Carbon and Its Compounds

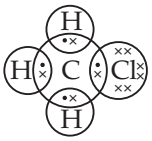
CHAPTER 4

NCERT FOCUS

ANSWERS

Topic 1

1. The molecule of chloromethane (CH_3Cl) consists of three elements *i.e.*, carbon (Z = 6), hydrogen (Z = 1) and chlorine (Z = 17). Carbon atom has four valence electrons (2, 4); hydrogen has one (1) while chlorine has seven electrons in the valence shell (2, 8, 7). In order to complete its octet, carbon shares three valence electrons with three hydrogen atoms while one is shared with the chlorine atom. The structure of covalent molecule may be written as follows :



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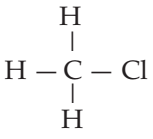
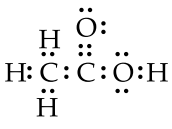


2. (i)



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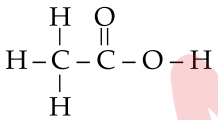


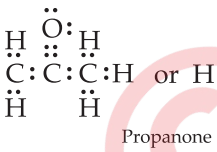
Ethanoic acid

(ii)

or H – S – H

Hydrogen sulphide

(iii)



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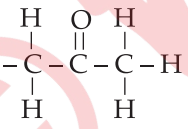


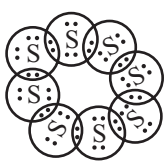
Propanone

(iv)

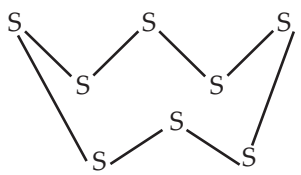
or F – F

Fluorine

3. The atomic number (Z) of sulphur is sixteen and its electronic configuration is 2, 8, 6. The sulphur atom has six valence electrons. The chemical formula of sulphur molecule is S_8. Each sulphur atom is linked to similar atoms on both sides by single covalent bonds and thus, completes its octet. The electron dot structure of the molecule is in the form of a ring but its shape is represented like a crown.

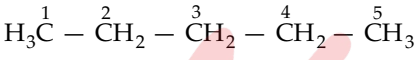


Ring structure of S_8 molecule

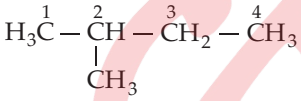


Crown shape of S_8 molecule

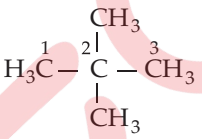
4. Pentane (C_5H_{12}) has a skeleton of five carbon atoms. It can exist as a straight chain as well as two branched chains. Hence, there are three structural isomers :



Pentane



2-Methylbutane



2, 2-Dimethylpropane

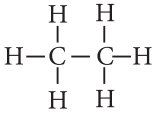
5. **(i) Catenation :** The unique property of self - linking of carbon atoms through covalent bonds to form long straight or branched chains and rings of different sizes is called catenation.

(ii) Linking of carbon with other atoms : Carbon is tetravalent in nature and can readily unite with atoms like hydrogen, oxygen, nitrogen, sulphur etc. by electron sharing.

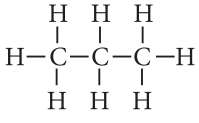
Topic 2

1. (a) Compounds of carbon and hydrogen are called hydrocarbons, *e.g.*, methane, ethene, propyne, etc.

(b) Saturated hydrocarbons contain single bonds between carbon atoms, *e.g.*,

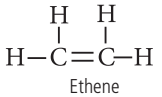


Ethane

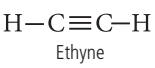


Propane

Unsaturated hydrocarbons contain atleast one double or triple bond between two carbon atoms.



Ethene



Ethyne

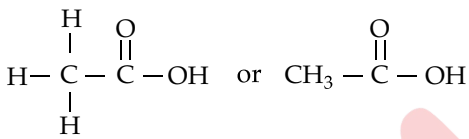
(c) An atom or group of atoms joined in a specific manner which is responsible for the characteristic chemical properties of the organic compounds, *e.g.*, hydroxyl groups (—OH), aldehyde group (—CHO), ketone group $\left(>C=O\right)$, carboxylic group (—COOH) etc.

2. (a) $>C=O$ - ketone
(b) — COOH - carboxylic acid
(c) — CHO - aldehyde
(d) — OH - alcohol

3. A homologous series can be defined as a family of organic compounds having the same functional group, similar chemical properties and the successive members of which differ by a – CH_2 group or 14 mass units. For example, CH_3OH (methanol), CH_3CH_2OH (ethanol), $CH_3CH_2CH_2OH$ (propanol), $CH_3CH_2CH_2CH_2OH$ (butanol), etc. constitute a homologous series of alcohols. They have the same functional group, *i.e.*, – OH (hydroxyl). Since they have the same functional group, they show similar chemical properties. The difference between any two successive members is a CH_2 group or 14 mass units. Their physical properties such as melting points and boiling points increase as the molecular mass increases. Their solubility in water however, decreases with increase in molecular mass.

4. (i) Bromoethane
(ii) Methanal
(iii) Hex-1-yne

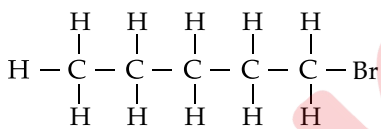
5. (i)



or $CH_3-C(=O)-OH$

Ethanoic acid

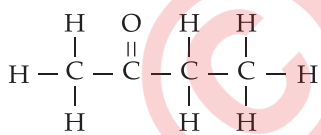
(ii)



Bromopentane

or $CH_3-CH_2-CH_2-CH_2-CH_2-Br$

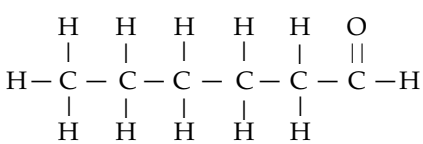
(iii)



But-2-one

or $CH_3-C(=O)-CH_2-CH_3$

(iv)

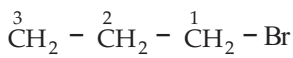


Hexanal

or $CH_3-CH_2-CH_2-CH_2-CH_2-C(=O)-H$

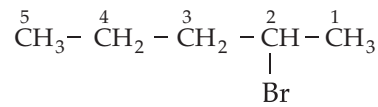
Bromopentane has a chain of five carbon atoms. It can exist in a number of forms which are structural isomers.

(i)



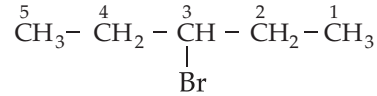
1-Bromopentane

(ii)



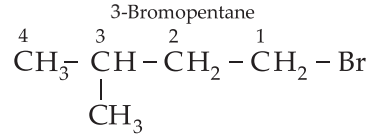
2-Bromopentane

(iii)



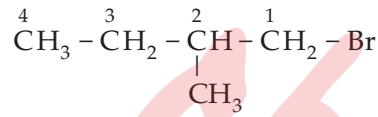
3-Bromopentane

(iv)



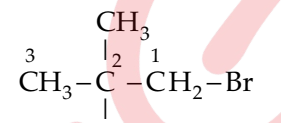
1-Bromo-3-methylbutane

(v)



1-Bromo-2-methylbutane

(vi)



1-Bromo-2, 2-dimethylpropane

The structural isomers (i), (ii) and (iii) which differ in the position of the Br atom are known as position isomers.

The structural isomers (iv), (v) and (vi) which differ in the arrangement of carbon atoms in the chain are called chain isomers.

When you write the IUPAC name, alphabetical order is followed while naming the different prefixes. Hence, bromo is written before methyl in IUPAC nomenclature.

Topic 3

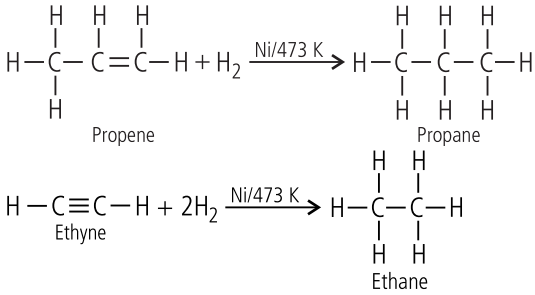
1. Ethanoic acid (CH_3COOH) has one oxygen atom more and two hydrogen atoms less than ethanol (C_2H_5OH). In general, loss of hydrogen and gain of oxygen is known as oxidation. Therefore, it is an oxidation reaction.

2. In order that a hydrocarbon may undergo addition reaction, it must be unsaturated in nature. It must be either an alkene (C=C) with general formula C_nH_{2n} or an alkyne (C≡C) with general formula C_nH_{2n-2}. Out of the list of the hydrocarbons given :

C_3H_6 (Propene) is an alkene with C=C bond. It corresponds to general formula C_nH_{2n} ($n = 3$).

C_2H_2 (Ethyne) is an alkyne with C≡C bond. It corresponds to general formula C_nH_{2n-2} ($n = 2$).

Both these hydrocarbons take part in addition reaction. For example, they react with hydrogen upon heating to 473 K in the presence of nickel catalyst to form corresponding alkanes.



3. When ethyne is burnt in oxygen, large quantity of heat along with light is produced. The heat evolved can be used for gas welding which is usually carried to weld broken small pieces of particles made up of iron.

$C_2H_{2(g)} + 5/2\ O_{2(g)} \longrightarrow 2CO_{2(g)} + H_2O_{(l)}$ + heat and light

Air mainly contains a mixture of nitrogen (4 parts) and oxygen (1 part). As we know, nitrogen gas does not support combustion, this means that in air, only oxygen will help in the combustion of ethyne. Therefore, it is always better to use oxygen for the combustion of ethyne.

4. Butter is saturated in nature while cooking oil is unsaturated. This means that cooking oil has at least one C═C bond present in the constituting compounds while butter does not have any such bond. The distinction between them can be made by reacting with bromine water or bromine dissolved in carbon tetrachloride. Cooking oil will discharge the yellow colour of bromine while butter will not.

5. The distinction can be made by the following tests :

(i) Dip a strip of blue litmus separately in both alcohol and carboxylic acid taken in two glass tubes. The colour will change to red in the tube containing carboxylic acid while there will be no change in colour in the tube containing alcohol.

(ii) Add a small amount of solid sodium hydrogen carbonate ($NaHCO_3$) in both the tubes. A brisk effervescence accompanied by bubbles due to the evolution of CO_2 will be noticed in the tube containing carboxylic acid and the tube containing alcohol will not show any change.

6. Oxidising agents are the substances which on reacting with another substance release oxygen in order to carry oxidation reactions. The commonly used oxidising agents are ozone, bromine water, a mixture of potassium dichromate and nitric acid or a mixture of potassium permanganate and sodium hydroxide.

7. Addition of hydrogen to an unsaturated carbon compound is called hydrogenation reaction. In industry, hydrogenation reaction is used for preparing vegetable ghee from vegetable oils. Vegetable oils such as groundnut oil, cottonseed oil, which contain double bonds in their molecules, are converted into ghee by hydrogenation in the presence of Ni. The process of converting a vegetable oil into a solid fat (vegetable ghee) is called hydrogenation of oil.

$$\underset{\text{(unsaturated oil)}}{\text{Vegetable oil}} + H_{2(g)} \xrightarrow{\text{Ni/Pt}} \underset{\text{(saturated fat)}}{\text{Vegetable ghee}}$$

8. Distinction based on physical properties :

(i) **Smell :** Ethanol has a characteristic smell known as alcoholic smell which is pleasant. Ethanoic acid has vinegar like smell.

(ii) **Litmus test :** Ethanol is neutral in nature and does not bring any change in the colour of litmus whether blue or red. Ethanoic acid is acidic and changes the colour of a blue litmus strip to red when dipped in it.

Distinction based on chemical properties :

(i) **Action with sodium hydrogen carbonate :**

On adding a small amount of sodium hydrogen carbonate to ethanoic acid, carbon dioxide gas is evolved with brisk effervescence. However, no such reaction is noticed in case of ethanol.

$$CH_3COOH + NaHCO_3 \longrightarrow \underset{\text{(Brisk effervescence)}}{CH_3COONa + CO_2\uparrow} + H_2O$$

(ii) **Action with caustic alkalies :** Ethanoic acid reacts with both sodium hydroxide (NaOH) and potassium hydroxide (KOH) to form corresponding salt and water. Ethanol fails to react with either of these.

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$
$$CH_3COOH + KOH \longrightarrow CH_3COOK + H_2O$$

9. (a) $CH_3-\underset{\underset{CH_3}{|}}{C}=\underset{\underset{CH_3}{|}}{C}-CH_3 + H_2 \xrightarrow{Ni} CH_3-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{CH_3}{|}}{CH}-CH_3$

Nickel acts as a catalyst in the hydrogenation reaction.

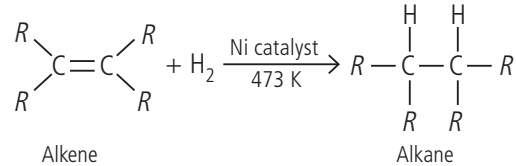
(b) $CH_3COOH + CH_3CH_2OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$

Conc. H_2SO_4 acts as a catalyst or dehydrating agent in esterification reaction.

(c) $CH_3CH_2OH \xrightarrow[\text{heat}]{\text{alk. } KMnO_4} CH_3COOH$

Alkaline $KMnO_4$ acts as an oxidising agent.

10. The reaction which is commonly used in the conversion of vegetable oils to fats is known as hydrogenation reaction. When hydrogen in presence of nickel or palladium catalyst is passed through oils having double bonds, hydrogen is added on double bonds and oils are converted into saturated fats.



$$\text{Vegetable oil} + H_2 \xrightarrow{\text{Ni, 473 K}} \text{Vanaspati ghee}$$

Topic 4

1. When an oily (dirty) piece of cloth is put into soap solution, the hydrocarbon part of the soap molecule attaches itself to the oily drop, and the —COO^- end orients itself towards water. The Na^+ ions in solution arrange themselves around the —COO^- ions. The negatively charged micelle so formed entrap

the oily dirt. The negatively charged micelles repel each other due to the electrostatic repulsion. As a result, the tiny oily dirt particles do not come together and get washed away in water during rinsing.

2. Soap is basically sodium or potassium salt of higher fatty acid. Hard water contains in it Ca^{2+} and Mg^{2+} ions as their salts. When soap is added to hard water, the corresponding calcium and magnesium salts are formed. These form of precipitates, are called 'scum'.

$$\underset{\text{Hard water}}{Ca^{2+}} + \underset{\text{Soap}}{2RCOONa} \longrightarrow \underset{\text{Calcium salt (ppt.)}}{(RCOO)_2Ca} + 2Na^+$$

$$\underset{\text{Hard water}}{Mg^{2+}} + \underset{\text{Soap}}{2RCOONa} \longrightarrow \underset{\text{Magnesium salt (ppt.)}}{(RCOO)_2Mg} + 2Na^+$$

3. When soap is dissolved in water, the solution is alkaline in nature due to the formation of alkali NaOH or KOH. The solution changes the colour of red litmus to blue. However, the solution does not change the colour of blue litmus.

4. No, it is not possible. Actually detergents produce foam in any type of water ; whether hard or soft. Therefore, a distinction between the two cannot be made. However, soaps can be used for this purpose.

5. The purpose of soap or detergent in washing is to reduce friction between oil drops carrying dirt particles and water so that they mix with each other. All the methods that have been suggested, are useful in loosening the bonds between the dust or oil particles and fabrics of clothes. The agitation helps in washing the clothes.

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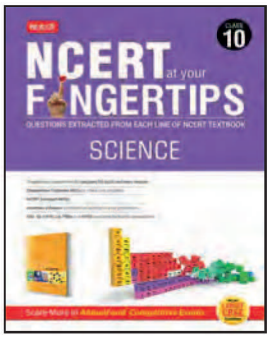

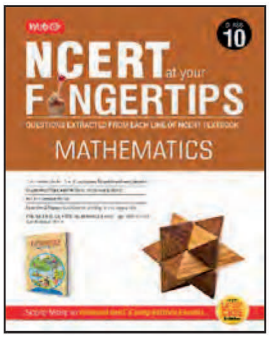

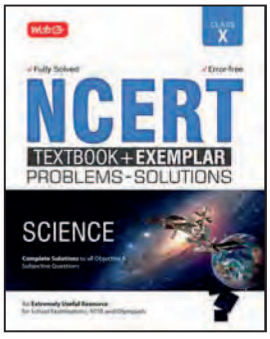

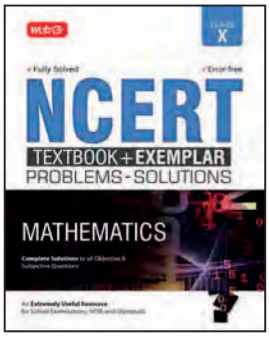

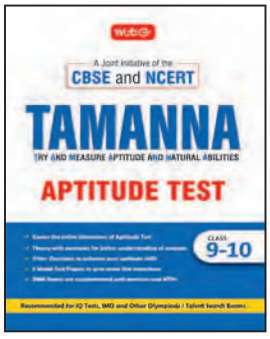

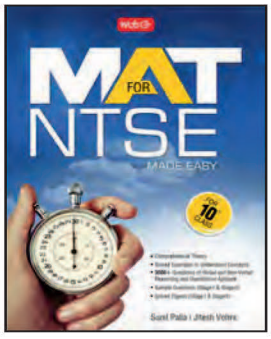

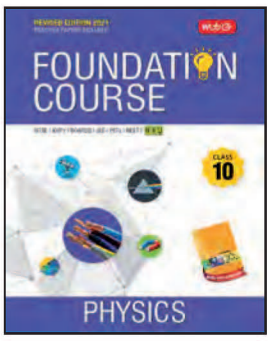

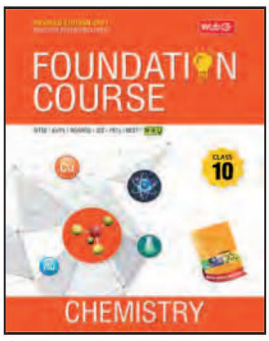

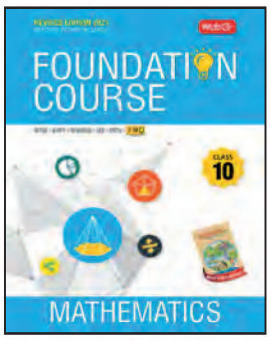

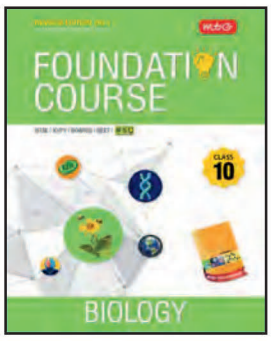

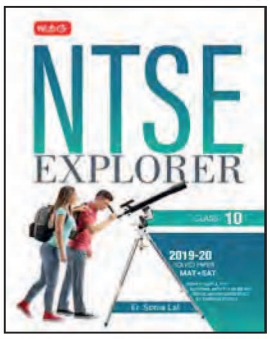

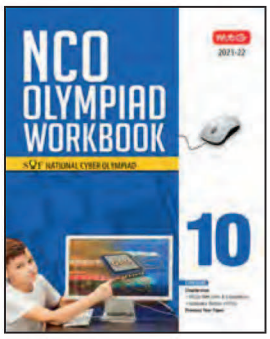

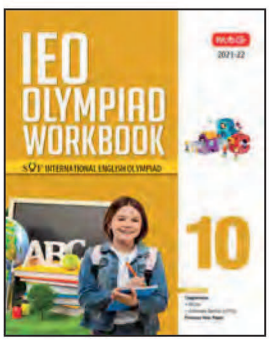

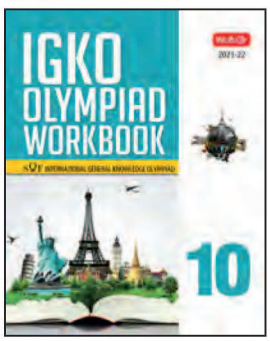

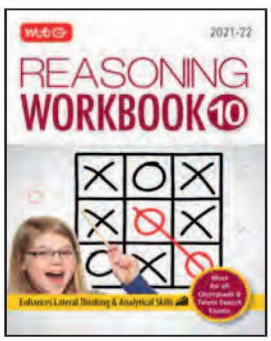

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