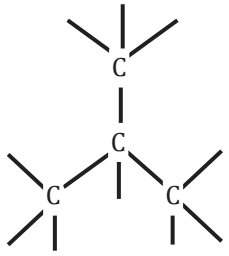
ALLOTROPES OF CARBON

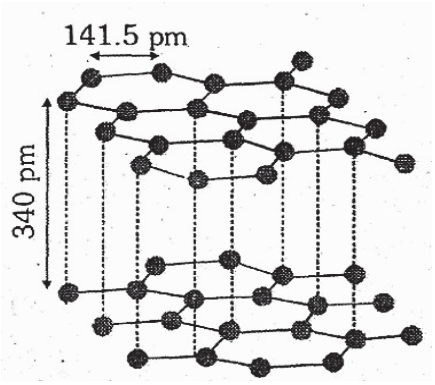
Allotropes of Carbon

Crystalline	Amorphous
Ex. Diamond	**Ex.** Coke
Graphite	Charcoal
Fullerene	Coal, C-lamp black

DIAMOND



GRAPHITE



Each carbon bonded with four other carbon atoms.	Each carbon bonded with three other carbon atoms.
Sp^3 Hybridisation	Sp^2 Hybridisation
Tetrahedral structure	Hexagonal layer structure
Insulator due to absence of free electrons.	Conductor due to presence of delocalized electrons.
Hard due to presence of strong sigma bond and 3D structure.	Soft due to presence of weak van der Waals forces between two layers.
Density=3.35gm/cm^3	Density = 2.22 gm/cm^3
High melting point (giant molecule)	Low melting point
Bond length(C-C) =1.54Å	Bond length (C-C) = 1.41Å

Special Point:

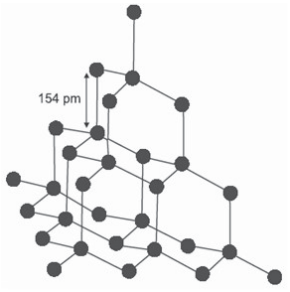
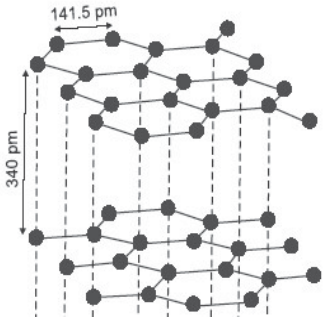
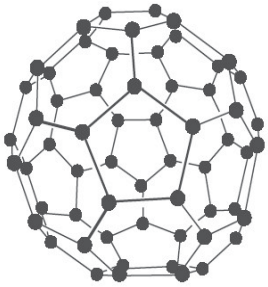
(i) From a thermodynamic perspective, graphite exhibits greater stability compared to diamond.
(ii) The aqueous solution of graphite is commonly referred to as "aqua Dag."
(iii) Graphite is also recognized by the name "plumbago" and is famously employed in lead pencils.
(iv) Graphite is utilized as a dry lubricant in various applications.
(v) Diamond stands as the hardest carbon allotrope, lampblack is the softest, and fullerene is acknowledged as the purest among them.

Fullerene

- C-60 & C-70 are common fullerene,
- C-60 is also known as Buckminster fullerene (Bucky ball)
- There are 32 rings 32 ⟨ 12 pentagonal / 20 hexagonal
- Each carbon atom bonded with 3 other carbons by sigma & double bond (resonance)
- sp^2 Hybridisation & aromatic in nature

Dangling Bond

In both diamond and graphite, certain surface carbon atoms possess unpaired valence electrons. These carbon atoms establish fresh connections with impurities, which are termed "dangling bonds."

	Diamond	Graphite	Fullerene
Structure			
Hybridisation	sp^3	sp^2	sp^2
Density (g/cm^3)	3.51	2.22	1.65
DH_f (KJ/mol)	1.9	0	38.1
Bond length	154 pm	141.5 pm	143.5 pm & 138.3 pm
	➢ Crystalline lattice. ➢ 3-D network: each C-atoms is linked to four other C-atoms in tetrahedral manner. ➢ One of the hardest – next to boron nitride (only at certain conditions) ➢ Uses: sharpening hard tools, cutter tools; as a gem.	➢ Layered structure ➢ Interlayer force-Vanderwaal's forces ➢ Each carbon atom is linked to three other carbon atoms, fourth electron forms a p bond. ➢ Good conductor along the sheet and semi-conductor perpendicular to the sheet. ➢ Inter layer distance 340 pm so cleavage	➢ Cage like molecules. ➢ C_{60}–Soccer ball shape–Buck minster fullerene ➢ 20- six membered rings and 12- five membered rings. ➢ Six membered ring is fused with six or five membered rings ➢ Five membered ring is fused only with six membered rings.

		between layers is easy. Soft and slippery– lubricant at high temperature. ➢ Natural graphite is found as a mixture with mica, quartz & silicates. ➢ $3C+SiO_2 \xrightarrow{\Delta} SiC + 2CO \xrightarrow{2500°C}$ C(graphite) + Si gas ➢ Thermodynamically most stable among allotropes. ➢ Graphite $\xrightarrow[50000–60000\,atm]{1600°C}$ synthetic diamond	➢ Heating of graphite in an electrical arc in the presence of inert gases such as helium or argon can result into fullerene

Coal

in its raw state, represents the elemental form of carbon, originating from the gradual decomposition of plant material influenced by heat, pressure, and a restricted air supply in nature. The evolutionary stages in this transformation include peat, lignite, bituminous, steam coal, and anthracite.

Bituminous coal, characterized by its hardness, combusts with a smoky flame. The highest quality of coal is anthracite, distinguished by its ability to burn with a non-smoky flame, making it particularly desirable.

Lamp black or carbon black is produced by burning substances rich in carbon, such as kerosene, petroleum, turpentine oil, and acetylene, under controlled conditions with a limited supply of air. This process results in the formation of fine particles of elemental carbon, commonly utilized in various applications.

Uses of Coal

Coal is utilized for diverse purposes, including the generation of coal gas, extraction of coal tar, production of coke, and the synthesis of synthetic petrol. Its applications span a wide range of industries, contributing significantly to energy production and various chemical processes.