Acid rain

- Various industries , automobiles, etc. release acidic oxides such as sulphur dioxide , nitrogen dioxide etc. Natural HCl emissions and other man-made activities also release HCl in the atmosphere.
- These oxides and HCl dissolve in moisture present in atmosphere to form corresponding acids , which slowly fall on earth as acid rain.
- Acid rain is a process of deposition of acid gases (SO_2 , NO_2 , HCl) from the atmosphere on land in the form of precipitation or rain.

$SO_2 + H_2O \longrightarrow H_2SO_3$ (Sulphurous acid)

$2SO_2 + O_2 + 2H_2O \longrightarrow 2H_2SO_4$ (Sulphuric acid)

$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$ (Nitric acid)

$HCl(g) + H_2O \longrightarrow$ Hcl (aq.)

More acid rains are likely to occur in the following areas:

- Thickly populated cities.
- Areas having large number of industries.

Harmful effects of acid rain

- Increased extent of acid-rains ,during the past years ,has progressively increased the acidity of rain water.
- Causes damage to fresh water-life.
- In mist form ,it causes direct damage to plant leaves.
- Lowering of P^H of rain-water due to acid rain changes the rate of metabolism of organisms.
- Causes irritation to eyes and mucus membrane.
- Accelerate the rate of corrosion of metals.
- Causes damage to building, rocks, etc., thereby causing faster weathering of these.
- Dissolves salts in the soil(e.g. $CaCO_3$) and metals (like aluminium) which pass into ponds, lakes , river, etc., where they cause toxic effects to aquatic life.

Methods to control acid rain

- One of the most fundamental acid rain solutions is to utilize fuels that burn more cleanly, or to burn coal more efficiently. This will greatly reduce the possibilities of acid rain developing in the atmosphere.
- ii. As fast as industrial power plants are concerned, the best solution is to attach devices known as ‘scrubbers’ in the chimneys of these plants. These scrubbers reduce the amount of sulfur produced in the smoke by 90 – 95% .
- iii. Vehicles and cars must be mandatory required to comply with very tight and efficient emission standards. Fitting catalytic converters into the exhaust pipes of vehicles also reduces the amount of sulfur dioxide produced by the vehicles.

Methods to control acid rain

- For industrial power plants, there are many more acid rain solutions that must be enforced, as they are clearly the biggest contributors to the formation of acidified water droplets in the atmosphere. Industries must regularly inspect and clean all their emission equipment and chimneys and pipes.

- All these acid rain solutions will be pointless unless people are informed and educated about the ill-effects and harms of acid rain. A widespread and nationwide effort must be made to make people aware. Only after that is done ,all the acid rain solutions actually make a difference.

Green house effect

- When the solar radiations strike the surface of earth, the infrared rays show further increase in their wavelength which prevents them to radiate back to the outer space by the envelope of gases like CO, CO_2 ,SO_2 etc , which surround the earth's atmosphere causing rise in temperature .
- This retention of heat energy by earth due to presence of green house gases like CO, CO_2 ,SO_2 etc. is known as green house effect or atmospheric effect.

Causes:

- Due to human civilization , excessive amount of CO_2 is being deposited in the atmosphere through furnaces of power plants, automobiles , factories, burning of charcoal or fossil fuels etc.
- There are other gases which also cause green house effect are methane (CH_4), NO_2 and CFCs .

Consequences:

- Green house effect or atmospheric effect results in increase in temperature of earth as a whole causing global warming.
- The rise in temperature of earth's atmosphere results increase in sea level due to melting of polar ice caps.
- Snow melting in the mountains would cause floods during monsoon.
- Warming up of the atmospheric temperature would cause more hurricanes and cyclones nearby oceans.
- Higher atmospheric temperature would increase evaporation of water from the farms , thus reduce crop yield.
- Monsoon may even stop altogether or rainfall may be altered .

Important measures to control green house effect

- Reducing consumption of fossil fuels such as coal and petroleum.
- Recovering green house gases from the atmosphere.
- Reduction of CFC production.
- Reforestation and conservation of forests , so that plants can take up CO_2 .
- Development of environmentally compatible technologies.

Ozone layer

- Ozone is a pale blue gas mainly present in the stratosphere in the form of layer known as ozonosphere.
- It is an allotropic form of oxygen. Under suitable conditions , these oxygen atoms combine to triatomic molecules called ozone.
- Ozone is formed in the upper atmosphere by the absorption of UV light.

Formation of Ozone

- O_2 Splits into atoms as they absorb UV radiation from the sun. The oxygen atom then combines with O_2 Molecule to give ozone molecule.

$$O_2 \xrightarrow{UV} O + O$$

$$O_2 + O \longrightarrow O_3$$

Importance of ozone layer

- The ozone layer acts as a protective shield for the existence of life on earth. It absorbs most of the harmful ultraviolet radiations coming from sun and thereby protects life from several radiation damage.
- In the absence of ozone layer, these ultraviolet radiations would cause

a) Diseases like skin cancer in men and animals, swelling of skin, burning sensation, skin aging , leukemia , breast cancer, haemorrhage , lungs injury , premature aging , inhibition and alternation of DNA replication and formation of DNA adduct and may even lead to death.

b) DNA mutation

c) Damage of plants

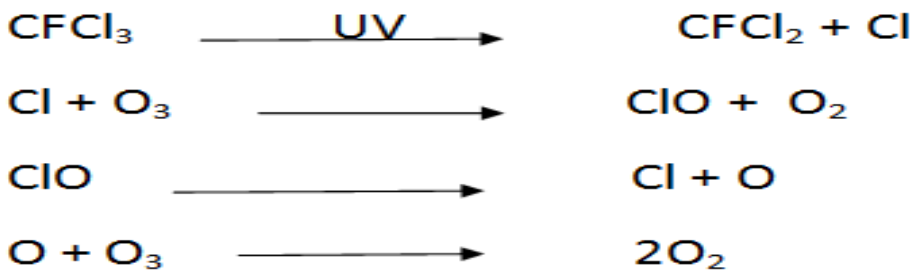
d) Faster deterioration of paints, fabrics, plastics, etc.

Causes of depletion of ozone layer

- Substances responsible for ozone layer depletion are CFCs , CO , NO , NO_2 , CH_4, etc. The main culprits for ozone layer depletion are chlorofluorocarbons(CFCs)
- Chlorofluorocarbons are extremely stable , non corrosive and inert compounds containing chlorine ,fluorine and carbon . They are also known as Freon.
- The CFCs are $CFCl_3$ (Freon-11), CCl_2F_2 (Freon-12) etc. Chlorofluorocarbons are the exhausts of supersonic air craft and jumbo jets flying in the upper atmosphere . CFCs were also used as coolants in refrigerators , air conditioners , etc

Causes of depletion contd……

- Once chlorofluorocarbons come in atmosphere , they remain in environment for along time and eventually migrate into the stratosphere . Here, it destroys ozone molecules.
- It is estimated that one molecule of CFC can destroy 100,000 molecules of ozone . The mechanism of destruction of ozone is as follows.



Causes of depletion contd….

- Chlorine atom is consumed in reaction 2, but it is generated in reaction 3. Thus, once chlorine atom is produced from the decomposition of CFC , hundreds of thousands of molecules of ozone are destroyed through the chain reaction . This creates a depletion of ozone layer or ozone hole in stratosphere.
- Another chemical reaction leading to the decomposition of ozone layer is,

Control of ozone layer depletion

- Due to hazardous and ozone depleting nature of CFCs, the need for their alternatives is quite necessary and CFCs units be phased out as early as possible .
- These days Hydrochlorofluorocarbons (HCFCs) and Hydrofluorocarbons (HFCs) are considered as ozone friendly substitutes for CFCs in the air conditioning and refrigeration on the basis of some toxicity tests and environmental impacts . They have smaller atmosphere life times and zero depletion to CFC's potential as compared . But they also possesses some toxicity ,so these are only short term alternatives according to Montreal protocol.

Control of ozone layer depletion

Other methods to control the depletion of ozone layer are as follows:

1) Minimize high altitude aircraft flights.
2) Encourage growth of plants that produce oxygen and discourage deforestation.
3) Decrease the releases of high temperature steam to the atmosphere.
4) Eliminate production and release of known ozone depleting chemicals as far as possible.