Chapter No.

16 Green Chemistry and Nanochemistry

Subtopics

The toxicity of Benzene

Benzene (C_6H_6) is widely used as a solvent in synthesis of various organic compounds. It is present in gasoline, automobile emissions as well as cigarette smoke. It has been categorised as air pollutant and a known carcinogen. Chronic exposure to benzene leads to leukemia and aplastic anemia (involves bone marrow damage).

Industrial workers are more prone to develop leukemia when are exposed to benzene (around 1 ppm) in atmosphere for long time. Thus, study of Green chemistry is important in designing safer chemicals.

Warning
Harmful chemicals

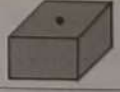
Quick Review

- **The 12 principles of green chemistry:**
  - i. Prevention of waste or by products
  - ii. Atom economy
  - iii. Less hazardous chemical synthesis
  - iv. Designing safer chemicals
  - v. Use of safer solvent and auxiliaries
  - vi. Design for energy efficiency
  - vii. Use of renewable feed stocks
  - viii. Reduce derivatives (Minimization of steps)
  - ix. Use of catalysis
  - x. Design for degradation
  - xi. Real-time analysis pollution prevention
  - xii. Safer chemistry for accident prevention

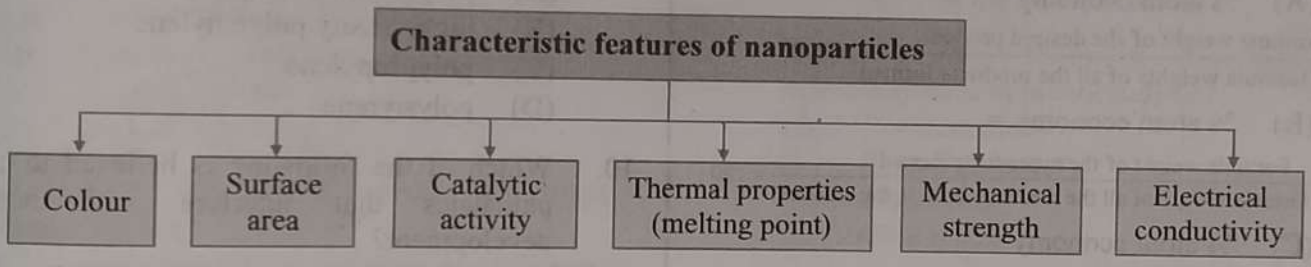
- **Formula of atom economy:**

$$\% \text{ atom economy} = \frac{\text{Formula weight of the desired product}}{\text{Sum of formula weight of all the reactants used in the reaction}} \times 100$$

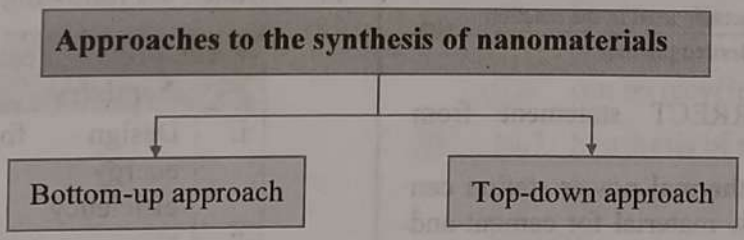
- **Types of nanomaterials according to dimensions:**

Nanomaterial Dimension	Nanomaterial Type	Example
All three dimensions < 100 nm	Nanoparticles, Quantum dots, nanoshells, nanorings, microcapsules	
Two dimensions < 100 nm	Nanotubes, fibres, nanowires	
One dimension < 100 nm	Thin films, layers and coatings	

Characteristic features of nanoparticles:



Synthesis of nanomaterials:



Techniques used for analysis or characterization of nanomaterials:

Name of technique	Information obtained
UV-visible spectroscopy	Preliminary confirmation of formation of nanoparticles
X-ray diffraction (XRD)	Particle size, crystal structure, geometry
Scanning Electron Microscopy (SEM)	Structure of surface of material i.e. morphology
Transmission Emission Microscopy (TEM)	Particle size
Fourier Transform Infrared Spectroscopy (FTIR)	Absorption of functional groups and binding nature