C has three **allotropes** (different structural forms)

1. **Graphite** – black lustrous and thermodynamic product at room temperature and 1atm .

Preparation: heavy electric current through pure coke rod.

Properties: It is an electrical conductor (remember Hall process) and dry lubricant (pencil "lead")

Impure forms of graphite such as soot, carbon-black are formed on heating gaseous hydrocarbons (1000°C) anaerobically and are used in reinforcing rubber, pigments and ink.

Waster organic molecules that are heated anaerobically produce activated charcoal (porous material which absorbs impurities).

The **structure** of graphite gives rise to its properties and industrial uses.

Structure of graphite:

Planar sheets of hexagons. Each atom is sp^2 hybridised leaving one electron in the remaining p orbital which is delocalised forming a π-network of electrons .

2. Diamond prepared by heating methane. This produces graphite + diamond but only graphite reacts with H_2 so treatment with hydrogen produces diamond alone.

Diamond is used in drill bits due to its hardness and its ability to conduct heat .

Structure sp^3 hybridised C atoms all tetrahedrally coordinated.

3. Fullerenes – produced from heating graphite in an atmosphere of He

Potential uses $C_{60}F_{60}$ lubricant, K_3C_{60} superconductor 18K, electron store (batteries) .

Structure is that of a cage of C atoms C_{60}, C_{70}, C_{84}, C_{90}, C_{94}, $C_{>100}$.

All C atoms are sp^2 hybridised. Linked hexagons and pentagons with alternate C-C and C=C bonds.

Oxygen compounds of C

Carbon Monoxide CO: emission from tobacco, car-exhaust.

Colourless inflammable, toxic gas .

Toxicity : CO is a Lewis Base (donates an electron pair on C) to d-block metals e.g. $Fe(CO)_5$, $Fe_2(CO)_9$, $Fe_3(CO)_{12}$.

In the same way it binds to Fe of haemoglobin and prevents it transporting O to the body cells.

Industrial use: To reduce iron oxide (800 ^oC in the Blast Furnace)

Laboratory preparation: HCO_2H (formic acid) $\rightarrow$ $H_2O_{(l)}$ + $CO_{(g)}$