



21CYM101I: ENVIRONMENTAL SCIENCE

M.Tech Sem: 2 ; Batch: 1

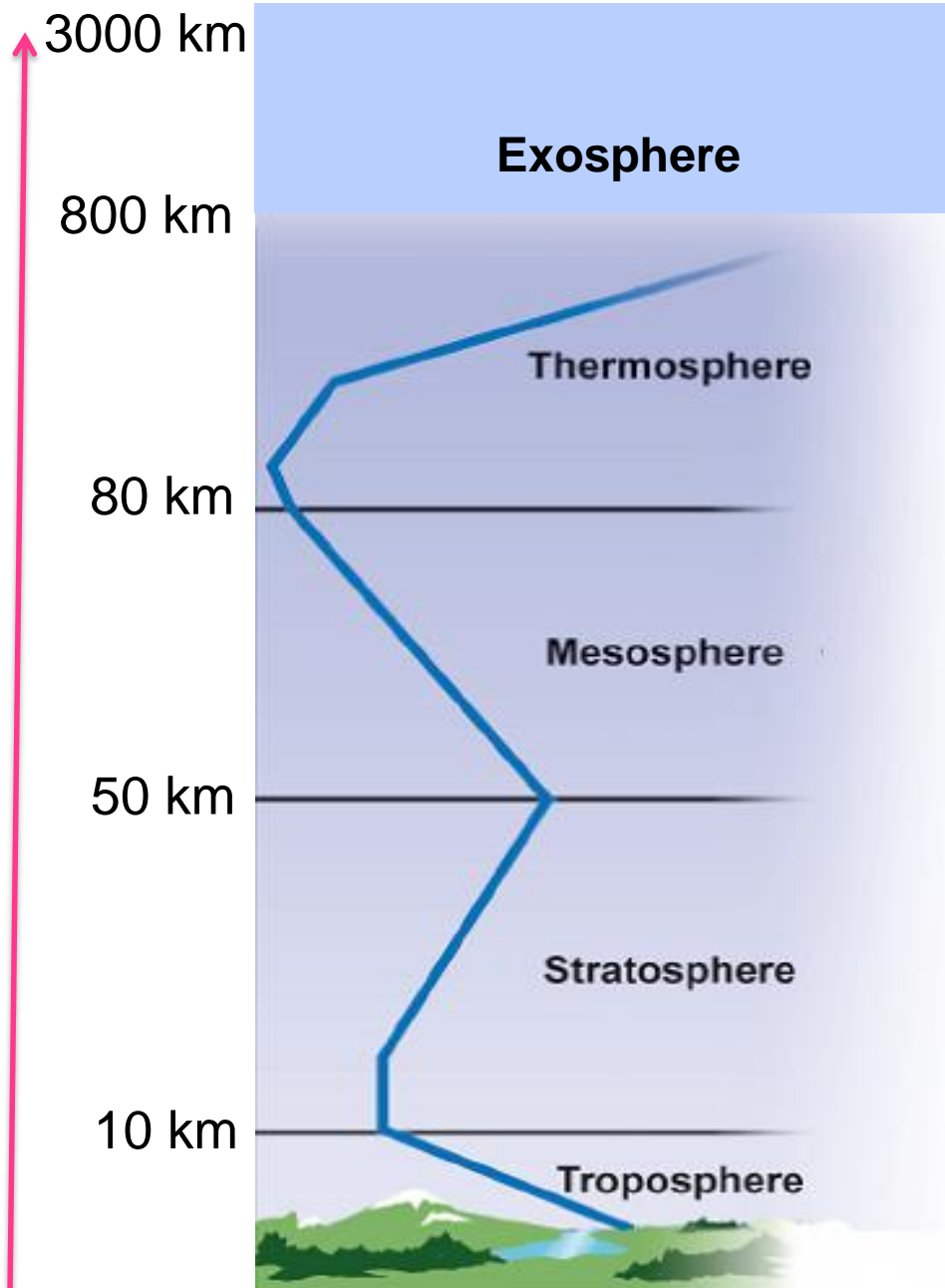
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Environment: one's surroundings

- **Boring's definition:** ``A persons' environment consists of the sum total of the stimulation which he receives from his conception until his death.``
- **Douglas and Holland's definition:** ``The term environment is used to describe, in the aggregate, all the external forces (*e.g., physical, intellectual, economic, political, cultural, social, moral and emotional*), influences, and conditions which affect the life, nature, behaviour, and growth, development and maturation of living organisms.``
- Environment has four segments (1) **atmosphere**, (2) **hydrosphere**, (3) **lithosphere**, and (4) **biosphere**.

Structure of Atmosphere



Radio broadcasting



Coldest layer

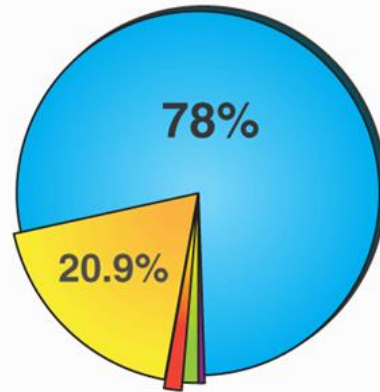


O₃ layer

Weather changes...we live

Earth's Atmosphere

The atmosphere is a blanket of gases and suspended liquids and solids that entirely envelops the earth



N₂ = 78 %
O₂ = 20.9 %
Argon = 0.9 %
CO₂ = 0.04 %
Other gases = 0.16 %

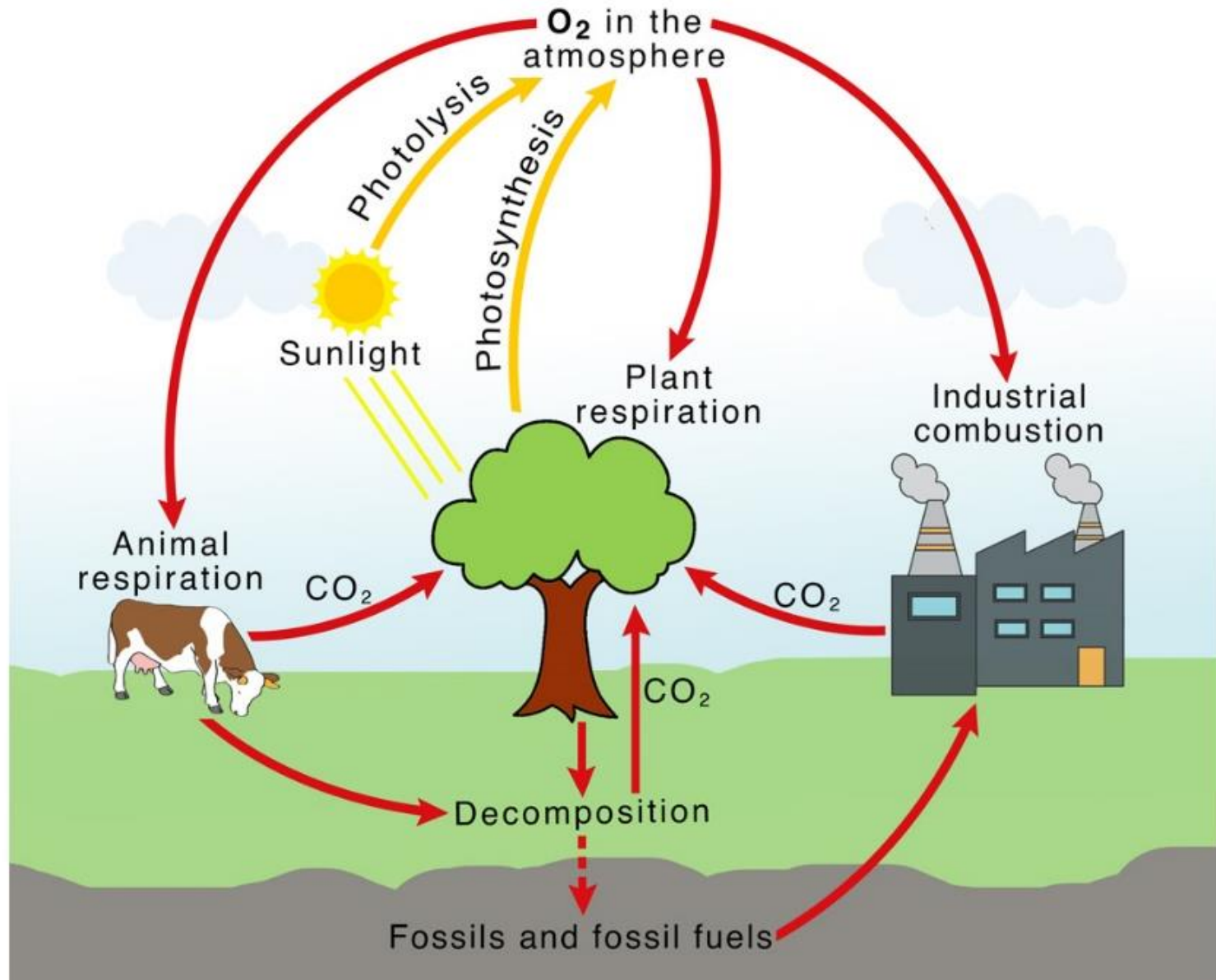
Composition of the Atmosphere Near Earth's Surface

Permanent Gases			Variable Gases	
Gas	Symbol	Percent (by Volume) Dry Air	Gas (and Particles)	Symbol
Nitrogen	N ₂	78.08	Water vapor	H ₂ O
Oxygen	O ₂	20.95	Carbon dioxide	CO ₂
Argon	Ar	0.93	Methane	CH ₄
Neon	Ne	0.0018	Nitrous oxide	N ₂ O
Helium	He	0.0005	Ozone	O ₃
Hydrogen	H ₂	0.0006	Particles (dust, soot, etc.)	-
Xenon	X ₂	0.000009	Chlorofluorocarbons	-

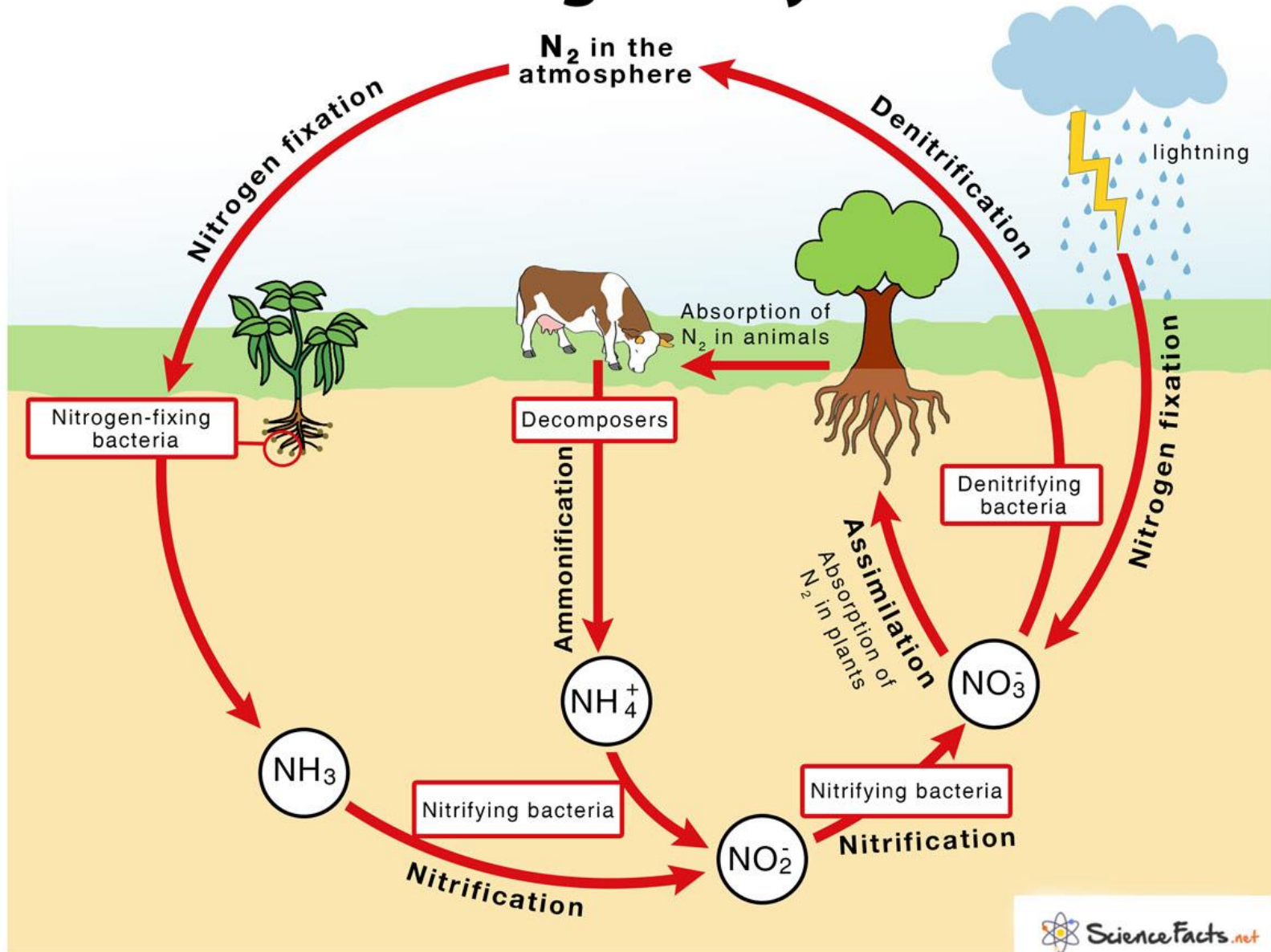
Gases Making Up Atmosphere

- **Permanent Gases** - Those gases whose relative abundance is constant within the homosphere (homogeneous mixture). Ex. O₂, N₂, CO₂ etc..
- **Variable Gases** - Gases present in amounts that vary greatly in abundance, either vertically, horizontal, or seasonal. Water vapor is the most important variable gas.

Oxygen cycle in the atmosphere



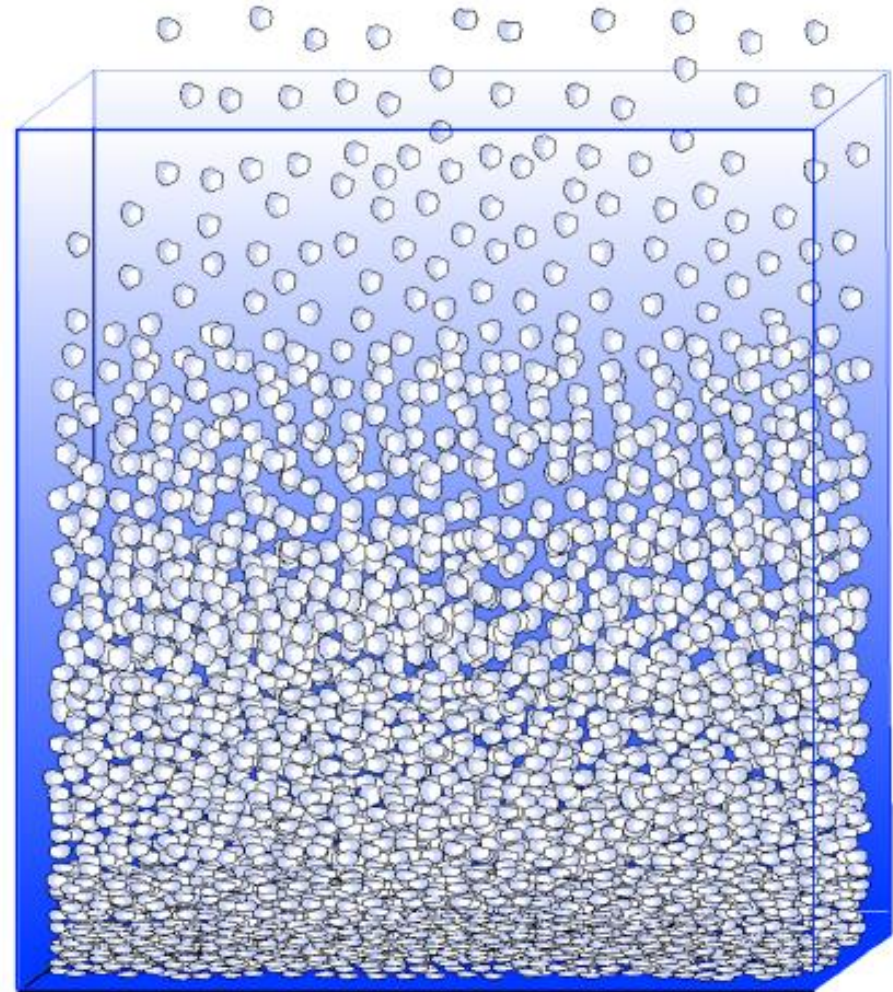
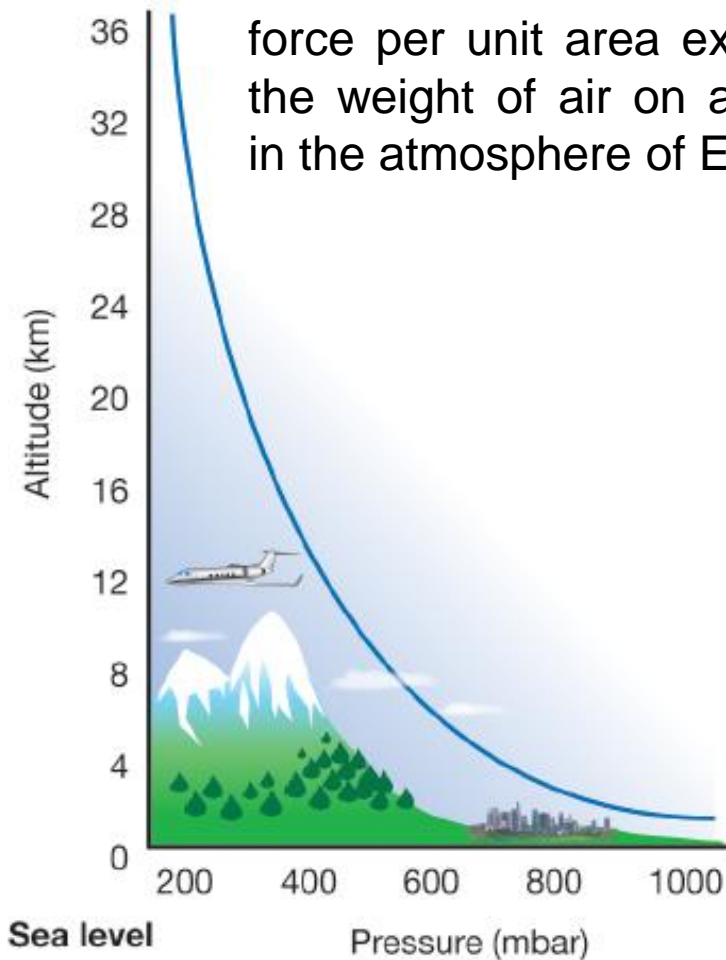
Nitrogen Cycle



Pressure changes with altitude

Pressure varies smoothly from the Earth's surface to the top of the mesosphere.

force per unit area exerted by the weight of air on a surface in the atmosphere of Earth



ENVIRONMENTAL POLLUTION

- **Air Pollution Sources**
- **Effects – acid rain, ozone layer depletion and greenhouse effect**

- **POLLUTION**

Any act that

1. Contaminates the environment.
2. Alters the surroundings unwantedly.
3. Decreases the quality of air, water and soil.
4. Affects the health of human, animals and plants.

- **POLLUTANTS**

The materials which cause Pollution.

CAUSES FOR POLLUTION

1. Tremendous uncontrolled growth of human populations.
2. Rapid industrialization
3. Rapid urbanization
4. Deforestation
5. Radio activities

Classification of Pollution

- Air pollution
- Water pollution
- Soil pollution
- Marine pollution
- Noise pollution
- Thermal pollution
- Nuclear (radioactive) pollution.

Air pollution

- ❖ Contamination of atmospheric air by gases, dust, smoke and wastes.
- ❖ Most of the air pollutant present in the troposphere.
- ❖ Injurious to living organism.



- Every person breathes ~ 22000 times /day and inhales 15-22 Kg of air daily.
- Polluted air causes physical illness, besides undesirable aesthetic and physiological effect.
- **WHO's definition:** Substances put into air by the activity of mankind into concentration sufficient to cause harmful effect to his health, vegetables, property.

Sources of air pollution

1. Natural sources

2. Man made (anthropogenic) sources

1. Natural sources

a) **Volcanic eruption** (CO_2 , SO_2)

b) **Forest fires** (CO_2 , CH_4 , N_2O)

c) **Biological decay** (H_2S , CH_4)

d) **Sand storms** (particulates)

2. Man-made sources

(a) Thermal power plants (CO_2 , SO_2)

(b) Vehicular emission (CO , NO_2 , C_6H_6 , Pb , SO_2 , polycyclic aromatic hydrocarbon (PAH), hydrocarbon, particulate).

(c) Fossil fuel burning (NO_2 , SO_2)

(d) Agricultural activities (H_2S , pesticides, and particulate matter)

(e) Smoking (CO , NO_2 , hydrocarbon, particulate)



Classification of air pollutants

i) Primary pollutants

ii) Secondary pollutants

- **Primary pollutants**: Substances directly emitted from a process.

Examples: Ash, CO₂, and SO₂ from a volcanic eruption, the carbon monoxide (CO) gas from a motor vehicle exhaust or sulfur dioxide (SO₂) released from factories.

- **Secondary pollutants** are not emitted directly. Rather, they form in the air when primary pollutants react or interact.

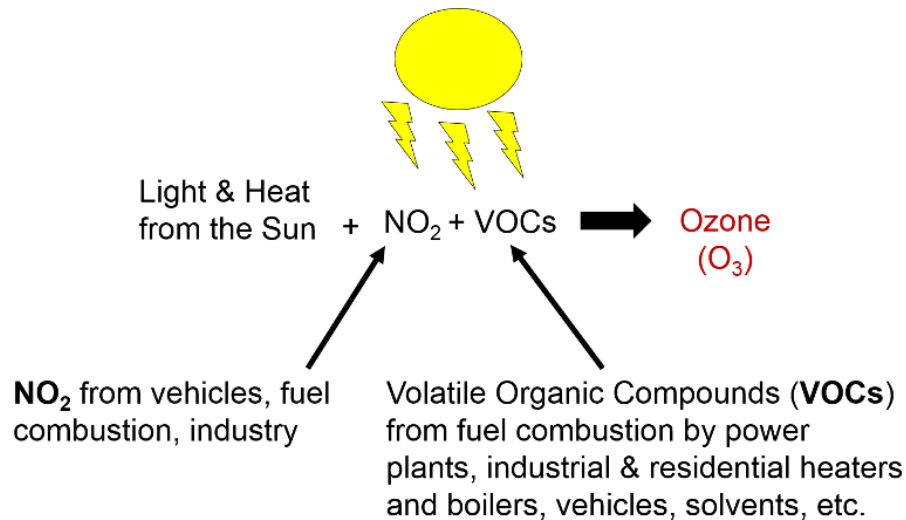
Examples: Ground level O₃ ozone is a prominent example of a secondary pollutant.

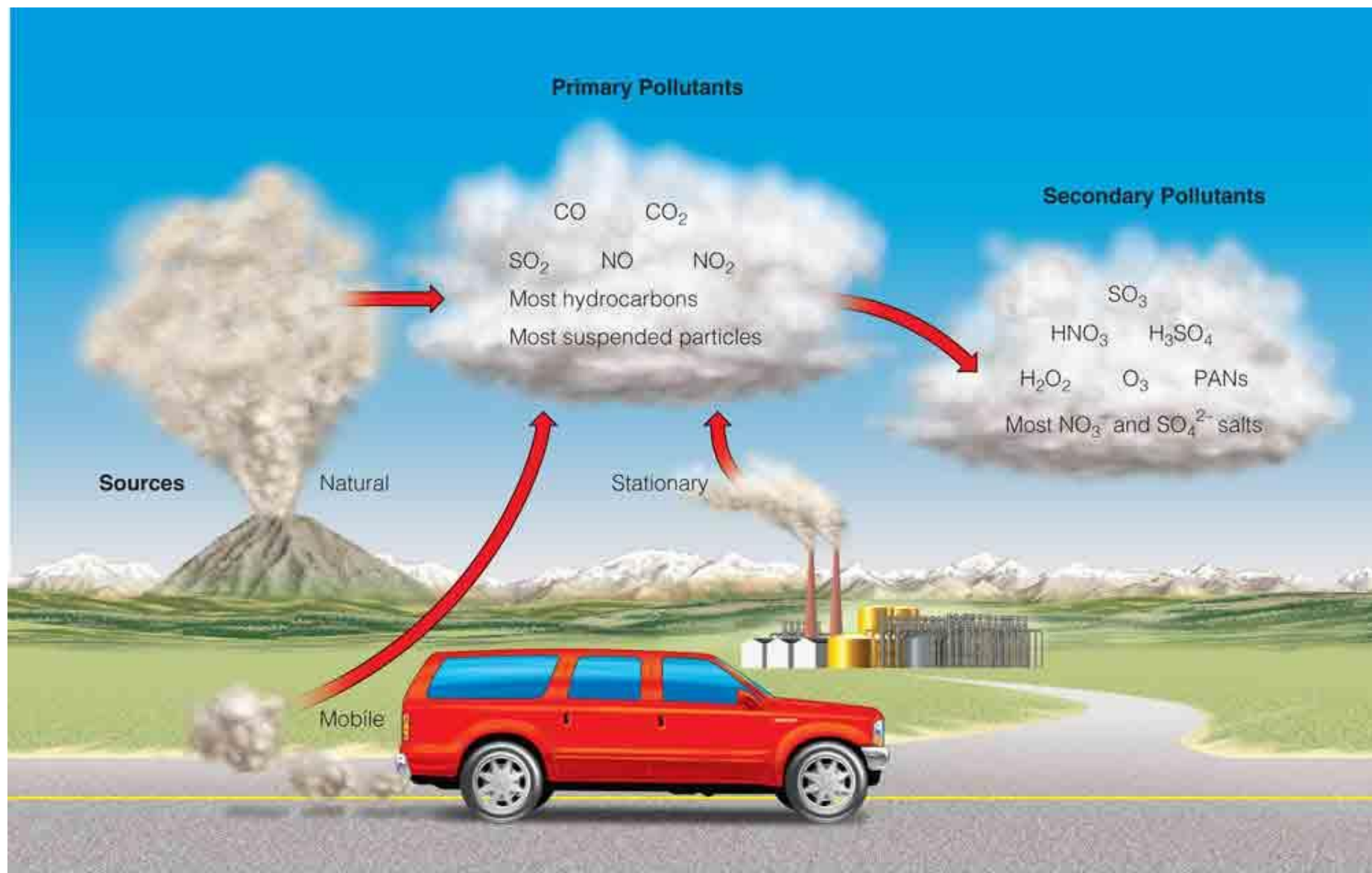
ii) Secondary pollutants

Ozone (O_3): forms when hydrocarbons (HC) and nitrogen oxides (NO_x) combine in the presence of sunlight.

NO_2 : is formed as NO combines with oxygen in the air

Acid rain: produced when sulfur dioxide or nitrogen oxide react with water.

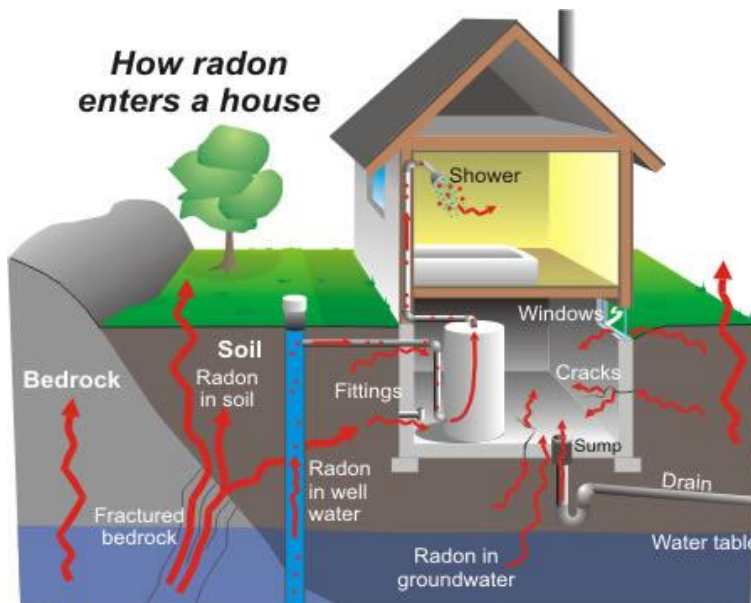




INDOOR AIR POLLUTANTS

Sources(causes):

- Radon gas: emitted from the building material like bricks, concretes, tiles etc. (**radioactive polonium, lead, and bismuth**)
- Burning of fuels in the kitchen, cigarette smoke liberates the pollutants like CO, SO₂.



Air pollutants may exist in two major forms (1) gases and (2) particulates

(microscopic particles of solid or liquid matter suspended in the air)

1. Gases: SO_2 , SO_3 , CO , CO_2 , NO_x , H_2S , O_3 .

2. Particulates: Dust, Smoke, Smog, Lead dust, Polynuclear aromatic hydrocarbon (PAH).

Common Air Pollutants: Sources and their Effects

Carbon monoxide (CO)

- **Properties:** Colorless, Odorless and toxic gas.
- **Sources:** About 77% comes from motor vehicles (mainly petrol engine vehicles), Cigarette smoking, Industrial source, Automobile exhaust gases.

Human sources of CO

- Incomplete combustion of fossil fuel
- Power plants

Human health effects

- CO binds with hemoglobin (RBC) to form carboxy hemoglobin, thereby hampering the transfer of oxygen to the tissues. Headache, anemia. At high levels it leads to coma and death.

Environmental effects

- It increases global temperature.

Sulphur dioxide (SO₂)

- Colorless and irritating gas.
- Formed from burning of coal and oil.
- It is converted into sulphurous acid (H₂SO₃) in acid rain process.

Human sources

- Power plants 88%.
- Industrial process 10%.

Health effects

- Breathing problems even for healthy people, eye irritation, throat problem, cardiac diseases to human.

Environmental effects

- Damage to agriculture, Chlorophyll destruction
Sulphurous acid in acid rain damage trees, plants, soil and aquatic life.

Carbon dioxide (CO₂)

- Colorless and odorless green house gas.
- Formed from combustion of fossil fuel, woods, etc. cement production.

Human sources

- Respiration process, Power plants

Health effects

- Respiratory disorders and suffocations

Environmental effects

- Increasing the temperature of climate.
- Each degree Celsius rise in temperature caused due to carbon dioxide levels could cause about 1,000 deaths. The gas boosts concentrations of surface ozone, particles and carcinogens, all of which are harmful to human health.

Ozone (O₃)

- i) Highly reactive
- ii) Irritating gas
- iii) Unpleasant odour
- iv) It forms in the troposphere
- v) It is a major component in the smog.

Human sources

- Nitrogen oxides
- Volatile organic compounds (VOC)

Health & Environmental effect

- Skin cancer in animals and human, causes lung infection, destruction of life in earth, moderates the climate

Sulphur trioxide(SO_3)

- Oxidation of SO_2 in the atmosphere under the influence of sunlight.
- Even 1 ppm of SO_3 in the air causes breathing trouble and irritation to the respiratory tract:

Hydrogen sulphide (H_2S)

- H_2S enter the atmosphere as the pollutant through decomposition of sewage wastes or organic matter from various industries.
- It is poisonous, it blackens the lead paints and causes corrosion of metals.

Nitrogen Oxides (N_2O , NO , NO_2)

Sources

- Combustion of fuel
- Acid manufacture
- Explosive industry
- Acid packing plants
- High temperature combination of N_2 and O_2

Health & environmental effects

- ❑ Human respiratory tract irritation, Eye irritation
- ❑ Damage to plants
- ❑ Reaction of hydrocarbon under sunlight form smog (produces O_3)
- ❑ Formation of nitric acid causes acid rain problems

Smoke is a collection of airborne particulates and gases emitted when a material undergoes combustion or pyrolysis,

Fog is a visible aerosol consisting of tiny water droplets or ice crystals suspended in the air at or near the Earth's surface.

Smog (Smoke + Fog)

- Smog, seen in the morning in winter when the humidity is very high.
- Smog is a kind of air pollution, commonly occurred in the industrial urban areas.
- presence of SO_2 along with the particulates. Sulphur dioxide oxidizes into sulphur trioxide in the atmosphere and forming acid aerosol.

Health effects

- Breathing problems, Cough, Heart diseases, Eye, Nose and Throat irritation.

Environmental effects

- Ozone depletion, It reduces the visibility, It can damage plants and trees

PHOTOCHEMICAL SMOG

- Photochemical smog is produced when pollutants from the combustion of fossil fuels react (nitrogen oxides and VOCs) with sunlight.
- When nitrogen oxides and VOCs interact with sunlight, secondary pollutants are formed, such as ozone and peroxyacetyl nitrate (PAN). These secondary pollutants are what we have been calling photochemical smog.
- Ozone causes serious problems with our lungs and vision. PAN is one of the chemicals that is responsible for damaging lung tissue.
- This is a toxic mixture of NO₂, troposphere Ozone, volatile organic compounds and peroxy-acetyl nitrate (PAN).
- All these chemicals are highly reactive and oxidizing substances. They are creating chemically reducing atmosphere