FOCUS

Class XI

NEET/JEE 2019

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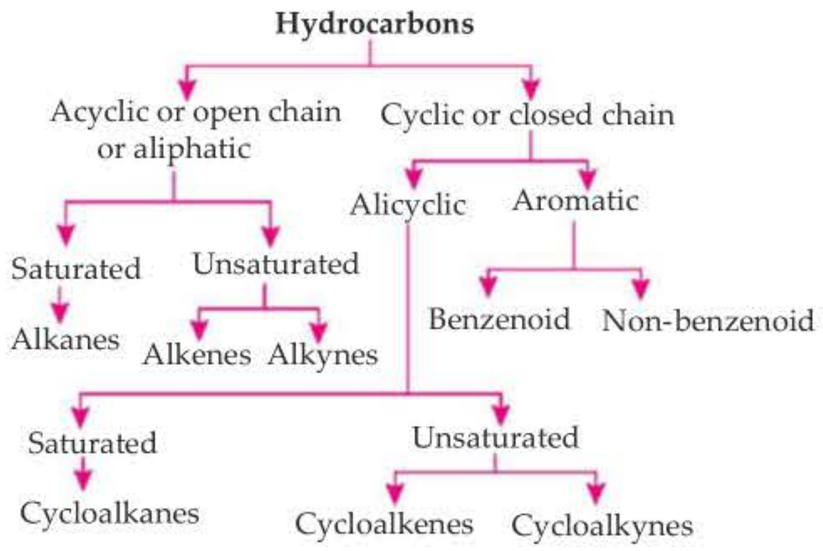
UNIT - 8 : Hydrocarbons and Environmental Chemistry

HYDROCARBONS

- Organic compounds composed of only carbon and hydrogen are known as hydrocarbons.

Classification

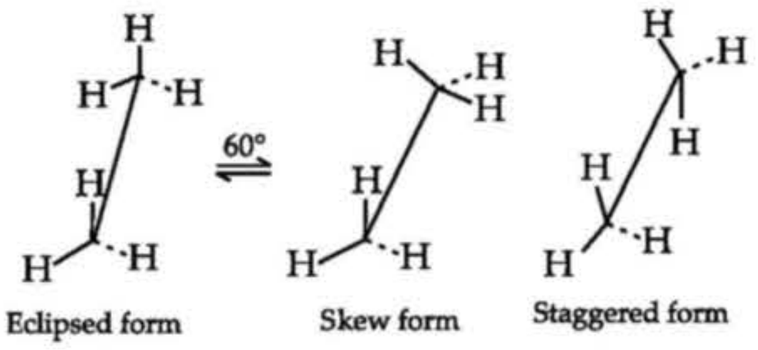


Alkanes

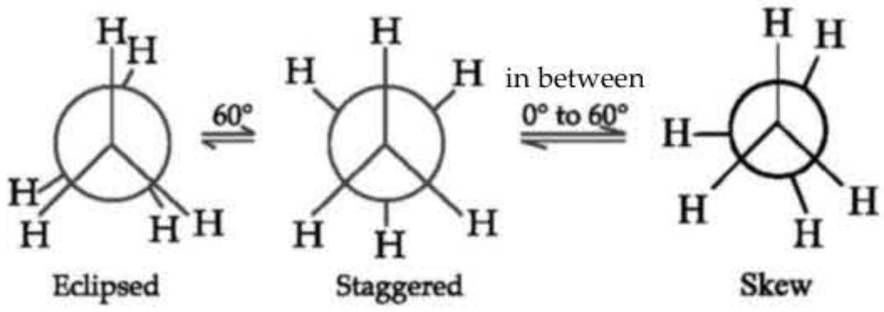
- General representation : R—H
- General formula : C_nH_{2n+2}
- Hybridisation : sp^3
- Geometry : Tetrahedral

Conformations

- **Sawhorse projection :** It is a view of molecule down a particular C – C bond, and groups connected to both the front and back carbons are drawn using sticks at 120° angle. The left-hand bottom end of this locates atoms nearer to the observer and right-hand top end atoms that is further away.



- **Newman projection :** In Newman projection, the two carbon atoms forming the σ-bond are represented by two circles, one behind the other, so that only front carbon is seen. The hydrogen atoms attached to the front carbon are shown by the bonds from the centre of the circle while the atoms attached to the back carbon are shown by the bonds from the circumference.



Methods of Preparation

Decarboxylation $R-COONa \xrightarrow[630\ K]{NaOH/CaO}$	A
Kolbe's electrolytic method $2RCOOK_{(aq)} \xrightarrow{Electrolysis}$	
Reduction of alkyl halide $R-X+2[H] \xrightarrow{Zn/HCl}$	L
$R-X+H_2 \xrightarrow{Pd}$	K
Wurtz reaction $R-X+2Na+X-R \xrightarrow{Dry\ ether}$	
Corey-House reaction $R_2CuLi+R'X \xrightarrow{Dry\ ether}$	A
From Grignard reagent $RMgX+H_2O \xrightarrow{H^+}$	
Frankland's method $RX+Zn+XR \xrightarrow{ether}$	N
Reduction method $RCH_2OH/RCHO/RCOR/RCOOH \xrightarrow[\Delta]{HI/Red\ P}$	
$RCHO/RCOR \xrightarrow{Zn-Hg/HCl}$ (Clemmensen reduction)	E
$RCHO/RCOR \xrightarrow[KOH]{H_2N-NH_2}$ (Wolff-Kishner reduction)	S

Chemical Properties

A	$\xrightarrow[h\nu]{X_2} R-X+HX$	(Halogenation)
L	$\xrightarrow[523-675\ K]{HO-NO_2} R-NO_2+H_2O$	(Nitration)
	$\xrightarrow[SO_3,\ 675\ K]{HO-SO_3H} R-SO_3H+H_2O$	(Sulphonation)
K	$\xrightarrow[KOH]{KMnO_4} R-OH$	
A	$\xrightarrow[O_2,\ \Delta]{Ag_2O} R-COOH$	(Oxidation)
	$\xrightarrow[100\ atm]{Cu/523\ K} R-OH$	
N	$\xrightarrow[HCl(Conc.),\ 573\ K,\ 35\ atm]{Anhyd.AlCl_3}$	Isomers of respective alkanes (Isomerisation)
E	$\rightarrow C_6H_{12}+H_2$ (Hexene)	
S	$C_6H_{14} \xrightarrow[6\text{-}7\ atm]{773\ K}$ Hexane $\rightarrow C_4H_8+C_2H_6$ (Butene, Ethane)	(Pyrolysis)
	$\rightarrow C_3H_6+C_2H_4+CH_4$ (Propene, Ethene, Methane)	

Alkenes

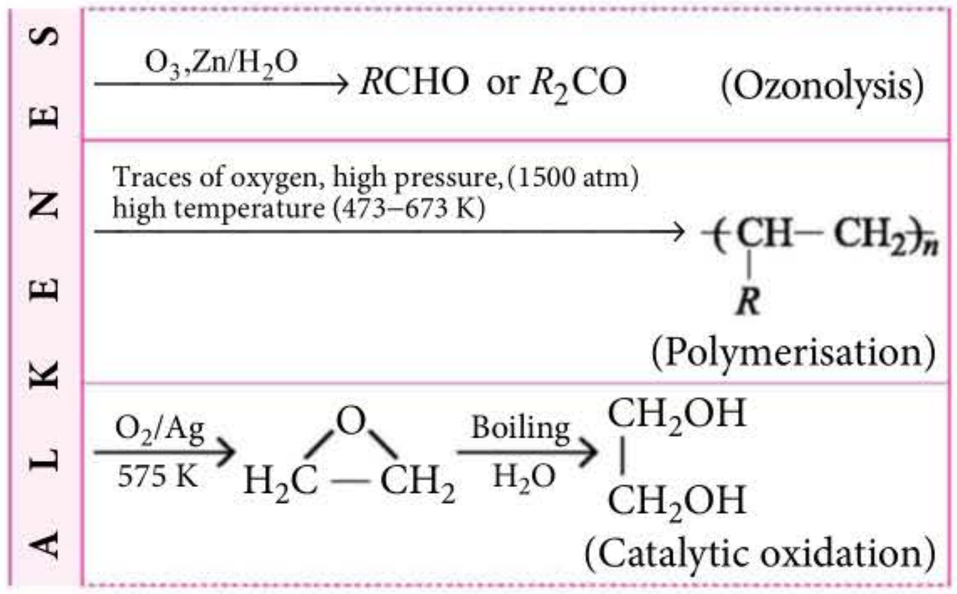
- General representation : $RR_1C{=}CR_2R_3$
- General formula : C_nH_{2n}
- Hybridisation : sp^2
- Geometry : Planar triangular

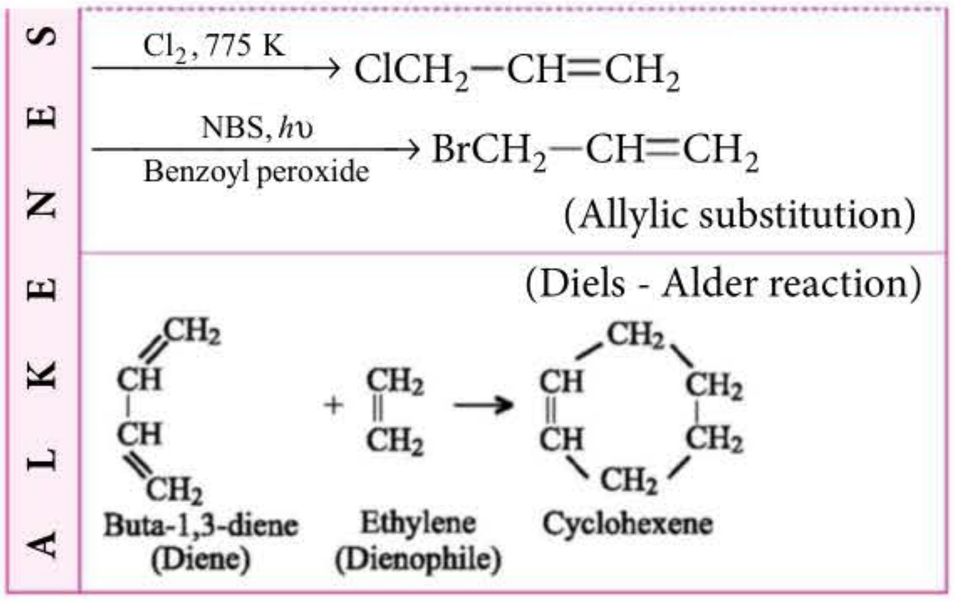
Methods of Preparation

Dehydration of alcohols $R-OH \xrightarrow[473\ K]{conc.\ H_2SO_4}$	A
$R-OH \xrightarrow[623\ K-673\ K]{Al_2O_3}$	L
Dehydrohalogenation of alkyl halides $R-Br+KOH_{(alc.)} \xrightarrow{\Delta}$	K
Dehalogenation of dihalides $R(Br)-R(Br) \xrightarrow[CH_3OH,\ \Delta]{Zn/Cu}$	E
Partial hydrogenation of alkynes $R-C\equiv C-R \xrightarrow[(Lindlar's\ catalyst)]{H_2,Pd/CaCO_3+S}$	N
$R-C\equiv C-R \xrightarrow[liq.\ NH_3]{Na}$ (Birch reduction)	E
Kolbe's electrolytic method $\begin{matrix}CH_2COONa\\ \vert \\ CH_2COONa\end{matrix} \xrightarrow{Electrolysis}$	S

Chemical Properties

A	$\xrightarrow[523\text{-}573\ K]{H_2/Ni,\ Pt\ or\ Pd} R-CH_3$
L	$\xrightarrow{Br_2/CCl_4} RCHBrCH_2Br$
	$\xrightarrow[(X=Br,\ Cl,\ I)]{HX} R-\underset{\underset{X}{\vert}}{CH}-CH_3$ (Markovnikov's rule)
K	$\xrightarrow[(X=Br)]{HX/Peroxide} R-CH_2-CH_2Br$ (Anti-Markovnikov's rule)
E	$\xrightarrow{H_2O/H_2SO_4} R-CH(OH)-CH_3$
N	$\xrightarrow{B_2H_6/H_2O_{2(alk.)}} RCH_2CH_2OH$ (Hydroboration – oxidation)
E	$\xrightarrow[H_2O]{(CH_3COO)_2Hg/THF} R-\underset{\underset{OH}{\vert}}{CH}-CH_3$ (Oxymercuration – demercuration)
S	$\xrightarrow[Cold]{alk.\ KMnO_4} RCH(OH)-CH_2(OH)$ (Oxidation)

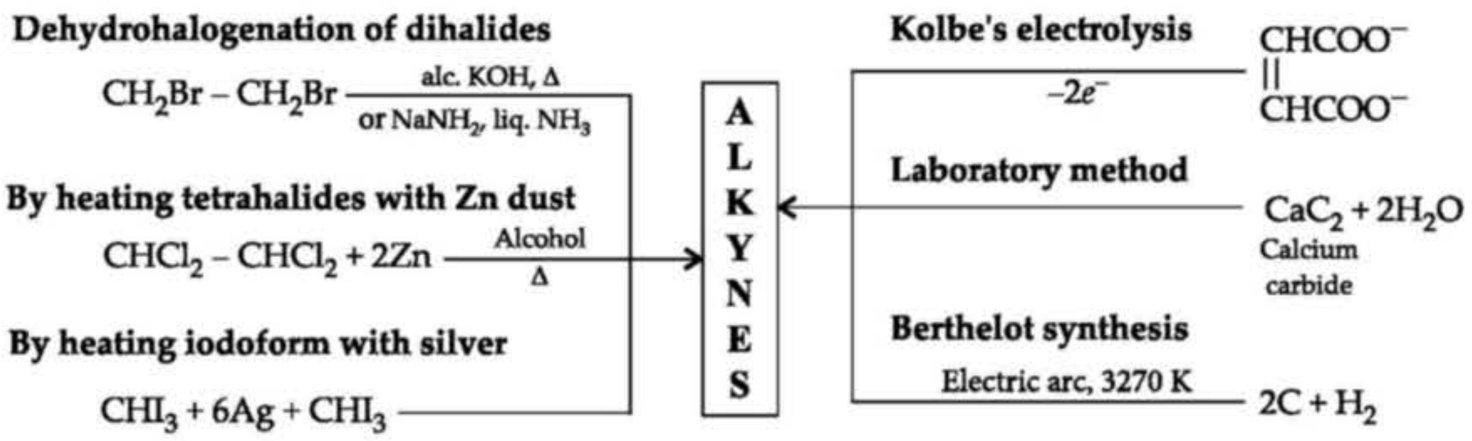




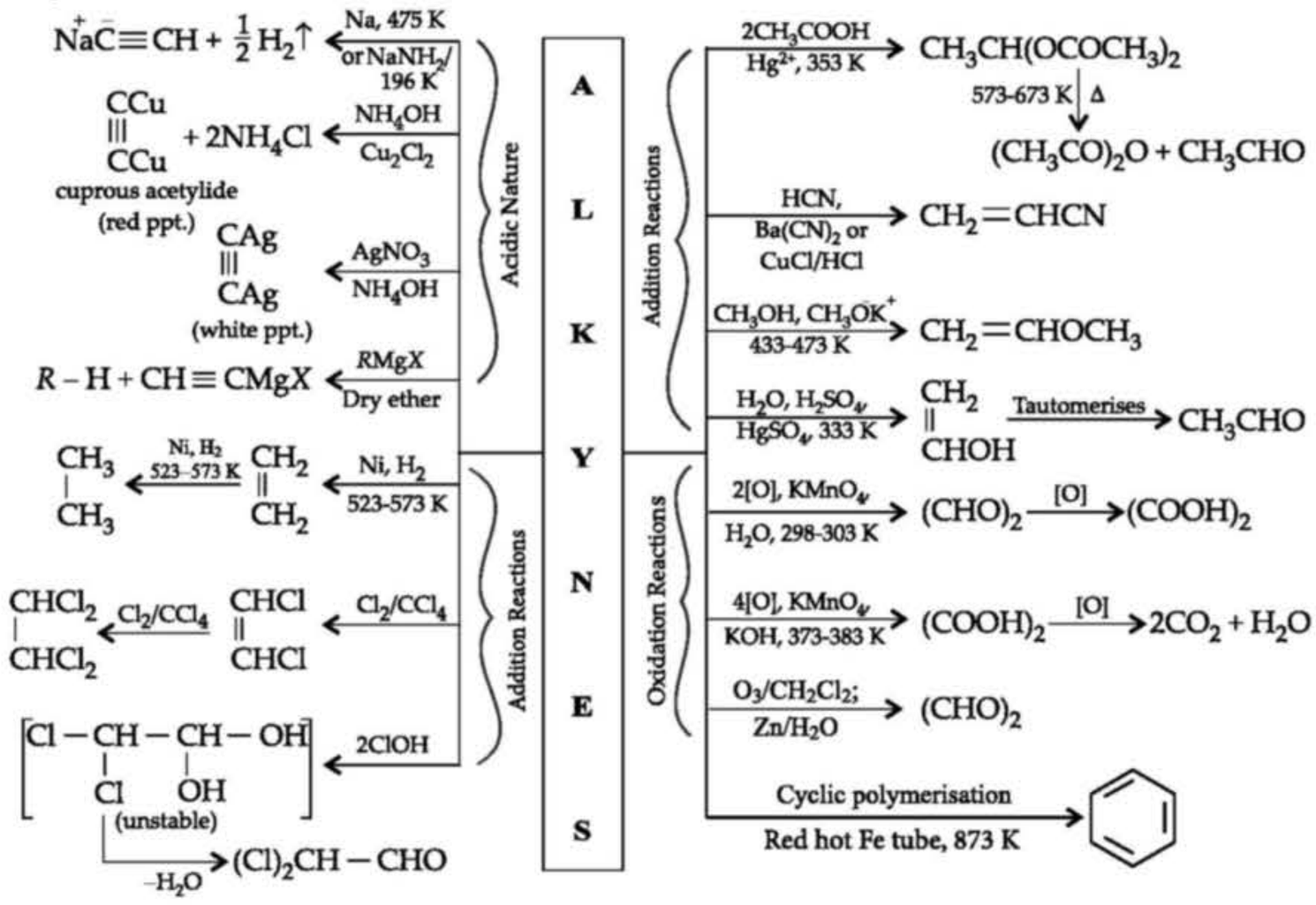
Alkynes

- General representation : $R_1C{\equiv}CR_2$
- General formula : C_nH_{2n-2}
- Hybridisation : *sp*
- Geometry : Linear

Methods of Preparation



Chemical Properties



Aromatic Hydrocarbons

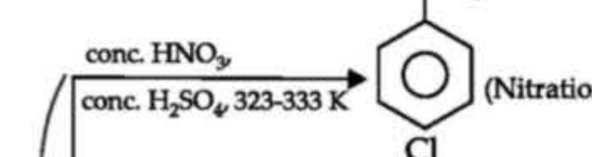
- Aromatic hydrocarbons are also called arenes. Benzene is the simplest aromatic hydrocarbon.
- Arenes can be described by the general formula C_nH_{2n-6m}, where n is the number of carbon atoms and m is the number of benzene rings.
  e.g., for monocyclic arenes,
  $m = 1$ and $n = 6$, or more. For bicyclic arenes, $n = 10$, $m = 2$

Benzene

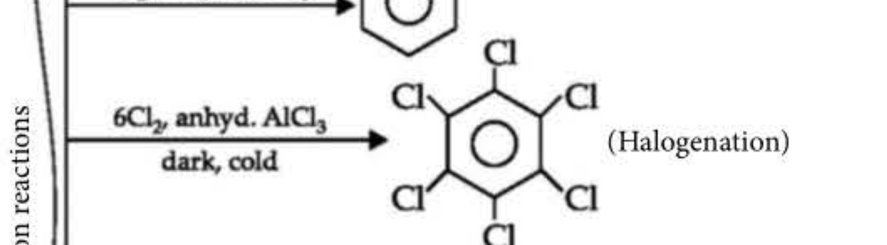
Naphthalene

Methods of Prepartion

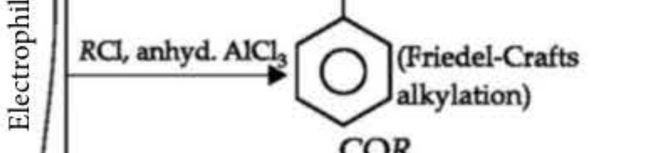
- **Cyclic polymerisation of ethyne :**



- **Decarboxylation of aromatic acids :**



- **Reduction of phenol :**

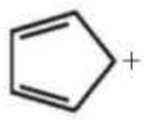


Chemical Properties

Hückel Rule of Aromaticity

- A compound is said to be aromatic, if it meets all of the following criteria :
  - Aromatic compounds contain one or more rings that have a cyclic arrangement of *p*-orbitals.
  - Aromatic rings are planar.
  - Aromatic systems are conjugated cyclic systems.
  - Aromatic systems must contain $(4n + 2)$ π–electrons used in delocalisation, where n = integer (0, 1, 2, ...).

Aromatic	Anti-aromatic	Non-aromatic
◆ Cyclic, planar molecule ◆ Complete delocalisation of π-electrons ◆ Follows Huckel's rule $(4n + 2)$ π e^-s	◆ Cyclic, planar molecule ◆ Complete delocalisation of π-electrons ◆ Follows $4n$ π e^-s	◆ Either non-cyclic, non-planar ◆ No delocalisation of π-electrons ◆ May or may not follow $(4n + 2)$ π e^-s rule.

◆ *e.g.*, cycloheptatrienyl cation (tropylium ion), cyclopropenyl cation, benzene, etc.  Cyclopropenyl cation (Aromatic)	◆ *e.g.*, cyclopropenyl anion, cyclopentadienyl cation, etc.  Cyclopentadienyl cation (Anti-aromatic)  **Cyclopropenyl anion (Anti-aromatic)**	◆ *e.g.*, cyclooctatetraene (tub-shaped), etc.  Cyclooctatetraene (Non-aromatic)

ENVIRONMENTAL CHEMISTRY

- Environmental chemistry deals with the study of the origin, transport, reactions, effects and fates of chemical species in the environment.
- Environment means surroundings and it has four major components : atmosphere, hydrosphere, lithosphere, biosphere.
  - ➢ Atmosphere is a cover of gases upto the height of 1600 km from the surface of earth. It is further divided into four regions :

Region	Altitude from earth's surface	Temperature range	Gases/Species present
Troposphere	0 – 11 km	Decreases from 15 to –56°C	N_2, O_2, CO_2, H_2O vapour
Stratosphere (Ozonosphere)	11 – 50 km	Increases from –56 to –2°C	N_2, O_2, O_3, O-atoms
Mesosphere	50 – 85 km	Decreases from –2 to –92°C	N_2, O_2, O_2^+ , NO^+
Thermosphere	85 – 500 km	Increases from –92 to 1200°C	O_2^+, O^+, NO^+, e^-

  - ➢ Hydrosphere is that part which contains water in the form of oceans, rivers, lakes, etc. and covers 75% of earth's surface.
  - ➢ Lithosphere consists of solid components like soil, rocks, mountains etc.
  - ➢ Biosphere is the part where living organisms interact with lithosphere, hydrosphere and atmosphere.

Types of Pollutants

- **Primary and secondary pollutants :** Primary pollutants are those which remain as such in the environment after their formation like NO, SO_2, NO_2 whereas secondary pollutants are formed from the primary pollutants like PAN (Peroxyacetyl nitrates).
- **Biodegradable and non-biodegradable pollutants :** Biodegradable pollutants are those which are easily decomposed by microorganisms either naturally or by suitable treatment *e.g.*, discarded vegetables and non-biodegradable pollutants are those which do not decompose or decompose very slowly and are harmful to living organisms *e.g.*, DDT, plastic materials, heavy metals, etc.

Types of Pollution

Air Pollution

- It is the addition of undesirable materials into the atmosphere either due to natural phenomena or due to human activity on the earth which adversely affect the quality of the air and hence, affects the life on the earth.

Pollutants	Major sources	Effects
CO	Incomplete combustion of carbonaceous matter in automobile engines and defective furnaces, incomplete combustion of agricultural and slash matter, volcanic eruptions, forest fires.	Carbon monoxide is toxic. It binds with haemoglobin in red blood cells and prevents them from combining with oxygen. Low levels of O_2 cause headache and dizziness.
NO_x	Combustion of fuel, natural forest fires, stationary combustion sources (factories and power plants), transportation.	Toxic to living tissues, harmful to plants and textiles.

SO_x	Stationary combustion sources, metal ore extraction, coal, organic decay products, volcanoes.	They are respiratory tract irritants, low concentration causes throat, eye irritation and breathlessness, affect larynx.
Hydrocarbons	Combustion of fuel in automobiles, refineries, anaerobic bacterial decomposition of organic matter, natural gas.	At concentration greater than 500–1000 ppm, they have carcinogenic effect in lungs. They react with O_2 and NO_x to form photochemical smog which have a strong damaging effect on human being as well as plants.
CFCs	CFCs were used primarily as refrigerants, in aerosol sprays and in the plastic industry. Freons are stable, inflammable and inert (in the lower atmosphere).	React with stratospheric ozone. When CFCs are broken down, chlorine free radicals are produced that depletes the ozone layer.
Particulates	Volcanic eruptions, fly ash, smelting and mining operations, smoke from incomplete combustion, dust from industrial crushers and grinders.	Inhalation of metallic particles leads to respiratory disorders like asthma, bronchitis, lung cancer, etc.

Greenhouse Effect and Global Warming :

- The trapping of IR radiations by gases such as carbon dioxide, methane, ozone, chlorofluorocarbon compounds (CFCs) and water vapours in the atmosphere leading to the heating up of earth's atmosphere is called greenhouse effect.
- The increase in concentration of greenhouse gases will lead to increase in average global temperature which is called global warming.

Acid Rain

- When the pH of rain water falls below 5.6 due to presence of H_2SO_4 and HNO_3, formed from the oxides of sulphur and nitrogen present in the air, it is called acid rain.
- Acid rain is harmful for agriculture, trees and plants as it dissolves and washes away nutrients required for their growth.
- It affects the aquatic ecosystem and damages buildings and other structures made of stone or metal.

Smog

- The word smog is derived from smoke and fog. It is a major air pollutant.

Smoke + Fog (containing harmful gases) $\longrightarrow$ Smog

Classical smog	Photochemical smog
Also called as London smog.	Also called as Los Angeles smog.
Formed due to oxides of sulphur.	Formed due to oxides of nitrogen.
Contains primary pollutants.	Contains secondary pollutants.
Causes bronchitis and problems in lungs.	Causes irritation in eyes.
It is reducing in nature.	It is oxidising in nature.

Stratospheric pollution (Ozone depletion)

- Ozone (O_3) present in the stratosphere prevents about 99.5% of UV radiations from reaching the earth's surface and thereby protecting humans and other animals from its harmful effects.
- A dynamic equilibrium exists between the production and decomposition of ozone molecules.

$$O_{2(g)} \xrightarrow{UV} O_{(g)} + O_{(g)}$$

$$O_{(g)} + O_{2(g)} \underset{}{\overset{UV}{\rightleftharpoons}} O_{3(g)}$$

- The main reason of ozone layer depletion is the release of chlorofluorocarbon compounds (CFCs), also known as freons.

Water Pollution

- Water pollution may be defined as any change in its physical, chemical or biological properties or contamination with foreign materials that can adversely affect human beings or reduce its utility for the intended use.

- **Major water pollutants and their sources :**

Pollutants	Major sources
Natural wastes	Leaching of minerals, silt from soil erosion, falling of organic matter from banks, etc.
Organic chemicals	Pesticides, surfactants, detergents, industrial wastes.
Metals (Hg, As, Pb, Cd, etc.)	Nuclear power plants, mining, metal plating industries.
Man-made wastes	Sewage, domestic waste, soaps and detergents, waste from animal sheds and slaughter houses, run off from agricultural fields, industrial wastes, oil pollution.

- **Effects of water pollution**
  - High concentrations of fluoride are poisonous and are harmful to bones and teeth at levels over 10 ppm.
  - Excess nitrate in drinking water can lead to blue baby syndrome.
  - Excess sulphate (> 500 ppm) have a laxative effect.
  - **Biochemical Oxygen Demand (BOD) :**

$$BOD = \frac{\text{Milligrams of } O_2 \text{ consumed by microorganisms}}{\text{Volume of sample (in L)}}$$

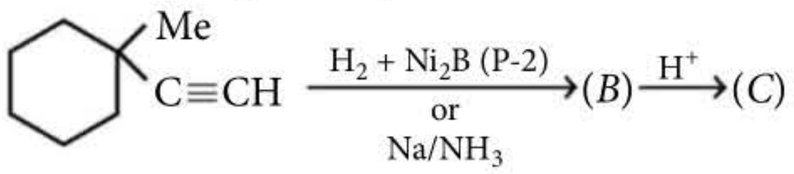
  - **Chemical Oxygen Demand (COD) :** Chemical oxygen demand refers to the amount of oxygen, expressed in parts per million, consumed under specific conditions in the oxidation of the organic and oxidizable inorganic matter contained in industrial waste water.

Soil Pollution

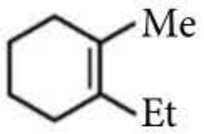
- The addition of substances in an indefinite proportion changing the productivity of the soil is known as soil pollution.
- **Sources of soil pollution :**
  - Agricultural pollutants or Agro Chemistry chemicals like pesticides, fertilisers, fumigants, insecticides, herbicides, fungicides.
  - Domestic and industrial wastes.
  - Radioactive wastes from research centres and hospitals.
  - Soil conditioners containing toxic metals like Hg, Pb, As, Cd etc.
  - Pollutants present in air from chemical works.

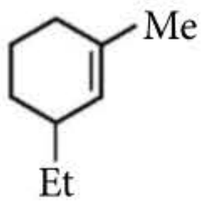
SPEED PRACTICE

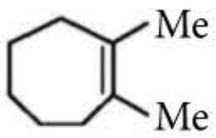
1. Observe the given sequence of reactions :

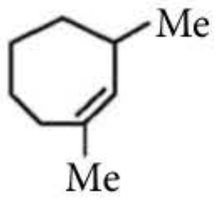


The compound (*C*) is

(a) 

(b) 

(c) 

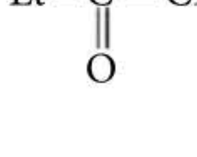
(d) 

2. Which one of the following substances is not aromatic ?

(a) 

(b) 

(c)

(d) 

3. Which oxide of nitrogen is not a common pollutant introduced into the atmosphere both due to natural and human activity?

(a) N_2O_5 (b) NO_2

(c) N_2O (d) NO **(NEET 2018)**

4. The major product '*P*' in the following reaction is

$$CH_3CH_2C{\equiv}CH \xrightarrow[THF]{BD_3} \xrightarrow{CH_3COOH} P$$

(a)

(b)

(c)

(d)