Hazardous Waste: Characteristics, Generation, Treatment, and Disposal

Hazardous waste refers to waste that poses substantial or potential threats to public health and the environment due to its toxic, reactive, corrosive, flammable, or infectious nature.
Its management requires special handling, treatment, and disposal methods to prevent contamination of soil, water, and air.

2. Characteristics of Hazardous Waste

- **Ignitability** – wastes that can easily catch fire (solvents, oils, fuels).
- **Corrosivity** – acids or alkalis that can corrode containers and damage ecosystems.
- **Reactivity** – unstable chemicals that can cause explosions or toxic gas release.
- **Toxicity** – harmful substances (heavy metals, pesticides) that can cause poisoning and diseases.
- **Infectious Nature** – biomedical waste carrying pathogens.

3. Generation of Hazardous Waste

- **Industrial Sources**
  - Chemical manufacturing, petroleum refineries, textile dyeing, tanneries.
  - By-products like heavy metals, acids, solvents, and sludge.
- **Agricultural Sources**
  - Pesticides, herbicides, fertilizers, and packaging residues.
- **Medical and Biomedical Sources**
  - Expired medicines, syringes, bandages, infectious laboratory waste.
- **Household Sources**
  - Batteries, paints, cleaning agents, insecticides.
- **E-Waste**
  - Computers, mobile phones, and appliances containing lead, mercury, cadmium.

4. Treatment of Hazardous Waste

- **Physical Methods**
  - Filtration, sedimentation, encapsulation of solid waste.
- **Chemical Methods**
  - Neutralization of acids/alkalis, oxidation-reduction reactions, precipitation of metals.
- **Biological Methods**
  - Bioremediation using microbes to degrade toxic compounds.
  - Phytoremediation using plants to absorb heavy metals.
- **Thermal Methods**
  - Incineration to destroy organic toxins.
  - Pyrolysis and gasification for energy recovery.

5. Disposal of Hazardous Waste

- **Sanitary Landfills (Engineered)**
  - Secure landfills with liners, leachate collection, and gas recovery systems.
- **Deep Well Injection**
  - Liquid hazardous waste injected into deep rock formations.
- **Encapsulation**

        - Hazardous waste sealed in drums or concrete blocks before burial.
- **Export and Co-processing**
    - Use of cement kilns and controlled export under **Basel Convention**.

6. Conclusion

Hazardous waste is a major environmental and health risk if not properly managed.
Effective handling requires prevention at source, strict regulations, advanced treatment, and scientific disposal.
Adopting cleaner production technologies, recycling, and secure landfills ensures protection of ecosystems and human health while promoting sustainable development.