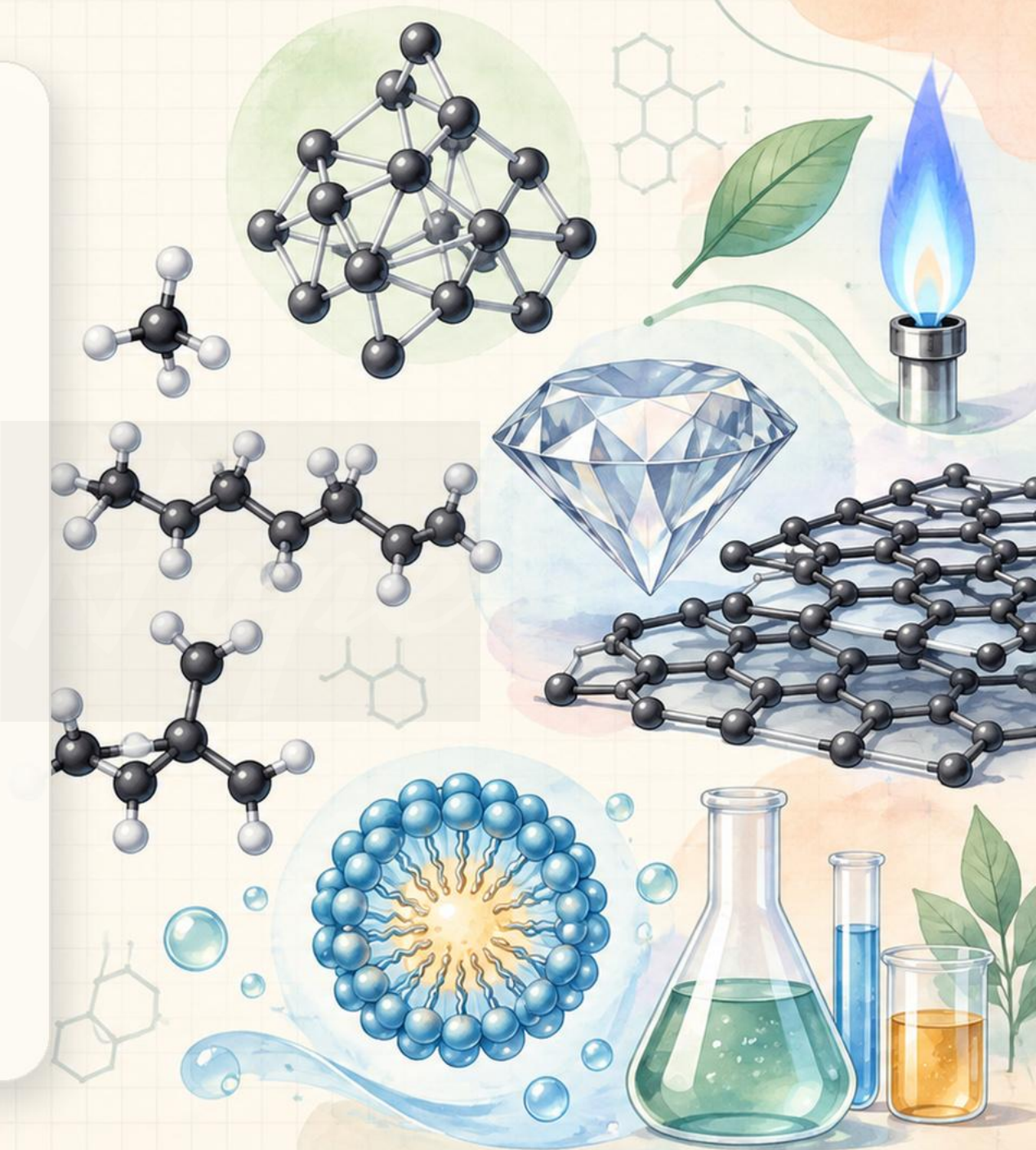


SCIENCE • CLASS 10

CHAPTER 4

Carbon and Its Compounds

CHAPTER NOTES

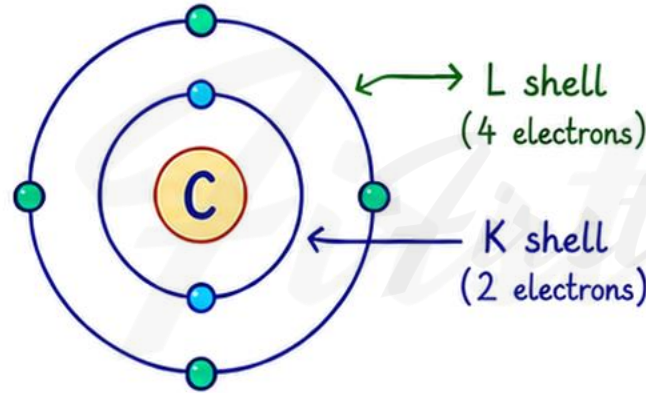


CARBON AND COVALENT BONDING

WHY CARBON MATTERS : all living structures and many everyday materials contain carbon; Earth's crust has about 0.02% carbon in forms such as carbonates, hydrogencarbonates, coal and petroleum; atmosphere has about 0.04% carbon dioxide.

ELECTRONIC CONFIGURATION

- Carbon atomic number = 6
- Shells: K = 2, L = 4
- Four valence electrons
- Valency = 4 (tetravalent)



WHY NOT IONIC?

Gain 4 e^-
to form C^{4-}

Would have 10 electrons.
Difficult for 6 protons
to hold.

Lose 4 e^-
to form C^{4+}

Needs extremely
high energy.

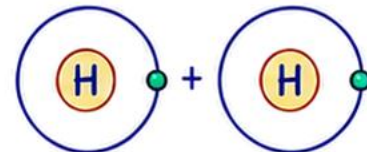
Therefore, carbon does
not normally form C^{4-} or C^{4+} ions.

THE SOLUTION: SHARING Carbon shares valence electrons with carbon or other atoms so each atom can complete its outer shell.

Covalent bond = bond formed by sharing one or more pairs of electrons between atoms.

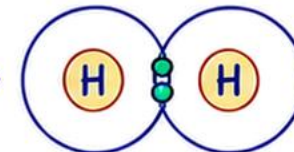
→ Shared electrons belong
to the outer shells
of both atoms.

BEFORE SHARING



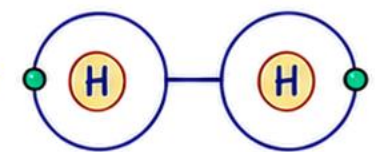
Each hydrogen has
1 valence electron.

SHARED PAIR



One pair of electrons
is shared.

SINGLE COVALENT BOND



Each hydrogen attains
a stable duet.

KEY IDEA: Carbon usually completes its octet by sharing electrons.

SINGLE, DOUBLE AND TRIPLE BONDS

A covalent bond is one or more shared pairs of electrons.

- • 1 shared pair = single bond (—)
- • 2 shared pairs = double bond (=)
- • 3 shared pairs = triple bond (≡)

1. HYDROGEN, H_2 — SINGLE BOND

- Each H has 1 valence electron.
- Each needs 1 more for a stable duet.
- Two H atoms share exactly one pair.

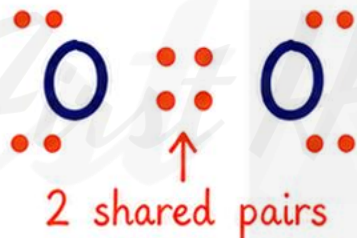


Line structure:



2. OXYGEN, O_2 — DOUBLE BOND

- Each O has 6 valence electrons.
- Each needs 2 more for an octet.
- Two O atoms share exactly two pairs.



Line structure:



3. NITROGEN, N_2 — TRIPLE BOND

- Each N has 5 valence electrons.
- Each needs 3 more for an octet.
- Two N atoms share exactly three pairs.



Line structure:



OTHER EXAMPLES:

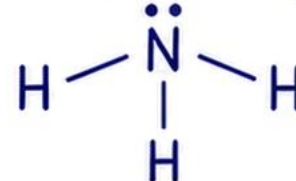
Cl_2 — one shared pair



H_2O — two O—H single bonds



NH_3 — three N—H single bonds

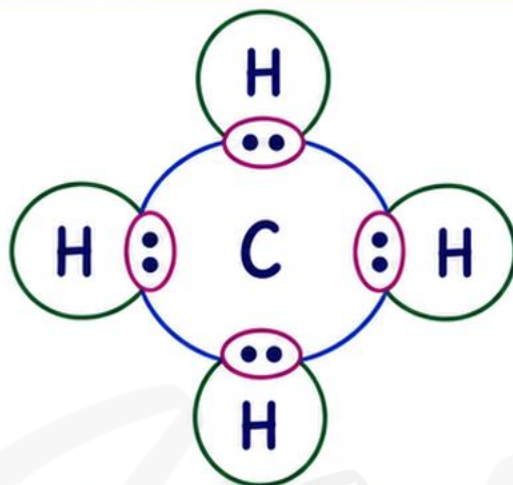


More shared pairs give double or triple covalent bonds.

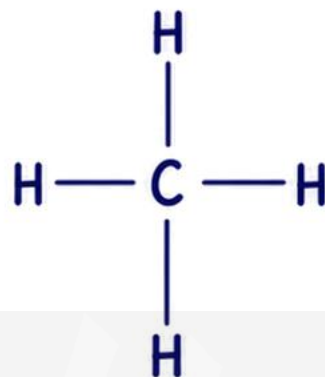
METHANE AND COVALENT COMPOUNDS

A METHANE, CH₄

- Carbon has 4 valence electrons; each H has 1.
- Carbon shares one electron pair with each of four H atoms, forming four C—H single covalent bonds.



Electron-dot structure
(Each bond has one shared pair;
C has an octet, each H a duet.)



Line structure
(four C—H single bonds)

Methane is a fuel and a major component of biogas and Compressed Natural Gas (CNG).

C PROPERTIES OF COVALENT COMPOUNDS

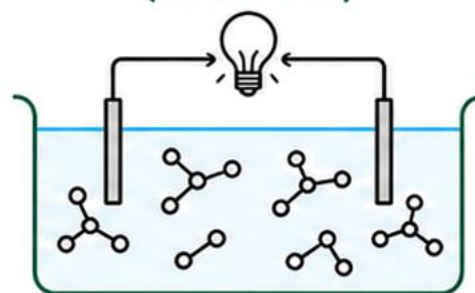
- strong bonds inside each molecule
- weak intermolecular forces between molecules
- generally low melting and boiling points compared with ionic compounds
- generally poor conductors of electricity because no free ions are formed

D EXAMPLES (K)

Compound	Formula	Melting point (K)	Boiling point (K)
Acetic acid	CH ₃ COOH	290 K	391 K
Chloroform	CHCl ₃	209 K	334 K
Ethanol	CH ₃ CH ₂ OH	156 K	351 K
Methane	CH ₄	90 K	111 K

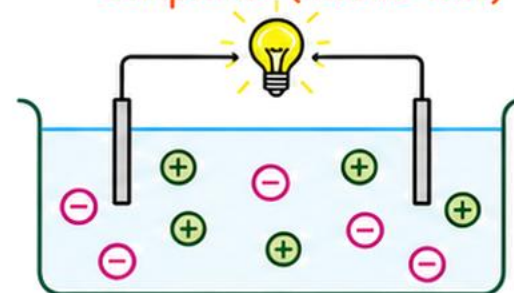
E COMPARE: CONDUCTIVITY

Covalent molecule
(no free ions)



Bulb does not glow

Molten/aqueous ionic
compound (mobile ions)



Bulb glows

KEY IDEA: Sharing forms molecules, not ions.

ALLOTROPES OF CARBON

- ★ Allotropes are different structural forms of the same element.
- ★ Diamond, graphite and fullerenes are allotropes of carbon. Their bonding is different, so their physical properties differ.

DIAMOND



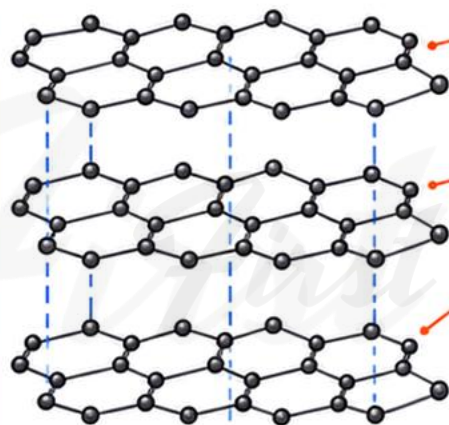
Each carbon atom bonded to 4 other carbon atoms, forming a rigid three-dimensional structure.

Properties:

- One of the hardest natural materials.
- Does not conduct electricity.

Synthetic diamonds are made from pure carbon at very high pressure and temperature and are otherwise like natural diamonds.

GRAPHITE



One layer of hexagonally arranged carbon atoms.

Weak attraction between layers.

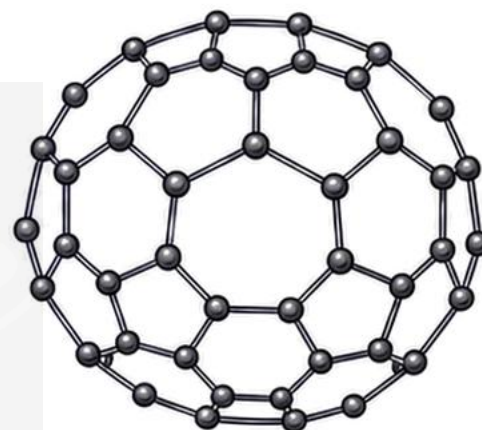
One electron per carbon can move through the layer (delocalised / free electron).

Properties:

- Smooth and slippery.
- Good conductor of electricity.

Each carbon atom bonded to 3 other carbon atoms in the same plane; layers slide over one another.

FULLERENE, C₆₀



The first fullerene identified; named Buckminsterfullerene because its shape resembles Buckminster Fuller's geodesic dome.

COMPARE

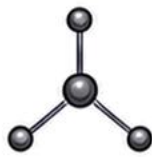
BONDING

Diamond:
4 neighbours
(tetrahedral).



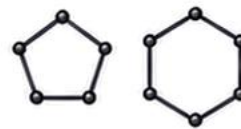
Graphite:

3 neighbours
(in the same plane).



C₆₀:

Cage structure
(pentagons and hexagons).



Physical properties differ even though all contain only carbon.

KEY IDEA: Structure controls properties.



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