



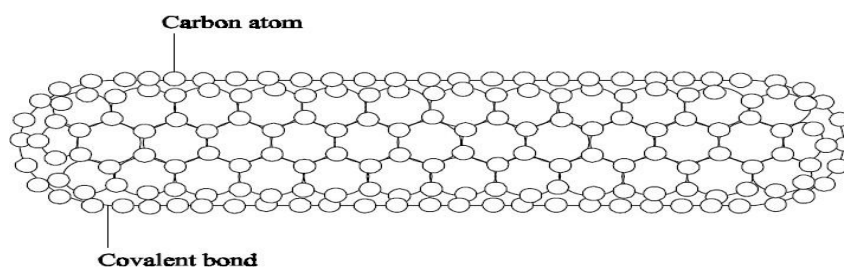
## Carbon nanotubes (CNTs)- Properties and uses

### Empathy questions

7. How might the commercialization of carbon nanotubes impact traditional industries and their workers?
8. What role do carbon nanotubes play in advancing sustainable economic development, and who stands to benefit the most?

### Carbon nanotubes (CNTs)

- Carbon nanotubes are allotropes of carbon with a nanostructure having a length- to-diameter ratio greater than 1,000,000. When graphite sheets are rolled into a cylinder, their edges joined and form carbon nanotubes i.e., carbon nanotubes are extended tubes of rolled graphite sheets.
- Nanotubes naturally align themselves into “ropes” and held together by vanderwaals forces.
- But each carbon atoms in the carbon nanotubes are linked by the covalent bond.



### Single walled carbon nano tubes (SWCNT) Structure

#### (or) Types of carbon nanotubes

- Depending upon the way in which graphite sheets are rolled, two types of CNTs are formed.

#### (i) Single - walled nanotubes (SWCNTs)

- SWCNTs consist of one tube of graphite. It is one-atom thick having a diameter of 2 nm



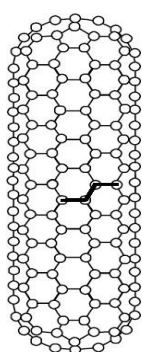
and a length of 100 nm.

- SWCNTs are very important, because they exhibit important electrical properties.
- It is an excellent conductor.
- Three kinds of nanotubes are resulted, based on the orientation of the hexagonal lattice.

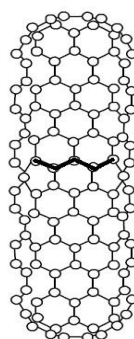
**(a) Arm-chair structures:** The lines of hexagons are parallel to the axis of the nanotube.

**(b) Zig-zag structures:** The lines of carbon bonds are down the centre.

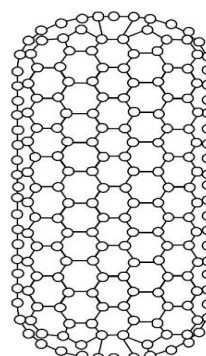
**(c) Chiral nanotubes:** It exhibits twist or spiral around the nanotubes.



Arm chair



Zig-zag



Chiral

## Structure of Single walled carbon nanotubes

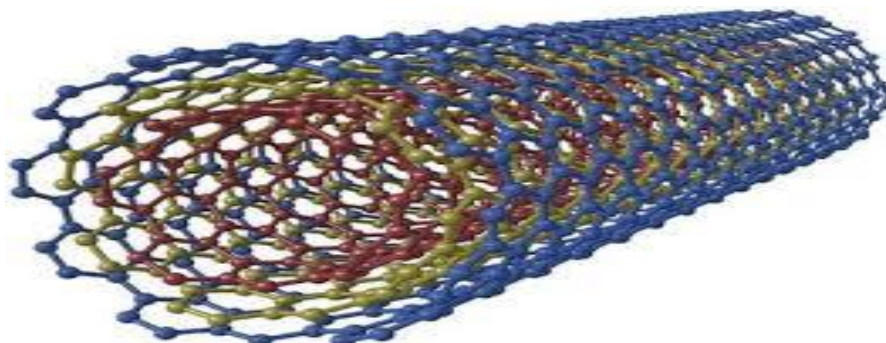
- It has been confirmed that arm-chair carbon nanotubes are metallic while zig-zag and chiral nanotubes are semiconducting.

### (ii) Multi - walled nanotubes (MWNTs)

- MWCNTs (nested nanotubes) consist of multiple layers of graphite rolled in on themselves to form a tube shape.
- It exhibits both metallic and semiconducting properties. It is used for storing fuels such as hydrogen and methane.



## Multi walled Carbon Nanotubes (MWCNT)



### SYNTHESIS OF CARBON NANOTUBES

- Carbon nanotubes can be synthesised by any one of the following methods.
  1. Pyrolysis of hydrocarbons.
  2. Laser evaporation.
  3. Carbon arc method.
  4. Chemical vapour deposition.

### Properties of CNT's

- CNTs are very strong and withstand extreme strain in tension and possess elastic flexibility.
- The atoms in a nano-tube are continuously vibrating back and forth.
- It is highly conducting and behaves like metallic or semiconducting materials.
- It has very high thermal conductivity and kinetic properties.
- It has high kinetic properties



## Uses of CNT's

- It is used in battery technology and in industries as catalyst.
- It is also used as light weight shielding materials for protecting electronic equipments.
- CNTs are used effectively inside the body for drug delivery.
- It is used in composites, ICs.
- Carbon nanotubes are used as sensors for gases
- They are used in desalination and to filter carbon di oxide from power plant emission