



Dr. Blosa Science


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SENIOR FIVE TERM 2

TOPIC 3/3: Organic Chemistry I PART 1

Topic competency: The learner analyses the structures, functional groups, and reactivity of organic compounds, and applies knowledge of organic reactions and organic reaction mechanisms to synthesise organic molecules.

Introduction

Organic is the study of the chemistry of carbon. Carbon out of 112 elements of the Periodic Table forms a branch of chemistry called organic chemistry; it must be unique.

Uniqueness of carbon

Carbon forms very many useful compounds of different chemical and physical properties.

Uses of organic compound

Organic compounds are used for making:

- Plastic chairs,
- Plastic tables,
- drugs,
- perfumes
- pens
- paper
- Herbicides.

Terminologies in organic chemistry

1. Hydrocarbons

These are compounds that contain carbon and hydrogen only.

2. Functional groups

Is an atom or groups of atoms that impart chemical properties to organic compounds. For instance, a double bond in alkenes ($-C=C-$), a triple bond in alkynes ($-C\equiv C-$), hydroxyl group in alcohols ($-OH$), a halogen atom in alkylhalides, carbonyl ($-CO-$) group and a carboxylic group ($-COOH$).

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3. **Homologous series** is group of organic compounds that
- are represented by similar general formula,
 - have similar functional group and hence similar chemical properties
 - are prepared by similar chemical methods
 - show varying chemical properties. For instance, members of a given homologous series may vary from gases to liquids to solids.

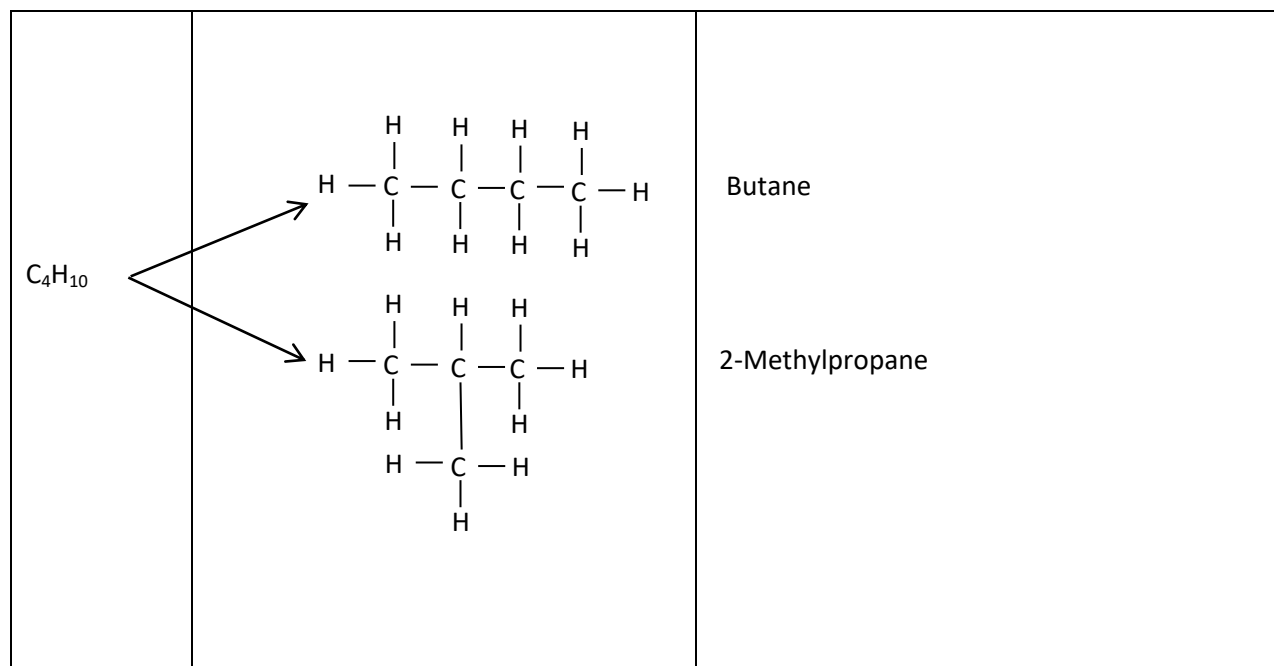
Alkanes

This is the simplest homologous series

General formula: C_nH_{2n+2} where $n \geq 1$

Examples

Formula	Structural formula	Name
CH ₄	<pre> H H — C — H H </pre>	Methane
C ₂ H ₆	<pre> H H H — C — C — H H H </pre>	Ethane
C ₃ H ₈	<pre> H H H H — C — C — C — H H H H </pre>	Propane



Compounds that have the same molecular formula but different structural formulae like butane and 2-methylpropane are called **isomers**.

Definitions

Isomerism is the existence of compounds with the same molecular formula but different arrangement of atoms in each of the compounds.

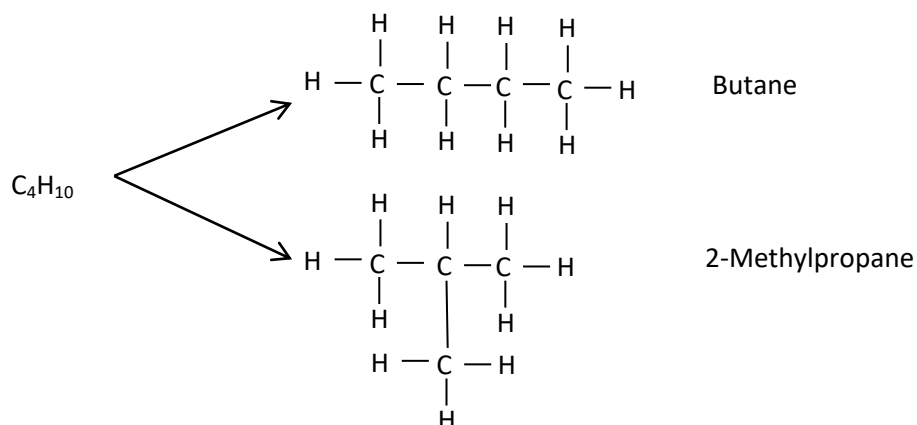
Types of isomerism

1. Structural isomerism
2. Optical isomerism

(a) Structural isomerism

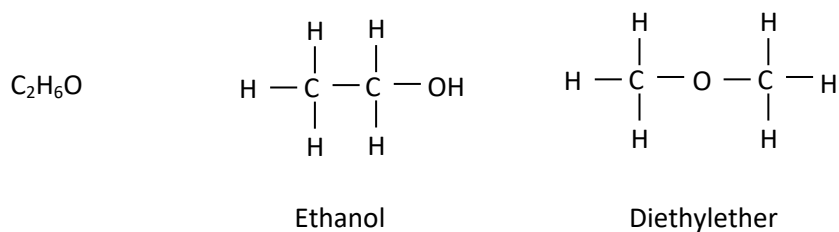
Here compounds differ in arrangement of atoms in isomeric compounds.

- (i) **Chain isomerism:** compounds have the same molecular formula but different arrangement of atoms in the chains. Some authors use chain isomerism and structural isomerism interchangeably. This kind of isomerism is common to alkanes, e.g.



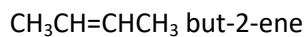
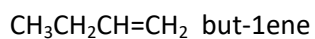
(ii) **Functional isomerism**

Compounds have the same molecular formula but different functional groups such as alcohols and ether, e.g.



(iii) **Positional isomerism:**

The isomers have the same molecular formula, same functional group but different positions of the functional group on each molecule, e.g.

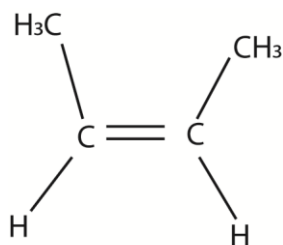


(b) Stereo isomerism

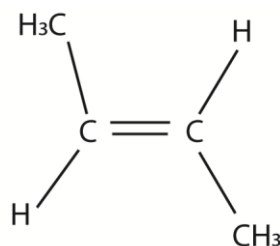
Compounds have the same molecular formula, the same functional group but different arrangement of atoms in space.

- (i) **Geometrical isomerism:** atoms, molecules are arranged differently about a double bonds:

Example



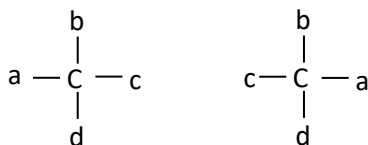
cis but-2-ene



trans but-2-ene

(ii) Optical isomers:

Compounds have the same molecular formula, the same functional group but differ in optical properties towards plane polarized light. Those that rotate light towards the right are called **dextro**-isomers and those that rotate light towards the left are called **levo**-isomers. They characteristically have four different groups attached to one carbon and are mirror images, i.e.



Nomenclature

(a) Straight chain isomers

Straight chain isomers are named according to the number of carbon atoms in the chain.

The names of the first ten straight chain isomers are given below

CH ₄	Methane
CH ₃ CH ₃	Ethane
CH ₃ CH ₂ CH ₃	Propane
CH ₃ CH ₂ CH ₂ CH ₃	Butane
CH ₃ CH ₂ CH ₂ CH ₂ CH ₃	Propane
CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Hexane
CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Heptane
CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Octane
CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Nonane
CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₂ CH ₃	Decane

Alkyl group

An alkyl group is an alkane less one hydrogen atom.

Examples

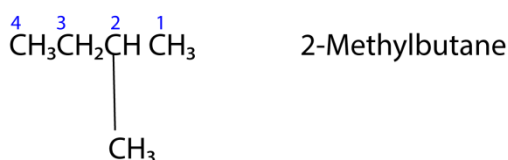
CH ₄	Methane	CH ₃ -	methyl group
CH ₃ CH ₃	Ethyl	CH ₃ CH ₂ -	Ethyl group
CH ₃ CH ₂ CH ₃	Propane	CH ₃ CH ₂ CH ₂ -	Propyl group
CH ₃ CH ₂ CH ₂ CH ₃	Butane	CH ₃ CH ₂ CH ₂ CH ₂ -	Butyl group

Because alkyl groups do not show variable chemical properties, they are generally represented by a letter R. However, the length of an alkyl group may influence the level of reactivity of a function group.

(b) Naming branched alkanes

- Determine the number of carbon atoms in the longest carbon chain that contains a branch.
- Number the carbon atoms from the side nearest the branch.

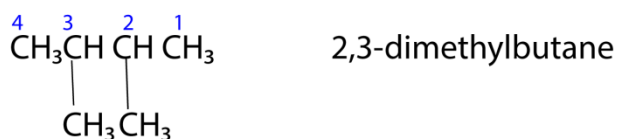
Example



Note: there should not be space between the alkyl group radical and the main alkane e.g. the correct name is 2-methylbutane **and NOT** 2-methyl butane

- If there are more than one similar alkyl groups attached to the longest chain; use di, tri, tetra to indicate the number of such groups on the main chain.

Example

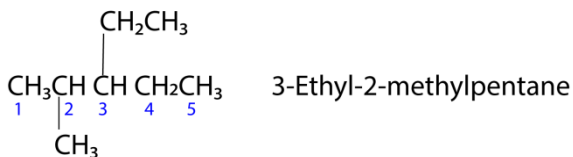


Note that

- This name implies that there is a methyl group attached to carbon in position 2 and another methyl group attached to carbon in position 3 of the butane molecule.
 - When writing the name of an organic compound, a comma (,) is placed between figures and a dash (-) between a figure and a letter.
- If different branches; name them alphabetically

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Example

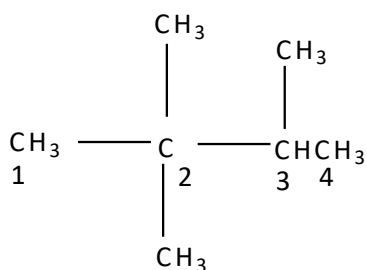


Note that

“E” for ethyl group comes before “M” for methyl group in the alphabets.

- (v) If branching occurs at equal distance from either side of the main chain, choose a name that gives the least sum of combination of numbers.

Example



2,2,3-trimethylbutane **AND NOT** 2,3,3-trimethylbutane

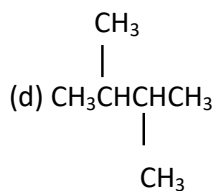
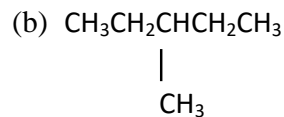
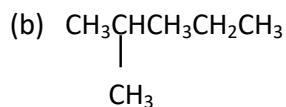
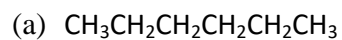
sum = 7

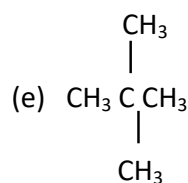
sum = 8

2,2,3-trimethylbutane is the correct name because it gives the least sum for the combination of numbers.

Trial 1

Name the following compounds

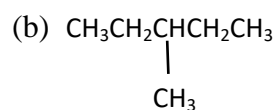




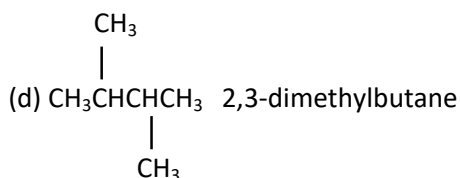
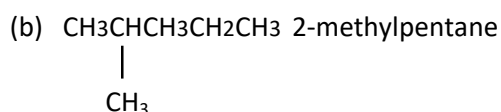
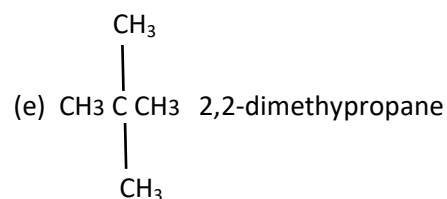
Solution



Hexane



3-methylpentane



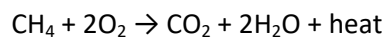
Physical properties of alkane

- they are insoluble in water
- they are soluble in organic solvents
- they range from gases to liquids to waxy solids

Chemical properties

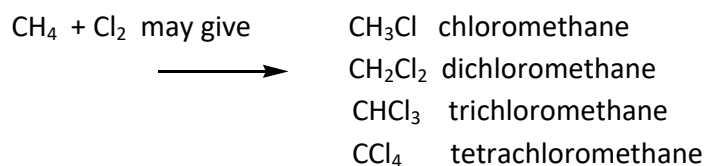
1. They burn in air to produce carbon dioxide, water and heat. Due to production of heat they are used as fuel.

Example



2. **Chlorination:** they react with chlorine in presence of sunlight or u.v-light to produce chlorinated alkanes.

Example



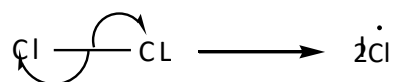
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Mechanism

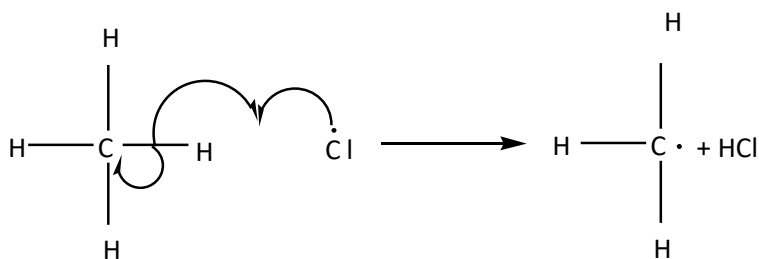
A **mechanism** is a step by step pathway followed by a reaction from the reactant to the products.

The following are steps followed in chlorination of methane

1. Chlorine molecules dissociates into free radicals/ atoms with unpaired electron. Free radicals are indicated by a dot on the atom that possesses un paired electron

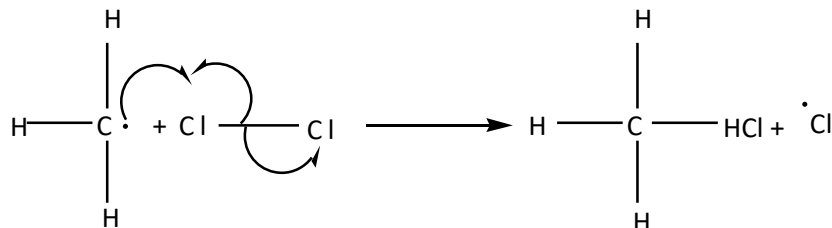


2. Chlorine radical attacks methane to produce hydrogen chloride and a methyl radical.



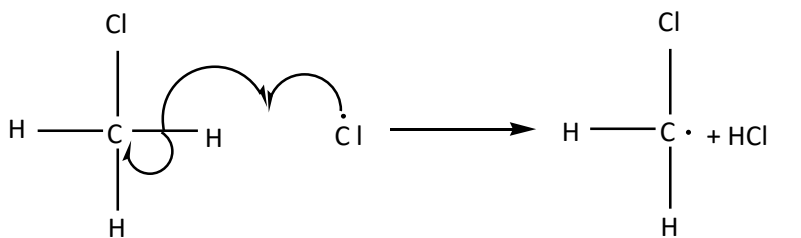
Methyl radical

3. Methyl radical reacts with a chlorine molecule to form chloromethane and a chlorine radical



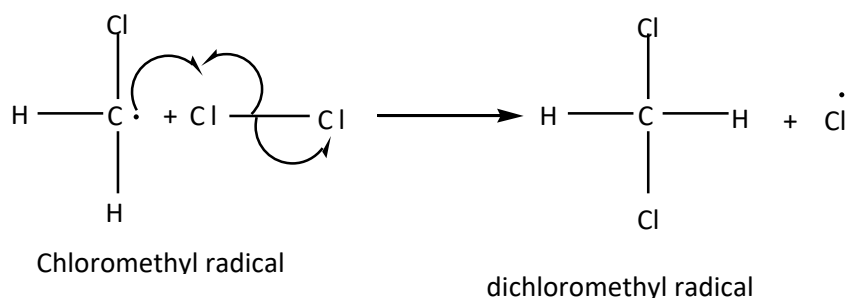
Chloromethane

4. Chlorine radical attacks a chloromethane to produce hydrogen chloride and a chloromethyl radical.

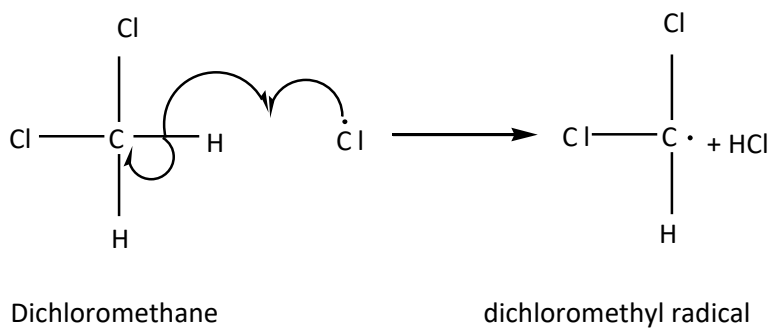


Chloromethyl radical

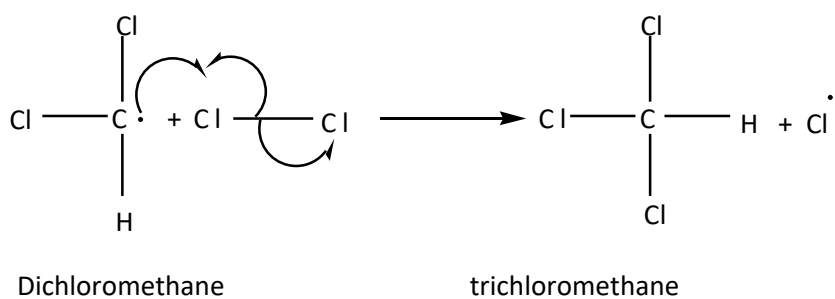
5. Chloromethyl radical reacts with a chlorine molecule to form dichloromethane and a chlorine radical



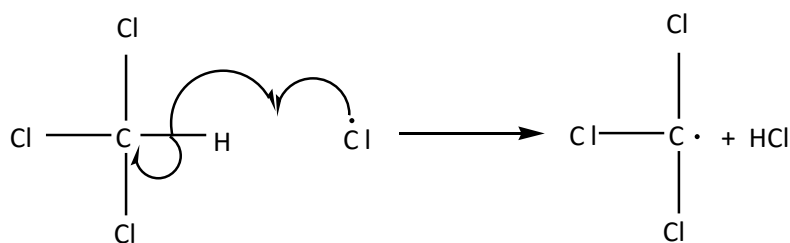
6. Chlorine radical attacks a dichloromethane to produce hydrogen chloride and a dichloromethyl radical.



7. Dichloromethyl radical reacts with a chlorine molecule to form trichloromethane and a chlorine radical



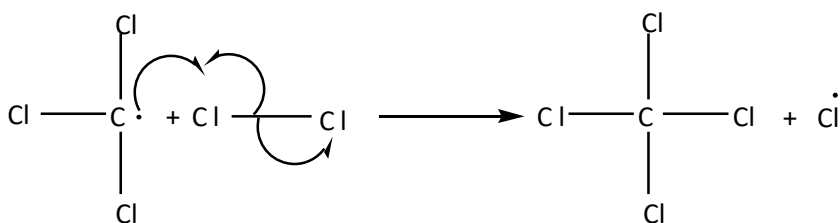
8. Chlorine radical attacks a trichloromethane to produce hydrochloride and a trichloromethyl radical.



Trichloromethane

Trichloromethyl radical

9. Trichloromethyl radical reacts with a chlorine molecule to form tetrachloromethane and a chlorine radical



Trichloromethyl radical

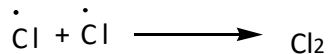
tetrachloromethane

Terminating steps

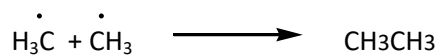
Meanwhile the radicals may combine to produce molecules. The reactions where radicals react to produce molecules is called terminating steps i.e., they eat up the free radicals and prevent the reaction from continuing.

Some of the terminating steps are:-

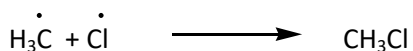
1. Chlorine radical + chlorine radical produces chlorine molecule



2. Methyl radical + methyl radical produces ethane



3. Methyl radical reacts with chlorine radical to form chloromethane and so on.



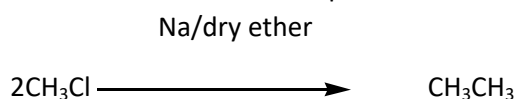
Sources of alkanes

1. Petroleum product
2. Biogas

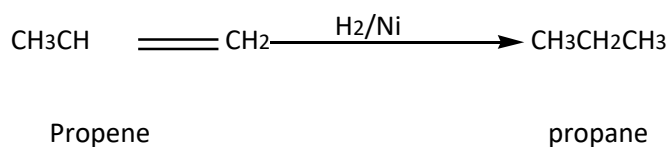
Biogas is produced by anaerobic decomposition of organic matter (such as cow dung, plant remains, and feces) in presence of water. The main component of biogas is methane.

Laboratory preparation

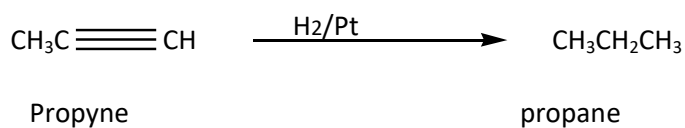
1. By coupling reaction of alkylhalide in presence of sodium and dry ether. For instance a chloromethane molecule couples with a chloromethane molecule to form ethane



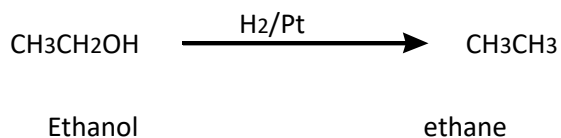
2. By reduction of alkenes, e.g.



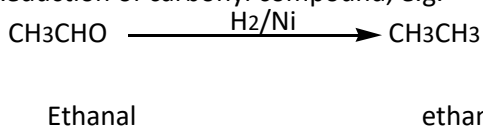
3. Reduction of alkynes, e.g.



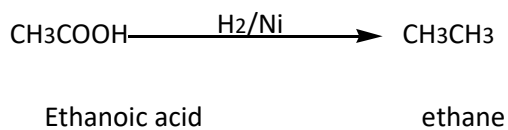
4. Reduction of alcohols, e.g.



5. Reduction of carbonyl compound, e.g.



6. By reduction of carboxylic acid, e.g.



7. By cracking long alkane

Cracking is the breakdown of long chain hydrocarbons into short chain alkanes.

Cracking may be catalytic where a catalyst is used or thermal when heat is used.

Alkenes

These are hydrocarbons that contain a double bond

General formula is C_nH_{2n} where $n \geq 2$

Examples are

Ethene $\text{CH}_2=\text{CH}_2$

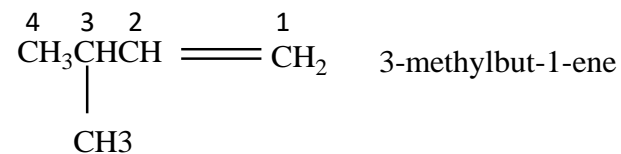
Propene $\text{CH}_3\text{CH}=\text{CH}_2$

But-1-ene $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$

But-2-ene $\text{CH}_3\text{CH}=\text{CHCH}_3$

For branched alkene we number the carbon atoms from the side nearest the double bond

For example



Physical properties

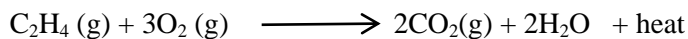
They like those of alkane

- they are insoluble in water
- they are soluble in organic solvents
- they are solvents
- they range from gases to liquids to waxy solids

Chemical properties

1. Combustion

They burn in air to produce carbon dioxide, water and heat.

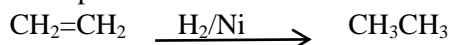


Because they produce heat they are used as fuel.

2. Reduction

They are reduced by hydrogen in presence of catalysts; nickel or platinum to alkenes

Example

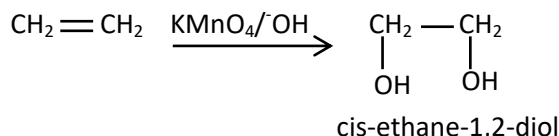


3. Hydration reaction

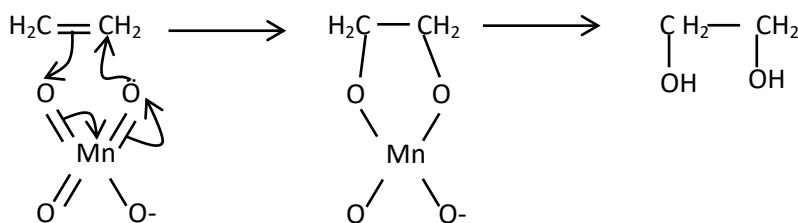
(i) Reaction of alkenes with KMnO_4 solution

Dilute alkaline KMnO_4 solution convert alkenes into compound called GLYCOLS (dihydroxyl alcohols)

Example



Mechanism



The reaction proceeds with decolorization of the solution and is used to test for unsaturation

4. Electrophilic addition reactions

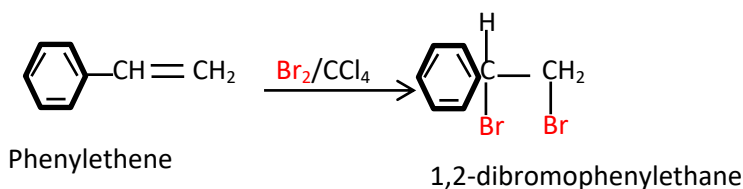
Alkenes react with electron deficient groups called electrophiles to form saturated compounds.

Definitions

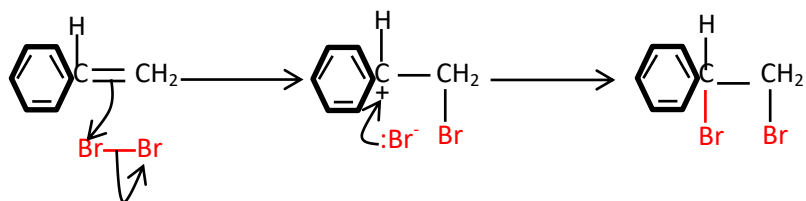
Electrophilic addition reaction is a reaction where an electron deficient group adds to an unsaturated compound (alkenes or alkynes) to form saturated compounds.

Example 3

Phenylethene plus bromine in presence of tetrachloromethane give 1,2-dibromophenylethane

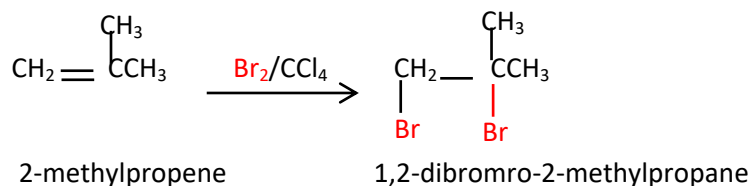


Mechanism

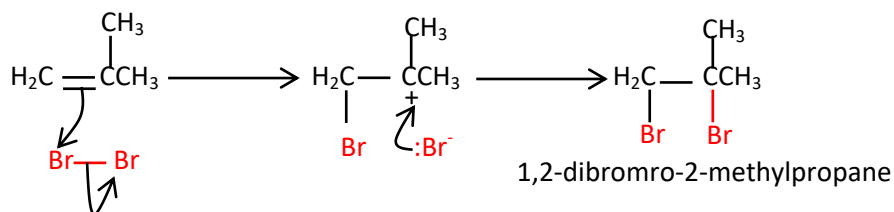


Example 4

2-methylpropene plus bromine in presence of tetrachloromethane gives 1, 2-dibromo-2-methylpropane



Mechanism



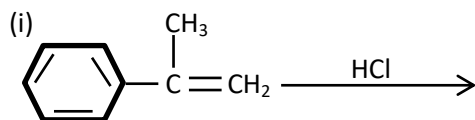
Reaction of alkenes with HX (X = Cl, Br, I)

The reaction is carried out by bubbling HX through alkenes. X of HX attaches its self to the carbon atom that carries the least number of hydrogen atoms while the hydrogen atom of HX to the carbon atom that carries the highest number of hydrogen atom of those carbon atoms that form the double bond. This empirical observation is called **Markoncoff** rule

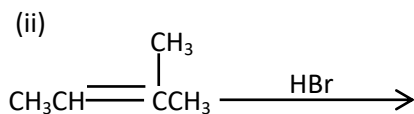
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Trial 2

Complete and write a mechanism



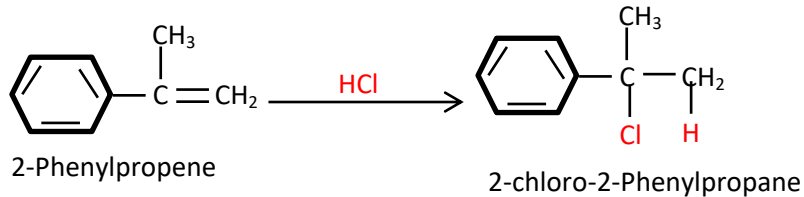
2-Phenylpropene



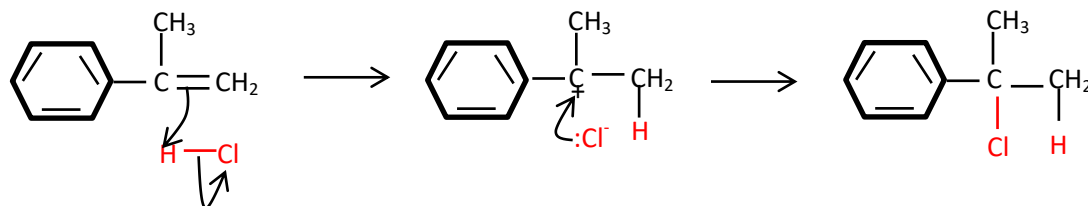
2-Methylbut-2-ene

Solution to trial 2

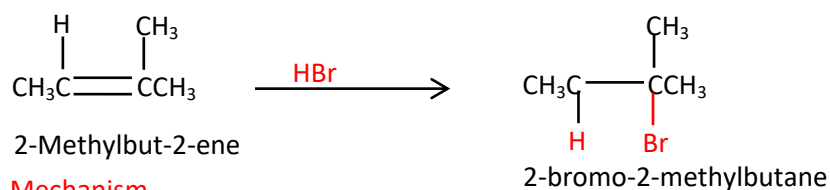
(i) 2-phenylpropene plus HCl gives 2-chloro-2-phenylpropane



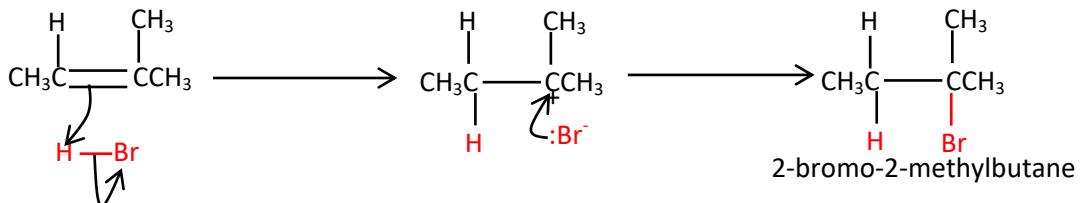
Mechanism



(ii) 2-methylbut-2-ene plus HBr gives 2-bromo-2-methylbutane



Mechanism

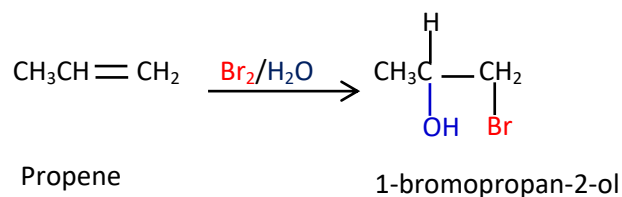


Reaction of alkenes with halogens in presence of water

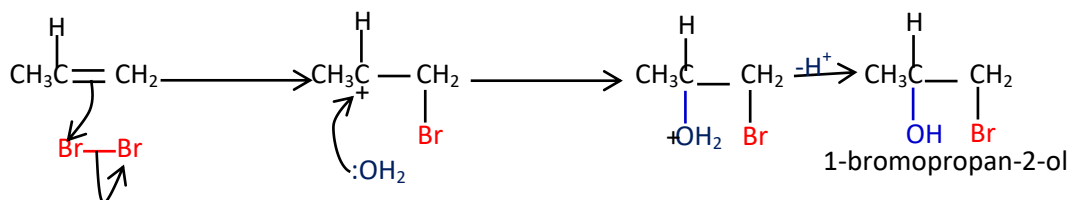
The reaction is carried out by bubbling alkenes through aqueous halogens. OH group attaches its self to carbon atom that carries the least number of hydrogen atoms of the carbon atoms that form a double bond

Example 7

Reaction of propene with bromine in presence of water gives 1-bromopropan-2-ol

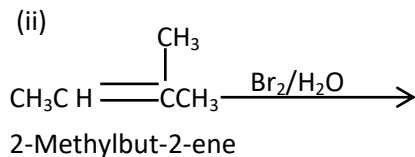
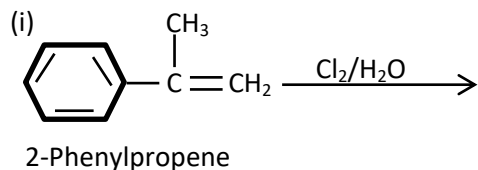


Mechanism



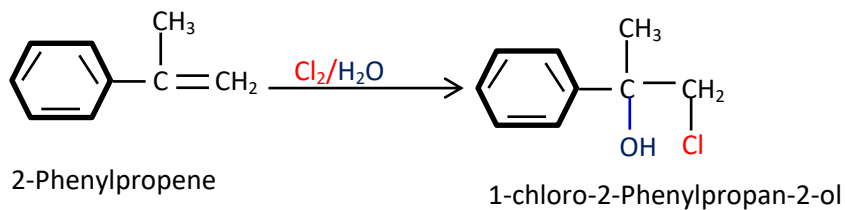
Trial 3

Complete the following and write mechanism (do not look at the answer before)

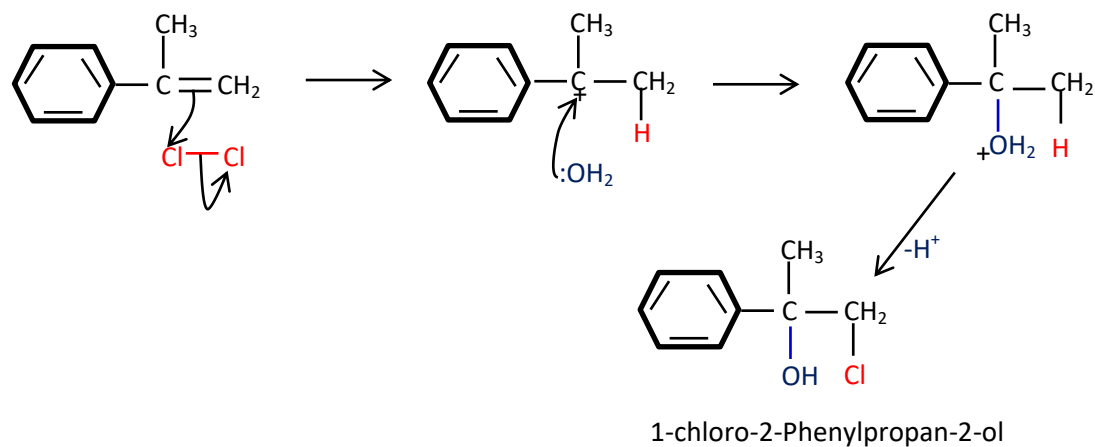


Solution to trial 3

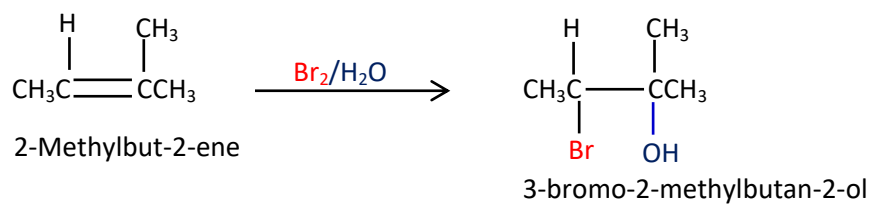
- (i) 2-phenylpropene plus HCl gives 1-chloro-2-phenylpropan-2-ol



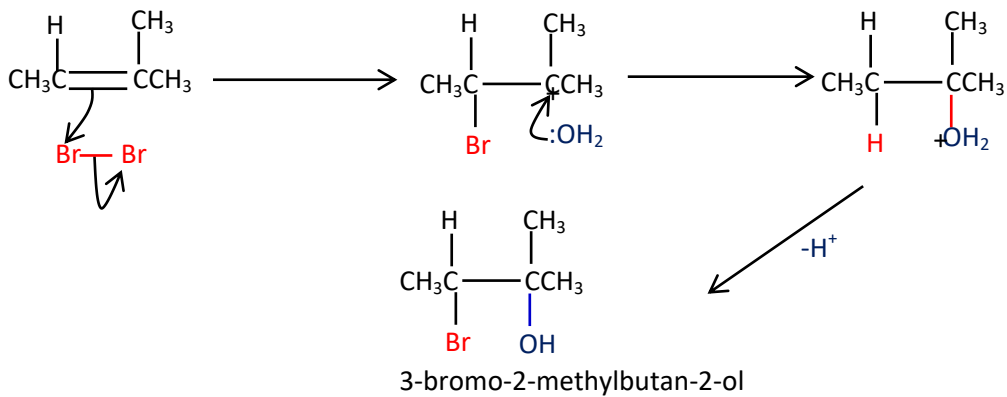
Mechanism



- (ii) 2-methylbut-2-ene plus bromine in presence of water gives 3-bromo-2-methylbutan-2-ol

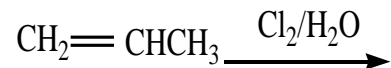


Mechanism



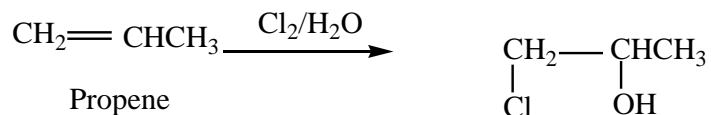
Trial 4

Complete and write a mechanism

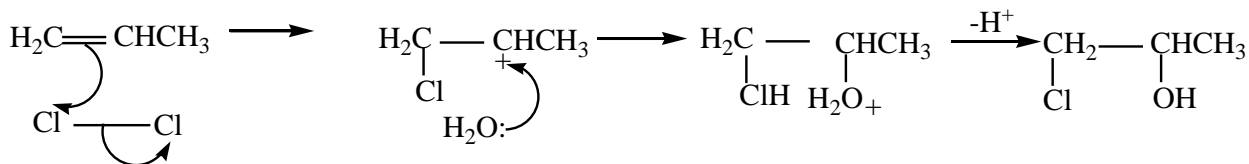


Propene

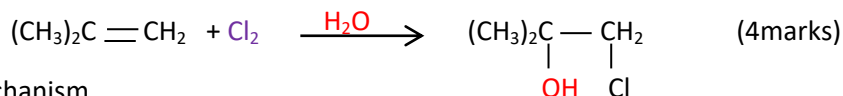
Solution



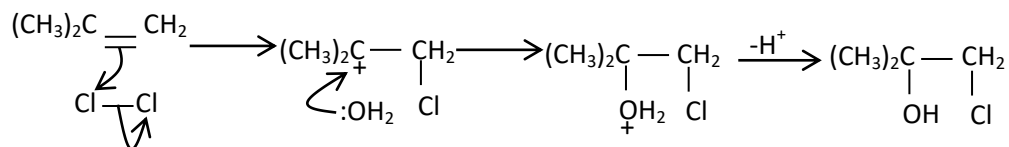
MECHANISM



Trial 5



Mechanism



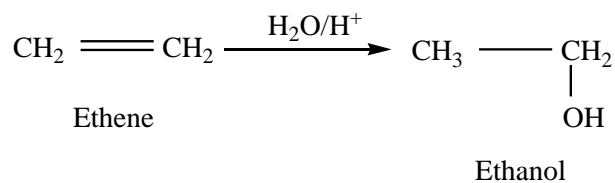
(d) **Reaction of alkene with water.**

The reaction is catalysed by an acid (sulphuric acid or phosphoric acid). Alcohols are produced

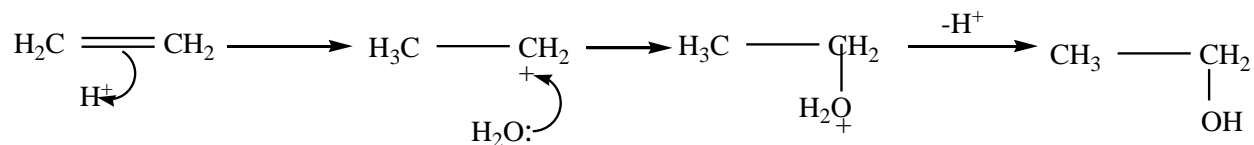
Example 8

Ethene reacts with acidified water to produce ethanol.

Please new and old curriculum notes, exams and marking guides on digitalteachers.co.ug website.

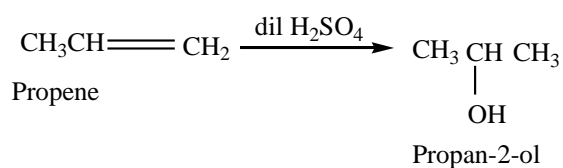


MECHANISM

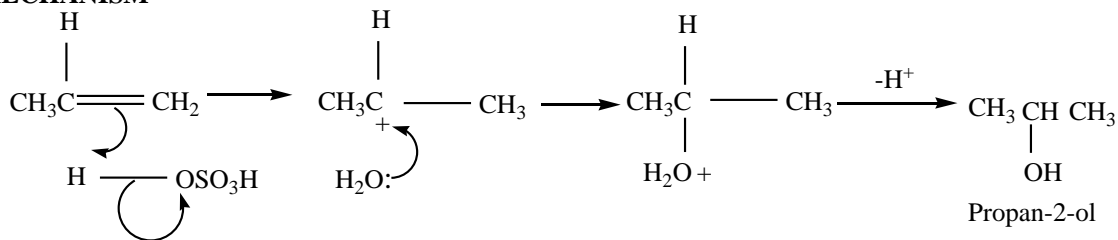


Example 9

Propene reacts with dilute sulphuric acid to form propan-2-ol

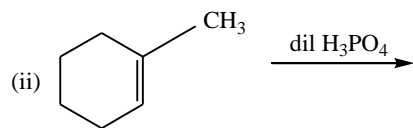
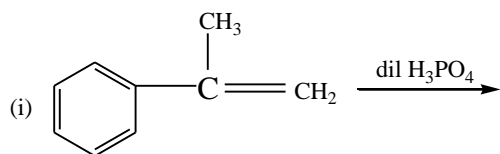


MECHANISM

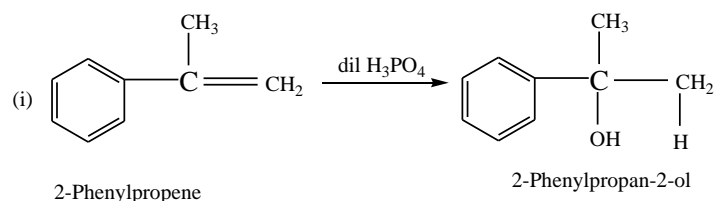


Trial 5

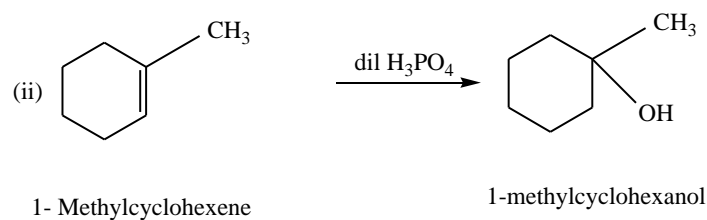
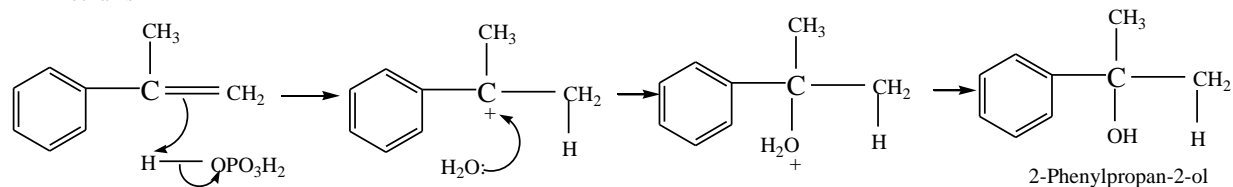
Complete the following equations and suggest mechanisms



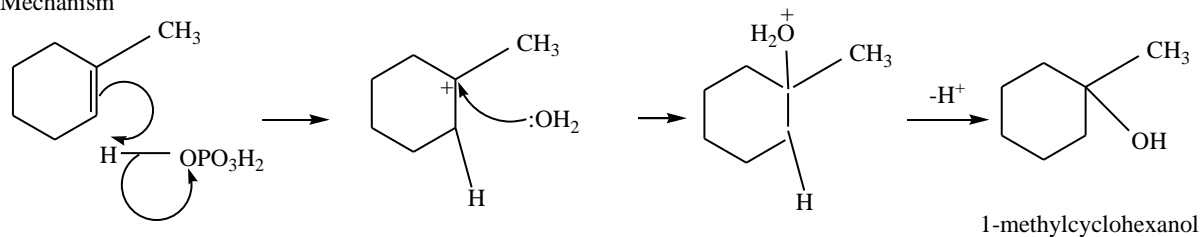
Solution to trial 5



Mechanism



Mechanism

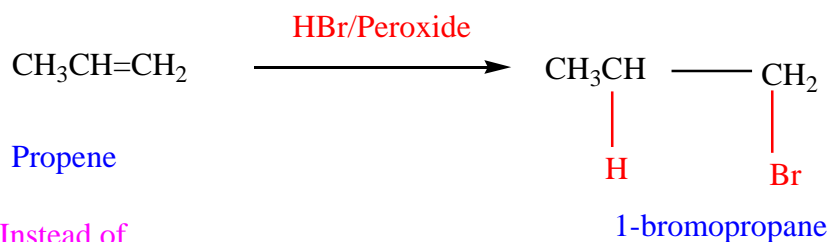


NB. The charges must be accounted for at every stage

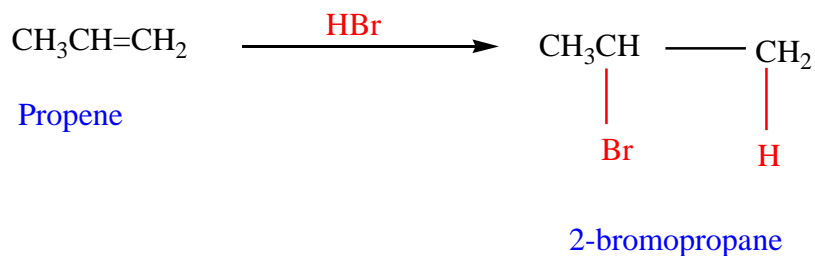
(e) Addition of hydrogen bromide in presence of a peroxide

In presence of a peroxide, alkenes react with HBr by free radical mechanisms; but in this case hydrogen atom goes to a carbon atom that carry the least number of a hydrogen atoms of those that form a double bond otherwise the bromine atom goes to a carbon with the highest number of hydrogen atoms.

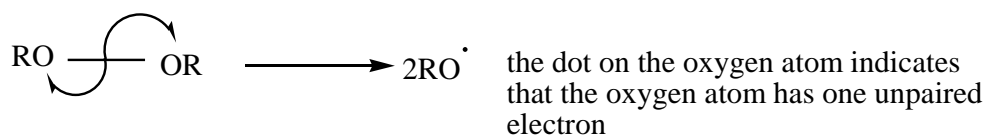
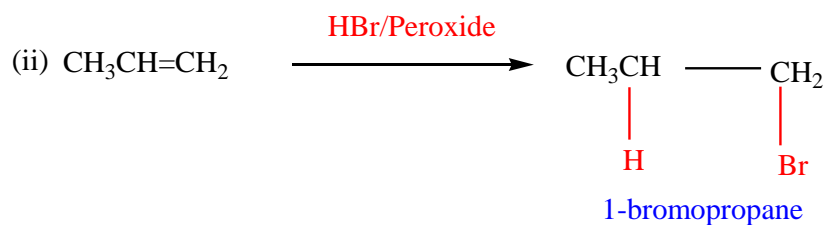
Example 10



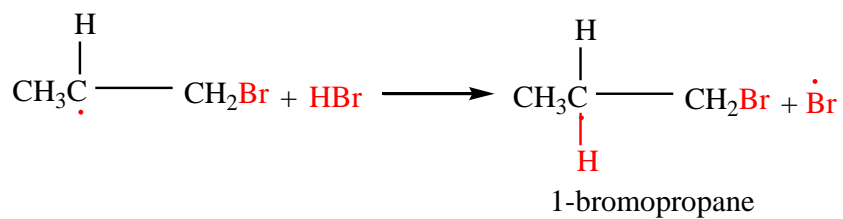
Instead of



Mechanism

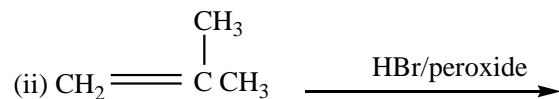
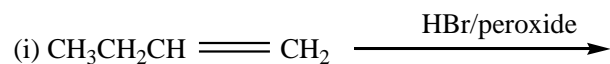


Then

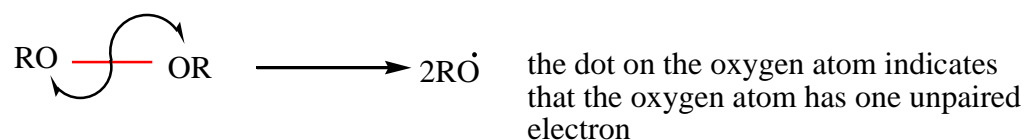


Trial 6

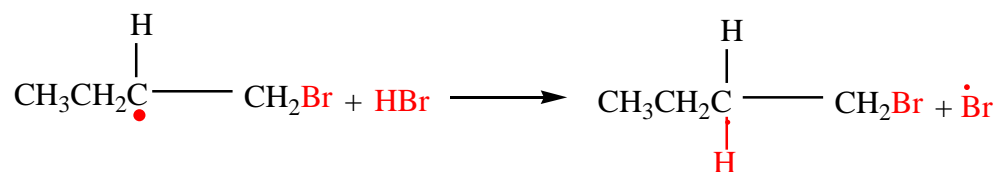
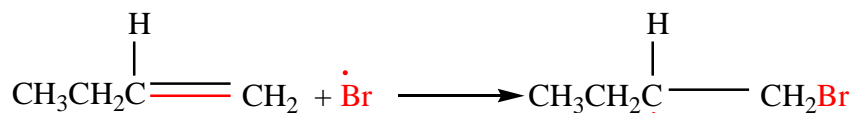
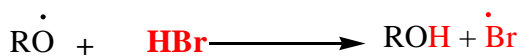
Complete and write a mechanism (it advisable you attempt these questions and mark yourself)

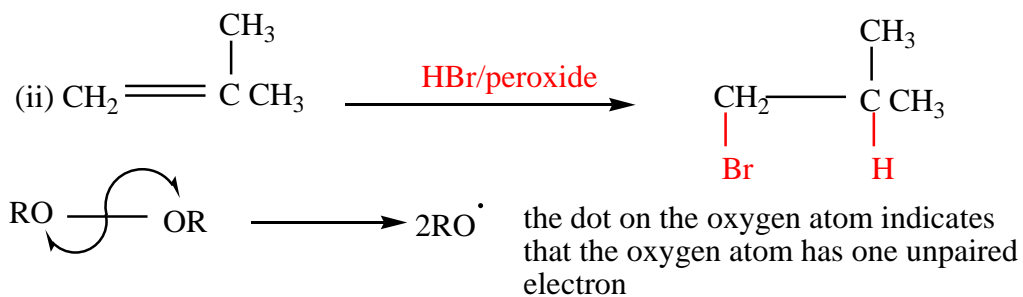


Solutions to trial 6

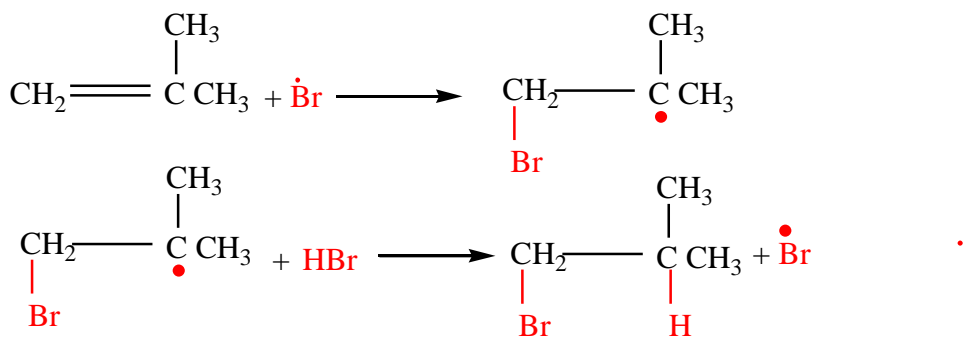
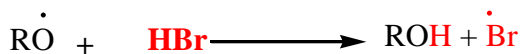


Then





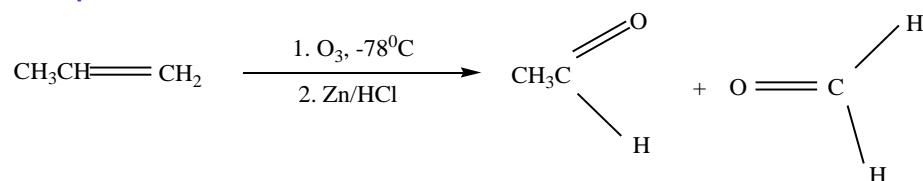
Then



(f) Ozonolysis (reaction of ozone with alkenes)

Ozone reacts with alkene to form unstable ozonide that is reduced by zinc in presence of hydrochloric acid to form carbonyl compounds.

Example 11



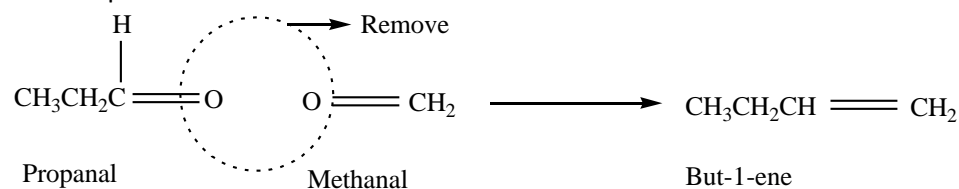
From the products of ozonolysis, it is possible to tell the position of the double bond in the compound that was ozonolyzed because ozonolysis breaks a compound at the double bond.

Example 12

Write the structure of an alkene which on ozonolysis gave

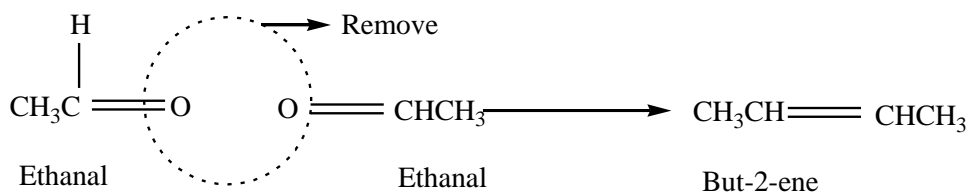
- (i) Propanal ($\text{CH}_3\text{CH}_2\text{CHO}$) and methanal (HCHO)

By removing the oxygen atoms from each compound create a double bond and hence the compound.



- (ii) One product ethanal

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Trial 7

An alkene X has molecular formula C_4H_8

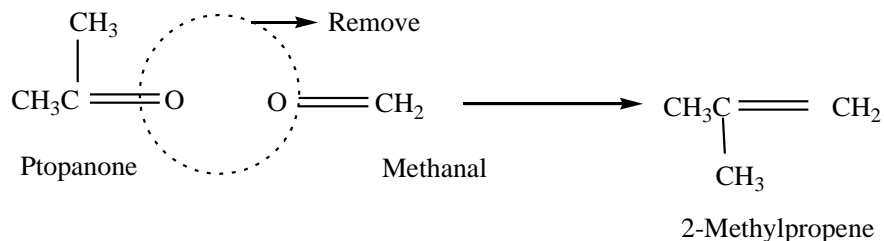
- Write and name all structural formulae of compound X.
- On ozonolysis X gave propanone (CH_3COCH_3) and methanal (HCHO). Identify X.

Solution

(a)



- (b) By removing oxygen atoms from the products of ozonolysis, the position of a double bond is created.



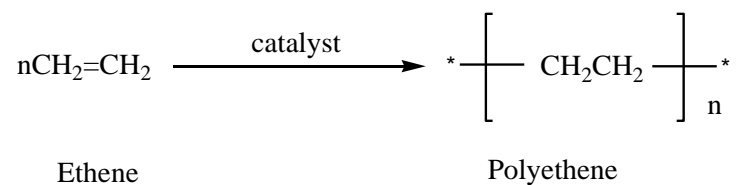
Therefore X is 2-methylpropene.

Polymerization

This is the joining of very many small molecules called monomers to form big molecules called polymers

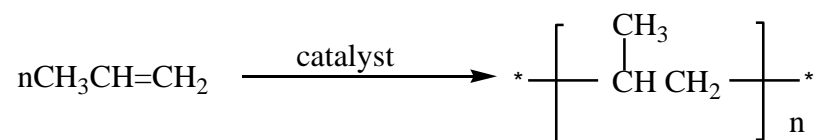
In presence of a catalyst, (acid) alkenes polymerize to form polyalkenes.

For example ethene plus a catalyst gives polyethene



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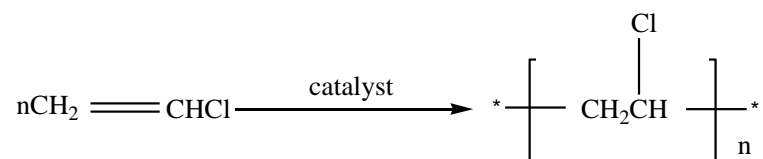
(ii) Propene polymerize to form polypropene



Propene

Polypropene

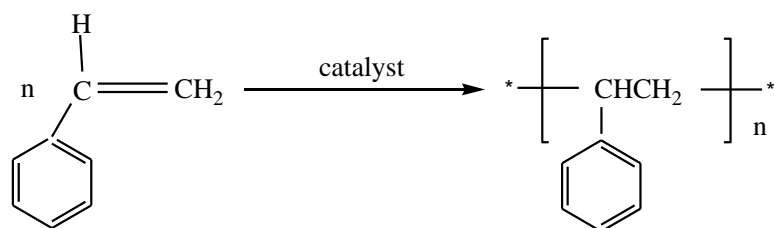
(iii) Vinyl chloride polymerize to form polyvinylchloride (PVC)



Vinyl chloride

Polyvinyl chloride

(iv) Styrene polymerizes to form polystyrene.



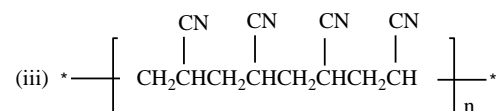
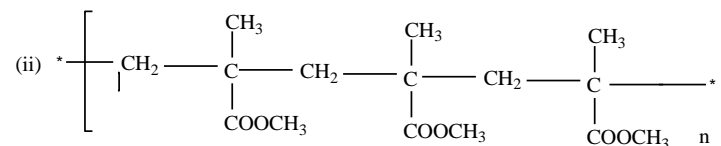
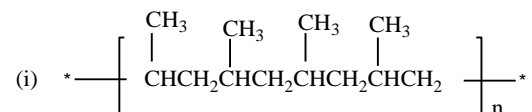
Styrene

Polystyrene

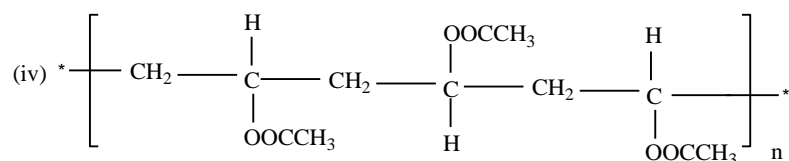
Note that when given a polymer without a double bond; then the monomer contains a single double bond.

Trial 8

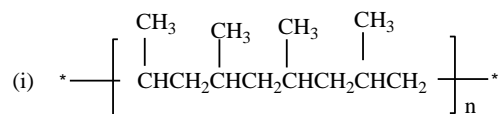
Write the structure and the names of monomer for the following polymers



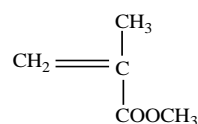
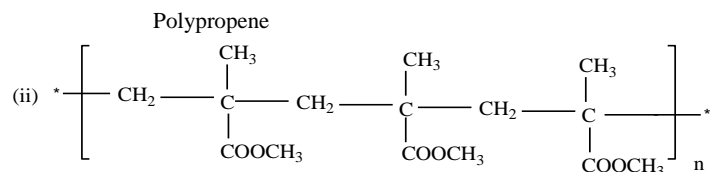
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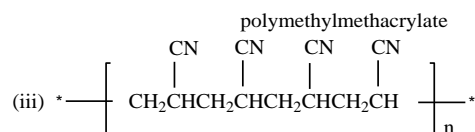
Solutions



$\text{CH}_3\text{CH}=\text{CH}_2$
Propene

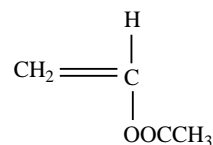
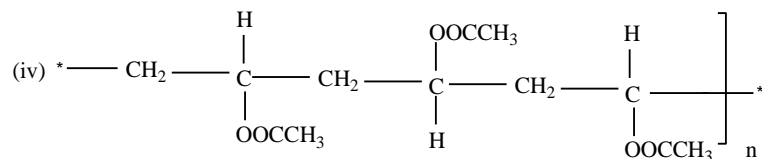


methylmethacrylate



$\text{CH}_2=\text{CHCN}$
Acrylonitrile

Polyacrylonitrile



Polyvinylacetate

vinylacetate

Uses of polyalkenes

- packing materials
- water pipes
- insulators

Alkenes undergo a type of polymerization called addition polymerization because monomers add to form a polymer without loss of any atom.

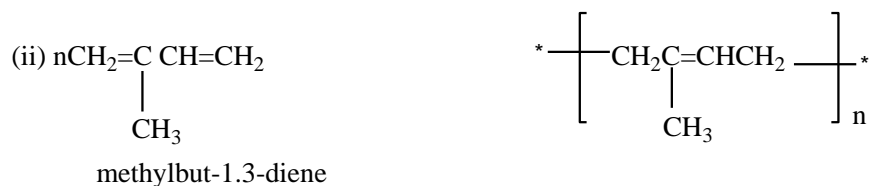
Polyalkenes are also called thermoplastics because they soften on heating and can be remolded.

Polymerization of dienes

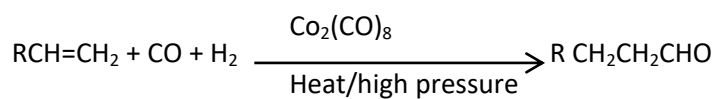
Alkenes with conjugated double bond undergo polymerization to form polyalkenes with double bonds

Example

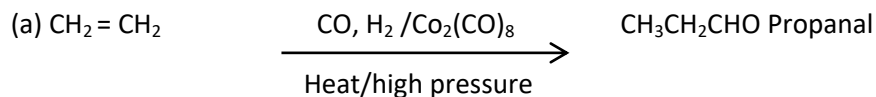
Please new and old curriculum notes, exams and marking guides on digitalteachers.co.ug website.



Reaction with carbon monoxide



Example



Preparation of alkenes

1. From alcohols

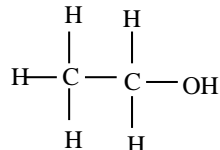
Alkenes are produced by dehydration of alcohols by hot sulphuric or phosphoric acid. Alcohols are organic compounds that contain hydroxyl group (-OH). The mechanism depends on the class of alcohol.

Classification of alcohols,

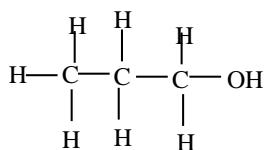
They are **three** classes of alcohols according to the number of alkyl groups attached to a carbon atom that carry -OH group.

- (a) Primary alcohols have one alkyl group on the carbon atom that carry OH group

Example 12



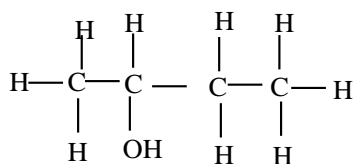
Ethanol



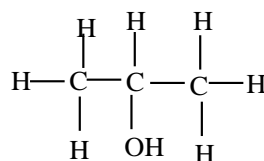
Propan-1-ol

- (b) Secondary alcohols have two alkyl groups attached to a carbon atom that carry OH group

Example 13



Butan-2-ol

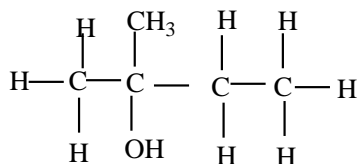


Propan-2-ol

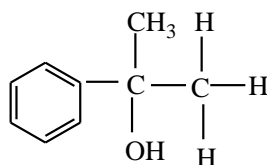
(c) Tertiary alcohols

Tertiary alcohols have three alkyl groups attached to the carbon atoms that carry OH group

Examples



2-methylbutan-2-ol



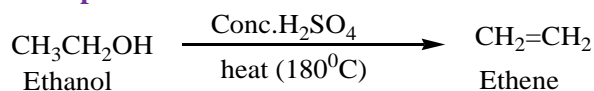
2-phenylpropan-2-ol

Mechanism

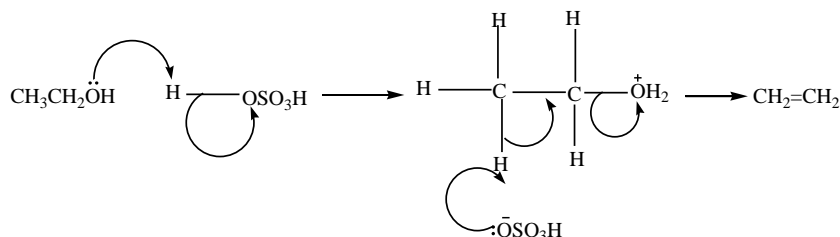
Depends on the class of alcohol.

- (a) Primary alcohol: undergo a mechanism called elimination bimolecular(E2). It is an elimination reaction because water molecule is removed from the alcohol. It bimolecular because the slow step involves two species.

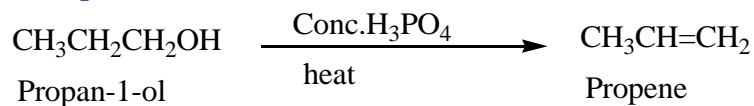
Example 14



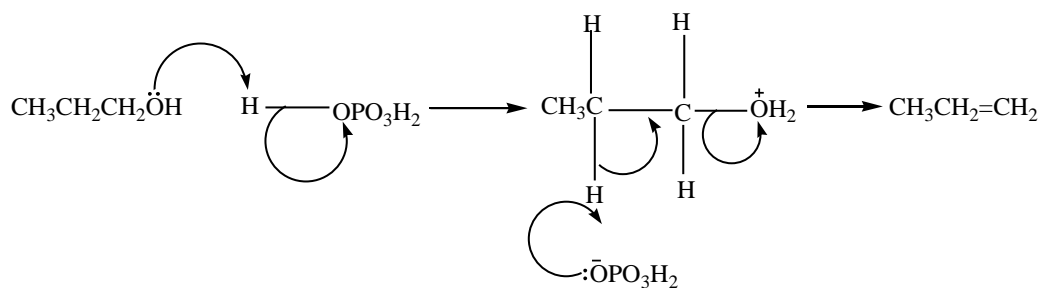
Mechanism



Example 15

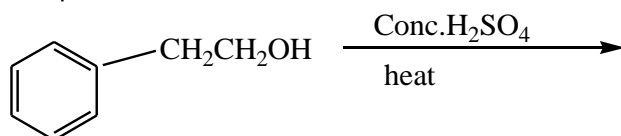


Mechanism

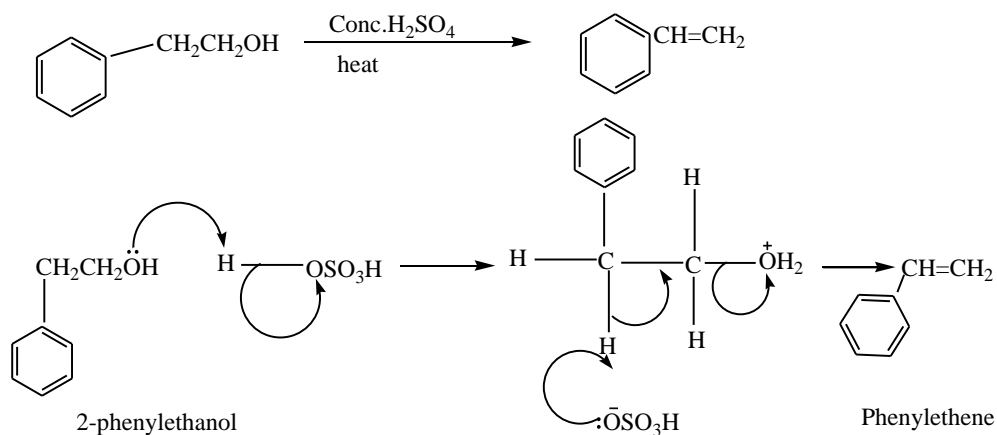


Trial 9

Complete and write a mechanism

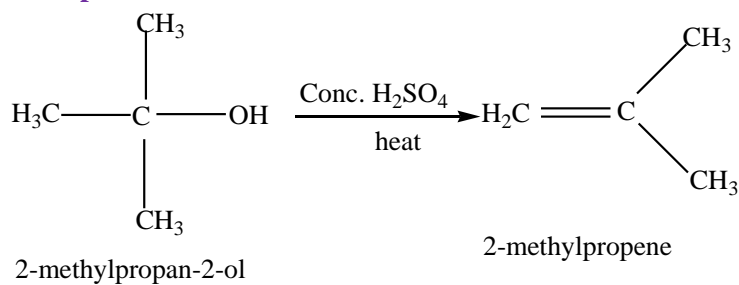


Solution

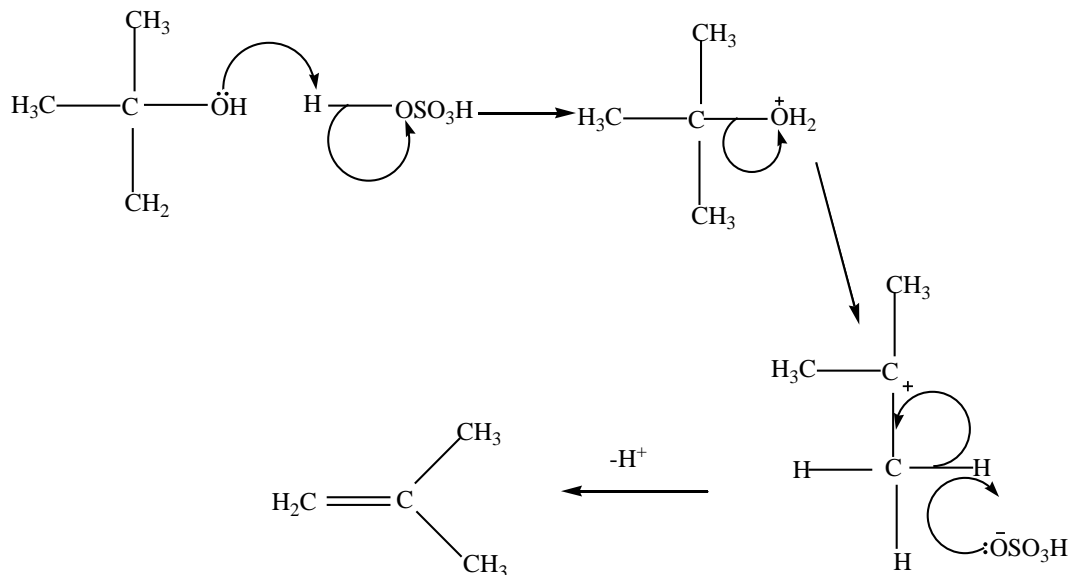


2. Secondary alcohols undergo the same mechanism as primary alcohol or that of tertiary alcohol
3. Tertiary alcohol undergoes a mechanism called E1 or elimination unimolecular because a water molecule is eliminated and the slowest step involves one molecule only.

Example 16

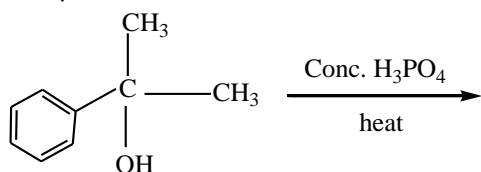


Mechanism

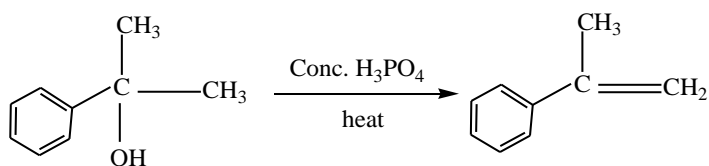


Trial 10

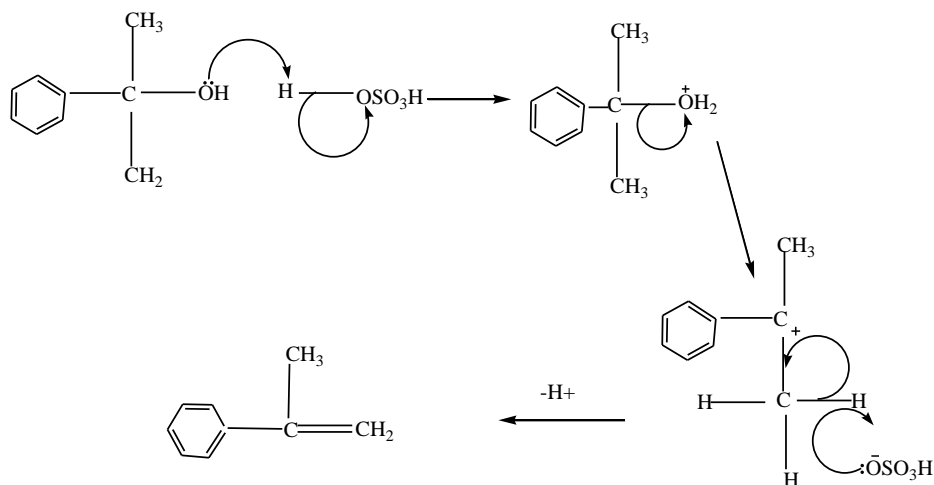
Complete and write a mechanism



Solution



Mechanism



Preparation of alkenes from alkylhalide (R-X where R is alkyl group and X is Cl, Br or I)

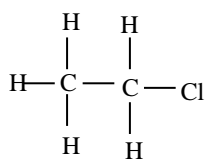
The mechanism depends on the class of alkylhalide

Classification of alkyl halide

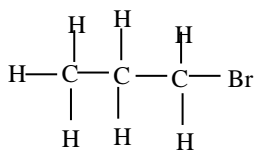
They are **three** classes of alkylhalide according to the number of alkyl groups attached to a carbon atom that carry a halide

(a) Primary alkylhalide have one alkyl group on the carbon atom that carries a halide.

Examples 18



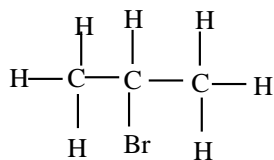
Chloroethane



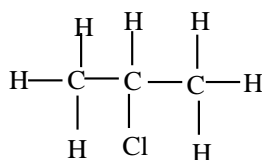
1-Bromopropane

(b) Secondary alkylhalide have two alkyl groups attached to a carbon atom that carry halogen atom

Examples19



2-Bromopropane

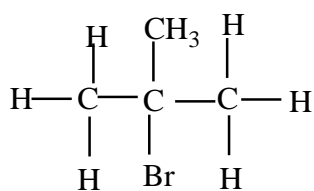


2-chlorobutane

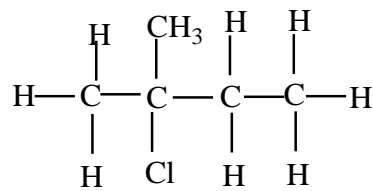
(c) Tertiary alkylhalide

Tertiary alkylhalide have three alkylgroups attached to the carbon atoms that carry OH group

Example 20



2-bromo-2-methylpropane



2-chloro-2-methylbutane

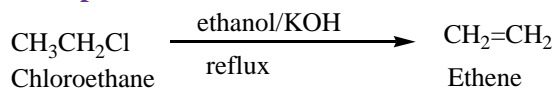
Mechanism

Depend on the class of alcohol.

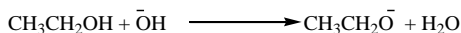
Please new and old curriculum notes, exams and marking guides on digitalteachers.co.ug website.

- (a) Primary alkyl halide: undergo a mechanism called elimination bimolecular(E2). It is an elimination reaction because HX is removed from the alkylhalide. It bimolecular because the slow step involves two species.

Example 21

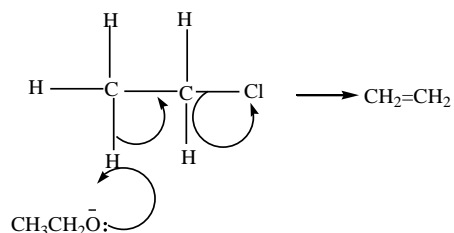


Mechanism

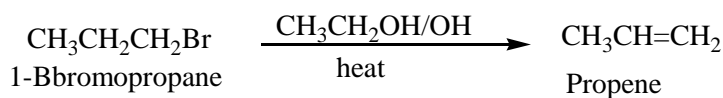


Ethanol

Then



Example 22

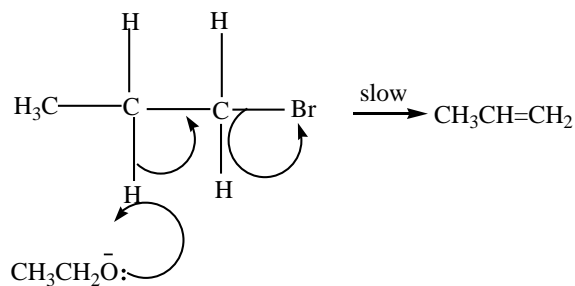


Mechanism



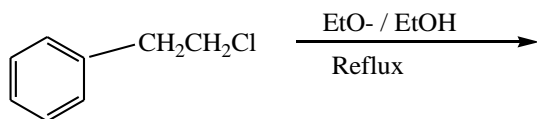
Ethanol

Then

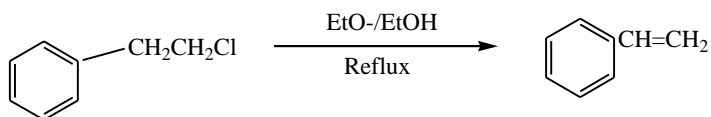


Trial 10

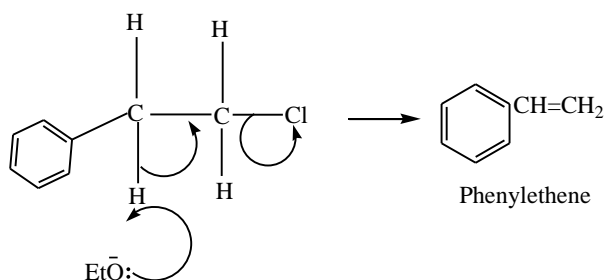
Complete and write a mechanism



Solution

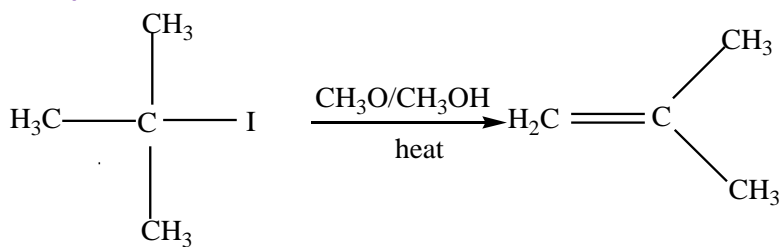


Mechanism



- Secondary alkyl halides undergo the same mechanism as primary alcohol or that of tertiary alcohol
- Tertiary alkyl halides undergo a mechanism called E1 or elimination uni-molecular because a water molecule is eliminated and the slowest step involve one molecule only.

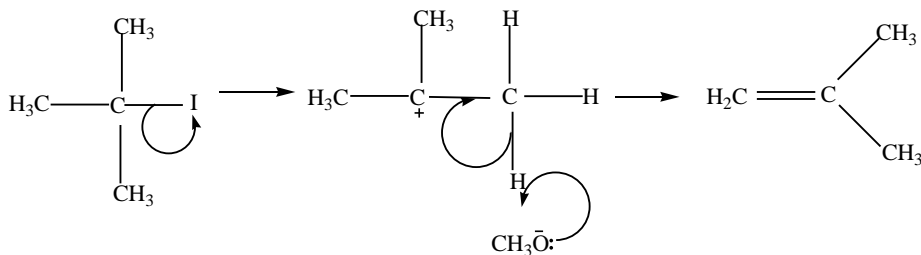
Example 23



2-Iodo-2-methylpropane

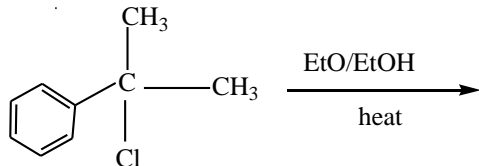
2-methylpropene

Mechanism

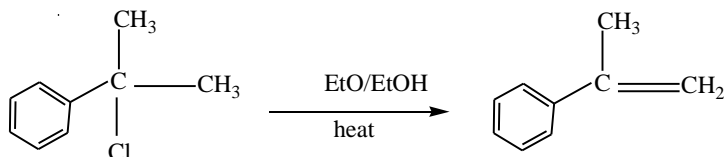


Trial 11

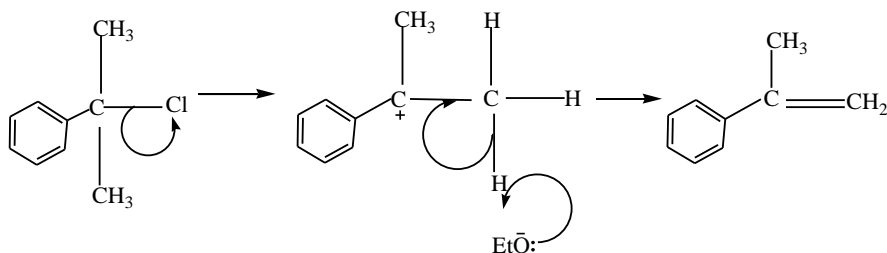
Complete and write a mechanism



Solution



Mechanism



Alkynes

General formula C_nH_{2n-2} where $n \geq 2$

They contain a triple bond

Examples

$HC \equiv CH$	Ethyne
$CH_3C \equiv CH$	Propyne
$CH_3CH_2C \equiv CH$	But-1-yne
$CH_3C \equiv CCH_3$	But-2-yne

Preparation

1. From vicinal dihalides.

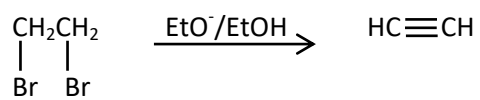
Vicinal dihalides are halides with two halogen atoms on adjacent carbon atoms

The reaction is carried out by refluxing vicinal dihalides with a mixture of an alcohol with its sodium or potassium salt.

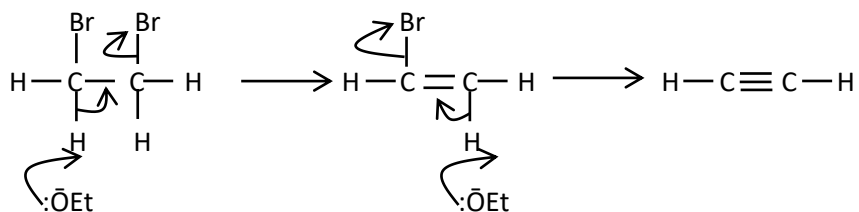
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Example 24

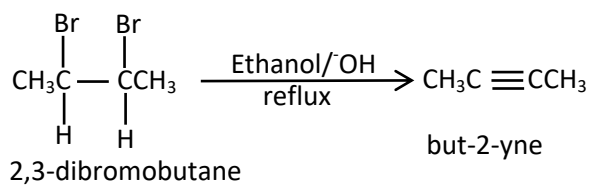
(i) Preparation of ethyne from 1,2-dibromoethane



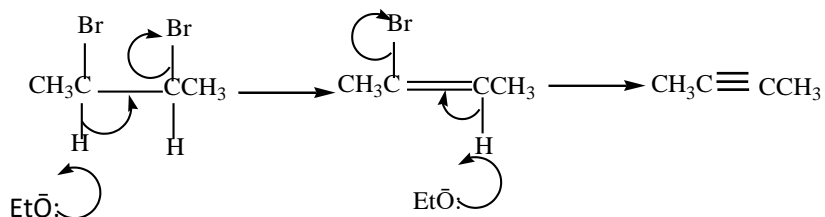
Mechanism



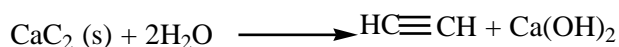
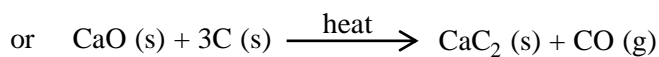
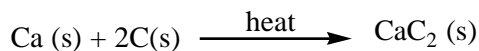
(ii) Preparation of but-2-yne from 2,3-dibromobutane



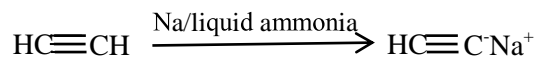
Mechanism



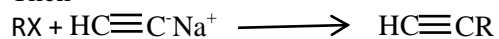
2. Preparation of ethyne from carbon



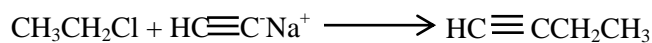
3. Preparation of long chain alkyne from ethyne



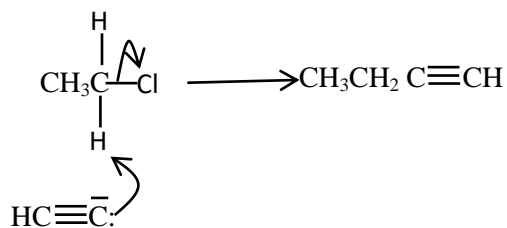
Then



Example 25

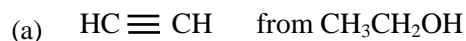


Mechanism

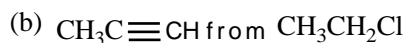


Trial 12

Synthesize



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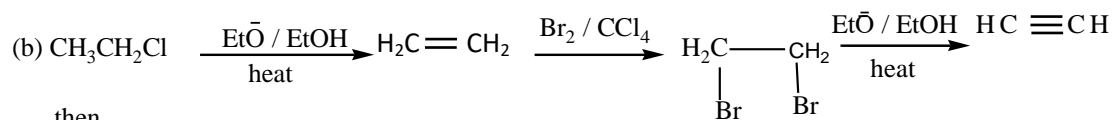
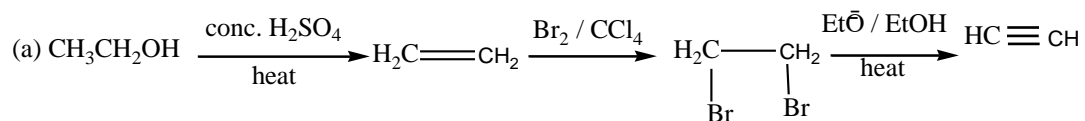


Questions involving synthesis requires a student to write a series of reactions including correct conditions; leading the formation of products from the reactant(s). Most of the times more than one equation is required because reactions of organic compounds are specific that we may need to convert the reactants into intermediate compounds before a product can be obtained.

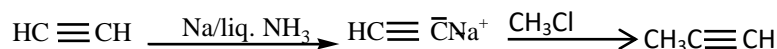
Note that the synthesis is only correct when **all the steps including the conditions** are correct.

For instance, before baking bread, wheat flour is first convert to dough. Usually think of the intermediates to enable you complete a synthesis equation.

Solution



then



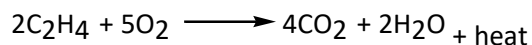
Physical properties of alkynes

1. They range from gases to liquids to solids
2. They are insoluble in water but soluble in organic solvents

Chemical properties of alkynes

1. They burn in oxygen to give carbon dioxide, water and heat.

Example

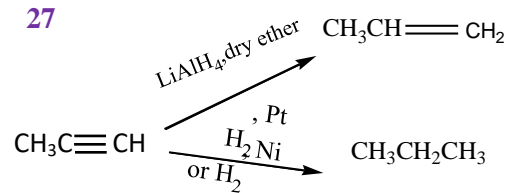


They are used as fuel because they produce heat

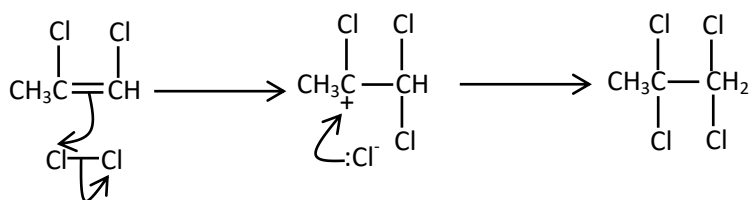
2. **Reduction**

Depending on conditions, alkyne may be reduced to alkenes or alkanes

**Example
27**

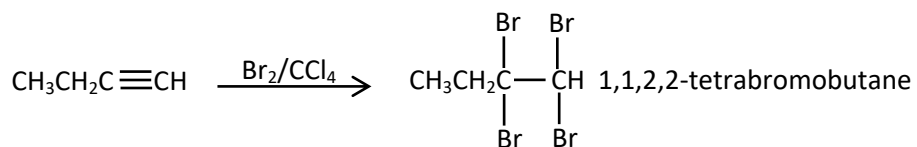


then

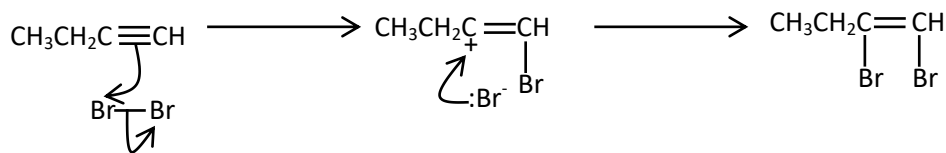


Trial 13

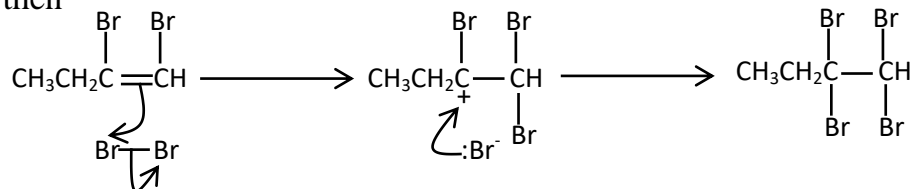
Complete and write a mechanism



Mechanism



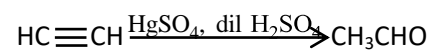
then



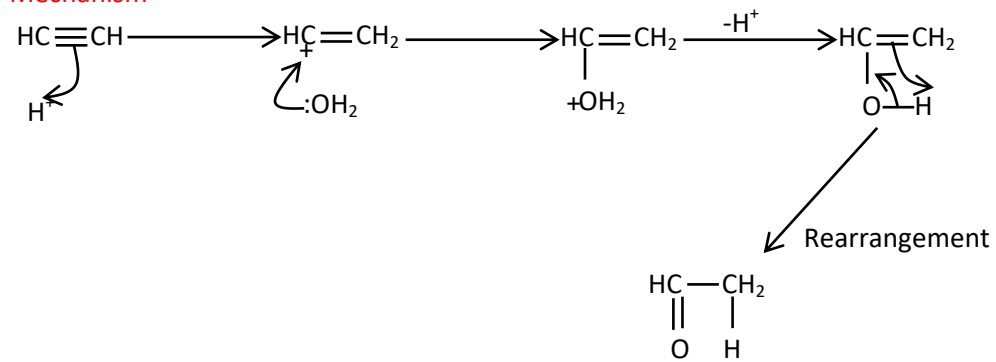
(c) **Addition of water.**

The reaction is catalyzed by mercury (II) sulphate and dilute sulphuric acid. Carbonyl compounds are formed.

Example 31



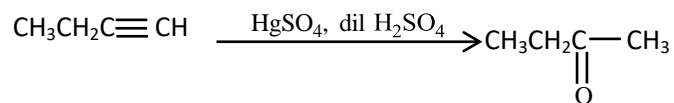
Mechanism



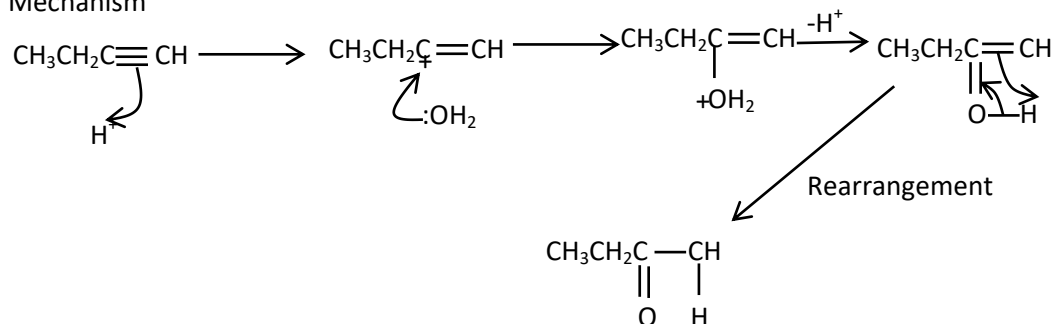
Complete and write a mechanism



Solution



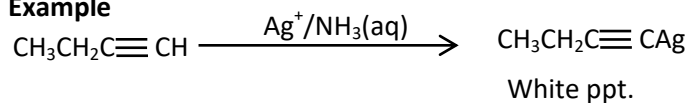
Mechanism



(d) **Reaction of terminal alkyne**

Alkynes with a triple bond at the end of the chain react with ammoniacal silver nitrate or ammoniacal copper I chloride to form white precipitate or red precipitate respectively.

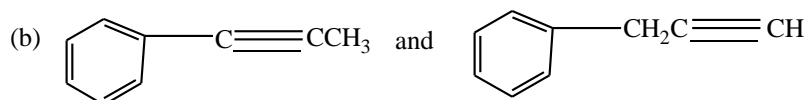
Example



This reaction is used to distinguish alkynes with a triple bond at the end from those with a triple bond in the middle of the chain.

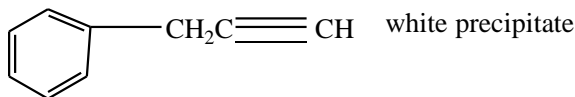
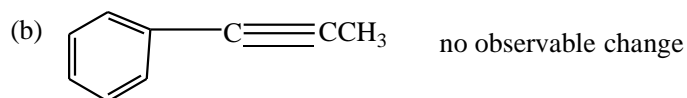
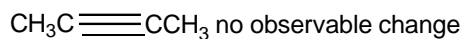
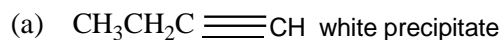
Exercise

Name one reagent that can be used to distinguish between the following pairs of compounds. In each case state what will be observed when the reagent is treated with each of the compounds of the pair.



Reagent: ammoniacal silver nitrate

Observation



Revision questions

1. 10cm^3 of a hydrocarbon X was exploded with 70cm^3 of Oxygen and cooled, the final volume was 55cm^3 . The volume of the mixture reduced to 15cm^3 when shaken with concentrated potassium hydroxide solution.
 - (a) Determine the molecular formula of X.
 - (b) Write and name all isomers of X.
 - (c) X formed a red precipitate with ammoniacal copper(I) chloride,
 - (i) Identify X.
 - (ii) Write equations and suggest mechanism for the reaction between X and acidified water, hydrogen in presence of palladium catalyst and hydrogen peroxide.
 - (d) Write equations and conditions to show how X can be prepared from a named alcohol
 - (i) Alcohol

Thank you
Dr. Bbosa Science