CHAPTER # 23

ENVIRONMENTAL CHEMISTRY

Q1~ Select the right answer from choices given?

i- All of the above (d)
ii- CO_2 (c)
iii- Acids (b)
iv- Ozone (b)
v- 25-28 Km (b)
vi- Chlorofluorocarbons (c)
vii- Chromium (VI) is used (a)
viii- All of the above (d)
ix- Biosphere (a)
x- HOCl (b)
xi- Eyes (a)
xii- Control growth of Fungus (a)

Q2~ Give Brief answers for the following questions?

i~ **What are the components of Environment?**

Answer~ These are the following components of environment.

(a) **Atmosphere →** It is related with **gases.**

(b) **Hydrosphere →** It is concerned with **all water bodies** i.e. oceans, rivers, streams, lakes etc.

(c) **Lithosphere →** It is concerned with **hard and rigid rocky** earth crust.

(d) **Biosphere →** It is concerned with area **on earth** which supports life i.e air, lakes etc.

ii~ **Briefly discuss role of atmosphere in our environment?**

Answer~ "Our surrounding on earth is called atmosphere".
It consists of gases i.e. N_2, CO_2, He, Ne, Kr, Xe and water vapours. Its thickness is about **1000 km** above the surface of earth.

Importance of these Gases:

i- These gases absorb harmful radiations (cosmic rays and electromagnetic radiations) of Sun to protect life on earth. Otherwise these rays are very harmful.

ii- N_2 is used by nitrogen fixing bacteria.

iii- O_2 is necessary for **breathing** in animals.

iv- CO_2 is necessary for **photosynthesis** in plants.

v- **Water vapours** are responsible for **sustaining life on earth.**

iii~ **What are the Sources of Air pollution?**

Answer~ These are the following sources of air pollution.

(a) Nitrogen Oxides (NO and NO_2).
(b) Volatile Organic compounds (VOCs).
(c) Carbon Oxides (CO and CO_2).
(d) Oxides of Sulphur (SO_2 and SO_3).

iv~ **What are the important air pollutants?**

Answer- These are the following important air pollutants.

(a) Nitrogen Oxides (NO and NO_2).
(b) Volatile Organic compounds (VOCs).
(c) Peroxyacetyl Nitrates (PAN).
(d) Carbon Oxides (CO and CO_2)
(e) Oxides of Sulphur (SO_2 and SO_3).

v~ **What are the sources of CO emission? Discuss its effects?**

Answer- **Sources:** There are following Sources of CO emission.

i- Incomplete combustion of agricultural of Slush (لاش)
ii- During the reaction in blast furnace.
iii- Cigarette Smoke
iv- Incomplete combustion of Carbon containing compounds.

Effects / Causes:

i- **Anoxia** (oxygen starvation) result Suffocation.
ii- Respiratory irritation.

Vi~ Differentiate Between:

(i) Industrial and Photochemical Smog.

(ii) Primary and Secondary Pollutants? (Extra)

Answer~

Smog:

It is a combination of Smoke and fog i.e. "Sm" from smoke and "og" from fog. Smog is of Two types:

(i) Industrial Smog (Reducing Smog):

This smog contains high contents of SO_2, it is chemically reducing in nature and is known as reducing smog. For example, the smoke and SO_2 produced from burning of coal can combine with fog to create industrial smog.

(ii) Photochemical Smog (oxidizing Smog):

Photochemical smog is termed as oxidizing smog which consists of higher concentration of oxidents like Ozone. It is a yellowish, brownish, grey haze which is formed in the presence of water droplets and chemical reactions of pollutants in the air. It has unpleasant odor because of its gaseous components.

vii - What is Global Warming?

Answer- **Global Warming:**

When sunlight consists of ultra-violet rays, visible light and infra red rays fall on the top of atmosphere, the harmful ultra violets rays are absorbed by O_3 layer and hence do not reach, on the other hands the visible light and infrared rays pass through the CO_2 layer and falls on the earth. Since the infrared radiations have heating effect they heat the earth and its objects. This is called global warming.

($\bar{x}$) - What are the latest predictions about global warming?

Answer~ These are the following predictions:

(a) If the atmosphere contains too much quantity of CO_2, the green house effect is considerably **increased**.

(b) Thus, due to excess quantity of CO_2 present in the atmosphere; the Temperature of the earth is **increased too much**. This too much Temperature melts all the **glaciers** (snow-mountains), floods the low-lying areas of earth.

(c) It also changes the **Biological activity** of oceans and the patterns of cropping etc.

VIII - What gases are responsible for green house effects?

Answer- The gases are:

(a) CO_2 and CO (b) Water vapours (c) Methane
(d) CFCs (e) Nitrogen Oxides

IX - What are different sources and Environment effects of: (i) VOCs (ii) PAN

(i) Volatile Organic Compounds (VOCs):

Sources	Environmental Effects
i- Evaporation of solvents ii- Evaporation of fuels. iii- Incomplete combustion of fossil fuels. iv- Naturally occuring compounds like terpenes from Trees.	i- Eye irritation ii- Respiratory irritation iii- Some are carcinogenic iv- Decreased visibility due to blue-brown haze.

(ii) Peroxyacetyl Nitrates (PAN):

Sources	Environmental Effects
i- Formed by the reaction of NO_2 with VOC.s (can be formed naturally in some environments).	i- Eye irritation ii- High Toxicity to plants iii- Respiratory irritation iv- Damaging to proteins.

X ~ What are the effects of excess of CO_2 present in atmosphere?

Ans→ Same as answer to question no. (x)

XI ~ Discuss the sources and Typical effects of SO_2 as pollutant?

Ans→

Sources	Environmental Effects
(i) Volcanic Eruption (ii) Burnt of oil and coal. (iii) Sulphide oves are roasted.	(i) Causes acid rain (ii) Respiratory irritation (iii) Loss of green colour in plants (iv) Fading in colour of Fabrics, leathers, paper and paints.

XII ~ Briefly discuss the sources and typical effects of oxides of nitrogen oxides (NO_x)?

Ans ~

	Sources	Environmental Effects
i-	Combustion of oil, coal, gas in both automobiles and industry.	i- Decreased visibility due to yellowish colour of NO_2.

ii- Bacterial action in soil iii- Forest fires iv- Volcanic action v- Lightning	ii- NO_2 contributes to heart and lung problems. iii- NO_2 can suppress plant growth. iv- Decreased resistance to infection. v- May encourage the spread of cancer.

xiii- What is ozone? How does it work as safeguard?

Ans→ **Ozone:**

"The protective layer in the atmosphere present at in stratosphere between **15 km to 25 km** is called ozone (O_3)".

Work as Safeguard:

The thickest layer of O_3 exists at a height of **23 km** from the surface of earth. The O_3 absorbs the harmful ultra-violet radiations coming from the sun. Thus, it saves the life from the harmful effects of ultra-violet rays and work as safe-guard.

xiv~ What do you know about "Ozone hole"

Ans~ In 1980 scientists showed that there is a hole in the O_3 layer. This hole was detected over the region of **Antarctica**. Due to the absence of O_3 layer, the ultra-violet rays coming from the sun can pass through the hole and thus can reach the earth's surface. The absence of O_3 in the atmosphere is due to the fact that the amount of O_3 present in stratosphere is getting **reduced day by day** and thus the ozone layer is becoming thinner and thinner. The depletion of Ozone layer is due to following sources:

i- Oxides of Nitrogen
ii- Nuclear Tests
iii- Role of Chloro-Fluoro Carbons

xv~ **What are the effects of Ozone layer depletion?**

ns→ If ozone layer in the atmosphere disappears completely, then all the **harmful ultra-violet radiations** coming from the sun would reach the earth and would cause **skin cancer in men and animals** and will also damage the **plants**. All the life on earth would then gradually be **destroyed**.

~ **What should we do to save Ozone?**

Ans~ Scientists are worried over the gradual destruction of ozone layer by the oxides of **nitrogen and chloro-fluoro carbons.** In order to save the destruction of ozone layer by chloro-fluoro carbons, their use should be banned or some new types of substances should be discovered which may be used as **aerosol spray propellants** and should not react with O_3 layer, so it may be saved.

xvi~ **What is water pollution? Write different types of water pollutants?**

Ans~ **Water Pollution:**

The contamination of water with the substances which have adverse effects on human beings, animals and plants is called water pollution, and the substances whose presence in the water makes it polluted are called **water pollutants**. These pollutants contain:

i- Oil spillage
ii- Live-stock Waste
iii- Industrial wastes
iv- Leather tanneries.

xvii **Briefly discuss the effects of water pollution?**

Ans~ These are the following effects of water pollution:

i- Polluted water is unsuitable for drinking, recreation, agriculture and industry.

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ii- It diminishes the aesthetic quality of lakes and rivers.

iii- The contaminated water destroys aquatic life and reduces its reproductive ability.

iv- The polluted water causes several diseases.

~ How preliminary treatment of waste water is done?

Ans~ In preliminary Treatment most of the suspended particles are removed which are visible.

i

ii

ii. - What is primary treatment of waste water?

iii. Ans~ Primary treatment involves the removal of sand particles or other particles which are visible.

x - What is secondary treatment of waste water?

→ Ans~ Secondary treatment involves:

- Solids removal.
- Oils and greases
- Soft organics
- Hard organics
- Acid and Alkalis
- Toxic materials

xviii~ How would avoid from thermal pollution?

Ans~ The companies use hot water in cooling their generators. When hot water is released in water bodies, it decreases the solubility of dissolved oxygen. Thus causes serious threat to life in water. So, the companies should decrease the temperature of hot water before discharging into water bodies.

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Qno-3 Give detailed answers for the following questions?

1~ Describe different chemical reactions occuring in our atmosphere?

Answer~ We know that air contains SO_2, NO_2 and CO_2.

i- SO_2 present in air undergoes photolytic and catalytic oxidation to form SO_3 which reacts with rainy water or moisture to form H_2SO_4 i.e.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

ii- NO_2 reacts with rainy water or moisture in the presence of O_2 and O_3 and produces HNO_3 i.e.

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$

iii- CO_2 reacts with rainy water or moisture to form H_2CO_3 i.e.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

iv- In some countries due to release of HCl by volcanic eruption, there is Temporary acid rain.

H_2SO_4, HNO_3, and H_2CO_3 formed as above come down the atmosphere as acid rain or acid snow. As far as H_2CO_3 is concerned, it has no severe effects on animals, plants or any other things.

2- Write a comprehensive note on acid rain?

Answer~ **Acid Rain:** "The pH of unpolluted rain water is 5.6. The rain water having pH less than 5 is considered as acid rain".

Explanation: The air contains SO_2, NO_2 and CO_2.

i- SO_2 present in air undergoes photolytic and catalytic oxidation to form SO_3 which reacts with rainy water or moisture to form H_2SO_4 i.e.

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IMPACTS :

i- It makes the **lakes** so acidic that they can no longer support fish life.

ii- The yield of **agricultural** crops is also **reduced.**

iii- **HNO_3 acid rain** gradually eats up **lime stone** and **marble** of the buildings and **corrodes metals.**

iv- It fades the **colour of fabrics** (e.g cotton, nylon and rayon), leather and paper.

v- Causes extensive **leaf-drop** in plants.

vi- It is very **corrosive** and **attacks skin.**

vii- Acidification of **soil and rocks** can leatch metals like Al, Hg, Pb and Ca and discharge them into water bodies. Then these metals (heavy) are eaten by fishes which proves very much dangerous for those animals and birds which eat these fishes.

viii- It also damages **steel, paint, plastic, cement, masonry work** and sculptural materials.

3~ How would you control air pollution? Describe different methods?

Answer In order to control the air pollution caused by hydrocarbons and CO etc the following methods are used.

1- **By adding lead tetraethyl Pb $(C_2H_5)_4$ to petrol:** $Pb(C_2H_5)_4$ is added to the petrol to slow down the rate of combustion of petrol. $Pb(C_2H_5)_4$ provides more time to the petrol for its combustion and hence enables it to burn more completely. Due to this quantity of unburnt hydrocarbons and CO coming out of the engine, with exhaust gases is reduced and hence air pollution is also minimized.

2- **Catalytic Oxidation / converter:** The pollution of air caused by unburnt hydrocarbons and CO present in the exhaust gases of the vehicle's engine can also be reduced by attaching gas device with the vehicle's engine, in which the exhaust gases can be mixed with more air and then burnt completely in the presence of **platinum catalyst** before they are discharged into the environment. Hydrocarbons and CO are oxidized by O_2 of the air in the presence of platinum catalyst.

$$2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18H_2O$$

$$2CO + O_2 \longrightarrow 2CO_2$$

Extra

4~ What is Thermal pollution? Discuss its sources and environmental effects?

Ans~ **Thermal Pollution:** Thermal pollution takes place because many many electric generating companies use water in the process of cooling their generator. This heated water is then released into the system by causing a warming trend of the surface water. Thermal pollution results when the heated effluent is released into poorly flushed system. In these cases permanent temperature increase

often result, which tend to decrease the solubility of dissolved oxygen. In lakes it also becomes possible to bring about nutrient redistributions and prolong summer stagnation periods.

When heated water gets released into large, well-flushed marine systems there is little if any permanent temperature rise. There are however problems related to the operation of plants utilizing marine water in the cooling process. Sea water tends to corrode the cooling pipes, which are generally constructed of **a copper nickel alloy termed "monel".** These metals readily dissolved in the heated seawater and are then released into the marine environment together with the heated effluent. This adds to the Nickel and copper concentrations of these systems. In addition to the screens covering the water intake pipes rapidly foul with marine organism, which decrease the flow of water into the plant. The screens have been commonly cleaned by using a concentrated detergent solution or copper sulfate. These cleaning materials have been then released into the contaminated waters in the surroundings.

5~ **What is waste water treatment? Discuss different methods of it?**

Ans~ **Waste Water Treatment:**

(i) **Analysis / Purification of water:** Industrial waste water treatment covers the mechanisms and processes used to treat waters that have been contaminated in some way by man's industrial or commercial activities prior to its release into the environment or its re-use.

Most industries produce some wet waste although recent trends in the developed world have been to minimize such production or recycle such waste within the

production process.

Treatment of industrial wastewater: The different types of contamination of wastewater require a variety of strategies to remove the contamination.

i- **Solids Removal:** Most solids can be removed by using simple **sedimentation** Techniques with the solids recovered as slurry or sludge.

ii- **Oils and Greases:** Many oils can be recovered from open water surfaces by **skimming devices**. However, hydraulic oils and the majority of oils that have degraded to any extent will also have a soluble or emulsified component that will require further treatment to eliminate.

iii- **Soft Organics:** Organic material of plants or animals origin is usually possible to treat using extended conventional waste water treatment processes. Problems can arise if the wastewater is excessively diluted with washing. The presence of cleaning agents, disinfactants, pesticides or anti-biotics can have detrimental impacts on treatment processes.

iv- **Hard Organics:** Synthetic organic materials including **solvents, paints, pharmaceuticals, pesticides, cooking products etc.** can be very difficult to treat. Treatment methods are often specific to the material being treated. Methods include distillation, absorption, nutrification, incineration, chemical immobilization or landfill disposal.

v- **Acids and Alkalis:** Acids and alkalis can usually be neutralized under controlled conditions. Neutralization

frequently produces a precipitate that will require treatment as a solid residue that may also be toxic. In some cases, gases may be evolved requiring treatment for the gas stream.

vi- **Toxic Materials:** Toxic materials including may organic materials, metals, acids, alkalis, non-metallic elements (such as arsenic or selenium) are generally resistant to biological processes unless very dilute. Metals can often be precipitated out by **changing the pH** or by treatment with other chemicals. Many, however are resistant to treatment or mitigation and may require concentration followed by land filling or recycling.

vi~ **Write a note on Green chemistry?**

Ans~ **Green Chemistry:**

Green chemistry is effective in reducing the impact of chemicles on human health and the environment. In addition, many companies have found that it can be cheaper and even profitable to meet environmental goals. Many environmental laws and regulations target hazardous chemicles and following all these requirements can be complicated. But green chemistry allows companies to comply with the law in much simpler and cheaper ways. Green chemistry is fundamental science-based approach. For example **Spinosad**, an insecticide manufactured by fermenting a naturally occuring soil organism, was registered by the **EPA** as a reduced-risk insectiside in 1997. Spinosad does not leach, bio-accumulate, volatilize, or persist in the environment and in field tests left **70 To 90%** of beneficial insects unharmed. It has a relatively low toxicity

to mammals and birds and is slightly to moderately toxic to aquatic organisms, but is toxic to bees until it dries.

Twelve Principles of Chemistry (Green):

Paul T. Anastas, an organic chemist working in the office of pollution prevention and toxins at the EPA and **John C. Warner** developed the Twelve principles of Green chemistry in 1991. These principles can be grouped into **"Reducing Risk"** and **"Minimizing the Environmental Footprint"**.

I- Reducing Risk in Laboratory:

Sigma-Aldrich is dedicated to providing alternative products designed with the health and safety of its employees, customers, and public in mind.

- **Use Safer Chemicals:** Utilize performance chemicals that have the lowest levels of toxicity.
- **Design Less Hazardous Synthesis Methods:** Where feasable, make use of synthetic or biosynthetic methods that pose little or no toxicity to human health and the environment.
- **Use Safer Solvents and Reaction Conditions:** Search for the most up-to-date information on green solvents that will optimize your process and provides a safer working environment.
- **Accident Prevention:** Select substances that minimize the potential for explosions, fires and chemical releases into the environment.

II- Minimizing Environmental Footprint:

The 12 Principles focus on reducing the volumes of chemicals used and pollution

prevention.

- **Waste Minimization and Prevention** — Develop chemical synthesis techniques, which reduce or prevent waste. It is better to prevent waste than to clean it up after its creation.

- **Use of Catalysts Instead of Stoichiometric Quantities:** Catalytic reactions inherently use smaller quantities of chemicals To carry out a specified transformation.

- **Reduce the Use of Chemical Derivatives** — The use of protecting groups or other forms of temporary modification of a functionality adds to the total waste incurred in a synthetic route.

- **Synthetic Efficiency (Atom Economy)** — An efficient chemical process ensures the maximum amount of your starting materials is used in the final product so that no atom is wasted.

- **Taking Advantage of Chemicals designed for Degradation** - Reduce the effect on environment by using chemicals that are designed To be biodegradable.

- **Establishment of In Process Controls for Pollution prevention** - To avoid the formation of hazardous substances, adopt - real-time analysis and in process monitoring during synthesis.

- **Use of Renewable Feedstocks** — Use raw materials or renewable feedstocks (waste from other processes or products derived from agricultural streams) whenever technically or economically feasable.

Encourage Energy Efficiency: The realization of the economical and environmental impact of energy use in a chemical processes and the development of alternative means to reduce the impact.