KitabCd Academy

Solutions

CHAPTER-9 – CARBON COMPOUNDS

Std.-X-Science & Technology -1

Maharashtra Board

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Chapter-9 – Carbon Compounds

Question 1: Match the pairs.

Group 'A'	Group 'B'
a. C_2H_6	1. Unsaturated hydrocarbon
b. C_2H_2	2. Molecular formula of an alcohol
c. CH_4O	3. Saturated hydrocarbon
d. C_3H_6	4. Triple bond

Answer:

Group 'A'	Group 'B'
a. C_2H_6	Saturated hydrocarbon
b. C_2H_2	Triple bond
c. CH_4O	Molecular formula of an alcohol
d. C_3H_6	Unsaturated hydrocarbon

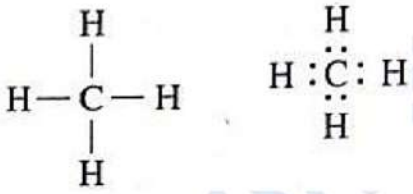
Question 2 : Draw an electron dot structure of the following molecules.

(Without showing the circles)

(a) Methane

Answer:

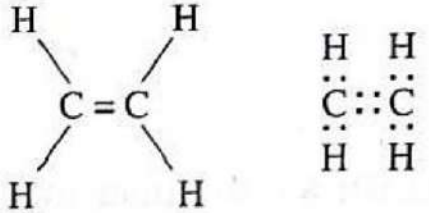
Methane : Molecular Formula - CH_4



(b) Ethene

Answer:

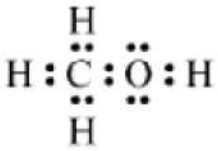
Ethene : Molecular Formula – $H_2C=CH_2$



(c) Methanol

Answer:

Methanol : Molecular Formula – $H_3C\text{-}OH$



(d) Water

Answer:

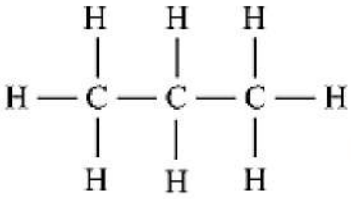
Water : Molecular Formula – H_2O

Question 3 : Draw all possible structural formulae of compounds from their molecular formula given below.

(i) C_3H_8 (ii) C_4H_{10} (iii) C_3H_4

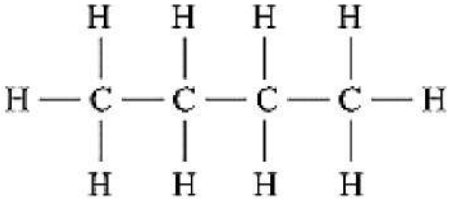
Answer:

(i) C_3H_8 (Propane)



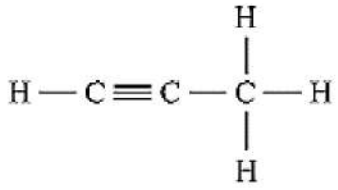
Propane

(ii) C_4H_{10} (Butane)



-butane

(iii) C_3H_4 (Propyne)



Propyne

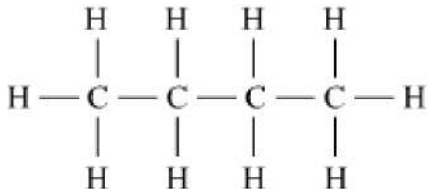
Question 4 : Explain the following terms with example.

(a) Structural isomerism

Answer:

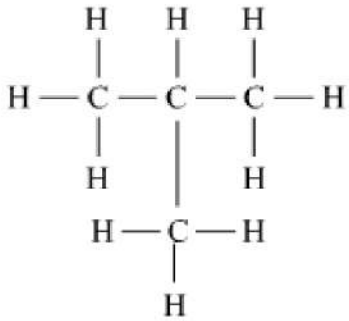
The phenomenon in which compounds having different structural formulae have the same molecular formula is called structural isomerism.

Example : Butane is represented by two different compounds as their structural formulae are different. These two different structural formulae have the same molecular formula i.e. C_4H_{10} Butane



n-butane

C_4H_{10}



Iso-butane

C_4H_{10}

(b) Covalent bond.

Answer:

The chemical bond formed by sharing of two valence electron between the two atoms is called covalent bond. It is also known as molecular bond.

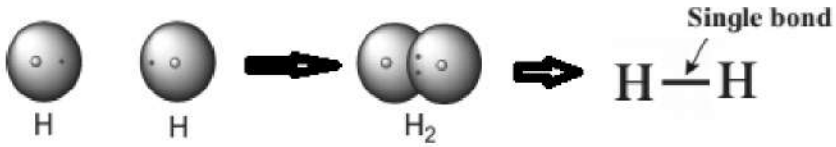
For example: Molecules that have covalent linkages are hydrogen H_2, nitrogen N_2, chlorine Cl_2, water H_2O, and ammonia NH_3.

A single line indicates a single bond between two atoms (*i.e.* involving one electron pair), double lines (=) indicate a double bond between two atoms (*i.e.* involving two electron pairs), and triple lines (≡) represent a triple bond (C≡O).

Examples :

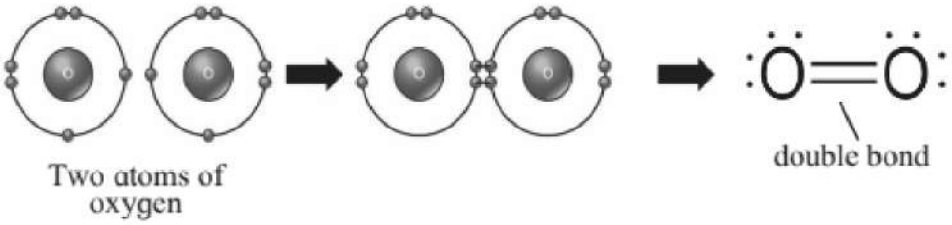
(i) Hydrogen molecule is formed by covalent bonding :

- Atomic number of hydrogen is 1, its atom contains 1 electron in K shell.
- It requires one more electron to complete the K shell and attain the configuration of helium (He).
- To meet this requirement two hydrogen atoms share their electrons with each other to form H_2 molecule.
- One covalent bond, that is a single bond is formed between two hydrogen atoms by sharing of two electrons.



(ii) Formation of oxygen molecule (O_2) :

- The atomic number of oxygen is 8. The electronic configuration is (2,6) Oxygen has 6 electrons in the outermost shell.
- It requires 2 electrons to complete the L shell and attain the configuration of neon(Ne).
- The O_2 molecule is formed by chemical combination of two oxygen atoms.
- On drawing the electron-dot structures of these two molecules, it becomes clear that the two oxygen atoms in O_2 molecule are joined with each other by two covalent bonds, that is, a double bond.



(c) Hetero atom in a carbon compound.

Answer:

Hetero atom in a carbon compound: It is a compound formed by replacement of carbon and hydrogen by hetero atom in a compound.

- A hetero atom is any atom other than carbon or hydrogen.
- The atoms of these compounds substitute one or more hydrogen atoms in the hydrocarbon chain.
- Typical heteroatoms are nitrogen, oxygen, sulfur, phosphorus, chlorine, bromine, and iodine.

Examples:

(i) Oxygen is hetero atom in ethanol (C_2H_5-**O**-H)

(ii) Nitrogen is the hetero atom in Ethyl amine (CH_3-CH_2-**N**H_2)

(d) Functional group

Answer:

The compound acquire specific chemical properties due to these hetero atoms or the groups of atoms that contain hetero atoms, irrespective of length and nature of the carbon chain in that

compound. Therefore these hetero atoms or groups of atoms containing hetero atoms are called the functional groups.

Example: Methyl alcohol, acetic acid.

- In methane (CH_4), when one hydrogen atom is replaced by an -OH group, methyl alcohol (CH_3OH), is formed. The -OH is known as the alcoholic functional group.
- Similarly, from methane (CH_4) when one hydrogen atom is replaced by -COOH group, acetic acid (CH_3COOH) is formed. The -COOH group is known as the carboxylic acid functional group.

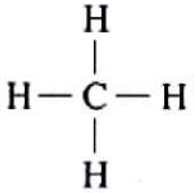
(e) Alkane

Answer:

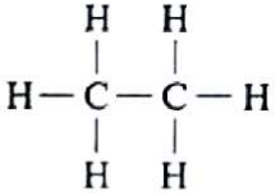
Alkane: In hydrocarbon, the four valancies of carbon atoms are satisfied only by the single bonds such compounds are called alkane.

- Alkane is a saturated hydrocarbon. It is formed, when there is sharing of one electron pair between carbon atoms in a compound. In which the carbon atoms are linked to each other by single bonds.

Example : In methane, four hydrogen atoms are bonded to carbon atom by four single covalent bonds.



Methane



Ethane

(f) Unsaturated hydrocarbon

Answer:

Unsaturated hydrocarbon: An unsaturated hydrocarbon is a hydrocarbon containing at least one double or triple bond. They are chemically more reactive.

Example:

Alkenes - These unsaturated hydrocarbons are molecules that contain at least one carbon-to-carbon double bond. With the chemical formula consisting of C_nH_{2n}. The simplest alkene is ethylene.

Alkynes - These unsaturated hydrocarbons are molecules that contain at least one carbon-to-carbon triple bond. Acetylenes are common examples of alkynes.

(g) Homopolymer.

Answer:

Homopolymer: A homopolymer is a polymer formed from same type of monomer units.

For examples: Polyvinylchloride (PVC), Polyethylene$(-CH_2- CH_2-)_n$, Polystyrene are homopolymer.

(h) Monomer.

Answer:

Monomer: A monomer is a molecule that forms the basic unit for polymers. They may be considered as building blocks from which proteins are made. Monomers may bind to other monomer unit to form a repeating chain molecule. Monomers may be either natural or synthetic in origin.

For example: Ethylene, vinyl chloride, styrene etc.

(i) Reduction.

Answer:

Reduction: The addition of hydrogen to a substance is called reduction.

The removal of oxygen from a substance is called reduction.

Examples:

(i) $2Ag_2O \rightarrow 4\ Ag + O_2 \uparrow$

In a reaction, silver oxide is changing to silver. That is, oxygen is being removed from silver oxide. Removal of oxygen from substance is called reduction, so silver oxide undergoes reduction.

(ii) $NiO + H_2 \rightarrow Ni + H_2O$

In a reaction, Nickle oxide is changing to nickle. That is, oxygen is being removed from nickle oxide. Removal of oxygen from substance is called reduction, so nickle oxide undergoes reduction.In a reaction, hydrogen is changing to H_2O. That is,oxygen is being added to hydrogen. Addition of oxygen to a substance is called oxidation, so hydrogen undergoes oxidation.

(j) Oxidant.

Answer:

Oxidant : The substance which gives oxygen for oxidation is called an oxidising agent or oxidant.

The substance which removes hydrogen is called an oxidising agent or oxidant.

Example:

$CuO + H_2 \rightarrow Cu + H_2O$

Oxidising agent = CuO

Reducing agent = H_2

Substance oxidized = H_2

Substance reduced = CuO

Question 5 : Write the IUPAC names of the following structural formulae.

(a) CH_3-CH_2-CH_2-CH_3

Answer:

The number of items in the longest chain : 4

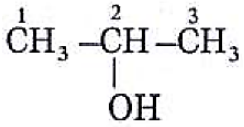
Parent Alkane : Butane

IUPAC Name : nButane

(b) CH_3-CHOH-CH_3

Answer:

The number of items in the longest chain : 3



Parent Alkane : Propane

Functional group : -OH (ol)

Assign the number : 2

The carbon atom to which the -OH group is attached is numbered as C_2. If the carbon chain of the compound contains a -OH group then change the ending of the parent name, i.e. 'e' of propane is replaced by 'ol'. (ol stands for alcohol)

Parent suffix : Propan-2-ol

IUPAC Name : Propan-2-ol

(c) CH_3-CH_2-COOH

Answer:

The number of items in the longest chain : 3

Parent Alkane :Propane

Functional group :- COOH (-oic acid)

If the carbon chain of the compound contains a -COOH group then change the ending of the parent name, i.e. 'e' of propane is replaced by 'oic acid'.

Parent suffix : Propanoic acid

IUPAC Name : Propanoic acid

(d) CH_3-CH_2-NH_2

Answer:

The number of items in the longest chain : 2

Parent Alkane : Ethane

Functional group : -NH_2 (amine)

If the carbon chain of the compound contains a -NH_2 group, then change the ending of the parent name, i.e. 'e' of ethane is replaced by 'amine'.

Parent suffix : Ethanamine

IUPAC Name : Ethanamine

(e) CH_3-CHO

Answer:

The number of items in the longest chain : 2

Parent Alkane : Ethane

Functional group : -CHO (al)

If the carbon chain of the compound contains a - CHO group, then change the ending of the parent name, i.e. 'e' of ethane is replaced by 'al'.

Parent suffix : Ethanal

IUPAC Name : Ethanal

(f) CH_3-CO-CH_2-CH_3

Answer:

The number of items in the longest chain : 4

Parent Alkane : Butane

Functional group : -CO -(one)

In the longest chain, the numbering of carbon atom starts from the carbon atom nearest to the function group.

If the carbon chain of the compound contains a (-CO-) group, then change the ending of the parent name, i.e. 'e' of butane is replaced by 'one'.

Parent suffix : Butan-2-one

IUPAC Name : Butan-2-one

Question 6 : Identify the type of the following reaction of carbon compounds.

(a) CH_3 -CH_2 -CH_2-OH → CH_3 -CH_2 -COOH

(b) CH_3 -CH_2 -CH_3 → $3CO_2$ + $4H_2O$

(c) CH_3 -CH = CH -CH_3 + Br_2 → CH_3 -CHBr - CHBr -CH_3

(d) CH_3 -CH_3 + Cl_2 → CH_3 -CH_2 -Cl + HCl

(e) CH_3 -CH_2 -CH_2 -CH_2 -OH → CH_3 -CH_2 -CH=CH_2 + H_2O

(f) CH_3 -CH_2 -COOH + NaOH → CH_3 -CH_2 -COO - Na^+ + H_2O

(g) CH_3 -COOH + CH_3 -OH → CH_3 -COO- CH_3 + H_2O

Answer:

(a) CH_3 -CH_2 -CH_2-OH → CH_3 -CH_2 -COOH = Oxidation reaction(acidic $KMnO_4$)

(b) CH_3 -CH_2 -CH_3 → $3CO_2$ + $4H_2O$ = Combusion reaction

(c) CH_3 -CH = CH -CH_3 + Br_2 → CH_3 -CHBr - CHBr -CH_3 = Addition reaction

(d) CH_3 -CH_3 + Cl_2 → CH_3 -CH_2 -Cl + HCl = Substitution reaction

(e) CH_3 -CH_2 -CH_2 -CH_2 -OH → CH_3 -CH_2 -CH=CH_2 + H_2O = Dehydration reaction

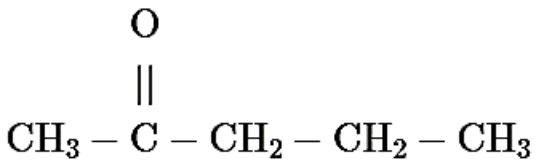
(f) CH_3 -CH_2 -COOH + NaOH → CH_3 -CH_2 -COO - Na^+ + H_2O = Neutralization reaction(reaction with base)

(g) CH_3 -COOH + CH_3 -OH → CH_3 -COO- CH_3 + H_2O = Esterification reaction

Question 7: Write structural formulae for the following IUPAC names.

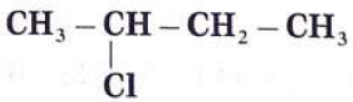
(a) Pent-2-one

Answer:



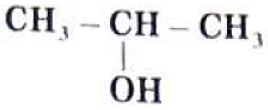
(b) 2-chlorobutane

Answer:



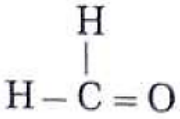
(c) propan- 2 ol

Answer:



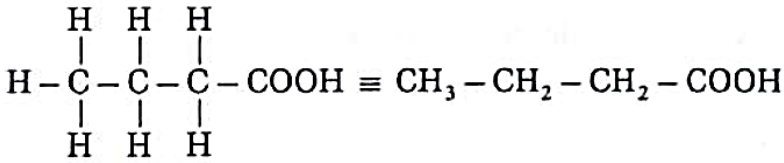
(d) methanal

Answer:



(e) butanoic Acid

Answer:



(f) 1-Bromopropane

Answer:

CH_3-CH_2-CH_2- Br

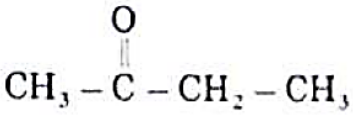
(g) ethanamine

Answer:

CH_3-CH_2-NH_2

(h) butanone

Answer:



Question 8 : Write answers as directed.

(a) What causes the existence of very large number of carbon compound ?

Answer:

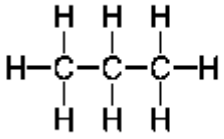
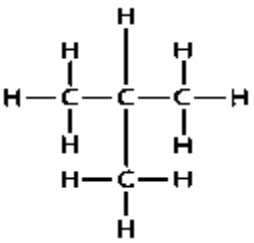
- Carbon has a unique ability to form strong covalent bonds with other carbon atoms, this results in formation of big molecules. This property of carbon is called catenation power. The carbon. has 4 valence electrons. That means each individual carbon atom can bind to 4 other atoms of almost any variety and each of those 4 can bind to 4 others atoms. This leads to formation of organic compounds having incredible variety and complexity - short chains, long chains, ring structures, branched structures and so on.
- One, two or three covalent bonds can bond together two carbon atoms. These bonds are called single covalent bond, double covalent bond and triple covalent bond respectively. Due to the ability of carbon atoms to form multiple bonds as well as single bonds, the number of carbon compounds increases.
- Carbon being tetravalent, one carbon atom can form bonds with four other atoms (carbon or any other). This results in formation of many compounds.
- Isomerism is one more characteristie of carbon compound which is responsible for large number of carbon compounds.

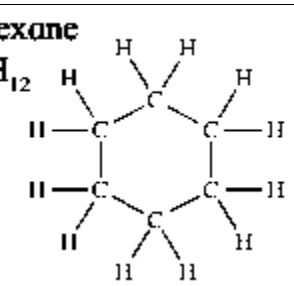
This characteristics leads to existance of very large number of carbon compound.

(b) Saturated hydrocarbons are classified into three types. Write these names giving one example each.

Answer:

Saturated hydrocarbons are classified into three types:

Saturated hydrocarbon	Example	Structure
1) Straight chain hydrocarbons	Propane C_3H_8	Propane C_3H_8 
2)Branched chain hydrocarbon	isobutane C_4H_{10}	isobutane C_4H_{10} 

3)Cyclic hydrocarbon	Cyclohexane C_6H_{12}	Cyclohexane C_6H_{12} 

(c) Give any four functional groups containing oxygen as the heteroatom in it. Write name and structural formula of one example each.

Answer:

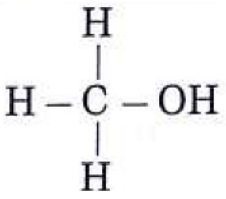
Four functional groups containing oxygen as the heteroatom in it are as follows:

(i) Alcohols: The functional group, which is present in alcohol, is -OH. The IUPAC group suffix of alcohol is –ol.

Structural Formula : – O – H

Condensed Structural Formula : – OH

Example: Methanol



(ii) Aldehydes: The functional group, which is present in an aldehyde, is -CHO. The IUPAC group suffix of an aldehyde is –al.

Structural Formula :

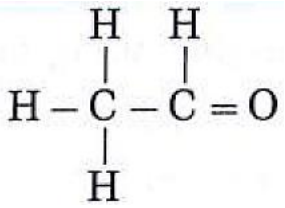
O

||

– C – H

Condensed Structural Formula : **– CHO**

Example: Acetaldehyde



(iii) Ketones: The functional group, which is present in a ketone is >C=O. The

IUPAC group suffix of a ketone is –one.

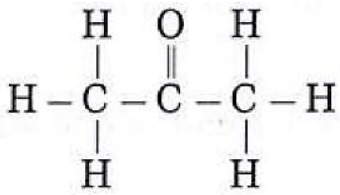
Structural Formula :

|

– C – 0

Condensed Structural Formula : – CO –

Example: Acetone



(iv) Carboxylic acid: The functional group present in a carboxylic acid is -COOH. The IUPAC group suffix of a carboxylic acid is –oic acid.

Structural Formula :

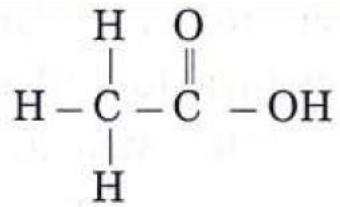
O

||

– C – O – H

Condensed Structural Formula : – COOH

Example: Acetic acid



(d) Give names of three functional groups containing three different hetero atoms. Write name and structural formula of one example each.

Answer:

Three functional groups containing three different hetero atoms are as follows:

(i) Carboxylic acid: The functional group present in a carboxylic acid is -COOH. Here, heteroatom is oxygen.

Structural Formula :

O

||

– C – O – H

Condensed Structural Formula : – COOH

Example: Acetic acid : CH_3COOH

(ii) Amine: The functional groups present in an amine are $-NH_2$ Here, heteroatom is nitrogen.

Structural Formula :

– N – H

|

H

Condensed Structural Formula : – NH_2

Example: Methylamine : CH_3 - NH_2

(iii) Halides: The functional group presence in halides is X(halogen = Cl, Br, I). Here, heteroatom is chlorine, Bromine, Iodine.

Structural Formula : -X(-Cl, -Br, -I)

Condensed Structural Formula : **-X(-Cl, -Br, -I)**

Example: CH_3Cl : Chloromethane, CH_3-CH_2-Br : Bromoethane

(e) Give names of three natural polymers. Write the place of their occurance and names of monomers from which they are formed.

Answer:

Natural polymers	**Monomer unit**	**Occurance**
1.Polysaccaride	Glucose	Starch/Carbohydrates
2.Cellulose	Glucose	Wood (cell wall of plant cells)
3.Proteins	alpha aminoacids	Muscles, Hairs, Skin, Egg
4.Rubber	Isoprene(CH_2=C(CH_3)-CH=CH_2)	Latex of rubber tree

(f) What is meant by vinegar and gashol? What are their uses ?

Answer:

(i) Vinegar is 5-8% solution of acetic acid (Ethanoic acid). It is basically produce by the process of fermentation of ethanol through ethanoic acid in the presence of bacteria .

Uses of Vinegar are:

- It is used in the preparation of the food .
- It is used in pickling.
- It is used as folk medicine material.
- It is used as a household cleaning agent

(ii) Gasohol is a mixture of 90% gasoline and 10% of anhydrous Alcohol (Ethyl Alcohol). It is commonly known as the alternative fuel or a motor fuel.

Benefits of gasohol are :-

- It is cheaper.
- It is eco-friendly.
- It has higher performance.
- It doesn't freeze in typical conditions.

Uses of gasohol are:

- It is used in a fuel or petroleum Industry
- It is used in a automobiles industry
- It is used as a flexible fuel vehicle, because it do not freeze in typical conditions.

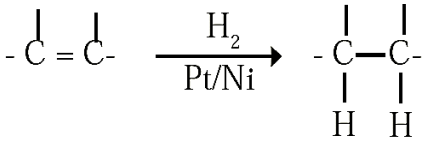
(g) What is a catalyst ? Write any one reaction which is brought about by use of catalyst ?

Answer:

Catalyst is a substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change.

Example : Vegetable oil (unsaturated compound) undergoes addition reaction with hydrogen in the presence of nickel catalyst to form vanaspati ghee (saturated compound)

$$\text{Hydrogen + Unsaturated Fats} \xrightarrow{Pt/Nickel} \text{Saturated Fats}$$



Other Examples :

E.g.	Name of process	Equations (in words or formulae)	Catalyst
1	Fermentation of glucose to form ethanol	Glucose ⟶ Ethanol + Carbon dioxide	Specific enzymes (in yeast)
2	Hydration of ethene to form ethanol	Ethene + Water (Steam) Heat ⟶ Ethanol	Phosphoric Acid
3	Haber's process	Nitrogen + Hydrogen ⟶ Ammonia	Iron

END