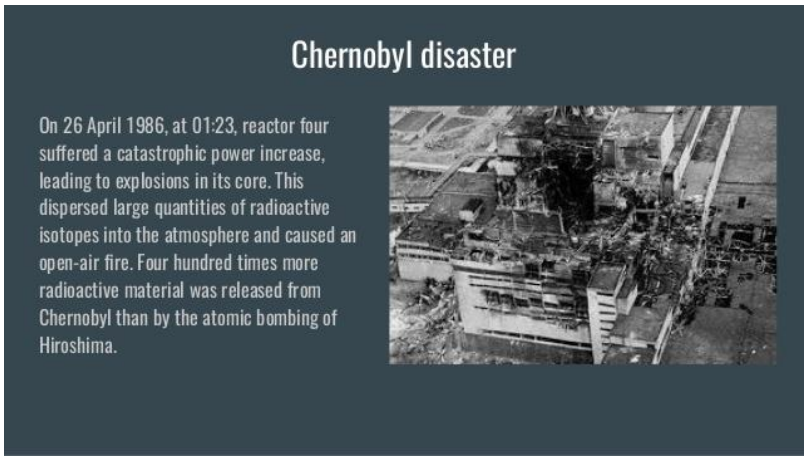
Air pollution

- Air Pollution,
- Air pollutant,
- Sources of Air Pollution,
- Effect of Air pollution and Remedies

Air Pollution

- The addition of undesirable materials into the atmosphere either by natural activities or man-made activities on the earth which adversely affect the quality of air and disturbs the dynamic equilibrium in the atmosphere is called air pollution.
- Air pollution is the presence of substances in the atmosphere that are harmful to the health of humans and other living beings, or cause damage to the climate or to materials. There are many different types of air pollutants, such as gases, particulates, and biological molecules.



Air Pollutants

- The unwanted or undesirable materials like different gases, particulars in atmosphere are called air pollutants.
- An air pollutant is a material in the air that can have adverse effects on humans and the ecosystem. The substance can be solid particles, liquid droplets, or gases. A pollutant can be of natural origin or man-made.
- Pollutants are classified as primary or secondary.
- Primary pollutants are usually produced by processes such as ash from a volcanic eruption. Other examples include carbon monoxide gas from motor vehicle exhausts or sulfur dioxide released from factories.
- Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact.
- Air pollutants can be also classified by gases(SOx, NOx, CO, CO_2, hydrocarbon) and particulates(dust, smoke, fly ash and O_3).

Sources of Air Pollution

- **SOx (SO_2 and SO_3)**
- **Sources-**
- By burning fuels containing sulphur.
- By burning sulphur
- From petroleum industry & sulphuric acid plant directly.

Sulphur dioxide

The major source of sulphur dioxide (SO_2) is the combustion of **fossil fuels** such as coal and crude oil (petroleum).

Fossil fuels contain sulphur.

When they are burnt, sulphur is converted to sulphur dioxide.

$S(s) + O_2(g) \rightarrow SO_2(g)$

Sulphur dioxide is also produced during volcanic eruptions.

Effects & Remedy of SOx

- High concentrations of SO_2 can affect lung function, worsen asthma attacks.
- irritates the skin and mucous membranes of the eyes, nose, throat, and lungs.
- can cause inflammation and irritation of the respiratory system.
- Can cause Acid rain.

Remedy of SOx

- Removal of SOx from fuel gases.
- Removal of sulphur from fuel burning
- Use of low sulphur fuels
- Substitution of other energy sources for fuel combination

NOx(NO and NO_2)

The mixture of NO and NO_2 are represented by NOx.

Sources

- During lightning

  $N_2 + O_2 \rightarrow 2NO$

  $NO + O_2 \rightarrow 2NO_2$

- By microbial processes in soil.
- Emitted by automobiles, construction equipments

Effect and Remedy of NOx

Effects

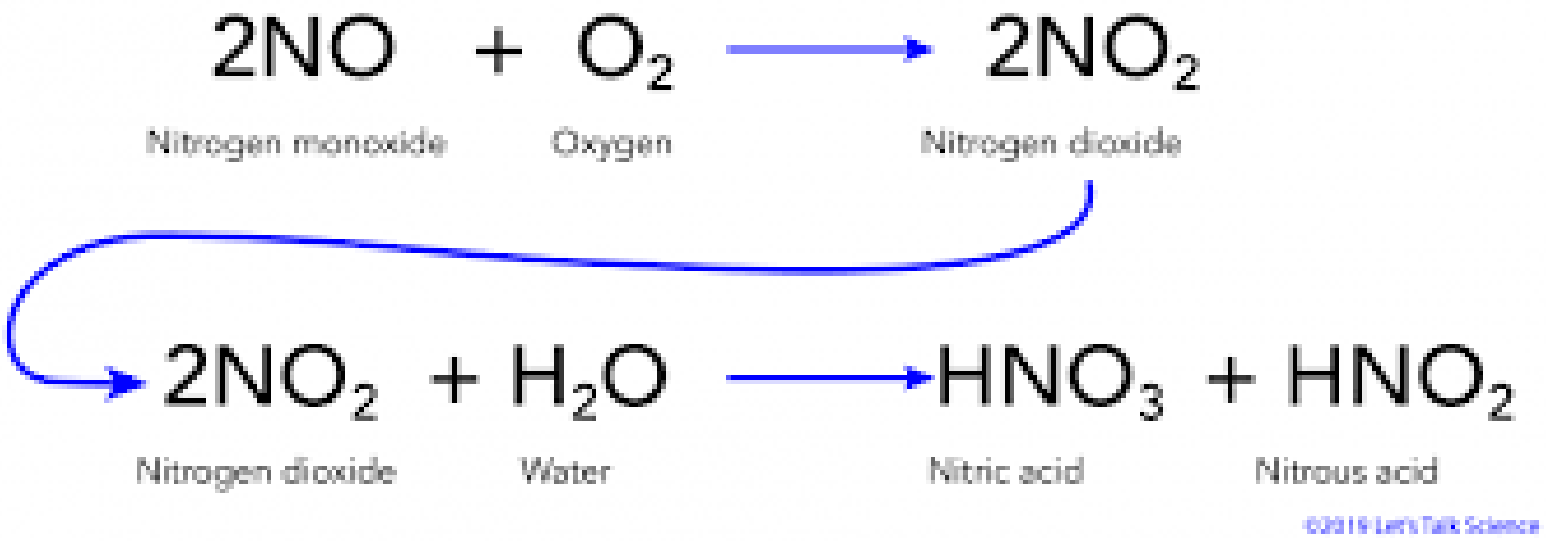
Affects respiratory system and damage the lungs

Causes acid rain which affects on marble building and metallic structure.

Remedy

Fuel burn out is completed at a relatively low temperature in excess air.

Use low nitrogen containing fuels by using selective catalytic reduction process.



Carbon monoxide (CO)

Sources

- Volcanic action
- Natural Gas emission
- Electric discharge during storm
- Seed germination

$2C + O_2 \rightarrow 2CO$

$CO_2 + C \rightarrow 2CO$

$CO_2 \rightarrow CO + [O]$

Effects

- Produce toxic gas which forms carboxyhemoglobin with iron in the haemoglobin of RBC

  $Hb + CO \rightarrow HbCO$

- As a result, blood cannot absorb oxygen and transport it to different parts of body.
- Thus, it may be fatal for us.

Remedy

- Modification of internal combustion engines to reduce the amount of pollutants formed during fuel combustion.
- Development of substitute fuels for gasoline.
- Development of pollution free power sources.

Hydrocarbon(HC)

Sources

- Petroleum industry
- Coal
- Wood burning
- Evaporation of solvent
- Natural gas

- Effects on human health:-
- Aromatic hydrocarbon may lead to cancer
- Inhalation of hydrocarbon causes irritation of respiratory tract.
- Methane creates narcotic effects on human beings
- Most of the hydrocarbon are carcinogenic to lungs

Remedy

- By removal of chemical and photochemical reaction from atmosphere

Particulates

- Solid particles in liquid droplets are known as particulates.

Sources

- Volcanic eruption
- Incomplete combustion process (smoke)
- Fly ash from different power plants

Remedy

- The techniques of remedies of particulates are :

i. Gravity settling chamber
ii. Cyclone collector
iii. Filters
iv. Scrubbers

Effects

- If the size of particulates are < 3µm, they are trapped in the nose and throat from which they are easily eliminated but finer particles can stay infected for years in the outermost region of the lungs .
- If the size of particulates are > 3µm it can cause the damage of lungs.
- Corrosive particulates accelerate the rate of corrosion of the material.
- Fumes, aerosols can bring severe damage to soil, buildings and mountains.

Ozone(O_3)

- Pale blue gas present in the stratosphere in the form of layer.
- Allotropic form of oxygen

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

$$O_2 + O^{\cdot} \rightarrow O_3$$

(In upper atmosphere)

$$NO_2 \xrightarrow{h\mu} NO + O^{\cdot}$$

$$O^{\cdot} + O_2 \rightarrow O_3$$

(In lower layer of atmosphere)

- Protects us from harmful UV rays of the sun which can cause skin cancer.
- Ozone layer is depleting due to excessive use of CFCs
- 10 ppm (concentration of Ozone)
- Used as strong germicide disinfectant sterilizing agent to purify atmosphere in kitchen, slaughter houses, theater etc.
- Also used to synthesize camphor and artificial silk

Effects of Ozone layer depletion(photochemical reaction)

- Ozone layer depletion caused increased UV radiation levels at the earth's surface which is damaging to human health.
- It may cause skin cancer, eye problem, immune deficiency disorder, also affect plant growth, reducing agricultural productivity.
- Gradual thinning of earth's ozone layer in the upper atmosphere caused by the release of chemical compounds containing gases chlorine or bromine from industry and other human activity is called ozone layer depletion.

Causes of Ozone layer depletion(photochemical reaction)

- Responsible substances for ozone layer depletion are CO, NO, NO_2, CH_4 and CFC like $CFCl_3$, $CFClF_2$, CF_2Cl_2 etc.
- CFC (Freon's) absorbs UV rays from the sun and decomposes to give Cl atom and it decomposed ozone (1 molecule of CFC can destroy 1 lakh ozone molecules)

$$CF_2Cl_2 \xrightarrow{h\upsilon} CF_2Cl + Cl^{\cdot}$$

$$CFCl_3 \xrightarrow{h\upsilon} CFCl_2 + Cl^{\cdot}$$

$$Cl^{\cdot} + O_3 \rightarrow ClO + O_2$$

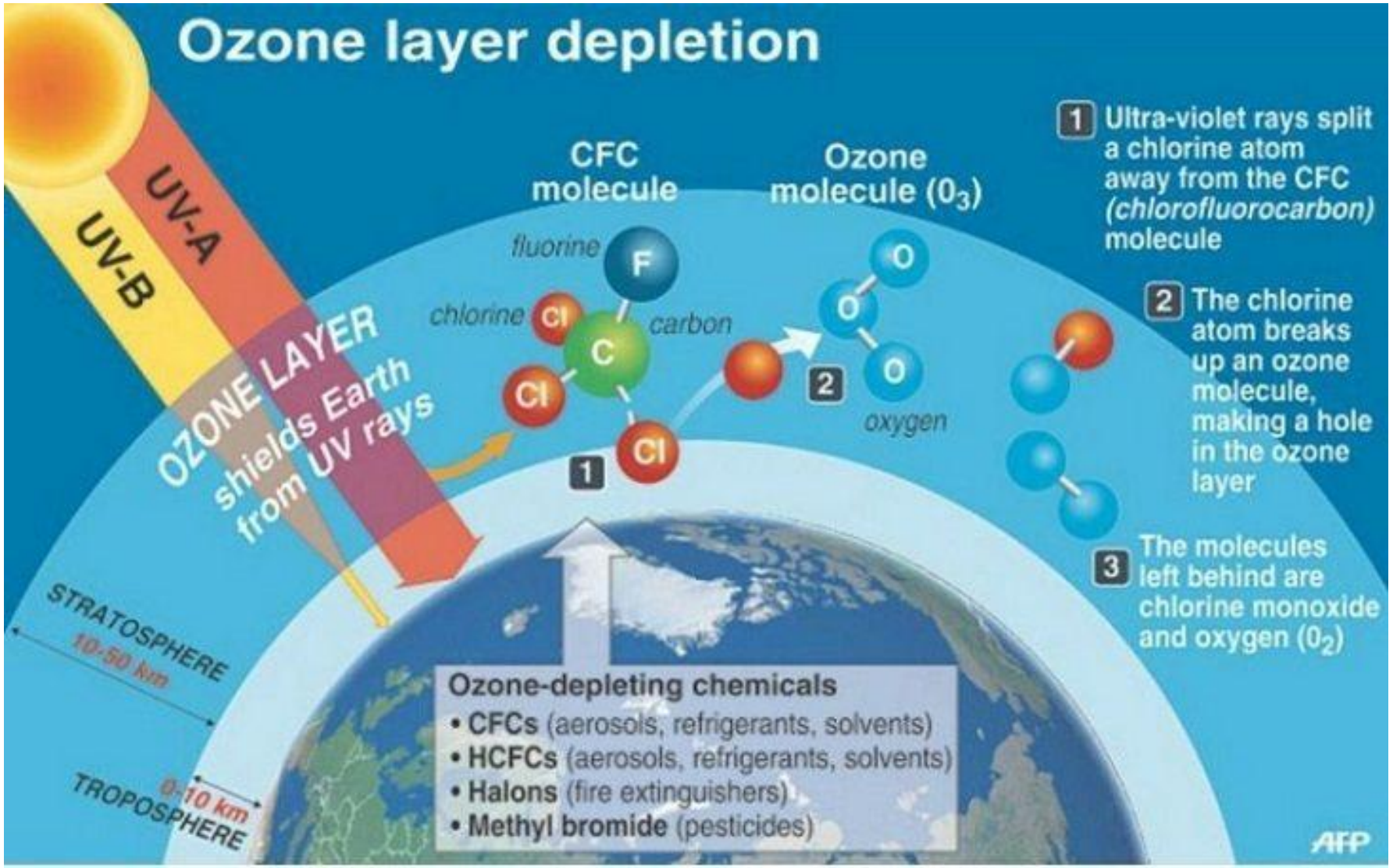
$$ClO^{\cdot} + O \rightarrow Cl + O_2$$

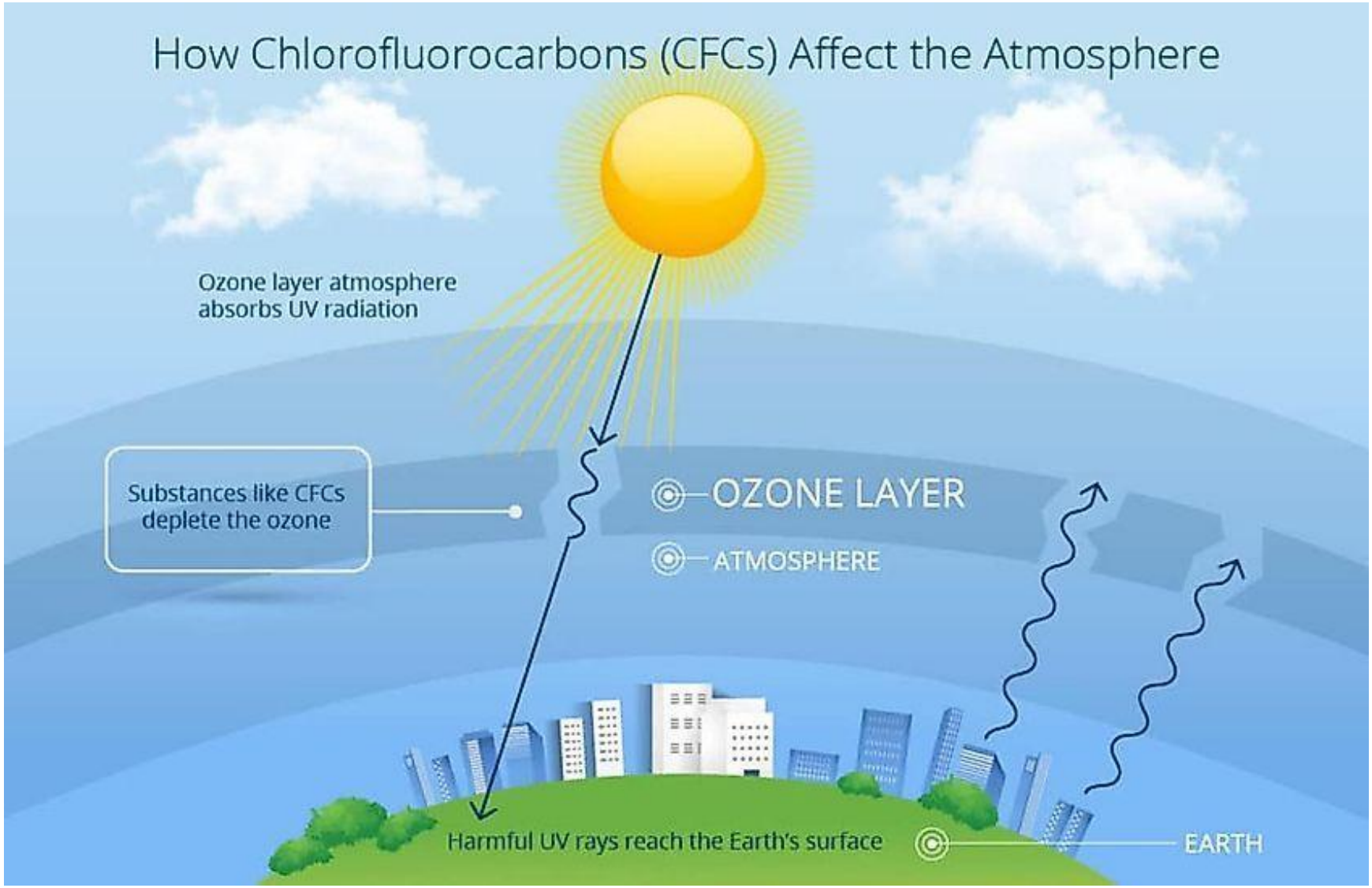
NO can also depletes ozone layer

$$NO^{\bullet}_{(g)} + O_{3(g)} \longrightarrow NO_{2(g)} + O_{2(g)}$$

$$NO_{2(g)} + O^{\bullet}_{(g)} \longrightarrow NO^{\bullet}_{(g)} + O_{2(g)}$$

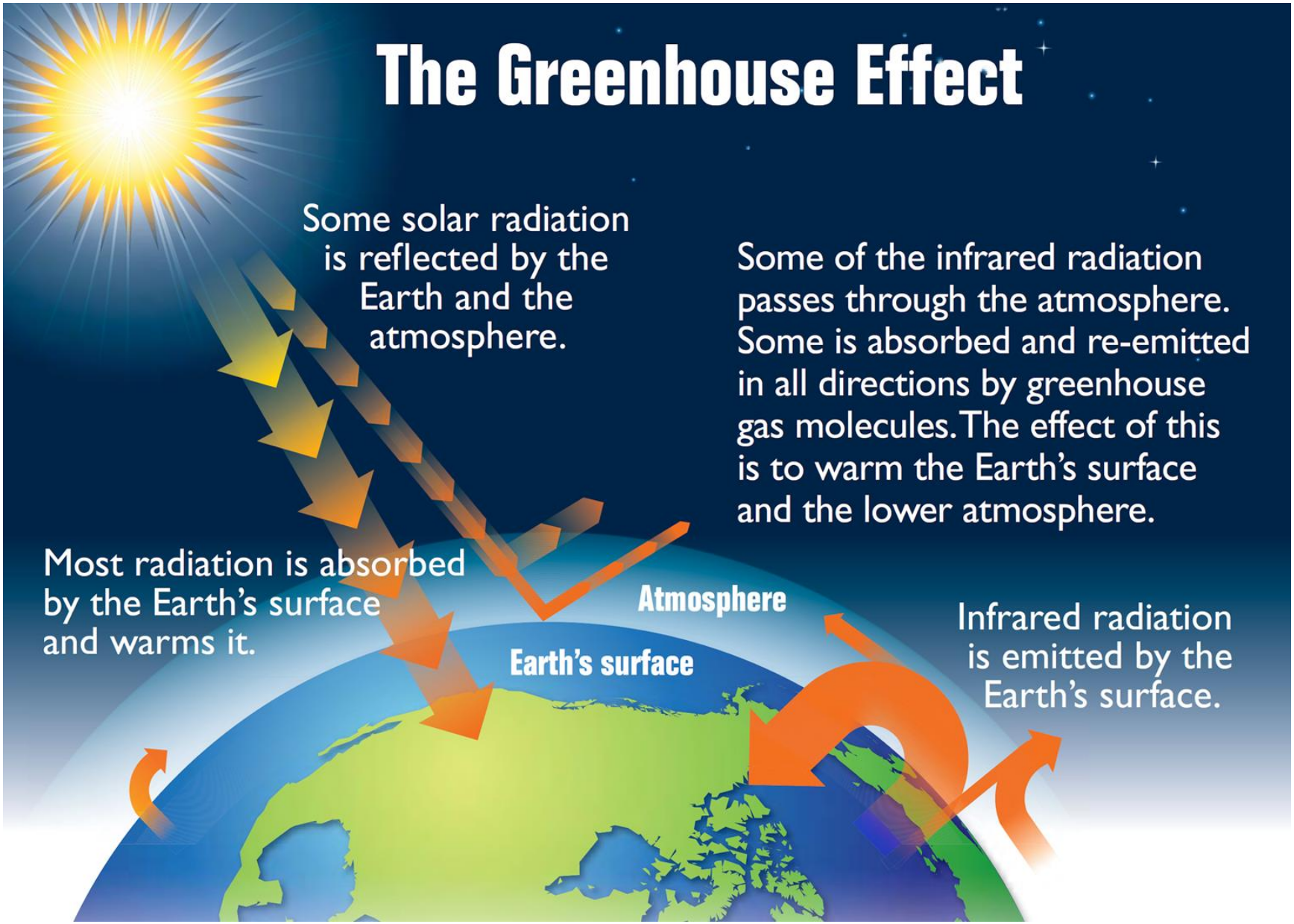
$$O_{3(g)} + O^{\bullet}_{(g)} \longrightarrow 2O_{2(g)}$$


Ozone layer depletion
UV-A
UV-B
OZONE LAYER shields Earth from UV rays
CFC molecule
fluorine
F
chlorine
Cl
C
carbon
Cl
Cl
1
Ozone molecule (0_3)
O
O
O
2
oxygen
1 Ultra-violet rays split a chlorine atom away from the CFC (chlorofluorocarbon) molecule
2 The chlorine atom breaks up an ozone molecule, making a hole in the ozone layer
3 The molecules left behind are chlorine monoxide and oxygen (0_2)
STRATOSPHERE
10-50 km
0-10 km
TROPOSPHERE
Ozone-depleting chemicals
• CFCs (aerosols, refrigerants, solvents)
• HCFCs (aerosols, refrigerants, solvents)
• Halons (fire extinguishers)
• Methyl bromide (pesticides)
AFP


How Chlorofluorocarbons (CFCs) Affect the Atmosphere
Ozone layer atmosphere absorbs UV radiation
Substances like CFCs deplete the ozone
OZONE LAYER
ATMOSPHERE
Harmful UV rays reach the Earth's surface
EARTH

Greenhouse effect

- The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases.
- Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, ozone and some artificial chemicals such as chlorofluorocarbons (CFCs).
- The absorbed energy warms the atmosphere and the surface of the Earth. This process maintains the Earth's temperature at around 33 degrees Celsius warmer.


The Greenhouse Effect
Some solar radiation is reflected by the Earth and the atmosphere.
Some of the infrared radiation passes through the atmosphere. Some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.
Most radiation is absorbed by the Earth's surface and warms it.
Atmosphere
Earth's surface
Infrared radiation is emitted by the Earth's surface.

Global Warming(enhanced greenhouse effect)

- The greenhouse effect is a natural process that warms the earth surface.
- It makes a comfortable place to live.
- In atmosphere different air pollutants like NOx, SOx, CO, HC are available due to human activity or natural process which cause the air pollution. Besides above air pollutants, CO_2 gas performs major role of heating up the atmosphere due to trapping IR rays which is called greenhouse effect.
- The sun rays consist of UV, visible and IR. IR easily passed through the CO_2 layer in the atmosphere. These IR cause heating effect to the object on the earth and atmosphere of the earth.

- The contribution of GHG to the average global temperature is of the order of 33°C warming effect .
- Thus, it has greater role to survive living or non-living organism on earth surface.
- But, every year the world wide concentration of the CO_2 is increasing by the rate of 0.75 ppm and temperature is raising at 0.05 ˚C per year. The current concentration of CO_2 is Mar. 2021 = 417.64 ppm . (source- https://www.co2.earth/annual-co2)
- As a result, temperature is increasing out of control and global warming is seen.
- Global warming refers to climate change that causes an increase in the average temperature of the lower atmosphere. It's a gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, CFCs, and other pollutants.
- Thus, global warming is the unusually increasing earth's average surface temperature over the past century primarily due to GHG released by people during fossil fuel.

Causes and Effects of Climate Change

Causes

- Rapid industrialization
- Energy use
- Agricultural practices
- Deforestation
- Consumer practices
- Livestock
- Transport
- Resource extraction
- Pollution

Effects

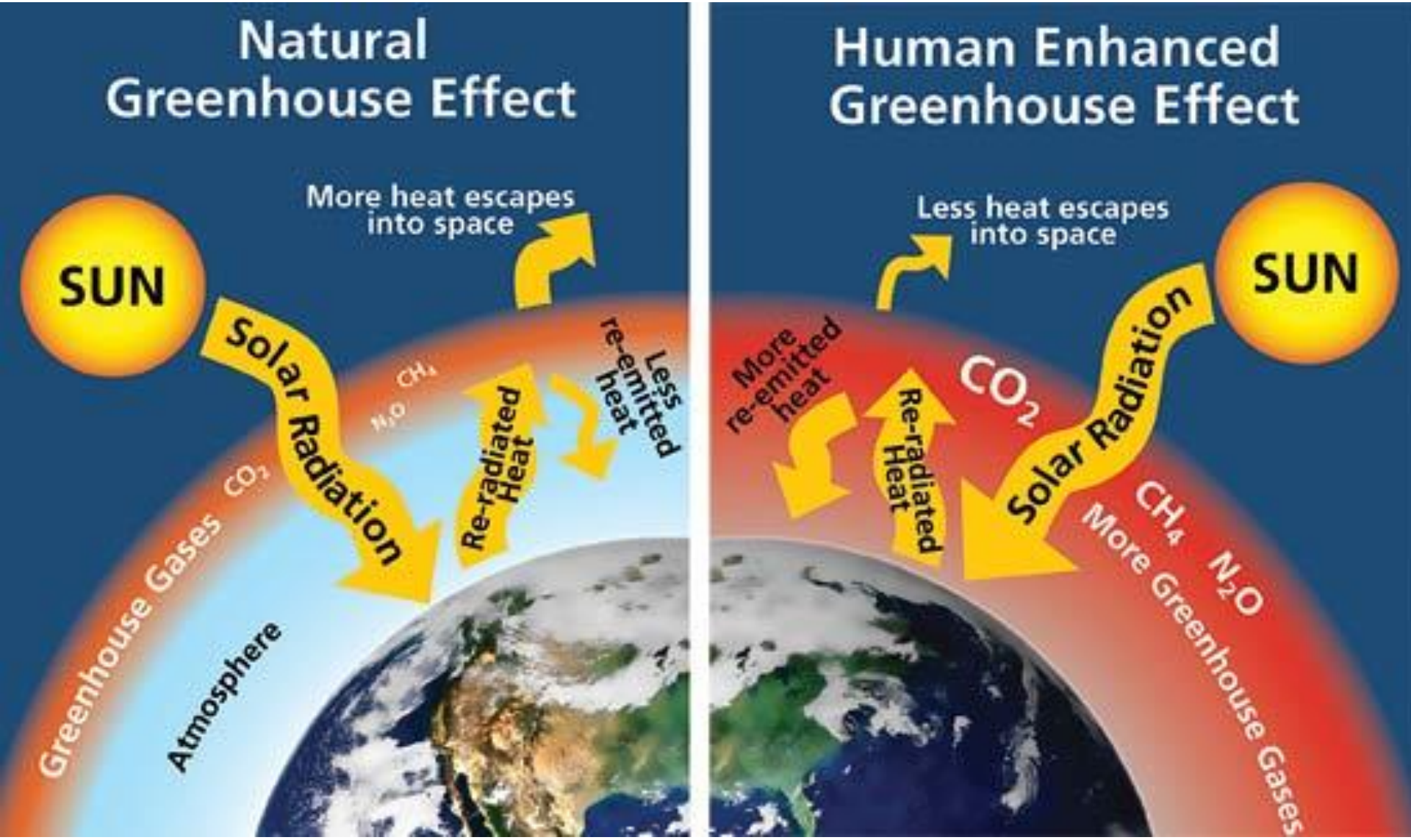
- Rising temperatures
- Rising sea levels
- Unpredictable weather patterns
- Increase in extreme weather events
- Land degradation
- Loss of wildlife and biodiversity

What are the social impacts of climate change?

Displaced people. Poverty. Loss of livelihood. Hunger. Malnutrition. Increased risk of diseases. Global food and water shortages.

Control of Global Warming

- Reducing consumption of fossil fuel.
- Recovering greenhouse gases from atmosphere.
- Reduction in CFC production.
- Reforestation and conservation of forest.
- Development of environmentally compatible technology.


Natural
Greenhouse Effect
More heat escapes
into space
SUN
Solar Radiation
Re-radiated
Heat
Less
re-emitted
heat
CH_4
N_2O
CO_2
Greenhouse Gases
Atmosphere
Human Enhanced
Greenhouse Effect
Less heat escapes
into space
SUN
More
re-emitted
heat
Re-radiated
Heat
CO_2
Solar Radiation
CH_4 N_2O
More Greenhouse Gases

Ozone Depletion vs Global Warming

More Information Online WWW.DIFFERENCEBETWEEN.COM

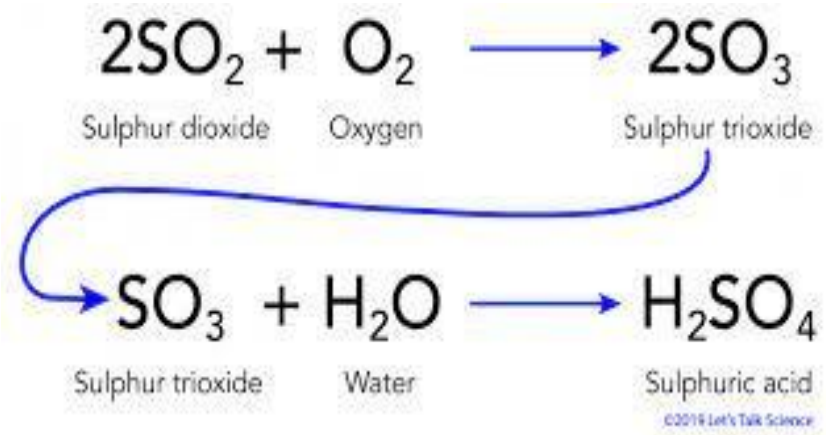
	Ozone Depletion	Global Warming
DEFINITION	Ozone depletion is the thinning of the Earth's ozone layer	Global warming is the gradual increase in the overall temperature of the earth's atmosphere
PROCESS	Decrease the thickness of the ozone layer, thus increasing the amount of UV rays reach the earth's atmosphere	Increase in the temperature due to greenhouse effect caused by increased levels of carbon dioxide, CFCs, and other pollutants
EFFECTS	Skin cancers and malignant melanoma in human skin, increased production of vitamin D, affect the growth of crops, etc.	Rising sea level, regional changes in precipitation, expansion of deserts, etc.

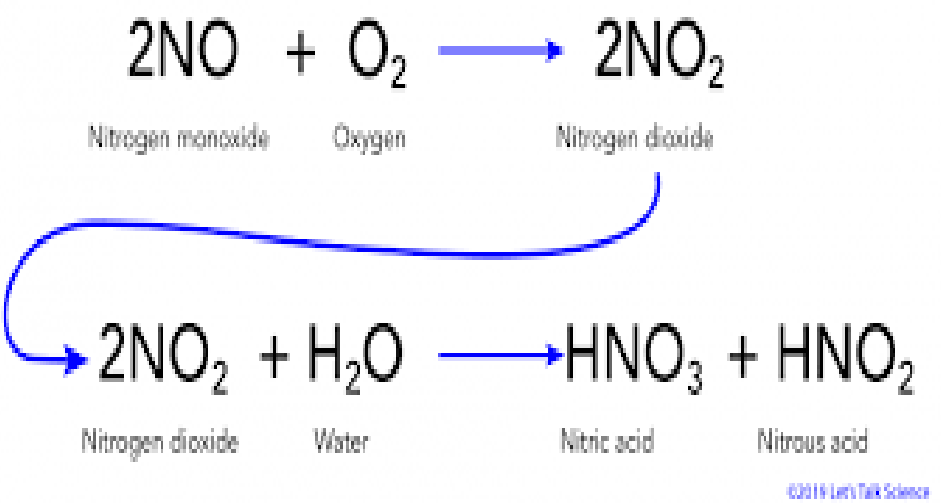
Acid Rain

- Rain water whose P^H value is lower than 5.7 is called acid rain.
- Unpolluted rain water is slightly acidic due to presence of CO_2 in air which combines with water droplets to form a weak solution of carbonic acid having P^H value 5.7.

  $CO_2 + H_2O \rightarrow H_2CO_3$
- In polluted Environment ,the rain passes through an atmosphere polluted with oxides of S and N and during this period, falling water reacts with these oxides to form mixture of sulphuric acid ,nitric acid and water. This is called acid rain whose P^H value is always smaller than 5.7
- Acid rain results when sulfur dioxide (SO_2) and nitrogen oxides (NO_X) are emitted into the atmosphere and transported by wind and air currents.
- The SO_2 and NO_X react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground.

Acid Rain





Effect of acid rain:-

- Increases the acidity of rainwater.
- Causes damage to freshwater life.
- Accelerates the rate of corrosion of metals.
- Damage to building and rocks.
- Changes the fertility rate of soil.

Indoor Air pollution

- Indoor air pollution is dust ,dirt or gases in the air inside a building such as our home and workplace that harms us if we inhaled it during breathing.
- Indoor air pollution may be particulates(microscopic dust and dirt) or gases(CO,NO,SO_2 etc).
- Indoor air pollution occurs when certain air pollutants from particles and gases contaminate the air of indoor areas.
- These air pollutants can cause respiratory diseases or even cancer.

causes of Indoor Air pollution

- **They are caused by many things such as**

i) Asbestos(They are most commonly found in coatings, paints, building materials, ceiling and floor tiles)

ii)Formaldehyde(found in paints, wood floors, Carpets and upholstery materials)

iii) Radon(found in various types of bedrock and other building materials)

iv)Tobacco smoke.

v) Biological pollutants mildew, mold, bacteria, viruses, pollen, dust mites, animal dander)

Causes of Indoor Air pollution

vi)Wood stoves, space heaters, water heaters, fireplaces and dryers, the fuel-burning combustion appliances

vii) Cleansing chemical, also called VOCS like volatile organic compounds like NH_3, acetone, xylene, formaldehyde, bleach etc.(found in air fresheners, carpet cleaner, oven cleaner pesticides and fungicides ,Varnishes and paints etc)

viii) Synthetic fragrances, perfumes, air fresheners and deodorizers

ix) Fumes from paraffin wax candles

xi)Minute particles and gases from office machines and stationery

xii)Dry cleaned clothes(contain trichloroethylene and perchloroethylene, which are highly toxic substances.)

Sources of Indoor Pollutants

Bathroom
Mould, mildew, odours and other microbial pathogens

Air conditioning units
Unable to remove pathogens, VOC's and odours
Circulates without ventilating rooms

Living room
Animal hair dust and dander, tobacco smoke, diesel particles, VOC's from paint, varnishes, upholstery, furniture and carpet

Outdoor air
Particulate matters, pathogens, VOC's, odours and emmissions

Bedroom
VOC's from perfumes, hairspray, nail polish, upholstery, furniture and carpet, dust mites in bedsheets

Laundry room
VOC's from cleaning products, mould, mildew, odours and other microbial pathogens

Kitchen
Cooking devices
Fuel oil

Effect of Indoor Air pollution

- Headaches,
- Respiratory problems,
- Frequent colds and sore throats,
- Chronic cough,
- Skin rashes ,allergy, eye irritation,
- Lethargy, dizziness and memory lapses.
- Long-term **effects** may include an increased risk of lung cancer, asthma ,heart disease and stroke , COPD(chronic obstructive pulmonary disease)

Effect of Indoor air pollutant

Pollutant	Effect
Combustion gases-CO,NO	Headache, vertigo, emesis, lung disease
Volatile organic compounds(VOCs)	the production of cancer
Fomaldehyde	skin stimulus ,lung cancer
ozeon	stimulus on the respiratory organs , exhaustion
Biological agents-molds, spores, danger	allergic disease, respiratory disease
Environmental tobacco smoke	Anxiousness, lung disease, lung cancer
Radon	lung cancer
Particulate matter	stimulus on the respiratory organs and mucous membrane, the production of cancer
Asbestos	skin stimulus ,lung cancer

Remedy of indoor air pollution

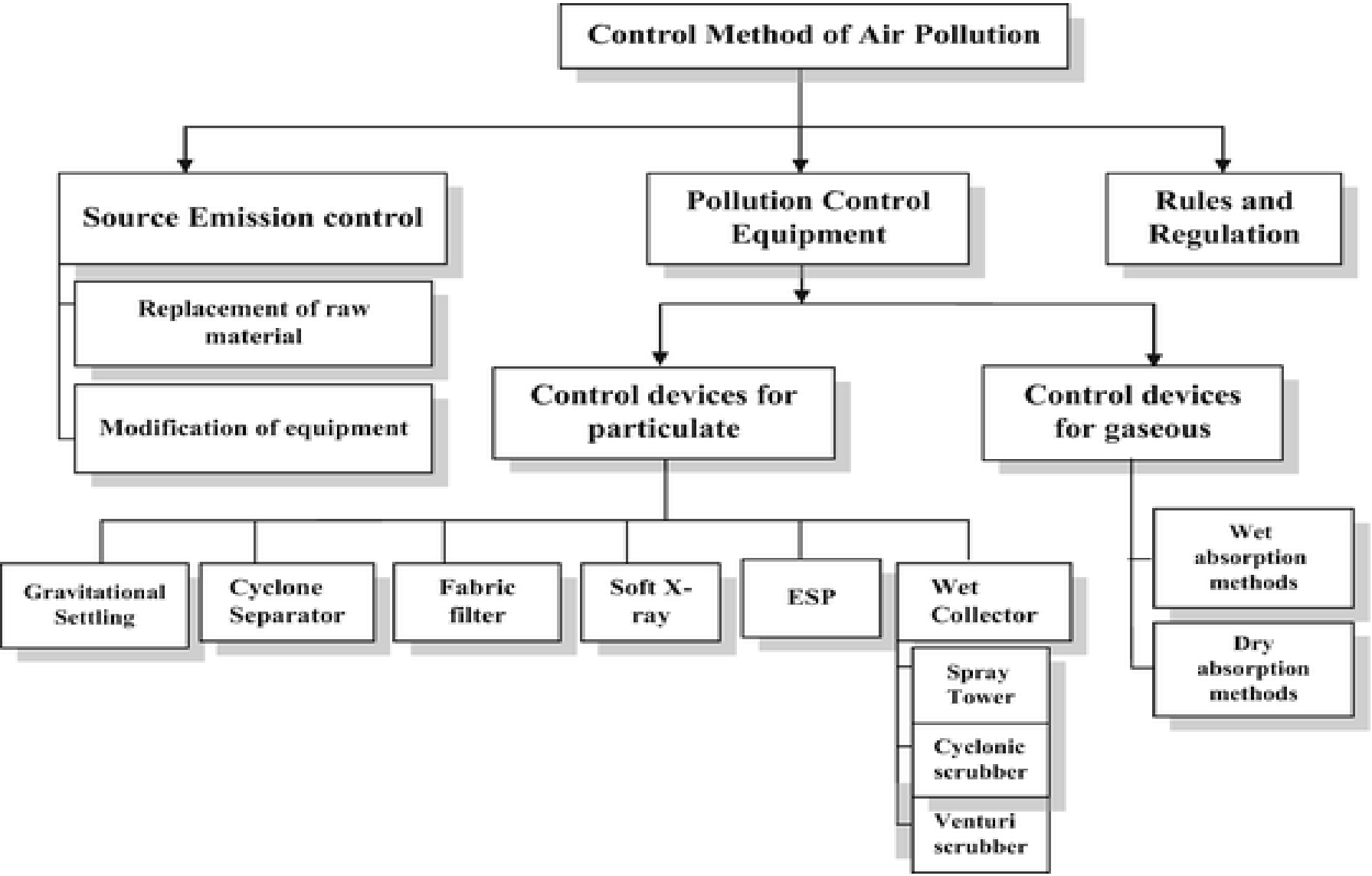
- Source control
- Source isolation
- Increased ventilation
- Dehumidification
- Use of filters
- Use of indoor plants

Air Purifying Plants

Use of Plants to Purify Indoor Air

Control of air pollution (prevention is better than cure)

- Use of purified fuels.
- Emphasis the renewable source of energy.
- Modernization of industries.
- Installation of air treatment plants.
- Change in lifestyle.
- Plantation of trees.
- Environmental education.
- Enforcement of environmental protection act,2076


Control Method of Air Pollution
Source Emission control
Pollution Control Equipment
Rules and Regulation
Replacement of raw material
Modification of equipment
Control devices for particulate
Control devices for gaseous
Gravitational Settling
Cyclone Separator
Fabric filter
Soft X-ray
ESP
Wet Collector
Spray Tower
Cyclonic scrubber
Venturi scrubber
Wet absorption methods
Dry absorption methods