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Subject : Environmental Science

⇒ Q. No.1:

What is the mechanism of ozone depletion? What chemicals in upper atmosphere are responsible for ozone layer depletion? What are the impacts of ozone layer depletion.

⇒ Introduction:-

Without ozone, life on earth would not have evolved in the way it has. The first stage of single cell development required an oxygen free environment. This type of environment found on earth over 3000 million years ago. As the primitive forms of plant life evolved, and multiplied they began to release a minute amount of oxygen through the photosynthesis reaction. They build up of oxygen in the atmosphere led to the formation of ozone layer in the stratosphere. This

byer filters out the incoming radiation in the "cell damaging" UV part of the spectrum. This with the formation of ozone layer came the formation of more advanced life forms.

2. Creation of Ozone layer:-

Most ozone is produced in upper atmosphere or stratosphere. While ozone can be found through the entire atmosphere, the greatest concentration occurs at altitudes between 19 and 30 km above the Earth's surface. This band of ozone rich air is known as the "Ozone layer".

8i) Ozone in troposphere:-

Ozone also occurs in very small amounts in the lowest few kilometers of the atmosphere, a region is known as troposphere. It is produced at ground level through sun light and volatile compounds. Ground level ozone is component of urban smog and

Can be harmful to human health

(ii)

Stratosphere Ozone

Stratosphere Ozone blocks harmful solar radiations, all life on earth has adapted to this filtered solar radiation.

Troposphere Ozone

Ground-level ozone, is simply a pollutant. It will absorb some incoming solar radiation, but it cannot make up of ozone losses in stratosphere.

(iii) $\Rightarrow$

Characteristics of Ozone :-

- I. Available in both troposphere and stratosphere.
- II. Most ozone is concentrated in stratosphere.
- III. $O_2/O_3 = 1025$ in troposphere and ~~1025~~ 3×10^5 in stratosphere.
- IV. Colourless, highly reactive, distinct odour.
- V. Protects earth from UV radiations from sun.
- VI. Secondary pollutant in troposphere.
- VII. Troposphere ozone has harmful effect on human health.

3. Formation of Ozone:-



4. Measurements of Ozone layer:-

Thickness of Ozone layer is measured in Dobson Unit (DU) where $1 \text{ DU} = 0.01 \text{ mm}$ of compressed air at 0°C and 760 mm mercury pressure. Average thickness of the Ozone layer is 230 DU which varies marginally with altitude.

5. Evidence of ozone Depletion:-

(ii)

Research of Mario Molina and F. Sherwood Rowland:-

In 1974, after millions of tons of ~~CFCs~~ CFCs had been manufactured and sold, chemist

F. ~~Sherwood~~ Rowland and Mario Molina

began to wonder ~~where~~ where

all these CFCs ended up

Rowland and Molina theorized

UV rays from sun would break up these radiations ~~in~~ in the atmosphere, then free chlorine atoms enter into a chain reaction, destroying ozone.

(ii) British Antarctic Survey:-

Depletion of ozone was first monitored by the British Antarctic Survey above Antarctica. The depletion above the south pole was so severe. Once the ozone depletion was verified, it came to be known throughout the world through a series of NASA Satellite photos as the Antarctic ozone Hole.

6. Mechanism of ozone depletion:-



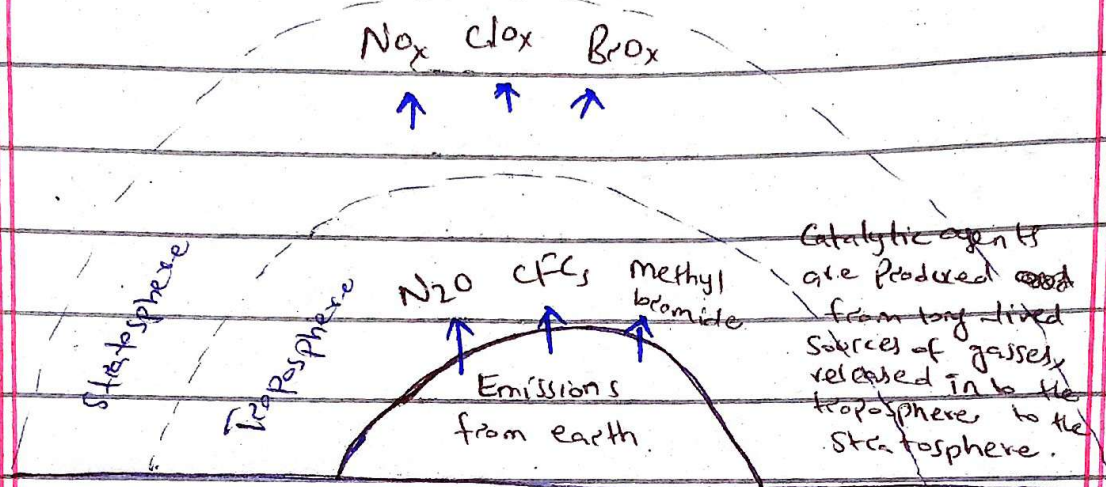
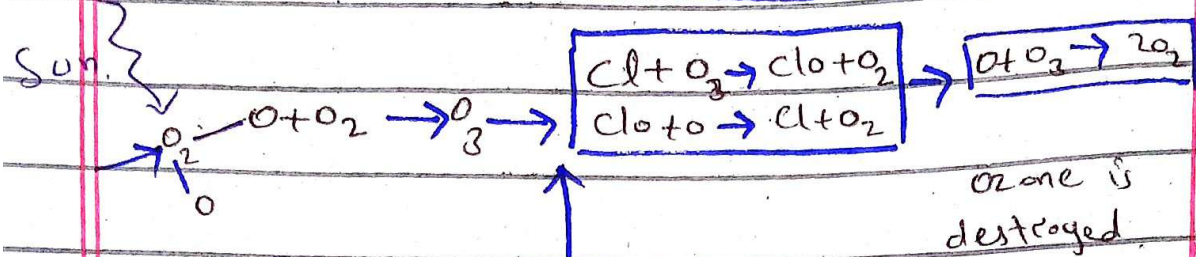
where X = reacting substance



Ozone is Produced by photosynthesis of O_2 by UV ϵ from the sun. O then combines with O_2 and produce O_3

O_3 is destroyed by catalytic chain reactions of ClO . Similar reactions occur with NO_x and BrO_x

Net Result



(Creation and depletion of ozone layer)

7. Ozone Depleting chemicals:-

- Chlorofluorocarbons
- Carbon Tetrachloride
- methyl Chloroform
- Halons
- methyl Bromide

8. Ozone Depleting Potential:-

Measures of destructive effects of an ozone depleting substances with respect to reference substance

$$\text{Ozone depleting potential} = \frac{\text{Ozone layer thickness destroyed by unit mass of ODS}}{\text{Ozone layer thickness destroyed by a unit mass of CFC-11}}$$

9. Effect of ozone Depletion:-

Ultraviolet (UV) radiations from the sun can cause a variety of health problems in humans including skin cancers, eye cataracts and a reduction in the ability to fight off disease.

Effects of ozone depletion

(i) Human Health:-

1. worse sunburns
2. more eye cataracts
3. more skin cancers
4. Immune system suppression.

⇒ (ii) Effects of ozone depletion on Food and forests:-

1. Reduced yields for some crops.
2. Reduced seafood supply from
3. reduced ~~phy~~ Phytoplankton.
4. Decreased forest productivity for UV-sensitive tree species.

⇒ (iii)

Effects on wildlife:-

1. Increased eye cataracts in some species.

2. Decreased populations of aquatic species sensitive to UV radiation.
3. Reduced populations of surface phytoplankton.
4. Disrupted aquatic food webs from reduced phytoplankton.

⇒ (iv).

Effects of ozone depletion on Air pollution and materials.

1. Increased acid deposition.
2. Increased photochemical smog.
3. Degradation of outdoor paints and plastics.

⇒ (v) Effects on Global Warming.
While in troposphere, CFCs act as greenhouse gases.

10) ⇒ Legislative measures to control ozone depletion.

Under the terms of Montreal Protocol, developed nations have ceased production of new CFCs, halons and other depleting chemicals to protect the ozone layer.

Trade controls on the supply of these substances have been put in place to ensure compliance with protocol.

The Montreal Protocol works through a system of trade barriers controlling supply to the market of ozone depleting chemicals. Imports of newly produced CFCs and halons by developed countries have already been banned, as have imports and exports in the ODCs carbon tetrachloride and 1, 1, 1 trichloroethane.

Unfortunately, the Montreal Protocol currently does not require parties to implement controls against illegal trade, although they have been urged to install ~~the~~ verification programs to reduce illegal trade in ODCs.
