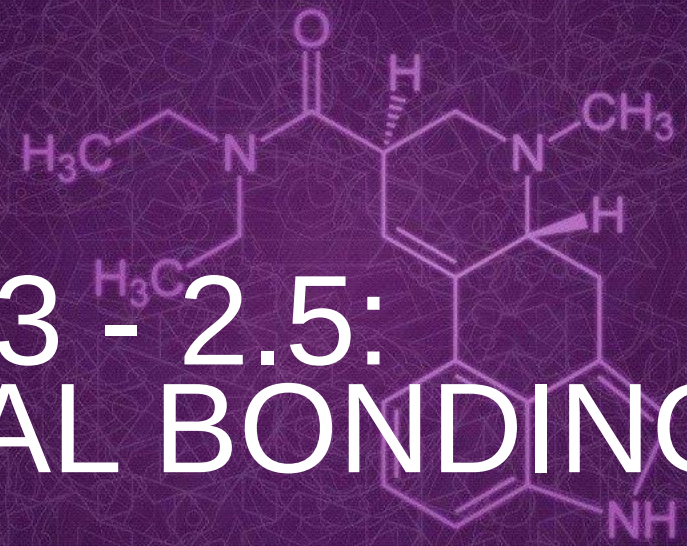


TOPIC 2.3 - 2.5: CHEMICAL BONDING

THE ABOUT

CHAPTER ANALYSIS

TIME

- Important chapter, will always be tested
- 2 **key** concepts

EXAM

- Commonly tested, especially for Section A
- Tested as together with other chapters
  → Atomic Structure, Chemical Equations

WEIGHTAGE

- Medium overall weightage
- Constitute to **4.5%** of marks for past 5 year papers

ELEMENTS, COMPOUNDS, MIXTURE

	Elements	Compound	Mixture
Formation	Naturally found	**Chemically** combined	**Physically** combined
Separation technique	Cannot be separated further	Separated using **chemical methods** (Decomposition, electrolysis, reduction with carbon)	Separated using **physical methods** (separation techniques)
Composition	Exist by itself or as diatomic molecules for gas such as N_2 or O_2.	**Fixed** ratio	**Any** ratio
Melting Point / Boiling Point	**Fixed** MP & BP	**Fixed** MP & BP	Melts and boils over a **range of temperature**

<u>*A compound must be a molecule, but a molecule need not be a compound.</u>

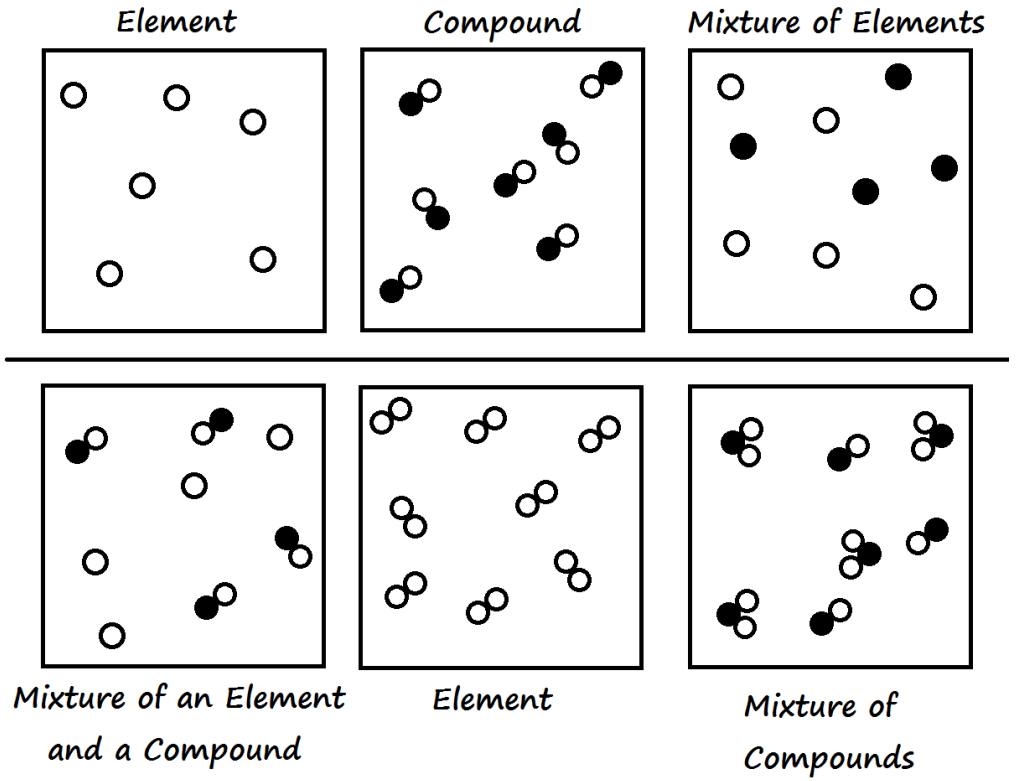
A molecule is defined as **2 or more atoms** chemically combined.

An **element** can exist as a **solid** or as a **molecule** if it is in gaseous form at room temperature. (N_2, O_2, H_2)

A **compound**, however, must be a molecule as a compound is defined as **2 or more elements chemically combined.**

Understanding the term 'molecule'

ELEMENTS, COMPOUNDS, MIXTURE



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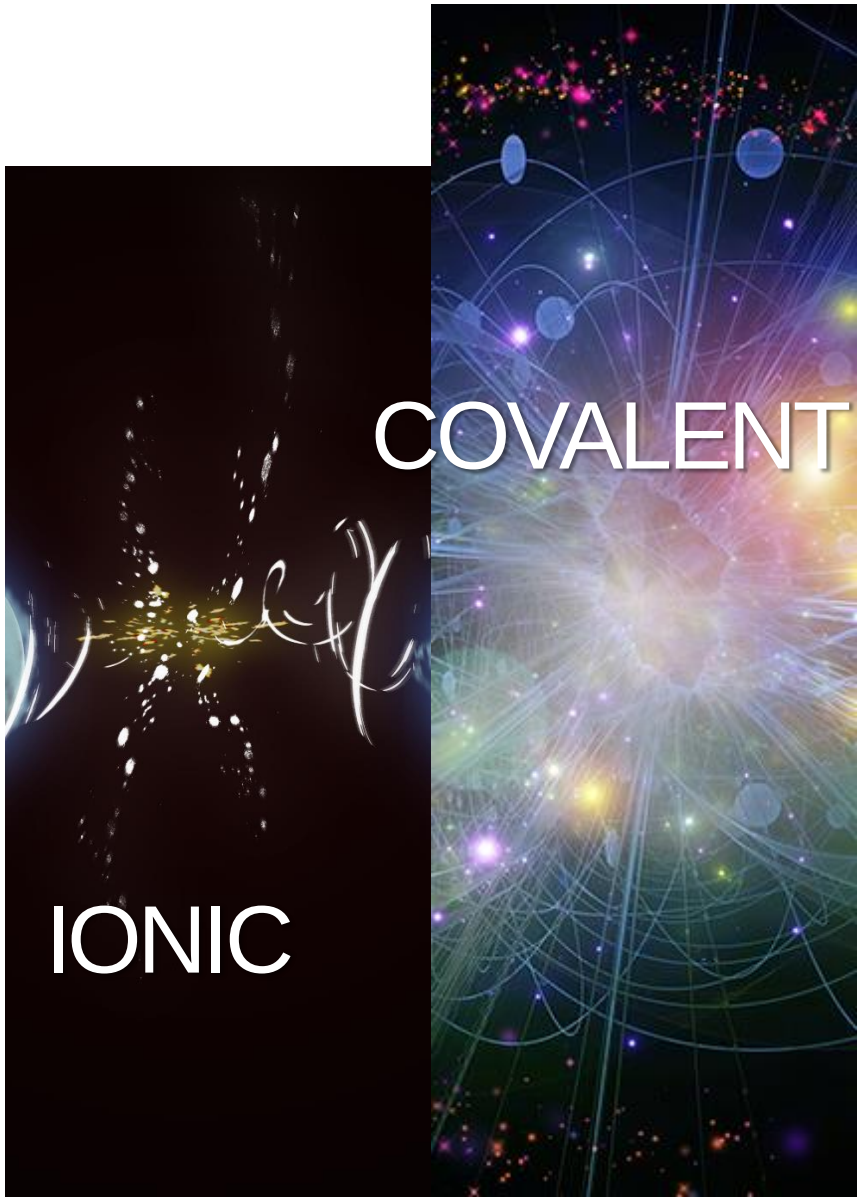


2 types of bonds

Understand all 2 types of bond to master this chapter while paying special attention to **keywords** you must include in your answers.

For each type of bond, you must be able to explain:
- How the bond is formed
- The dot-&-cross diagram
- The structure
- Physical properties (with explanations)

MUST KNOW

BASICS

Why are bonds formed?

Atoms of elements aim to attain **stability*** by achieving a **stable electronic configuration (2,8,8)**. This is achieved by forming chemical bonds with other atoms.

This is done by **transferring electrons, sharing electrons or forming a metal lattice**.

Non-metal atoms, like the Group VII halogens, form **ionic bonds** with metal atoms. They also form **covalent bonds** with other non-metal atoms.

Metal atoms form **metallic bonds** with other metal atoms.

**Recall 'Atomic Structure',*
"atom → ion → compound"
"single → seeking partner → in a relationship"

KEY CONCEPT

IONIC BONDS

METAL ION + NON-METAL ION

GIANT IONIC LATTICE STRUCTURE

Recall:

Ca**t**ion: positively charged ion
→ t = '+' sign, positive

A**n**ion: negatively charged ion
→ n = negative

KEY CONCEPT

IONIC BONDS

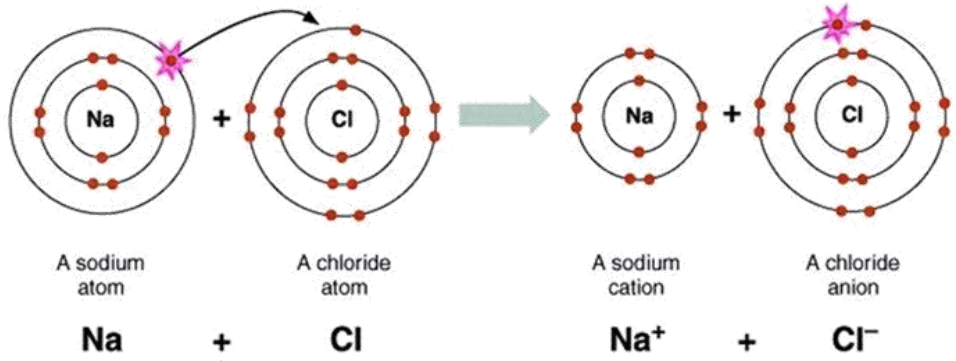
Ionic bonds are formed between **metals** and **non-metals**.

The **transfer of electron** from the metal to the non-metal allow both to have **complete valence shells** and to **attain a stable electronic configuration**.

The metal now becomes a **cation** while the non-metal becomes the **anion**.

These **oppositely charged ions** are attracted to each other by strong **electrostatic forces of attraction**.

This **forces of attraction between oppositely charged ions** is the ionic bond itself.



GIANT IONIC LATTICE STRUCTURE

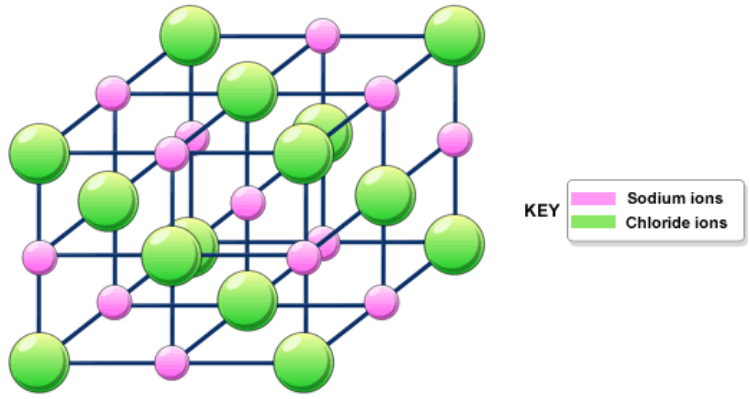
GIANT IONIC LATTICE STRUCTURE

Ionic compounds have a **giant ionic lattice structure** held together by **electrostatic forces of attraction between oppositely charged ions**.

Within the lattice, oppositely charged ions are arranged to be as near to each other as possible. Ions of the same charge are arranged to be as far apart as possible.

This maximises attraction and minimises repulsion, resulting in a highly stable structure.

Naming convention: (Cation)(Anion) eg: Sodium Chloride



ADVANCED

giant ionic lattice

Physical properties

- High MP & BP (usually exist as crystals at rtp)
- Soluble in water
- Conducts electricity in molten & aqueous state
- Poor conductor of heat
- Not volatile (does not evaporate easily)
- Hard

High melting and boiling points

Ionic substances generally have **high melting and boiling points.** (<1000 Degree Celsius)

The ions are held together by **strong ionic bonds** which **require a large amount of energy to overcome**.

Solubility

Most ionic compounds are **soluble in polar solvents like water**, but insoluble in organic solvents like acetone and benzene.

Ionic compounds are soluble in water because the partially charged (polar) water molecules attract the ions, disrupting the ionic lattice structure. This causes the ions to separate and dissolve in the solution.

Electrical conductivity & Thermal conductivity

To conduct electricity, the substance needs to have **mobile charge carriers**.

Since the ions in an ionic solid are all tightly held in place, **ionic compounds in solid state do not conduct electricity**.

However, when **in molten or aqueous state**, the ions are free to move, acting as mobile charge carriers, allowing it to **conduct electricity**.

Due to their high melting points, ionic compounds are able to **withstand exceedingly high temperatures** and are often used as refractories, which are materials specially selected due to their **heat-resistant properties**.

KEY CONCEPT

COVALENT BONDS
SIMPLE MOLECULAR STRUCTURE

KEY CONCEPT

COVALENT BONDS

Covalent bonds are formed between **non-metal & non-metal**.

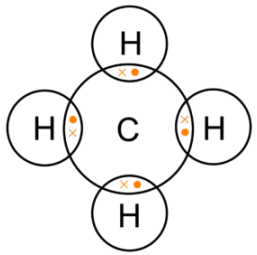
A covalent bond is defined as the **electrostatic force of attraction between the nuclei of the atoms and the shared electrons.**

In order to attain a stable electronic configuration, the atoms **share their valence electrons** so that they can both have full valence shells.

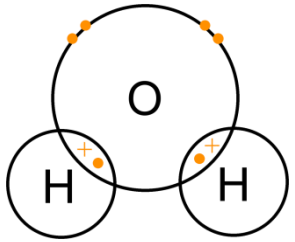
This sharing of electrons is known as a covalent bond.

Examples:

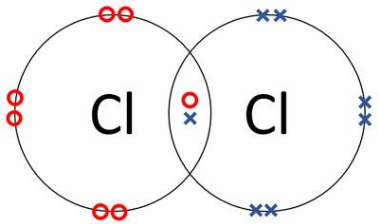
Methane Compound:

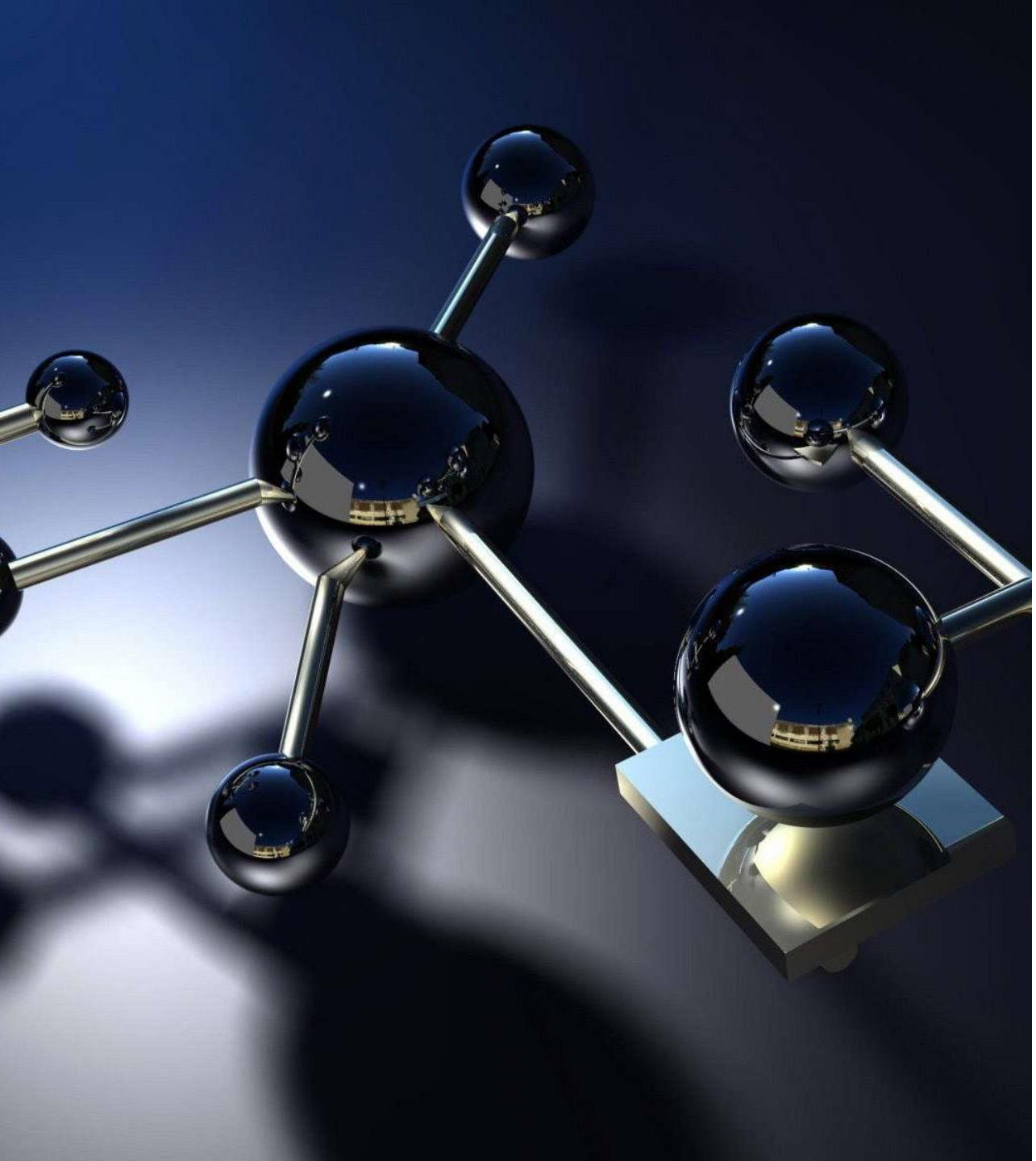


Water Compound:



Chlorine molecule:





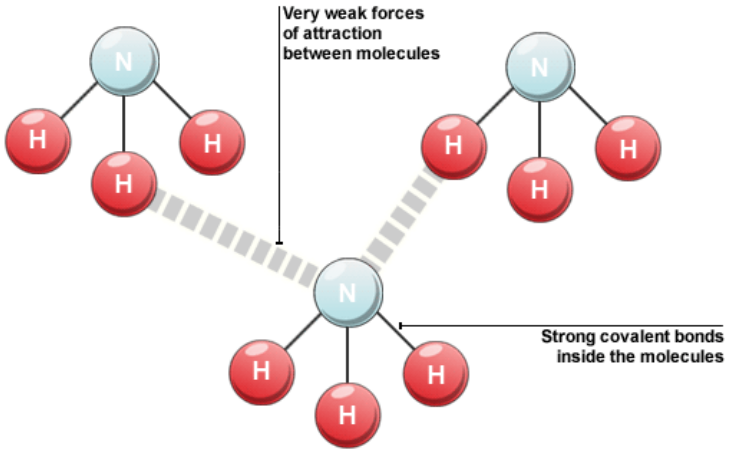
SIMPLE MOLECULAR STRUCTURE

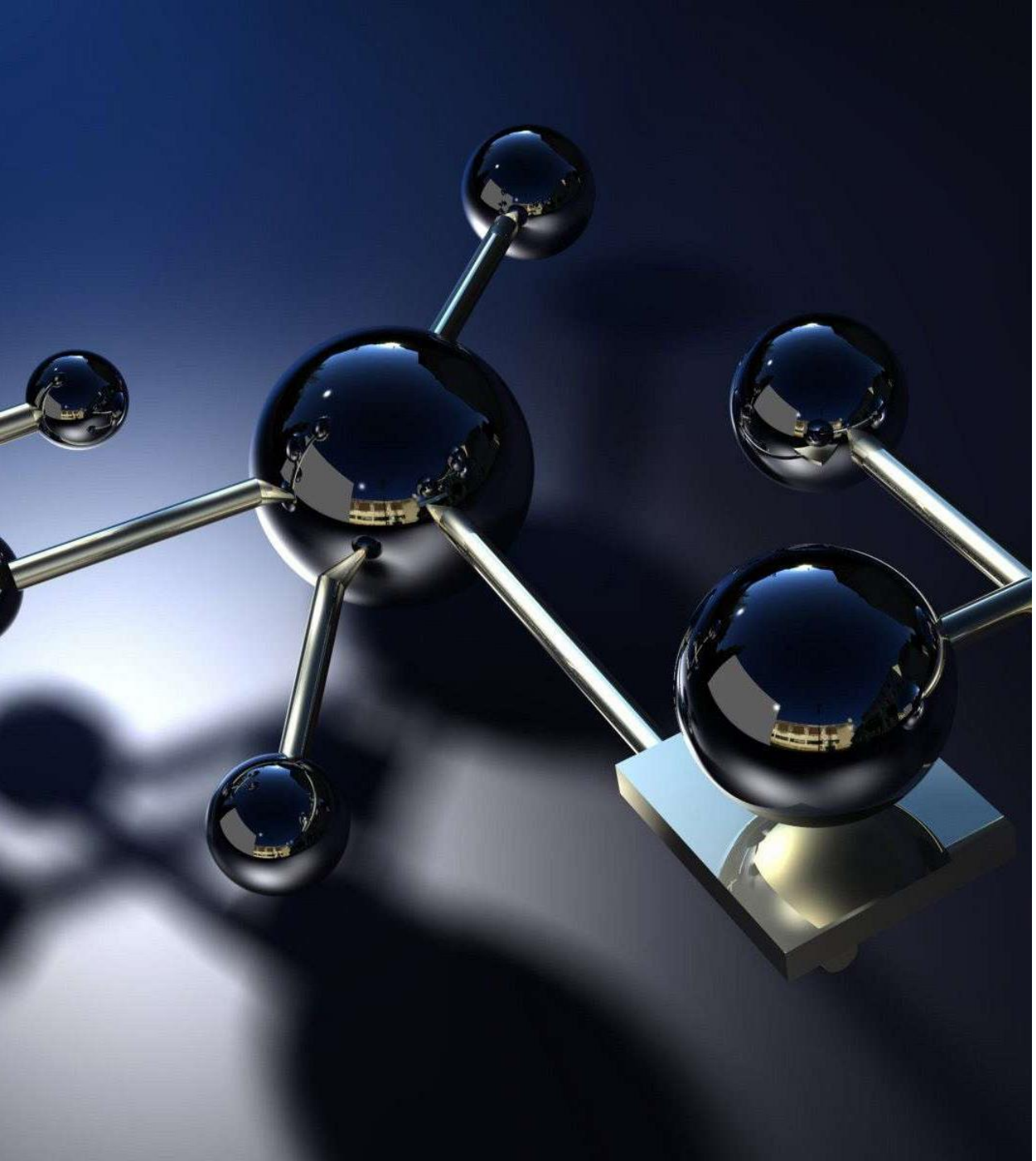
Elements and compounds that are made up of small molecules have simple molecular structure.

Weak intermolecular forces of attraction, *AKA van der Waals' forces*, exist between the molecules that make up these compounds.

These intermolecular forces are easy to overcome, hence they have **low melting and boiling points.**

However, atoms within the molecules are held together by **strong covalent bonds**.



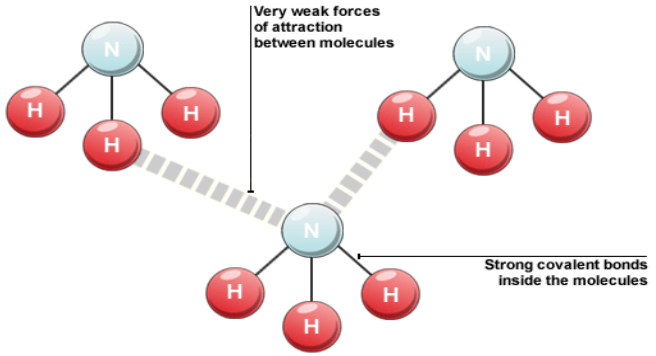


SIMPLE MOLECULAR STRUCTURE

For example, water is a compound with a simple molecular structure, consisting of water molecules.

These water molecules experience **weak intermolecular forces of attraction between neighbouring water molecules.** Hence, the low MP & BP.

HOWEVER, within the water molecules itself are **strong covalent bonds** that are holding together single oxygen atom and two hydrogen atoms.



TAKE NOTE!

Are covalent bonds strong? **Yes, very strong**.

Then why the low MP & BP? Because the **intermolecular forces are weak and easy to overcome.**

It is easy to make water change its state (melting/boiling) but **extremely difficult to break a water molecule back into hydrogen and oxygen atoms**, as that will involve breaking the covalent bond itself.

Covalent bonds & Intermolecular forces are different things!!!

ADVANCED

simple molecular structure

Physical properties

- Low MP & BP (usually exist as gas or liquid state
- Insoluble in water
- Does not conduct electricity in any state
- Poor conductor of heat
- Highly Volatile

Low melting and boiling points

The molecules are held together by **weak intermolecular forces of attraction**.

Melting or boiling only requires the separation of molecules from neighbouring molecules, not breaking the covalent bonds within the molecule itself.

Hence**, little energy is needed to overcome the weak intermolecular forces**, resulting in low melting and boiling points.

Solubility

Most simple molecular substances **are soluble in organic (non-polar) solvents**.

Most simple molecular substances are insoluble in water. The induced partial charges in simple molecular substances are too weak to overcome the attractive forces between permanent partial charges of polar solvents.

Hence, simple molecular substances are **insoluble in water**.

Electrical conductivity & Thermal conductivity

Simple molecular substances **do not conduct electricity** due to the absence of mobile charged carriers (electrons or ions).

They are also **poor conductors of heat**.

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