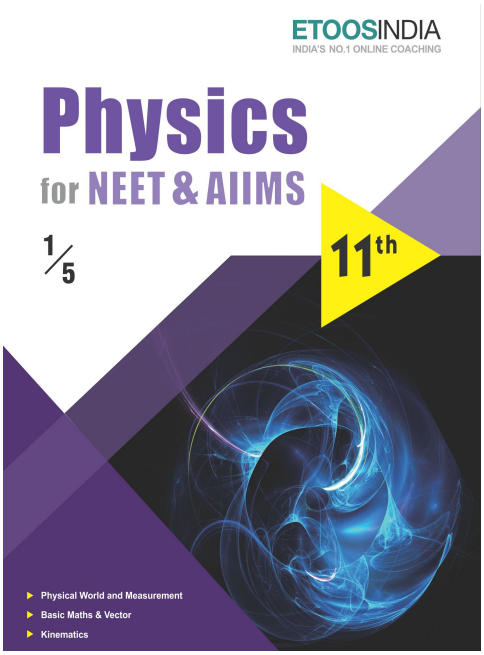
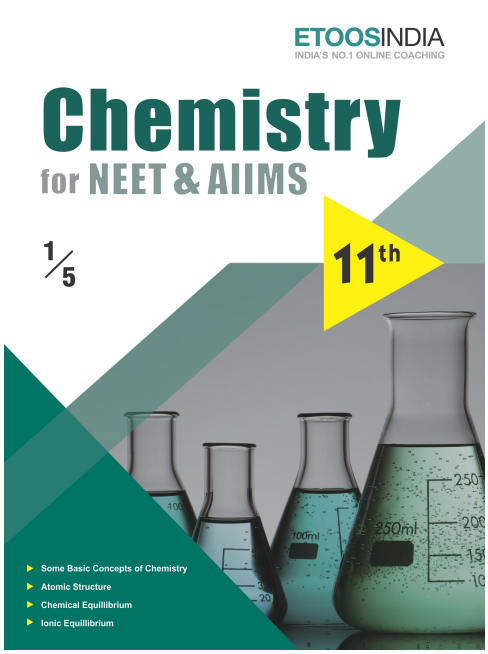
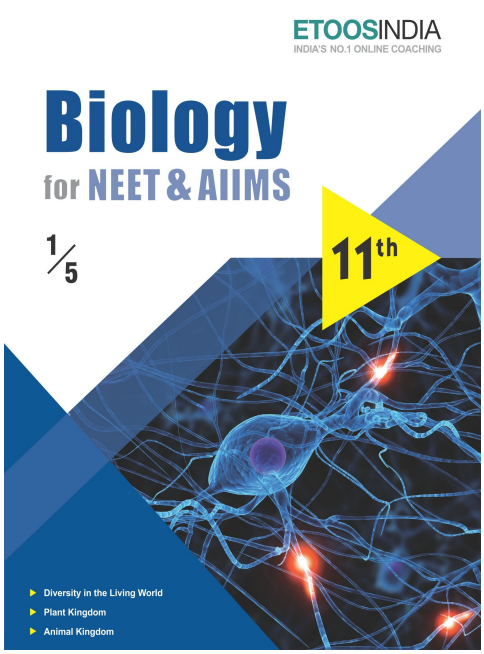
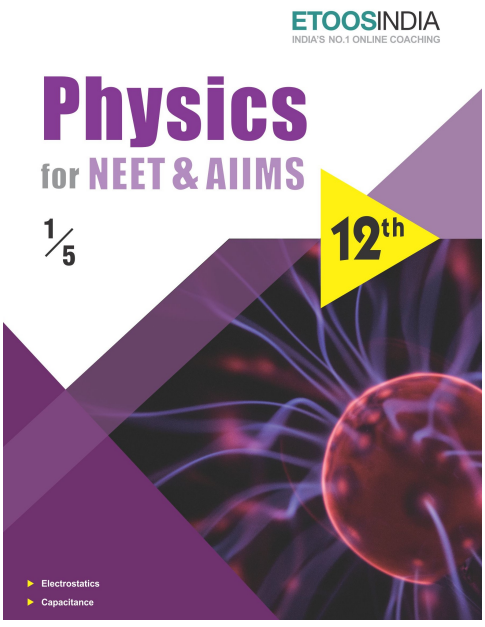
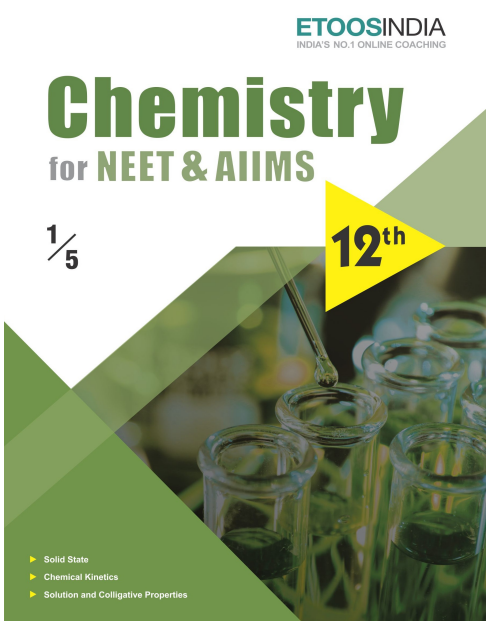
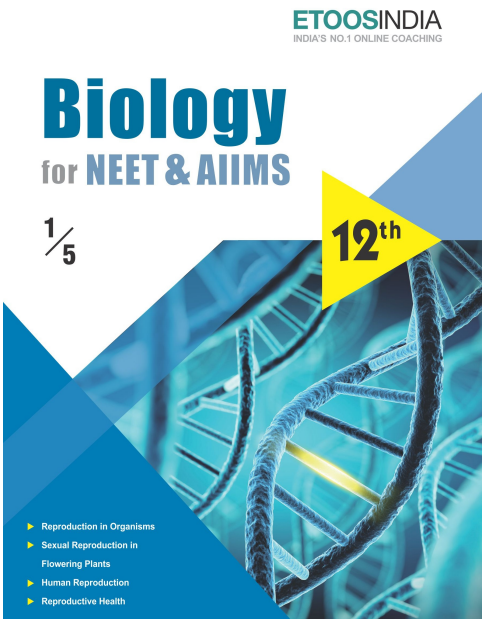












CHAPTER 10

HALOALKANES AND HALOARENES

The reactions of organic magnesium compounds are of two kinds - reactions of substitution and reactions of addition.

"VICTOR GRIGNARD"

INTRODUCTION

Compounds derived from hydrocarbons by replacement of one or more H-atoms by corresponding no. of halogen atoms are known as **halogen derivatives**.

There are three major classes of organohalogen compounds; alkyl halides, vinyl halides, and aryl halides.

An **alkyl halide** simply has a halogen atoms bonded to one of the sp^3 hybrid carbon atoms of an alkyl group. A **vinyl halide** or **Aryl halide** has a halogen atom bonded to one of the sp^2 hybrid carbon atoms or an aromatic ring. They are different from alkyl halides because their bonding and hybridization are different.

Ex. $CH_3-\underset{\underset{O}{\|}}{C}-CH_3$, $CH_3-\underset{\underset{O}{\|}}{C}-CH_2-CH_3$, $CH_3-\underset{\underset{O}{\|}}{C}-CH_2$ .....CH_3 etc. (All methyl ketones)

$CH_3-\underset{\underset{O}{\|}}{C}-COOH$, $CH_3-\underset{\underset{O}{\|}}{C}-CHO$ Also show haloform reaction.

(–) ve haloform reaction : Reaction in which haloforms are not formed with X_2 and alkali.

$CH_3-\underset{\underset{O}{\|}}{C}-\ddot{C}l$, $CH_3-\underset{\underset{O}{\|}}{C}-\ddot{O}H$, $CH_3-\underset{\underset{O}{\|}}{C}-\ddot{N}H_2$, CH_3, $CH_3-\underset{\underset{O}{\|}}{C}-\ddot{O}-CH_3$. do not show haloform reaction.

(iii) Preparation of pure $CHCl_3$:

$$\underset{\text{Chloral hydrate}}{CCl_3CHO.\,2H_2O} \xrightarrow[\Delta]{NaOH} CHCl_3 + HCOONa + 2H_2O$$
(Pure Chloroform)

(iv) Industrial Preparation :

$$\underset{\text{or } CH_3COCH_3}{CH_3CH_2-OH} \xrightarrow{\text{aq. NaCl/electrolysis}} CHCl_3 + \underset{\text{or } CH_3COONa}{HCOONa}$$

Physical Properties :

$CHCl_3$ is colourless and sweet smelling liquid. it's B.P. is 61°C and it is insoluble in H_2O and have density more than H_2O. Chloroform is used as Anaesthetic.

Chemical Properties :

(i) Oxidation : $CHCl_3 + [O] \xrightarrow{\text{Air and light}} \underset{\substack{\text{Phosgene gas or}\\ \text{Carbonyl Chloride}\\ \text{(Poisonous gas)}}}{COCl_2} + HCl$

$CHCl_3$ is stored in dark coloured bottles which are filled upto the brim to prevent oxidation of $CHCl_3$ into $COCl_2$ and 1% ethanol is also added to chloroform.

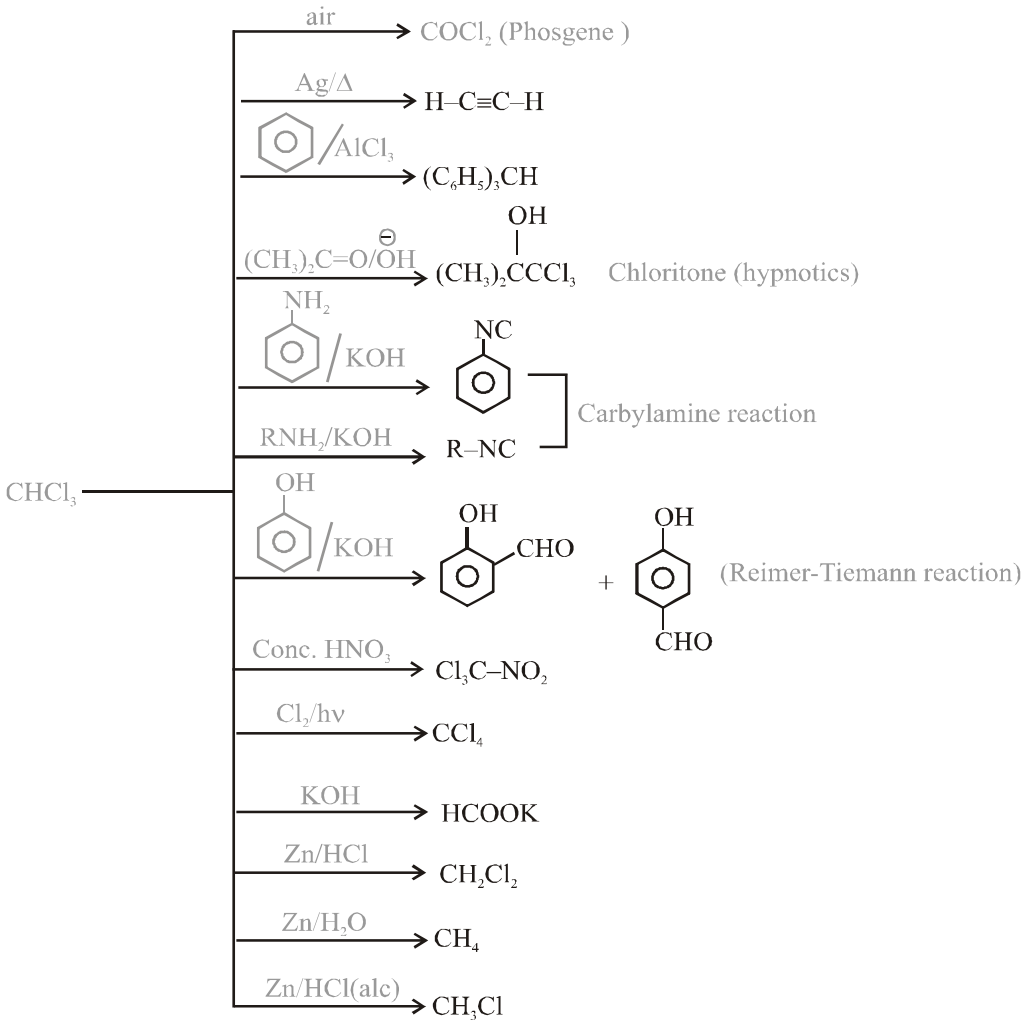
$$O=C\begin{matrix}Cl\\Cl\end{matrix} + 2HO-C_2H_5 \xrightarrow{-2HCl} O=C\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}$$

ETOOS KEY POINTS

Reagent	Pure $CHCl_3$	Impure $CHCl_3$($COCl_2$ + HCl)
Blue litmus	No Change	turns into red
$AgNO_3$	No reaction	White ppt of AgCl
Conc. H_2SO_4	No reaction	Yellow solution

Etoos Tips & Formulas

Reactions of chloroform :



- Purity of chloroform (presence of phosgene) can be tested before use as anaesthetic by treating with aqueous solution of $AgNO_3$ because the presence of $COCl_2$ may cause cardiac failure.
- Chloroform is stored in dark colour bottle containing small amount of ethyl alcohol. (It converts phosgene into diethylcarbonate).

SOLVED EXAMPLE

Ex. 1 Which of the following is used as insecticide :

(A) D.D.T. **(B)** Chloritone

(C) Chloropicrin **(D)** **(A)** and **(C)** both

Sol. **(D)**

Ex. 2 The product in the following reaction is :

$Ph - Cl + Fe / Br_2 \longrightarrow$ Product

(A) o– bromo-chloro benzene

(B) p– bromo-chloro benzene

(C) **(A)** and **(B)** both

(D) 2, 4, 6-tribromo chloro benzene

Sol. **(C)** Since – Cl group is deactivating and o/p directing group so only o– and p– products are formed.

Ex. 3 The most reactive towards SN^1 is :

(A) $PhCH_2Cl$

(B) Ph–Cl

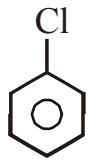
(C) $CH_3CHCl(CH_3)$

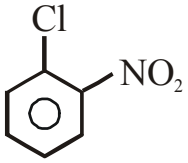
(D) $p\text{–}NO_2\text{—}Ph\text{—}CH_2\text{—}Cl$

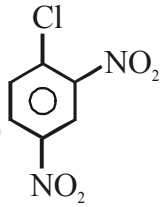
Sol. **(A)** S_{N^1} the intermediate carbocation is formed.

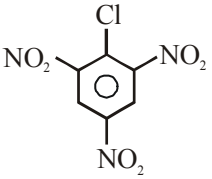
$C_6H_5\text{—}CH_2Cl \longrightarrow C_6H_5\overset{\oplus}{C}H_2$ is maximum stable due to resonance.

Ex. 4 Which of the following undergoes Hydrolysis most easily :

(A) 

(B) 

(C) 

(D) 

Sol. **(D)** If there is more m-directing group then there will be more nuclephilic substitution reaction.

Ex. 5 The order of reactivity of following alcohols with halogen acids is .....

(i) $CH_3CH_2 - CH_2 - OH$

(ii) $CH_3CH_2 - \underset{\displaystyle CH_3}{\overset{|}{C}H} - OH$

(iii) $CH_3CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - OH$

(A) (i) > (ii) > (iii) **(B)** (iii) > (ii) > (i)

(C) (ii) > (i) > (iii) **(D)** (i) > (iii) > (ii)

Sol. **(B)** Reaction between alcohols and halogen acid follows S_N^1 mechanism. In S_N^1 mechanism carbocations are formed as intermediates.

Let us consider the formation of carbocations with the given three alcohols

$CH_3 - CH_2 - CH_2 - OH \qquad CH_3 - CH_2 - \overset{+}{C}H + OH^-$

In this case, 1° carbocation is formed. It is least stable. So, here S_N^2 mechanism is followed. In this S_N^2 mechanism a transitory state is observed in α-carbon is linked with two nucleophiles.

$CH_3 - CH_2 - \underset{\displaystyle CH_3}{\overset{|}{C}H} - OH \qquad CH_3 - CH_2 - \underset{\displaystyle CH_3}{\overset{|}{\overset{+}{C}}}H + OH^-$

2° carbocation (more stable than 1° carbocation)

$CH_3 - CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - OH \qquad H_3C - CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C^+}}}} + OH^-$

3° carbocation (most stable)

The raction proceeded with stable carbocatio. Higher the stability of carbocation, higher will be the possibilities of attack of X^- ion to the carbocation.

As, the tertiary carbocation is most stable so the possibilities of attack of X^- ion are more prominent in case of tertiary carbocations. Thus, attack of X^- ion to carbocation is proceeded with tertiary carbocation as follows

$$H_3C - CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C^{\oplus}}}}} + X \longrightarrow H_3C - CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - X$$

3° carbocation

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. How many structural isomers are possible for a compound with molecular formula C_3H_7Cl
(A) 2 (B) 5
(C) 7 (D) 9

2. In CH_3CH_2Br, % of Br is
(A) 80 (B) 75
(C) 70 (D) 7

3. Gem- dibromide is
(A) $CH_3CH(Br)OH(Br)CH_3$
(B) $CH_3CBr_2CH_3$
(C) $CH_2(Br)CH_2CH_2$
(D) CH_2BrCH_2Br

4. Ethylidene dibromide is
(A) $CH_3 - CH_2 - Br$
(B) $Br - CH_2 - CH_2 - Br$
(C) $CH_3 - CHBr_2$
(D) $CH_2 = CBr_2$

5. Benzylidene chloride is
(A) $C_6H_5CH_2Cl$ (B) $C_6H_5CHCl_2$
(C) $C_6H_4ClCH_2Cl$ (D) $C_6H_5CCl_3$

6. Which of the following halide is 2^o
(A) Isopropyl chloride (B) Isobutyl chloride
(C) *n*-propyl chloride (D) *n*-butyl chloride

7. Haloforms are trihalogen derivatives of
(A) Ethane (B) Methane
(C) Propane (D) Benzene

8. Benzene hexachloride is
(A) 1, 2, 3, 4, 5, 6-hexachlorocyclohexane
(B) 1, 1, 1, 6, 6, 6-hexachlorocyclohexane
(C) 1, 6-phenyl-1, 6-chlorohexane
(D) 1, 1-phenyl-6, 6-chlorohexane

9. Number of π – bonds present in *B.H.C.* (Benzene hexachloride) are
(A) 6 (B) Zero
(C) 3 (D) 12

10. The general formula for alkyl halides is
(A) $C_nH_{2n+1}X$ (B) $C_nH_{2n+2}X$
(C) $C_nH_{n+1}X$ (D) $C_nH_{2n}X$

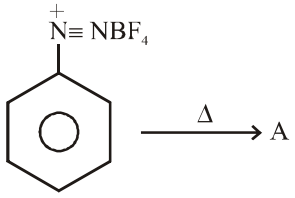
11. The following reaction is known as

$$C_2H_5OH + SOCl_2 \xrightarrow{\text{Pyridine}} C_2H_5Cl + SO_2 + HCl$$

(A) Kharasch effect
(B) Darzen's procedure
(C) Williamson's synthesis
(D) Hunsdiecker synthesis reaction

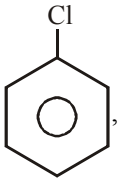
12. What is the main product of the reaction between 2-methyl propene with *HBr*
(A) 1-bromo butane
(B) 1-bromo-2 methyl propane
(C) 2-bromo butane
(D) 2-bromo-2 methyl propane

13. Halogenation of alkanes is
(A) A reductive process
(B) An oxidative process
(C) An isothermal process
(D) An indothermal process

14. 

In the above process product *A* is
(A) Fluorobenzene
(B) Benzene
(C) 1, 4-difluorobenzene
(D) 1, 3-difluorobenzene

15. Silver acetate + $Br_2 \xrightarrow{CS_2}$. The main product of this reaction is
(A) $CH_3 - Br$ (B) CH_3COI
(C) CH_3COOH (D) None of these

16. Diazonium salts + Cu_2Cl_2 + HCl → 

,
the reaction is known as
(A) Chlorination
(B) Sandmeyer's reaction
(C) Perkin reaction
(D) Substitution reaction

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. Consider the following reaction sequence,

$CH_3C \equiv CH \xrightarrow[HgSO_4]{aq.H_2SO_4} A \xrightarrow[Heat]{PCl_5} B.$

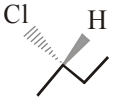
The products (A) and (B) are, respectively,
(A) CH_3COCH_3 and $CH_3CCl_2CH_3$
(B) CH_3CH_2CHO and $CH_3CH_2CHCl_2$
(C) $CH_3CHOHCH_3$ and $CH_3CHClCH_3$
(D) $CH_3CH_2CH_2OH$ and $CH_3CH_2CH_2Cl$

2. Which of the following has highest dipole moment:
(A) CH_3Cl (B) CH_3F
(C) CH_3Br (D) CH_3I

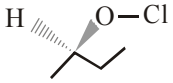
3. In S_{N^1} the first step involves the formation of
(A) free radical (B) carbanion
(C) carbocation (D) final product

4. The product formed in the reaction

$+ SOCl_2 \rightarrow$ is-

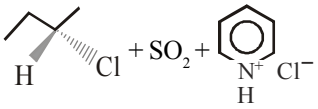
(A) 

(B) 

(C) 

(D) 

5. The reaction 

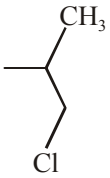


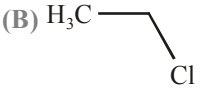
proceeds by the mechanism
(A) S_{N^1} (B) S_{N^2}
(C) S_Ni (D) S_{E^2}

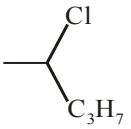
6. 1, 3- Dibromopropane reacts with metallic zinc to form
(A) propene (B) cyclopropane
(C) propane (D) hexane

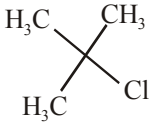
7. To form alkane isonitrile, alkyl halide is reacted with:
(A) KCN (B) AgCN
(C) HCN (D) NH_4CN

8. Which one of the following compounds most readily undergoes substitution by S_N2 mechanism ?

(A) 

(B) 

(C) 

(D) 

9. Sec. Butyl chloride undergo alkaline hydrolysis in the polar solvent by
(A) S_{N^2} (B) S_{N^1}
(C) S_{N^1} and S_{N^2} (D) none of these

10. The products of reaction of alcoholic silver nitrite with ethyl bromide are
(A) Ethane (B) Ethene
(C) Ethyl alcohol (D) Nitro ethane

11. The reaction ,$CH_3Br + OH^- \longrightarrow CH_3OH + Br^-$ obeys the mechanism
(A) S_{N^1} (B) S_{N^2}
(C) E_1 (D) E_2

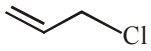
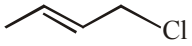
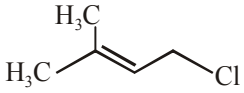
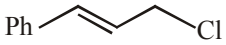
12. Ethylidene chloride can be prepared by the reaction of HCl and
(A) Ethane (B) Ethylene
(C) Acetylene (D) Ethylene glycol

13. Grignard reagent can be prepared by
(A) $CH_3—CH_2—Cl + Mg \xrightarrow[ether]{dry}$
(B) $CH_3—\underset{Cl}{CH}—\underset{OH}{CH_2} + Mg \xrightarrow[ether]{dry}$
(C) $CH_3—\underset{CH_3}{\overset{CH_3}{C}}—OH + Mg \xrightarrow[ether]{dry}$
(D) All of them

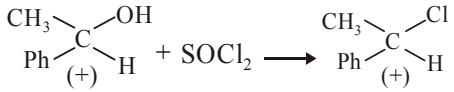
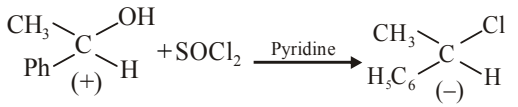
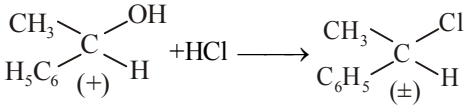
14. Most stable carbocation formed from $(CH_3)_3C–Br$, $(C_6H_5)_3CBr$,$(C_6H_5)_2CHBr$ and $C_6H_5CH_2Br$ would be
(A) $C_6H_5\overset{\oplus}{C}H_2$ (B) $(CH_3)_3\overset{\oplus}{C}$
(C) $(C_6H_5)_3\overset{\oplus}{C}$ (D) $(C_6H_5)_2\overset{\oplus}{C}H$

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

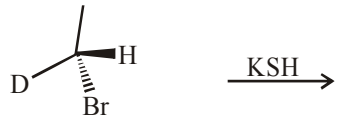
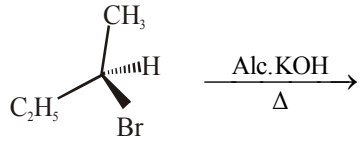
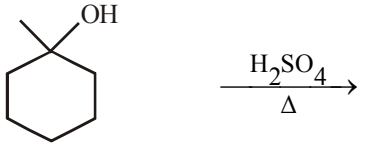
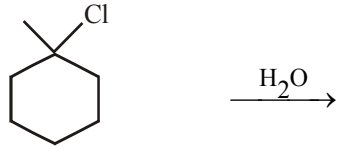
1. Match the column I with column II.

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

2. Match the column I with column II.

Column-I (reaction)	Column-II (Mechanism)
(A) 	(p) S_N1
(B) 	(q) S_N2
(C) $CH_3—\underset{\displaystyle CH_3}{\overset{\displaystyle |}{CH}}—Br + \overset{\ominus}{O}C_2H_5/EtOH \longrightarrow$	(r) S_Ni
(D) 	(s) E_2

3. Match the column I and II.

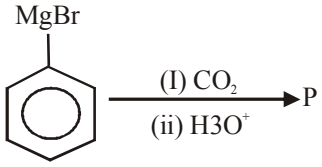
Column I Reaction	Column II Type of reaction
(A) 	(p) S_N1
(B) 	(q) S_N2
(C) 	(r) E1
(D) 	(s) E2

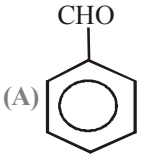
Exercise # 4

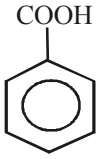
PART - 1 | PREVIOUS YEAR (NEET/AIPMT)

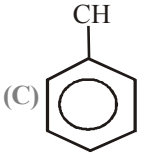
1. An organic compound A (C_4H_9Cl) on reactiion with Na/diethly gives a hydrocarbon which on monochlorination gives only one chlora derivative, then A is [CBSE AIPMT 2001]
(A) t-butyl chloride (B) s-butyl chloride
(C) iso-butyl chioride (D) n-butyl chloride

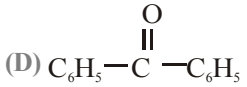
2. Reactivity order of halides for dehydrohalogenation is [CBSE AIPMT 2002]
(A) R—F > R—CI > R—Br > R—I
(B) R—I >R—Br > R—Cl>R—F
(C) R—I >RCI>R—Br>R—F
(D) R—F > R—I > R—Br > R—CI

3. 

In the above reaction product 'P' is [CBSE AIPMT 2002]
(A) 

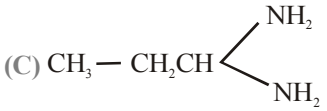
(B) 

(C) 

(D) 

4. $CH_3CH_2Cl \xrightarrow{NaCN} X \xrightarrow{Ni/H_2} Y \xrightarrow{Aceticanhydride} Z$
In above reaction sequence, Z is [CBSE AIPMT 2002]
(A) $CH_3CH_2CH_2NHCOCH_3$
(B) $CH_3CH_2CH_2NH_2$
(C) $CH_3CH_2CH_2CONHCH_3$
(D) $CH_3CH_2CH_2CONHCOCH_3$

5. When phenol is treated with $CHCl_3$ and NaOH, the product formed is [CBSE AIPMT 2000]
(A) benzaldehyde (B) salicylaldehyde
(C) salicylic acid (D) benzoic acid

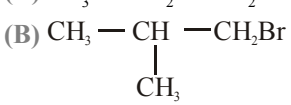
6. When $CH_3CH_2CHCl_2$ is treated with $NaNH_2$, the product formed is [CBSE AIPMT 2002]
(A) $CH_3 - CH = CH_2$
(B) $CH_3 - C \equiv Ch_2$
(C) 

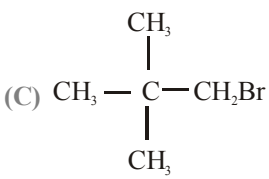
(D) 

7. Which of the following is responsible for depletion of the ozone layer in the upper strate of the atmosphere? [CBSE AIPMT 2004]
(A) Polyhalogens (B) Ferrocenes
(C) Fullerenes (D) Freons

8. Chloropicrin is obtained by the reaction of [CBSE AIPMT 2004]
(A) steam on carbon tetrachloride
(B) nitric acid on chlorobenzene
(C) chlorine on picric acid
(D) nitric acid on chloroform

9. Which of the following undergoes nucleophilic substitution exclusivery by S_N1 mechanism [CBSE AIPMT 2005]
(A) Benzyl chloride (B) Ethyl chloride
(C) Chlorobenzene (D) Isoproply chloride

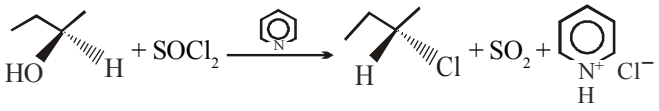
10. In a S_N2 substitution reaction of the type [CBSE AIPMT 2008]
$R - Br - Cl^- \xrightarrow{DMF} R - Cl + Br^-$
Which one of the following has the highest relative rate ?
(A) $CH_3 - CH_2 - CH_2Br$
(B) 

(C) 

(D) CH_3CH_2Br

MOCK TEST

STRAIGHT OBJECTIVE TYPE

1. The reaction  proceeds by the mechanism

(A) S_{N^1} (B) S_{N^2} (C) S_Ni (D) S_{E^2}

2. The products of reaction of alcoholic silver nitrite with ethyl bromide are
(A) Ethane (B) Ethene (C) Ethyl alcohol (D) Nitro ethane

3. For the reaction

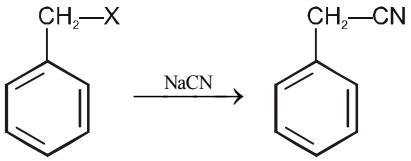
$CH_3CH(X)CH_2CH_3 \xrightarrow{\text{alc. KOH}} CH_3—CH=CH—CH_3$ and $CH_2=CH—CH_2—CH_3$

(A) $CH_3—CH=CH—CH_3$ predominates (B) $CH_2=CH—CH_2—CH_3$ predominates
(C) Both are formed in equal amounts (D) The product ratio depends on the halogen

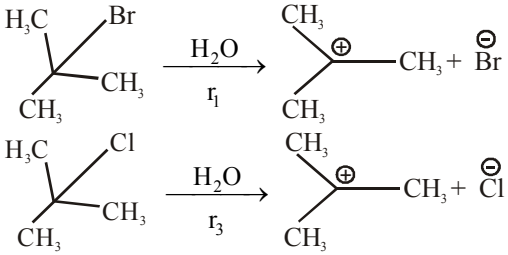
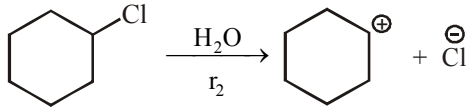
4. Identify 'Z' in the following reaction series, $CH_3.CH_2CH_2Br \xrightarrow{\text{aq.NaOH}} (X) \xrightarrow[\text{Heat}]{Al_2O_3} (Y) \xrightarrow{HOCl} (Z)$:

(A) Mixture of $CH_3\underset{Cl}{CH}—\underset{Cl}{CH_2}$ and $CH_3\underset{OH}{CH}—\underset{OH}{CH_2}$ (B) $CH_3—\underset{OH}{CH}—\underset{Cl}{CH_2}$
(C) $CH_3—\underset{Cl}{CH}—\underset{OH}{CH_2}$ (D) $CH_3—\underset{Cl}{CH}—\underset{Cl}{CH_2}$

5. Ethyl alcohol reacts at a faster rate with HI than with HCl in forming the corresponding ethyl halides under identical conditions mainly because -
(A) HI, being a stronger acid, protonates ethyl alcohol at oxygen much better and helps substitution
(B) the bond length in HI is much shorter than that in HCl
(C) I^- is a much better leaving group
(D) I^- is a much better nucleophile than Cl^-

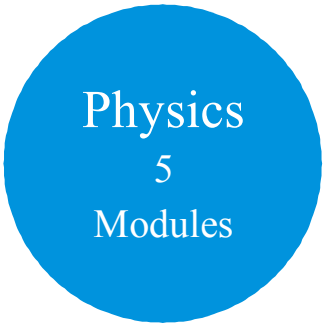
6. 
In the given reaction rate is fastest, when (X) is :

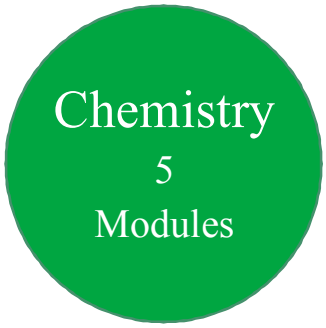
(A) –OH (B) $–NH_2$ (C) $—S(=O)(=O)—OCH_3$ (D) $—O—S(=O)(=O)—CH_3$

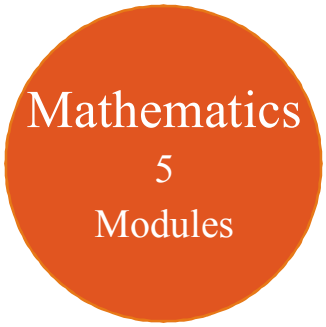
7. 

the rates r_1, r_2 and r_3 are in the order :

(A) $r_1 > r_2 > r_3$ (B) $r_3 > r_1 > r_2$ (C) $r_1 > r_3 > r_2$ (D) $r_2 > r_1 > r_3$

11th Class Modules Chapter Details

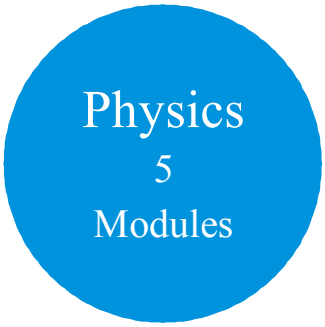


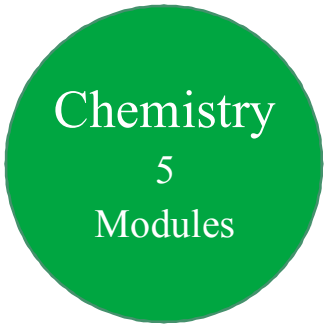


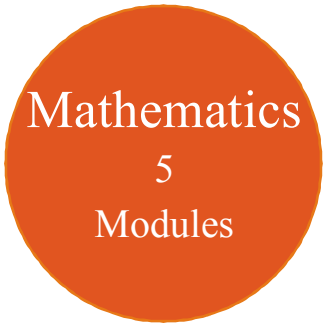


PHYSICS	CHEMISTRY	BIOLOGY
Module-1 1. Physical World & Measurements 2. Basic Maths & Vector 3. Kinematics **Module-2** 1. Law of Motion & Friction 2. Work, Energy & Power **Module-3** 1. Motion of system of particles & Rigid Body 2. Gravitation **Module-4** 1. Mechanical Properties of Matter 2. Thermal Properties of Matter **Module-5** 1. Oscillations 2. Waves	**Module-1(PC)** 1. Some Basic Conceps of Chemistry 2. Atomic Structure 3. Chemical Equilibrium 4. Ionic Equilibrium **Module-2(PC)** 1. Thermodynamics & Thermochemistry 2. Redox Reaction 3. States Of Matter (Gaseous & Liquid) **Module-3(IC)** 1. Periodic Table 2. Chemical Bonding 3. Hydrogen & Its Compounds 4. S-Block **Module-4(OC)** 1. Nomenclature of Organic Compounds 2. Isomerism 3. General Organic Chemistry **Module-5(OC)** 1. Reaction Mechanism 2. Hydrocarbon 3. Aromatic Hydrocarbon 4. Environmental Chemistry & Analysis Of Organic Compounds	**Module-1** 1. Diversity in the Living World 2. Plant Kingdom 3. Animal Kingdom **Module-2** 1. Morphology in Flowering Plants 2. Anatomy of Flowering Plants 3. Structural Organization in Animals **Module-3** 1. Cell: The Unit of Life 2. Biomolecules 3. Cell Cycle & Cell Division 4. Transport in Plants 5. Mineral Nutrition **Module-4** 1. Photosynthesis in Higher Plants 2. Respiration in Plants 3. Plant Growth and Development 4. Digestion & Absorption 5. Breathing & Exchange of Gases **Module-5** 1. Body Fluids & Its Circulation 2. Excretory Products & Their Elimination 3. Locomotion & Its Movement 4. Neural Control & Coordination 5. Chemical Coordination and Integration

12th Class Modules Chapter Details







PHYSICS

Module-1

1. Electrostatics
2. Capacitance

Module-2

1. Current Electricity
2. Magnetic Effect of Current and Magnetism

Module-3

1. Electromagnetic Induction
2. Alternating Current

Module-4

1. Geometrical Optics
2. Wave Optics

Module-5

1. Modern Physics
2. Nuclear Physics
3. Solids & Semiconductor Devices
4. Electromagnetic Waves

CHEMISTRY

Module-1(PC)

1. Solid State
2. Chemical Kinetics
3. Solutions and Colligative Properties

Module-2(PC)

1. Electrochemistry
2. Surface Chemistry

Module-3(IC)

1. P-Block Elements
2. Transition Elements (d & f block)
3. Co-ordination Compound
4. Metallurgy

Module-4(OC)

1. HaloAlkanes & HaloArenes
2. Alcohol, Phenol & Ether
3. Aldehyde, Ketone & Carboxylic Acid

Module-5(OC)

1. Nitrogen & Its Derivatives
2. Biomolecules & Polymers
3. Chemistry in Everyday Life

BIOLOGY

Module-1

1. Reproduction in Organisms
2. Sexual Reproduction in Flowering Plants
3. Human Reproduction
4. Reproductive Health

Module-2

1. Principles of Inheritance and Variation
2. Molecular Basis of Inheritance
3. Evolution

Module-3

1. Human Health and Disease
2. Strategies for Enhancement in Food Production
3. Microbes in Human Welfare

Module-4

1. Biotechnology: Principles and Processes
2. Biotechnology and Its Applications
3. Organisms and Populations

Module-5

1. Ecosystem
2. Biodiversity and Conservation
3. Environmental Issues