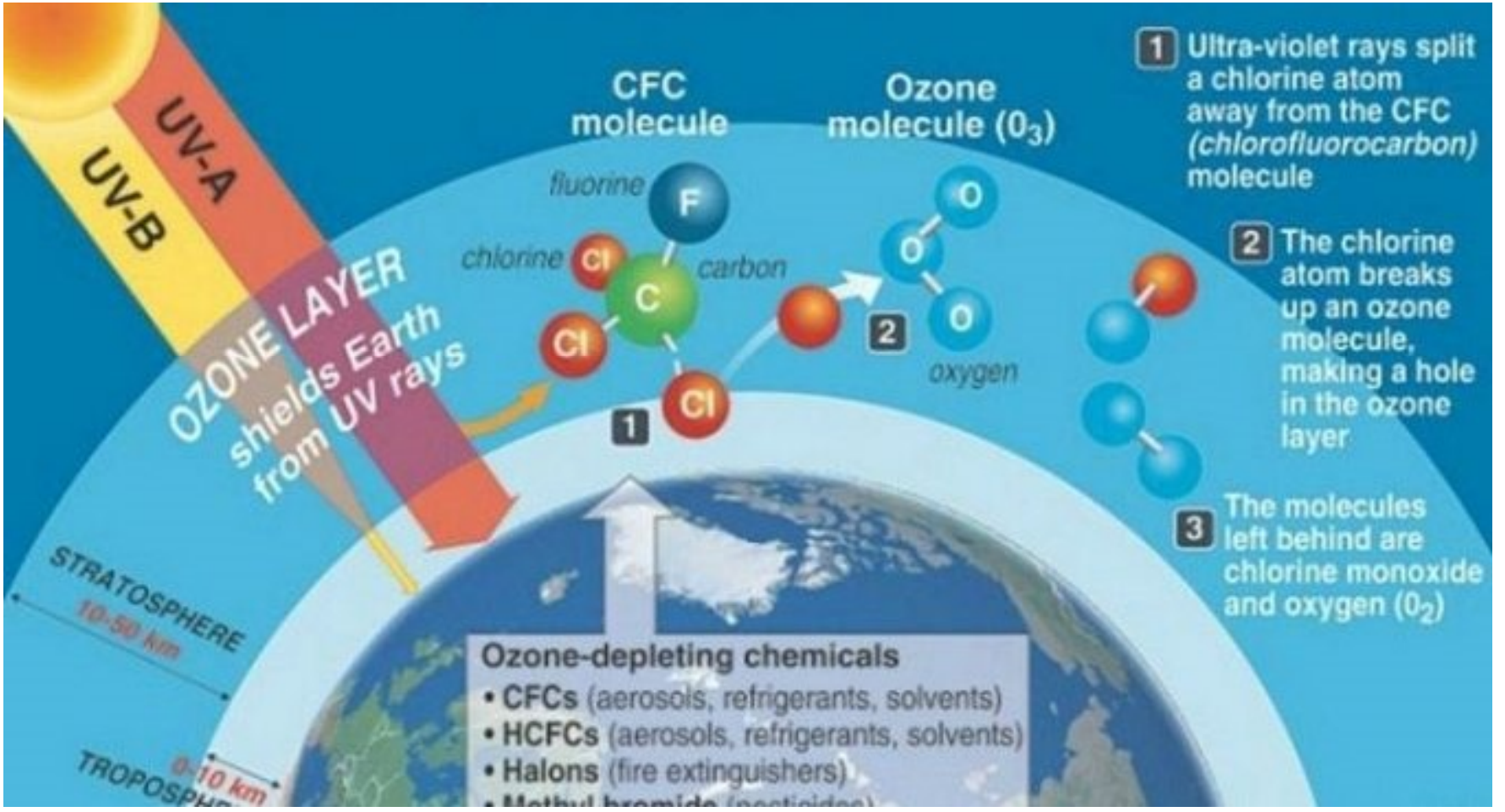
Environmental Chemistry



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1. troposphere.

up to the height of ~ 10 km.
Turbulent
Contains air, water vapour ,clouds

2. stratosphere.

between 10 and 50 km
Has N2, O2, O3 and water vapour.

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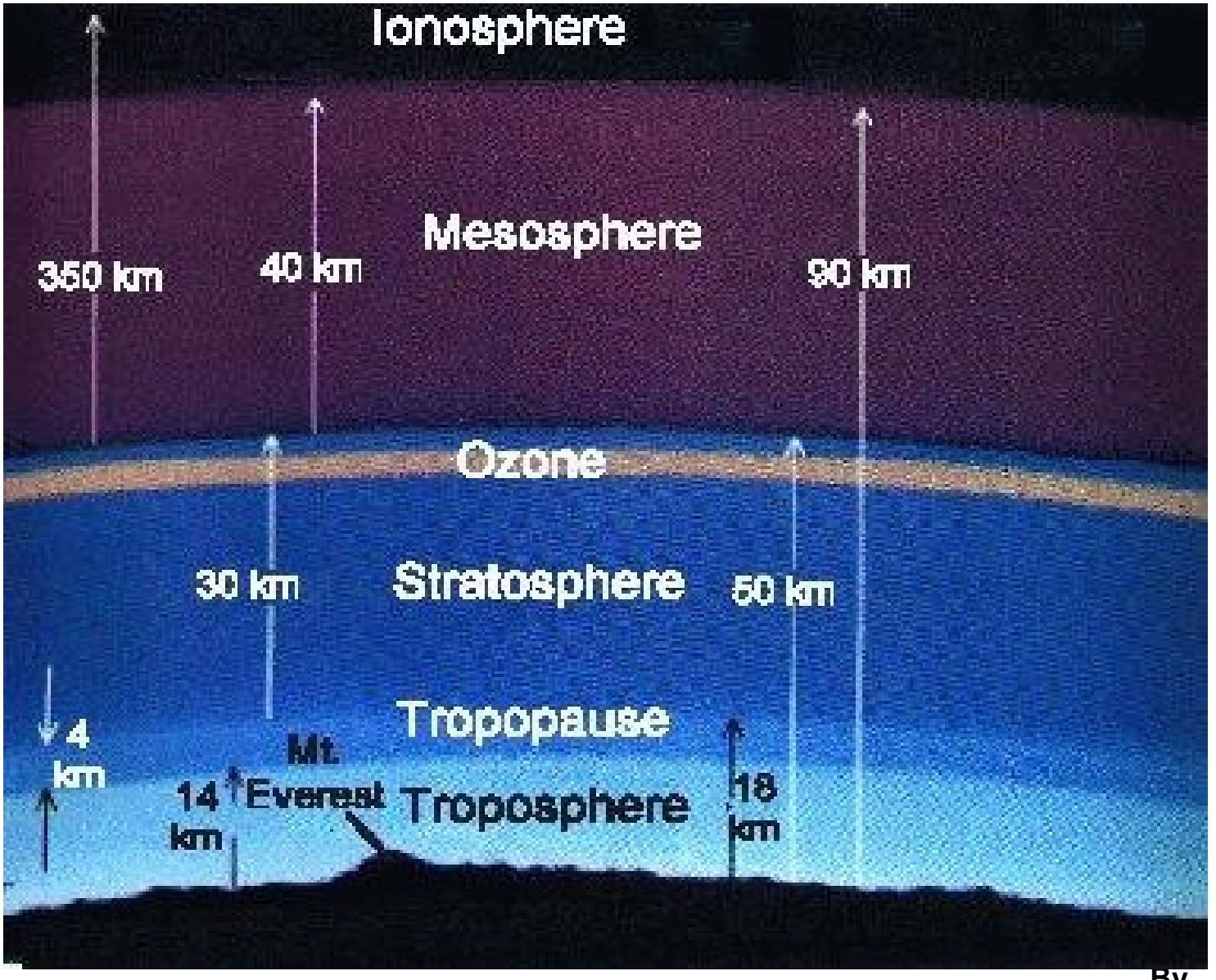

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1. Gaseous air pollutants:

These are oxides of sulphur, nitrogen and carbon, hydrogen sulphide, hydrocarbons, ozone and other oxidants.

2. Particulate pollutants:

These are dust, mist, fumes, smoke, smog etc.

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1. Gaseous air pollutants : Sulphur oxides

1. Burning fossil fuel

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

2. promoted by ozone and hydrogen peroxide.

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

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

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Oxides of Nitrogen

1. lightning: $O_2 + N_2$ form oxides of nitrogen.

2. NO_2 is oxidised to nitrate ion, NO_3^-

3. Automobile engine

$$N_2(g) + O_2(g) \rightarrow 2NO(g)$$

NO reacts instantly with oxygen to give NO_2

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

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nitric oxide with ozone form NO_2

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

irritant red haze in the traffic and congested places is due to oxides of nitrogen.

Higher concentrations of NO_2 retard the rate of photosynthesis.

Nitrogen dioxide is a lung irritant
acute respiratory disease in children.

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Hydrocarbons:

Hydrocarbons are carcinogenic

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Carbon monoxide:

CO + Haemoglobuline → carboxyhaemoglobin, 300 times more stable

In blood, thelimit concentration of **carboxyhaemoglobin** reaches about **3–4 per cent,** the oxygen carrying capacity of blood is greatly reduced

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Green house Gases:

carbon dioxide, other greenhouse gases are methane, water vapour, nitrous oxide, CFCs and ozone.

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Acid rain

1. normally rain water has a pH of 5.6
2. **When the pH of the rain water drops below 5.6, acid rain.**

SO_2 and NO_2 after oxidation and reaction with water are major contributors to acid rain

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2. Particulate Pollutants

1. **Classical smog :**

occurs in cool humid climate

mixture of smoke, fog and sulphur dioxide.

it is a reducing mixture and so it is also called as reducing smog.

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2. Particulate Pollutants

2. Photochemical smog :

occurs in warm, dry and sunny climate.
main components action of sunlight on unsaturated hydrocarbons and nitrogen oxides produced by automobiles and factories.

Main component : ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate (PAN).
high concentration of oxidising agents and is, therefore **oxidising smog.**

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Formation of photochemical smog

1. $NO \rightarrow NO_2$
2. NO_2 absorbs energy from sunlight to → nitric oxide & O atom

$NO_2(g) \rightarrow NO(g) + O(g)$ (i)

Oxygen atoms with the O_2 in air to produce ozone.

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

The ozone with NO(g) to regenerate NO_2.

NO_2 is a brown gas and at sufficiently high levels can contribute to haze.

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

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Formation of photochemical smog

$3CH_4 + 2O_3 \rightarrow 3CH_2 = O + 3H_2O$

Formaldehyde

$CH_2=CHCH=O$

Acrolein

CH_3COONO_2

Peroxyacetyl nitrate (PAN)

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control

1. the primary precursors of photochemical smog, such as NO_2 and hydrocarbons,

2. the secondary precursors such as ozone and PAN, the photochemical smog will automatically be reduced.

3. Usually catalytic converters are used in the automobiles.

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Formation of Ozone

Ozone in the stratosphere is a product of UV radiations acting on dioxygen (O2) molecules.

The UV radiations split apart molecular oxygen into free oxygen (O) atoms.

These oxygen atoms combine with the molecular oxygen to form ozone.

$O_2 (g) \rightarrow O(g) + O(g)$

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

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Dissociation of Ozone

1. CFCs released in the atmosphere, and get broken down by UV radiations, releasing chlorine free radical.

$CF_2Cl_2 (g) \rightarrow C \bullet l (g) + C \bullet F_2Cl (g)$

2. The chlorine radical with stratospheric ozone form chlorine monoxide radicals and molecular oxygen.

$C \bullet l (g) + O_3 (g) \rightarrow ClO \bullet (g) + O_2 (g)$

3.Reaction of chlorine monoxide radical with atomic oxygen produces more chlorine radicals.

$ClO \bullet (g) + O (g) \rightarrow C \bullet l (g) + O_2 (g)$

(iii) The chlorine radicals cause the breakdown of ozone.

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Dissociation of Ozone

It also reacts with hydrogen chloride produced as per reaction to give molecular chlorine.

$ClO \bullet (g) + NO_2 (g) \rightarrow ClONO_2(g)$ (iv)

$C \bullet l (g) + CH_4 (g) \rightarrow C \bullet H_3(g) + HCl(g)$ (v)

$ClONO_2(g) + H_2O (g) \rightarrow HOCl (g) + HNO_3 (g)$ (vi)

$ClONO_2(g) + HCl (g) \rightarrow Cl_2 (g) + HNO_3 (g)$

HOCl and Cl_2 are photolysed by sunlight, as given in reactions

$HOCl (g) \xrightarrow{h\nu} O \bullet H (g) + C \bullet l(g)$ (viii)

$Cl_2 (g) \xrightarrow{h\nu} 2\ C \bullet l (g)$ (ix)

The chlorine radicals thus formed, initiate the chain reaction for ozone depletion as described earlier.

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Biochemical Oxygen Demand (BOD).

Thus, the amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a sample of water, is called Biochemical Oxygen Demand (BOD).

The amount of BOD in the water is a measure of the amount of organic material in the water, in terms of how much oxygen will be required to break it down biologically.

Clean water would have BOD value of less than 5 ppm

whereas highly polluted water could have a BOD value of 17 ppm or more.

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Eutrophication.

This process in which nutrient enriched water bodies support a dense plant population, which kills animal life by depriving it of oxygen and results in subsequent loss of biodiversity is known as Eutrophication.

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1 polychlorinated biphenyls, (PCBs)

2.detergents available are biodegradable.

3.Fertilizers contain phosphates as additives enhances algae growth.

Such profuse growth of algae, covers the water surface and reduces the oxygen concentration in water.

This leads to anaerobic conditions inhibits the growth of other living organisms in the water body.

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International Standards for Drinking Water

Metal	Maximum concentration (ppm or mg dm^{-3})
Fe	0.2
Mn	0.05
Al	0.2
Cu	3.0
Zn	5.0
Cd	0.005

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International Standards for Drinking Water

Fluoride:	1 ppm or 1 mg dm^{-3}
Lead:	50 ppb.
Sulphate:	500 ppm
Nitrate:	50 ppm

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Pesticides

Pesticides : synthetic toxic chemicals with ecological repercussions.

DDT ,Aldrin , Dieldrin

new series of less persistent or more bio-degradable products organo-phosphates and carbamates are severe nerve toxins and hence more harmful to humans.

sodium chlorate ($NaClO_3$), sodium arsinite (Na_3AsO_3) are herbicides

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Green Chemistry in day-to-day Life

(i) Dry Cleaning of Clothes

liquefied carbondioxide in place of Tetra chlroroethene ($Cl_2C=CCl_2$) as solvent for dry cleaning.

hydrogen peroxide (H_2O_2) in place of Cl_2.

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Green Chemistry in day-to-day Life

(ii) Bleaching of Paper

H_2O_2 in place of Cl_2

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Green Chemistry in day-to-day Life

(iii) Synthesis of Chemicals :

Ethanal (CH3CHO from ethene in the presence of ionic catalyst in aqueous medium with a yield of 90%.

$$CH_2 = CH_2 + O_2 \xrightarrow[Pd(II)/Cu(II)(\text{in water})]{\text{Catalyst}} CH_3CHO\,(90\%)$$

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Green Chemistry in day-to-day Life

kernel of tamarind in place of alum
to treat waste water

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