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CHEMISTRY

Class 10th (KPK)

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Unit 12
HYDROCARBONS

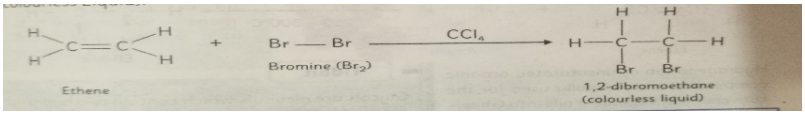
Short Questions:

Q1. How would you test that alkenes undergoes an addition reaction?

Ans: Addition reaction of alkenes: alkenes are unsaturated hydrocarbons and can be converted to saturated hydrocarbon. Addition reaction is **c**haracteristics properties of alkenes. One of the addition re action is addition of halogens (Halogenation).

Halogenation of alkene:

When bromine is added to ethene in the presence of an inert solvent like carbon tetra chloride (CCl_4), the double bond of it is converted into single bond. The red colour of bromine is disappear and produces 1, 2-dibromoethane.



Q2. Which one is more reactive between alkane and alkene? Explain.

Ans: Alkenes are more reactive than the corresponding alkanes due to the following reason:

Reason: Alkenes contain C-C double bonds and double bonds are weaker and can easily be broken. Therefore, alkenes are more reactive. On the other hand alkanes contain all C.C single bonds which are stronger and cannot be easily broken that is why alkenes are more reactive than the corresponding alkanes.

For example, ethane does not react with bromine solution while ethane reacts easily with bromine solution decolourizing its red colour.

Q3. Justify alkenes and alkynes as unsaturated hydrocarbons.

Ans: Unsaturated hydrocarbons:

The hydrocarbons containing at least one carbon-carbon double or triple bond are called unsaturated hydrocarbons. Alkenes contain C=C double and alkynes contains C≡C triple bonds. Therefore, alkenes and alkynes are termed as unsaturated hydrocarbons.

Q4. Why alkane is inert in nature?

Ans: Alkanes are chemically inert in nature due to the following reason:

Reason: Alkanes are chemically inert in nature because they contain carbon-carbon single bonds. The single bonds are very strong and stable and high energy is required to break them; therefore, alkanes are chemically inert as compared to alkynes and alkenes because they contain double or triple bonds which can easily be broken.

Q5. What happened when alkyl halide is reduced?

Ans: Reduction of alkyl halides:

Reduction means addition of hydrogen. Alkyl halides on reaction with nascent hydrogen in the presence of Zinc dust and HCl form the corresponding alkane's i.e. methyl halide will form methane, ethyl halide will form ethane etc.

General reaction of alkyl halide and nascent hydrogen to form alkane is:

$R{-}X + 2[H] \rightarrow R{-}H + HX$

Methyl iodide gives methane and hydrogen iodide HI.

$CH_3{-}I + 2[H] \rightarrow CH_3{-}H + HI$

Similarly, ethyl bromide gives ethane and hydrogen bromide HBr.

$CH_3{-}CH_2{-}Br + 2[H] \rightarrow CH3{-}CH_2{-}H + HBr$

Q6. Can you predict the products if $KMnO_4$ solution reacts with alkene?

Ans: Oxidation of alkanes by $KMnO_4$ (Baeyer's test):

Alkenes react with cold dilute potassium permanganate solution to form glycol. Glycols are the alcohols containing two hydroxyl groups (-OH) on two adjacent carbon atoms.

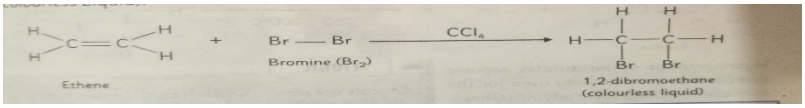
The reaction of potassium permanganate with ethane is given below:

$$3CH_2{=}CH_2+2KMnO_4+4H_2O \rightarrow 3CH_2(OH)\text{-}CH_2(OH)+2MnO_2+2KOH$$

(Ethylene glycol).

Q7. Why colour of bromine water discharges on addition to ethene?

Ans: when bromine water having red brown colour is added to ethene in the presence of inert solvent like carbon tetra chloride, its colour is discharged. Because during this reaction bromine water reacts with ethene in carbon tetra chloride to form ethylene bromide which is colourless compound.



Q8. Compare the reactivity of alkane and alkene.

Ans: Alkenes are more reactive than the corresponding alkanes due to the following reason:

Reason: Alkenes contain C-C double bonds and double bonds are weaker and can easily be broken. Therefore, alkenes are more reactive. On the other hand, alkanes contain all C.C single bonds which are stronger and cannot be easily broken that is why alkenes are more reactive than the corresponding alkanes.

For example, ethane does not react with bromine solution while ethane reacts easily with bromine solution decolourizing its red colour.

Q9. Why addition reactions take place in ethane and ethyne but not in ethane?

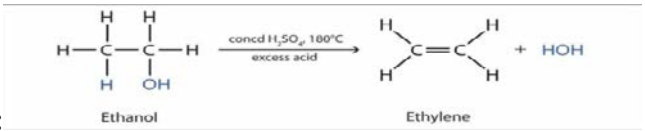
Ans: Addition reactions take place in ethane and ethyne but not in ethane due to the following reason.

Reason: Carbon atom has four electrons in its valance shell and it can directly for bond with maximum of four atoms.

Ethane and ethyne are unsaturated hydrocarbons containing C-C double and triple bonds respectively. Therefore, the two carbon atoms of ethane and ethyne are directly bonded with less than 4 other atoms. Therefore, no further atoms can be added to it i.e. addition reaction does not occur only substitution reaction occur in ethane by the replacement of H-atoms.

Q10. Write equation for the preparation of ethene from ethyl alcohol and ethyl chloride.

Ans: Ethene from ethyl alcohol:



Ethene from ethyl chloride:

LONG QUESTIONS

Q1. (i). write down the equations for the preparation of alkanes, alkenes and alkynes.

Ans: Preparation of alkanes:

1. Hydrogenation of alkenes:

Alkanes can be prepared by the hydrogenation of alkenes**.** During this reaction alkenes are hydrogenated in the presence of Nickel (Ni) catalyst at 250- 300 ^{0}C temperature.

$H_2C{=}CH_2 + H{-}H \rightarrow H_3C{-}CH_3$

Ethene Ethane

2. Hydrogenation of alkynes:

Alkynes are hydrogenated to alkenes in the presence of Nickel (Ni) catalyst at 250- 300 ^{0}C temperature in the first step and in the second step, alkene is further hydrogenated and converted into alkanes.

$HC \equiv CH + H{-}H \rightarrow H_2C{=}CH_2$

$H_2C{=}CH_2 + H{-}H \rightarrow H_3C{-}CH_3$

3. Reduction of alkyl halides: Alkyl halides on reaction with nascent hydrogen in the presence of Zinc dust and HCl form the **corresponding** alkanes i.e. methyl halide will form methane, ethyl halide will form ethane etc.

General reaction of alkyl halide and nascent hydrogen to form alkane is:

$R{-}X + 2[H] \rightarrow R{-}H + HX$

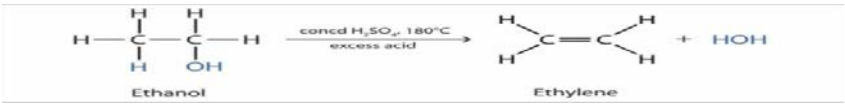
Methyl iodide gives methane and hydrogen iodide HI.

$CH_3{-}I + 2[H] \rightarrow CH_3{-}H + HI$

Preparation of alkenes:

1. Dehydrogenation of alcohols:

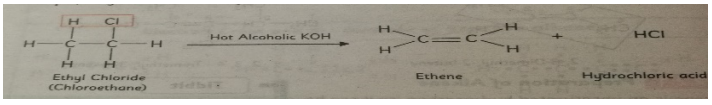
In this reaction water molecule is removed from alcohol and double bond is formed. This reaction is carried out in the presence of concentrated Sulphuric acid at 180^{o}C.



2. Dehydrohalogenation of alkyl halides:

When an alkyl halide is heated with alcoholic solution of potassium hydroxide (KOH) a molecule of hydrogen halide is removed and an alkene is formed. During this reaction hydrogen is removed from one carbon and halogen is removed from the other adjacent carbon atoms.

For example, ethyl chloride on dehydrohalogenation gives ethene and hydrogen chloride (HCl).



Preparation of alkynes:

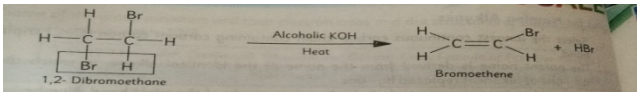
1. Dehalogenation of adjacent Dihalides:

The organic compound in which dihalides are attached to the adjacent carbon atoms are called vicinal dihalides.

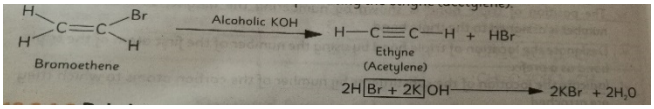
The reaction occurs in two steps.

Step 1.

Vicinal dihalides such as 1, 2-dibromoethanethane is heated with alcoholic potassium hydroxide solution, removal of hydrogen takes place from one carbon and bromine from other. It results in double bond and produces bromoethane and hydrogen bromide.

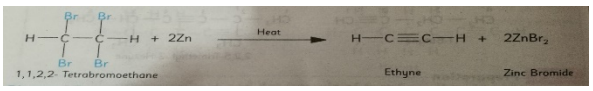


Step 2. In the next step another molecule of hydrogen bromide is removed and the double bond is converted into triple bond.



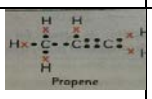
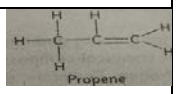
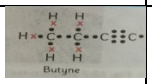
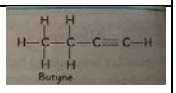
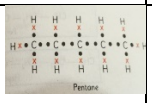
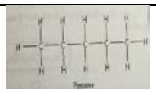
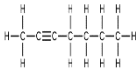
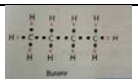
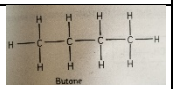
2. Dehalogenation of Tetra halide:

The compound contain four halogens atoms at two adjacent carbon atoms are called tetra halides. When alkyl tetra halides for example 1, 1, 2,2-tetrabromoethane is treated with reactive metal like zinc (Zn) dust. It eliminates two bromine and form triple bond, producing ethyne and zinc bromide ($ZnBr_2$).



Q1.(ii) Draw the molecular, dot, and cross, condensed and structural formula of each of the following.

Propene, Butyne, Pentane, Heptyne, butane.

s.no	Molecular formula	Condensed formula	Dot and cross formula	Structural formula
Propene	C_3H_6	CH_2CHCH_3		
Butyne	C_4H_6	CH_3CH_2CCH		
Pentane	C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$		
Heptyne	C_7H_{12}	$CH_3CH_2CH_2CH_2CH_2C{\equiv}CH$		
Butane	C_4H_{10}	$CH_3CH_2CH_2CH_3$		

Q2. (i). the general formula of alkanes is C_nH_{2n+2}. Determine the general formula of cycloalkane?

Ans: **Cycloalnaes**: The alkanes in which carbon atoms are arranged in a ringorcyclic structure is called cycloalkanes·**The general formula of Cycloalnaes:** The general formula of cycloalkanes is C_nH_{2n}. Cycloalkanes have less than two hydrogen atom than in corresponding straight chain alkanes.

(ii). write a balanced equation for the complete combustion of each of the following.

a. **Methane b. Ethane c. Ethyne**

a.Combustion of Alkanes: Alkanes burn completely in the presence of excess of air (oxygen) to produce a lot of heat, carbon dioxide and water. The reaction is highly exothermic and thus alkanes is used as a fuel.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + heat

Combustion of Alkenes: On complete combustion, alkenes produce carbon dioxide and water with the release of high amount of energy.

C$_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$ + heat

C.Combustion of Alkynes: On complete combustion, alkynes produce carbon dioxide and water with the release of high amount of energy,

2C$_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$ + heat.

(iii). Explain briefly that why ethyne (a) undergoes addition rection in two steps?

Answer: In addition reaction of ethyne first triple bond is converted into double bond and then double bond is converted into single bond**.** That is the reason ethyne undergoes addition rection in two step.se

Example: hydrogenation of ethyne:
Step 1.$HC \equiv CH + H{-}H \rightarrow H_2C{=}CH_2$ **Step 2.** $H_2C{=}CH_2 + H{-}H \rightarrow H_3C{-}CH_3$.

Q3. (i). Give an example reaction of that would yield the following products. Name the organic reactants and products in each reaction.

Ans: a). Alkanes:

Hydrogenation of alkenes: alkanes can be prepared by the hydrogenation of alkenes**.** During this reaction alkenes are hydrogenated in the presence of Nickel (Ni) catalyst at 250- 300 ^{0}C temperature.

$H_2C{=}CH_2 + H{-}H \rightarrow H_3C{-}CH_3$
Ethene Ethane
b). Mon halogenated alkanes: Alkanes react with halogens in the presence of UV light and produce alkyl halide and hydrogen halide.

$H_3C{-}H + Cl{-}Cl \rightarrow H_3C{-}Cl + HCl$
Methane methyl chloride **c). Di halogenated alkanes:**

$Cl{-}CH_2{-}H + Cl{-}Cl \rightarrow Cl{-}CH_2{-}Cl + H{-}Cl$
methyl chloride Dichloromethane

d). Tetra halogenated alkanes:

$Cl_3C{-}H + Cl - Cl \rightarrow CCl_4 + H{-}Cl$

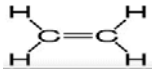
Dichloromethane tetrachloromethane

(ii). (a). Alkanes are unsaturated hydrocarbons. Explain the word unsaturated.

Ans: The word unsaturated means the organic compound having at least one carbon-carbon double or triple bond**.** The unsaturated hydrocarbons having hydrogen less than that of saturated hydrocarbons. Therefore, unsaturated hydrocarbons can easily undergo addition reaction.

(b). Describe the bonding between two carbon atoms in ethene.

Ans: bonding in ethene: Ethene is an unsaturated hydrocarbon containing two carbon atoms that are bonded to each other. With each carbon atom also bonded two hydrogen atoms.



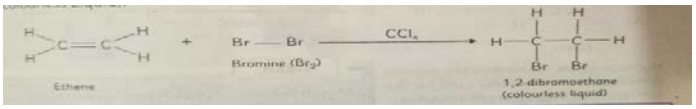
(c). which functional group is present in alkene?

Ans: In alkene C═C double bond functional group is present.

(d). Describe a simple chemical test to determine whether an unknown hydrocarbon is unsaturated. Describe the result if the test is positive.

Ans: The two widely used tests for determining the unsaturation in compound is bromine water test and Baeyer's test.

1. Bromine water test: add a few drops of bromine water to the substance under test and shake. If there are any carbon═ carbon double bonds then the red coloured bromine water will become colourless. The red colour of bromine is disappearing. During this test bromine water reacts with ethene to form ethylene bromide which is colourless compound.



2. Baeyer's test:

This test is used for determining the presence of double bond in compounds. Alkenes is reacted with acidified aqueous solution of potassium permanganate ($KMnO_4$) and form ethylene glycol (1, 2-ethanediol). During this reaction purple colour of $KMnO_4$.

$$3H_2C{=}CH_2 + 2KMnO_4 + 4H_2O \rightarrow 3H_2C{-}\underset{|\quad|}{CH_2} + 2MnO_2 + 2KOH$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad OH\ OH$$

b

Q4. Using structural formula, give balanced equations for the following reactions.

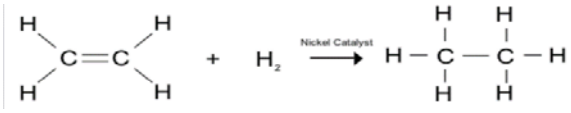
(a). Ethene with Chlorine:

Chlorine readily react with ethene in the presence of inert solvent carbon tetra chloride to form dichloro ethane.

(b). Ethene with hydrogen, name the catalyst used. Which industrial process uses a similar reaction?

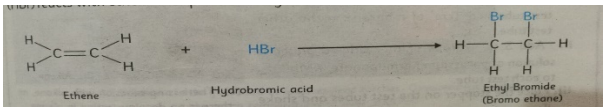
Hydrogenation of ethene:

When hydrogen (H_2) is added to ethene, the double bond is converted into single bond and produces ethane. The reaction occur in the presence of nickel as a catalyst at 250-300^{0}C.



(c). Ethene with hydrogen bromide:

The hydrogen (HBr) react with reacts with ethene and produces Ethyl bromide (Bromoethane).



(d). Ethene with $KMnO_4$:

Alkenes react with acidified aqueous solution of potassium permanganate ($KMnO_4$) to form glycol. Glycol are alcohols which contain two hydroxyl groups (-OH) on two adjacent carbons.

$$3H_2C{=}CH_2 + 2KMnO_4 + 4H_2O \rightarrow 3H_2C(OH){-}CH_2(OH) + 2MnO_2 + 2KOH$$

b

Q5. Illustrate the following accordingly has been instructed.

(A). Alkane from Alkyl Halide

Reduction of alkyl halides: Alkyl halides on reaction with nascent hydrogen in the presence of Zinc dust and HCl form the corresponding alkanes i.e. methyl halide will form methane, ethyl halide will form ethane etc. General reaction of alkyl halide and nascent hydrogen to form alkane is:R─X + 2[H] → R─H + HX Methyl iodide gives methane and hydrogen iodide HI.CH_3─I+ 2[H] → CH_3─H+ HI**(b). Bromoethane from Ethene:** When bromine is added to ethene in the presence of an inert solvent like carbon tetra chloride (CCl_4), the double bond of it is converted into single bond. The red colour of bromine is disappearing and produces 1, 2-dibromoethane.

(c) Ethylene glycol (1, 2-ethanediol) from Ethene:

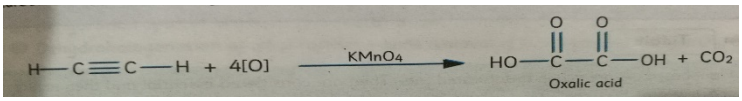
Alkenes react with acidified aqueous solution of potassium permanganate ($KMnO_4$) to form glycol. Glycol are alcohols which contain two hydroxyl groups (-OH) on two adjacent carbons.

$$3H_2C{=}CH_2 + 2KMnO_4 + 4H_2O \rightarrow 3H_2C(OH){-}CH_2(OH) + 2MnO_2 + 2KOH$$

b

(d). Oxalic acid from Acetylene:

The reaction of acetylene with potassium permanganate gives carboxylic acid and carbon dioxide on breaking the molecule of carbon─carbon triple bond.



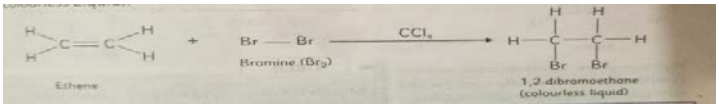
TOPIC WISE QUESTIONS

Q2. What are addition reaction?

Ans: Addition reaction: The reaction in which two or more substances react to form only one substance are called addition reaction.

With regard to organic compounds addition reactions can be defined as:

"the reaction in which molecules like H_2, Cl_2,HCl etc. are added to alkene and alkynesis called addition reaction. Addition reaction occur only in unsaturated hydrocarbons. During addition reaction unsaturated hydrocarbons are changed to saturated hydrocarbons



Q3. Write down the physical properties of Alkanes;

Ans: Physical properties:

i. Physical state: The first four members (methane, ethane, propane, butane) of alkane series are gases. Next thirteen members (from C_5H_{12} to $C_{17}H_{36}$) are colourless liquids and higher members of the series are solids.

ii. Solubility: Since alkanes are non-polar therefore, they are soluble in non-polar solvents like benzene, acetone, ether etc. However they are insoluble on polar solvents like water.

iii. Meting points and boiling points: The melting points and boiling points of alkanes increases with the increase in molecular masses because generally higher molecular masses alkanes have stronger intermolecular forces.

iv. Density: the density of alkanes increases regularly with increase in molecular mass.

V. viscous: Alkanes become more viscous as their molecular sizes increase.

vi. Flammable: Alkanes are flammable. With the increase of atomic mass the percentage of carbon in alkanes molecules also increases. As a result, alkanes become less flammable.

Q4. Give important chemical reactions of alkanes.

Ans: Chemical properties: As carbon atoms of alkanes are directly bonded with 4 other atoms therefore, only **Substitution** reaction reactions can occur in alkanes. Alkanes are chemically inert at room temperature due to all C-C and C-H single bonds presents in them. However at higher temperature, absorption of light etc the following reactions take place in them.

i. Halogenation: The substitution of hydrogen of an alkane by halogen is called halogenations.

Example: For example chlorine reacts with methane in the presence of diffused sunlight to form chloro-methane (methyl chloride).

$H_3C-H + Cl-Cl \rightarrow H_3C-Cl + HCl$

Methane methyl chloride

This reaction does not stop here. The remaining three hydrogen atoms are also replaced by chlorine atoms to form di, tri and tetra chloro-methane respectively

$Cl-CH_2-H + Cl-Cl \rightarrow Cl-CH_2-Cl + H-Cl$

methyl chloride Dichloromethane

$Cl-CH_2-Cl + Cl-Cl \rightarrow Cl_3CH + HCl$

Dichloromethane Chloroform (tri-Chloromethane)

$Cl_3CH + Cl-Cl \rightarrow CCl4$

Chloroform Carbon tetrachloride

ii. Combustion: Alkanes react with oxygen or air at higher temperature to form carbon dioxide, water vapours with evolution of large amount of heat.

Examples:

$$CH_{41g}+O_{21g} \rightarrow CO_{21g}+H_2Og+Heat$$

$$2C_2H +70_{21g}\ 4CO_{21g}+6HO_g+ Heat$$

In limited supply of oxygen, incomplete combustion of alkanes takes place and produce carbon monoxide, water and carbon.

$$3CH_{41g}+ 4O_{21g} \rightarrow 2CO+ 6H_2O + C$$

Q5. What is alkene? How it can be named?

Ans: Alkenes:

The unsaturated hydrocarbons containing at least one C-C double bond are called alkenes".

General Formula: They have the general formula of C_nH_{2n}

In alkenes all the carbon atoms are not bonded with 4 other atoms i.e. at least two carbon atoms are bonded with 3 other atoms. Addition reaction occur in alkenes.

Examples:

i. Methene (C_2H_4)4

ii. Propene (C_3H_6)

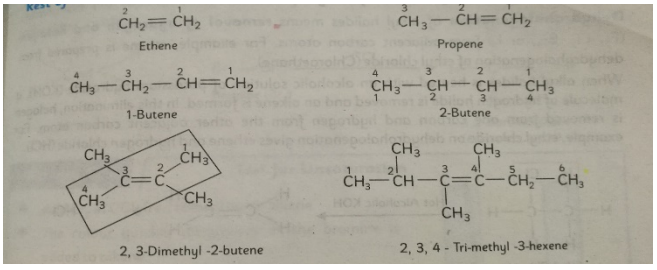
iii. Butene (C_4H_8)

iv. Pentene C_5H_{10}

Rules for naming alkenes:

The IUPAC rules for alkenes are as follow.

1. Select the longest continuous chain containing double bond (C═C) as the parent chain.
2. The parent name is derived from the named of the identical alkanes, in which the last –ane of alkanes is replaced –ene.
3. Number the chain so as to include both carbon atoms of the double bond. Numbering begins from the end which is nearer to the double bond.
4. The position of double is shown by numbering the alkene, so that minimum number is assigned to the double bond
5. Designate the location of the double bond by using the number of the first atom of the double bond as a prefix.
6. Indicate the location of the branches by numbers of the carbon atoms to which they are attached.



Q6. Write down physical and chemical properties of Alkenes.

Ans: Physical properties of alkenes:

i. Physical state: The first three members of alkene (ethene, propene, butene) are gases. Other members are liquids and higher are solids

ii. Solubility: alkenes are non-polar therefore, they are soluble in non-polar solvents like benzene, acetone, ether etc. However they are insoluble on polar solvents like water.

iii. Meting points and boiling points: The melting points and boiling points of alkenes increases with the increase in molecular masses because generally higher molecular masses alkenes have stronger intermolecular forces.

Chemical properties Alkenes:

Because of the unsaturated nature of alkenes, they easily undergoes addition reaction and in this way, they are converted into saturated compounds.

Important reaction of alkenes: Important reaction of alkenes include halogenation, addition of hydrogen halides, oxidation by $KMnO_4$, and hydrogenation. Theses reaction has already been discuss in exercise.

Q7. Define alkynes. Give the rules for naming of alkynes.

Ans: Alkynes:"

The hydrocarbons which contain at least on carbon─carbon which contain at least on carbon- carbon triple bonds are called alkynes."

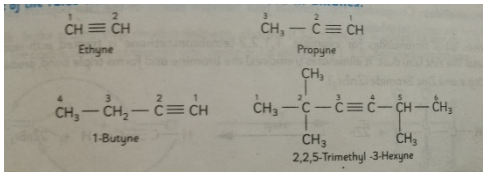
General formula: They have the general formula of C_nH_{2n-2}, where n is the number of carbon atoms.

Examples: Ethyne (C_2H_2), propyne (C_3H_4), butyne (C_4H_6), and pentyne (C_5H_8) etc are the examples of alkynes.

Rules for naming alkenes:

The IUPAC rules for alkenes are as follow.

1. Select the longest continuous chain containing carbon- carbon triple bond (C ≡ C) as the parent chain.
2. The parent name is derived from the named of the identical alkanes, in which the last –ane of alkanes is replaced –yne.
3. Number the chain so as to include both carbon atoms of the triple bond. Numbering begins from the end which is nearer to the triple bond.
4. The position of triple bond is shown by numbering the alkyne, so that minimum number is assigned to the triple bond
5. Designate the location of the double bond by using the number of the first atom of the triple bond as a prefix.
6. Indicate the location of the branches by numbers of the carbon atoms to which they are attached.



Q8. Write down physical and chemical properties of Alkynes.

Ans: Physical properties of alkynes:

i. Physical state: The first three members of alkyne (ethyne, propyne, butyne) are gases. Other members are liquids and higher are solids

ii. Solubility: alkynes are non-polar therefore, they are soluble in non-polar solvents like benzene, acetone, ether etc. However they are insoluble on polar solvents like water.

iii. Meting points and boiling points: The melting points and boiling points and density of alkynes increases with the increase in molecular masses because generally higher molecular masses alkenes have stronger intermolecular forces.

iv.Combustion: on complete combustion, they produce carbon dioxide and water with the release of high amount of energy,.

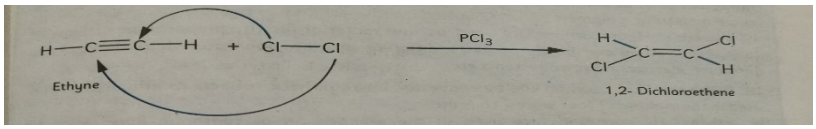
Chemical properties Alkynes:

Because of the unsaturated nature of alkynes, they easily undergoes addition reaction and in this way, they are converted into saturated compounds.

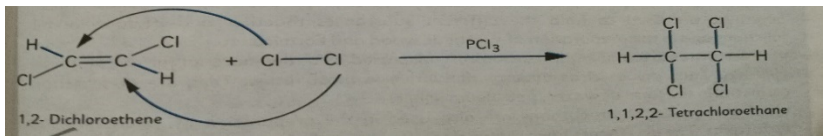
Important reaction of alkenes:

1. Halogenation: Alkynes react with halogens such as chlorine and bromine in the presence catalyst phosphorus trichloride (PCl_3). The addition of halogens take place in two steps.

Step 1. In the first step a halogen molecule, i.e. chlorine (Cl_2) or bromine (Br_2) is added to triple bond. Triple bond is converted into double bond and forms 1, 2-dichloroethene.



Step 2. In the second step another halogen molecule, i.e. chlorine (Cl_2) or bromine (Br_2) is added to double bond. thw double bond is converted into single bond and forms 1,1,2,2-tetra chloro ethene.



2. Oxidation with $KMnO_4$:

The oxidation of ethyne with potassium permanganate givs carboxylic acid and carbon dioxide on breaking the molecule at carbon – carbon triple bond.