CHEMISTRY

WORKSHEET-3

STEP

A PROJECT BY PUNJAB GROUP

Worksheet-3

(C. Organic Chemistry)

Alkyl Halides

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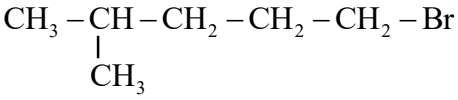
Q.1 The type of alkyl halides in which halogen is attached with such C-atom which is further attached with two C-atoms are called?

A) 1° alkyl halides C) 3° alkyl halides

B) 2° alkyl halides D) 4° alkyl halides

Q.2 Consider the following structure formula of alkyl halide:



The correct name according to IUPAC is:

A) 1-Bromo-4-methylpentane

B) 2-Methyl-5-bromopentane

C) 2-Methyl-1-bromopentane

D) 2-Methyl-2-bromopentane

Q.3 Which of the following is the best method to prepare alkyl halides?

A) Reaction of alcohol with HCl in the presence of catalyst $ZnCl_2$

B) Reaction of alcohol with PCl_5

C) Reaction of alcohol with PCl_3

D) Reaction of alcohol with $SOCl_2$ in the presence of pyridine solvent

Q.4 Which of the following alkyl halides cannot be prepared by the direct halogenation of alkanes?

A) R – Cl C) R – I

B) R – Br D) R – F

Q.5 Which of the following is good leaving group?

A) NH_2^- C) OR^-

B) HSO_4^- D) OH^-

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Q.6 Which of the following statements is not correct for S_N2 mechanism reaction?

A) It is bimolecular, 2nd order reaction

B) Order of ease of S_N2 mechanism in alkyl halide is 1° alkyl halide > 2° alkyl halide > 3° alkyl halide

C) It takes place in the presence of polar solvent

D) It involves 100% inversion in the products

Q.7 Mark the incorrect statement about alkyl halide:

A) Boiling points of haloalkanes are greater than that of alkanes

B) Order of decreasing boiling points in alkyl halides is

R – I > R – Br > R – Cl > R – F

C) Alkyl halides are soluble in water

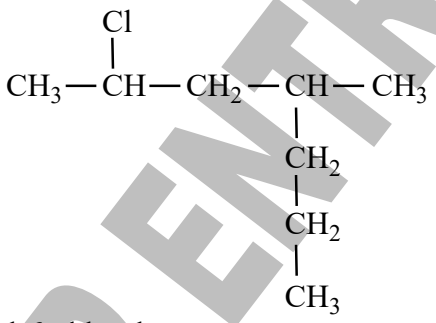
D) Primary alkyl halides can be prepared by reaction of PCl_5 or $SOCl_2$ with alcohols but not aryl halide

Q.8 Which of the following halide ion (X^-) is good nucleophile and good leaving group?

A) I^- C) F^-

B) Cl^- D) Br^-

Q.9 Which one of the following is the correct name according to IUPAC system for the formula given below?



A) 4-Methyl-6-chloroheptane

B) 2-Chloro-4-methylheptane

C) 2-Chloro-4-n propylhexane

D) 2-Chloro-4-n propylpentane

Q.10 CCl_4 has all of the following characteristic features EXCEPT:

A) It is colourless liquid

B) It is used as industrial solvent

C) It is insoluble in water and soluble in alcohol for fat, oil etc

D) It is inflammable

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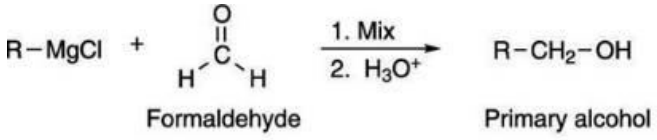
Q.11 Considered the following reaction of Grignard reagent with methanal (a carbonyl compound) followed by hydrolysis:



The mechanism of reaction before hydrolysis is:

A) Electrophilic addition reaction

B) β-elimination

C) Nucleophilic addition reaction

D) Nucleophilic substitution reaction

Q.12 Which of the following type of alkyl halide is the most reactive w.r.t S_N1.

A) R – X

C) $R - CH_2 - X$

B) $R-\underset{\underset{R}{|}}{\overset{\overset{R}{|}}{C}}-X$

D) $R - \underset{\underset{|}{R}}{CH} - X$

Q.13 Alkyl halides are considered to be very reactive compounds towards nucleophiles because:

A) They have an electrophilic carbon

B) They have an electrophilic carbon and a good leaving group

C) They have an electrophilic carbon and bad leaving group

D) They have a nucleophilic carbon and a good leaving group

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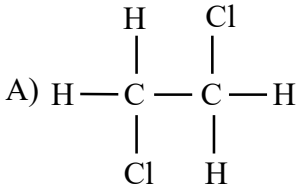
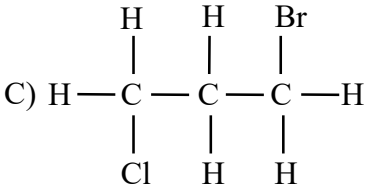
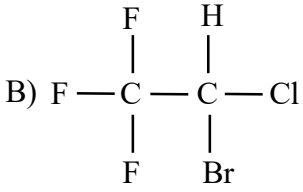
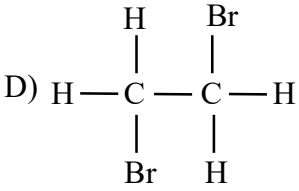
Q.14 Which one of the followings is Halothane?

A) 

C) 

B) 

D) 

Q.15 Identify the incorrect statement about the use of chloroform:

A) It is used as an anesthetic substance

B) It is used as a solvent for fats waxes and resins

C) It is used in manufacturing freons

D) It is used as preservative for anatomical specimen

Q.16 All of the following are characteristic features of Teflon plastic EXCEPT:

A) It is valuable plastic which resists the action of acid and alkali

B) It is used as coating the electrical wiring

C) It is used as a non-stick coating for cooking pans

D) It reacts with oxidants

Q.17 Which of the following is the most dangerous factor which damages ozone?

A) Aerosol spray

B) Use of chlorofluorocarbons

C) Effect of SO_2 and NO_2 pollutant

D) Global warming by CO_2

Q.18 Grignard reagent is reactive due to:

A) The presence of halogen atom

B) The polarity of C – Mg bond

C) The presence of Mg atom

D) The polarity of C – X bond

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Q.19 In which of the following reactions alcohol is produced?

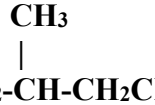
A) Reaction of alkyl halide with aqueous KOH

B) Reaction of alkyl halide with alcoholic KOH

C) Reaction of alkyl halide with KCN followed by acidic hydrolysis

D) Reactions of alkyl halide with sodium alkoxide

Q.20 Consider the following structure of alkyl halide:

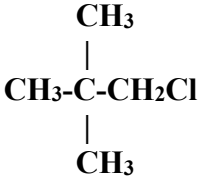


Which of the following correct name of given structure according to IUPAC system is:

A) 1-Bromo-2-methylbutane C) 4-Bromo-2-methylbutane

B) 4-Bromo-3-methylbutane D) 1-Bromo-3-mehtylbutane

Q.21 Consider the following structure of alkyl halide:



Which of the following correct name of given structure according to IUPAC system is:

A) 3-Chloro-2,2-dimethylpropane

B) 1-Chloro-2,2-dimethylpropane

C) 2-Chloro-2,2-dimethylpropane

D) 1-Chloro-2,3-dimethylpropane

Q.22 Which of the following correct statement about substrate and leaving group?

A) The molecule which undergoes nucleophilic substitution reaction is called substrate

B) The group are species which leaves the substrate is called leaving group (nucleofuge)

C) Both A and B

D) Neither A nor B

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Q.23 Which of the following carbocation is most stable?

A) $(CH_3)_3C-C^+H_2$ C) $CH_3CH_2C+H_2$

B) $(CH_3)_3C^+$ D) $CH_3C+HCH_2CH_3$

Q.24 Which one of the following is a correct statement about the two alkenes

$CH_3-CH_2-CH=CH_2$ and $CH_3-CH=CH-CH_3$?

A) Neither may be polymerized

B) Neither reacts with bromine to give 1,4-Dibromobutane

C) Neither reacts with hydrogen to form butane

D) Neither exhibits cis-trans isomerism

Q.25 In elimination reaction there is another site present in the alkyl halide molecule where the attacking reagent (base) can attack at the same time. Such a site is an electrophilic hydrogen atom (β-hydrogen is acidic in nature) which is attached to the β-carbon of the alkyl halide. When the attack takes place on hydrogen we get an alkene there are two types of elimination reactions (E1 and E2):
Which of the following statements is incorrect about E2 elimination reaction?

Opt.	E2 Elimination
A)	 Bromoethane Ethane
B)	Rate of reaction = k[R-X][base] it is bimolecular and shows second order kinetics
C)	Order of ease of E2 elimination reaction in alkyl halides is 3^o alkyl halide > 1^o alkyl > 2^o alkyl halide
D)	It completes in one step

Q.26 Consider the following statement about physical property of alkyl halide:

I. Lower alkyl halides CH_3Cl, C_2H_5Cl and CH_3F are gases at room temperature.

II. Alkyl halides upto C_{18} are colorless liquids.

III. Those beyond C_{18} are colourless solids.

IV. They are usually insoluble in water due to their inability to form hydrogen bonding with water.

Which of the above statement is/are correct?

A) I only C) III and IV only

B) II only D) I, II, III and IV

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Q.27 In elimination reaction there is another site present in the alkyl halide molecule where the attacking reagent (base) can attack at the same time. Such a site is an electrophilic hydrogen atom (β-hydrogen is acidic in nature) which is attached to the β-carbon of the alkyl halide. When the attack takes place on hydrogen we get an alkene there are two types of elimination reactions (E1 and E2):
Which of the following statements is incorrect about E1 elimination reaction?

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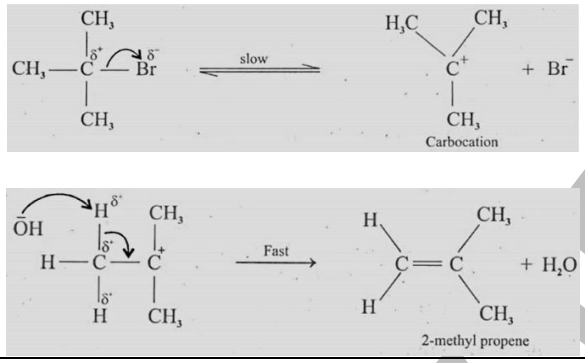
Opt.	E1 Elimination
A)	Mechanism of reaction 
B)	Rate of reaction = k [R-X] It is unimolecular and second order kinetics reaction
C)	Order of ease of E1 elimination reaction in alkyl halide is 2° alkyl halide > 3° alkyl halide > 1° alkyl halide
D)	It completes in two step

Q.28 Consider the following different between S_N1 and S_N2 reactions.

S_N1	S_N2
I. A two-step mechanism	A one-step mechanism
II. Rate depends only on concentration of alkyl halide.	Rate depends on concentration of alkyl halide and nucleophile.
III. Is unimolecular	Is biomolecular
IV. Rate depends on structure of halide	Rate depends on structure of halide
$3^o > 2^o > 1^o > CH_3X$	$CH_3X > 1^o > 2^o > 3^o$

Which of the above statement is/are correct?

A) I only
B) II only
C) III and IV only
D) I, II, III and IV

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Q.29 Which one of the following halides is most reactive towards nucleophilic substitution reaction?

A) C_2H_5Br C) C_2H_5I

B) C_2H_5F D) C_2H_5Cl

Q.30 All electron deficient species are classified as:

A) Nucleophiles C) Electrophiles

B) Bases D) All of these

Q.31 The carbon atom carrying positive change and attached to three other atoms or groups is called:

A) Carbonium ion C) Carbon ion

B) Oxonium ion D) Carbonion

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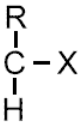
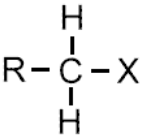
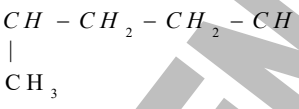
ANSWER KEY (Worksheet-3)					
1	B	12	B	23	B
2	A	13	B	24	B
3	D	14	B	25	C
4	C	15	C	26	D
5	B	16	D	27	C
6	C	17	B	28	D
7	C	18	B	29	C
8	A	19	A	30	C
9	B	20	A	31	A
10	D	21	B		
11	C	22	C		

ANSWERS EXPLAINED

Q.1 (B) **2° alkyl halide** 

1° alkyl halide 

3° alkyl halide 

Q.2 (A) 

According to **IUPAC** the **correct name** of the given structure is **1-Bromo-4-methylpentane.**

Q.3 (D) This is the best method to prepare **alkyl halides** because the side products in this reaction are in the gaseous state

$$RCH_2OH + SOCl_2 \xrightarrow{Pyridine} R\text{-}CH_2\text{-}Cl + HCl_{(g)} + SO_{2(g)}$$

Q.4 (C) **Order of reactivity** of **halogens** with **alkane** is as follow $F_2 > Cl_2 > Br_2 > I_2$. This order shows that I_2 is **least reactive** and it **does not react** with **alkane** to form **alkyl halide.** It is clear that **R – I cannot** be prepared from **alkane.**

Q.5 (B)

Good Leaving Group	Poor Leaving Group
Cl^-, Br^-, I^- and HSO_4^-	OH^-, OR^- and NH_2^-
Less polar	More polar
Low bond energy	Greater bond energy
Give fast reaction	Give slow reaction

Q.6 (C) **S_N2 mechanism reaction** takes place in the presence of **non-polar solvent** such as **n-hexane not** in the presence of **polar solvent (e.g. H_2O).**

Q.7 (C) **Alkyl halides** are **soluble** in **non-polar solvent.**

Q.8 (A) **Leaving group** ability can be **explained** on the basis of strength of the **C-X bond.** The **C-I** bond is the **weakest bond** hence iodide is the **best leaving group.**

- Increasing order of the leaving groups:
  $F^- < Cl^- < Br^- < I^-$ ……i
  The greater the electronegativity, the more stable the halide ion (since electrons are tightly held).
- Increasing order of the nucleophiles
  $F^- < Cl^- < Br^- < I^-$ ……ii
- Since iodine is the least electronegative, **it is the least stable halide hence the strongest nucleophile.**
- Another important factor would be **Hard-Soft concept. Alkyl halides** are soft electrophiles so the substitution is favored by soft nucleophiles. The **softness** of the **nucleophiles increases down the group i.e. $F^- < Cl^- < Br^- < I^-$**

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- **Other (B, C and D) are weak nucleophile and poor leaving group**
- The relative rate at which a nucleophile ($Nu:^-$) reacts to displace (substitute for) a leaving group is called 'nucleophilicity'. Consider the following nucleophilic substitution reactions:

- $CH_3OH + HI \rightarrow CH_3I + HOH$
- $CH_3OH + HCl \rightarrow CH_3Cl + HOH$
- The first reaction is much faster than the second because I^- is a much better $Nu:^-$ than Cl^-. The leaving group (HOH) was the same in both cases. The nucleophilicity (relative reactivity) of various $Nu:^-$'s is listed in the following table ...

Reactivity	$Nu:^-$	Relative Reactivity
very weak	HSO_4^-, $H_2PO_4^-$, RCOOH	< 0.01
weak	ROH	1
	HOH, NO_3^-	100
fair	F^-	500
	Cl^-, $RCOO^-$	20×10^3
	NH_3, CH_3SCH_3	$\sim 300 \times 10^3$
good	N_3^-, Br^-	$\sim 600 \times 10^3$
	OH^-, CH_3O^-	2×10^6
very good	CN^-, HS^-, RS^-, $(CH_3)_3P:$, I^-, H^-	$> 100 \times 10^6$

- Note that $Nu:^-$'s are electron donors as are Lewis bases and reducing agents. $Nu:^-$'s are either uncharged (with non-bonded electrons) or they are anions, but they are never cations. $Nu:^-$'s are basic, neutral, or sometimes weakly acidic, but not strongly acidic. Strong acids (HCl, H_2SO_4) and Lewis acids ($AlCl_3$, $SnCl_2$) are electrophiles (E^+'s), i.e., electron acceptors as are oxidizing agents.
- Within any given row of the periodic table, nucleophilicity decreases from left to right as polarizability decreases (because electronegativity of the central atom is increasing).

CH_3^-	>	NH_2^-	>	OH^-	>	F^-
	>	NH_3	>	OH_2	>	HF
		PH_2^-	>	SH^-	>	Cl^-
		PH_3	>	SH_2	>	HCl

- For nucleophiles with the same attacking atom, the anion is more nucleophilic than the neutral compound.
- $Cl^- > HCl$ $OH^- > HOH$ $RO^- > ROH$ $NH_2^- > NH_3$ $CH_3CO_2^- > CH_3CO_2H$ $CN^- > HCN$
- Nucleophilicity increases down any column of the periodic table; as the polarizability of atoms increases ...

NH_2^-	OH^-	F^-
H_2P^-	HS^-	Cl^-
H_2As^-	HSe^-	Br^-
H_2Sb^-	HTe^-	I^-

- Note the similarities and differences of nucleophiles and bases.
- Nu:-'s and bases are both electron donors
- Basicity deals with equilibrium position (Keq). At equilibrium, a stronger base holds a greater proportion of H^+. Nucleophilicity deals with kinetics. A stronger Nu:- attacks faster than a weaker one.
- Basicity deals with interaction with H^+ while nucleophilicity is broader and also deals with interaction with other atoms, especially, but not only C atom.
- Polarizability of Nucleophiles:
- A polarizable nucleophile, e.g., I-, is large and soft ('teddy bear-like') because its valence (donor) electrons are far from the nucleus (in the 5th period). The electron cloud is readily distorted during bond making and breaking which reduces the energy maximum in the transition state and thus speeds up reactions.

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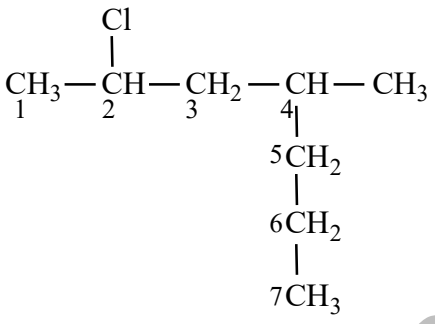
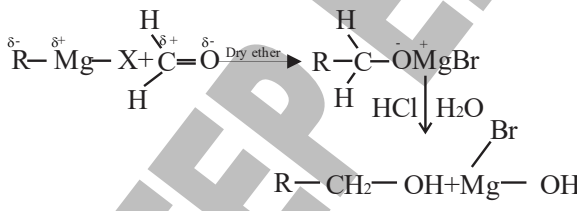
- A non-polarizable nucleophile, e.g., F- is small and hard ("golf ball-like"). Its outer valence electrons are close to the nucleus (in the 2nd period) and tightly held. F-forms strong bonds but its electron cloud is not easily distorted during bond formation and breaking so its transition state is at high energy (slow reaction) state.
- It is generally true that good nucleophiles are also good leaving groups for the same reasons.

Q.9 (B) The correct name according to IUPAC of the given structure is 2-Chloro-4-methylheptane.



Q.10 (D) CCl_4 is **non-polar** and is **non-flammable.**

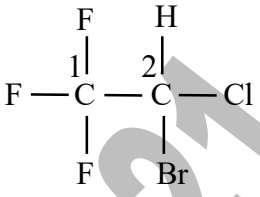
Q.11 (C) Mechanism of reaction in the formation of intermediate product **before** hydrolysis is **nucleophilic addition** reaction as shown below. **Others A, B, and D are not related.**



Q.12 (B)

Q.13 (B) Alkyl halides are considered to be very reactive compounds towards nucleophiles because they have an electrophilic carbon and a good leaving group.

Q.14 (B) The structure of halothane is given below:



2-Bromo-2-Chloro-1,1,1-triflouroethane

Q.15 (C) A, B and D are the uses of chloroform except C.

Q.16 (D) Teflon plastic not only reacts with acid and alkali but also it reacts with oxidant.

Q.17 (B) Use of chlorofluorocarbons is the most dangerous for ozone layer Chlorofluorocarbons used as refrigerants in air conditioning and in aerosol sprays are inert in the troposphere but slowly diffuse into stratosphere, where they are subjected to ultraviolet radiation generating $Cl^{\bullet}$ free radicals. Chlorofluorocarbons (CFCs) play an effective role in removing O_3 in the stratosphere due to following reactions.

$$CFCl_3 \longrightarrow CFCl_2^{\bullet} + Cl^{\bullet}$$

$$Cl^{\bullet} + O_3 \longrightarrow ClO^{\bullet} + O_2$$

$$ClO^{\bullet} + O \longrightarrow Cl^{\bullet} + O_2$$

Q.18 (B) The greater reactivity of Grignard's reagent is due to the polarity of α-carbon and Mg bond (the electronegative of C = 2.5, Mg = 1.2 and the difference is 1.3 so C – Mg bond is polar). The α-carbon develops the partial negative charge and acts as nucleophilic centre $R^{\delta-} - Mg^{\delta+} - X$ **.**

Q.19 (A) As a reaction of alkyl halide with aqueous KOH, alcohol is formed as shown in the reactions:

A) $R - CH_2 - CH_2 - X + KOH \xrightarrow{H_2O} R - CH_2 - CH_2 - OH + KX$

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Q.20 (A)

$$Br\text{-}{}^{1}CH_2\text{-}{}^{2}CH(CH_3)\text{-}{}^{3}CH_2{}^{4}CH_3$$

Q.21 (A)

$$(CH_3)_3{}^{3}CH_3\text{-}{}^{2}C\text{-}{}^{1}CH_2Cl$$

1-Chloro-2,2-dimethylpropane

Q.22 (C)

- The molecule which undergoes nucleophilic substitution reaction is called substrate
- The group are species which leaves the substrate is called leaving group (nucleofuge)

Q.23 (B) $(CH_3)_3C^+$ carbocation is most stable.

Q.24 (B)

- 1-Butene and 2-Butene do not give 1,4-Dibromobutane on bromination as shown in the reactions.
- 1-Butene on bromination gives 1,2-Dibromobutane.

$$CH_3\text{-}CH_2\text{-}CH=CH_2 + Br_2 \xrightarrow{CCl_4} CH_3\text{-}CH_2\text{-}\underset{Br}{CH}\text{-}\underset{Br}{CH_2}$$

1,2-Dibromobutane

- 2-Butene on bromination gives 2,3-Dibromobutane

$$CH_3\text{-}CH=CH\text{-}CH_3 + Br_2 \xrightarrow{CCl_4} CH_3\text{-}\underset{Br}{CH}\text{-}\underset{Br}{CH}\text{-}CH_3$$

2,3-Dibromobutane

Q.25 (B) It is incorrect statement. The correct statement is as follow:

C)	**Order of ease of E2 elimination reaction in alkyl halides is** **1^o alkyl > 2^o alkyl halide > 3^o alkyl halide**

Q.26 (B) Physical property of alkyl halide are:

V. Lower alkyl halides CH_3Cl, C_2H_5Cl and CH_3F are gases at room temperature.

VI. Alkyl halides upto C_{18} are colorless liquids.

VII. Those beyond C_{18} are colourless solids.

VIII. They are usually insoluble in water due to their inability to form hydrogen bonding with water.

Q.27 (C) It is incorrect statement. The correct statement is as follow:

Order of ease of E1 elimination reaction in alkyl halide is
3^o alkyl halide > 2^o alkyl halide > 1^o alkyl halide

Q.28 (D)

S_N1	S_N2
1. A two-step mechanism	**1.** A one-step mechanism
2. Rate depends only on concentration of alkyl halide.	**2.** Rate depends on concentration of alkyl halide and nucleophile.
3. Is unimolecular	**3.** Is biomolecular
4. Rate depends on structure of halide $3^o > 2^o > 1^o > CH_3X$	**4.** Rate depends on structure of halide $CH_3X > 1^o > 2^o > 3^o$
5. Reaction is favoured by polar solvents	**5.** Reaction is favoured by non-polar solvents
6. Reaction can occur with weak bases	**6.** Reaction requires strong bases.

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Q.29 (C) **C_2H_5I halides is most reactive towards nucleophilic substitution reaction.**

Q.30 (C) **All electron deficient species are classified as electrophiles.**

Q.31 (A) **The carbon atom carrying positive change and attached to three other atoms or groups is called carbonium ion.**

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STEP

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