

ENVIRONMENTAL

LESSON NOTES FOR ADVANCE LEVEL

....with more questions for revision



CHEMISTRY

LESSON NOTES
FOR ADVANCE LEVEL



THE DARK – ROOM
+255(0)773542465 / 0714789590

MR. SANCHO



ZANZIBAR - TANZANIA

Prepared by: **Makame Kh. H. Sancho**
0773542465 / 0714789590

Dark – Room,
It bright the future lives more than a torch does!
Zanzibar – Tanzania.
September, 2012

ENVIRONMENTAL CHEMISTRY

OBJECTIVES OF THE TOPIC:

After studying this topic, you will be able to:

- ♠ understand the meaning of environmental chemistry.
- ♠ explain the meaning and significance of environmental conservation.
- ♠ compare between resource protection and utilization.
- ♠ describe possible reasons for environmental destruction.
- ♠ discuss the meaning and significance of pollution in real life.
- ♠ describe aquatic, terrestrial and aerial pollution and their intervention measures.
- ♠ explain the chemical basis of ozone layer destruction.
- ♠ describe the chemical basis of greenhouse effect

Proudly prepared by: M Kh. H. Sancho, Dark-room - Zanzibar

INTRODUCTION:

The terms such as ozone depletion, greenhouse effect, acid rains, e.t.c., have become the hot topics of discussion among the socially and educationally advanced people. In addition, environmental pollution has become one of the most important issues of global concern. Whenever we talk about these hot problems, we tend to curse industrialization and related developments in transportation, refrigeration, air conditioning and the manufacture of all kinds of chemicals.

The branch of chemistry which deals with the study of various chemical phenomena occurring in the environment is called environmental chemistry.

Environmental chemistry: It can be defined as the study of the sources, reactions, transport, effects, and fates of chemical species in the air, soil, and water environments; and the effect of human activity on these.

Environmental chemistry is an multidisciplinary science that includes atmospheric, aquatic and soil chemistry, as well as heavily relying on analytical chemistry and being related to environmental and other areas of science.

- * *Environmental chemistry involves first understanding how the uncontaminated environment works, which chemicals in what concentrations are present naturally, and with what effects.*
- * *Environmental chemistry is the scientific study of the chemical and biochemical phenomena that occur in natural places. It should not be confused with **green chemistry**, which seeks to reduce potential pollution at its source.*
- * *Without this it would be impossible to accurately study the effects humans have on the environment through the release of chemicals*

Green chemistry: Is a program of developing new chemical products and chemical processes or making improvements in the already existing compounds and processes so as to make them less harmful to human health and environment. It refers to the program of alternative synthetic pathways for prevention of environmental pollution.

It is also, known as environmentally benign (nonthreatening) chemistry or clean chemistry or benign by design chemistry.

Environmental Chemistry is the discipline which deals with:

- (i) *the environmental impact of pollutants,*
- (ii) *the reduction of contamination and*
- (iii) *management of the environment.*

Environmental Chemistry: Is thus the study of the behaviour of pollutants with respect to their environmental fate and effects on the environment.

Toxic compounds consist of naturally occurring elements in variable quantities which usually have no adverse environmental effects. The effect of a chemical depends:

- (i) *on its distribution,*
- (ii) *its form*
- (iii) *its concentration*

ENVIRONMENT:

Environment: Is the total sum of conditions in which an organism lives.

The natural environment encompasses all living and non-living things occurring naturally on Earth or some region thereof. It is an environment that encompasses the interaction of all living species.

Environment may refer to:

- ♠ the physical and biological factors along with their chemical interactions that affect an organism.
- ♠ the surroundings of a physical system that may interact with the system by exchanging mass, energy, or other properties.

Environment has three components. These are,

- * Physical surroundings such as, soil, water bodies, and atmosphere.
- * Living organisms such as, plants, animals, human beings.
- * Meteorological factors such as, sunlight, temperature, rainfall, wind speed.

Environment of a place depends upon the following three factors:

- * Climatic factors
- * Geographical factors
- * Nature of human activities in that area.

The major accessible components (environmental segments) of environments are:

1. Atmosphere
2. Hydrosphere
3. Lithosphere (Geosphere)
4. Biosphere

These environments are interrelated and are related with human activities.

Atmosphere: Is a thin protective blanket that upbringing life on earth. This comprises a blanket of gaseous layer that extends to a height of about 1600km above the surface of earth.

- * It consists of gases like N₂, O₂, H₂O(g) as major components, Ar, CO₂ as minor components and noble gases, oxides of nitrogen, NO_x, oxides of sulphur, H₂, O₃ as trace components.
- * Atmosphere protects the life on earth from harmful radiations coming from outer space and sun. It moderate earth temperature within a suitable range for life
(*Quran 21:32*).
- * The main layers of the atmosphere from the surface of the earth upwards are;
 - (i) Troposphere
 - (ii) Stratosphere
 - (iii) Mesosphere
 - (iv) Thermosphere

(*More details of these layers are described on ozone layer section*).

Hydrosphere: All the surface and ground water resources such as oceans, seas, rivers, lakes, glaciers, polar ice caps, etc., collectively constitute hydrosphere.

- * Water covers 70% of the earth surface and over 97% of world's total water is ocean. About 2.4% of the earth's water exists in the form of glaciers and polar ice caps, thus only about 0.6% of water is available for domestic, agricultural and industrial use.
- * Is essential part of all living environment (from which the life evolved and in which life exists – *Quran 21:30*).

Lithosphere: It refers to earth's solid crust containing the outer mineral cover like soil, rocks, mountains, etc.

- * Crust is a part of geosphere which human live and extracts most of their food, minerals and fuels. It is composed of silicate based minerals.

Biosphere: Is part of environment consisting organism and living biological materials. The combination of lithosphere, hydrosphere, atmosphere, and all the living organisms living is called biosphere.

- * The main components of biosphere are;
 - (i) Abiotic (non-living) components
 - (ii) Biotic (living) components

ENVIRONMENTAL CONSERVATION

Environmental conservation is the act of conserving or saving our natural resources through careful management. This means we can use the resources but wisely and responsibly.

Examples: reducing your waste, saving trees, recycling, using renewable resources that don't deplete our natural resources.

Environmental conservation is the protection and preservation of natural resources from destruction, wastage, or loss. Natural resources include soil, minerals, water, aquatic life, air, forests, and animals (domestic and wild).

Resource Conservation is a phenomenon that prepares individuals for the diverse opportunities that exist in environmental conservation, natural resource management and efforts to build sustainable livelihoods and communities. Conservation is fundamentally a social enterprise that requires knowledge and skill in the natural and social sciences.

Natural resource and energy conservation is achieved by managing materials more efficiently. Preservation is different. When we preserve we strictly don't use it at all.

Three primary strategies for effectively managing materials and waste are reduce, reuse, and recycle.

This is achieved by:

- ♠ Reduce waste by making smart decisions when purchasing products, including the consideration of product packaging
- ♠ Reuse containers and products, which provide another significant way to conserve resources
- ♠ Recycle materials ranging from paper to food scraps, yard trimmings, and electronics

Natural resources are conserved for their biological, economic, and recreational values, as well as their natural beauty and importance to local cultures. For example, tropical rain forests are protected for their important role in both global ecology and the economic livelihood of the local culture; a coral reef may be protected for its recreational value for scuba divers; and a scenic river may be protected for its natural beauty.

Ways that can take part in environmental conservation

1. Plant more trees at home and in school. Do not cut trees carelessly.
2. Do not harm animals both domestic and wild. Be kind to all animals.
3. Educate other people on the importance of environmental conservation.
4. Do not litter (waste) the environment. Place rubbish and any other waste in designated areas or in disposal bins.
5. Use materials that are more efficient so that less waste is generated.
6. Do not start fire near forest areas. Any fire lit (start to burn) should be monitored until it goes out or put off.
7. Take part in environmental conservation programs and tasks

Environmental conservation measures

1. Legislation; laws are being made that will govern environmental conservation.
2. Education; people are being educated on the importance of environmental conservation.
3. Setting up organizations and institutions, many organizations have been set up for the purpose of environmental conservation. These include,
 - The government ministries and agencies, include Ministry of agriculture, livestock, and environment.
 - International agencies include the United Nations Environmental Program (UNEP).

4. Pollution prevention and control; a lot of effort is being directed towards preventing and controlling pollution. This is being done by setting up recycling factories, establishing of laws and policies to control pollution, among others.
5. International agreements; international bodies such as UN and European Union have drafted agreements which help in the conservation of the environment. Such as agreements include the Kyoto protocol, which was agreed upon in Kyoto, Japan on 11, Dec. 1997.
6. Personal involvement; It is important that we are all involved in environmental conservation. This is because the effects of destroying the environment affect everyone.
7. Research; research is being carried out on the best ways to protect and conserve the natural resources. Some of the areas of research include, alternative source of energy, methods of preventing and controlling pollution and sustainable use of natural resources.

Significance of environmental conservation

- * Conservation of the environment is essential for the Earth's existence. It saves our natural resources, reduces pollution and landfills. For instance, fresh water levels in many parts of the world have dropped alarmingly. Water shortage is a growing problem. If there is no water on Earth, there will be no life, no environment. So, it is very important that we conserve fresh water. By saving water we would be saving the lives of plants, animals and mankind. That's how conservation would benefit the environment
- * Conservation refers to protecting our biodiversity from being endangered (vanished). Biodiversity is greatly affected by the human activities and climatic changes. Biodiversity has brought us many advantages provides us food and is a source of raw materials, example wood from plants can be used for making furniture. Its loss can affect our water supply and atmosphere. Therefore conserving biodiversity has great importance.
- * Conservation is important because destruction is forever, living things are threatening so next turn of the wild world there are different kinds of animals and the old living things are already destroyed.

MINERAL ORES

An ore is a rock deposit that contains enough mineral to make it economically feasible to extract and purify to derive a desired product material.

Ore: Is a mixture of a metal containing mineral and other materials from the surrounding rocks, which can be described as impurities with respect to what you want from the ore

Mineral is an element or chemical compound that is normally crystalline and that has been formed as a result of geological processes.

Minerals are naturally occurring inorganic solids with a crystalline structure and a definite range of chemical formula. **Ores** are concentrations of minerals in rock that are high enough to be economically extracted for use.

All ores are minerals, but all minerals are not necessarily ores.

Minerals are a non-renewable resource. The rate of formation is much smaller than the rate at which the humans consume these minerals. It is necessary to reduce wastage in the process of mining.

Minerals can be conserved in by the following measures:

- * Use of improved technologies to allow use of low grade minerals at low costs
- * Using substitutes.
- * Use of scrap metals
- * Recycling of metals is good way in which the mineral resources can be conserved.

WASTE MANAGEMENT

Waste management: Is the collecting, transporting, processing, recycling or disposal and monitoring of waste material.

Waste management: Is disposal, processing, controlling, recycling, and reusing the solid, liquid, and gaseous wastes of plants, animals, humans, and other organisms. It includes control within a closed ecological system to maintain a comfortable environment. Some of the waste materials involved are hazardous while others are simply so voluminous (huge) that their permanent disposal becomes a problem.

The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources.

METHODS OF DISPOSAL

Land fill: This is a disposal option involving carefully designed structures built into or on top of the ground in which waste is isolated from the surrounding environment.

Landfills were often established in abandoned or unused quarries, mining or borrow pits. A properly designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Poorly managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin. Another common byproduct of landfills is gas (mostly composed of methane and carbon dioxide), which is produced as organic waste breaks down anaerobically. This gas can create odor problems, kill surface vegetation, and is a greenhouse gas.

Pros

- Waste is properly considered
- Facilities are properly sited with necessary controls
- Suitable for numerous waste streams

Cons

- Transportation concerns/costs
- Potential spread of pathogens from biological incidents
- Total capacity limited in each landfill

Incineration: Also called combustion, this treatment option burns waste under controlled conditions.

Incineration is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products.

Incineration is a controversial (debated) method of waste disposal, due to issues such as emission of gaseous pollutants.

Pros

- Reduces waste volume needing disposal
- Can inactivate disease agents
- Can reduce the toxicity of waste
- Can produce energy
- It requires lesser land to dispose off a large amount of waste

Cons

- Residues still require proper testing and disposal
- May produce undesirable by-products
- Transportation concerns/costs
- Capacity limitations
- It causes air pollution

Recycling: Is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. The materials from which the items are made can be reprocessed into new products.

Recycling these materials protects the environment by saving resources, including energy, materials, and landfill space. This option should be considered before more permanent disposal options in order to minimize the amount of waste needing disposal.

Pros

- May generate revenue by selling the material
- Produces a usable product
- Saves resources and energy
- Saves space in landfills

Cons

- May require treatment first to ensure safe usability
- May require sampling before recycling
- Public perception regarding usability of product

RESOURCE PROTECTION

Environmental protection is a practice of protecting the environment, on individual, organizational or governmental level, for the benefit of the natural environment and/or humans.

- * It is influenced by three interwoven (linked) factors: *environmental legislation, ethics and education*. Each of these factors plays its part in influencing national level environmental decisions and personal level environmental values and behaviors.

Environmental protection: policies and procedures aimed at conserving the natural resources, preserving the current state of natural environment and where possible, reversing its degradation.

Resource utilization: Is the total amount of resources actually consumed, compared against the amount of resources planned for a specific process. It is normally measured as a percentage

COAL

Coal is primarily used as a solid fuel to produce electricity and heat through combustion. Coal is important source of energy and about one third of the energy used by human kind is provided from coal.

*It is formed due to natural processes such as flooding; these forests were buried under the soil. As more and more soil deposited over them, they were compressed. The temperature also rose as they sank deeper and deeper. For the process to continue, the plant matter was protected from biodegradation and oxidization, usually by mud or acidic water. Under high pressure and high temperature dead vegetation were slowly converted to coal. As coal contains mainly carbon, the conversion of dead vegetation into coal is called **carbonization**.*

Advantages (Pros) of coal:

- * Very large resource base
- * Relative cheap to mine and transport by rail
- * Useful; Coal is not only burned directly, but it can also be transformed into liquid or gas form. It is claimed that liquefied or gasified coal burns cleaner, meaning less air pollution.

Disadvantages (Cons) of coal:

- * Emission of air pollutants SO_2 , NO_2 .
- * Coal burning produces large quantities of ash.
- * Mining posts safety and health threat to miners.
- * Nonrenewable; like other fossil fuels, coal is a nonrenewable energy source. Environmentalists, conservationists, and other opponents of coal use advocate cleaner, renewable energy sources, such as wind power.
- * Release of carbon dioxide, a greenhouse gas, which causes climate change and global warming.
- * Coal-fired power plants emit mercury, selenium, and arsenic, which are harmful to human health and the environment.
- * Interference with groundwater and water table levels due to mining.

PETROLEUM

Petroleum: or simply crude oil, is a naturally occurring, flammable liquid found primarily in underground geological formations and consists of a complex mixture of hydrocarbons of various molecular weights plus other organic compounds.

Pros

- * Oil is one of the most abundant energy resources.
- * Liquid form of oil makes it easy to transport and use.
- * Oil has high heating value.
- * Relatively inexpensive
- * No new technology needed to use

Cons

- * Oil burning leads to emissions of CO_2 , NO_x , SO_2 , contributing to global warming, acid rain.
- * Oil drilling endangers the environment and ecosystems
- * Oil transportation (by ship) can lead to spills, causing environmental and ecological damage (major oil spill near Spain in late Fall 2002)

NATURAL GAS

Natural gas: Is a flammable gas, consisting largely of methane and other hydrocarbons, occurring naturally underground (often in association with petroleum) and used as fuel.

A hydrocarbon gas obtained from underground sources, often in association with petroleum and coal, which is formed naturally in the earth when organic material decomposes under pressure.

It generally contains a high percentage of methane, varying amounts of ethane, and inert gases; used as a heating fuel.

Pros (Advantages)

- Relative inexpensive
- Used extensively for power generation as well as heat
- Cleanest of all the fossil fuels
- Burns quite efficiently.
- Emits less CO₂ per unit energy.
- Can be used as an automotive fuel
- No waste (e.g. ash) or residue to deal with
- Can be used to makes plastics, chemicals, fertilizers and hydrogen

Cons (Disadvantages)

- Non-renewable fuel, supply cannot be replaced for millennia
- Emits carbon dioxide when burned
- Contains 80-95% methane, a powerful greenhouse gas.
- Explosive, potentially dangerous
- Concentrated sources require long distance transmission and transportation
- Requires extensive pipelines to transport over land

POSSIBLE REASONS FOR ENVIRONMENTAL DESTRUCTION

Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems and the extinction of wildlife. It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable.

1. Agricultural chemicals: Is defined as chemical agents such as fungicides and insecticides that are used to control crop-harming organisms (e.g., fungi, nematodes, mites, insects, and rodents) or viruses.

Agricultural chemical covers substances which are intended to destroy any pest or plant, repel or inhibit any pest, modify the physiology of a pest or plant, modify the effect of another agricultural chemical, or attract a pest for the purposes of destroying it.

An agricultural chemical: Is an agricultural compound that is applied directly to or on plants for one or more of the purposes listed in the Agricultural Compounds and Veterinary Medicines. Agricultural chemicals range from herbicides to plant growth regulators.

Agricultural compound: Is any substance, mixture of substances, or biological compound, used or intended for use in the direct management of plants and animals, or to be applied to the land, place, or water on or in which the plants and animals are managed, for the purposes of:

- (a) managing or eradicating pests, including vertebrate pests; or
- (b) maintaining, promoting, or regulating plant or animal productivity and performance or reproduction; or
- (c) fulfilling special nutritional requirements; or
- (d) preventing or treating conditions of animals; or
- (e) Enhancing the effectiveness of an agricultural compound used for the treatment of plants and animals.

Agricultural chemicals are classified as follows by application target.

(a). Insecticides	Agents for controlling harmful insect pests that damage field crops.
(b). Fungicides	Agents for controlling diseases that damage field crops.
(c). Insect-fungicides	Agents that simultaneously control harmful insect pests and diseases that damage field crops.
(d). Herbicides	Agents for controlling weeds
(e). Rodenticides	Agents for controlling rats and other rodents
(f). Plant growth regulators	Agents to promote or inhibit the growth of field crops.
(g). Attractants	Agents that attract mainly harmful insect pests by odor or other means.
(h). Repellents	Agents for having repellent action on harmful mammals and birds that damage field crops.
(i). Spreaders	Agents that are mixed with other agricultural chemicals to enhance the adherence of these chemicals.

Environmental problems of agriculture are due to:

The environmental impact of agriculture varies based on the wide variety of agricultural practices employed around the world.

- Land erosion and Salinity converting the arable land into non-agricultural uses.
- Runoff of pesticides and similar agricultural chemicals
- Water-borne diseases
- Loss of arable land to other uses.
- Animal-based agriculture cause air pollution, water pollution and greenhouse gas emissions.
- Inappropriate land use, soil mismanagement.

2. Damping of solid and liquid industrial wastes on the land and into water

Industrial waste is a type of waste produced by industrial activity, such as that of factories, mills and mines. It has existed since the outset of the industrial revolution.

Solid waste: All solid waste generated from an industrial or manufacturing process and solid waste generated from non-manufacturing activities, such as service and commercial establishments.

Industrial solid waste does not include office materials, restaurant and food preparation waste, discarded machinery, demolition debris, municipal solid waste combustor ash or household refuse.

The following problems are generally encountered in cities and towns while dealing with industrial solid waste.

- There are no specific disposal sites where industries can dispose their waste;
- Industries are located in non-conforming areas and as a result they cause water and air pollution problems besides disposing solid waste.
- Industrial estates (land) located in city limits do not have adequate facilities so that industries can organize their collection, treatment and disposal of liquid and solid waste.

Waste Water: Is any water that has been adversely affected in quality by anthropogenic influence. It comprises liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture and can encompass a wide range of potential contaminants and concentrations.

Industrial waste means any liquid, gaseous, or solid waste substance resulting from any process of industry, manufacture, trade, or business, or from the development, processing, or recovery of any natural resource, together with such sewage as is present.

Waters of the state means all streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and other bodies or accumulations of water, surface and underground, natural or artificial, regardless of the depth of the strata in which underground water is located, that are situated wholly or partly within, or border upon, this state, or are within its authority, except those private waters that do not combine or effect a junction with natural surface or underground waters.

Disposal of wastewaters from an industrial plant is a difficult and costly problem. Other Industrial processes that produce a lot of waste-waters such as paper and pulp production has created environmental concern leading to development of processes to recycle water use within plants before they have to be cleaned and disposed of.

Waste water (OIL SPILL)

An oil spill: Is the release of a liquid petroleum hydrocarbon into the environment, especially marine areas, due to human activity, and is a form of pollution. The term is usually applied to marine oil spills, where oil is released into the ocean or coastal waters, but spills may also occur on land.

Oil spills may be due to releases of crude oil from tankers, offshore platforms, drilling rigs and wells, as well as spills of refined petroleum products (such as gasoline, diesel) and their by-products, heavier fuels used by large ships such as bunker fuel, or the spill of any oily refuse or waste oil.

Note: *Cleanup and recovery from an oil spill is difficult and depends upon many factors, including the type of oil spilled, the temperature of the water (affecting evaporation and biodegradation), and the types of shorelines and beaches involved. Spills may take weeks, months or even years to clean up.*

ENVIRONMENTAL EFFECTS OF OIL SPILLS

Oil spills have affected many people and many industries. They affect both the economy and the environment. Some of the things affected are:

- * Marine life
- * Local industries (often tourist industry)
- * Fishing industry

Effect on marine life

People immediately think of birds and fish as being species affected by an oil spill

- * Oil penetrates and coat feathers of seabirds and the fur of mammals, reducing its insulating ability, and making them more vulnerable (weak) to temperature fluctuations. That is, making them unable to fly and insulate from the cold.
- * Oil can impair a bird's ability to fly, preventing it escaping from predators.
- * Oil can also blind an animal, leaving it defenseless.
- * The ingestion of oil causes dehydration and impairs the digestive process.
- * Animals can be poisoned, and may die from oil entering the lungs or liver.

Effect on local industries

- * Oil, dead fish and birds all get washed up on the shores and the oil interferes in activities such as fishing, sailing, and swimming.

The local tourist industry suffers because tourists are not interested in coming to a coastal area where they cannot do the activities as listed above.

Effect on fishing industry

The fishing industry suffers badly when an oil spill occurs, because the fish are often covered in oil, or have swallowed oil making them poisonous.

- * Also a large number of fish die, decreasing the number of fish that could have possibly been caught.
- * It is also difficult for boats to sail because the oil can damage them and the devices they use to catch the fish.

3. Opening up gaseous effluents from industry into the air.

Effluent: Is an out flowing of water or gas from a natural body of water, or from a human-made structure.

Effluent: Is defined as wastewater treated or untreated that flows out of a treatment plant, or industrial outfall.

Generally refers to wastes discharged into surface waters.

Most of the air emissions from commercial and general industrial facilities originate with the fuel used for heating purposes or for generating steam for process purposes. Concentrations of contaminants emitted from the stacks of significant sources such as boilers, furnaces, incinerators, and electrical generating equipment, should not exceed the limits presented.

ENVIRONMENTAL POLLUTION

Environmental pollution: Is the contamination of the environment with harmful (toxic and poisonous) substances due to certain natural phenomena and human activities.

Environmental pollution: Is the direct or indirect changes as a result of human activities, which adversely influence the biological and non-biological equilibrium of the environment.

Environmental pollution, in general, may be described as the contamination of the environment with harmful wastes arising mainly from human activities. These activities release certain materials which produce pollution in the atmosphere, water and soil.

The environmental pollution may be caused by:-

- *Chemical agents (gases, pesticides, particulates),
- * Physical agents (heat, noise, radiation), or
- * Biological agents (micro-organisms)

Pollution refers to the introduction of harmful or undesirable substance to the environment (i.e. the act of making air, water and soil unfit for use). Or

Pollution is the contamination of Earth's environment with materials that interfere with human health, the quality of life, or the natural functioning of ecosystems (living organism and their physical surroundings).

Pollution produces adverse effect on living as well as non-living materials. For example, it can:

- (i) cause illness or even death in case of humans and animals.
- (ii) retard the growth of plants and may cause them server injury.
- (iii) result in corrosion of metals, marble and decolorize paints

The effects of pollution are increasing at an alarming rate and if the same are not checked and controlled, they will pose a serious threat to human existence and habitat.

Common terms frequently used in the study of environmental pollution:

1. Pollutant: Is defined as anything which is in a wrong place, time, and concentration and which interferes with normal life activities.

Pollutant: Is any substance or species produced either by a natural source or by human activity, which produces adverse effect on the environment. Pollutant can be chemical substances or energy in the form of sound (noise), heat or light.

- * *The name pollutant is given to a substance which is already present in nature but human activity increase its concentration beyond undesirable limits so that it becomes harmful to natural environment.*
- * *It is not necessary that the pollutant will cause damage only at its place of generation. The pollutants get transported from one place to another by air, water or are dumped on the land by the man.*
- * *Pollutants are quite often thought be highly toxic substance only, but even the substances that are normally considered harmless can cause pollution if they are present in undesirable concentrations or in wrong places at the wrong time. For example, nitrates are added to soil to increase plant growth but excessive concentration of nitrates in drinking water can be toxic.*

There are two main categories of pollutants.

- (a) **Biodegradable pollutants** are materials, such as sewage, that rapidly decompose by natural processes. These pollutants become a problem when added to the environment faster than they can decompose.

That is, they become harmless after their natural destruction, and they cause no permanent harm if dispersed and treated adequately. Examples disposal wastes, leaves, rotten food.

- (b) **Nondegradable pollutants** are materials that either do not decompose or decompose slowly in the natural environment. Once contamination occurs, it is difficult or impossible to remove these pollutants from the environment.

Undegradable pollutants include heavy metals, pesticides and herbicides, plastics, glass, and they accumulate in the environment and in food chains, especially in the tissue of animals at a high concentration.

*For example, molecules of toxic compounds may collect on the surface of aquatic plants without doing much damage to the plants. A small fish that grazes on these plants accumulates a high concentration of the toxin. Larger fish or other carnivores that eat the small fish will accumulate even greater, and possibly life-threatening, concentrations of the compound. This process is known as **bioaccumulation**.*

The effects of these pollutants may be immediate or delayed.

- (i) **Primary effects of pollution** occur immediately after contamination occurs, such as the death of marine plants and wildlife after an oil spill at sea.
- (ii) **Secondary effects of pollution** may be delayed or may be persisted in the environment into the future, perhaps going unnoticed for many years.

*These secondary effects, publicized as **Silent Spring**, threatened the survival of species due to the hidden effects of nondegradable chemical compounds.*

- 2. Contaminant** is a substance which does not occur in nature but is introduced in significant amount into the atmosphere by human action or accidentally. It may or may not be harmful to the living organism or non-living component.

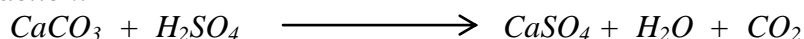
Note: *The contaminant is classified as pollutant when it has some harmful effect. For example, in Delhi, pyrosulphuric acid ($H_2S_2O_7$) leakage from a defective tank killed many persons and caused skin and breathing problems to many others. Since pyrosulphuric acid does not occur in the atmosphere, so it is a contaminant. But because of its dangerous effect, it is also regarded as a pollutant.*

- 3. Source:** Is the site from which the pollutants or contaminants originate.

The source is particularly important because its knowledge helps us to develop the methods to eliminate pollutants.

- (a) **Point-source pollution** comes from specific, localized, and identifiable sources, such as sewage pipelines or industrial smokestacks, oil spills into the water bodies.
- (b) **Nonpoint-source pollution** comes from dispersed or uncontained (uncontrolled) sources (sources that cannot be precisely identified), such as contaminated water runoff from urban areas (or fertilizer from a field is carried into a stream) or automobile emissions or mining operations.

- 4. Sink:** Is the material or medium which consumes or interacts with a long lived pollutant. *For example, a marble wall acts as a sink for atmospheric sulphuric acid because of the reaction:*

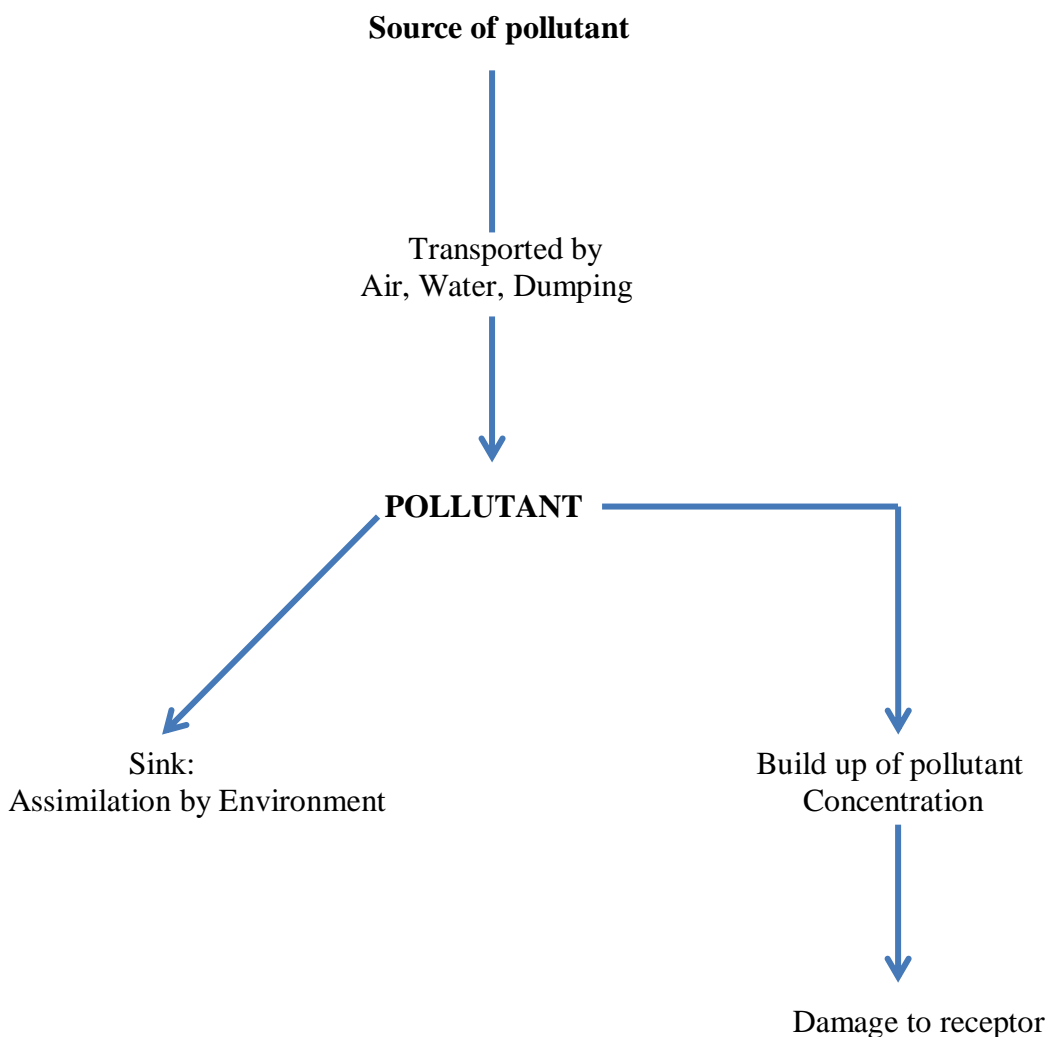


Similarly, the oceans act as sink for atmospheric carbon dioxide and other water soluble gases. Ground water and subsoil water also act as sinks for pesticides used in agriculture.

- 5. Receptor:** Is anything that is affected by the pollutants. For example, human beings are the receptor of photochemical smog which causes irritation in the eyes and also breathing problems.

- 6. Pollution process:** Is the mechanism from generation of any pollutant to the damage caused by it. The environmental pollution process may be summarized as follows.

A pollutant originates from source and gets transported by air or water or it is dumped by humans on land. Some of the pollutants may be assimilated (absorbed) or chemically changed by the environment while the rest build up their concentrations slowly and gradually and become harmful to the environment. This has been shown in the flow sheet below;



TYPES OF POLLUTION

Pollution exists in many forms and affects many different aspects of Earth's environment.

There are **three main types of pollution**. These are:

1. Terrestrial (land) pollution
2. Water pollution
3. Air pollution

1. AIR POLLUTION

Air pollution is the presence of any foreign substances in the atmosphere that are harmful to man, animals, vegetation, and buildings.

Air pollution may thus, be referred to as any condition in which the chemical substance already present in air or those which are added or formed in air, gradually build up their concentration in the atmosphere to such extent that is undesirable and produce harmful effects on man and his environment.

*Air in the atmosphere is not pure and clean. It contains many chemical substances which arise because of natural or human activity. **Natural sources:** Include volcanic eruptions, suspended particles or hot springs. **Human made sources:** Include industries, combustion of fuels, deforestation, and chemical substances.*

In general, the air pollutants can be divided into two categories:

(i) Primary pollutants: These pollutants are emitted directly from the sources and remain as such after they enter the environment.

Some examples are: particulate matter such as smoke, ash, dust, fumes, etc., inorganic gases such sulphur dioxide, carbon monoxide, hydrogen sulphide, nitric oxide, ammonia, hydrocarbons and radioactive substances.

(ii) Secondary pollutants: These pollutants are formed in the atmosphere or hydrosphere by chemical interactions among primary pollutants and normal atmospheric constituents.

Some examples are; sulphur trioxide, nitrogen dioxide, aldehyde, ketones, ozone, various sulphate and nitrate salts. The chemical reactions in the atmosphere which convert primary pollutants into secondary pollutants may be oxidation, dissolution, and dissociation.

Primary pollutants	Process in Atmosphere	Secondary pollutant
SO ₂	———— Oxidation —————>	SO ₃
NO ₂	———— Decomposition —————>	NO + ½ O ₂
SO ₂ + H ₂ O	———— Dissolution —————>	H ₂ SO ₃
SO ₃ + H ₂ O	———— Dissolution —————>	H ₂ SO ₄

Major air pollutants

Major air pollutants can be divided into two categories, namely: gaseous pollutants and particulates pollutants.

- ❖ Carbon monoxide and Carbon dioxide (CO₂)
- ❖ Sulphur dioxide
- ❖ Oxide of nitrogen (NO, NO₂)
- ❖ Ozone (O₃)
- ❖ Hydrogen sulphide (H₂S)
- ❖ Particulate pollutants (Finely divided solid particles or liquid droplets suspended in air). Particulates in the atmosphere, may be viable or non-viable)
- ❖ Hydrogen sulphide

Causes of air pollution

- (i) Air pollution is caused by industrial emission of fumes and gasses into the atmosphere due to burning of coal or oil. Pollutants in air are gasses like sulphur dioxide, nitrogen dioxide, dinitrogen oxide, methane, carbon monoxide, carbon dioxide, chlorofluorocarbons from industries, machines, and exhaust pipes.
- (ii) Atmospheric dusts i.e. fine particles of clay or limestone.
- (iii) Black soot and smoke from factories.
- (iv) Burning of biomass, fossil fuels, and deforestation.

Effects of air pollution

1. *Reduced visibility*; particulate (finely divided solid particles or liquid droplets suspended in air), (smog) cause scattering and absorption of sunlight and reduce visibility. They also produce blurring effect on vision; the reduced visibility is dangerous practically for aircraft and motor vehicles drivers.
2. *Health problems*; the health effects caused by air pollutants include difficulty in breathing, wheezing and coughing.
 - NO, may be incorporated into hemoglobin in the blood to interfere with the transport of oxygen around the body. In addition, it may cause cellular inflammation at very high concentrations.
 - NO₂, -irritate (inflammation of lung tissues) lungs; –has irritating effects on mucous membrane and higher doses of NO₂ may cause bronchitis and respiratory infection such as influenza.
 - CO enters the red blood corpuscles (RBC) and binds itself to hemoglobin, thereby replacing oxygen. Thus CO causes obstruction in the normal functioning of blood that further produces disorders in normal metabolism due to less O₂ level. The presence of *CO in blood can cause mental retardation, respiration problems, muscular weakness, dizziness (faintness), and even death depending on its concentration in blood.*
 - SO₂, causes cough, shortness of breath and spasm of larynx (voice box). It also causes acute irritation to the membrane of eyes resulting tears and redness.
 - O₃, has negative effect to living things such as skin cancer and cataracts and also reduce the ability of immune systems to respond to infection.
3. *Acid rain*; -damages forests and corrodes many ancient buildings and sculptures (monument) made of marble. –Weakens tree health and make them susceptible to pest and disease. –Kills fingerlings in aquatic bodies. Indirect toxicity release of aluminium from soil, Al³⁺ increase leaching of K⁺, Mg²⁺ and Ca²⁺ -Corrosion of exposed metallic structures.
4. *Depletion of the ozone layer*; the consequences of continued depletion of the ozone layer would be dramatic harmful radiation from the sun reaches the earth.
5. *Global warming*; which is caused by greenhouse gases.
6. Production of unpleasant or offensive odours.
7. Cause change in the climate of the earth.
8. *Effects on plants*; particulates get deposited on the leaves of the plants thereby blocking the stomata and retarding the transpiration of minerals from the soil. They also, hinder the intake of CO₂ from the air thereby causing obstruction in photosynthesis process.
9. *Effects on materials*; the adverse effects of particulates on materials include corrosion of metals (when the atmosphere is humid), erosion and soiling of buildings, sculptures and painted surfaces and soiling of clothes and draperies.

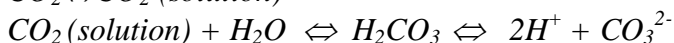
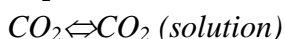
Methods of preventing air pollution.

Air pollution can be controlled either at source or at the dispersal stage of various pollutants. Although, the problem of controlling air pollution at source is not easy, yet it can be reduced to some extent.

1. Strict laws should be enacted; environmental laws that ensure all chemical wastes, whether solid, gaseous, or liquid, are disposed off safely should be enacted. Vehicles and industries, which emit a lot of pollutants (toxic gasses), should not be allowed to operate.
2. Modification and improvements in internal combustion engine. They should not produce smoke or carbon monoxide.
3. Reducing over-dependence on fossil fuels (Use of other fuels); clean uses of energy include solar energy, wind energy and hydroelectric power. The use of other fuels such as CNG (Compressed natural gas), LPG (Liquefied petroleum gas), and LHG (Liquefied hydrogen gas) which are almost pollution free.
4. Alternative power sources (Using fuel-efficient systems); a large proportion of air pollutants come from power generation plants, especially those that use coal or petroleum fuels. Reducing energy consumption by using energy saving appliances would therefore help reduce emission.
5. Use of anti-pollution exhaust catalyst (finely divided platinum); automobile exhaust can be treated with an anti-pollution catalyst before discharging into atmosphere.
6. Careful storage of atomic bomb and atomic reactors to avoid bomb blasting.
7. Encourage planting many trees, grasses and conserving the available forests or vegetation's. Trees reduce carbon dioxide concentration in the atmosphere by photosynthesis.
8. Efforts should be made to reduce the use of CFCs and instead get substituent for the same use.

ACID RAIN: *Is the rain having the pH less than 5.7 due to reaction with acidic gases (SO_2 , NO_2) rather than CO_2 . Acid rain is very common in developed world (Europe, Korea, Japan, and USA). The oxides combine with water vapor in the air to form acids, which return to the ground as acid rain.*

- CO_2 react with water



- Acid rain has the following damaging effects:

- Damages the nutrition level of leaves of the plants.
- Lead to loss of soil fertility
- Harms the aquatic life, viz., it kills fish.
- Promotes corrosion. It damage building, iron bridges, statues, and it may also corrode water supply pipes results in contamination of the drinking water.

SMOG: *Urban air pollution is commonly known as smog. The word "Smog" is obtained from the combination of the words 'smoke' and 'fog' caused by vehicle exhaust gases and industrial smoke.*

- As the smog, ages and reacts with oxygen, organic and sulfuric acids condense as droplets, increasing the cloud (mist). Smog, a mixture of smoke (particulates) and fog; irritates the eyes, throat, lungs and damages plants.
- **Photochemical smog:** *Is the chemical reaction of sunlight with oxides of nitrogen and volatile organic matter in the atmosphere. It is particularly harsh form of smog, is created when sunlight generates (cause) a chemical reaction between the unburned hydrocarbons and the oxides of nitrogen in automobile exhaust.*

TERRESTRIAL (LAND) POLLUTION

Land pollution: refers to the dumping of waste materials onto the land thereby lowering its quality and bringing unhealthy condition to man and other animals.

Land pollution: Is the dumping of dead materials on the land to make it dirty, inhabitable, and undesirable for supporting life.

That is the deposition of undesirable materials on the land surface and soil, such as empty cans, scrap(piece) metals, plastic containers, rotten organic matter, glass and plastic paper/bags and unwanted chemicals (like insecticides).

Land pollution: Is defined as the degradable of the earth's land surface through human activities. *These activities include poor agricultural practices, mineral exploitation, industrial waste dumping, and urban waste disposal.*

Causes of terrestrial pollution

*Pollution in the soil has adverse effect on the plant growth. Any factor that deteriorates the quality, texture, and mineral content of the soil or disturbs the biological balance of the organisms in the soil is referred to as **soil pollutant**.*

1. Use of agricultural pesticides; pesticides are substances which are used to kill or block the reproduction processes of unwanted organisms.
2. Use of chemical fertilizer in the soil; fertilizer contaminate the soil with impurities which come from the raw materials used for their manufacture. For instance, As, Pb, and Cd present in traces in rock phosphate mineral transferred to superphosphate fertilizers
3. Oil spillages that seep (leak) into the soil.
4. Deforestation; it results in floods and cause soil erosion. During the past few years quite a vast green land has been converted into deserts.(Thar desert in India)
5. Mining; this results in the production of solid waste in form of overburden, waste rock, and heap leach spent ore.
6. Industries; these produce solid chemical waste.
7. Sewage (manure) treatment plants; these produce solid waste in the form of biomass sludge and settled solids.
8. Solid fuels; these produce ashes, the residual matter that remains after solid fuels are burned.
9. Nuclear plants; produce nuclear waste, this is the radioactive waste from nuclear reactors and nuclear bomb production.
10. Garbage disposal; this comprises of waste matter from foods that are degradable and other waste matter that is not degradable, such as glass, metal, cloth, plastic, wood and paper.

Effects of land (terrestrial) pollution

- a) Soil erosion and use of fertilizers spoil the quality of soil.
- b) Industrial waste (radioactive waste and other waste) have lethal effects to man.
- c) Chemicals like DDT may kill soil organism directly or they may disrupt (disturb) their natural environment resulting into their death.
- d) It reduces amount of land available for useful purposes such as agriculture and settlement.
- e) Decaying waste attract household pests. This makes homes and other places unhealthy, dirty, and unpleasant places to reside in.
- f) The heaps (loads) of garbage on land make it dirty and uninhabitable (not fit to live in).
- g) Treating the soil with chemical fertilizers, pesticides, and fungicides interferes with the natural processes occurring within the soil and destroys useful organisms such as bacteria, fungi, and other microorganisms.

- h) Most types of solid waste matter are not biodegradable, which means they cannot be broken down by the action of microorganisms. They therefore remain in the environment for long, in this way; they pose a health threat to people and other living organisms. For instance,
- ⇒ Empty cans, glass, and plastic containers keep water in which mosquitoes breed and spread malaria.
 - ⇒ Plastic bags if swallowed by animals cannot be digested and thus lead to death.
 - ⇒ Dirty water from bathrooms is a source of several diseases like cholera if allowed to flow into the roads and streets.
 - ⇒ Broken glass may cut your bare foot and introduce disease germs like tetanus.

Methods of preventing terrestrial pollution

- (a) Recycling and re-use; recycling is the collection, sorting and processing of solid materials into usable raw materials instead of discarding them as waste. Materials such paper, glass and some kinds of plastics can be recycled.
Expanding recycling programs worldwide can help reduce solid waste pollution, but the key to solving severe solid waste problems lies in reducing the amount of waste generated. Waste prevention, or source reduction, such as altering the way products are considered or manufactured to make them easier to reuse, reduces the high costs associated with environmental pollution.
- (b) The use of fertilizers can be reduced by applying bio-fertilizers and manures. Biological methods of pest control can also reduce the use of pesticides and thereby minimize soil pollution.
- (c) Practicing good methods of farming, control of land loss can be attempted through restoring forest and grass cover to check soil erosion and flooding. Crop rotation mixed cropping and a forestation can improve the fertility of the land.
- (d) Proper methods should be adopted for the disposal of solid wastes. The simplest and most widely used technique of solid waste management is to bury the waste in locations situated away from residential areas. Acidic and alkaline waste should be first neutralized.
- (e) Mining activities should be followed by infilling the pits.
- (f) Formulating and enacting policies and laws, strict laws should be enacted to protect the third world countries against becoming a dumping place. Leaders who sign the importation of pacts for industrial toxic wastes should be dealt accordingly.
- (g) Urban authorities should construct free flowing sanitation (hygiene) system.
- (h) All solid rubbish should be kept in containers or tanks prior to collection.
- (i) Using designated dumping sites, urban waste should only be discarded in designated sites to control the problem of littering. Some of the methods that can be used to treat urban waste include incineration and recycling.
- (j) Using biodegradable plastics; these include
- ⇒ Photodegradable plastics, which break down on being exposed to light.
 - ⇒ Soluble plastics, which can be broken down by water.
- (k) Creating awareness, the public should be educated on the importance of keeping the environment clean. This should be done in schools, colleges, market places and any other appropriate forums. The mass media such television, radio and newspapers can also be used to educate the people on environmental issues.

WATER POLLUTION

Water constitutes about 80% of the earth's surface. The part of the earth, which comprises water, is called hydrosphere. Survival of plants is not possible without water. Water in abundance is required for domestic use, agricultural activities, and industries. Human activities have polluted much of this limited quality of water, and rain water on its way down to earth also brings number of air pollutants that mix with water on the ground and pollute it.

Water pollution refers to the presence of any foreign substance (organic, inorganic, radioactive, or biological) in water, which produces harmful effect and decrease the usefulness of water.

Water pollution is the contamination of water (is the introduction of substance that lower quality of water) into the water sources such as oceans, rivers and lakes by addition of pollutants that bring harm to aquatic life and cause to be unsafe for human use.

Causes of water pollution

1. Pesticides; that are applied on highlands are washed out into rivers by rain water. Many of them contain highly poisonous chemicals that accumulate and disturb food chain. They can also drain down into groundwater, these contaminate the water, affecting the living organisms in the water and making water unsafe for drinking.
2. Acid rainfall into the water.
3. Dusts and other air pollutants introduced into the water by wind.
4. Infectious or disease causing agents; these are the various pathogenic micro-organisms which may enter the water along with sewage or other waste. These microbes (mainly bacteria and viruses) can cause various diseases such as cholera, typhoid, dysentery, polio, hepatitis etc.
5. Oil spills; oil and oil wastes enter rivers and other water bodies from different sources such as oil refineries, storage tanks, automobile waste oil, petro-chemical plants, and industrial effluents. Normal taker operations and spillage from oil tanker accidents cause marine pollution and shore contamination.
6. Marine debris; is the trash (rubbish) in the ocean. The debris mainly comes from urban waste and garbage thrown overboard from the ships and boat.
7. Plant nutrients; the presence of plant nutrients in lakes and slow moving waters supports high populations of aquatic plants which on decay produce disagreeable (unpleasant) odour. Beside this, these plants also produce dissolve oxygen (DO) making the survival life problematic. The enrichment of water by nutrients is known as ***eutrophication***.
 - ❖ ***Eutrophication*** clogs or stops water ways and blocks light from penetrating into the deeper waters.
 - ❖ Most of the biological activity in the oceans (and all of the photosynthesis) takes place in the near-surface waters through which sunlight penetrates; the so called ***photic zone***.
8. Air pollution; it contributes substantially to water pollution. Pollutants like mercury, sulphur dioxide, nitrogen oxides, and ammonia can get into the water bodies from air. This can cause problems like mercury contamination in fish, acidification of lakes and eutrophication. Most of the air pollution that affects water comes from coal-fired power plants, vehicle exhaust fumes, and industrial emissions.
9. Radioactive waste; in the industrialized nations, radioactive waste are disposed off by putting them in tanks and deeping them in deep oceans. When the containers corrode, chances are that the radioactive materials will be spread by ocean currents. This will affect the aquatic life and human beings.
10. Mining

11. Domestic wastes; man's sewage and waste dumped into rivers causes bad smell and diseases. Some types of soap and detergents are not easily broken down by bacteria. When the detergents are washed into the drains and finally into water bodies, they form foam over the water surface. Detergents containing phosphate increase biological oxygen demand (BOD) of river water because they support the rapid growth of algae and other aquatic plants.
12. Inorganic minerals and chemical compounds; these include various metals and metallic compounds released from human activities or from natural minerals. These pollutants enter water bodies from municipal and industrial waste and mine run off. The acid-rain consisting sulphate and nitrate ions make the water acidic. Heavy metals such as cadmium, mercury, chromium, lead, and silver are toxic.
13. Suspended solids and sediments; suspended solids in water are mainly sand, silt and minerals eroded (erosion is the wearing away of topsoil by wind and rain) from the land. The eroded sediments were deposited nearby streams, rivers, and lakes, thus reduce their water storage capacity. The suspended particles in water bodies also block the sunlight required by bottom vegetation for the photosynthesis and thus reduce the availability of food to fish.
14. Sewage and other oxygen demanding waste; sewage from municipalities and other oxygen demanding waste from industry and agriculture comprise of organic matter, which undergoes oxidation in rivers under the action of micro-organisms. Thus, sewage and other oxygen-demanding wastes become water pollutants on two accounts;
 - ❖ They give rise to compounds that have an extremely offensive odour.
 - ❖ They deplete the dissolved oxygen (DO) from water, which is rendered harmful because water devoid of dissolved oxygen cannot sustain aquatic life. It affects or even kills fish and other aquatic living beings.

NOTE: - *Waterborne chemical pollution entering rivers and streams comes from two major sources: point pollution and nonpoint pollution.*
- *It is estimated that each year 10 million people die worldwide from drinking contaminated water.*

Effects of water pollution

- 1) Waterborne disease; human infectious are among the most serious effects of water pollution. Waterborne diseases occur when parasites or other disease causing microorganisms are transmitted through the contaminated water. Contaminated water also facilitates the spread of intestinal parasites such as roundworms and hookworms. The diseases include typhoid, cholera, and dysentery. Polluted beach water can cause rashes, respiratory infections, diarrhea, vomiting and stomach aches.
- 2) Leads to death of aquatic creatures due to toxic chemicals in the water and oil spill.
- 3) Thermal pollution; fish and other water organisms are adapted to a particular temperature range. Rise in the water temperatures can kill the organisms through thermal shock. Excessive heat may disrupt spawning or kill young fish. Warmer temperatures lower the amount of oxygen dissolved in the water.
- 4) Exposure to mercury in unborn babies can result in delayed or incomplete mental development, autism, and brain damage.
- 5) Leads to change in colour and taste of water.
- 6) Nitrate from fertilizers, phosphate contained in detergents, fertilizers and sewage encourage the over growth of algae that increase the Biological Oxygen Demand (BOD) in the river where most of oxygen is used up and fish die of suffocation.
- 7) Suspended solids may exert oxygen demand and complicates drinking water treatment.

Methods of preventing water pollution

1. Too much use of pesticides, which are not biodegradable, should be avoided. These are highly toxic substances.
2. Radioactive waste should be buried in the land and not in oceans.
3. Stopping deforestation; forests act like a sponge soaking up the rains, holding the water and filtering it before it makes its way to nearby water bodies. Clearing the forests affects this cycle.
4. Septic tanks should be for each house. This will reduce the flow of municipal sewage and human excreta into river, lake, or pool.
5. Education should be given to the people about the importance of protecting the environment.
6. Oil ship tankers should be checked thoroughly before transportation to rule out leakage and spillage.
7. Cleaning up existing and abandoned mines, new mines should not be established in areas where they are likely to cause water pollution problems. In addition, mining companies should clean up abandoned mines, which continue to release pollutants.
8. Controlling coastal development, building structures near the shores contributes greatly to water pollution. Most of the waste from these establishments is disposed of into the nearby water body.
9. Treating sewage and industrial waste.
10. Reducing mercury emissions.
11. The waste should be recycled instead of dumping in the water.
12. Strict laws should be enacted and enforced to control the disposal of toxic industrial wastes and effluent.
13. Control measures should be taken to protect the introduction of heavy metals into water bodies.

OTHER TYPES OF POLLUTION

Hazardous wastes are solid, liquid, or gas wastes that may be deadly or harmful to people or the environment and tend to be persistent or non-degradable in nature. Such wastes include toxic chemicals and flammable or radioactive substances, including industrial wastes from chemical plants or nuclear reactors, agricultural wastes such as pesticides and fertilizers, medical wastes, and household hazardous wastes such as toxic paints and solvents.

Noise pollution is pollution due to introduction of harmful unwanted sounds in the environment, which may affect human being physically or psychologically. Unwanted sound, or noise, such as that produced by airplanes, traffic, or industrial machinery, is considered a form of pollution. Noise pollution is at its worst in densely populated areas. It can cause hearing loss, stress, high blood pressure, sleep loss, distraction, and lost productivity.

Solutions to noise pollution include adding insulation and sound-proofing to doors, walls, and ceilings; using ear protection, particularly in industrial working areas; planting vegetation to absorb and screen out noise pollution; and zoning urban areas to maintain a separation between residential areas and zones of excessive noise.

Thermal pollution: Is made when waste-heat (as hot water) passed river/lake, usually by industries. It disturbs the erosion and increases the activity of oxygen demanding bacteria.

OZONE LAYER AND ITS DEPLETION

Stratification of atmosphere

Atmosphere absorbs most of the cosmic rays from outer space and protect earth surface from their effect. Unfortunately, atmosphere is used as a dumping area for many gaseous pollutants that affect the living organism. In order to understand the role of ozone layers it is quite reasonable to know about the different layers of the atmosphere and temperature distribution among them.

On basis of air temperature, the atmosphere can be divided vertically into different layers namely troposphere, stratosphere, mesosphere and thermosphere.

1. Troposphere

- The troposphere is the layer from the earth's surface and extends to about 10-15km altitude and its upper limit called **tropopause**.
- As altitude increases, air temperature decreases in this region.
- The fall in temperature is due to fall of pressure and density of air.
- Most of our weather occurs in the troposphere.
- Clouds and rain are formed within this region.

2. Stratosphere

- The stratosphere is the layer above troposphere and extends to about 50km.
- This is the region of ozone activity and is known as **ozonosphere**.
- The upper limit of this region is called **stratopause**.
- This is characterised by increase in temperature with increase in altitude.
- The rise in temperature is due to absorption u.v radiation by ozone present.
- Planes also fly in the stratosphere.

3. Mesosphere

- The mesosphere extends to about 80km in altitude.
- The temperature decreases rapidly with altitude.
- The upper limit of mesosphere is called **mesopause**.
- Most meteors burn while entering the earth's atmosphere.

4. Thermosphere

- The thermosphere is the layer above mesosphere.
- This region is characterized by continuous rise in temperature with altitude.
- The rise in temperature caused by absorption of uv solar radiation by N₂ & O₂.
- The lower part of the thermosphere contains **ionosphere**, the region contains high concentration of charged particles called ions and free electrons.
- The ionosphere plays important role in communications.

Characteristics of major layers of the atmosphere

Name of the layer	Height above the earth's surface(km)	Temperature range (°C)
Troposphere	0 – 11	15 to – 56
Stratosphere	11 – 50	- 56 to – 2
Mesosphere	50 – 85	- 2 to – 92
Thermosphere	85 – 500	- 92 to 1200

Note: *The troposphere and stratosphere are collectively known as the lower atmosphere.*

OZONE LAYER

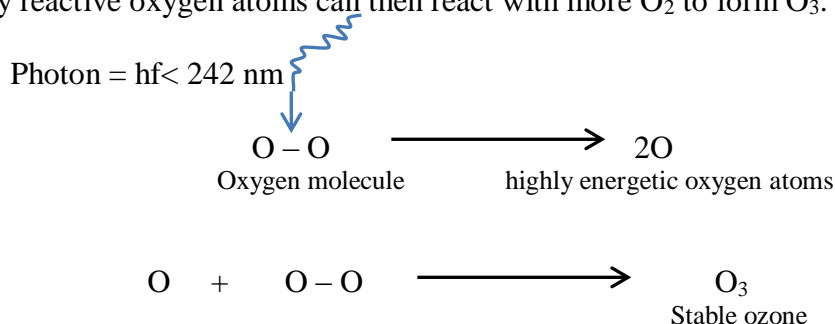
Ozone: An unstable, poisonous allotrope of oxygen having the chemical formula O_3 .

Ozone layer: Is a layer in the earth's stratosphere at an altitude of about 10 km (6.2 miles) containing a high concentration of ozone, which absorbs most of the ultraviolet radiation reaching the earth from the sun.

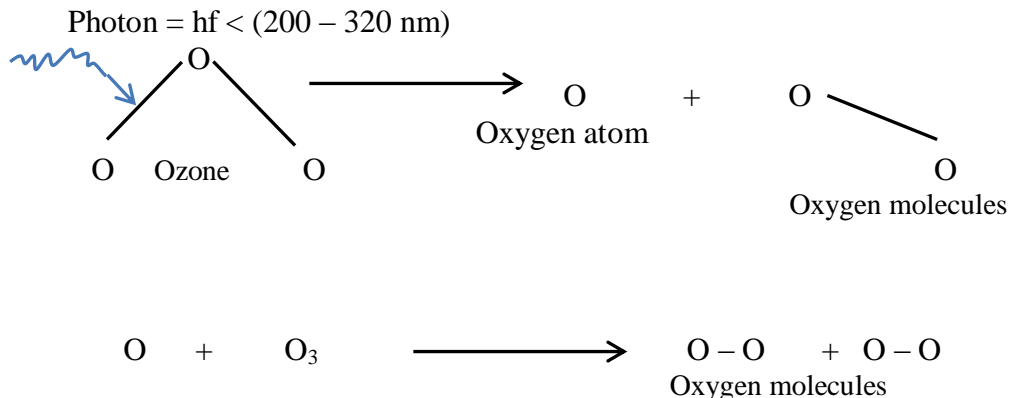
Ozone is a stable molecule composed of three oxygen atoms. While it is stable, it is highly reactive. Ozone layer in the atmosphere is very significant because it protect us from the harmful effect of ultraviolet radiations of sun.

Ozone formation and destruction in the stratosphere

- ♠ Ozone forms in the atmosphere through the process of photolysis, when ultraviolet radiation from the Sun strikes oxygen molecules (O_2), causing them to split apart. These highly reactive oxygen atoms can then react with more O_2 to form O_3 .



- ♠ In a similar way, ozone is destroyed by solar radiation. Ultraviolet radiation hits ozone and breaks it back down into molecular oxygen (O_2) and atomic oxygen (O). The oxygen atom O then reacts with another ozone molecule to form two oxygen molecules.



Chemical substances which lead to destruction the ozone layer

The rate at which ozone is being destroyed is much faster than the rate at which it is being formed.

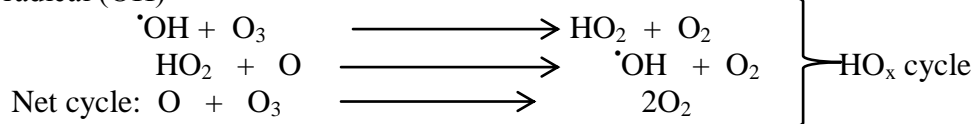
The important catalysts for stratospheric O_3 destruction are:

- Hydroxyl radical ($\cdot\text{OH}$)
- Chlorine and Bromine (Cl and Br)
- Nitrogen oxide (NO_x)

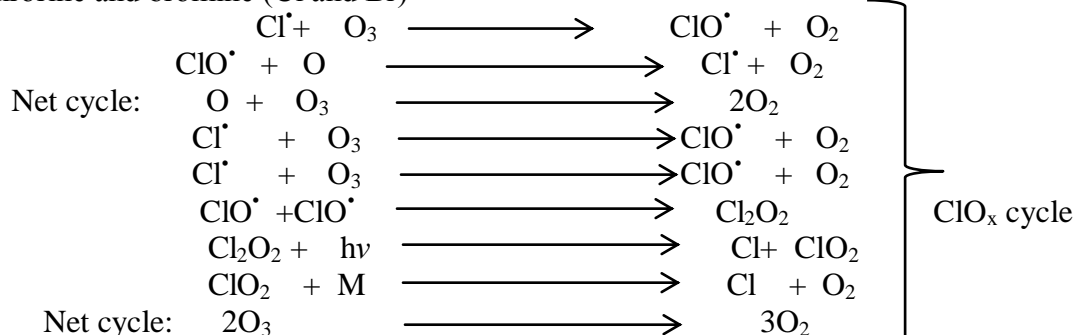
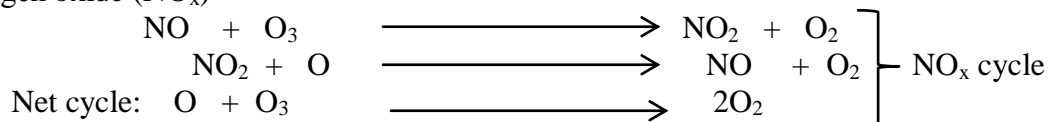
While there are natural sources for all of these species, the concentrations of chlorine and bromine have increased markedly in recent years due to the release of large quantities of man-made organohalogen compounds, especially chlorofluorocarbons (CFCs) and bromofluorocarbons.

Chemical reactions which lead to destruction of ozone layer

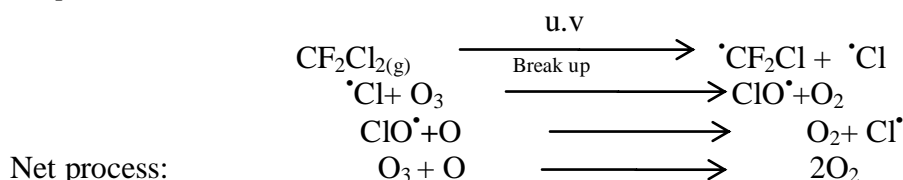
♠ Hydroxyl radical (OH)



♠ Chlorine and bromine (Cl and Br)

♠ Nitrogen oxide (NO_x)**NOTE:**

- ♠ The main sources of bromine and chlorine atoms in the atmosphere are: Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs); chemicals used in refrigeration, air-conditioning systems, cleaning solvents, and aerosol sprays—destroy the ozone layer. CFCs release chlorine into the atmosphere; chlorine, in turn, breaks down ozone molecules. Because chlorine is not affected by its interaction with ozone, each chlorine molecule has the ability to destroy a large amount of ozone for an extended period.



- ♠ CFC's find wide and varied applications due to their properties like non-corrosiveness, non-inflammability, low toxicity and high chemical stability.
- ♠ Once these CFC's enter the atmosphere by gradual evaporation from their source, they do not react with any substance due to their chemical inertness and thus cannot be eliminated from the atmosphere. They up float the atmosphere unchanged and eventually go to the stratosphere.

Termination reaction

For Cl: $\text{Cl}^\bullet + \text{CH}_4 \longrightarrow \text{CH}_3 + \text{HCl}$ Stable in stratosphere

For NO_x: $\begin{array}{l} \text{NO}_2 + \text{OH}^\bullet \\ \text{ClO}^\bullet + \text{NO}_2 \end{array} \longrightarrow \begin{array}{l} \text{HNO}_3 \\ \text{ClONO}_2 \end{array} \left. \vphantom{\begin{array}{l} \text{NO}_2 + \text{OH}^\bullet \\ \text{ClO}^\bullet + \text{NO}_2 \end{array}} \right\} \text{Inhibit the HO}_x \text{ and ClO}_x \text{ cycles}$

NO_x inhibit the HO_x and ClO_x cycles for O₃ destruction by removing radical species in the two cycles.

Ozone hole

Ozone depletion describes two distinct but related phenomena:

- (a) A steady decline of about 4% per decade in the total volume of ozone in Earth's stratosphere (the ozone layer), and
- (b) A much larger springtime decrease in stratospheric ozone over Earth's Polar Regions.

*The latter phenomenon is referred to as the **ozone hole**.*

- *Industrial chemicals released into the atmosphere have caused ozone to break down, opening holes in the ozone layer that tend to concentrate at the poles.*

Why is an ozone hole formed only above Antarctica and not over developed countries that emit a lot of CFCs?

1. Chlorofluorocarbon gases (CFCs) take six or seven years to move up to the stratosphere and the winds spread them all round the world.
2. Extreme cold, a freezing vortex wind, frozen stratospheric clouds and 6-month darkness over Antarctica all provide ideal conditions for chlorine to break from the CFCs.
3. The chlorine (and bromine) gases destroy the ozone during spring (Sept to Dec) and this is what causes the ozone hole.

Consequences of ozone layer depletion

Because of decreased concentration of ozone in stratosphere, the influx of UV radiation reaching the earth's surface would increase. The effects of ozone layer depletion are:

- Skin cancer (*melanoma*) increases in human due to exposure to UV radiation.
- Cataracts—a clouding of the eye's lens.
- Increased production of Vitamin D; vitamin D is produced in the skin by ultraviolet light. While, higher levels of Vitamin D are associated with higher mortality, the body has mechanisms that prevent sunlight from producing too much Vitamin D.
- Effects on crops; an increase of UV radiation would be expected to affect crops
- Plant proteins get affected by UV radiations that lead to the harmful mutation of cells. It also increases evaporation of surface water through the stomata of the leaves and decreases the moisture content of the soil.
- Aquatic animals and aquatic plants also get damaged by their excessive exposure to UV radiation. Ultra-violet radiation kills many micro-phytoplankton's and damages the fish productivity.
- Increased tropospheric ozone — Increased surface UV leads to increased tropospheric ozone. Ground-level ozone is generally recognized to be a health risk, as ozone is toxic due to its strong oxidant properties

Methods of protecting the ozone layer depletion

The most effective way of controlling the depletion of ozone layer is to ban the production and use of all ozone depleting substances. Less harmful substances should be used in place of the ozone-depleting substances.

Hints:

1. Check the freezer and car air-conditioning. If they do not function properly, have them repair because they may have leaks.
2. Avoid buying insulating material made up of CFC. Instead you can use dark chipboard cork that performs the same function and does not contaminate the environment.
3. Avoid buying and using sprays composed of chlorofluorocarbon (CFC).
4. Avoid using fire extinguishers with halogenated hydrocarbon since it is a very destructive substance for the ozone layer.
5. Encourage growth of plants that produce oxygen, discourage deforestation

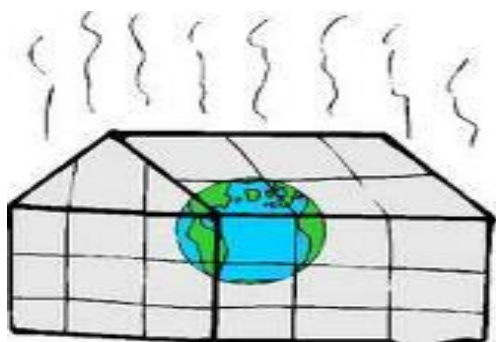
GREENHOUSE EFFECT AND GLOBAL WARMING

Introduction

The term greenhouse effect had its origin from the practice of encasing (covering or coating) vegetation in glass chambers to protect them from frost particularly in cold countries. It was observed that there was a continued rise in temperature in such chambers even when the outside temperature remained low. This enabled the warming up of the vegetation inside the chamber, resulting in good plant growth.

What happen in a typical greenhouse?

The transparent roof and wall of the glass chamber allow sun rays to pass through and heat up the soil and plants in the chamber. The warm soil and plants emits infra-red radiation. Since glass is opaque to IR radiations. It partly absorbs and partly reflects these radiations back to soil and plants. In this way, energy of sun remains trapped in greenhouse. This causes rise in temperature inside the chamber.



Glass, the material that greenhouse is made of,

- Transmit short-wavelength visible light.
- Absorbs and redirects the longer wavelengths of energy.

❖ *These two aspects make the greenhouse warmer than outside air temperature.*

Greenhouse effect of the atmosphere (around the earth)

Atmosphere around the earth acts like a glass of the greenhouse chamber

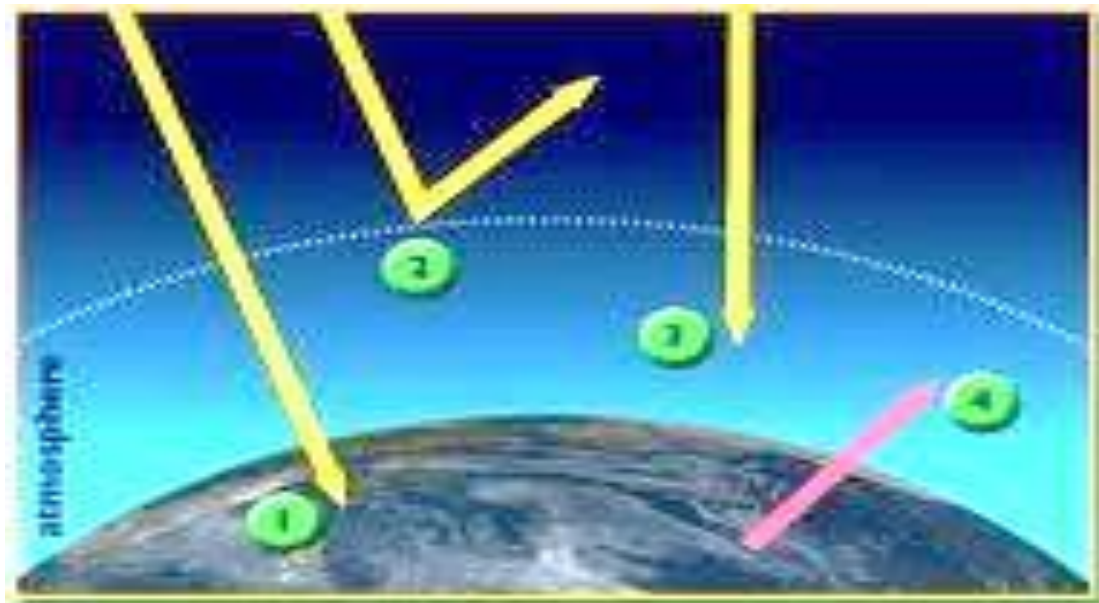
- Sunlight penetrates the atmosphere and warms the earth's surface.
 - Longer wavelength infrared radiation is radiated from the earth's surface.
 - A considerable amount of the outgoing IR radiation is absorbed by gases in the atmosphere and reradiated back to the earth.
- The atmosphere around the earth traps sun's heat near the earth's surface and keep it warm. This is called **natural greenhouse effect**, which is responsible in maintaining the temperature and making earth perfect for life.
 - The gasses present in the atmosphere which cause greenhouse effect (that act like a glass in a greenhouse) are referred to as **greenhouse gasses**.
 - When concentration of greenhouse gases rises, they trap more heat within the atmosphere, causing worldwide temperatures to rise.
 - The various greenhouse gasses are: Carbon dioxide, water vapours, chlorofluorocarbons, and dinitrogen oxide, out of these, the most significant role is played by CO₂. *The carbon dioxide strongly absorbs infrared and does not allow as much of it to escape into space.*
 - Without these gases, Earth would be a frozen planet with an average temperature of about -18°C (about 0°F) instead of a comfortable 15°C (59°F).

A greenhouse gas: (sometimes abbreviated **GHG**) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect.

Greenhouse effect: refers to circumstances where the short wavelengths of visible light from the sun pass through a transparent medium and are absorbed, but the longer wavelengths of the infrared re-radiation from the heated objects are unable to pass through that medium.

Greenhouse effect: Is a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, and is re-radiated in all directions.

Since part of this re-radiation is back towards the surface, energy is transferred to the surface and the lower atmosphere. As a result, the temperature there is higher than it would be if direct heating by solar radiation were the only warming mechanism.



Global warming is the increase in temperature of the earth's atmosphere, that is caused by increase of greenhouse gases especially carbon dioxide.

Global warming is referred to as gradual increase in the concentration of CO₂ and other greenhouse gases, has in turn increased the greenhouse effect and it poses serious threat to mankind as it leads to slow and gradual increase in temperature of the earth's environment.

MAJOR GREENHOUSE GASES

- ❖ H₂O
- ❖ CO₂
- ❖ CH₄
- ❖ O₃
- ❖ N₂O
- ❖ CFCs

Factors determine the contribution of a greenhouse gas to global warming:

1. Concentration: H₂O and CO₂ are the two biggest contributors to the atmospheric warming because of their higher concentrations.
2. Lifetime: The longer – live a gas is, the higher the contribution.
E.g. N₂O contribution > CH₄
3. Absorption capacity: Effectiveness as an infrared absorber. E.g. CFC – 11 and CFC – 12.

Sources of greenhouse gases

Sources of Carbondioxide:

- ❖ Natural: respiration of vegetation and soil detritus.
- ❖ Man-made:
 - ✓ Fossil fuel combustion, CO₂ is a byproduct in the combustion of fossil fuels such as petroleum. These fossil fuels are burned in cars, power stations, and industries.
 - ✓ Deforestation (Clearing and burning of vegetation).
 - ✓ Produced by other chemical reactions, (e.g. manufacture of cement).

Sink of CO₂: Slow exchange of carbon dioxide between surface atmosphere and deep layers of ocean. (Seawater is alkaline while CO₂ is acidic --- the oceans are a vast reservoir of CO₂)

Sources of Methane

- ❖ Natural: end-product of the metabolism from anaerobic bacteria, from animals particularly cud-chewing animals like cows.
- ❖ Man-made: From agricultural activities like in rice paddies, gas drilling and transmission, landfills (an area of land where large amounts of waste material are buried under the earth), coal, and oil mining, biomass burning.

Sink of Methane: $\cdot\text{OH} + \text{CH}_4 \longrightarrow \text{CH}_3\cdot + \text{H}_2\text{O}$

Sources of Dinitrogen oxide

- ❖ Natural: Nitrification process and denitrification process for energy production by anaerobic bacteria.
- ❖ Man-made: Combustion of fossil fuels in vehicle and power stations, use of nitrogeneous fertilizers and the burning of vegetation and animal waste.

Sink of N₂O: Photolysis in the stratosphere

Sources of Chlorofluorocarbons

- ❖ No natural sources
- ❖ Man-made: Coolant/refrigerator, air conditioners, and aerosols.

Sink of CFCs: Photolysis in the stratosphere

Consequences (effects) of global warming

1. Melting of polar ice and mountain glaciers; the high temperature of the atmosphere may melt polar ice caps releasing enormous amount of water and the level of sea is likely to rise by 100m thereby sinking most of the coastal areas and causing large scale destruction.
2. The high temperature may reduce crop production, thereby causing famines.
3. Acidification of the ocean; the CO₂ dissolves in the water and forms a weak carbonic acid, thereby lowering the pH of the ocean waters. Increased acidity and temperature of ocean waters eventually lead to the bleaching and death of coral reefs.
4. Rising temperatures would raise sea levels as well, reducing supplies of fresh water as flooding occurs along coastlines worldwide and salt water reaches inland. In addition, sea levels are rising due to thermal expansion of the oceans and the melting of land ice.
5. The high temperature will reduce work efficiency of human beings.
6. Extreme weather events; these include floods, droughts, heat waves, hurricane (storm) and tornadoes (wind storm) are often the result of global warming.

7. Change in world's climatic patterns; it is becoming hard to forecast the weather accurately. Rain no longer fall when expected, sometimes the rains are heavier than expected, leading to flooding. Other times, the rains are far less than expected, leading drought.
8. Effects on agriculture; higher or lower agricultural yields, changes in the length of growing season, and growth of undesirable plant species.
9. Certain vector-borne diseases carried by animals or insects, such as malaria, would become more widespread as warmer conditions expanded their range.
10. Biodiversity, the change in ocean temperature will adversely affect the marine life. Some species may grow too quick and overshoot their reproductive period (e.g. reef corals), forest could be devastated if the rate of climate change outpaced the rate which forest species could migrate.
11. Tropical rains and hurricanes will become more frequent and stronger causing more destruction.
12. Impacts on human health; changes in patterns of sickness and death, respiratory problems affected by air quality change.
13. Increasing concentration of greenhouse gases are expected to cause cooling of stratosphere. This may happen because most of the thermal IR radiation will be absorbed at lower altitude and little of them will be left to warm stratosphere. Cooling of stratosphere would mean enhanced greenhouse effect i.e., greater global warming.
14. Submerging of islands and coastlines; small islands and low-lying areas will be totally covered by ocean waters and displace millions of peoples.

Ways of reducing global warming

To lessen (reduce) those long-term effects, many nations, communities and individuals are taking action now to reduce greenhouse gas emissions and slow global warming by:

- ❖ Reducing dependence on fossil fuels, these measures include the use of public transport to minimize the number of vehicles on the roads and the use of fuel-efficient cars.
- ❖ Increasing the use of renewable energy, such as solar and wind energy.
- ❖ Expanding forests; replant trees (afforestation) that would absorb CO₂ and stop deforestation.
- ❖ Reuse and recycle products.
- ❖ Making lifestyle choices that help to sustain the environment; countries should commit themselves to minimize the emission of greenhouse gases into the atmosphere. This is being done through agreements such as the Kyoto protocol.
- ❖ Promote use of organic products.

POSSIBLE INTERVENTION MEASURES FOR PROPER ENVIRONMENTAL MANAGEMENT

Environmental Intervention: Is exchange between the economy and the environment including resource extraction, emissions to the air, water, or soil, and aspects of land use. An environmental effect is the consequence of an environmental intervention in an environmental system.

Environmental Management: Are those aspects of an overall management function (including planning) that determine and lead to implementation of an environmental policy.

The environmental management interventions are:

1. Chemical treatment of urban sewage:

Sewage treatment is the process of removing contaminants from wastewater and household sewage, both runoff (effluents) and domestic.

Sewage is generated by residential, institutional, and commercial and industrial establishments. It includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers.

Its objective is to produce an environmentally safe fluid waste stream (or treated effluent) and a solid waste (or treated sludge) suitable for disposal or reuse (usually as farm fertilizer). Using advanced technology it is now possible to re-use sewage effluent for drinking water, (although Singapore is the only country to implement such technology).

2. Chemical treatment of urban supplies of edible/portable water:

Is water edible (not poisonous)? Yes, water is edible. In fact, you should be drinking 2L every day to keep your body healthy.

If the water cannot be sufficiently purified through physical means, a wastewatertreatment plant may apply chemicals to clean it. Chlorine is most commonly used for chemicalwastewatertreatment, though ozone is sometimes used and has a similar bacteria-killing effect.

Numerous chemicals are used in different phases of the filtration process to separate out solids, kill bacteria and parasites, and remove dangerous toxins. Chemical compounds of ferric chloride, alum, ozone, chlorine, and lime help to purify even the most polluted concentrations of sewage. After wastewater has been filtered, disinfected, and neutralized, it no longer poses an environmental threat and is deemed safe for public use and consumption.

Solution for the environmental problems can be done by:

1. Reducing the over consumption of natural resources and emission of carbon into atmosphere from vehicles.
2. Try to control the industrial developmental projects that cause water pollution and also the activities which catalysis global warming and climate changes.
3. Reduce deforestation for developmental activities and consumption of non-biodegradable materials.
4. Decrease the activities causing pollution of water bodies, air, forests, and soil.
5. Recycle is the method that can reduce environmental strain. Create compost plant waste to minimize the waste and carbon dioxide output while creating healthy organic fertilizer. Recycle the used materials with available technologies to reduce deforestation. This can in turn save trees.

THE END OF THE TOPIC

Proudly prepared by: MakameKh. H. Sancho
0773542465/0714789590.

Dark – Room,
It bright the future life more than a torch does!
September, 2012

(A). CONCEPTUAL QUESTIONS

FOR ACSEE AND OTHER COMPETITIVE EXAMINATION

1. (a) The pH of pure water is 7 and that of rainwater under very clean atmospheric condition is 5.6. Briefly explain why this is so?
(b) Although CO_2 is present in much higher concentration than NO_x and SO_2 . Why CO_2 does not form acid to some extent as other two gases.
(c) Briefly explain why CO is the most obvious hazardous product of combustion.
2. (a) Describe how the chemical compounds that are responsible for depletion of ozone layer destroy stratospheric ozone molecules. You may include chemical equations as part of your answer.
(b) Identify the major environmental consequence of the depletion of stratospheric ozone and its possible effects on ecosystem and/or human health that can result.
(c) As an environmental chemists propose possible measures that might be useful to prevent the ozone layer depletion.
3. (a) Define (i) Greenhouse effect (ii) Ozone hole (iii) Photochemical smog
(b) Industries are among the leading sources of air pollution.
(i) Name four (4) substances from industries that contribute to air pollution.
(ii) Give two (2) other sources of air pollution.
(iii) What are the three (3) effects of air pollution?
4. (a) The world's is very worried on greenhouse effect on troposphere. However, without greenhouse effect the life would be impossible on the earth. Comment on this statement.
(b) Identify two gases other than CO_2 that contribute to the anthropogenic increase in global warming. For each gas describe a major human activities that leads to its release.
(c) Name two greenhouse gases and give their sources and sinks.
5. (a) Give fundamental difference between:
(i) Point sources and nonpoint sources
(ii) Biodegradable pollutants and nodegradable pollutants.
(iii) Environmental protection and environmental conservation
(iv) Natural and enhanced greenhouse effect.
(b) Describe the advantages and disadvantages of using petroleum versus coal as sources of energy.
6. You are invited as a guest speaker to give talk to the Ordinary level secondary school students on terrestrial pollution. Give outline of your talk showing important points to be covered.
7. (a) What is environment? Name its accessible components.
(b) Explain the terms sink and receptor.
(c) What are particulate pollutants? What are their roles in air pollution? What measures can be taken to control it?
7. **Questions from Ordinary level past papers.**

(B). ABSTRACT QUESTIONS

FOR ACSEE AND OTHER COMPETITIVE EXAMINATION

"You should not receive the hints offered in this section as an entire respond, please, seek more information".

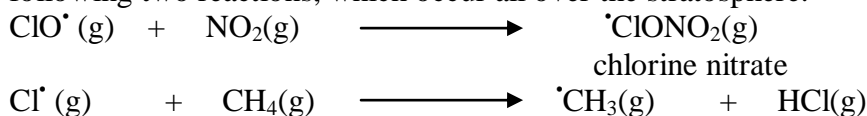
1. Briefly explain why CO is the most obvious hazardous product of combustion.
2. SO₂ contributes more to the acidity of acid rain than CO₂ for two main reasons. Write down the two reasons.
Hints: (a) SO₂ is more soluble in water than CO₂
 (b) Value of K_a; SO₂ = 1.7×10^{-2} , and CO₂ = 4.4×10^{-7}
3. Why do you consider acid rain as a secondary air pollutant?
4. How is photochemical smog formed? What are the damaging effects of photochemical smog? How it can be prevented/controlled?
Hints: *Formation*; it is formed (produced) from the action of sunlight on the nitrogen oxide and hydrocarbons present in the exhaust gases of the automobile and factories.
Effects; - It causes eye irritation, - damages plants
 - It decreases the visibility and thus affects air and road traffic.
Control; - minimize the use of personal vehicles.
 - Install efficient catalytic converters in automobile.
5. Why burning biodiesel fuel has a different impact on atmospheric CO₂ concentrations than does burning fossil fuel?
6. (i) Why rain water is always weak acid?
 (ii) What is acidic rain and what causes acidic rain?
 (iii) What are the effects of acidic rain?
7. Explain why there are great risks associated with eating large predator fish than eating small fish from the same aquatic body.
8. Describe the advantages and disadvantages of using petroleum versus coal as sources of energy.
9. Oceans act as a source and sink of CO₂. Elaborate.
10. What are the advantages of using natural gas over the other sources of energy?
11. What are the effects of oil spills in aquatic environmental and what are the possible fates of the spilled oil?
Hints: *Possible fates of the spilled oil*
 - Weathering: a series of chemical and physical changes that cause spilled oil to break down and become heavier than water.
 - Evaporation: the lighter or more volatile components within the oil mixture become vapours and leave the surface of water.
 - Biodegradation: microorganisms feed on oil hydrocarbons.
12. Use of pesticides is always associated with environmental consequences but it remains to be necessary for effective production. Explain.
13. Discuss the environmental impacts of mining industry in Tanzania with the special emphasis on the North Mara gold mining as a case study.
Hints: - Loss of biodiversity
 - Health damage
 - Acidification of rivers
 - Cyanide and other chemical releases
 - Water (surface and ground) contamination
 - Air pollution

14. What do you mean by ozone hole? What are its consequences? What are the reactions involved for ozone layer depletion in the atmosphere?
15. Give fundamental difference between natural and enhanced greenhouse effect.
16. The world is very worried on greenhouse effect on troposphere. However, without greenhouse effect the life would be impossible on the earth. Comment on this statement.
17. Using the relevant equations indicate natural formation of ozone (O_3) and its depletion in presence of CF_2Cl_2 pollutant in stratosphere.
18. State four important roles played by atmosphere.
19. Is it possible for two substances with equal toxicity and absorption to differ in the hazard they can cause to the living organisms? Justify your answer.
20. As an environmental chemist, propose possible measures that might be useful to prevent water pollution in your country.
21. Identify two gases other than CO_2 that contribute to the anthropogenic increase in global warming. For each gas describe a major human activities that leads to its release.
22. A large number of fish are suddenly found floating dead on a lake. There is no evidence of toxic dumping but you find the abundance of phytoplanktons. Suggest a reason for the fish kill.
23. Explain, with aid of diagram, what the greenhouse effect is.
24. Why should the ozone hole occur in Polar Regions only at certain times of year and then replenish soon after?

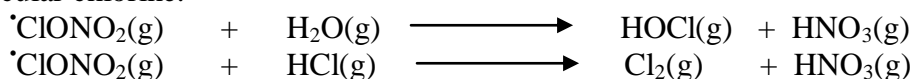
Hints: - Sources of CO_2 for plant photosynthesis. - Sources of O_2 for respiration
 - Absorb most cosmic rays from outer space.
 - Absorb most EM radiation from the sun.
 - Transport water from the oceans to land.
 - Sources of N_2 an essential component of life molecules.

Hints: - It may differ in hazard depending on the nature of their biotransformation.
 - If it is transformed into a more toxic metabolite (bioactivated) has greater hazard.

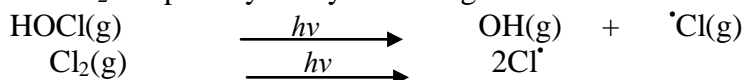
Hints: Ozone hole is not created at other places in the stratosphere because of the following two reactions, which occur all over the stratosphere.



- * Once these reactive free radicals are tied up, the chain reactions involving the depletion of ozone is not initiated.
- * During the Antarctica winter, special types of cloud called Polar stratospheric clouds (PSCs) are formed over Antarctica. On the surface of the PSCs, chlorine nitrate (ClONO_2) gets hydrolysed to form HOCl and react with HCl to form molecular chlorine.



- * During September – October, when the sun begins to shine over Antarctica, the HOCl and Cl_2 are photolysed by the sunlight.



and the chlorine radicals (Cl^\bullet) become available for the depletion of ozone through the chain mechanism.

(C). QUESTIONS AND ANSWERS

FOR ACSEE AND OTHER COMPETITIVE EXAMINATION

1. Carbon monoxide gas is more dangerous than carbon dioxide gas. Why?

Solution: CO combines with haemoglobin to form a complex entity, carboxyhaemoglobin that is about 300 times more stable than oxy-haemoglobin. In blood, when the concentration of carboxyhaemoglobin reaches 3-4% the oxygen carrying capacity of the blood is significantly reduced. In other words, the body becomes oxygen starved. This results in headache, nervousness, cardiovascular disorder, weak eye-sight.

2. How can domestic waste be used as manure?

Solution: Domestic waste comprises of two types of materials, biodegradable such as food, etc., and non-biodegradable such as plastics, glass, etc. The non-biodegradable waste should be deposited in the landfills. With passage of time, it is converted into compost manure.

3. (i) "Oxygen plays a key role in the troposphere while ozone in the stratosphere".

Elucidate.

(ii) Name two important sinks of CO₂

(iii) What is marine pollution?

(iv) Fish do not grow as well in warm water as in cold water. Why?

Solution: (i) All biological activity takes place in the troposphere for which oxygen is required. Ozone in the stratosphere absorbs the harsh ultraviolet radiation coming from the sun which otherwise causes skin cancer, affects the cornea of the eye and may cause even blindness.

(ii) Oceans (which dissolve it) and plants (which use it for photosynthesis).

(iii) Pollution of sea water due to discharge of wastes into it is called marine pollution.

(iv) The amount of dissolved oxygen in warm water is less than in cold water.

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

Solution: The solar energy radiated back from the earth surface is absorbed by the greenhouse gases (i.e., CO₂, CH₄, O₃, CFC's and water vapour) present near the earth's surface. They heat up the atmosphere near the earth's surface and keep it warm. As a result, they keep the temperature of the earth constant and help in the growth of plants and existence of life on the earth. If there were no greenhouse gases, there would have been no vegetation and life on the earth.

"Always remember environmental protection begins with us"

ACKNOWLEDGEMENT

I take pleasure in presenting the pamphlet of **Environmental Chemistry** for the students of form V–VI. This pamphlet has been written according to the new syllabus issued by Ministry of education and vocational training of the United Republic of Tanzania. The author has endeavored to grade the standard of the work by leading up carefully to more difficult portions of the subject matter and in a few cases more advanced material has been printed in italic or bolded form so as to possess thoughtfulness to the readers. While developing the text, special attempt has been made to keep the language and presentation simple, concise, and free from confusion as possible. In addition there are numbers of examples and questions that provide wide range of concept to the students, and the problems to try on their own. This pamphlet offers students with very best qualifications and the opportunities to experience non-examined activities with the aim to develop the well-rounded skills that make you more marketable to the top. In addition, it may also enhance and stimulate teachers in their teaching activities as a reference. Your time is valuable and when every moment counts, you need efficient study material, so in order to succeed in your study of environmental chemistry you need only the desire to learn and the willingness to work hard. This is the pamphlet which the examiner's use.

Preparation of any work that intends to help the society is a great deal. Despite the fact that individual person could able, to handle but the others finger should be there for better successes. My sincere and heartfelt thanks should positively go to those who are in one way or another participated in the accomplishment of this pamphlet.

Exceptional and esteemed appreciation for the massive help they have shown and large amount of time and effort, incentive that resulted in the invaluable comments whenever called upon, also, their contribution and positive critique provided a shining shape of the presented pamphlet are due to the following teachers:

Talhiya A. M. Barout – Fidel Castro Secondary School, Pemba.

Masoud M. M. Chirco- Mikindani Day Secondary School, Mtwara.

Rahil A. Said – Lumumba Secondary School, Unguja.

Shafii A. Khamis – Hamamni Secondary School, Unguja.

Purposely, I congratulate all authors of the text books and other literatures that helped enrich this work. Their contribution in the production of this pamphlet is very useful. I am also thank you for taking your time to pass through my work. Before closing, I wish to place on record my most sincere personal thanks to my wife **MARISA** and our dearest daughter **LAFINGA** for their constant support and for bearing my partial absence during the preparation of this pamphlet.

I hope you will find that this pamphlet builds on the strengths and serves students even better. Any errors arising from this pamphlet are the sole responsibility of the author.

*Proudly prepared by: MakameKh. H. Sancho
0773542465/0714789590.*

Dark – Room,

It bright the future life more than a torch does!

Zanzibar – Tanzania.

September, 2012