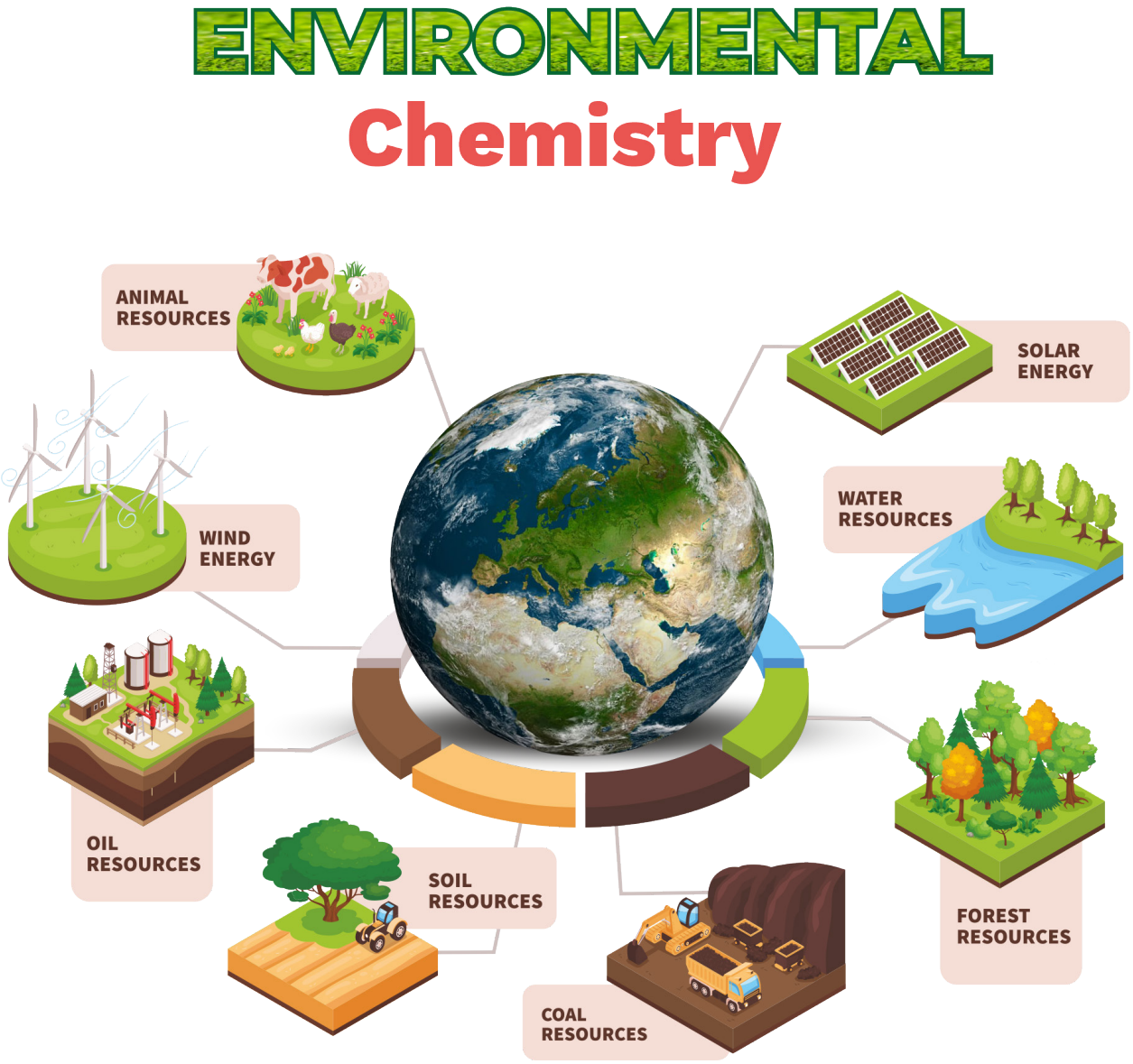
Environmental Chemistry



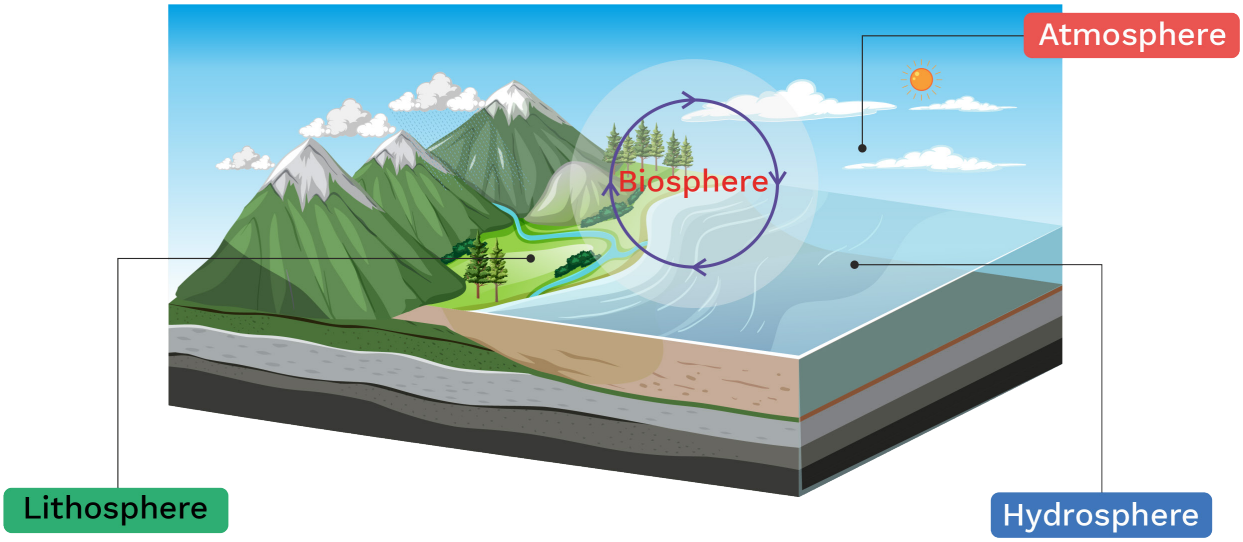
Environmental

- It means surroundings conditions in which we live.
- Environment consists of air, water, soil, the
- atmosphere and the plants around us.
- Environment consists of four segments:
  1. Atmosphere
  2. Hydrosphere

Definitions

Environmental chemistry deals with the changes in chemical dynamics taking place around us and the damage it causes to the environment.

3. Lithosphere
4. Biosphere



Atmosphere

The layer of air surrounding the earth at a height of around 1600 km and it consists of many gases is known as atmosphere. The major constituents of the atmosphere are nitrogen, oxygen and water vapour. The minor constituents are argon and carbon dioxide, the trace components include inert gases like methane.

Hydrosphere

Hydrosphere consits of all the types of resources having water like lakes, ground water, seas, rivers, oceans, polar ice caps and reservoirs.

Lithospheres

Landmass available on the surface of earth excluding the water bodies is part of Lithosphere. It is solid component of earth having rocks, mountains and soil.

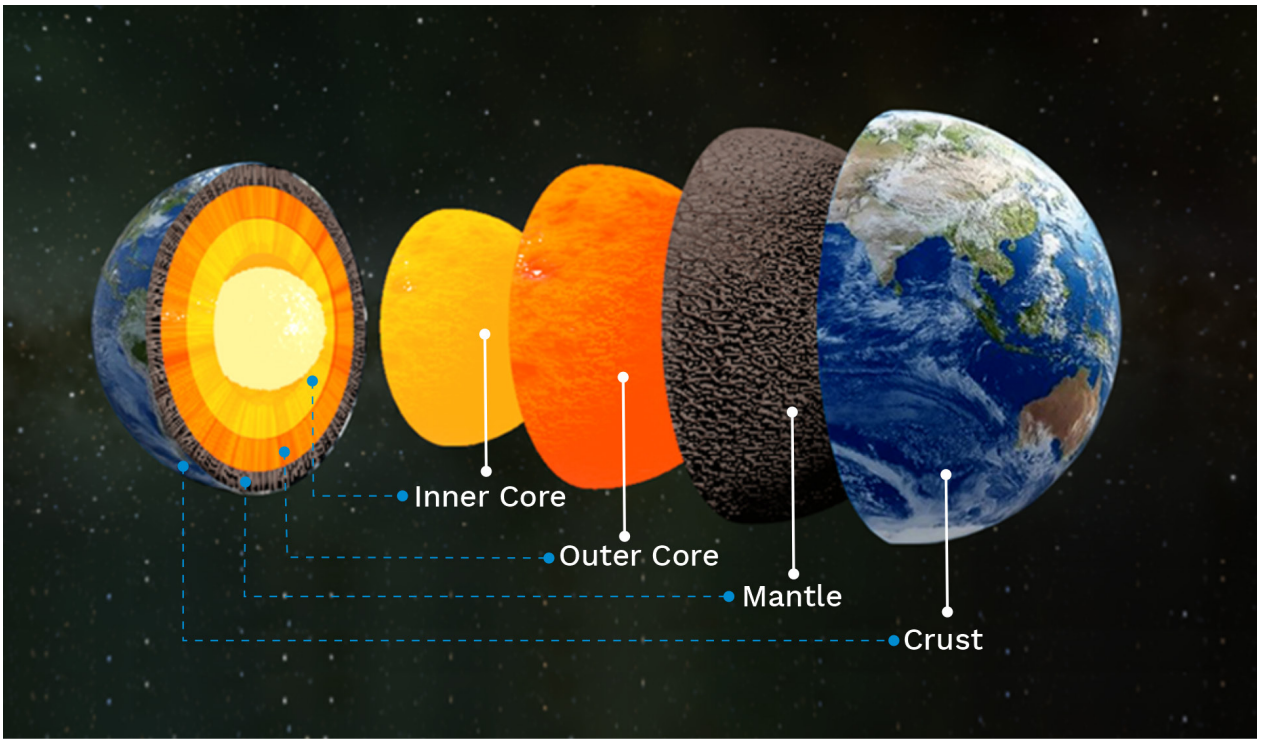
The solid, thick, uppermost part of earth is called crust.

Concept Ladder

The atmosphere maintains the heat balance on the earth by absorbing electromagnetic radiations coming from sun and transmitting ultraviolet, visible and infra-red radiation.

Rack your Brain

What does the inner layers of lithosphere contain?



Biosphere

Biosphere includes all the living organisms and their interactions with the atmosphere, lithosphere, environment, and hydrosphere. For example, levels of oxygen and carbon dioxide in atmosphere depend on the plants and trees.

ENVIRONMENTAL POLLUTION AND POLLUTANTS

- It is caused by the addition of any undesirable substance to water, soil, or air, naturally or by human activities to such an extent that its adverse effects are observed on human beings, animals, and plants.
- Contaminants are substances which are not present in nature but are introduced into the environment by human activities and have adverse effects on environment. For example, methyl isocyanate (MIC).

Concept Ladder

Pollutant is that substance whose presence in undesirably higher concentrations causes pollution in turn, adversely affects the environment. Hg, Pb, CO, SO_2 are some examples of pollutants.

- Receptors are the medium effected by the pollutants. Human eyes are receptors for smoke released by automobiles which causes irritation in the eyes.
- Sink is medium which interacts with the long-lived pollutants and removes the pollution. Sea water acts as the sink for carbon dioxide. The main causes of pollution are increase inpopulation and depletion of natural resources, industrialization, urbanization, and deforestation.

Rack your Brain

Which gas was responsible in Bhopal Gas Tragedy?

Concept Ladder

[a]Troposphere constitutes the major portion of the atmosphere.
[b]Also called ozonosphere as ozone layer is found here.

Regions of Atmosphere

	Troposphere[a]	Stratosphere[b]	Mesosphere	Thermosphere
Altitude (km)	0-10	10–50	50–85	85–500
Temperature range	15°C–56°C	56°C–2°C	2°C–92°C	92°C–1200°C
Gases/species	N_2, O_2, CO_2, Water vapours	N_2, O_2, O_3, O^-	N_2, O_2, O_2^+, NO^+	O_2^+, O^+, NO^+, e^-


Atmosphere
EXOSPHERE
THERMOSPHERE
MESOSPHERE
STRATOSPHERE
TROPOSPHERE

Types of Pollutants

Primary pollutants

The pollutants after their formation, enter the environment and remain unchanged. For example, CO, SO2 ,NO, NO2.

Secondary pollutants

They are formed as the result of the chemical reactions between primary pollutants present in atmosphere and those in the hydrosphere. For example, peroxy acyl nitrate.

Concept Ladder

Carbon monoxide combines with haemoglobin to form carboxy haemoglobin due to which the haemoglobin loses the oxygen carrying capacity.

Biodegradable pollutants

This type of pollutants can be easily decomposed with help of microorganisms and are not harmful. For example sewage, domestic, cow dung.

Rack your Brain

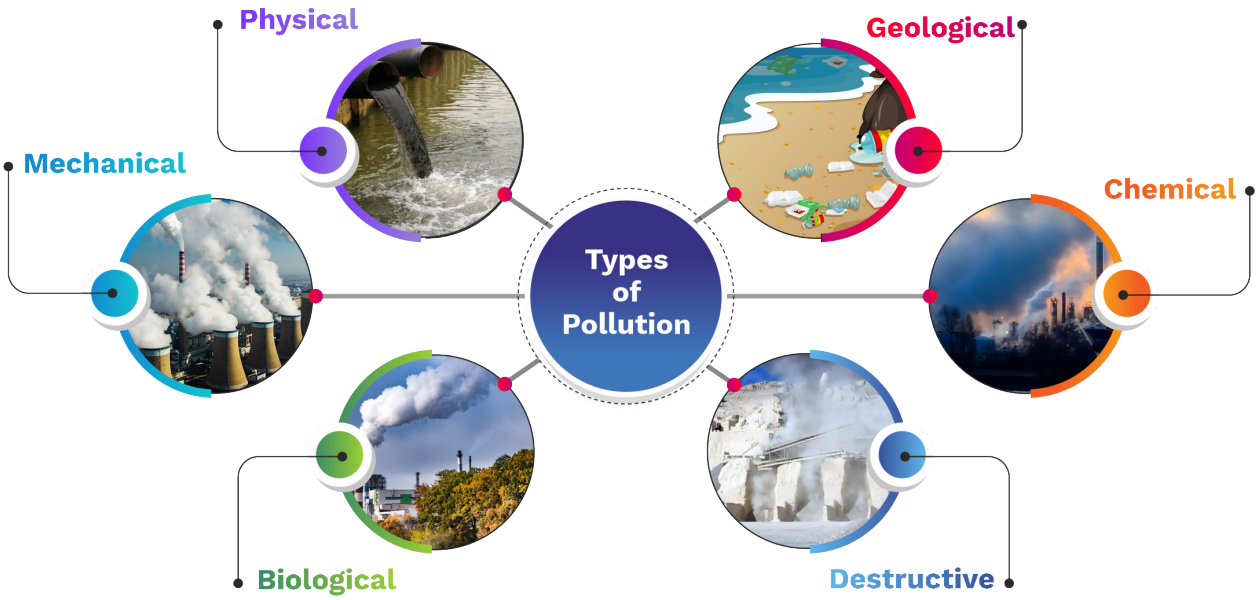
Which smog cause death of several people in London?

Non-biodegradable pollutants

The pollutants that cannot be decomposed, and their presence is very harmful for animals and human beings. For example, mercury, DDT.

Types of Pollution

(1) Physical Pollution
(2) Geological Pollution
(3) Chemical Pollution
(4) Mechanical Pollution
(5) Biological Pollution
(6) Destructive Pollution



Air pollution This is caused by the addition of undesirable substances into the atmosphere. It is of the following two types:

Tropospheric pollution :- It is caused by gaseous air pollutants like SO_2, NO_2, CO_2, or H_2S.

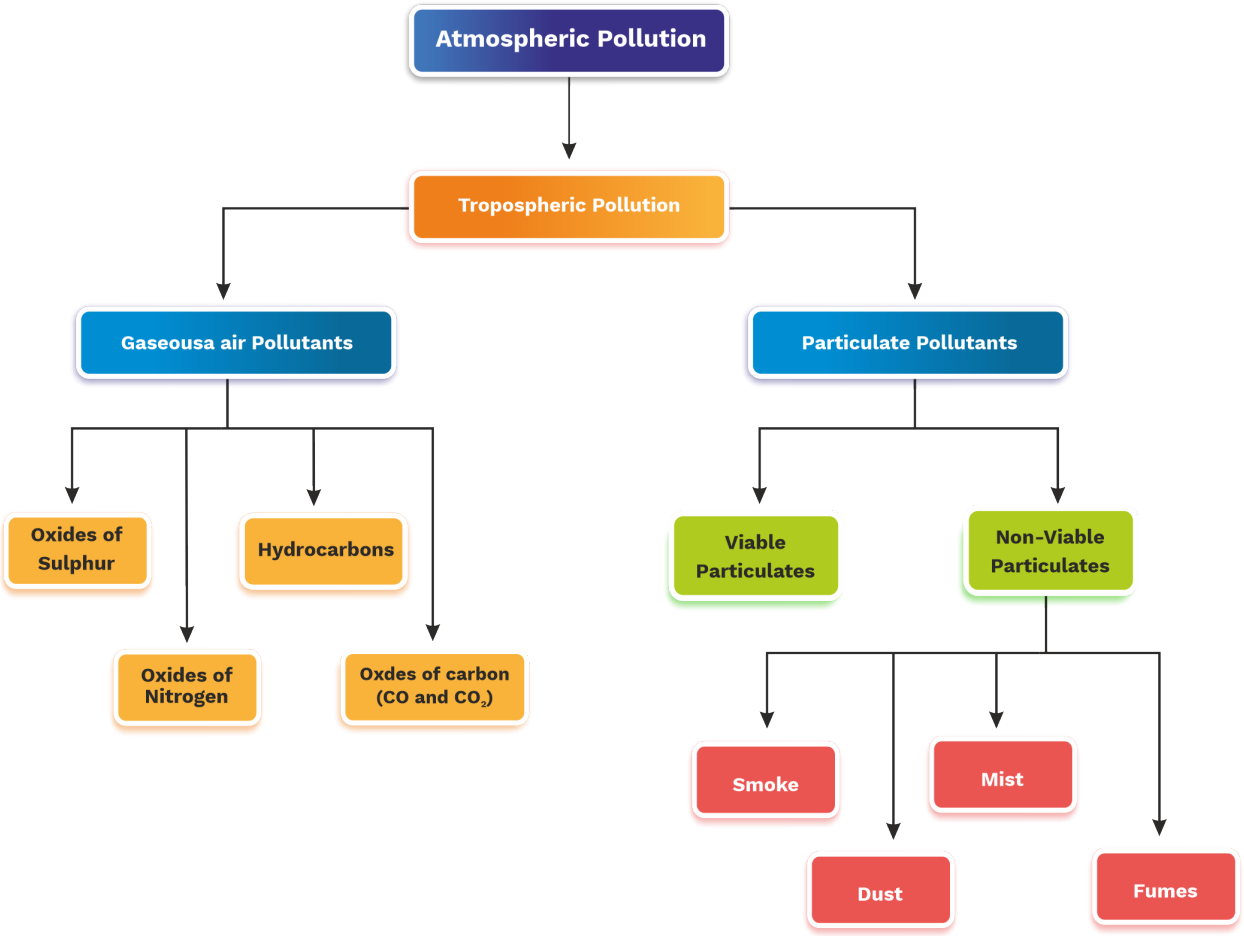
Stratospheric pollution :- The damage to the ozone layer by the action of compounds like nitric acid and chloroform carbons constitute this particular type of pollution.

Rack your Brain

Why rain water is mildly acidic even without sulphur oxides and nitrogen oxides dissolving?

Definitions

The phenomenon of abnormal heating up of the earth's surface due to the presence of excess of greenhouse gases is called greenhouse effect.



Some common air pollutants are as follows:

- Metals like lead and mercury.
- Oxides of nitrogen like N_2O, NO.
- Oxides of Sulphur like SO_2.
- Most of air pollution is caused by automobiles in which the carbon fuels undergo incomplete combustion and liberate carbon monoxide.
- Chlorofluoro carbons (freons).
- Hydrocarbons like methane and butane.
- Oxides of carbon like CO and CO_2.
- Organic pollutants like benzopyrene, biocides.

$$2C + O_2 \longrightarrow 2CO$$

Definitions

The microorganisms and enzymes which can naturally degrade pollutants must be developed. Such control measures are called bio remedies.

- Due to the degradation of organic substances, methane gas will be liberated which oxidizes into CO.

$$2CH_4 + 3O_2 \longrightarrow 2CO + 4H_2O$$

- Oxides of nitrogen like N_2O, NO and NO_2 are liberated into the air during combustion of fossil fuels.
- Nitrogen oxide coming out of the supersonic jets directly enters in the stratosphere and decomposes the ozone present there.

$$NO + O_3 \longrightarrow NO_2 + O_2$$
$$NO_2 + O_3 \longrightarrow NO + 2O_2$$

- SO_2 is released into the atmosphere directly by burning of sulphur, by roasting sulphide ores or by burning of fuels containing sulphur and it causes respiratory diseases. SO_2 bleaches chlorophyll and thus prevents photosynthesis process.
- Carcinogenic benzopyrene is released into the air by diesel engine of automobiles.
- Methane is released into air by the degradation of biomass.
- When the oxides of nitrogen and sulphur combine with rainwater, to form acid rain.
- **Acid rain** The pH of rainwater is normally 5.6 due to dissolution of CO_2 in it.

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

Acid rain is due to the large-scale emission of acidic gaseous oxides (NO_2, SO_2 etc) into atmosphere by the thermal power plants, industries and automobiles. The oxides of sulphur and nitrogen dissolve in rain water forming sulphuric acid and nitric acid resulting in acid rain.

Concept Ladder

Depletion of ozone layer O_3 layer is present in stratosphere and it prevents U.V rays to reach earth by converting them into Infra-Red Rays.

Rack your Brain

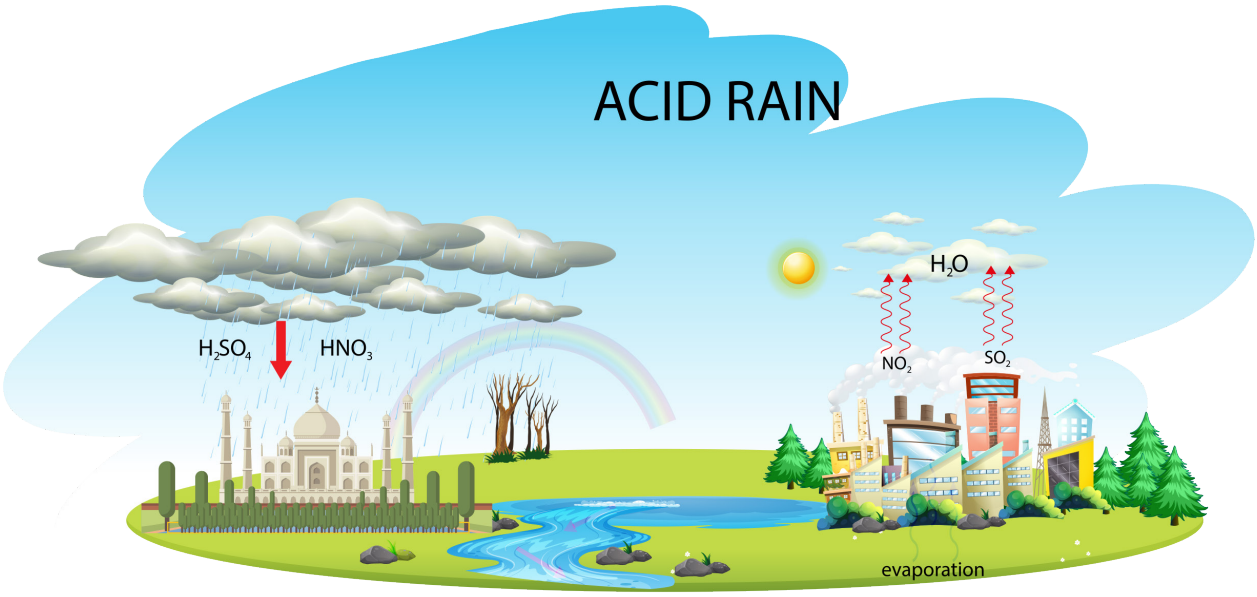
What is the effect of presence of oxides of N_2 in the atmosphere?

Previous Year's Questions

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

[AIPMT]

(1) N_2O_5 (2) NO_2
(3) N_2O (4) NO



$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$
$$SO_2 + 1/2O_2 \longrightarrow SO_3$$
$$SO_3 + H_2O \longrightarrow H_2SO_4$$

- It is toxic to plant life and vegetation.
- Life of buildings is reduced by acid–rain.
- The Taj Mahal is affected by acid rain due to the reaction of rain and marble (CaCO3).

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + SO_2 + H_2O$$

It corrodes water pipes because of which heavy metals (Cu, Fe, Pb etc) mix in water and cause toxic effects.

Greenhouse effect or Global warming

- Carbon dioxide is the main greenhouse gas. Some other greenhouse gases are O3 (18%), CFCs (17%), water vapour (2%) and NO (4%).
- Here due to selective energy absorption by these gases the heat from sun can reach earth but cannot be radiated back into the space

which causes an increase in the temperature of earth that is Global Warming.

- It results in melting of ice caps, which in turn decreases in unseasonal rains, ground water , effects on agriculture due to the rapid depletion of surface water.
- Chlorofluoro carbons (CF_2Cl_2) called freons, absorb the ultraviolet radiations and get photolysed to liberate free chlorine atoms. The free chlorine atoms catalyse the decomposition of ozone resulting in the depletion of ozone layer.
-

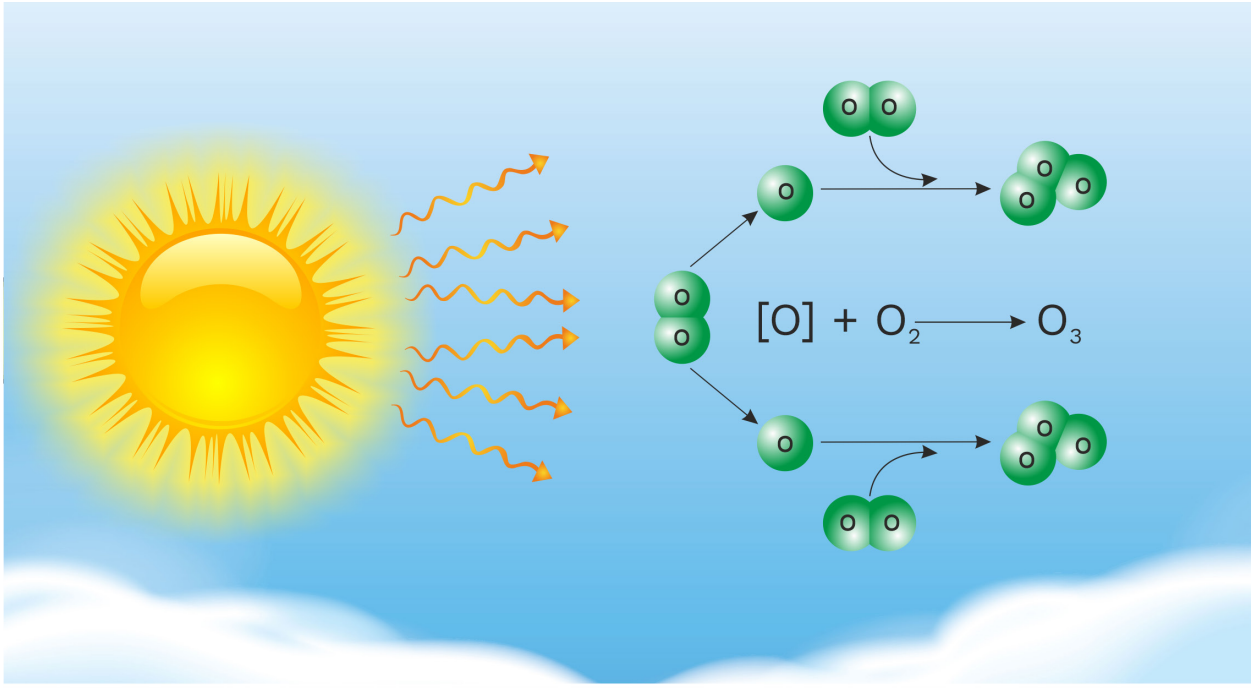
$$CF_2Cl_2 \xrightarrow{h\nu} CF_2Cl + \overset{0}{Cl}$$

$$CFCl_3 \xrightarrow[uv]{H\nu} CFCl_2 + \overset{0}{Cl}$$

$$\overset{0}{Cl} + O_3 \longrightarrow ClO^{\circ} + O_2$$

$$Cl^{\circ} + [O] \longrightarrow Cl^{\circ} + O_2$$

- Formation of ozone takes place as shown below :



Rack your Brain

Which type of converters can be used in the automobiles which can prevent the liberation of Nitrogen oxides?

It has been noticed that the one molecule of CFC can destroy more than one thousand ozone molecules in the stratosphere due to this reaction a huge ozone hole was created in ozone layer over Antarctica. However, in other parts of stratosphere ozone hole is not observed due to the fact that both ClO° and Cl° can be consumed shown by following reaction.

$$ClO^{\circ} + NO_2 \longrightarrow ClONO_2$$

$$Cl^{\circ} + CH_4 \longrightarrow \overset{0}{C}H_3 + HCl$$

- Due to the damage done to an ozone layer, the ultra- violet light from sun directly falls on earth, causing skin cancer, irritation to eyes and is harmful to vegetation also.

Controlling air pollution

- Auto-mobiles must be fitted with tune ups (for high air fuel ratio) and catalytic convertors (to change NO_2 into N_2O_5 and CO into CO_2)
- Fly ash (coal-thermal plants) should be removed using wet method and should be used in the building materials.
- Clean and green, environment friendly (eco-friendly) technology must be developed.
- Bagasse and Rice husk should not be used as fuel.
- By dissolving or absorbing harmful gases and chemicals.
- Petrol without lead and Diesel with less 'S' must be used.
- Industries must be situated far away from urban area.
- Use of vehicles should be limited.
- A large-scale plantation of trees must be carried out.
- Industrial wastes can be checked by using wet scrubbers, chimneys, cyclone collectors bag filters, electro static precipitators etc.

Concept Ladder

One molecule of CFC can destroy more than one thousand O_3 molecules in the stratosphere.

Rack your Brain

How can one detect the presence of fluoride?

Concept Ladder

If the fluoride content in drinking water is more than 3 ppm, it is harmful and causes a disease called fluorosis. Here, the fluoride reacts with calcium present in teeth and bones to form calcium fluoride due to which the teeth become yellow and the bones become weak.

Formation of photochemical smog:

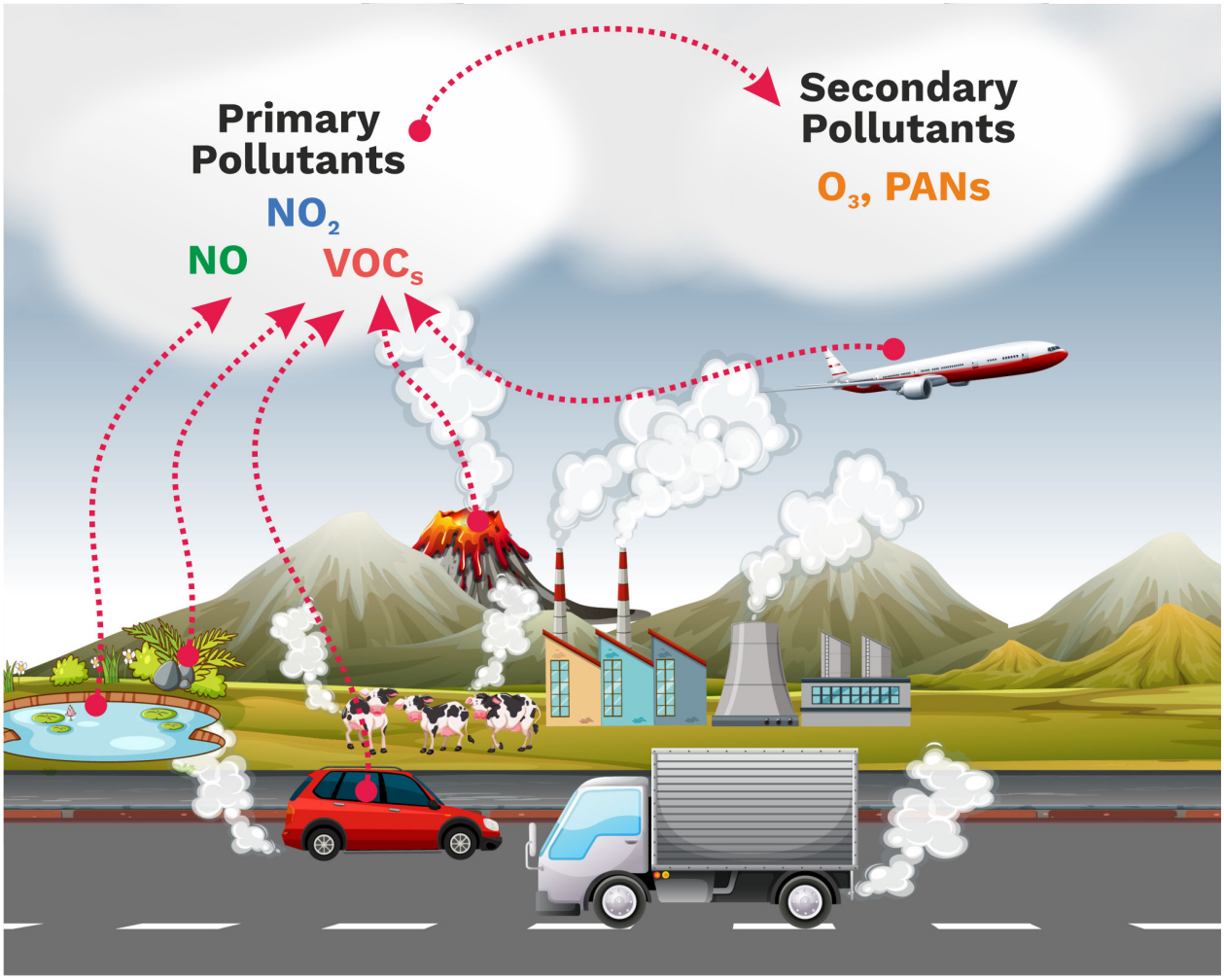
On combustion of fossil fuels, a large number of pollutants are released into troposphere. Two of such pollutants that are emitted are nitric oxide (NO) and hydrocarbons (unburnt fuels).

When such pollutants are sufficiently high, a chain reaction takes place because of which their interaction with sunlight in which NO changes into NO_2. The NO_2 in turn absorbs energy from sunlight and breaks up into nitric.

$$NO_2(g) \xrightarrow{h\nu} NO(g) + O(g)$$

Concept Ladder

Photochemical smog is a brownish-gray haze caused by the action of solar ultraviolet radiation on atmosphere polluted with hydrocarbons and oxides of nitrogen.



Oxygen atoms are so highly reactive that they combine with the O_2 in air to produce ozone as follows:

$$O(g) + O_2(g) \rightleftharpoons O_3(g)$$

O_3 produced here reacts rapidly with NO (g) formed then its produce NO_2 It's a brown colured gas and at sufficiently high levels can contribute to haze.

$$NO(g) + O_3(g) \rightleftharpoons NO_2(g) + O_2(g)$$

As both O_3 and NO_2 are strong oxidizing agents so can react with unburnt hydrocarbons in polluted air to produce chemical like formaldehyde, peroxyacetyl nitrate (PAN) and acrolein as follows:

$$NO_2 \xrightarrow{h\nu} NO + O$$

$$O + O_2 \longrightarrow O_3$$

$$O_3 + NO \longrightarrow NO_2 + O_2$$

$$R - \overset{\circ}{C}(=O) + O_2 \longrightarrow R - C(=O) - O - O - (RCO)_3$$

$$R - \overset{\circ}{CO_3} + NO_2 \longrightarrow RCO_3NO_2$$

$$R - \overset{\circ}{CO_3} + \text{Hydrocarbon} \longrightarrow R - CHO, R_2CO$$

$$CH_3 - C(=O) - O - O - NO_2, \quad H - C(=O) - O - O - NO_2$$

PAN

PFN (Peroxy farmyl nitrate)

$$\varnothing - C(=O) - O - O - NO_2$$

PB_zN

Peroxy benoyl nitrate

Effects of photochemical smog:

The main components of photochemical smog are nitric oxide, ozone, acrolein, form aldehyde and peroxyacetyl nitrate (PAN).

Concept Ladder

NO_2, ozone and PANs are called photochemical oxidants because they can react and oxidize certain compounds in the atmosphere or within a person's lungs that are not normally oxidized.

Rack your Brain

Which comopund undergoes a complex series of reactions with hydrocarbons to produce the components of photochemical smog?

Previous Year's Questions

Which one of the following is not a common component of photochemical smog?

[AIPMT]

(1) Ozone
(2) Acrolein
(3) Peroxyacetyl nitrate
(4) Chlorofluorocarbons

- It causes serious health problems. Both PAN and ozone act as powerful eye irritants.
- It leads to cracking of rubber and extensive damage to plant life. It also causes corrosion of stones, metals , building materials, painted surfaces and rubber.
- Nitric oxide and ozone irritate the throat and nose and their high concentration causes headache, difficulty in breathing, dryness of the throat, chest pain and cough.

Control of Photochemical Smog: A number of techniques are used to control formation of photochemical smog.

- If we are able to control the primary sources of photochemical smog like hydrocarbons and NO2, the secondary precursors like PAN and ozone, the photochemical smog will automatically be reduced.
- Some plants like Pinus, Juniperus, Quercus, Vitis and Pyrus can metabolise nitrogen oxide so their plantation will help in controlling photochemical smog

1. **Fumes:** These are condensed vapours. Fumes of metals are the well-known particulates of this type. These are normally liberated from metallurgical or chemical processes.
2. **Mists:** These are the particles that are produced by spray liquids and are formed by condensation of vapours in air. Common examples of this type, portions of herbicides and insecticides that miss their targets and travel through the air.

Harmful effects of particulate pollutants

- The effect of particulate pollutants is largely dependent on the particle size. Air borne particles such as mist, dust fumes etc. are dangerous for human health.

Concept Ladder

When combined with hydrocarbons, the chemicals contained within it form molecules that cause eye irritation. Radicals in the air interfere with the nitrogen cycle by preventing the destruction of ground level ozone.

Rack your Brain

What is the necessary condition for reaction of N_2 and O_2?

Concept Ladder

Smog is a byproduct of modern industrialization. Due to industry and the number of motor vehicles, this is more of a problem in large cities that have a warm, sunny and dry climate.

- Particulate pollutants of size more than 5 microns are likely to enter the nasal passage, whereas particles of about 1.0 micron or less enter into lungs easily.

Following changes occur in polluted water:

- Decrease in the number of aquatic animals.
- The water develops bad taste and an offensive odour.
- Uncontrolled growth of weeds in water.
- Change in colour and increase in salinity of water.

Rack your Brain

Which value can estimate the extent of water pollution?

Types of Water Pollution and Pollutants :

Type	Pollutants
Ground water pollution	Fertilizers , Pesticides
Surface water pollution	Agriculture wastes, Industrial
Lake water pollution	Industrial wastes, Organic wastes
River water pollution	Domestic sewage, Industrial waste
Sea water pollution	Radioactive waste, Oily waste

Effects of Water Pollution

- Use of polluted water by animal and human waste cause diseases like cholera, diarrhoea, typhoid and jaundice.
- Polluted water is non-potable.
- Tourists avoid dirty beaches. Some water pollutants and their side effects are disscussed in the following two categories:
- Aquatic life is damaged.

Inorganic pollutants

- Cyanides, NO_2 , H_2S, CO_2 and sulphites change pH of water and make it toxic for aquatic animals. Heavy metals like Pb and Hg also make water toxic.

Definitions

Water pollution: The phenomenon by which the quality of water in the hydrosphere deteriorates due to the contamination of water by foreign substances is called water pollution.

- Algal nutrients like O_2, H_2, CO_2, N_2 nitrates, sulphate, phosphates and micronutrients like Cu, Zn, B, Cl_2 , V, Mn, Fe cause eutrophication.
- Salts, trace elements (Zn, Cu, As) and metals coming from chromium plating industry are also pollutants.
- Metals and complex compounds decrease the growth of algae and affect photosynthesis.

Organic pollutants

- Organic pollutants include pharmaceuticals, pesticides, fungicides, weedicides, and insecticides, plastics, fibres, detergents, paints, dyes.
- The domestic waste and industrial waste degrade in the presence of microorganisms there by decreases the amount of dissolved oxygen (DO) in H_2O.
- Wastes released from agriculture land and industries make the water toxic.
- Sewage from commercial, domestic, industrial effluents and food processing consume oxygen present in water.

Concept Ladder

Radioactive waste is any pollution that emits radiation beyond what is naturally released by the environment. It's generated by uranium mining, nuclear power plants, and the production and testing of millitary weapons.

- The pesticides and insecticides like malathion, chlorophenoxy group compounds, DDT, dithiocarbonate derivatives, phenyl mercury acetate are also some water pollutants.

Bio amplification: It is the process of increasing the concentration of pollutants in higher animals and human beings or lower animals. The carriers through which bio amplification takes place constitute food chains. For example, animals, plants, birds and fish.

Eutrophication: It is over nutrition provided to ponds and takes in the form of organic substances generated from industrial wastes and agricultural. This leads to rapid presence of unwanted algae and other plants which fill the pond and dry it up.

Removal of Pollutants from Water: Major pollutant sources like sewage waste, industrial waste water is made pollution free by the following :

From domestic water: Treatment of domestic sewage water is done in the following manner:

- The water is first passed through sieves to separate solids and then decantation is done.
- The decanted water is exposed to oxidation by aerobic bacteria which removes all the soluble organic substances from it.
- The phosphates present in the domestic sewage water can be removed by addition of lime in the form of powderous calcium phosphate.
- Finally, it is chlorinated or ozonised and released into ponds.

Treatment of industrial waste water:

It is treated by following methods:

- Organic substances like DDT and endrin can be removed by adsorption using activated charcoal.

Concept Ladder

When water pollution causes an algal bloom in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plant and algae growth, which in turn reduces oxygen levels in the water.

Previous Year's Questions

Which one of the following statements is not true?

[NEET-2013]

(1) Clean water would have a BOD value of 5 ppm.

(2) Fluoride deficiency in drinking water is harmful. Soluble fluoride is often used to bring its concentration upto 1 ppm.

(3) When the pH of rain water is higher than 6.5, it is called acid rain.

(4) Dissolved oxygen (DO) in cold water can reach a concentration upto 10 ppm.

- Some dyes and chlorinated pesticides can be removed by passing the water through ion-exchange resins. However, fluoride ion cannot be removed by ion exchange owing to its presence in minute quantity.
- The fluoride ion in water can be reduced from 5–12 ppm to 1 ppm by passing the waste water through activated carbon so that fluoride ions are adsorbed.
- The deactivated carbon is produce active form again by washing it first with 4% Sodium hydrooxide then by 10% H_3PO_4.
- When water containing fluorine is treated with bleaching powder, alum and lime in the same order, F- ions get precipitated as calcium aluminium fluoride [$Ca(AlF_3)_2$].

Dissolved oxygen (DO):

It is amount of oxygen present in water. The optimum value of dissolved oxygen (DO) desired for good quality water is 4–6 mg/L (or 4 – 6 ppm).

- DO is consumed by oxidation of organic substance in presence of microorganisms or reducing agents as follows:

$$CH_2O + O_2 \xrightarrow{\text{Microorganism}} CO_2 + H_2O$$

$$4Fe^{2+} + O_2 + 10H_2O \longrightarrow Fe(OH)_3 + 8H^+$$

Reducing agent

$$2SO_3^{2-} + O_2 \longrightarrow 2SO_4^{2-}$$

- Dissolved oxygen (DO) is also consumed due to bio-oxidation of nitrogenous substance like NH_3, NH_4^+ etc. .

$$2NH_4^+ + 2O_2 \longrightarrow 2H^+ + NO_3^- + H_2O$$

Chemical oxygen demand (COD)

- COD is the amount of O_2 required to oxidize the inorganic and organic substances present in H_2O. It is the amount of O_2 in part per

Previous Year's Questions

Which one of the following statement is not true?

[AIPMT-2011]

(1) pH of drinking water should be between 5.5 - 9.5.

(2) Concentration of DO below 6 ppm is good for the growth of fish.

(3) Clean water would have a BOD value of less than 5 ppm.

(4) Oxides of sulphur, nitrogen and carbon, are the most widespread air pollutant.

Concept Ladder

COD can be determined by oxidizing the organic matter with acidified (50% H_2SO_4) potassium dichromate solution.

million consumed by the pollutants. COD for pure H_2O is 4 part per million.

- COD is an important H_2O quality parameter. Chemical oxygen demand is the index of the organic content of H_2O.

Biochemical oxygen demand (BOD):

BOD is expressed in ml/L If BOD < 5 ppm, the water is pure, if it BOD > 5 ppm, the water is polluted.

$$BOD = \frac{\text{NO. of miligcrams of } O_2 \text{ needed}}{\text{No. oflitres of the samples}}$$

In case of polluted H¬2O BOD is > 17 ppm.

Soil or land pollution

- Major components of soil are mineral matter (clay, sand, gravel), biological species (algae, bacteria) and organic matter (humus).
- When quality of soil is damaged due to addition of industrial wastes or excessive mining of minerals, which causes soil pollution.

Types of sand or soil pollution

(1) **Positive Soil Pollution:** It causes decrease in soil productivity due to addition of unwanted substances like pesticides, fertilizers etc.

(2) **Negative Soil Pollution:** It causes decrease in soil productivity because of erosion and over use.

(3) **Landscape:** Here fertile land becomes barren one due to addition of dumping wastes like ash, garbage, broken cans, bottles etc. it also known as third pollution.

Soil salination : It increases the salt concentration in soil to make it barren. It is called as Holomorphic.

Major sources of soil pollution

- Industrial Water: It is poisonous and biodegradable.

Definitions

It is the amount of oxygen used by the microorganisms present in water at 20° C for five days.

Concept Ladder

When harmful substances from industrial processes, chemicals are improperly disposed of on the land or in illegal landfills or storages, the chemicals and other substances could end up in the groundwater system.

- Agriculture Pollutants: These includes fertilizers, insecticides, herbicides, fungicides.
- Soil conditioners having toxic metals like Pb, Cd, Hg also pollute the soil.
- Radioactive Pollutants: Nuclear wastes excreted from nuclear power plants. Nuclear tests cause soil pollution.
- Urban Wastes These include polythene bags, paper, plastic goods.

Control of Environmental Pollution and Green Chemistry

Environmental pollution can be controlled by implementing these techniques:

(1) By using environmental affectionate processes like Green Chemistry etc.
(2) By Burning and Incineration.
(3) By plantation or vegetation.
(4) By management of wastes.
(5) By Dumping
(6) By Recycling of waste materials into useful materials.
(7) By Sewage Treatment

Green chemistry

Green chemistry has a vital role in our lives by providing us medicines, fertilizers, textiles, cosmetics, food preservatives, polymer etc. Yet some chemical processes are creating quite hazardous wastes that damage our environment and cause various types of pollutions. Green chemistry is developing to design and implement such chemical processes that reduce wastes and minimize or eliminate the creation of hazardous substances.

Concept Ladder

Green chemicstry applies across the life cycle of a chemical product, including its design, manufacture, use and ultimate disposal. Green chemistry is also known as sustainable chemistry.

Definitions

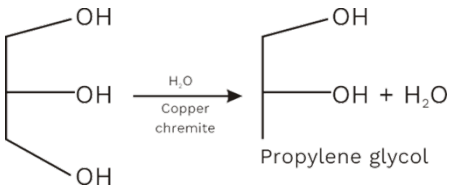
Green chemistry is the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances.

The following twelve principles form the base of green chemistry:

(1) Design safer chemicals
(2) Avoid accidents
(3) Maximize atom economy
(4) Minimize derivatives
(5) Use less hazardous methods/processes
(6) Use safer solvents
(7) Use catalysis
(8) Use renewable feedstocks
(9) Prevent wastes
(10) Design for energy efficiency
(11) Design for degradation
(12) Monitor pollution in real time

Examples

A new method of transform glycerol into a by-product of producing biodiesel fuel from vegetable oils into propylene glycol (Anti-freezing agent for Auto mobiles) is developed.



Synthesis of ibuprofen

Previous Year's Questions

Green chemistry means such reactions which

[AIPMT]

(1) produce colour during reactions
(2) reduce the use and production of hazardous chemicals
(3) are related to the depletion of ozone layer
(4) study the reaction in plants

Q1 Define environmental chemistry.

Sol. Environmental chemistry refers to the study of chemical and biochemical processes that occur in nature. It also delves into the reaction, origin, effects and transport of the chemical species in our earth.

.

Q2 List gases which are responsible for greenhouse effect.

Sol. The major gases that responsible for greenhouse effect are:
1) Chlorofluorocarbons (CFCs)
2) Methane (CH_4)
3) Carbon dioxide (CO_2)
4) Nitrous oxide (NO)
5) Water (H_2O)
6) Ozone (O_3)

Q3 What do you mean by ozone hole?

Sol. Stratospheric clouds existing in Polar Regions provide a surface for the reaction of chlorine nitrate and HClO which on further reaction, gives Cl_2. HClO and Cl_2 get photolysed to get chlorine-free radicals. These radicals in the reaction with atomic oxygen (O), resulting in formation of more Cl radicals. This reanimation of chlorine-free radicals results in a continuous breakdown of O_3 in stratosphere, thus almost permanently damaging ozone layer. This phenomenon is called as the 'ozone hole'

Q4 What are its consequences?

Sol. Earth is shielded from harmful UV radiations of the sun by ozone layer. When this layer gets depleted, a amount of radiations increase will enter earth's atmosphere. They are harmful since they lead to cataract, skin cancer, ageing effect and also cause sunburns. They prove fatal to phytoplankton, thus resulting in a decreases in fish productivity. Excess exposure to these rays may, in some cases, also lead to mutation in plants. The moisture content of the soil decreases with an increase in exposure to UV radiations.
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Q5 What do you mean by Biochemical Oxygen Demand (BOD)?

Sol. Biochemical oxygen demand (BOD) is the amount of O2 required by bacteria to decompose organic substance in a certain volume of a sample of water. Clean water will have a BOD of below 5 ppm whereas a highly polluted water source will have a BOD of more than 17 ppm.

Q6 Do you observe any soil pollution in your neighbourhood? What efforts will you make for controlling the soil pollution?

Sol. Fertilizers and Pesticides are the main pollutants that cause soil pollution. When insecticides like Dichloro-Diphenyl-Trichloroethane (DDT) are used, they get stuck in the soil for a longer time since they are not soluble in H2O and thus contaminating the soil and crops. Insecticides and pesticidesare are not biodegradable in nature and when they enter the food chain, they go highest trophic levels and thus affect the whole biodiversity of an area. Soil pollution can be controlled by the addition of fertilizers and pesticides and instead use compost and manures.

Q7 What are pesticides and herbicides? Explain giving examples.

Sol. Mixture of more than two substances that are used to kill, microorganism is known as Pesticide. Pests that need to be killed are pathogens, plant weeds, insects, mollusks, etc. which affect the plants and lead to their death. Some common pesticides include Aldrin and Dieldrin. Pesticides are similar to Herbicides. Ex. sodium chlorate ($NaClO_3$), sodium arsenite (Na_3AsO_3).

Q8 How can domestic waste be used as manure?

Sol. First, the waste has to be classified into biodegradable and non-biode- gradable wastes. That can be degraded by micro organism like bacteria such as food wastes, leaves are biodegradable and dumped in landfills with micro-organisms that decompose it. Decomposed matter known Humus can be used as dung. The reaming of the wastes, which are non-biodegradable have to be recycled..

Q9 A large number of fish are suddenly found floating dead on a lake. There is no evidence of toxic dumping but you find an abundance of phytoplankton. Suggest a reason for the fish kill.

Sol. Phytoplankton (alga) is consumed by bacteria which require dissolved oxygen (DO) for this process. Thus, the higher the amount of Phytoplankton (alga), the larger is the use of dissolved oxygen (DO) by bacteria to consume Phytoplankton. Thus, all the O2 in the lake is used up and BOD drops below 6 ppm, suffocating the fish.

Q10 What would have happened if the greenhouse gases were totally missing in the earth's atmosphere? Discuss.

Sol. Greenhouses gases are present in our atmosphere trap the Ultra violet rays coming from Sun and heat up the earth.
In the absence of greenhouse gases (CO2, CFC, etc), the earth will not be able to maintain any heat which is essential for the survival for most of species on the earth. Without greenhouse gases, the earth's average temperature will drop thus making this planet uninhabitable..

Q11 For your agricultural field or garden you have developed a compost producing pit. Discuss the process in the light of bad odour, flies and recycling of wastes for a good product.

Sol. Compost pit should be covered to prevent files and bad odour.
Non-biodegradable wastes should not be dropped into compost pit so as not interfere in the decomposition of the wastes. Instead, they should be sent for recycling..

Q12 What do you mean by green chemistry?

Sol. Green chemistry is production process which uses existing knowledge that we have on principles of chemistry to create, develop and implement chemical com- pounds and products to decrease the amount of hazardous substances in the environment.

Summary

1. Thermosphere is the region where temperature increases with increase in altitude.
2. Sound waves cannot propagate in mesosphere.
3. Polluted atmosphere and hydrosphere affects biosphere.
4. By eating fish contaminated by mercury many people in Japan's Minamata Island died. Due to a minamata disease.
5. Spilling of oil into sea water cause water pollution.
6. Speciation is identification of different pollutants as organic, inorganic or organo-metallic origin.
7. The toxic effect of pollutant depends on category to which it belongs. For example, mercury com pounds are more toxic than lead compounds.

- Pollen and spores cause allergic reactions or hay fever in certain people.
- Mine dust destroys vegetation and causes many deformities in animals and human beings.
- Mercury poisoning produces a crippling and often fatal disease called Minamata disease.
- Spraying of DDT on crops causes pollution of air, water and soil.
- Holomorphic is a process of increasing salt con centration of soil.
- Photochemical oxidants are secondary pollutants such as ozone, PAN, aldehydes and phenols. These are produced due to photochemical reactions between nitrogen oxides and unsaturated (reactive) hydrocarbons.
- Abiotic (non-living) components of the environment are lithosphere,
- hydrosphere, and atmosphere. Biotic (living) components are plants, animals and human beings. Energy components are solar, geometrical, thermochemical, hydroelectric and nuclear energy.
- Polychlorinated biphenyls (PCBS) are the recently formed chemical compounds
- which are used as flu ids in transformers and capacitors. Being resistant to oxidation, these are released in atmosphere as vapours. They mix with rain water and thus contaminate water. These have been found to be carcinogenic and are

thus a source of pollution.

- Threshold limit value (TLV) indicates the permissible level of the pollutant or toxic substance in atmosphere to which a healthy person can be exposed to, without causing any adverse effect.
- BOD_5 means the amount of oxygen consumed in 5 days at 20°C (293 K) and it is
- reported in ppm. Pure water has BOD_5 of less than 5 ppm whereas highly polluted water has BOD_5 value of more than 17 ppm. The untreated sewage has BOD_5 of 100–400 ppm.
- Particulates are small solid particles and liquid droplets suspended in air. These
- are of two types— viable and non-viable.
- Viable particulates are small sized microorganisms dispersed in the air which may cause diseases. For example, fungi, bacteria.
- Non-viable particulates are formed by the condensation of small species or disintegration of large species. For example, mist, smoke, fume, dust.
- The particulate pollutants like lead, carbon and metals are released from the automobile exhausts causing respiratory disorders.
- Particulates can be removed from air by using gravity setting chamber, cyclone collector, wet scrubbers and electrostatic precipitators.