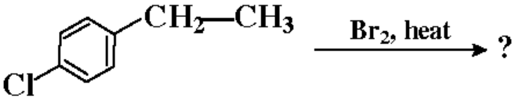
Short Answer Questions-II

Short Answer Questions-II (PYQ)

Q.1. Draw the structures of the major monohalo product for each of the following reactions:

[*CBSE (F) 2017*]

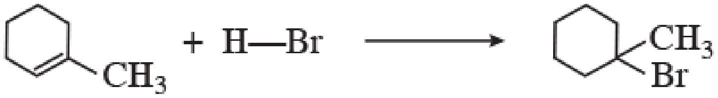
Q.



Ans.

Q.

Ans.



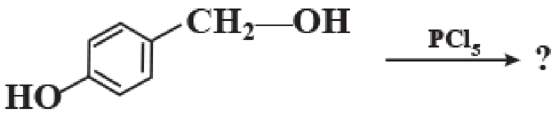
Q.

Ans.

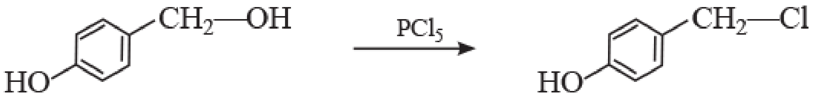
Q.2. Write the major product(s) in the following reactions:

[*CBSE (F) 2016*]

Q.



Ans.



Q.

Ans.

Q.

$$CH_3CH_2Cl \xrightarrow{KNO_2} ?$$

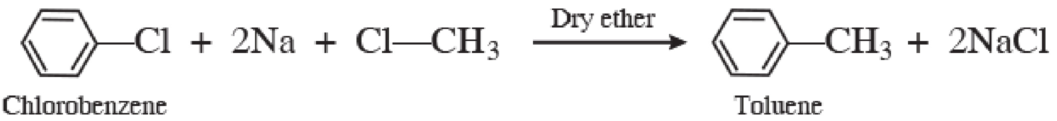
Ans. $CH_3—CH_2—Cl \xrightarrow{KNO_2} CH_3—CH_2—ONO$

Q.3. How do you convert

[*CBSE East 2016*]

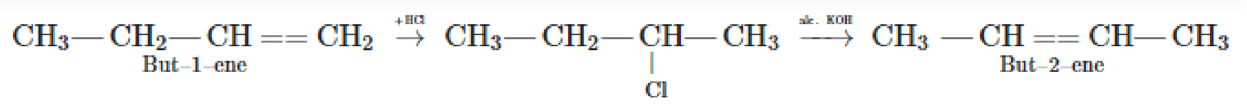
Q. chlorobenzene to toluene?

Ans.



Q. **but-1-ene to but-2-ene?**

Ans.



$$\underset{\text{But-1-ene}}{CH_3—CH_2—CH{=\!=}CH_2} \xrightarrow{+HCl} CH_3—CH_2—\underset{\underset{Cl}{|}}{CH}—CH_3 \xrightarrow{alc.\ KOH} \underset{\text{But-2-ene}}{CH_3—CH{=\!=}CH—CH_3}$$

Q. ethanol to ethyl iodide?

Ans.

$$\underset{\text{Ethyl alcohol}}{3CH_3—CH_2—OH} + PI_3 \xrightarrow[\text{reflux}]{\text{From (P and }I_2)} \underset{\text{Ethyl iodide}}{3CH_3—CH_2—I} + H_3PO_3$$

Q.4. Following compounds are given to you:

2-Bromopentane, 2-Bromo-2-methylbutane, 1-Bromopentane

[*CBSE Delhi 2017*]

Q. Write the compound which is most reactive towards S_N2 reaction.

Ans. 1-Bromopentane, it is primary halide therefore undergoes S_N2 reaction faster.

Q. Write the compound which is optically active.

Ans. 2-Bromopentane as carbon number two is symmetric carbon.

Q. Write the compound which is most reactive towards β-elimination reaction.

Ans. 2-Bromo-2-methyl butane, because tertiary alkyl halides on dehydrogenation form most substituted alkene which is more stable.

Q.5. **Answer the following questions**

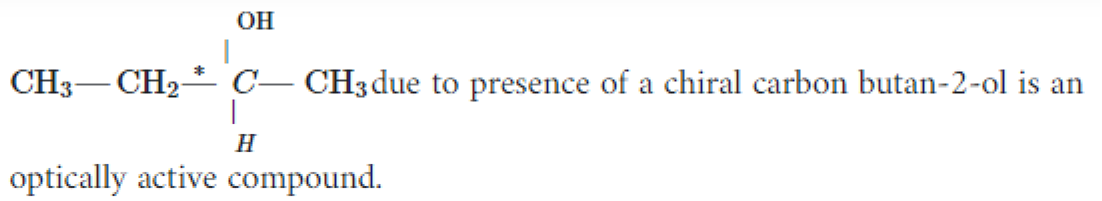
[*CBSE (F) 2015*]

Q. Why are alkyl halides insoluble in water?

Ans. This is due to the inability of alkyl halide molecule to form intermolecular hydrogen bonds with water molecules.

Q. Why is butan-1-ol optically inactive but butan-2-ol is optically active?

Ans.



$CH_3—CH_2—\overset{*}{C}H(OH)—CH_3$ due to presence of a chiral carbon butan-2-ol is an optically active compound.

Q. Although chlorine is an electron withdrawing group, yet it is *ortho*, *para* directing in electrophilic aromatic substitution reactions. Why?

Ans. As the weaker resonance (+ *R*) effect of Cl which stabilise the carbocation formed tends to oppose the stronger inductive (– *I*) effect of Cl which destabilise the carbocation at ortho and para positions and makes deactivation less for ortho and para position.

Q. 6. Give reasons:

[*CBSE Delhi 2015*]

***Q. n*-Butyl bromide has higher boiling point than *t*-butyl bromide.**

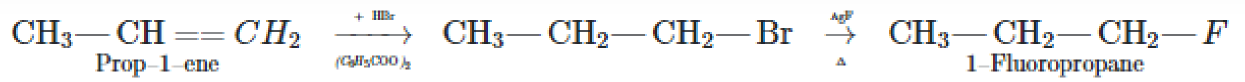
Ans. *n*-Butyl bromide being a straight chain alkyl halide has larger surface area than *tert*.butyl bromide. Larger the surface area, larger the magnitude of the van der Waal's forces and hence higher is the boiling point.

Q.7. How do you convert the following:

[*CBSE Panchkula 2015*]

Q. Prop-1-ene to 1-fluoropropane

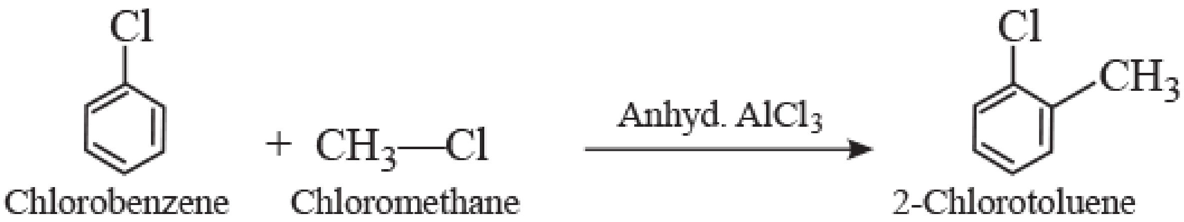
Ans.



$$\underset{\text{Prop-1-ene}}{CH_3—CH=CH_2} \xrightarrow[(C_6H_5COO)_2]{+\,HBr} CH_3—CH_2—CH_2—Br \xrightarrow[\Delta]{AgF} \underset{\text{1-Fluoropropane}}{CH_3—CH_2—CH_2—F}$$

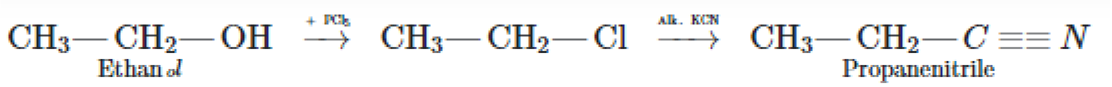
Q. Chlorobenzene to 2-chlorotoluene

Ans.



Q. Ethanol to propanenitrile

Ans.



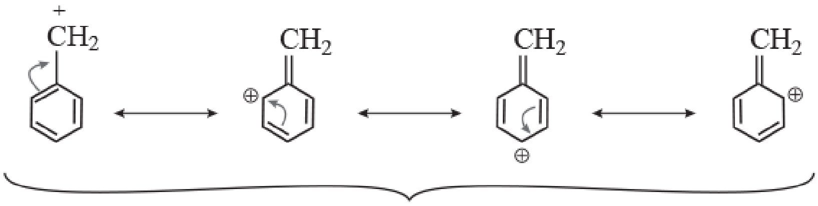
$$\underset{\text{Ethanol}}{CH_3—CH_2—OH} \xrightarrow{+PCl_5} CH_3—CH_2—Cl \xrightarrow{\text{Alk. KCN}} \underset{\text{Propanenitrile}}{CH_3—CH_2—C \equiv N}$$

Q.8. Give reasons for the following:

[***CBSE Bhubaneshwar 2015***] [***HOTS***]

Q. Benzyl chloride is highly reactive towards the S_N1 reaction.

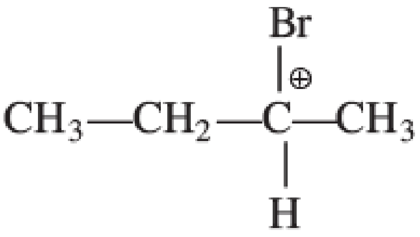
Ans. Benzyl chloride is highly reactive towards the S_N1 reaction because the intermediate benzyl carbocation formed in slowest step is stabilized through resonance.



Benzyl cation stabilised by resonance

Q. 2-bromobutane is optically active but 1-bromobutane is optically inactive.

Ans. 2-bromobutane is a chiral molecule as it contains an asymmetric carbon atom therefore, it is optically active whereas 1-bromobutane is an achiral molecule as it does not contain asymmetric carbon atom therefore it is optically inactive.



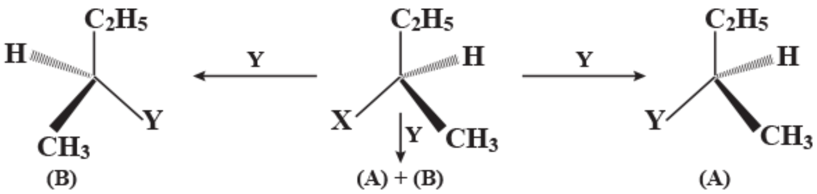
$$CH_3—CH_2—\overset{\overset{\displaystyle Br}{|\oplus}}{\underset{\underset{\displaystyle H}{|}}{C}}—CH_3$$

Carbocation of 2-Bromobutane

Q. Electrophilic reactions in haloarenes occur slowly.

Ans. Halogen in haloarenes withdraws electrons through –*I* effect and release electrons through +*R* effect. The inductive effect is stronger than resonance effect and causes net electron withdrawal. As a result, the electrophilic substitution reactions in haloarenes occur slowly.

Q.9. Consider the three types of replacement of group X by group Y as shown here.



This can result in giving compound (A) or (B) or both. What is the process called if

i. **(A) is the only compound obtained?**
ii. **(B) is the only compound obtained?**
iii. **(A) and (B) are formed in equal proportions?**

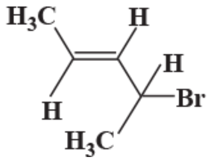
[*CBSE (F) 2013*]

Ans.

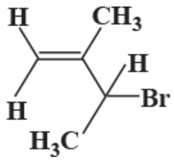
i. Retention
ii. Inversion
iii. Racemisation

Q.10. Write IUPAC names of the following:

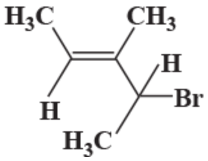
(*i*)



(*ii*)



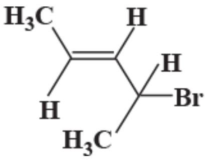
(*iii*)

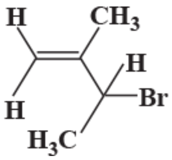


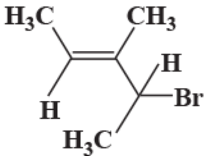
Ans.

i. 4-Bromopent-2-ene
ii. 3-Bromo-2-methylbut-1-ene
iii. 4-Bromo-3-methylpent-2-ene

Q. 11. **Write IUPAC names of the following:**

(*i*)


(*ii*)


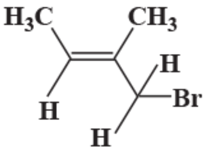
(*iii*)


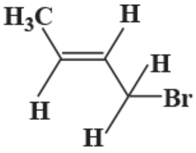
Ans.

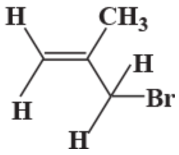
- **i.** 4-Bromopent-2-ene
- **ii.** 3-Bromo-2-methylbut-1-ene
- **iii.** 4-Bromo-3-methylpent-2-ene

Q.12. Write IUPAC names of the following:

[*CBSE (AI) 2011*]

(*i*)


(*ii*)


(*iii*)


Ans.

- **i.** 1-Bromo-2-methylbut-2-ene
- **ii.** 1-Bromobut-2-ene
- **iii.** 1123-Bromo-2-methylpropene

Q. Give reasons for the following:

***SE (AI) 2013*]**

Q. Ethyl iodide undergoes S_N2 reaction faster than ethyl bromide.

Ans.

Since I^- ion is a better leaving group than Br^- ion, hence, CH_3I reacts faster than CH_3Br in S_N2 reaction with OH^- ion.

Q. (±) 2–Butanol is optically inactive.

Ans. (±) 2-Butanol is a racemic mixture, *i.e.*, there are two enantiomers in equal proportions. The rotation by one enantiomer will be cancelled by the rotation due to the other isomer, making the mixture optically inactive.

Q. C–X bond length in halobenzene is smaller than C–X bond length in CH_3–X.

Ans.

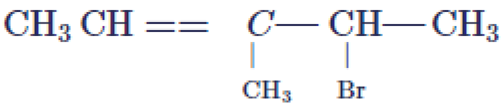
In CH_3–X the carbon atom is sp^3 hybridised while in halobenzene the carbon atom is sp^2 hybridised. The sp^2 hybridised carbon is more electronegative due to greater *s*-character and holds the electron pair of C–X bond more tightly than sp^3 hybridised carbon with less *s*-character. Thus, C–X bond length in CH_3–X is bigger than C–X in halobenzene.

Short Answer Questions-II (OIQ)

Q.1. Give the IUPAC name of the following organic compounds:

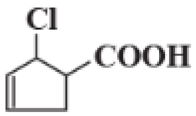
(*i*) $(CH_3)_3CCH_2Br$

(*ii*)



$$CH_3\,CH = \underset{\displaystyle CH_3}{\underset{|}{C}} — \underset{\displaystyle Br}{\underset{|}{CH}} — CH_3$$

(*iii*)



Ans.

- **i.** 1-Bromo-2, 2-dimethyl propane.
- **ii.** 4-Bromo-3-methyl pent-2-ene.
- **iii.** 2-Chloro-cyclopent-3-ene carboxylic acid.

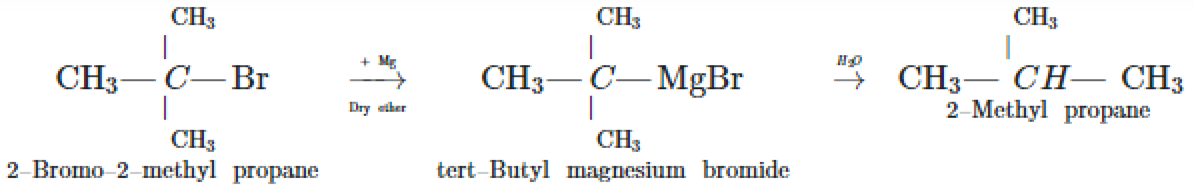
Q.2. Complete the following giving the structures of major organic products.

[*HOTS*]

Q.

$$(CH_3)_3—C—Br \xrightarrow{Mg} \ldots\ldots\ldots\ldots \xrightarrow{H_2O} \ldots\ldots\ldots\ldots$$

Ans.



$$CH_3—\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}—Br \xrightarrow[\text{Dry ether}]{+\,Mg} CH_3—\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}—MgBr \xrightarrow{H_2O} CH_3—\overset{\displaystyle CH_3}{\overset{|}{CH}}—CH_3$$

2-Bromo-2-methyl propane

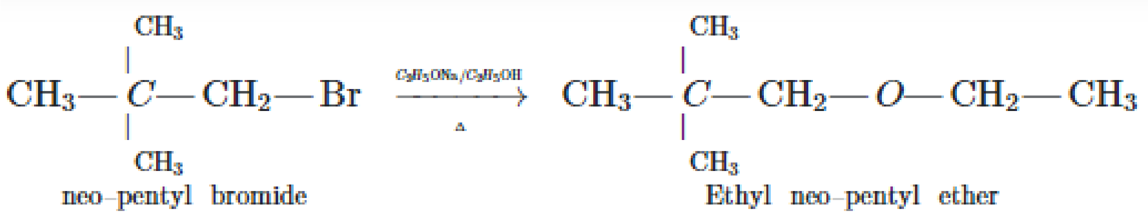
tert-Butyl magnesium bromide

2-Methyl propane

Q.

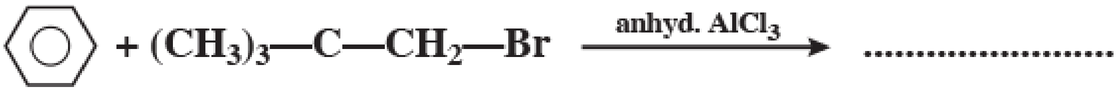
$(CH_3)_3—C—CH_2—Br \xrightarrow[\Delta]{C_2H_5ONa/C_2H_5OH}$ ……………………………………

Ans.

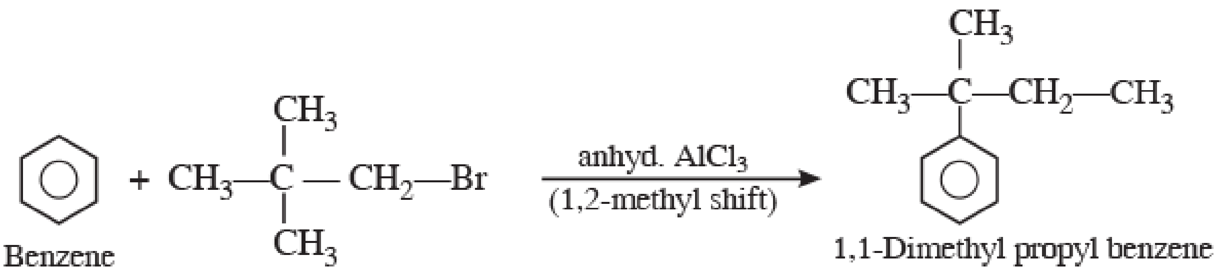


$$CH_3—\underset{CH_3}{\overset{CH_3}{C}}—CH_2—Br \xrightarrow[\Delta]{C_2H_5ONa/C_2H_5OH} CH_3—\underset{CH_3}{\overset{CH_3}{C}}—CH_2—O—CH_2—CH_3$$

Q.



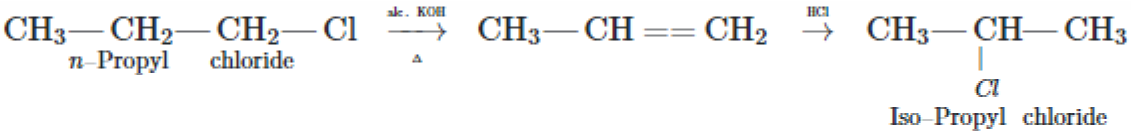
Ans.



Q.3. How will you bring about the following conversions?

Q. *n*-Propyl chloride to iso-propyl chloride

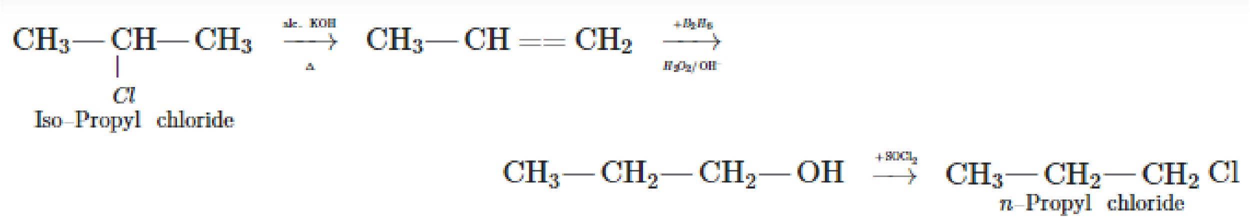
Ans.



$$CH_3—CH_2—CH_2—Cl \xrightarrow[\Delta]{alc.\ KOH} CH_3—CH=CH_2 \xrightarrow{HCl} CH_3—\underset{Cl}{CH}—CH_3$$

Q. Iso-propyl chloride to *n*-propyl chloride

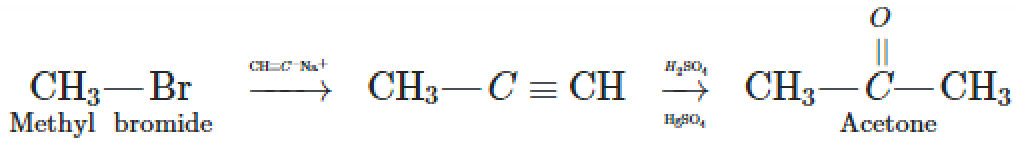
Ans.



$$CH_3-\underset{\underset{Cl}{|}}{CH}-CH_3 \xrightarrow[\Delta]{alc.\ KOH} CH_3-CH=CH_2 \xrightarrow[H_2O_2/OH^-]{+B_2H_6} CH_3-CH_2-CH_2-OH \xrightarrow{+SOCl_2} CH_3-CH_2-CH_2Cl$$

Q. Methyl bromide to acetone

Ans.

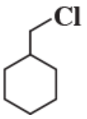
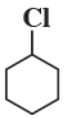


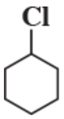
$$CH_3-Br \xrightarrow{CH\equiv C^-Na^+} CH_3-C\equiv CH \xrightarrow[HgSO_4]{H_2SO_4} CH_3-\overset{\overset{O}{||}}{C}-CH_3$$

Q.4. Answer the following questions

[*CBSE Sample Paper 2015*]

Q. In the following pairs of halogen compounds, which would undergo S_N1 reaction faster? Explain.


and


Ans.  ' because of greater stability of secondary carbocation than primary.

Q. Amongst the isomeric dihalobenzenes which isomer has the highest melting point and why?

Ans. Amongst the isomeric dihalobenzenes para-isomer has the highest melting point. This is due to greater symmetry of para-isomer that fits in crystal lattice better as compared to ortho and meta isomers.

Q. Arrange the following haloalkanes in the increasing order of density. Justify your answer.

CCl_4, CH_2Cl_2 and $CHCl_3$

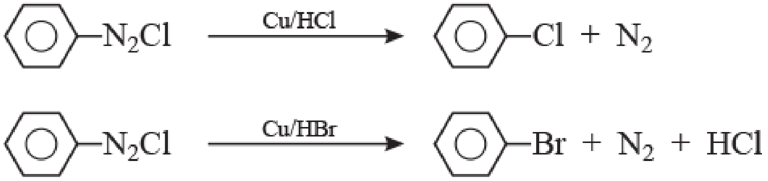
Ans. Density increases with increase in molecular mass, so the order is $CH_2Cl_2 < CHCl_3 < CCl_4$.

Q.5. Answer the following questions

[*CBSE Sample Paper 2016*]

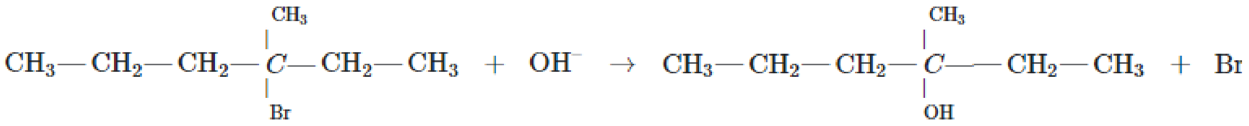
Q. Explain why the dipole moment of chlorobenzene is lower than that of cyclohexyl chloride.

Ans. Gatterman's Reaction: The reaction of diazonium salts with 'Cu' powder in the presence of corresponding halogen acids is known as Gatterman's reaction.



Q. An optically active compound having molecular formula $C_7H_{15}Br$ reacts with aqueous KOH to give a racemic mixture of products. Write the mechanism involved in this reaction.

Ans. Since the optically active compound, $C_7H_{15}Br$ reacts with KOH forms a racemic mixture, therefore it must be tertiary alkyl halide and the reaction will follow S_N1 mechanism.

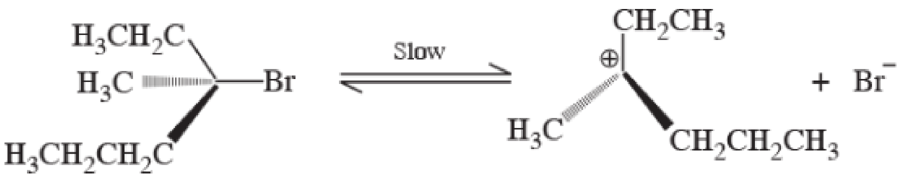


$$CH_3—CH_2—CH_2—\overset{\overset{CH_3}{|}}{\underset{\underset{Br}{|}}{C}}—CH_2—CH_3 + OH^- \rightarrow CH_3—CH_2—CH_2—\overset{\overset{CH_3}{|}}{\underset{\underset{OH}{|}}{C}}—CH_2—CH_3 + Br$$

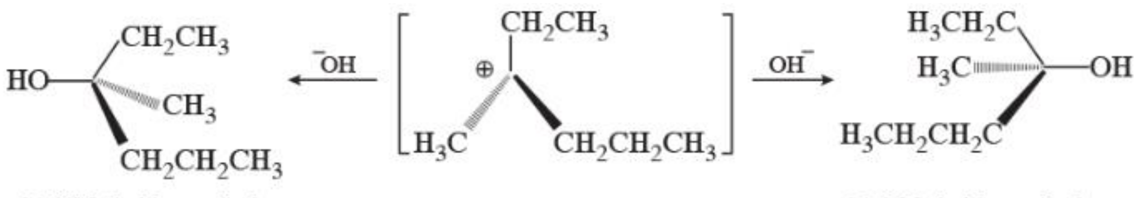
(±) 3–Methyl–hexan–3–ol

Mechanism:

(a).



(b)



(+) 3-Methyl-hexan-3-ol

(–) 3-Methyl-hexan-3-ol

Q.6. Give reasons for the following observations:

[*CBSE Sample Paper 2017*]

Q. *p*-dichlorobenzene has higher melting point than those of *o*– and *m*– isomers.

Ans. It is due to the greater symmetry of para-isomer that fits in the crystal better as compared to ortho and meta-isomers.

Q. Haloarenes are less reactive than haloalkanes towards nucleophillic substitution reaction.

Ans. As C–X bond in aryl halide acquires a partial double bond character due to resonance while the C–X bond in alkyl halide is a pure single bond.

Q. The treatment of alkyl chloride with aqueous KOH leads to the formation of alcohol but in the presence of alcoholic KOH, alkene is the major product.

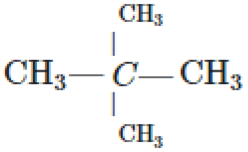
Ans. Alkoxide ion present in alcoholic KOH, is not only a strong nucleophile but also a strong base so preferentially eliminate a molecule of HCl from alkyl halide to form alkenes.

Q.7. A hydrocarbon of molecular mass 72 g mol^{-1} gives a single monochloro derivative and two dichloro derivatives on photochlorination. Give the structure of the hydrocarbon. [*NCERT Exemplar*]

[*HOTS*]

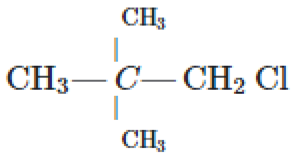
Ans. C_5H_{12}, pentane has molecular mass 72 g mol^{-1}, *i.e.*, the isomer of pentane which yield single monochloro derivative should have all the 12 hydrogens equivalent.

The hydrocarbon is



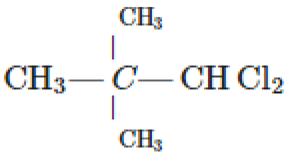
$$CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-CH_3$$

Monochloro derivative



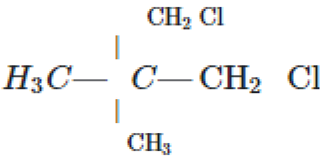
$CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CH_2Cl$

Dichloro derivative



$CH_3-\underset{CH_3}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CHCl_2$

(*i*)



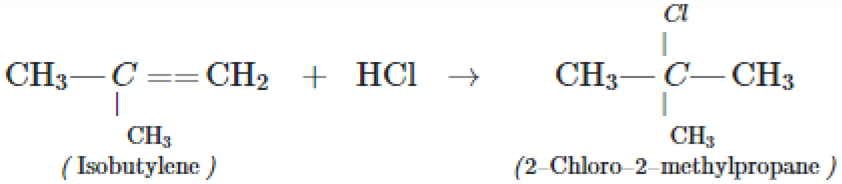
$H_3C-\underset{CH_3}{\overset{CH_2Cl}{\underset{|}{\overset{|}{C}}}}-CH_2Cl$

(ii)

Q.8. Predict the major product formed when HCl **is added to isobutylene. Explain the mechanism involved. [*NCERT Exemplar*]**

[*HOTS*]

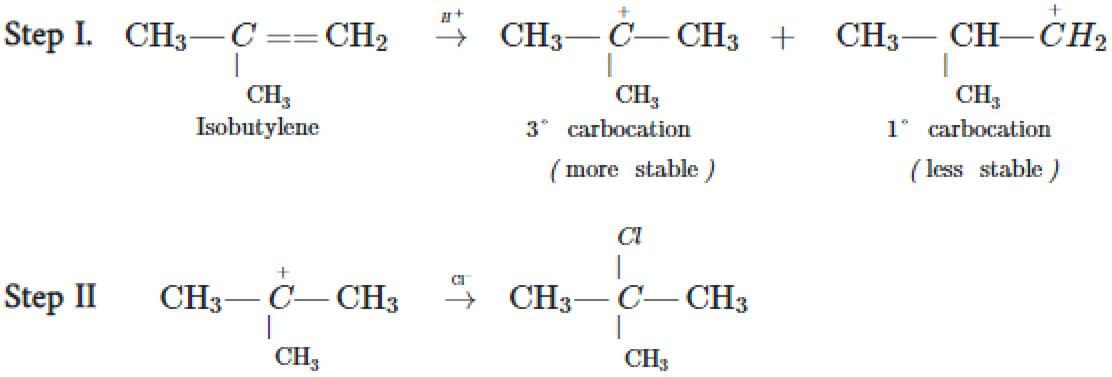
Ans.



$CH_3-\underset{CH_3}{\underset{|}{C}}=CH_2 + HCl \rightarrow CH_3-\underset{CH_3}{\overset{Cl}{\underset{|}{\overset{|}{C}}}}-CH_3$

(Isobutylene) (2–Chloro–2–methylpropane)

The mechanism involved in this reaction is:



Step I. $CH_3-\underset{CH_3}{\underset{|}{C}}=CH_2 \xrightarrow{H^+} CH_3-\underset{CH_3}{\underset{|}{\overset{+}{C}}}-CH_3 + CH_3-\underset{CH_3}{\underset{|}{CH}}-\overset{+}{C}H_2$

Isobutylene; 3° carbocation (more stable); 1° carbocation (less stable)

Step II $CH_3-\underset{CH_3}{\underset{|}{\overset{+}{C}}}-CH_3 \xrightarrow{Cl^-} CH_3-\underset{CH_3}{\overset{Cl}{\underset{|}{\overset{|}{C}}}}-CH_3$

Q.9. Compound 'A' with molecular formula C_4H_9Br is treated with aq. KOH solution. The rate of this reaction depends upon the concentration of the compound 'A' only. When another optically active isomer 'B' of this compound was treated with aq. KOH solution, the rate of reaction was found to be dependent on concentration of compound and KOH both.

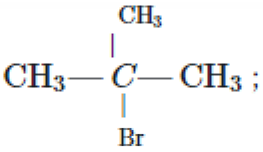
i. **Write down the structural formula of both compounds 'A' and 'B'.**

ii. **Out of these two compounds, which one will be converted to the product with inverted configuration?**

[*NCERT Exemplar*] [*HOTS*]

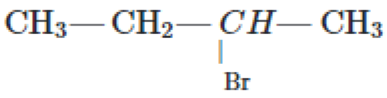
Ans.

(*i*) Compound A:



$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{Br}{|}}{C}}-CH_3$;

Compound B:



$CH_3-CH_2-\underset{\underset{Br}{|}}{CH}-CH_3$

(*ii*) Compound 'B'.