AIR POLLUTION

1. Pollution:

- **Pollution**: Addition of undesirable substances into the environment due to human activities.
- **Pollutants**: Physical, chemical or biological agents causing harm to humans, organisms, property, or ecological processes.
- **Major types**:
  - Air
  - Water
  - Soil
  - Noise
  - Thermal
  - Radiation
- **Legal Framework**:
  - **Environment (Protection) Act, 1986**
  - Enacted after **Bhopal Gas Disaster (1984)**

2. Air Pollution: Definition

- Presence of **solid, liquid or gaseous substances** (including noise & radiation) in the atmosphere at concentrations harmful to:
  - Human health
  - Other organisms
  - Property
  - Environmental processes

3. Major Sources of Air Pollution

- Burning of **fossil fuels** (coal, petroleum)
- **Thermal power plants**
- Industries & mining
- Vehicular emissions
- Construction activities
- Stone quarries

Key Point: Fossil fuels contain **nitrogen & sulphur** → oxides formed on combustion.

4. Acid Rain & Marble Cancer

- Oxides of **Nitrogen (NOx)** & **Sulphur (SO_2)** react with water vapour →
  - **Nitric acid (HNO_3)**
  - **Sulphuric acid (H_2SO_4)**
- Precipitation of acids → **Acid Rain**

- **Marble Cancer**: Corrosion of marble monuments (e.g., **Taj Mahal**)

5. Smog

- Mixture of **smoke + fog**
- Caused by:
  - Suspended particulates
  - Hydrocarbons
  - Condensed water vapour
- Reduces visibility, especially in winter

6. Classification of Pollutants

A. Based on Formation

Primary Pollutants

- Emitted directly
- Examples:
  - CO, CO_2
  - SO_2, NOx
  - Plastics, DDT

Secondary Pollutants

- Formed by chemical reactions
- Example:
  - **PAN (Peroxyacetyl Nitrate)**

B. Based on Occurrence

Quantitative Pollutants

- Naturally present but harmful beyond threshold
- Examples: CO_2, NOx

Qualitative Pollutants

- Not found naturally
- Human-made
- Examples: DDT, herbicides, fungicides

7. Particulate Pollutants (SPM)

- Suspended matter: dust, soot, fly ash
- Size range: **0.001 – 500 µm**

Size	*Behaviour*
>10 µm	*Settle down*

Size	Behaviour
<10 µm	Float freely
<2.5 µm (PM2.5)	Most harmful
<0.02 µm	Persistent aerosols

- **PM2.5** (CPCB): Causes maximum health damage
- Diseases:
  - Asthma
  - Bronchitis
  - **Pneumoconiosis**

8. Fly Ash

Source

- Coal-based **thermal power plants**

Composition

- Silica (SiO_2)
- Alumina
- Calcium oxide (CaO)
- Heavy metals: **Lead, Arsenic, Cobalt**

Impacts

- Air & water pollution
- Crop damage (leaf deposition)
- Heavy metal contamination

Uses

- Fly ash bricks
- Cement replacement (up to **35%**)
- Road embankments
- Mine filling
- Soil fertility improvement

Policy

- Mandatory use within:
  - **100 km** of Thermal Power Plant (construction)
  - **50 km** for mine filling

9. Heavy Metal Pollutants

Lead

- Sources:
  - Petrol (TEL)
  - Batteries
  - Paints
- Effects:
  - Nervous system damage
  - Kidney & liver damage
  - Reduced IQ in children
  - Cumulative poisoning

10. Nanoparticles (NPs)

- Size: ~**1 nanometre**
- Sources:
  - Natural: volcanoes, forest fires, dust storms
  - Man-made: industrial & mechanical processes

Environmental Impacts

- Accumulate in air, water, soil
- Enter food chains
- Produce **Reactive Oxygen Species (ROS)**

Special Effects

- **Asian Brown Clouds** → Glacier melting
- Ozone depletion (Cl^- radicals)
- Stratospheric cooling (via water vapour & PSCs)

11. Major Gaseous Air Pollutants

Carbon Monoxide (CO)

- Colourless, odourless, toxic
- Source: incomplete combustion
- Forms **carboxyhaemoglobin**
- Not a GHG but promotes:
  - Ozone formation
  - Methane increase

Carbon Dioxide (CO_2)

- Greenhouse gas
- Causes:
  - Global warming
  - Ocean acidification

- 7% concentration → fatal asphyxiant

Chlorofluorocarbons (CFCs)

- Used in ACs, refrigerators, aerosols
- Cause ozone depletion
- Controlled under **Montreal Protocol**

Ozone (O_3)

- **Stratosphere**: Protective
- **Troposphere**: Toxic pollutant
- Causes:
  - Eye irritation
  - Respiratory issues

Nitrogen Oxides (NOx)

- Produced at high temperatures
- Sources:
  - Engines
  - Power plants
  - Lightning
- Effects:
  - Acid rain
  - Smog
  - Tropospheric ozone

Sulphur Dioxide (SO_2)

- Pungent smell
- Causes acid rain
- Sources:
  - Coal burning
  - Volcanic eruptions
  - Ore roasting

Volatile Organic Compounds (VOCs)

- Easily evaporate
- Sources:
  - Paints
  - Perfumes
  - Furniture polish
- Effects:
  - Headache

- Nausea
- Liver damage

12. Other Pollutants

Benzene

- Component of petrol
- Causes cancer & bone marrow failure

Ethylene

- Used for fruit ripening
- Low toxicity
- **Ethylene oxide** is carcinogenic

Biological Pollutants

- Pollen, fungi, mites
- Cause asthma & allergies

Asbestos

- Causes:
  - Lung cancer
  - Mesothelioma
  - Asbestosis

Radon

- Soil-emitted radioactive gas
- Causes lung cancer in poorly ventilated houses