UNIT-15 ENVIRONMENTAL CHEMISTRY

MY REVISION TIMELINE:-

SUMMARY:-

- Environmental pollution is any undesirable change in our environment that has harmful effects on plants, animals and human beings is called environmental pollution.
- Classification of pollutants:
  - Bio-degradable. Example: Plant and animal wastes etc…
  - Non-biodegradable. Example: Metal wastes etc…
- Regions of atmosphere and gases present in them:
  - Troposphere: N_2, O_2, CO_2, H_2O (vap)
  - Stratosphere (Ozonosphere): N_2, O_2, O_3
  - Mesosphere: N_2, O_2^+, NO^+
  - Thermosphere: O_2^+, O^+, NO^+
- Types of environmental pollution:
  - Air pollution
  - Water pollution
  - Soil pollution
- Greenhouse effect is the heating up of the Earth surface due to trapping of infrared radiations reflected by Earth's surface by CO_2 layer in the atmosphere.
- Global warming is the heating up Earth through Greenhouse effect.
- Types of particulates:
  - Viable. Example: bacteria, fungi, moulds etc…
  - Non-viable. Example: smoke, dust, mists, fumes etc…
- Green chemistry is the chemical philosophy encouraging the design of products and processes that reduce or eliminate the use and generation of hazardous substance.

TEXTBOOK EVALUATION

Multiple choice questions:-

1. The gaseous envelope around the earth is known as atmosphere. The region lying between an altitude of 11-50 km is
(a) Troposphere (b) Mesophere
(c) Thermosphere **(d) Stratosphere**

2. Which of the following is natural and human disturbance in ecology?
(a) Forest fire (b) Floods
(c) Acid rain (d) Greenhouse effect

3. Bhopal Gas Tragedy is a case of
(a) thermal pollution **(b) air pollution**
(c) nuclear pollution (d) land pollution

4. Haemoglobin of the blood forms carboxyhaemoglobin with
(a) Carbon dioxide (b) Carbon tetrachloride
(c) Carbon monoxide (d) Carbonic acid

5. Which sequence for greenhouse gases is based on GWP?
(a) CFC > N_2O > CO_2 > CH_4 (b) CFC > CO_2 > N_2O > CH_4
(c) CFC > N_2O > CH_4 > CO_2 (d) CFC > CH_4 > N_2O > CO_2

6. Photo chemical smog formed in congested metropolitan cities mainly consists of
(a) Ozone, SO_2 and hydrocarbons **(b) Ozone, PAN and NO_2**
(c) PAN, smoke and SO_2 (d) Hydrocarbons, SO_2 and CO_2

7. The pH of normal rain water is
(a) 6.5 (b) 7.5
(c) 5.6 (d) 4.6

8. Ozone depletion will cause
(a) forest fires (b) eutrophication
(c) bio magnification **(d) global warming**

9. Identify the wrong statement in the following.
(a) The clean water would have a BOD value of more than 5 ppm
(b) Greenhouse effect is also called as Global warming
(c) Minute solid particles in air is known as particulate pollutants
(d) Biosphere is the protective blanket of gases surrounding the earth

10. Living in the atmosphere of CO is dangerous because it
(a) Combines with O_2 present inside to form CO_2
(b) Reduces organic matter of tissues
(c) Combines with haemoglobin and makes it incapable to absorb oxygen
(d) Dries up the blood

11. Release of oxides of nitrogen and hydrocarbons into the atmosphere by motor vehicles is prevented by using –
(a) grit chamber (b) scrubbers
(c) trickling filters (d) catalytic convertors

12. Biochemical oxygen Demand value less than 5 ppm indicates a water sample to be
(a) highly polluted (b) poor in dissolved oxygen
(c) rich in dissolved oxygen (d) low COD

13. Match the list I and list II and select the correct answer using the code given below in the list:

List – 1	**List – 2**
A. Depletion of ozone layer	CO_2
B. Acid rain	NO
C. Photochemical smog	SO_2
D. Greenhouse effect	CFC

Code:	A	B	C	D
(a)	3	4	1	2
(b)	2	1	4	3
(c)	**4**	**3**	**2**	**1**
(d)	2	4	1	3

14. Match the list I and list II and select the correct answer using the code given below in the list:

List – 1	**List – 2**
A. Stone leprosy	CO
B. Biological magnification	Greenhouse gases
C. Global warming	Acid rain

D. Combination with haemoglobin	DDT

Code: A B C D
(a) 1 2 3 4
(b) 3 4 2 1
(c) 2 3 4 1
(d) 4 2 1 3

The questions gives below consists of an assertion the reason. Choose the correct option out of the choices given below each question
i) Both (A) and (R) are correct and (R) is the correct explanation of (A)
ii) Both (A) and (R) are correct and (R) is not the correct explanation of (A)
iii) Both (A) and (R) are not correct
iv) (A) is correct but(R) is not correct

15. Assertion (A): if BOD level of water in a reservoir is more than 5 ppm it is highly polluted.
Reason(R): High biological oxygen demand means high activity of bacteria in water
(a) (i) (b) (ii)
(c) (iii) **(d) (iv)**

16. Assertion (A): Excessive use of chlorinated pesticide causes soil and water pollution.
Reason (R): Such pesticides arc non-biodegradable.
(a) (i) (b) (ii)
(c) (iii) (d) (iv)

17. Assertion (A): Oxygen plays a key role in the troposphere.
Reason (R): Troposphere is not responsible for all biological activities
(a) (i) (b) (ii)
(c) (iii) **(d) (iv)**

Write brief answers to the following questions:-

18. Dissolved oxygen in water is responsible for aquatic life. What processes are responsible for the reduction in dissolved oxygen in water?

- The growth of **algae** in extreme abundance covers the water surface and reduces the oxygen concentration in water. Thus, **bloom-infested** water inhibits the growth of other living organisms in the water body. This process in which the nutrient rich water bodies support a dense plant population, kills animal life by depriving it of oxygen and results in loss of biodiversity is known as **eutrophication**.
- **Chemicals** from industries.
- Toxic **pesticides**.
- **Detergents** and **oil floats**.
- Acids from **mine drainage** and salts from various sources.

19. What would happen, if the greenhouse gases were totally missing in the earth's atmosphere?

- The primary greenhouse gases in Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide and ozone.
- Without the heating caused by greenhouse gases, Earth's average **surface temperature** would be only about **-18°C (0°F).** As a result, life on Earth would be impossible.
- Naturally occurring greenhouse gases allow **solar radiations** to reach the earth's surface, while trapping radiations from the earth on its way back out to space.
- There would be no life on Earth without the **warmth** provided by natural greenhouse gases.

20. Define smog.

- Smog is a combination of **smoke** and **fog** which forms droplets that remain suspended in the air.
- Smog is a chemical mixture of gases that forms a **brownish-yellow haze** over urban cities.
- Smog mainly consists of **ground-level ozone**, **oxides of nitrogen**, **volatile organic compounds, SO_2 acidic aerosols** and **gases,** and **particulate matter.**

21. Which is considered to be earth's protective umbrella? Why?

- At high altitudes in the atmosphere consists of a layer of **ozone (O_2)** which acts as an umbrella for harmful UV radiations. Ozone is considered to be earth's protective umbrella.
- It protects us from **harmful effects of UV-radiations** of the sun such as skin cancer.
- Ozone layer prevent the **UV radiations** to reach the earth surface. So it acts as an umbrella for the Earth.

22. What are degradable and non-degradable pollutants?

- **Bio-degradable:** The pollutants which **can be easily decomposed** by the natural biological processes are called biodegradable pollutants. For example plant wastes, animal wastes.
- **Non-biodegradable:** The pollutants which **cannot be decomposed** by the natural biological processes are called non-biodegradable pollutants. For example, metal wastes such as Hg and Pb, D.D.T. plastics, nuclear wastes.

23. From where does ozone come in the photo chemical smog?

Ozone is formed by a series of reactions that occur from the **sun shines**.

$$N_2 + O_2 \rightarrow 2NO$$

$$2NO + O_2 \rightarrow 2NO_2$$

$$NO_2 \xrightarrow{\text{sun light}} NO + (O)$$

$$(O) + O_2 \rightarrow O_3$$

24. A person was using water supplied by corporation. Due to shortage of water he started using underground water. He felt laxative effect. What could be the cause?

There may be excess **concentration (>500ppm) of sulphates** in the ground water. So he could have felt **laxative effect**.

25. What is green chemistry?

- Green chemistry is a **chemical philosophy** encouraging the design of products and processes that **reduces** or **eliminates** the use and **generation of hazardous substances**.
- Scientists are trying to develop methods to produce **eco-friendly compounds**.
- **Styrene** is produced both by traditional and greener routes.
- To avoid **carcinogenic benzene**, greener route is to start with cheaper and environmentally safer xylenes.

26. Explain how does greenhouse effect cause global warming.

- Greenhouse effect is defined as the heating up of the earth surface due to trapping of **infrared radiations** reflected by earth's surface by CO_2 layer in the atmosphere.
- The earth's atmosphere allows most of the visible light from the sun to pass through and reach the earth's surface. As earth's surface is heated by **sunlight**, it radiates a part of this energy back towards the space as **longer IR wavelengths**.
- Some of the heat is trapped by CH_2, CO_2. CFC's and water vapour present in the atmosphere. They absorb **IR radiations** and block a large portion of earth's emitted radiations.
- The radiations thus absorbed is partly remitted to the **earth's surface**. Therefore the earth's surface gets heated up by a phenomenon called **greenhouse effect**.

27. Mention the standards prescribed by BIS for quality of drinking water.

S.No	Characteristics	Desirable limit
I	**Physico-chemical characteristics**	
1	pH	6.5 to 8.5
2	Total Dissolved Solids (TDS)	500 ppm
3	Total Hardness (as $CaCO_3$)	300ppm
4	Nitrate	45 ppm
5	Chloride	250 ppm
6	Sulphate	200 ppm
7	Fluoride	1 ppm
II	**Biological characteristics**	
1	Escherichia Coli (E.Coli)	Not at all
2	Coliforms	Not to exceed 10 (In 100 ml water sample)

28. How does classical smog differ from photochemical smog?

S.No	Classical smog	Photo chemical smog
1	It occurs in cool, humid climate.	It occurs in warm, dry and sunny climate.
2	It consists of coal smoke and fog	It is formed by the combination of smoke, dust and fog with air pollutants like N_2 and hydrocarbons in presence of light.
3	It generally occurs in the morning and becomes worse when the sun shines.	It forms when sun shines and becomes worse in the afternoon.
4	This is mainly due to the induced oxidation of SO_2 to SO_3 which reacts with water yielding sulphuric acid aerosol.	This is mainly due to the induced oxidation of N_2 to NO, NO_2 and [O] + O_2 to O_3. NO and O_3 are strong oxidising agents and can react with unburnt hydrocarbons in polluted air to form HCHO, Acrolein and PAN.
5	Chemically it is reducing in nature because of high concentration of SO_2	Chemically it is oxidising in nature because of high concentrations of oxidising agents like NO_2 and O_2
6	It is called reducing smog.	It is called oxidising smog.

29. What are particulate pollutants? Explain any three.

- Particulate pollutants or non-viable particulates are **small solid particles** and **liquid droplets** suspended in air.
  Examples: dust, pollen, smoke, soot and liquid aerosols.
- There are **four types** of non-viable particulates in the atmosphere. They are
  - **Smoke**: Smoke particulate consists of solid particles formed by **combustion of organic matter**. For example, cigarette smoke, oil smoke, smokes from burning of fossil fuels, garbage and dry leaves.
  - **Dust**: It is composed of fine solid particles produced during **crushing** and **grinding** of solid materials. For example, sand from sand blasting, saw dust from wood works and fly ash from power generating units.
  - **Mist**: They are formed by particles of **sprayed liquids** and **condensation of vapours in air**. For example, sulphuric acid mist, herbicides and insecticides sprays can form mists.
  - **Fumes**: They are obtained by **condensation of vapours** released during **sublimation, distillation, boiling** and **calcination** and by several other chemical reactions. For example: organic solvents, metals and metallic oxides.

30. Even though the use of pesticides increases the crop production, they adversely affect the living organisms. Explain the function and the adverse effects of the pesticides.

- Pesticides are chemicals that are used to kill or stop the growth of unwanted organisms. But these pesticides can affect the health of human beings.These are further classified as
  - **Insecticides**: Insecticides like **DDT, BHC, aldrin** etc. can stay in soil for long period of time and are absorbed by soil. They contaminate root crops like carrot, raddish, etc.
  - **Fungicide**: **Organo mercury compounds** are used as most common fungicide. They dissociate in soil to produce mercury which is highly toxic.
  - **Herbicides**: Herbicides are the chemical compounds used to control unwanted plants. They are otherwise known as **weed killers**. Example **sodium chlorate** ($NaClO_3$) and **sodium arsenite** (Na_3AsO_3). Most of the herbicides are toxic to mammals.

31. Ethane burns completely in air to give CO2, while in a limited supply of air gives CO. The same gases are found in automobile exhaust. Both CO and CO2 are atmospheric pollutants
i) What is the danger associated with these gases
ii) How do the pollutants affect the human body?

- Carbon monoxide released into the air binds with **haemoglobin** and form **carboxy haemoglobin** which impairs with normal oxygen transport by blood and hence the **oxygen carrying capacity of the blood is reduced**. Increased level of carbon dioxide is responsible for **global warming**.
- Increase in **carbon dioxide** and **carbon monoxide** headache, nausea, dizziness, tension, loss of conscious, blurring of eye sight and cardiac arrest.

32. On the basis of chemical reactions involved, explain how do CFC's cause depletion of ozone layer in stratosphere?

- The **chloro-fluoro derivatives** of methane and ethane are named **Freons** (CFC's).
- They slowly pass from **troposphere to stratosphere**.

- They stay for a very longer period of about **50-100 years**.
- In the presence of UV radiations, CFC's break up into chlorine free radicals.

$$CF_2Cl_2 \xrightarrow{h\upsilon} {}^{\bullet}CF_2Cl + Cl^{\bullet}$$

$$CFCl_3 \xrightarrow{h\upsilon} {}^{\bullet}CFCl_2 + Cl^{\bullet}$$

$$Cl^{\bullet} + O_3 \rightarrow ClO^{\bullet} + O_2$$

$$ClO^{\bullet} + (O) \rightarrow Cl^{\bullet} + O_2$$

- Chlorine radical is regenerated in the course of the reaction. Due to this continuous **attack of Cl free radicals**, **thinning of ozone layer** takes place which leads to the formation of **ozone hole**.
- Li is estimated that for every reactive chlorine atom generated in the stratosphere **1,00,000 molecules** of **ozone** are **depleted**.

33. How is acid rain formed? Explain its effect

- Rainwater normally has a **pH** of **5.6** due to dissolution of atmospheric CO_2 into it.
- **Oxides** of **sulphur** and **nitrogen** in the atmosphere, may be **absorbed** by **droplets of water** that make up clouds and get chemically **converted into sulphuric acid and nitric acid** respectively as a results of pH of rainwater drops to the level **5.6**, hence it is called **acid rain**.
- Acid rain is a **by-product** of a variety of **sulphur** and **nitrogen oxides** in the atmosphere.
- Burning of **fossil fuels** (coal and oil) in power stations, furnaces and petrol, diesel in motor engines produce sulphur dioxide and nitrogen oxides.
- The main contributors to acid rain are **SO_2** and **NO_2**. They are converted into sulphuric acid and nitric acid respectively by the reaction with oxygen and water.
- **$2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$**
  $4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$

Harmful effects of acid rain:

- Acid rain causes extensive damage to buildings and structural materials of marbles. This attack on marble is termed as **Stone leprosy**.
  $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2 \uparrow$
- Acid rain affects **plants** and **animal** life in aquatic ecosystem.
- It is harmful for **agriculture, trees and plants** as it dissolves and removes the nutrients needed for their growth.
- It **corrodes water pipes** resulting in the leaching of heavy metals such as iron, lead and copper into drinking water which have **toxic effects**.
- It causes **respiratory ailment** in humans and animals.

34. Differentiate the following (i) BOD and COD (ii) Viable and non-viable particulate pollutants.

S.No	Biochemical oxygen demand (BOD)	Chemical oxygen demand (COD)
1	The total amount of oxygen (in milligrams) consumed by microorganisms in decomposing the waste in one litre of water at 20°C for a period of 5 days is called biochemical oxygen demand (BOD).	The total amount of oxygen (in milligrams) consumed by microorganisms in decomposing the waste in one litre of water at 20°C for a period of 5 days is called biochemical oxygen demand (BOD).
2	Its value is expressed in ppm.	Its value is expressed in mg/litre.

3	DOD is used as a measure of the degree of water pollution.	COD is a measure of amount of organic compounds in a water sample.
4	BOD is only a measurement of consumed oxygen by microorganisms to decompose the organic matter.	COD refers to the requirement of dissolved oxygen for both the oxidation of organic and inorganic constituents.
5	Clean water would have BOD value less than 5 ppm.	Clean water would have COD value greater than 250 mg/litre.

S.No	Viable pollutants	Non-viable pollutants
1	The viable particulates are small size living organisms such as bacteria, fungi, moulds, algae which are dispersed in air.	The non-viable particulates are small solid particles and liquid droplets suspended in air.
2	They are all organic particulates.	They are all inorganic particulates.
3	They contain living organisms.	They contain non-living organisms.
4	Viable particles are the particles with at least one microorganism affecting the sterility of the product.	They act as transporting agent to viable particles.
5	Eg. Fungi, bacteria, algae, moulds.	Eg. Smoke, dust, mist, fumes.

35. Explain how oxygen deficiency is caused by carbon monoxide in our blood? Give its effect.

- Carbon monoxide released into the air binds with **haemoglobin** and form **carboxy haemoglobin** which impairs with normal oxygen transport by blood and hence the **oxygen carrying capacity of the blood is reduced**.
- This **oxygen deficiency** results in headache, nausea, dizziness, tension, loss of conscious, blurring of eye sight and cardiac arrest.

36. What are the various methods you suggest to protect our environment from pollution?

- **Waste management**: Environmental pollution can be controlled by the proper disposal of wastes.
- **Recycling**: A large amount of disposed waste material can be reused by recycling the waste, thus it reduces the landfill and converts waste into useful forms.
- **Substitution of less toxic solvents** for highly toxic ones used in certain industrial processes.
- Use of **fuels with lower sulphur content** (e.g., washed coal)
- Growing **more trees**.
- Control measures in **vehicle emissions** are adequate.
- Efforts to control environmental pollution have resulted in the development of science for the synthesis of chemicals favourable to the environment and it is called **green chemistry.**