NEET Revision Notes
Chemistry
Environmental Chemistry

Environmental pollution: Pollution is the introduction of any material (solid, liquid, or gas) or a variety of energy (such as heat, sound, or radioactivity) into the setting at a pace faster than it is spread, diluted, decomposed, recycled, or hold on in a very harmless kind.

Air Pollution:

- Harmful gases and aerosols (solids and liquids suspended in the air) are emitted by both natural and human processes, resulting in air pollution.
- Particulate matter and greenhouse gases are released into the atmosphere by wildfires and volcanoes, for example.
- Human activities, such as burning fossil fuels like coal, natural gas, and oil for power, transportation, and industry, account for the bulk of air pollution.

Some common air pollutants are:

- Particulate matter is some kind of dust (dust, dirt, soot, smoke, etc.)
- Methane (CH_4), carbon dioxide (CO_2), and nitrous oxide (N_2O) are direct greenhouse gases that trap heat in the atmosphere and contribute to climate change.
- When fossil fuels and biomass are burned, indirect greenhouse gases such as carbon monoxide, sulphur dioxide, and volatile organic compounds (VOCs) are emitted (e.g. wood).
- In the atmosphere, these molecules chemically combine to generate more harmful substances that worsen climate change and endanger human health.

Water pollution:

Water pollution is outlined because of the discharge of pollutants into underground groundwater or lakes, streams, rivers, estuaries, and seas to the point where the contaminants hinder useful water usage or system working. Pollution

involves the discharge of energy, like radiation or heat, into bodies of water that are added to the discharge of substances like chemicals, debris, or microbes.

Soil Pollution:

- Soil pollution is the poisoning of soil with harmful chemicals in abnormally high amounts.
- It is a significant environmental problem since it has several health dangers.
- Exposure to soil with high levels of benzene, for example, raises the risk of leukaemia.
- Many substances, such as heavy metals, hydrocarbons, mineral oils etc., are potential pollutants causing soil pollution.

Chemical Reactions in the atmosphere:

Atmospheric pollution is generally regarded as tropospheric and stratospheric pollution, where various chemical reactions produce harmful gases and pollutants to cause atmospheric pollution.

There are two main types of undesirable pollutants that cause atmospheric pollution:

1. Gaseous air pollutants
2. Particulate pollutants

Gaseous air pollutants: Oxides of elements like sulphur, carbon, and nitrogen are some examples of gaseous air pollutants.

Oxides of sulphur: When the sulphur contained fossil fuels are burnt, the produce sulphur dioxide that is harmful for both flora and fauna.

$$2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$$

$$SO_2(g) + O_3(g) \longrightarrow SO_3(g) + O_2(g)$$

$$SO_2(g) + H_2O_2(l) \longrightarrow H_2SO_4(aq)$$

Oxides of nitrogen:

At high altitudes, when lightening takes place the inert dinitrogen and dioxygen gas of air reacts together to yield oxides of nitrogen and nitrate ions that are slipped into soil as fertilizers and decreases its fertility.

$$N_2(g) + O_2(g) \xrightarrow{1483K} 2NO(g)$$

$$2NO(g) + O_2(g) \longrightarrow NO_2(g)$$
$$NO(g) + O_3(g) \longrightarrow NO(g) + O_2(g)$$

Oxides of carbon: Carbon monoxide is one of the most harmful air pollutants, and carbon dioxide is the primary greenhouse gas. Natural processes like respiration and metabolism generate carbon dioxide, which plants use for photosynthesis.

Particulate pollutants: The tiny solid particles or liquid droplets emitted from vehicles, fireplaces, industrial chimneys, etc., can harm flora and fauna and degrade the abiotic components.
This can include smoke, dust, mists, fumes etc., that cause atmospheric pollution.

Smog:

- Smog is a form of pollution that occurs when there is a build-up of pollutants in the atmosphere.
- It is a mixture of dangerous pollutants (typically visible as a yellow-brown haze low to the ground) released into the atmosphere by both natural and human-caused activities.
- Smog is made up of a variety of substances, including nitrogen oxides (NO_x), sulphur dioxide (SO_2), and carbon monoxide (CO), and volatile organic compounds (VOCs).

There are two types of smog:

1) Classical smog or normal smog
2) Photochemical smog

- Normal smog (also known as London-type smog) is primarily caused by the combustion of significant volumes of high sulphur coal.
- Photochemical smog, on the other hand, is a relatively recent phenomenon caused by vehicle emissions coming into contact with sunlight—mostly from gasoline and diesel combustion.
- In warm, heavily populated cities with many automobiles, photochemical haze arises.

Formation of photochemical smog:

- Sunlight decomposes nitrogen dioxide (NO_2) into nitric oxide (NO) and an oxygen radical (O). Ozone .is formed when oxygen radicals react with atmospheric oxygen.
- Nitric oxide consumes ozone to generate nitrogen dioxide and oxygen. Reactions of nitrogen dioxide with different hydrocarbons, which are molecules built from carbon, hydrogen, and other components, yield harmful chemicals as PAN- Peroxy acetyl nitrate.

$$NO_2 + sunlight \longrightarrow NO + O$$

$$O + O_2 \longrightarrow O_3$$

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

$$NO_2 + R \longrightarrow products\ such\ as\ PAN$$

Acid rain:

- Any type of precipitation containing acidic elements, such as sulfuric or nitric acid, that falls to the ground from the atmosphere in wet or dry forms is called acid rain, also known as acid deposition. Rain, snow, fog, hail, and even acidic dust might fall under this category.

$$H_2O(l) + CO_2(g) \leftrightarrows H_2CO_3(aq)$$

$$H_2CO_3(aq) \leftrightarrows H^+(aq) + HCO_3^-$$

And

$$2SO_2(g) + O_2(g) + H_2O(l) \rightleftarrows 2H_2SO_4(aq)$$

$$NO_2(g) + O_2(g) + H_2O(l) \rightleftarrows 4HNO_3(aq)$$

The acid formed in the above reactions lowers the pH of precipitate and when the pH of rain drops below 5.6, it is considered as acidic rain.

Ozone layer:

- The ozone layer is a gaseous layer in the upper atmosphere that shields people and other living things from the sun's damaging ultraviolet (UV) radiation.
- Although ozone is found in minor amounts throughout the atmosphere, the majority (about 90%) is found in the stratosphere, a layer 10 to 50 kilometres above the Earth's surface.

- The ozone layer is essential to life on Earth because it filters away most of the sun's damaging UV rays.

Ozone hole:

- The South Pole has the most ozone depletion. It mostly happens in mid-August till November, with peak depletion in early October, when ozone is often destroyed in vast regions.
- This extreme depletion results in the so-called "ozone hole," seen in satellite photographs of Antarctic ozone.
- In most years, the hole's greatest extent is larger than the continent of Antarctica itself.
- Although ozone losses in the Northern Hemisphere are less severe, considerable ozone layer depletion has been detected across the Arctic and even continental Europe.
- Because ozone-depleting compounds released by human activities linger in the stratosphere for decades, ozone layer recovery is a slow and lengthy process.
- Due to the lag induced by ozone-depleting compounds persisting in the stratosphere for a long period, the hole expanded in the years after the adoption of the Montreal Protocol.
- The ozone hole's maximum size is now shrinking.

Reactions involved in ozone depletion:

- In the stratosphere, ozone gas is the product of UV radiation acting on the di-oxygen molecule.
- These UV radiations can also split the molecular oxygen into nascent oxygen atoms.
- The nascent oxygen atoms combine with the molecular oxygen to yield ozone gas.

$$O_2(g) \xrightarrow{UV} O(g) + O(g)$$

$$O(g) + O_2(g) \overset{UV}{\leftrightarrows} O_3(g)$$

- Thermodynamically, ozone is an unstable gas, and it further decomposes to molecular oxygen and nascent oxygen.
- Therefore, a dynamic equilibrium exists between the generation and decomposition of ozone molecules.

Any of the several organic compounds made of carbon, fluorine, and chlorine is known as chlorofluorocarbons (CFCs). Hydrochlorofluorocarbons, or HCFCs, are CFCs that also include hydrogen in place of one or more chlorines. **Freons are also termed CFCs.**

- Refrigerators and air conditioners employ freons as refrigerants. It serves as a propellant for the foams used in pesticides, shaving creams, and deodorants.
- Stratosphere layer contains the powerful UV radiation that breaks down the Freon molecule and yield chlorine free radical.

  $CF_2Cl_2(g) \xrightarrow{UV} Cl^{\bullet}(g) + C^{\bullet}F_2Cl(g)$
- The chlorine free radical consequently reacts with ozone gas to form chlorine monoxide radical and molecular oxygen.

  $Cl^{\bullet}(g) + O_3(g) \longrightarrow Cl^{\bullet}O(g) + O_2(g)$
- The chlorine monoxide radical reacts with atomic oxygen and produce more chlorine radicals.

  $Cl^{\bullet}O(g) + O(g) \longrightarrow Cl^{\bullet}(g) + O_2(g)$
- The chlorine radicals are continuously regenerated in the cycle and cause the breakdown of ozone gas leading to the depletion of ozone layer.

Effects of depletion of ozone layer:

- The quantity of UV radiation that reaches the Earth's surface rises as the ozone layer depletes. UV radiation induces non-melanoma skin cancer and has a key role in developing malignant melanoma. It has also been associated with the formation of cataracts, a clouding of the eye's lens.
- Plants' physiological and developmental activities are influenced by ultraviolet light. Plant development can be directly influenced by UV radiation, despite mechanisms to decrease or repair these effects, as well as the capacity to adapt to higher amounts of UV.
- UV indirectly impacts changes in plant structure, how nutrients are dispersed throughout the plant, developmental phase timing, and secondary metabolism. These changes may affect the competitive balance of plants, herbivory, plant diseases, and biogeochemical cycles.
- Early embryonic stages of fish, shrimp, crab, amphibians, and other aquatic species have been damaged by UV light. The most serious consequences include reduced reproductive capability and disruption in larval development. Tiny increases in UV radiation may cause population

declines in small marine species, which might impact the entire marine food chain.

- Increases in UV radiation may impact terrestrial and aquatic biogeochemical cycles, affecting greenhouse gas and chemically significant trace gas sources and sinks (e.g., carbon dioxide, carbon monoxide, carbonyl sulphide, ozone, and possibly other gases). Certain possible alterations might result in biosphere-atmosphere feedbacks that reduce or increase the quantities of these gases in the atmosphere.

Greenhouse effect:

- The presence of water vapour, carbon dioxide, methane, and other gases in the air creates the greenhouse effect, which increases the warming of the Earth's surface and troposphere (the lowest layer of the atmosphere).
- Although the greenhouse effect is a naturally occurring phenomenon, it is likely that human-caused emissions of greenhouse gases into the atmosphere would intensify the impact.
- Carbon dioxide levels in the atmosphere grew by around 30%, while methane levels more than doubled from the beginning of the Industrial Revolution to the end of the twentieth century.
- According to some experts, human-caused increases in atmospheric carbon dioxide and other greenhouse gases might result in a 3 to 4 ^{o}C increase in global average temperature by the end of the twenty-first century, compared to the 1986–2005 average.
- Global warming might change Earth's climates, resulting in new patterns and extremes of drought and rainfall and disrupting food production in some areas.

Global warming:

Global warming is the long-term warming of Earth's climate system that has been seen from the pre-industrial period (between 1850 and 1900) as a result of human activity, mainly fossil fuel combustion, which elevates heat-trapping greenhouse gas levels in the atmosphere.

Pollution due to industrial waste:

- Industrial solid waste can be categorised into two types: biodegradable and non-biodegradable waste.

- The biodegradable waste is generated from the industries such as sugar mills, food processing units, textile industries, paper mills, Cotton industries etc. biodegradable waste is easily decomposed or recycled for the same purpose.
- Non-biodegradable waste or produced from thermal power plants, blast furnaces, metal industries, pharmaceuticals, rubber industries, industries dealing in producing pesticides, drugs, dyes etc.
- If non-biodegradable industrial waste is not disposed of in a proper method, then it may cause a serious threat to our environment.
- Many innovations and techniques have been developed to re-utilise. The waste material is generated from the industries.
- A large amount of toxic waste is usually destroyed by controlled incineration and is burnt along with the fat factory garbage in open landfills. This produces a large number of toxic gases directly into the atmosphere and enhances the level of air pollution in the environment.
- Some of the toxic waste material from industries is dumped deep into the land and leads to land pollution and somehow affects soil fertility.
- Overall if the solid waste from the industries is not managed effectively can affect the various components of the environment.

Green Chemistry:

- Green chemistry is an approach utilising the existing knowledge and techniques of chemistry and other sciences to prevent a harmful environmental impact.
- It is a creative process that produces minimum pollution and deterioration to the surrounding environment.
- Using existing knowledge to reduce chemical hazards and developmental techniques is the basis of green chemistry.
- For a chemical reaction to occur, a reaction medium is required for reactants and attacking reagents. The extent of any reaction is dependent upon the physical parameter in which the reaction is taking places, such as temperature, pressure, and use of catalyst.
- If the reactants are fully converted into environmentally friendly products and produce no chemical pollutants, they can be considered a part of green chemistry.

- Green Chemistry promotes conducting synthetic reactions in an aqueous medium since water is non-inflammable, cost-effective, has low volatility, high specific heat and lacks any carcinogenic effects.
- Green chemistry is the cost effective approach that involves reducing energy consumption and waste generation and preventing environmental degradation.

Strategy for control of environmental pollution:

- As the demand for natural resources grows by the day due to increased human activity, appropriate measures must be put in place to reduce it.
- If things continue to go as they are, life on Earth will become unsustainable. Many scientists and environmentalists are striving to put specific measures in place to reduce pollution, and this is not occurring for several reasons.
- They created some pollution-control strategies, but they never got around to implementing them. In addition to the solid waste we see in our garbage cans, there are industrial, medical, mining, and agricultural wastes.

Industrial waste management:

They should be separated into biodegradable and non-biodegradable groups. We can make them harmless before disposing of them.

The following are some of the industrial waste management strategies:

- Reduce - to cut down on the number of natural resources used.
- Reuse - to reuse an item several times.
- Recycling is the process of repurposing garbage.

Collection of Waste:

- The garbage will wind up in the sewers if it is not properly collected for disposal. Plastic bags and other non-biodegradable rubbish block sewers and cause incontinence; some of them are consumed by cattle.
- The cattle eat the polythene bags and choke on them. This makes it difficult for them to breathe, and it may result in death.

Disposal of waste:

- As responsible citizens, we should engage in the proper waste disposal and work with the government. Garbage disposal in uncomfortable places should be avoided at all costs.

- To reduce vehicular emissions, efforts are being undertaken to encourage public transportation, carpooling, and the development of greener alternatives to existing fuels.
- Promoting renewable energy sources will go a long way toward making our world a safer and better place to live.