# 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 | Combined using chemical methods | Combined using physical methods |
| Separation technique | Cannot be separated further | Separation by chemical methods (Decomposition, electrolysis, reduction with carbon) | Separation by physical methods<br><br>(separation techniques) |
| Composition | Exist by itself or in diatomic molecule form for gases such as $H_2$ 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 |

***A compound is a subset of a molecule, but a molecule does not need to be a compound.**

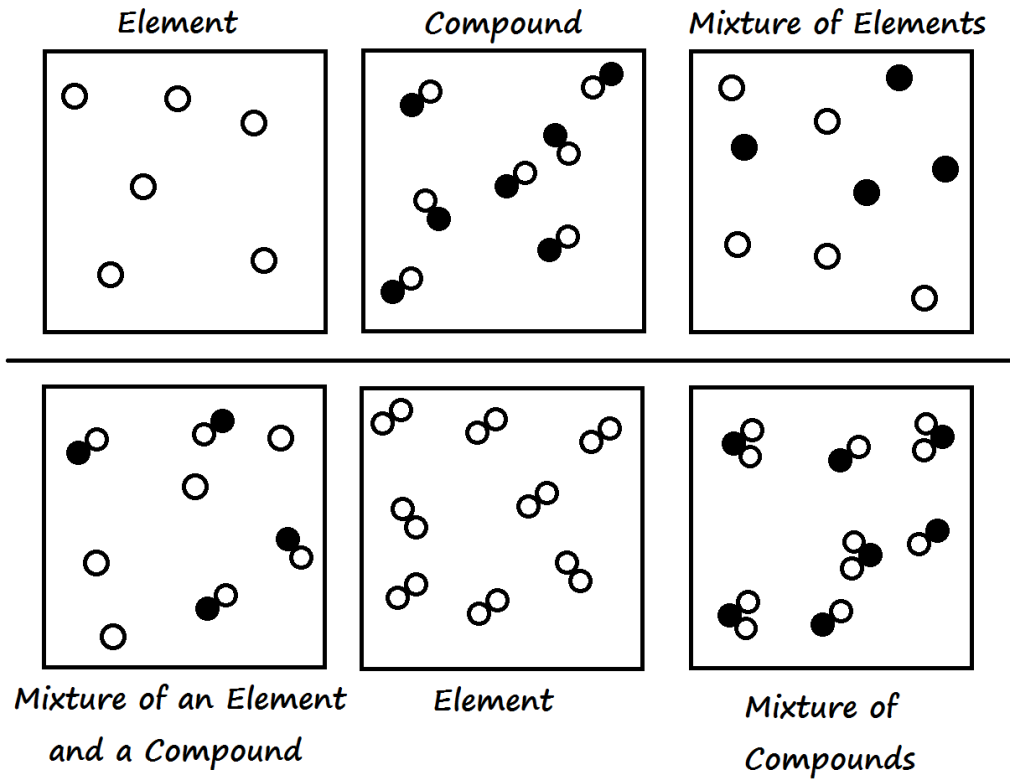
Definition of a molecule is when **2 or more atoms** chemically combined.

An **element** can also exist as a diatomic **molecule**. ($N_2$, $O_2$, $H_2$)

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

Understanding the term 'molecule'

# ELEMENTS, COMPOUNDS, MIXTURE

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Understanding the term 'molecule'

MUST KNOW

# BASICS

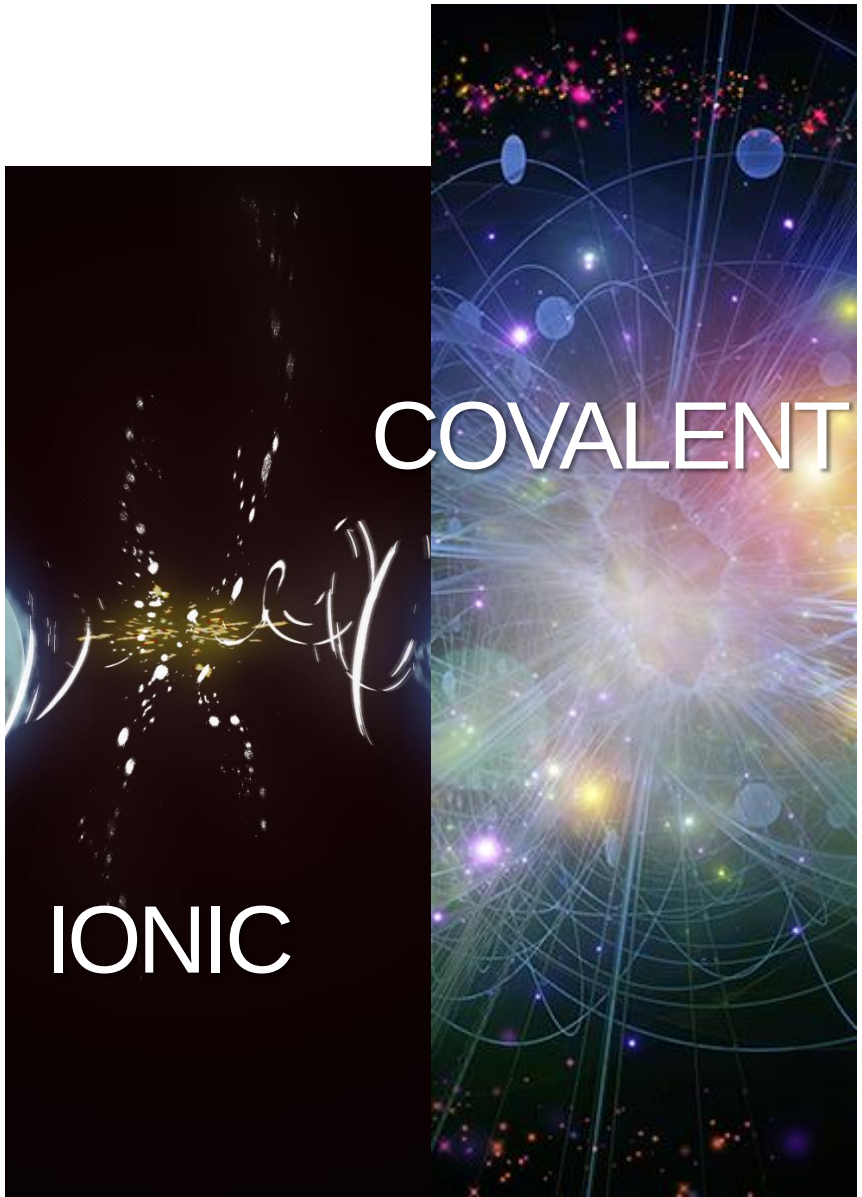
**Why are chemical bonds formed?**

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

The formation of chemical bonds can be done by **transferring electrons, sharing electrons or forming a metal lattice**.

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

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




# 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)

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

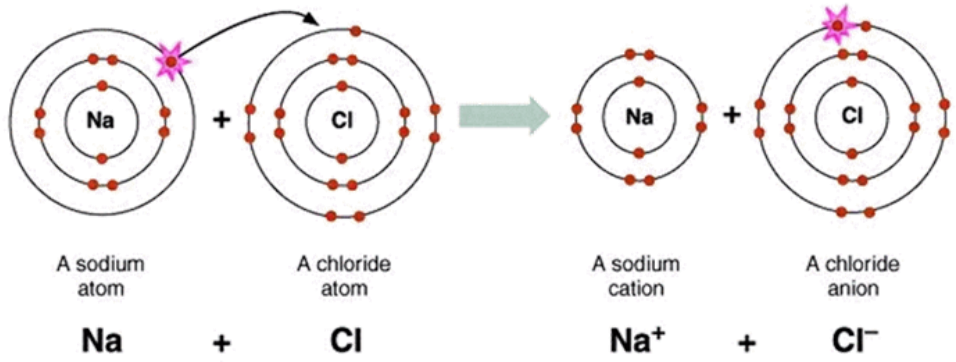
# IONIC BONDS

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

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

The metal would become a **cation** while the non-metal would become the **anion**.

Ionic bond **formed** is the **forces of attraction between oppositely charged ions**.

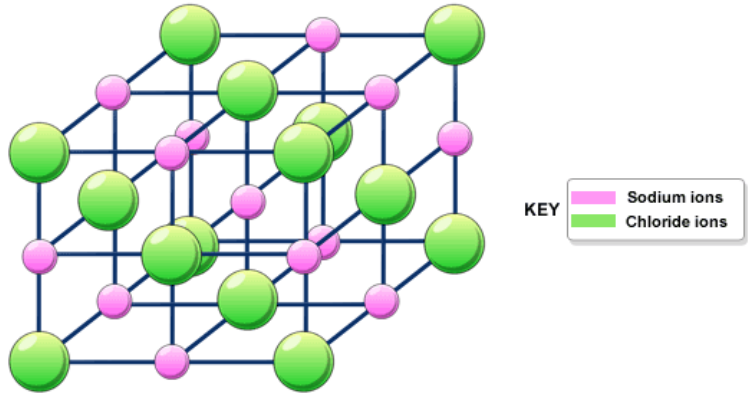


# GIANT IONIC LATTICE STRUCTURE

## GIANT IONIC LATTICE STRUCTURE

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

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



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# giant ionic lattice

**Physical properties**

- High MP & BP
- Soluble in water
- Able to conduct electricity in molten & aqueous state
- Poor conductor of heat
- Not volatile (does not evaporate easily)
- Strong

## High melting and boiling points

Ionic compounds usually have **high melting and boiling points.** (<1000 Degree Celsius)

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

## Solubility

Ionic compounds are **soluble in water** because the partially charged (polar) water molecules can attract the ions, causing disruption to the ionic lattice structure.

This results in the ions separating and dissolving in the solution.

## Electrical conductivity

To conduct electricity, there needs to be the presence of **mobile charge carriers**.

In its solid state, as the ions are all held tightly in place, **ionic compounds in solid state do not have the ability to conduct electricity**.

However, when **in molten or aqueous state**, the ions are able to move freely, able to act as mobile charge carriers to **conduct electricity**.

KEY CONCEPT

# COVALENT BONDS
## SIMPLE MOLECULAR STRUCTURE

KEY CONCEPT

# COVALENT BONDS

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

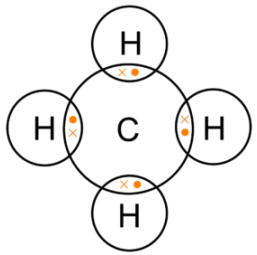
A covalent bond is defined as the **electrostatic force of attraction between the nuclei of the atoms and the shared electrons.**

To attain a stable electronic configuration, the two atoms **share their valence electrons** so that they can both attain stable and full valence shells.

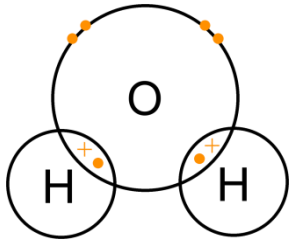
Covalent bond is formed from the sharing of electrons.

**Examples:**

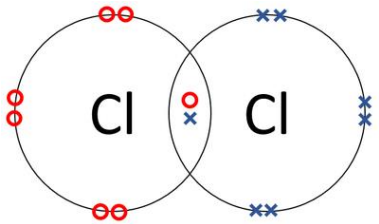
Methane Compound:

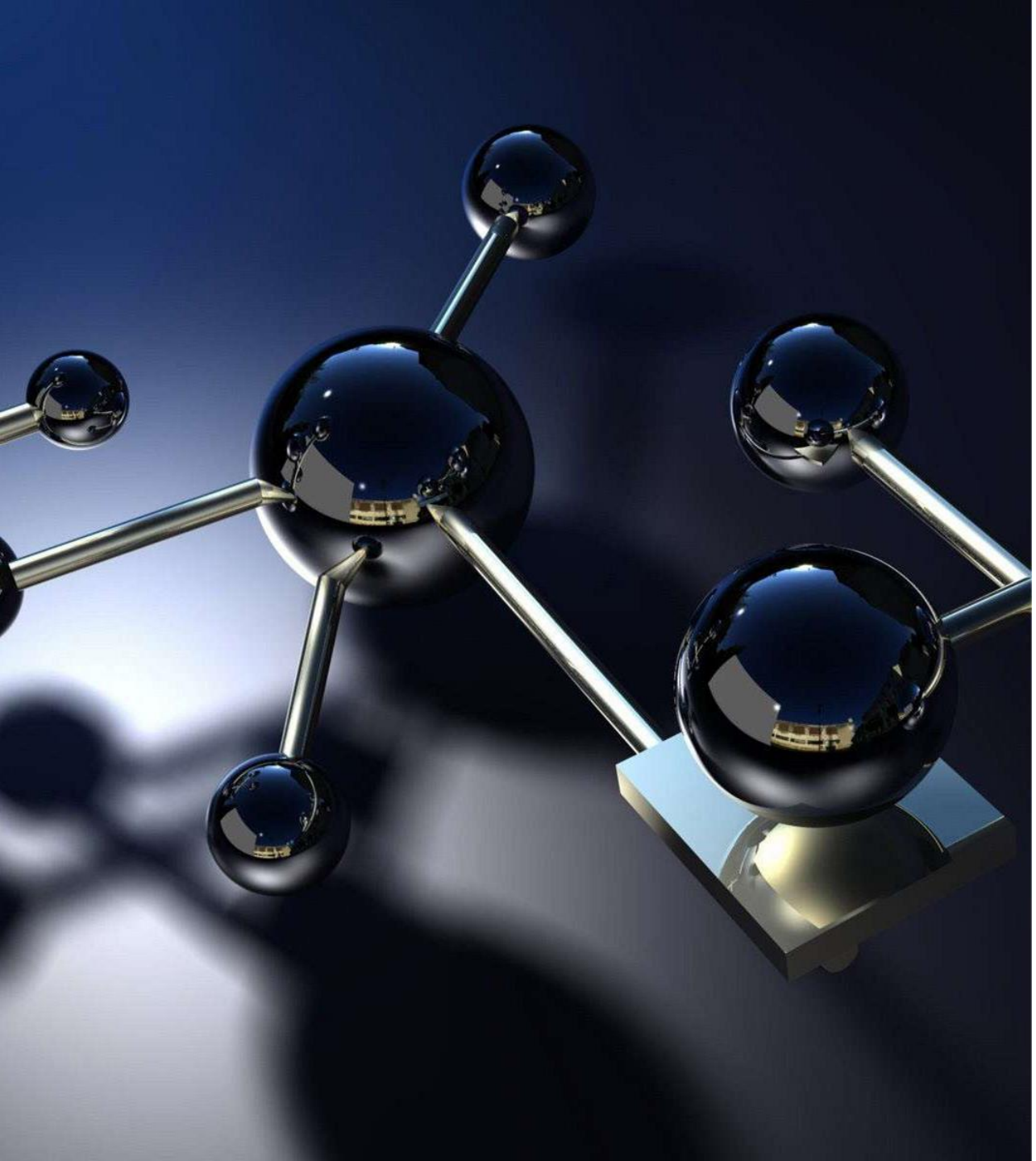



Water Compound:




Chlorine molecule:





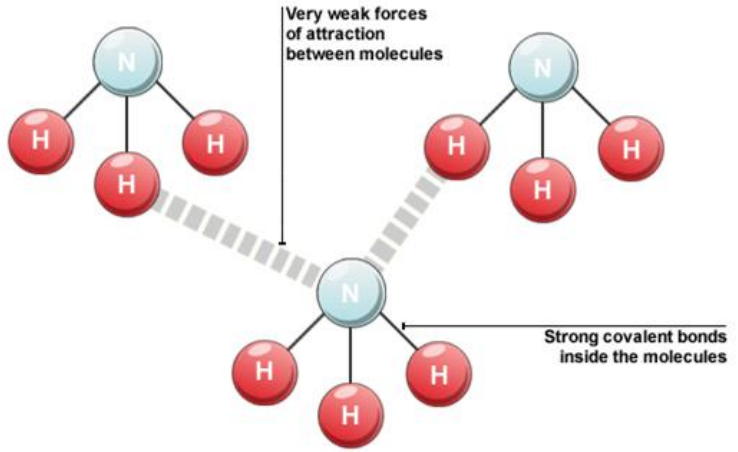
## SIMPLE MOLECULAR STRUCTURE

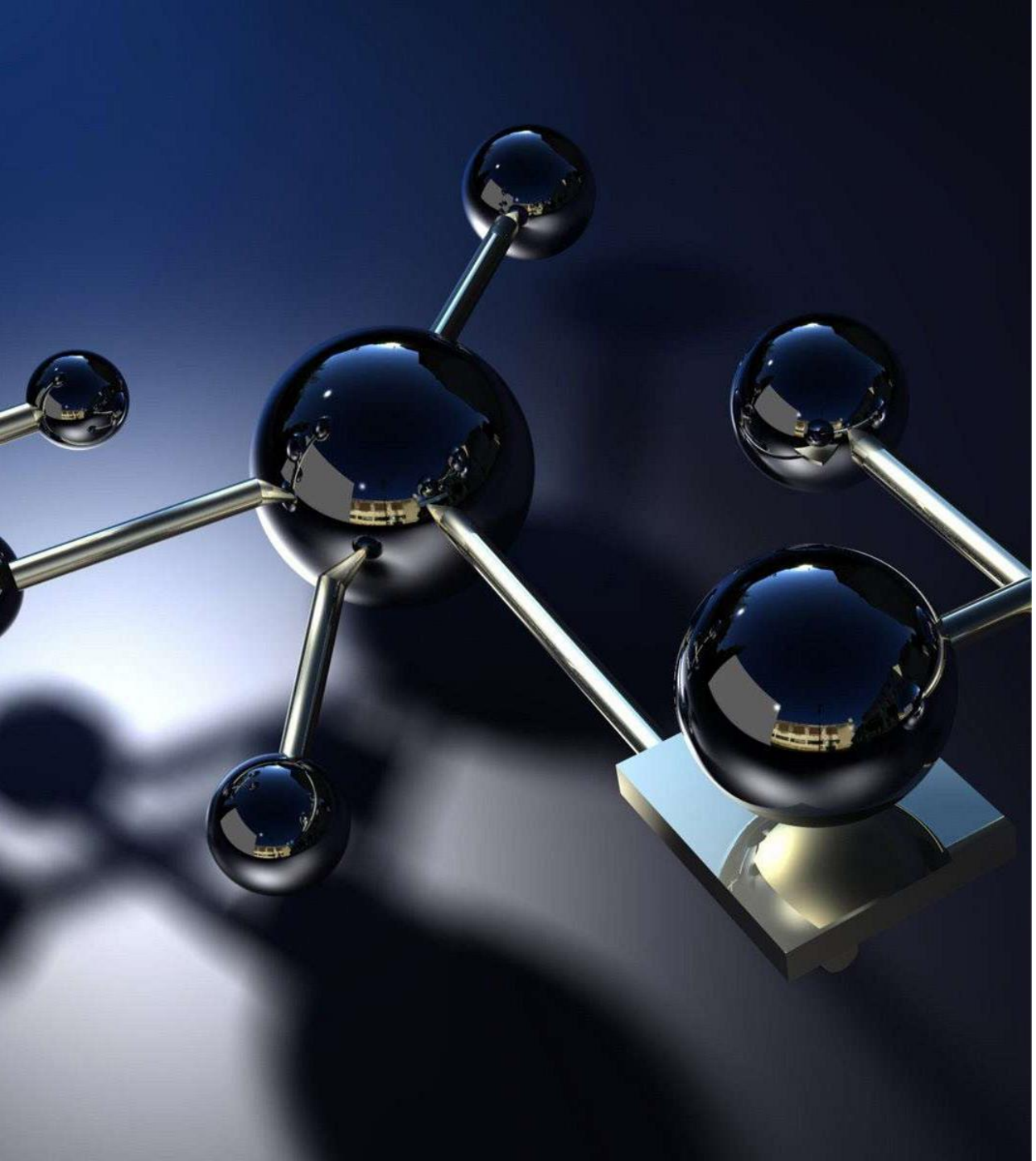
Covalent compounds that are made up of small, discrete molecules have simple molecular structures.

Between the small molecules, they are held together by **weak intermolecular forces of attraction**, *AKA van der Waals' forces*.

These weak intermolecular forces can be overcome easily, hence they have **low melting and boiling points.**

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



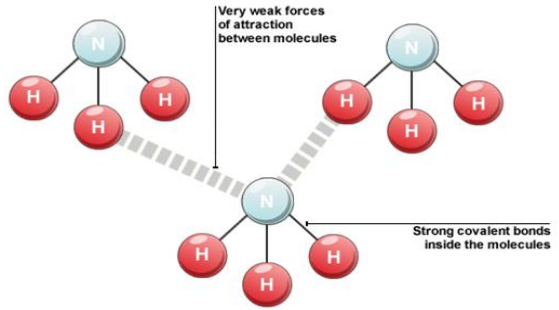


## SIMPLE MOLECULAR STRUCTURE

For example, ammonia has a simple molecular structure.

These ammonia molecules experience **weak intermolecular forces of attraction between other ammonia molecules.** Hence, they have low melting point & boiling point.

**HOWEVER**, within the ammonia molecules are **strong covalent bonds** that holds together a single nitrogen atom and three hydrogen atoms.




## TAKE NOTE!

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

Then why the low MP & BP? Because it is the weak **intermolecular forces that are being overcame.**

For example, it is easy to change the state of water (melting/boiling) but **extremely difficult to break a water molecule back into the individual hydrogen and oxygen atoms**, as that would involve breaking the strong covalent bonds.

**Covalent bonds & intermolecular forces of attraction are different things!!!**

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# simple molecular structure

**Physical properties**

- Low MP & BP (usually exist as gas or liquid state at rtp)
- Insoluble in water
- Unable to conduct electricity in any state
- Poor conductors 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 breaking of the weak intermolecular forces between molecules, and 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**.

Simple molecular substances are **insoluble in water**.

### Electrical conductivity & Thermal conductivity

Simple molecular substances **are unable to conduct electricity** due to the absence of mobile charged carriers (electrons or ions).

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

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