

## Chemistry Part II Chapter#10 (Alkyl Halides) SHORT QUESTIONS

1. What are primary and tertiary alkyl halides? Give one example of each.

**Ans: Primary alkyl halides:**

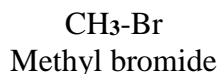
The alkyl halides in which halogen atom is attached to a carbon atom which is further attached with one carbon atom or no carbon atom are called primary alkyl halides.

**Tertiary alkyl halides:**

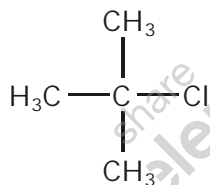
The alkyl halides in which halogen atom is attached to a carbon atom which is further attached with three carbon atoms are called tertiary alkyl halides.

**Examples:**

**Primary alkyl halide:**



**Tertiary alkyl halide:**



2-Chloro-2-methylpropane

2. How alkyl halides can be prepared by alcohols? Give two examples.

**Ans: (a) Reaction of alcohols with halogen acids:**

Alcohols may be converted to the corresponding alkyl halides by the action of halogen acid in the presence of  $\text{ZnCl}_2$ , which acts as a catalyst



**(b) Reaction of alcohols with thionyl chloride:**

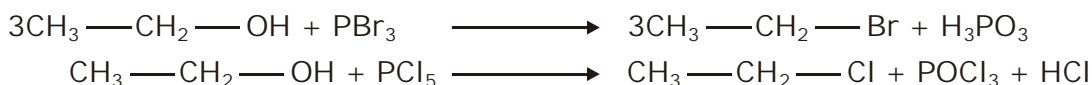
Alcohols react with thionyl chloride in pyridine as a solvent to give alkyl chlorides. This is the best method because  $\text{HCl}$ , and  $\text{SO}_2$  gases escape leaving behind the pure product.



3. Write down reactions of ethanol with (i)  $\text{PBr}_3$  (ii)  $\text{PCl}_5$

**Ans: Reactions of ethanol with phosphorus halides:**

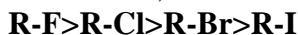
Phosphorus tribromide and Phosphorus pentachloride react with Ethanol to produce alkyl halides as follows.



**4. Explain the order of reactivity of alkyl halides on the basis of bond polarity.**

**Ans:** According to this factor, greater the electronegativity difference between carbon and halogen greater the bond polarity. Greater the polarity greater the reactivity. So with this rule the alkyl fluorides should be the most polar and the most reactive and alkyl iodides least polar and least reactive.

It means reactivity order must be like this;

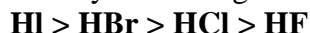


**5. What is the order of reactivity of HX with Ethene?**

**Ans:** Ethene reacts with HX to form Ethyl halide.

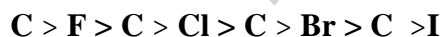


The order of reactivity of HX is given below.



**6. How the bond dissociation energy of carbon suggests that alkyl iodides should have maximum reactivity?**

**Ans:** Bond energy directly depends on bond polarity. The bond dissociation energy of C-X bond is in the order:



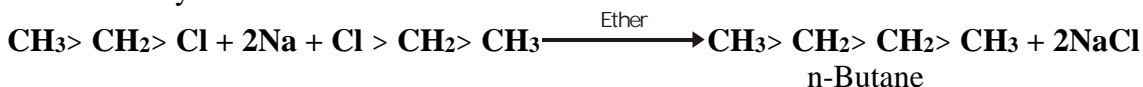
Greater the bond energy, stronger the bond and lesser the reactivity. With this rule the reactivity order must be like this;



Alkyl iodides should be most reactive due to least bond energy.

**7. What is Wurtz's synthesis reaction?**

**Ans:** Alkyl halides react with sodium in ether (solvent) to give alkanes. This is called Wurtz's synthesis. The reaction is particularly useful for preparation of symmetrical alkanes with double number of carbon atoms as compared with that in alkyl halide used.



**8. What is difference between molecularity and order of reaction?**

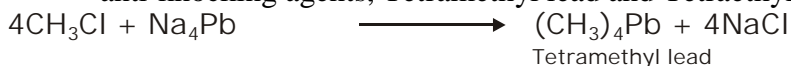
**Ans:**

Molecularity	Order of Reaction
Molecularity is defined as the number of molecules taking part in the rate determining step of reaction.	Sum of exponents of conc. terms in the rate expression of a chemical equation is called order of reaction.
It is calculated through balanced chemical equation	It is always experimentally determined.

**9. How antiknocking agents are prepared?**

**Ans: Preparation of anti-knocking agents:**

Methyl chloride and Ethyl chloride can react with sodium lead alloy to produce anti-knocking agents, Tetramethyl lead and Tetraethyl lead respectively.



**10. In tertiary alkyl halides,  $S_N1$  reaction takes place but not  $S_N2$  reaction. Why?**

**Ans** In tertiary alkyl halide, attacking nucleophile cannot reach directly at the electrophilic center (carbon) due to steric hindrance. So attachment of attacking nucleophile and removal of leaving group can't occur simultaneously as occurs in  $S_N2$  reactions. As a result in tertiary alkyl halides nucleophilic substitution occurs in two steps i.e.  $S_N1$  mechanism occurs. In first step halogen (leaving group) is removed to reduce steric hindrance and planar carbocation is formed. In second step attack of new nucleophile takes place.

**11. What is the role of Carbonium ion for determining  $S_N1$  or  $S_N2$  mechanism?**

**Ans:** Greater the stability of the carbonium ion, greater the possibility for two step mechanism which is  $S_N1$ . These alkyl halides which can provide unstable carbonium ion give  $S_N2$  mechanism, which is a single step reaction. Carbonium ion is stable if it is bonded to maximum number of alkyl groups.

**12. What is meant by attacking nucleophile? Give examples.**

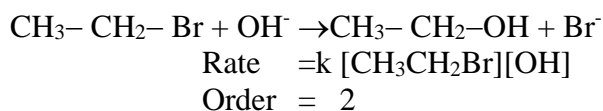
**Ans:** In  $S_N$  reactions, the nucleophile which attacks on the electrophilic carbon of alkyl halide from outside is called attacking nucleophile.

**Examples:**

$-\text{OH}^-$ ,  $-\text{CN}$  etc.

**13. Reaction of Ethyl bromide with  $\text{OH}^-$  nucleophile is  $S_N2$ . Why?**

**Ans:** Reaction of ethyl bromide with  $\text{OH}^-$  is  $S_N2$  because it is a bimolecular reaction. The rate of reaction depends upon the concentration of nucleophile as well as substrate.



**14. What is difference between Electrophile and Nucleophile?**

**Ans:**

Electrophile	Nucleophile
(i) It is an electron deficient species.	It is electron rich species.
(ii) It always acts as Lewis acid.	It always acts as Lewis base.
(iii) It may be neutral or positively charged.	It may be negatively charged or neutral with one or more lone pairs.
(iv) Examples: $\text{NO}_2^+$ , $\text{SO}_3$	Examples: $\text{Cl}^-$ , $\text{NH}_3$

**15. What are differences between  $S_N1$  and  $S_N2$  reactions?**

**Ans:**

$S_N1$	$S_N2$
(i) It is a two step mechanism.	It is a single step mechanism.
(ii) First step is slow and second is fast.	It has only one step and that is slow.
(iii) It is unimolecular reaction.	It is a bimolecular reaction.
(iv) It is favored in polar solvents.	It is favored in non-polar solvents.

**16. Why tertiary alkyl halides follow  $S_N1$  mechanism and not  $S_N2$  mechanism? OR During  $S_N1$  reaction, what is the significance of first step?**

**Ans:**  $S_N1$  mechanism involves two steps. Due to steric (space) hindrance, the attack of nucleophile on the  $\text{-C}$  of substrate is not directly possible. In order to create space for the attack, older nucleophile means halogen needs to be removed first. This is the reason that reaction occurs in two steps. The first step is the reversible ionization of the alkyl halide. This step provides a **carbocation** as an intermediate. In the second step this carbocation is attacked by the nucleophile to give the substitution product.

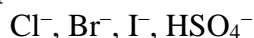
In  $S_N2$  reactions, there is no issue of steric hindrance as  $\text{-C}$  of primary alkyl halide is surrounded by small groups e.g. Hydrogen atoms and attacking nucleophile finds space to attack on carbon.

**17. What are leaving group and substrate?**

**Ans: Leaving Group:**

Leaving group (L) is also a nucleophile. In  $S_N$  reactions of alkyl halides, the halogens are the leaving groups. It is called leaving group because it departs from alkyl halide.

**Examples:**



**Substrate Molecule:**

The alkyl halide molecule on which a nucleophile attacks is called a substrate molecule.

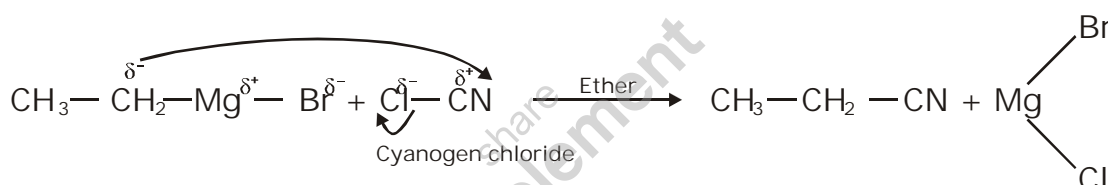
18. What is difference between Elimination and substitution reactions?

Ans:

Elimination	substitution
Elimination of two atoms or groups from adjacent carbon atoms in the presence of a nucleophile or a base is called elimination reaction.	Substitution reaction involves the breakage of C-X bond and the formation of C-Nu bond.
The product of an elimination reaction is alkene usually.	Substitution reaction yields substitution product
<b>Example:</b> $\text{CH}_3\text{CH}_2\text{X} + \text{OH}^- \longrightarrow \text{H}_2\text{C}=\text{CH}_2 + \text{H}_2\text{O}$	<b>Example:</b> $\text{CH}_3\text{-X} + \text{OH}^- \longrightarrow \text{CH}_3\text{-OH} + \text{X}^-$

19. How do we get alkyl nitriles from Grignard's reagent?

Ans: When  $\text{Cl-CN}$  is reacted with Grignard's reagent. The alkyl group of the Grignard's reagent combines with  $-\text{CN}$  group to give Alkyl nitrile. See example below;



20. Explain the structure and reactivity of Grignard's reagent.

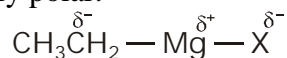
Ans: Grignard's reagent are much reactive than most of the organic compounds. The reactivity is due to the nature of C-Mg bond which is highly polar.



Magnesium is more electropositive than carbon and C-Mg bond though covalent is highly polar, giving alkyl carbon the partial negative charge. The negative charge is an unusual character which makes the alkyl groups highly reactive towards electrophilic centers.

21. What is the nature of C-Mg bond in R-Mg-X?

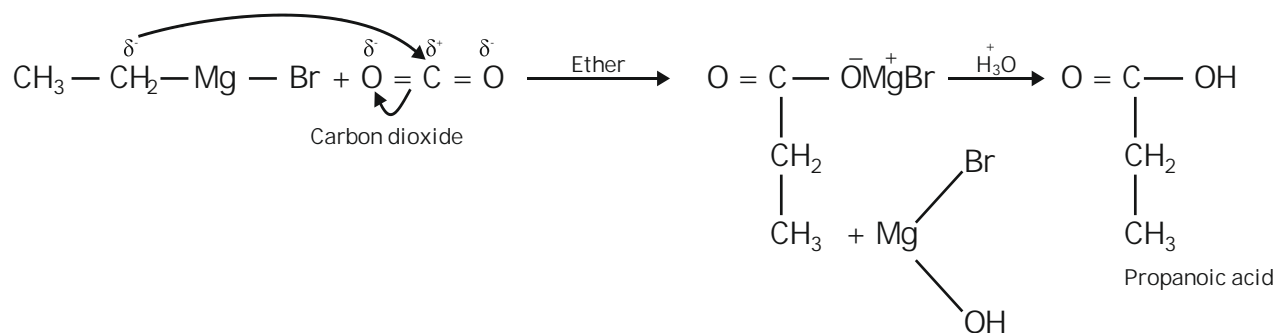
Ans: Grignard's reagents are very reactive organic compounds. Their reactivity is due to C-Mg bond which is highly polar.



Magnesium is less electronegative than carbon so partial positive charge appears on magnesium and partial negative on carbon attached to it. This  $-ve$  charge on carbon is very unusual which makes alkyl group very reactive towards electrophiles.

22. How is carboxylic acid prepared from Grignard's reagent?

**Ans:** When Grignard's reagent is reacted with carbon dioxide gas, we get carboxylic acids as follows;



**23. How Grignard reagent reacts with epoxides to form alcohol?**

**Ans:** Grignard's reagent reacts with epoxide in dry ether to generate primary alcohols.

