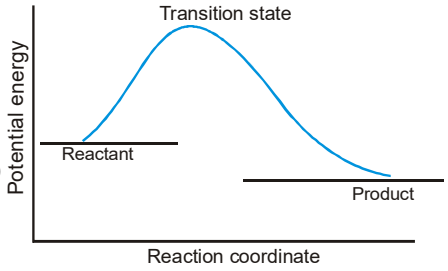
38.  $\xrightarrow[\text{Pyridine}]{SOCl_2} A + SO_2 + HCl$

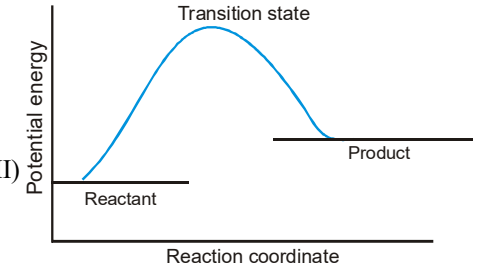
The product A in the above reaction is

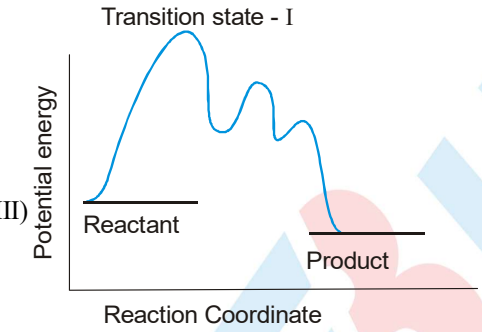
(A)  **(B)** 

(C)  **(D)** 

39. Following are the curves for nucleophilic substitution reaction.

(I)


(II)


(III)


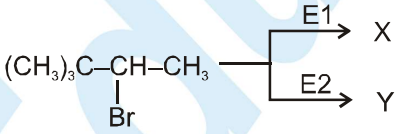
The correct statement (s) is (are)

(A) 'I' is potential energy diagram for S_N2 reaction that takes place with a negative potential energy change.

(B) 'II' is potential energy diagram for S_N2 reaction with a positive potential energy change

(C) 'III' shows potential energy diagram for S_N1 reaction with large potential energy of activation for first (slowest) step

(D) All of the above

40. 

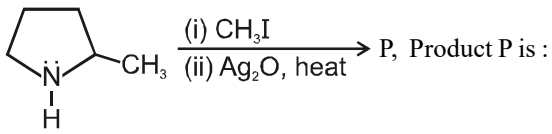
X and Y are respectively

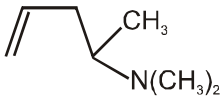
(A) $(CH_3)_2C=C(CH_3)_2$ and $(CH_3)_3CCH=CH_2$

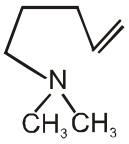
(B) $(CH_3)_3CCH=CH_2$ and $(CH_3)_2C=C(CH_3)_2$

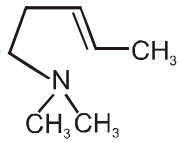
(C) $(CH_3)_2CH–C(CH_3)=CH_2$ and $(CH_3)_2C=C(CH_3)_2$

(D) $(CH_3)_2C=C(CH_3)_2$ and $(CH_3)_2CH–C(CH_3)=CH_2$

41.  P, Product P is :

(A) 

(B) 

(C) 

(D) None

42. $(CH_3)_3C–O–CH_2–C_6H_5$ can be prepared from Williamsons synthesis, using :

(A) $(CH_3)_3C–Cl$ and $C_6H_5CH_2ONa$

(B) $C_6H_5CH_2Cl$ and $(CH_3)_3C–ONa$

(C) $(CH_3)_3C–O–CH_2–Cl$ and C_6H_5ONa

(D) All of these

Part # II [Assertion & Reason Type Questions]

These questions contains, Statement-I (assertion) and Statement-II (reason).

(A) Statement-I is True, Statement-II is True ; Statement-II is a correct explanation for Statement-I

(B) Statement-I is True, Statement-II is True ; Statement-II is NOT a correct explanation for Statement-I

(C) Statement-I is True, Statement-II is False.

(D) Statement-I is False, Statement-II is True.

1. **Statement-I :** Primary benzylic halides are more reactive than primary alkyl halides towards S_{N^1} reaction.
Statement-II : Reactivity depends upon the nature of the nucleophile and the solvent.

2. **Statement-I :** Vinylic halides are reactive towards nucleophilic substitution reaction.
Statement-II : Reactivity is due to the polarity of carbon-halogen bond.

3. **Statement-I :** Aryl halides undergo electrophilic substitution less readily than benzene.
Statement-II : Aryl halide gives only meta product w.r.t. electrophilic substitution.

4. **Statement-I :** Iodination of akanes is carried out by heat in presence of readucing agent.
Statement-II : Iodination of alkanes takepalce explosively.

5. **Statement-I :** Chloropropane has higher boiling point than chloroethane.
Statement-II : Haloalkanes are polar molecules.

6. **Statement-I :** Polar solvent slows down S_N^1 reaction.
Statement-II : CH_3–Br is less reactive than CH_3Cl.

7. **Statement-I :** Optically active 2-iodibutane on treatment with NaI in acetone undergoes racemisation.
Statement-II : Repeated Walden inversions on the reactant and its product eventually gives a racemic mixture.

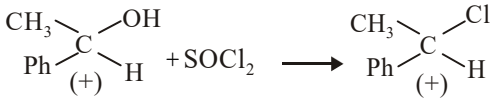
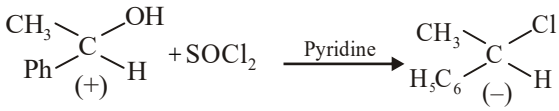
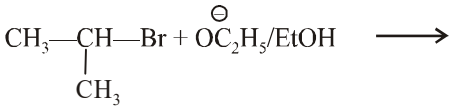
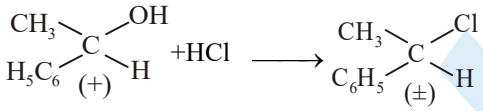
8. **Statement-I :** Free radical chlorination of n-butane gives 72% of 2-chlorobutane and 28% of 1-chlorobutane though it has six primary and four secondary hydrogens.
Statement-II : A secondary hydrogen is abstracted more easily than the primary hydrogen.

9. **Statement-I :** Boiling point of alkyl halide increases with increasse in molecular weight.
Statement-II : Boiling point of alkylhalides are in the order RI > RBr > RCI > RF.

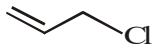
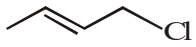
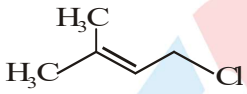
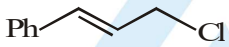
10. **Statement-I :** Nucleophilic substitution reaction on an optically active alkyl halide gives a mixture of enantiomers.
Statement-II : The reaction occurs by S_{N^1} mechanism.

Exercise # 3 Part # I [Matrix Match Type Questions]

1. Match the column I with column II.

	Column-I (reaction)		Column-II (Mechanism)	
(A)			**(p)**	S_N1
(B)			**(q)**	S_N2
(C)			**(r)**	S_Ni
(D)			**(s)**	E_2

2. Match the column I with column II.

	Column-I (Substrate)	Column-II (Relative rate of solvolysis in 50% aqueous ethanol at 45°C)	
(A)		**(p)**	7700
(B)		**(q)**	1
(C)		**(r)**	91
(D)		**(s)**	1,30,000

Part # II [Comprehension Type Questions]

Comprehension # 1

Nucleophilic substitution reactions generally expressed as

$$Nu^- + R - L \longrightarrow R - Nu + L^-$$

Where Nu^- ⟶ Nucleophile ; R—L ⟶ substrate ; L ⟶ leaving group

The best leaving groups are those that become the most stable ions after they depart. Since most leaving groups leave as a negative ion, the best leaving groups are those ions that stabilize a negative charge most effectively. A good leaving group should be

(A) electron-withdrawing to polarize the carbon

(B) stable once it has left (not a strong base)

(C) polarisable- to maintain partial bonding with the carbon in the transition state (both S_N1 and S_N2). This bonding helps to stabilise the transition state and reduces the activation energy.

1. Among the following which is feasible ?

(A) $X^- + CH_3—CH_2—H \longrightarrow CH_3—CH_2—X + H^-$

(B) $X^- + CH_3—OH \longrightarrow CH_3—X + \bar{O}H$

(C) $\bar{X} + H_3C—\overset{\oplus}{O}H_2 \longrightarrow CH_3—X + H_2O$

(D) $X^- + CH_3—CH_3 \longrightarrow CH_3—X + \bar{C}H_3$

2. Among the following which is false statement ?

(A) The weaker the base after the group departs, the better the leaving group

(B) A reactive leaving group would raise the energy of the product, driving the equilibrium towards the reactants

(C) Relative leaving group ability may vary with change of solvent

(D) Better leaving group only increases S_N2 rate, not S_N1.

3. $\underset{(I)}{CH_3Br}$ $\underset{(II)}{CH_3F}$ $\underset{(III)}{CH_3OH}$ $\underset{(IV)}{CH_3OSO_2CF_3}$

The correct order of decreasing reactivity of the above compounds towards CH_3O^- in an S_N2 reaction is :

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

4. $\underset{(I)}{Cl^-}$ $\underset{(II)}{CH_3O^-}$ $\underset{(II)}{CH_3S^-}$ $\underset{(IV)}{I^-}$

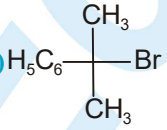
The correct order of increasing leaving group capability of above anoins

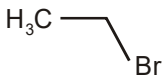
(A) III < IV < II < I **(B)** II < III < I < IV **(C)** II < IV < III < I **(D)** I < III < II < IV

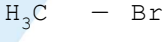
Comprehension # 2

Nucleophilic aliphatic substitution reaction is mainly of two types : S_N1 and S_N2. The S_N1 mechanism is a two step process. Reaction velocity of S_N1 reaction depends only on the concentration of the substrate. Since product formation takes place by the formation of carbocation, optically active substrate gives (+) and (–) forms of the product. In most of the cases the product usually consits of 5-20% inverted product and 80-95% racemised species. The more stable the carbocation, the greater is the proportion of racemisation. In solvolysis reaction, the more nucleophilic the solvent, the greater is the proportion of inversion.

1. Which one of the following compound will give S_N1 reaction predominantly ?

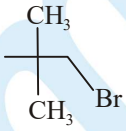
(A) 

(B) 

(C) 

(D) All of these

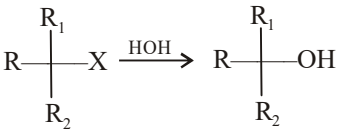
2. Which of the following compounds will give S_N1 and S_N2 reactions with considerable rate ?

I. $C_6H_5—CH_2—Br$ II. $CH_2=CH—CH_2—Br$ III. $CH_3—CH(Br)CH_3$ IV. 

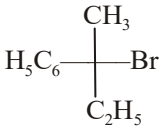
Select the correct answer from the codes given below

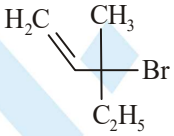
(A) I, II and III **(B)** I, II and IV **(C)** II, III and IV **(D)** I, III and IV

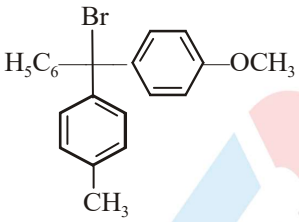
3. For the given reaction

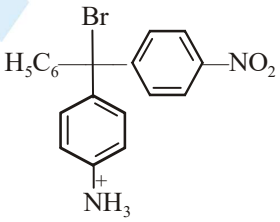


Which substrate will give maximum racemisation ?

(A) 

(B) 

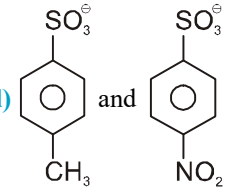
(C) 

(D) 

Exercise # 4 [Subjective Type Questions]

1. In each of the following pairs of species which species is better leaving group :

(a) $OH^{\ominus}$ and H_2O **(b)** $OH^{\ominus}$ and $F^{\ominus}$

(c) $Br^{\ominus}$ and $F^{\ominus}$ **(d)**  and

2. Label each of the following solvent as Protic or Aprotic

(a) Tetrahydrofuran **(b)** Acetonitrile **(c)** Acetic acid **(d)** Acetone

(e) DMSO **(f)** Formamide **(g)** Cyclohexane **(h)** Ammonia

3. Which of the following are non-polar solvent ?

(a) DMS **(b)** CCl_4 **(c)** $CHCl_3$ **(d)** Acetone

(e) Ethyl alcohol **(f)** Dimethylacetamide **(g)** Benzene **(h)** Tetrahydrofuran

4. Which of the followings are electrophile ?

(a) CN^- **(b)** H^+ **(c)** Br^+ **(d)** $AlCl_3$

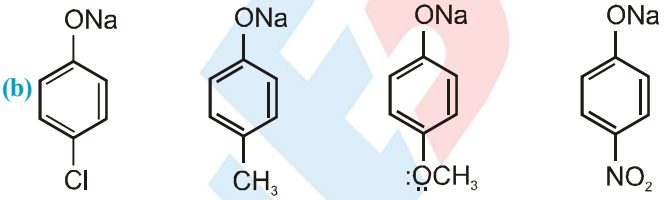
(e) BH_3 **(f)** $CH_3 - \overset{\oplus}{C} = O$ **(g)** NH_3 **(h)** $\overset{\oplus}{N}O_2$

5. Which of the followings are nucleophille ?

(a) HS^- **(b)** BF_3 **(c)** $C_2H_5 - OH$ **(d)** $(CH_3)_3\overset{\oplus}{N}$ **(e)** $:CH_2$

6. Arrange the given species in decreasing order of their nucleophilicity :

(a) H_2O $Cl^{\ominus}$ $Br^{\ominus}$ $I^{\ominus}$

(b) 

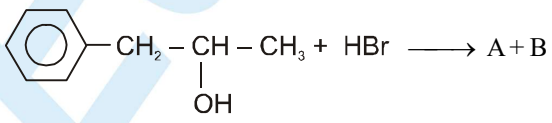
7. Which compound in the following couples will react faster in S_N1 reaction and why ?

(a) 1-Bromopentane or 2-Bromopentane **(b)** 1-Bromo-2-methylbutane or 2-Bromo-2-methylbutane.

8. What effect do you expect due to following changes in S_N1 reaction of $(CH_3)_3CBr$ with CH_3OH ?

(a) The concentration of $(CH_3)_3CBr$ is doubled and that of CH_3OH is halved.

(b) The concentration of both $(CH_3)_3CBr$ and CH_3OH are tripled.

9. 

A and B are two structural isomeric products of this reaction. Identify each. Which is predominant ?

10. Explain the order of the rate of esterification of the following acid with MeOH :

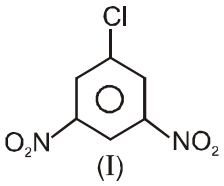
$CH_3COOH > MeCH_2COOH > Me_2CHCOOH > Me_3CCOOH$

11. What will be the major product of the following reaction ?

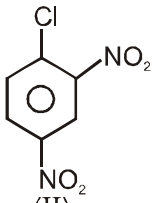
(a) $CH_3-\overset{O}{\overset{\|}{C}}-Cl + CH_3OH \longrightarrow$

(b) $CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5 + H_2O \longrightarrow$

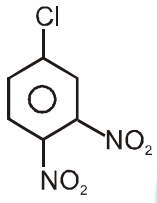
12. Write the correct reactivity order with NaOH for the following compounds.



(I)

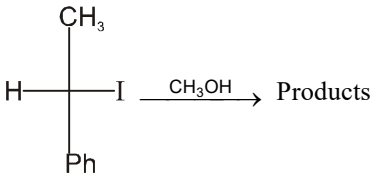


(II)



(III)

13. Write the product of the following reaction with proper stereochemistry.

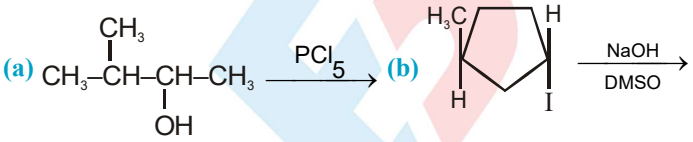


14. Arrange the compounds of each set in order of reactivity towards S_N2 displacement.

(a) 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane

(b) 1-Bromo-3-methylbutane, 2-Bromo-2-methylbutane, 2-Bromo-3-methylbutane

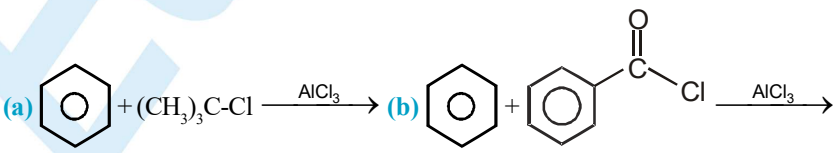
15. What will be the major product of the following reaction ?



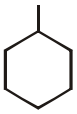
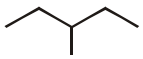
16. Arrange the following in decreasing order of their reactivity with an electrophile.

(I) (II) (III) (IV)

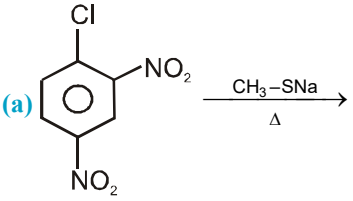
17. Complete the following reactions :

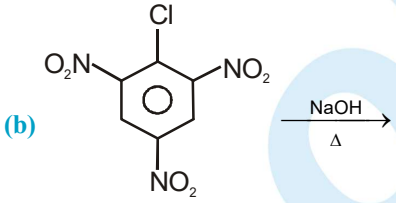


18. Give the major product of monobromination of following compounds.

(a)  **(b)**  **(c)**  **(d)** 

19. Give the products in following reactions :

(a) 

(b) 

20. Complete the following reaction.

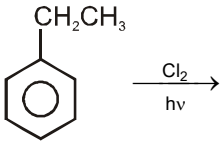
(a) Ph–CHO $\xrightarrow[(ii)H_2O]{(i)PhMgBr}$

(b) $Ph-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow{HCN}$

21. How many compounds out of following will give secondary alcohol on treatment with Grignard reagent.

(a) Ph–CO–CH_3 **(b)** Ph–CHO **(c)** HCHO **(d)** CH_3CH_2CHO

22. Give products of reaction when 2-Methylbut-2-ene react with HBr in presence and absence of peroxide.

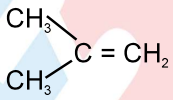
23. 

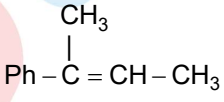
X (major product) + Y (minor product)

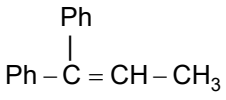
Give structure of X & Y.

24. What will be order of reactivity of following compounds towards ionic addition of HBr ?

$CH_3-CH=CH-CH_3$ (I)

 (II)

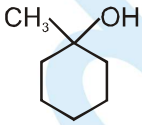
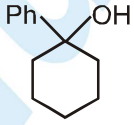
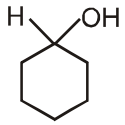
 (III)

 (IV)

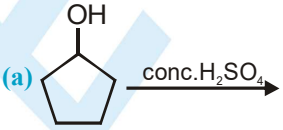
25. Give the product formed when But-1-yne reacts with two moles of Br_2.

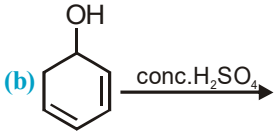
26. Give the product formed when But-1-yne reacts with two moles of HBr in prensence of peroxide.

27. Arrange the following alcohol in increasing order of reactivity towards acid catalyzed dehydration.

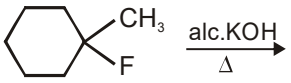
(I)  (II)  (III) 

28. What would be the major product in the following reaction ?

(a) 

(b) 

29. What would be the major product in the following reaction ?



30. Give major product and classifiy the mechanism in the following reactions.

(a) $CH_3-\underset{\underset{Br}{|}}{CH}-CH_2-CH_3 \xrightarrow[\Delta]{alc.KOH}$

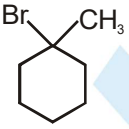
(b) $CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-Ph \xrightarrow[\Delta]{Cons.\ H_2SO_4}$

(c) $CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-\underset{\underset{O}{||}}{C}-Ph \xrightarrow[\Delta]{Conc.\ NaOH}$

31. Arrange the following alkyl halide in increasing order of reactivity towards alcoholic KOH.

(I) $CH_3-\underset{\underset{Cl}{|}}{CH}-CH_3$ (II) $CH_3-\underset{\underset{Br}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2CH_3$ (III) $CH_3-\underset{\underset{Cl}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2CH_3$

32. What is the major product of dehydrohalogenation when following compounds are treated with alcoholic KOH.

(a) $CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{Cl}{|}}{C}}-CH_2-CH_3$ **(b)**  **(c)** $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-Br$

33. '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). Identify the numbers Y and Z.

34. 3, 3-Dimethylbutan-2-ol loses a mole of water in the presence of concentrated sulphuric acid to give tetramethylethylene as a major product. Suggest a suitable mechanism.

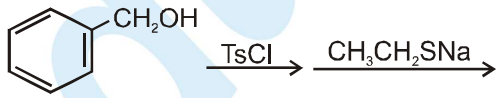
35. Predict the major products (including stereochemistry) when R–2–Butanol reacts with the following reagents.

(a) PBr_3 **(b)** $SOCl_2$ /  **(c)** Lucas reagent **(d)** TsCl / pyridine, then NaI

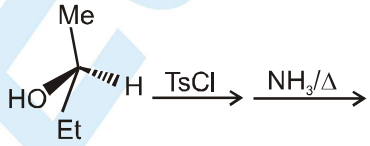
36. $Cl-CH_2-CH_2-CH_2-\underset{\underset{O}{||}}{C}-Ph + KOH + MeOH \longrightarrow$ Product , Identify the product.

37. The order of nucleophilicity in a period does not depend on nature of solvent whether it is protic or aprotic but the order of nucleophilicity in a group is different in polar protic and polar aprotic solvent. Explain.

38. Write the product of the following reaction :

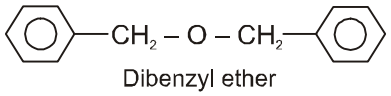
(a) 

(b) $CH_3-CH_2-CH_2-CH_2-Br \xrightarrow{CH_3-C\equiv C-Na}$

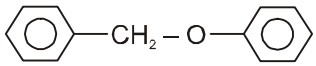
(c) 

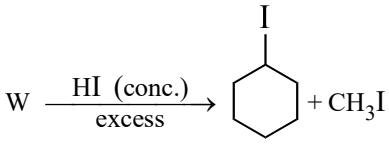
39. (a) Optically active 2-Bromobutane undergoes recemization on treatment with a solution of KBr.Give a mechanism for this racemization.
(b) In contrast, optically active 2-Butanol does not recemize on treatment with a solution of KOH. Explain why a reaction like that in part (a) does not occur.
(c) Optically active 2-Butanol racemizes in dilute acid. Propose a mechanism for this racemization.

40. Identify the reactants / products in following reactions :

(a) 

Dibenzyl ether

(b) 

(c) 

(d) $Z \xrightarrow[\text{excess}]{HI\ (conc.)} (CH_3)_2CHI + CH_3CH_2CH_2I$

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

$$\underset{\text{ethyl bromide}}{CH_3CH_2-Br} + \underset{\text{potassium t–butoxide}}{(CH_3)_3C-OK} \longrightarrow \underset{\text{ethyl t–butyl either}}{(CH_3)_3C-O-CH_2CH_3}$$

(a) What happens to the reaction rate if the concentration of ethyl bromide is doubled?
(b) What happens to the rate if the concentration of potassium t-butoxide is tripled and the concentration of ethyl bromide is doubled?
(c) What happens, if the temperature is raised?

42. When (R)-2-bromobutane is heated with water, the S_N1 substitution proceeds twice as fast as the S_N2. Calculate the approximate enantiomeric excess and the specific rotation expected for the product. The specific rotation of (R)-2 butanol is –13.5°.

43. In 80% ethanol at 55°C Isopropyl bromide react with hydroxide according to the following kinetic equation. where the rate is expressed as moles per litre per second.

$$\text{rate} = 4.7 \times 10^{-5}(RX)(OH^-) + 0.24 \times 10^{-5}(RX)$$

What percentage of isopropyl bromide react with S_N1 mechanism when $[OH^-]$ conc is 5 molar

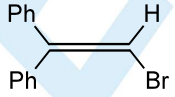
44. The alkene (X) produced by solvolysis of 3-chloro-3-methylpentane, is more in quantity than the alkene (Y) produced by solvolysis of 3-chloro-3-ethylpentane. Explain and also write the structure of X and Y.

45. Which reacts faster

(a) $PhCH_2Br$ and $PhCMe_2Br$ $(H_2O - C_2H_5OH)$
(b) $PhCH_2-CH_2Br$ and $PhCMe_2Br$ $(NaI - Acetone)$
(c) $PhCH_2-CH_2-Cl$ and $PhCMe_2Br$ $(KOH + C_2H_5OH)$

46. What is the effect of increasing solvent polarity over the reactions

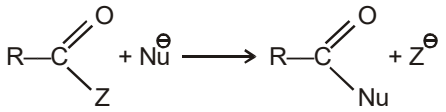
(a) $CH_3-Cl + NH_3 \longrightarrow CH_3\overset{\oplus}{N}H_3\ Cl^{\ominus}$ **(b)** $Me_3\overset{\oplus}{S} + OH^{\ominus} \longrightarrow Me-OH + Me_2S$

47. 

$+ KNH_2 \longrightarrow$ Product , Identify the product.

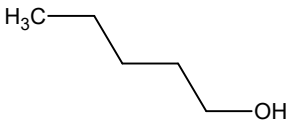
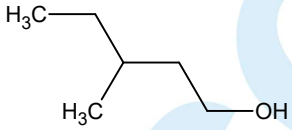
Exercise # 5 Part # I [Previous Year Questions] [AIEEE/JEE-MAIN]

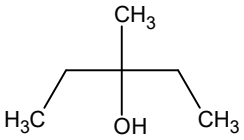
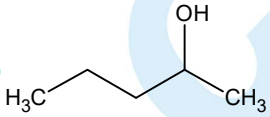
1. Rate of the reaction is fastest when Z is : **[AIEEE-2004]**



(A) Cl **(B)** $OCOCH_3$ **(C)** OC_2H_5 **(D)** NH_2

2. Among the following compound which can be dehydrated very easily is ? **[AIEEE-2004]**

(A)  **(B)** 

(C)  **(D)** 

3. Tertiary alkyl halides are practically inert to substitution by S_N2 mechanism because of **[AIEEE-2005]**
(A) steric hindrance **(B)** inductive effect **(C)** instability **(D)** insolubility

4. Elimination of HBr from 2-bromobutane result in the formation of **[AIEEE-2005]**
(A) Predominantly 2-butyne **(B)** Predominantly 1-butene
(C) Predominantly 2-butene **(D)** Equimolar mixture of 1 and 2-butene

5. 2-Methylbutane on reacting with bromine in the presence of sunlight gives mainly ? **[AIEEE-2005]**
(A) 1-Bromo-3-methylbutane **(B)** 1-Bromo-2-methylbutane
(C) 2-Bromo-3-methylbutane **(D)** 2-Bromo-2-methylbutane

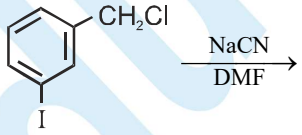
6. A reaction involving two different reactants can never be : **[AIEEE- 2005]**
(A) unimolecular reaction **(B)** first order reaction
(C) second order reaction **(D)** bimolecular reaction

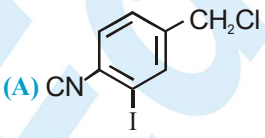
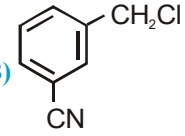
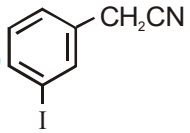
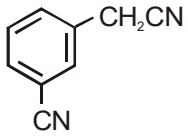
7. Consider an endothermic reaction X $\longrightarrow$ Y with the activation energies E_b and E_f for the backward and forward reaction, respectively. In general **[AIEEE- 2005]**
(A) $E_b < E_f$ **(B)** $\Delta H = \Delta U$ **(C)** $\Delta H < \Delta U$ **(D)** $\Delta H > \Delta U$

8. The decreasing order of the ratio of HCN addition to compounds a to d is **[AIEEE-2006]**
(a) HCHO (b) CH_3COCH_3 (c) $PhCOCH_3$ (d) PhCOPh
(A) d > b > c > a **(B)** d > c > b > a **(C)** c > d > b > a **(D)** a > b > c > d

9. $CH_3Br + Nu^- \longrightarrow CH_3 - Nu + Br^-$
The decreasing order of the rate of the above reaction with nucleophiles (Nu^-) A to D is : **[AIEEE-2006]**
[Nu^- = **(A)** $\rightarrow PhO^-$, **(B)** $\rightarrow AcO^-$, **(C)** $\rightarrow HO^-$, **(D)** $\rightarrow CH_3O^-$]
(A) D > C > B > A **(B)** A > B > C > D **(C)** B > D > C > A **(D)** D > C > A > B

10. The structure of the major product formed in the following reaction is **[AIEEE-2006]**



(A)  **(B)**  **(C)**  **(D)** 

11. Which of the following is the correct order of decreasing S_N2 reactivity ? **[AIEEE-2007]**
(A) $RCH_2X > R_3CX > R_2CHX$ **(B)** $RCH_2X > R_2CHX > R_3CX$
(C) $R_3CX > R_2CHX > RCH_2X$ **(D)** $R_2CHX > R_3CX > RCH_2X$

12. Which of the following reactions will yield 2,2-dibromopropane ? **[AIEEE-2007]**

(A) $CH_3-C\equiv CH+2HBr\longrightarrow$ **(B)** $CH_3CH=CHBr+HBr\longrightarrow$

(C) $CH\equiv CH+2HBr\longrightarrow$ **(D)** $CH_3-CH=CH_2+HBr\longrightarrow$

13. The organic chloro compound, which shows complete stereochemical inversion during an S_N2 reaction, is **[AIEEE-2008]**

(A) $(CH_3)_3CCl$ **(B)** $(CH_3)_2CHCl$ **(C)** CH_3Cl **(D)** $(C_2H_5)_2CHCl$

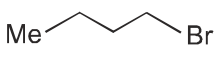
14. For a reaction $\frac{1}{2}A\longrightarrow 2B$, rate of disappearance of 'A' related to the rate of appearance of 'B' by the expression. **[AIEEE- 2008]**

(A) $-\frac{d[A]}{dt}=\frac{1}{4}\frac{d[B]}{dt}$ **(B)** $-\frac{d[A]}{dt}=\frac{d[B]}{dt}$ **(C)** $-\frac{d[A]}{dt}=4\frac{d[B]}{dt}$ **(D)** $-\frac{d[A]}{dt}=\frac{1}{2}\frac{d[B]}{dt}$

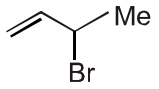
15. From amongst the following alcohols the one that would react fastest with conc. HCl and anhydrous $ZnCl_2$, is **[AIEEE-2010]**

(A) 2-Butanol **(B)** 2-Methylpropan-2-ol **(C)** 2-Methylpropanol **(D)** 1-Butanol

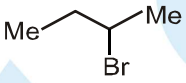
16. Consider the following bromides : **[AIEEE-2010]**



(A)



(B)



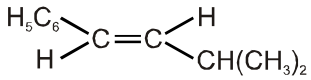
(C)

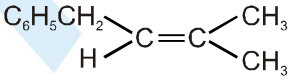
The correct, order of S_N1 reactivity is :

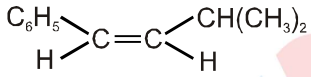
(A) B > C > A **(B)** B > A > C **(C)** C > B > A **(D)** A > B > C

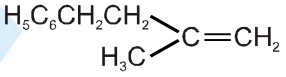
17. The main product of the following reaction is : **[AIEEE-2010]**

$C_6H_5CH_2CH(OH)CH(CH_3)_2\xrightarrow{\text{conc. } H_2SO_4}$

(A) 

(B) 

(C) 

(D) 

18. Sodium ethoxide has reacted with ethanoyl chloride. The compound that is produced in the above reaction is: **[AIEEE-2011]**

(A) Diethyl ether **(B)** 2-Butanone **(C)** Ethyl chloride **(D)** Ethyl ethanoate

19. Consider thiol anion ($RS^{\ominus}$) and alkoxy anion ($RO^{\ominus}$). Which of the following statement is correct ? **[AIEEE-2011]**

(A) $RS^{\ominus}$ is less basic but more nucleophilic than $RO^{\ominus}$.

(B) $RS^{\ominus}$ is more basic and more nucleophilic than $RO^{\ominus}$.

(C) $RS^{\ominus}$ is more basic but less nucleophilic than $RO^{\ominus}$.

(D) $RS^{\ominus}$ is less basic and less nucleophilic than $RO^{\ominus}$.

20. Which branched chain isomer of the hydrocarbon with molecular mass 72u gives only one isomer of mono substituted alkyl halide ? **[AIEEE-2012]**

(A) Tertiary butyl chloride **(B)** Neopentane **(C)** Isohexane **(D)** Neohexane

21. A solution of (–) – 1 – Chloro–1–phenylethane in toluene racemises slowly in the presence of a small amount of $SbCl_5$, due to the formation of : **[JEE(Main)-2013]**

(A) carbanion **(B)** carbene **(C)** carbocation **(D)** free radical

22. An unknown alcohol is treated with the "Lucas reagent" to determine whether the alcohol is primary, secondary or tertiary. Which alcohol reacts fastest and by what mechanism : **[JEE(Main)-2013]**

(A) secondary alcohol by S_N1 **(B)** tertiary alcohol by S_N1

(C) secondary alcohol by S_N2 **(D)** tertiary alcohol by S_N2

23. In S_N2 reactions, the correct order of reactivity for the following compounds : **[JEE(Main)-2014]**

CH_3Cl, CH_3CH_2Cl, $(CH_3)_2CHCl$ and $(CH_3)_3CCl$ is :

(A) $CH_3CH_2Cl > CH_3Cl > (CH_3)_2CHCl > (CH_3)_3CCl$ **(B)** $(CH_3)_2CHCl > CH_3CH_2Cl > CH_3Cl > (CH_3)_3CCl$

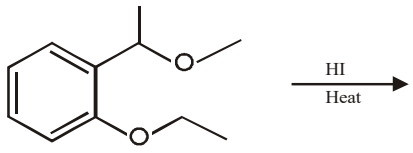
(C) $CH_3Cl > (CH_3)_2CHCl > CH_3CH_2Cl > (CH_3)_3CCl$ **(D)** $CH_3Cl > CH_3CH_2Cl > (CH_3)_2CHCl > (CH_3)_3CCl$

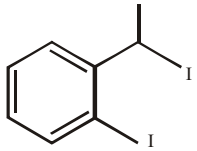
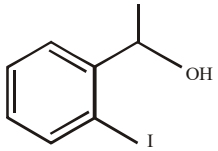
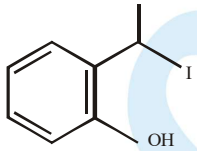
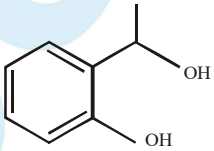
24. The increasing order of the reactivity of the following halides for the S_N1 reaction is : **[JEE(Main)-2017]**

$CH_3\underset{\underset{Cl}{|}}{C}HCH_2CH_3$ (I) $\quad CH_3CH_2CH_2Cl$ (II) $\quad p-H_3CO-C_6H_4-CH_2Cl$ (III)

(A) (III) < (II) < (I) **(B)** (II) < (I) < (III) **(C)** (I) < (III) < (II) **(D)** (II) < (III) < (I)

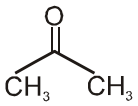
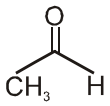
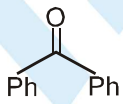
25. The major product formed in the following reaction is : **[JEE(Main)-2018]**



(A)  **(B)**  **(C)**  **(D)** 

Part # II [Previous Year Questions][IIT-JEE ADVANCED]

1. The order or reactivity of phenyl magnesium bromide with the following compounds is : **[JEE-2004]**

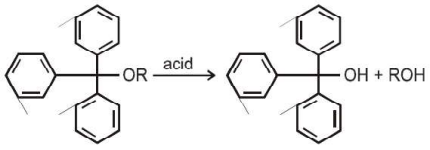
 I  II  III

(A) (II) > (III) > (I) **(B)** (I) > (III) > (II)
(C) (II) > (I) > (III) **(D)** all react with the same rate

2. The major product obtained on acid–catalysed hydration of 2–phenylpropene is : **[JEE-2004]**
(A) 2-Phenylpropan-2-ol **(B)** 2-Phenylpropan-1-ol **(C)** 3-Phenylpropan-2-ol **(D)** 1-Phenylpropan-1-ol

3. Which is the best reagent to convert cyclohexanol into cyclohexene. **[JEE-2005]**
(A) conc. HCl **(B)** conc. HBr **(C)** conc. H_3PO_4 **(D)** $HCl + ZnCl_2$

4. The acidic hydrolysis of ether (X) shown below is fastest when : **[JEE-2014]**



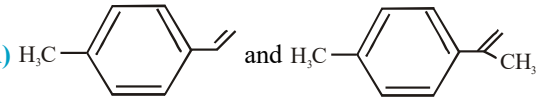
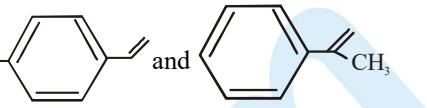
[X]

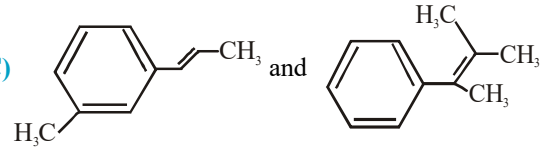
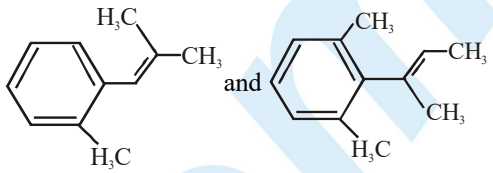
(A) one phenyl group is replaced by a methyl group.
(B) one phenyl group is replaced by a para-methoxyphenyl group.
(C) two phenyl groups are replaced by two para-methoxyphenyl groups
(D) no structural change is made to X.

5. Compounds P and R upon ozonolysis produce Q and S, respectively. The molecular formula of Q and S is C_8H_8O. Q undergoes Cannizzaro reaction but not haloform reaction, whereas S undergoes haloform reaction but not Cannizzaro reaction.

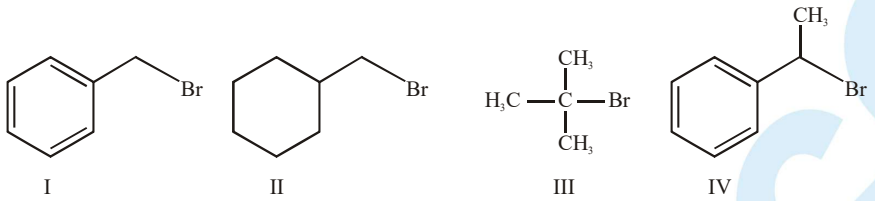
(i) P $\xrightarrow[\text{ii) } Zn/H_2O]{\text{i) } O_3/CH_2Cl_2}$ Q (C_8H_8O) (ii) R $\xrightarrow[\text{ii) } Zn/H_2O]{\text{i) } O_3/CH_2Cl_2}$ S (C_8H_8O)

The option(s) with suitable combination of P and R, respectively, is(are) **[JEE-2017]**

(A)  **(B)** 

(C)  **(D)** 

6. For the following compounds, the correct statement(s) with respect to nucleophilic substitution reactions is(are)



I II III IV

[JEE-2017]

(A) I and II follow S_N2 mechanism

(B) Compound IV undergoes inversion of configuration

(C) The order of reactivity for I, III and IV is : IV > I > III

(D) I and III follow S_N1 mechanism

Paragraph for Q. 7 & Q. 8

The reaction of compound P with CH_3MgBr (excess) in $(C_2H_5)_2O$ followed by addition of H_2O gives Q. The compound Q on treatment with H_2SO_4 at 0°C gives R. The reaction of R with CH_3COCl in the presence of anhydrous $AlCl_3$ in CH_2Cl_2 followed by treatment with H_2O produces compound S. [Et in compound P is ethyl group]

P

[JEE-2017]

7. The reactions, Q to R and R to S are

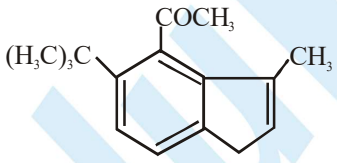
(A) Friedel-Crafts alkylation and Friedel-Crafts acylation

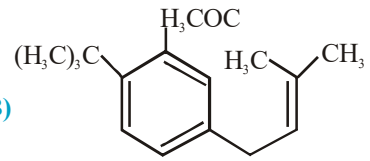
(B) Dehydration and Friedel-Crafts acylation

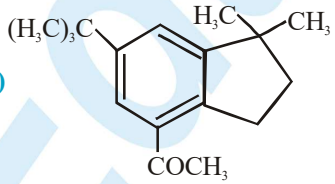
(C) Friedel-Crafts alkylation, dehydration and Friedel-Crafts acylation

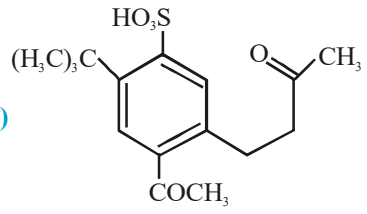
(D) Aromatic sulfonation and Friedel-Crafts acylation

8. The product S is

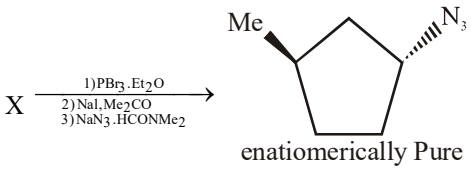
(A) 

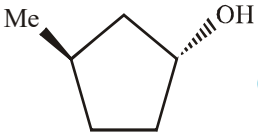
(B) 

(C) 

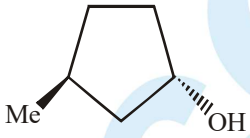
(D) 

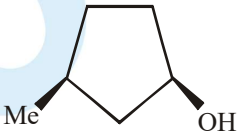
9. In the following reaction sequence, the correct structure(s) of X is (are) **[JEE(ADVANCED) 2018]**



(A) 

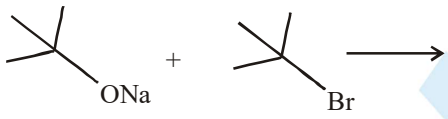
(B) 

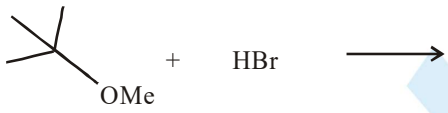
(C) 

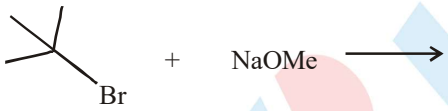
(D) 

10. LIST - I contains reactions and LIST - II contains major products. **[JEE Advanced 2018]**

LIST - I

(P) 

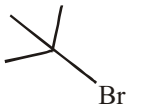
(Q) 

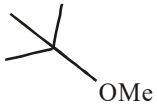
(R) 

(S) 

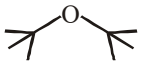
LIST - II

(1) 

(2) 

(3) 

(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

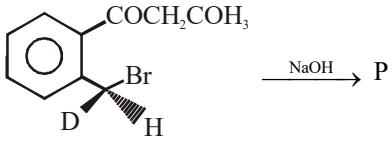
(B) P → 1, 4 ; Q → 2, 4 ; R → 4 ; S → 3

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

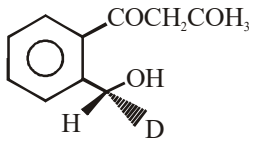
(D) P → 4, 5 ; Q → 4 ; R → 4 ; S → 3, 4

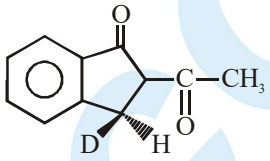
MOCK TEST

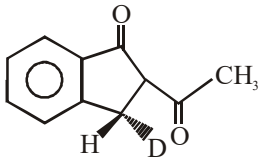
SECTION - I : STRAIGHT OBJECTIVE TYPE

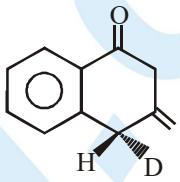
1 

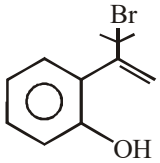
Which of the following statement is correct

(A) P = 

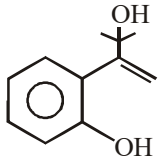
(B) P = 

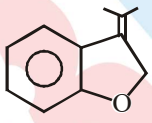
(C) P = 

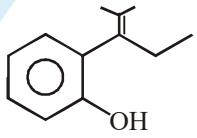
(D) P = 

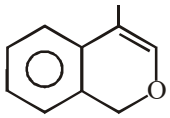
2 

NaOH → Product, Product is

(A) 

(B) 

(C) 

(D) 

3 $CH_3 - CH_2SH \xrightarrow[\text{(ii) ethylene oxide}]{\text{(i) } CH_3O^{\ominus}}$ Product, Product is :

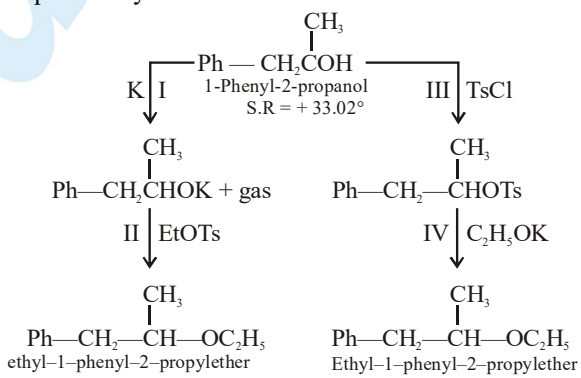
(A) $CH_3 - CH_2 - S - CH_2 - CH_2 - OH$

(B) $CH_3 - CH_2O^{\ominus}$

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

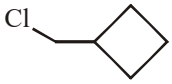
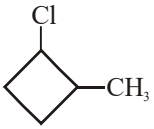
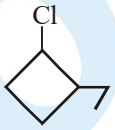
(D) $CH_3 - CH_2 -$ 

4 Read the following road map carefully



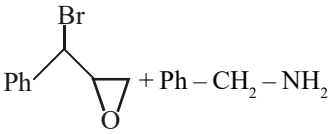
(A) Both the ethers obtained by the two routes have opposite but equal optical rotation.
(B) One of the either is obtained as a recemic mixture.
(C) Step II & III both are S_N2 reaction and both have inversion
(D) Step II has inversion but step III has retention.

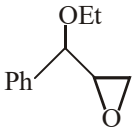
5 A compound A has the molecular formula C_5HgCl. It does not react with bromine in carbon tetrachloride. On treatment with strong base it produces a single compound B. B has a molecular formula C_5H_8 and reacts with bromine in carbon tetrachloride. Ozonolysis of B produces a compound C which has a molecular formula $C_5H_8O_2$. Which of the following structures is that of A?

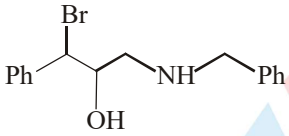
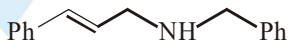
(A)  **(B)**  **(C)**  **(D)** 

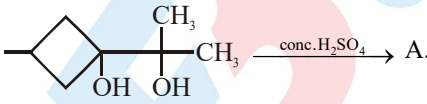
6 $PhOH \xrightarrow[NaOH]{Me_2SO_4}$ P, P is

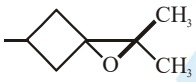
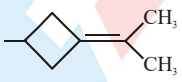
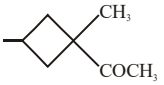
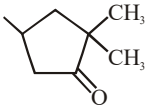
(A) Ph–O–SO_2OMe **(B)** PhOMe **(C)** $PhOSO_2OPh$ **(D)** PhMe

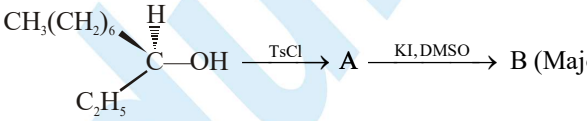
7  Product, Product is

(A)  **(B)** 

(C)  **(D)** 

8 In the reaction  A. The product A is –

(A)  **(B)**  **(C)**  **(D)** 

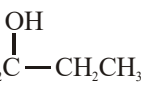
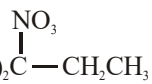
9 

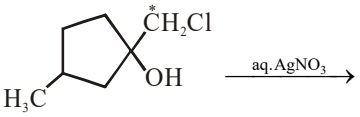
(A) R **(B)** S **(C)** R, S both **(D)** None of these

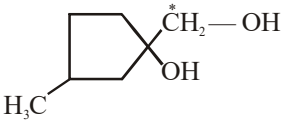
10 $(CH_3)_3CCl + (CH_3)_3CO^-K^+ \longrightarrow$ Product

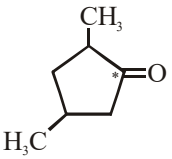
(A) S_N Product will be more **(B)** E_2 Product will be more
(C) both will be same **(D)** None of these

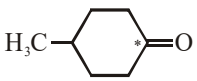
11 Neopentyl iodideis treated with aq. $AgNO_3$ solution, a yellow precipitate is formed along with other compound which is

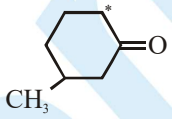
(A) $(CH_3)_3CCH_2NO_3$ **(B)**  **(C)** $(CH_3)_3CCH_2OH$ **(D)** 

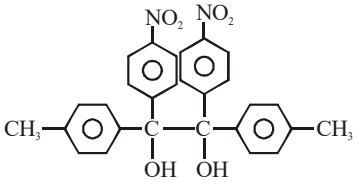
12 The major end product of the following reaction is 

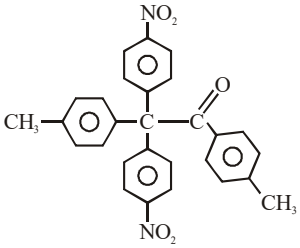
(A) 

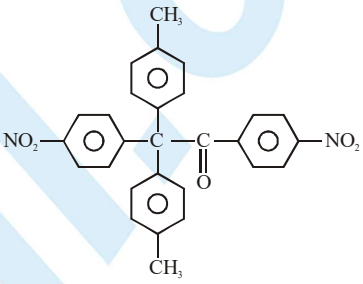
(B) 

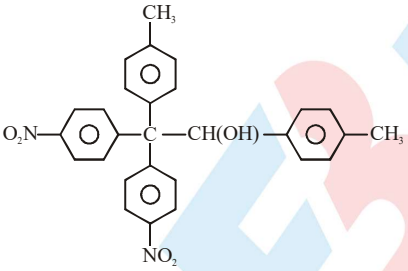
(C) 

(D) 

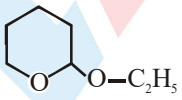
13  A; Product 'A' is

(A) 

(B) 

(C) 

(D) None of these

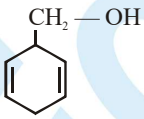
14 The products of hydrolysis of  , is

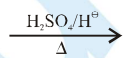
(A) $HOCH_2CH_2CH_2CH_2CHO + CH_3CHO$

(B) $HOCH_2CH_2CH_2CH_2CH_2OH + CH_3CHO$

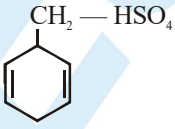
(C) $HOCH_2CH_2CH_2CH_2CHO + C_2H_5OH$

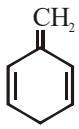
(D) $HOCH_2CH_2CH_2CH_2CH_2OH + C_2H_5OH$

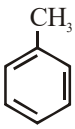
15 



A. The produt is :

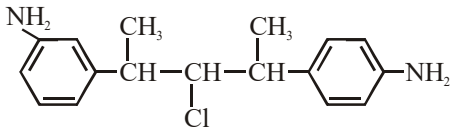
(A) 

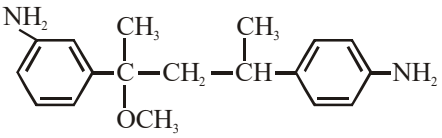
(B) 

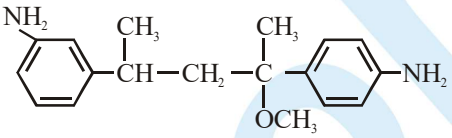
(C) 

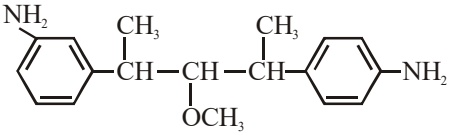
(D) 

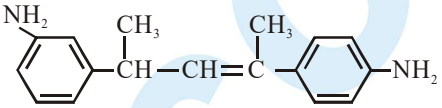
16 The major product P of the following reactionis

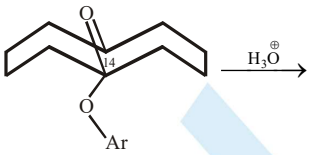


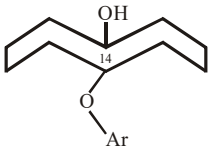
(A)


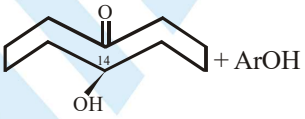
(B)


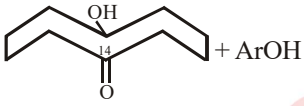
(C)


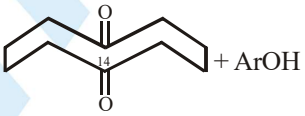
(D)


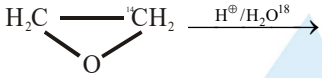
17 The product of following reaction is


(A)


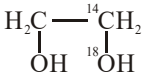
(B)


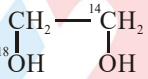
(C)


(D)


18


Which can not be the product

(A)


(B)


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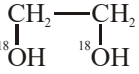


(D) A and B both

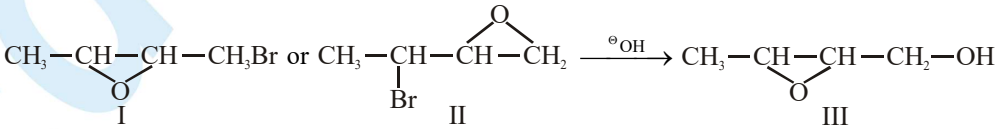
SECTION - II : MULTIPLE CORRECT ANSWER TYPE

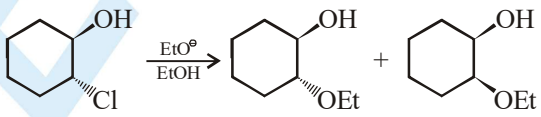
19 Which of the following reaction(s) is/are possible

(A) $CH_3-CHClCH_2NEt_2 \xrightarrow{OH^{\ominus}} CH_3CH(NEt_2)CH_2-OH$

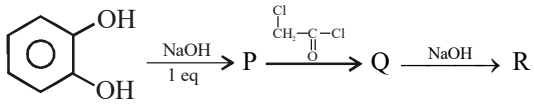
(B) Either $CH_3-\underset{OH}{CH}-CH_2-SEt$ or $CH_3CH(sEt)CH_2OH \xrightarrow{HCl} CH_3CHClCH_2SEt$

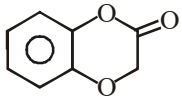
(C) Treatment of either epoxide I or epoxide II with aqueous $^{\ominus}OH$ gives the same product III

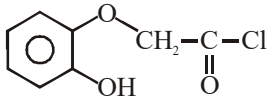


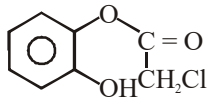
(D)


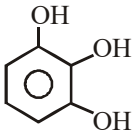
20



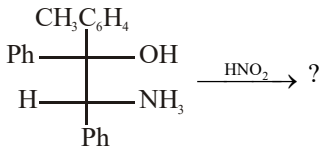
(A) R = 

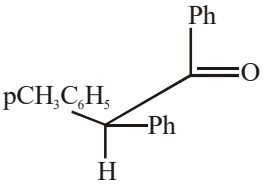
(B) Q = 

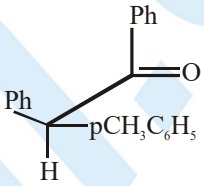
(C) Q = 

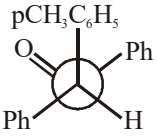
(D) P = 

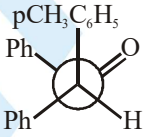
21



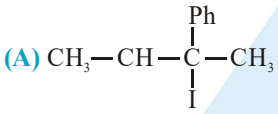
(A) 

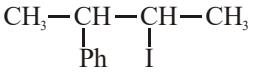
(B) 

(C) 

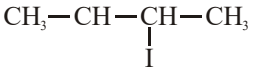
(D) 

22 The correct of SN^2 / E2 ratio for the % yield of product of the following halide is –

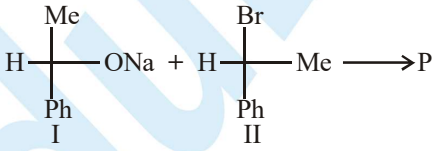
(A) 

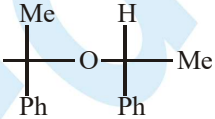
(B) 

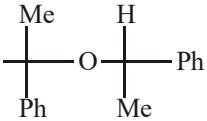
(C) $CH_3 - CH_2 - I$

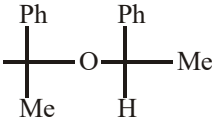
(D) 

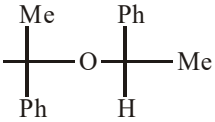
23 The product in the given reaction is



(A) 

(B) 

(C) 

(D) 

24 The correct statement(s) about solvent effect is/are :

(A) Decreasing soslvent polarity causes a large increase in the rate of the SN^2 attack by ammonia on an alkyl halide

$$RX + \ddot{N}H_3 \longrightarrow R\overset{\oplus}{N}H_3 + \overset{\ominus}{X}$$

(B) Increasing solvent polarity causes a large causes a large decrease in the rate of the SN^2 attack by hydroxide ion on trimethylsulfonium ion.

$$H\overset{\ominus}{O} + (CH_3)_3\overset{\oplus}{S} \longrightarrow CH_3OH + (CH_3)_3S$$

Trimethyl sulphonium ion   DMS

(C) Increasing solvent polarity causes a small decrease in the rate of the SN^2 attack by trimethylamins on trimethylsulfornium ion.

$$(CH_3)_3\ddot{N} + (CH_3)_3\overset{\oplus}{S} \longrightarrow CH_3\overset{\oplus}{N}(CH_3)_3 + (CH_3)_2S$$

SECTION - III : ASSERTION AND REASON TYPE

Read the following question and choose the correct answer

(A) Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1.

(B) Statement-2 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-1.

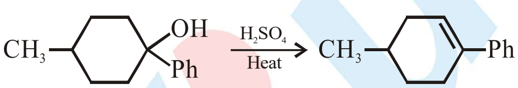
(C) Statement-1 is True, Statement-2 is Fasle

(D) Statement-1 is False, Statement-2 is True.

25 **Statement-1 :** $(CH_3)_3CCH(OH) \xrightarrow{H_2SO_4} (CH_3)_3CCH=CH_2 + (CH_3)_2C=C(CH_3)_2 + CH_2=C(CH_3)CH(CH_3)_2$

Statement-2 : It follows Hofmann's elimination by E2.

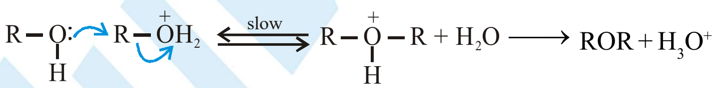
26 **Statement-1 :**



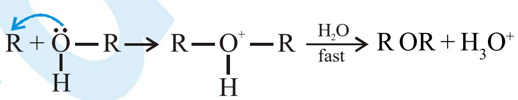
Statemen-2 : Elimination follows E_1 mechanism.

27 **Statement-1**: Ethers are prepared from alcohols acid medium through S_N1 or S_N2 mechanisms depending upon nature of alcohol.

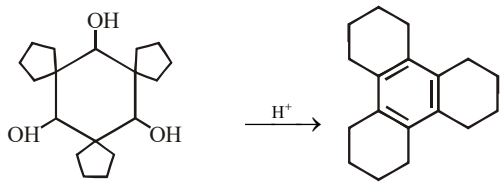
Statement - 2 : $ROH + H^+ \rightleftharpoons R-\overset{+}{O}H_2$



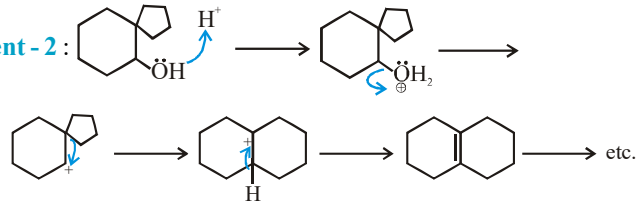
or $R-OH + H^+ \rightleftharpoons R\overset{+}{O}H_2 \underset{}{\overset{slow}{\rightleftharpoons}} R^+ + H_2O$



28 **Statement - 1 :**

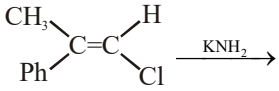
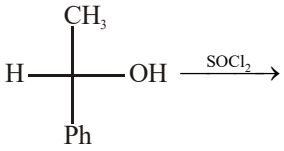
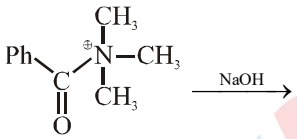
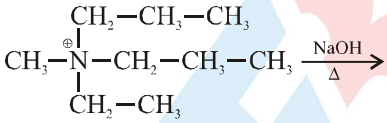


Statement - 2 :

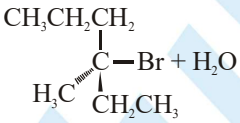
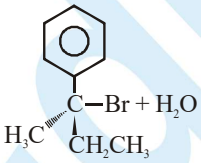
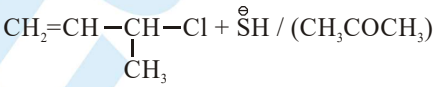


SECTION - IV : MATRIX - MATCH TYPE

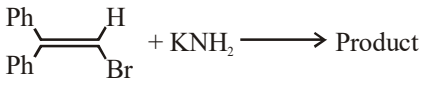
29 Match the column I with column II.

Column (I) Reactions	Column (II) Reactions
(A) 	**(P)** β-elimination
(B) 	**(Q)** S_N^2
(C) 	**(R)** α-elimination
(D) 	**(S)** SN_i

30

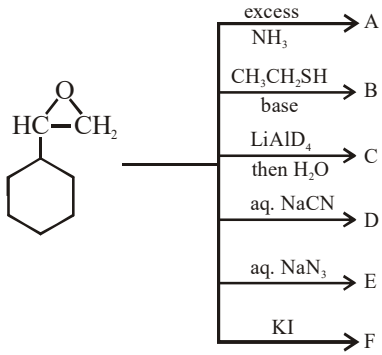
Substrate	stereochemistry of product
(A) 	**(p)** Retention
(B) $CH_3CHDCl + OH^-$	**(q)** Racemisatioin
(C) 	**(r)** Inversion
(D) 	**(s)** Mixture of inversion & product with π-bond shift

SECTION - V : SUBJECTIVE TYPE

31 

Identify the product

32 Give products



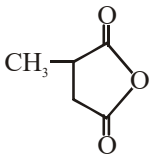
SECTION - VI : COMPREHENSION TYPE

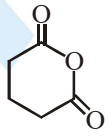
Read the following comprehensions carefully and answer the questions.

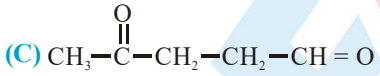
Comprehension

A hydrocarbon (X) of the formula C_6H_{12} does not react with bromine water but reacts with bromine in presence of light, forming compound (Y).Compound (Y) on treatment with Alc. KOH gives compound [Z] which on ozonolysis gives (T) of the formula $C_6H_{10}O_2$. Compound (T) reduces Tollens reagent and gives compound (W). (W) gives iodoform test and produce compound (U) which when heated with P_2O_5 forms a cyclic anhydride (V).

33 Compound V is

(A) 

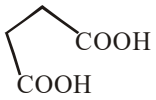
(B) 

(C) 

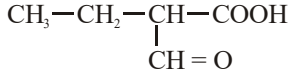
(D) $CHO-CH=CH-CHO$

34 Compound W is

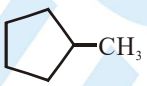
(A) $COOH-(CH_2)_2-COOH$

(B) 

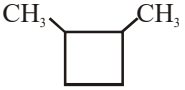
(C) 

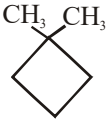
(D) 

35 Compound 'X' is

(A) 

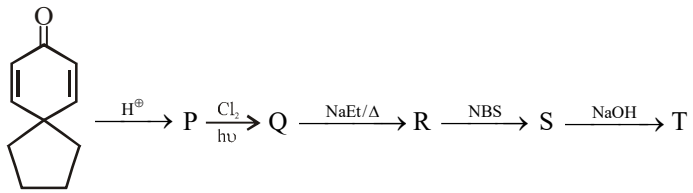
(B) 

(C) 

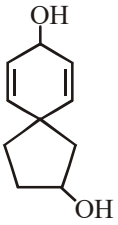
(D) 

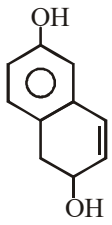
Comprehension

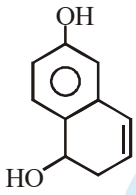
Read the following reaction

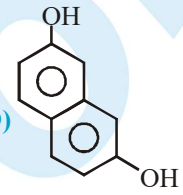


36 Compound T is

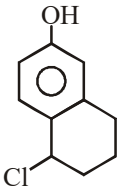
(A) 

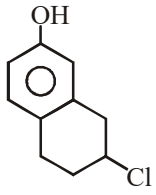
(B) 

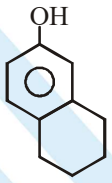
(C) 

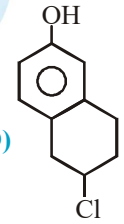
(D) 

37 Compound 'Q' is

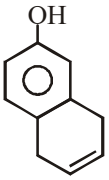
(A) 

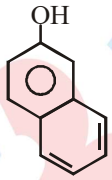
(B) 

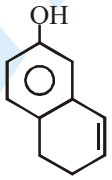
(C) 

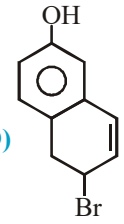
(D) 

38 When treating 'S' with strong base, product obtained is

(A) 

(B) 

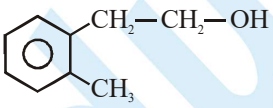
(C) 

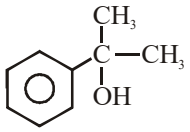
(D) 

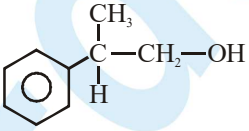
Comprehension

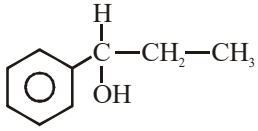
Two optically active isomeric alcohols X and Y (M.F. = $C_9H_{12}O$) on oxidation with $KMnO_4$ give benzoic acid. X gives positive iodoform test but Y does not X looses optical activity on oxidation with CrO_3/H^+ but Y does not.

39 'Y' can be

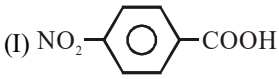
(A) 

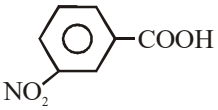
(B) 

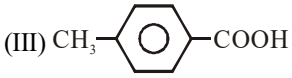
(C) 

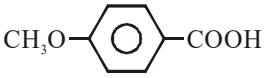
(D) 

40 The rate of reaction of 'X' with the following acids will be in the following order is

(I) 

(II) 

(III) 

(IV) 

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

41 The possible product(s) on reaction of 'X' with NaBr + H_2SO_4 (along with appropaite mechanism) will be

(A) $PhCH_2-\underset{\underset{Br}{|}}{CH}-CH_3$ by S_N2 mechanism

(B) $PhCH_2-\underset{\underset{Br}{|}}{CH}-CH_3$ S_N1 mechanism

(C) $Ph-\underset{\underset{Br}{|}}{CH}-CH_2CH_3$ by S_N1 mechanism

(D) $Ph-\underset{\underset{Br}{|}}{CH}-CH_2CH_3$ by S_N2 mechanism

ANSWER KEY

EXERCISE - 1

1. C **2.** C **3.** C **4.** C **5.** B **6.** B **7.** C **8.** C **9.** A **10.** D **11.** D **12.** C **13.** D
14. C **15.** A **16.** C **17.** A **18.** B **19.** A **20.** D **21.** B **22.** C **23.** C **24.** D **25.** A **26.** D
27. C **28.** B **29.** C **30.** B **31.** B **32.** C **33.** D **34.** D **35.** C **36.** D **37.** C **38.** B **39.** A
40. A **41.** B **42.** A **43.** D **44.** B **45.** C **46.** B **47.** A **48.** A **49.** C **50.** A **51.** D **52.** C
53. C **54.** C **55.** D **56.** A **57.** B **58.** B **59.** B **60.** C

EXERCISE - 2 : PART # I

1. A, B **2.** C, D **3.** B, C, D **4.** A, B, D **5.** B, D **6.** A, C **7.** A, B, D **8.** A, B, C
9. A, B, C **10.** A, D **11.** B, C, D **12.** B, C **13.** A, B, D **14.** A, C **15.** C, D **16.** A, C **17.** A, C
18. D **19.** B **20.** B **21.** C **22.** C **23.** B **24.** C **25.** C **26.** C **27.** A **28.** C **29.** B **30.** D
31. A **32.** B **33.** C **34.** C **35.** A **36.** A **37.** D **38.** A **39.** D **40.** A **41.** B **42.** B

PART # II

1. B **2.** D **3.** C **4.** D **5.** B **6.** C **7.** A **8.** A **9.** B **10.** A

EXERCISE - 3 : PART # I

1. A → (r), B → (q), C → (s), D → (p) **2.** A → (q), B → (r), C → (s), D → (p)

PART # II

Comprehension # 1 : **1.** C **2.** D **3.** B **4.** B **Comprehension # 2 :** **1.** A **2.** A **3.** C

EXERCISE - 5 : PART # I

1. A **2.** C **3.** A **4.** C **5.** D **6.** A **7.** A **8.** D **9.** D **10.** C **11.** B **12.** A **13.** C
14. A **15.** B **16.** A **17.** A **18.** D **19.** A **20.** B **21.** C **22.** B **23.** D **24.** B **25.** D

PART # II

1. C **2.** A **3.** C **4.** C **5.** B, C **6.** A, B, C, D **7.** B **8.** C **9.** B **10.** B

MOCK TEST

1 C **2** B **3** A **4** A **5** B **6** B **7** B **8** D **9** A **10** C **11** B **12** D **13** B
14 C **15** C **16** B **17** C **18** C **19** A,B,C,D **20** A,C,D **21** A,C **22** A **23** A **24** (B,C)
25 D **26** A **27** A **28** A **33** B **34** C **35** A **36** B **37** A **38** B **39** C **40** A **41** C