Overview - Nanophysics

1. Definition - nanoscale, nanoscience, nanomaterial, nanoparticle, quantum dot, nanostructures.
2. Classification of nanomaterials : (i) 1-D nanomaterial (ii) 2-D nanomaterial (iii) 3-D nanomaterial.
3. Why properties change when we move from bulk to nano scale :
   (i) Surface area to volume ratio increases
   (ii) Band Gap changes (increases)
   (iii) Quantum Confinement or Electron Confinement comes into play - which in simple words means that when we move from bulk to nano sized paricles, particle is not free to have continuous values of energy and momentum.
4. Classification of Nanomaterials :
   (i) Carbon Based like fullerenes and Carbon nanotubes
   (ii) Metal Based like nanogold, nanosilver
   (iii) Dendrimers - nanosized polymers with branched units
   (iv) Nanocomposites - multiphase solid material in which one type of nanoparticles are combined with other type of nanoparticles.
5. Properties of Nanoparticles/nanomaterials (in brief)
   (i) Optical (ii) Electrical (iii) Mechanical (iv) Chemical (v) Magnetic properties.
6. What are Carbon nanotubes (CNTs) - Give their classification/types. Write their peculiar properties. Mention some applications.
7. Synthesis techniques of nano materials -
   (A) Ball Milling Technique - Mechanical method - Top to bottom technique -

Main Steps in Ball Milling Technique (Top-Bottom Technique)

1. Collision and Grinding-Trapping of particles in colliding balls
2. Compaction- (i) Rearrangement and restacking of particles (ii)

Elastic and Plastic deformation of particles

3. Particle Fracture- Deformation and fragmentation of particles

   (B) Sol - Gel Technique - Chemical Technique - Bottom to Up technique -

Main Steps involved in Sol-Gel Technique (Bottom-Up Technique)

1. Mixing- Formation of stable solution
2. Gelation or Gelling- Formation of Gel from solution
3. Aging & Shape formation-Transformation of gel into solid mass via polycondensation reactions
4. Drying and Dehydration -(i) Removal of water and/or other volatile liquids from the gel network and (ii) Removal of surface bound M-OH groups to avoid rehydration
5. Densification & Decomposition- Collapsing of pores and removal of remaining organic species(volatile in nature) at high temperatures

Write advantages/disadvantages of these techniques. Which technique is better ?

8. Applications of nanotechnology
9. Disadvantages/ potential risks of nanotechnology.