



# INTRODUCTION TO CHEMISTRY

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General Chemistry

Semester 1 (Fall Semester)

Merged all weeks

# What is chemistry?

**Chemistry** is the **science** of studying the **Composition, structure, properties, and behavior of matter & energy** and also the **changing** of them during a **reaction**.



It is essential for understanding much of the natural world and central to many other scientific disciplines, including **geology, astronomy, paleontology, biology, and medicine**.

# ATOMS

**Atom** is the **smallest constituent** unit of **all materials**.

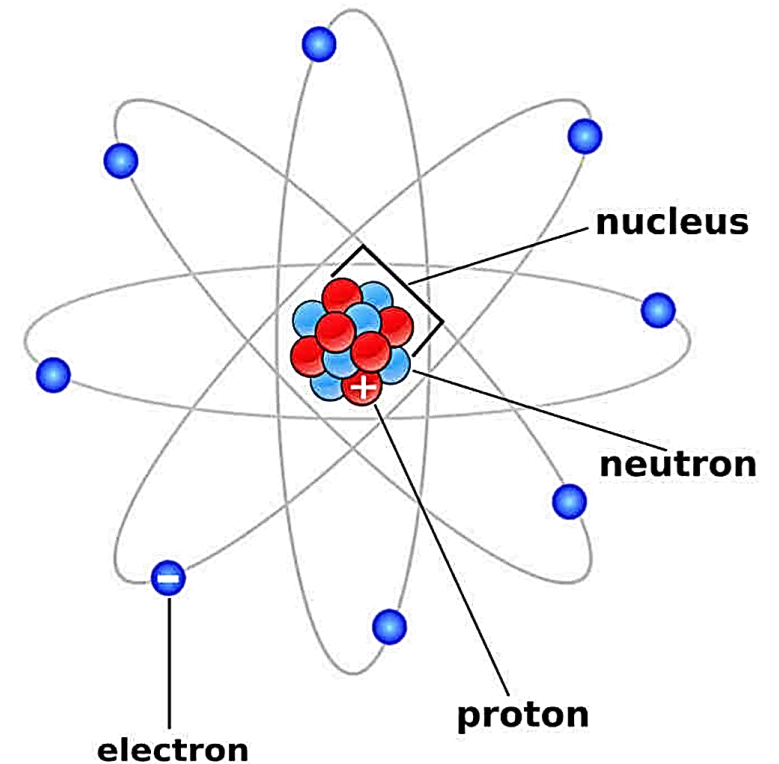
**Atoms:** The ancient Greeks (it means **indivisible**) first proposed that matter consisted of fundamental particles called **atoms**.

Every **solid**, **liquid**, **gas**, and **plasma** is composed of neutral or ionized atoms.

Every atom is composed of a **nucleus** and **one or more electrons** bound to the **nucleus**. The **nucleus** is made of **one or more protons** and a **number of neutrons**. **Protons and Neutrons** are called **Nucleons** (Nucleus).

**Note:** Only the most common Hydrogen has no neutrons.

## Atomic Structure





# ATOMIC SYMBOL

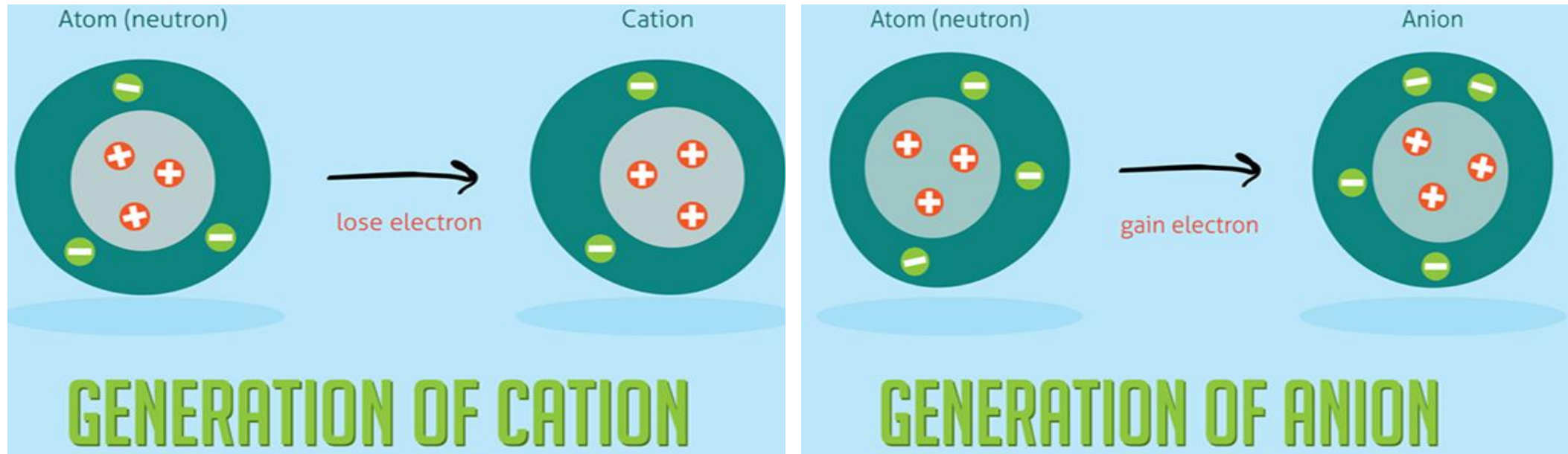
Is a **one-** or **two letters** from the Latin alphabet and are written with the first letter capitalized.

For example: Chlorine has the symbol **Cl**, Sodium is given the symbol **Na** from its Latin name, Natrium.

What will be the atomic symbol of the followings:

Phosphorus, Oxygen, Nitrogen, Carbon, Magnesium, Manganese

# IONS



**Proton= P<sup>+</sup>**

**Electron= E<sup>-</sup>**

**Neutron= N**

If protons = electrons; the atom is electrically **neutral**.

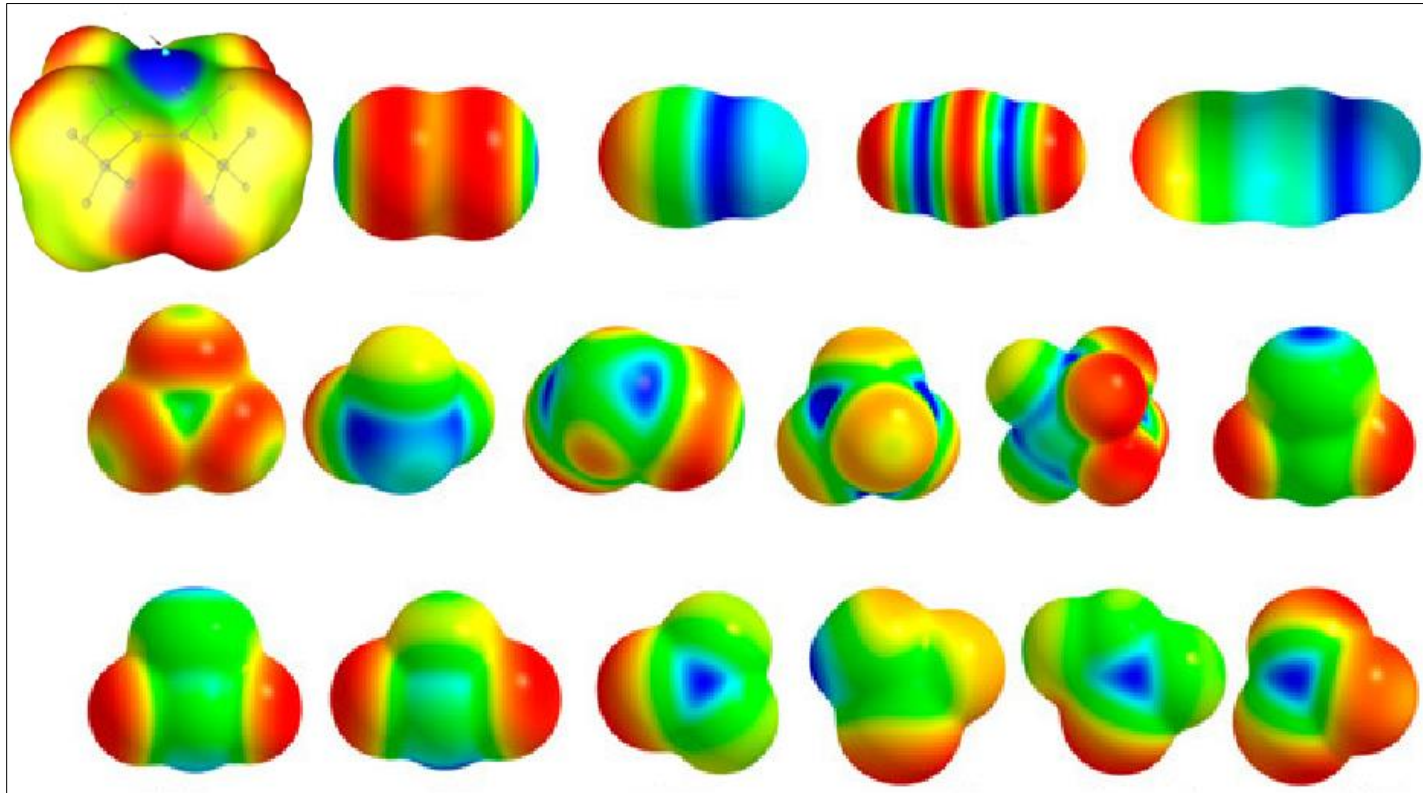
If protons > electrons; the atom is electrically **positive**.

If protons < electrons; the atom is electrically **negative**.

**These atoms are called ions.**

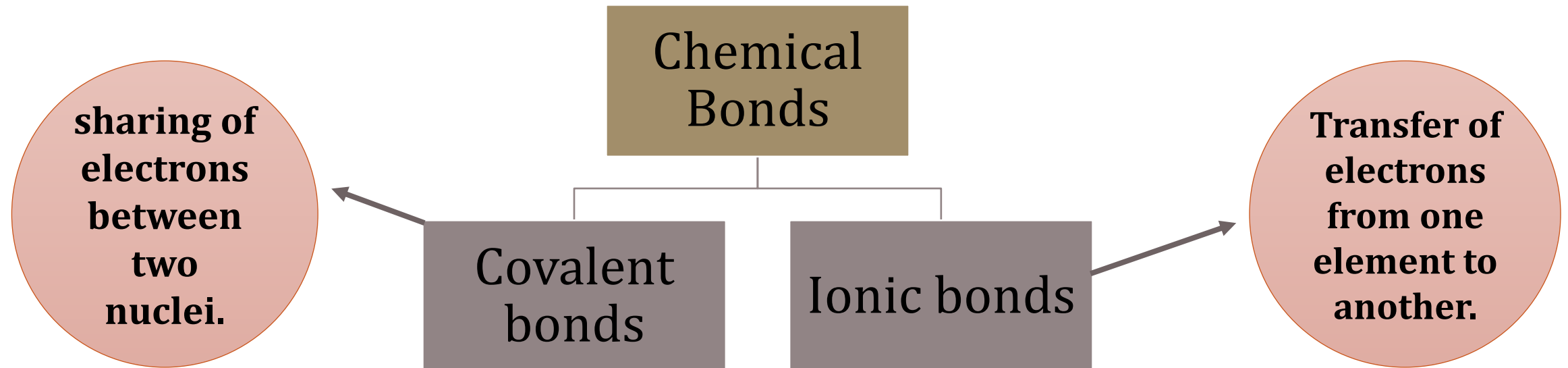
# MOLECULES

**Electrically neutral groups of two or more atoms held together by chemical bonds.**



# CHEMICAL BONDING

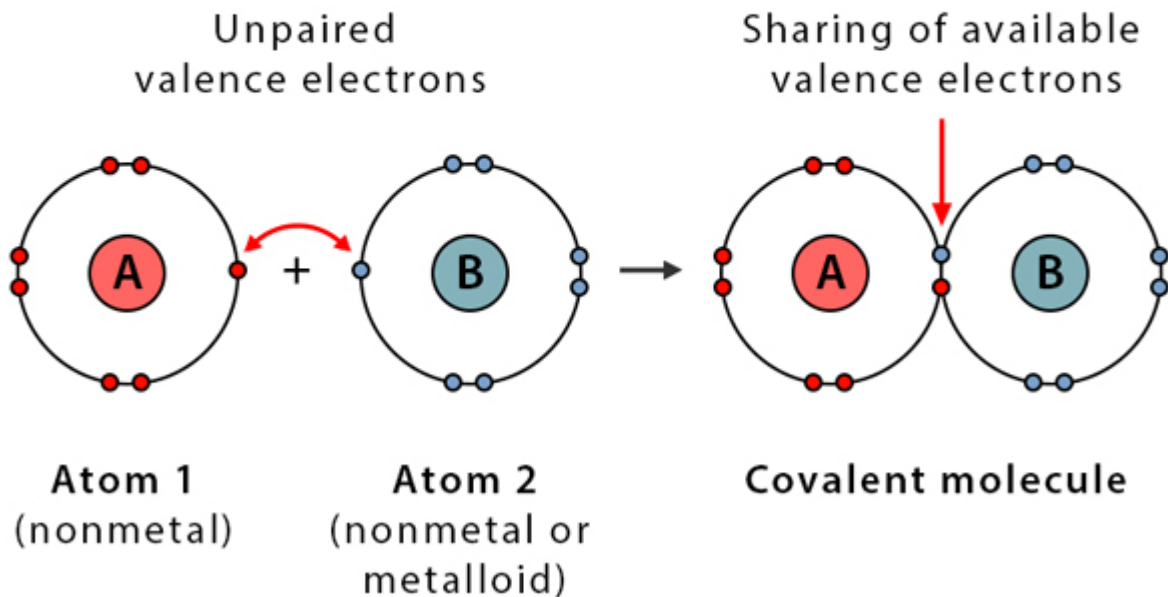
- **Bonding is the joining of two atoms in a stable arrangement.**
- Joining two or more elements will form **compounds**.
- There are only **118 elements** exist, but more than 30 million compounds are known.
- **Through bonding, atoms attain a complete outer shell of valence electrons.**



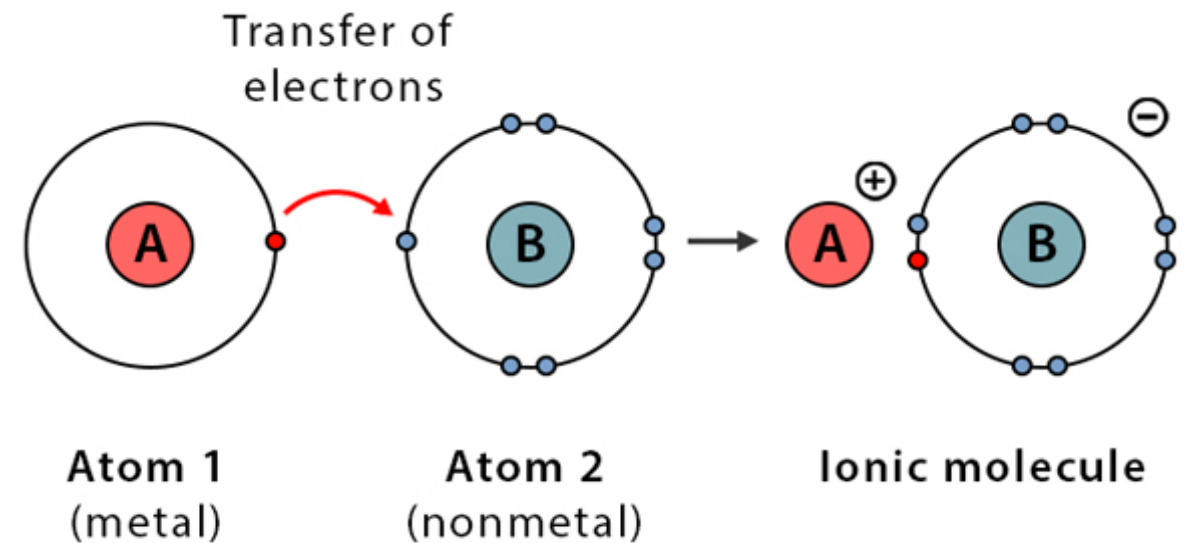
# CHEMICAL BONDING (Covalent vs Ionic)



## Covalent Bond



## Ionic Bond



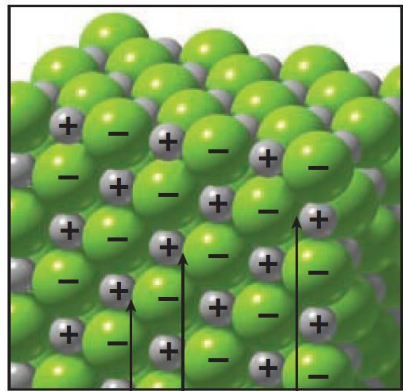


# INTERMOLECULAR FORCES



## Ionic Compounds

Particles held together by extremely strong electrostatic



strong electrostatic interaction

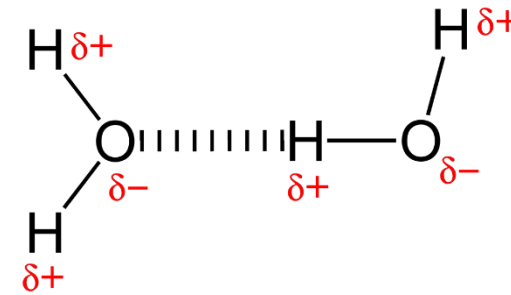
## Covalent Compounds

There are three different types of interactions:

**Hydrogen bonding**

**Dipole-Dipole interactions**

**van der Waals forces**



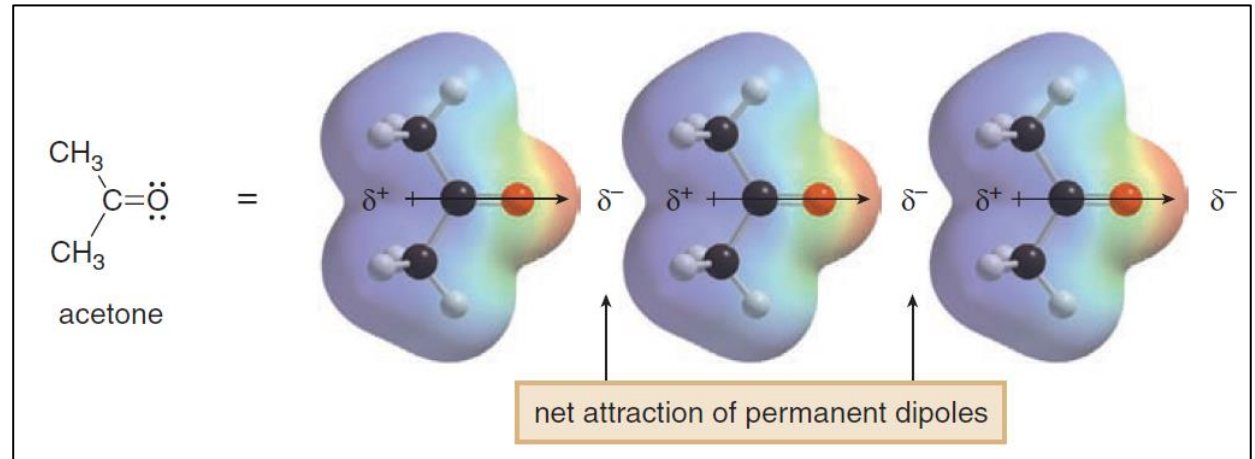
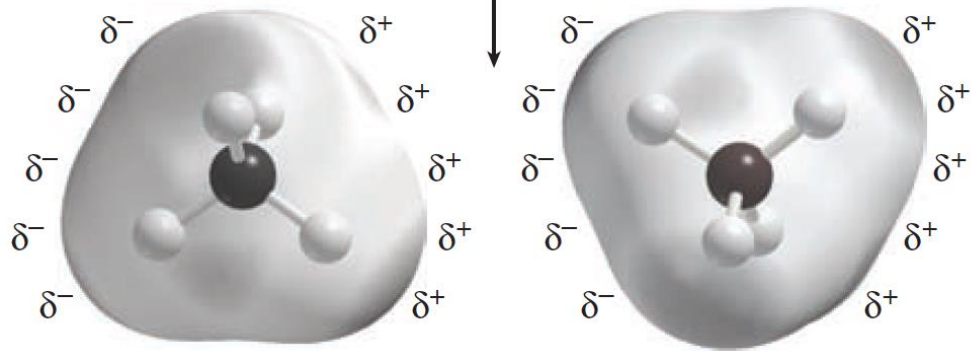
Typically occurs when a hydrogen atom bonded to **O, N, or F**, is electrostatically attracted to a lone pair of electrons on an O, N, or F atom in another molecule.

the attractive forces between the permanent dipoles of two polar molecules.

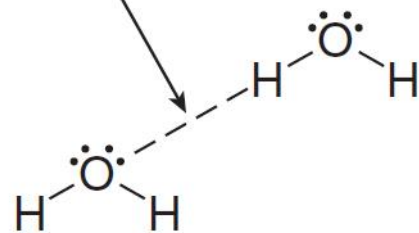
also called **London forces**, are very weak interactions caused by the **momentary changes in electron density in a molecule**. van der Waals forces are the only attractive forces present in nonpolar compounds.

# INTERMOLECULAR FORCES (Examples)

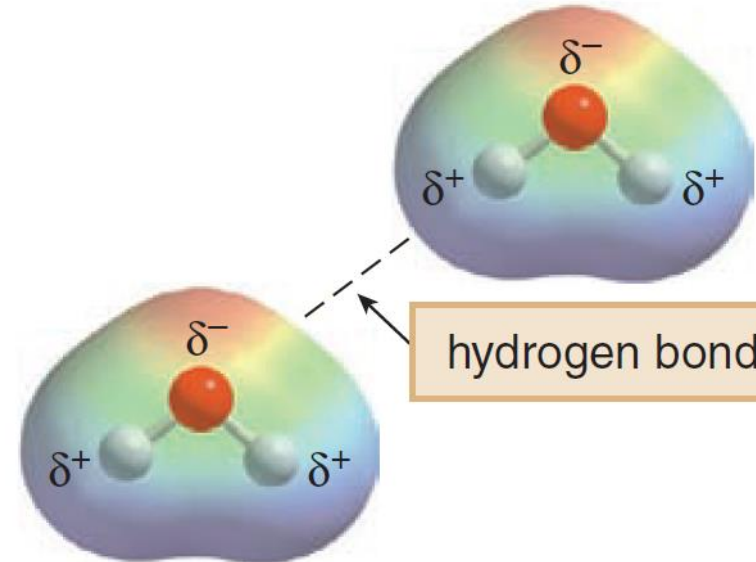
van der Waals interaction between two CH<sub>4</sub> molecules



hydrogen bond



=



# What is Analytical Chemistry?

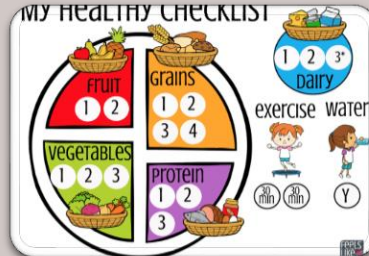
**Analytical chemistry** is the branch of chemistry that deals with the analysis of matter, both **qualitatively** (What is present?) and **quantitatively** (How much is present?).



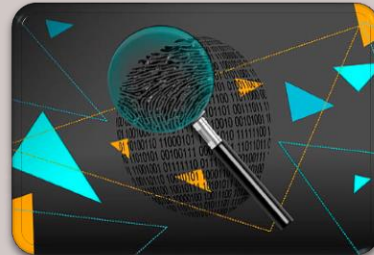
Environ-  
mental  
science



Medicine



Food and  
beverage  
industry



Forensic  
science



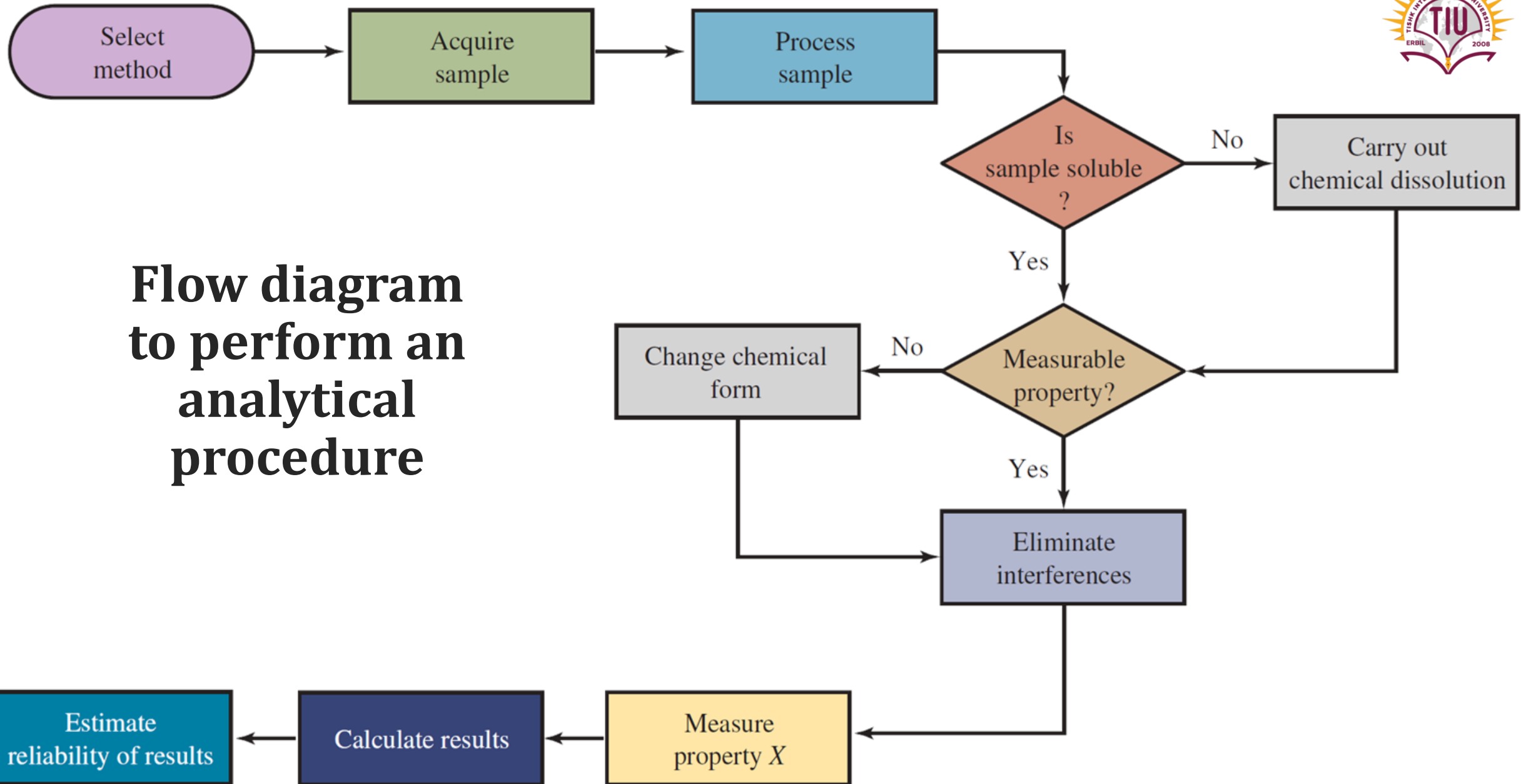
Materials  
science



Pharma-  
ceutical  
industry

**The relationship between analytical chemistry, other branches of chemistry, and the other sciences.**





# Flow diagram to perform an analytical procedure

Estimate reliability of results

Calculate results

Measure property X

Eliminate interferences

Change chemical form

Carry out chemical dissolution

Measurable property?

Is sample soluble?

Process sample

Acquire sample

Select method

# Analytical Chemistry and Medical Analysis



- Medical analysts are using analytical chemistry techniques to diagnose diseases, track the effectiveness of treatment, and evaluate the health of patients. For instance, the analysis of thyroid hormones for the purpose of diagnosis.

**Disease  
Diagnosis**



- Medical analysts can collaborate with analytical chemists to create and execute novel diagnostic tests for emerging diseases or specific genetic markers.

**Developing  
techniques**



- Analytical chemistry is used to measure drug levels in patients' blood to ensure optimal therapeutic effects and avoid potential toxicity. It also plays a role in analyzing biological samples for drugs or poisons in toxicology

**Drug  
monitoring**





# What is Inorganic Chemistry?

Inorganic chemistry is the branch of chemistry that deals with the study of the composition, structure, and properties of inorganic compounds. These are compounds that generally **do not contain carbon-hydrogen bonds**. This distinction, however, is not absolute, as there is some overlap with organic chemistry in the subfield of organometallic chemistry, which studies compounds containing both organic and inorganic moieties.

# Some of the most common inorganic compounds:



Metals and alloys

Salts

Acids and bases

Oxides

Sulfides

Nitrides

Hydrides

Inorganic chemistry plays an important role in many aspects of our daily lives. For example, inorganic compounds are used in the production of fertilizers, plastics, pharmaceuticals, and electronic devices. They are also essential for many biological processes, such as photosynthesis and respiration.



# What is Organic Chemistry?



organic chemistry is the study of the compounds of carbon. Perhaps its most remarkable feature is that most organic compounds consist of carbon and only a few other elements—chiefly, hydrogen, oxygen, and nitrogen. Chemists have discovered or made well over 10 million compounds composed of carbon and these three other elements. Organic compounds are all around us—in our foods, flavors, and fragrances; in our medicines, toiletries, and cosmetics; in our plastics, films, fibers, and resins; in our paints and varnishes; in our glues and adhesives; in our fuels and lubricants; and, of course, in our bodies and the bodies of all living things.



# Some key areas of focus in organic chemistry:

- The structure of organic compounds: This involves determining how the atoms are arranged in a molecule, both in terms of their positions in space and the types of bonds they form.
- The properties of organic compounds: This includes their physical properties, such as boiling point and melting point, as well as their chemical properties, such as reactivity and solubility.
- The reactions of organic compounds: This involves understanding how organic molecules can be transformed into new molecules through chemical reactions.
- The synthesis of organic compounds: This is the process of creating new organic molecules, either from scratch or by modifying existing ones.

# What is Biochemistry?



Biochemistry is the fascinating science that bridges the gap between chemistry and biology! It delves into the chemical processes that occur within living organisms, explaining the "how" behind life at the molecular level.



# Here's a breakdown of what biochemistry is all about:

- **Biomolecules:** These are the building blocks of life, including proteins, carbohydrates, lipids, and nucleic acids (DNA and RNA). Biochemistry investigates their structures, functions, and interactions.
- **Metabolic pathways:** These are complex chains of chemical reactions that transform molecules within an organism. Biochemistry explains how these pathways break down food for energy (catabolism) and build essential molecules (anabolism).
- **Enzymes:** These are specialized proteins that act as biological catalysts, speeding up important reactions in cells. Biochemistry explores how enzymes work and their roles in various processes.
- **Gene expression:** Understanding how genes are translated into proteins is crucial for life. Biochemistry explains the chemical processes involved in this central dogma of biology.



# Why biochemistry is important?

- **Understanding health and disease:** Many diseases stem from disruptions in biochemical processes. Studying biochemistry helps develop drugs, diagnose illnesses, and understand how our bodies function in health and disease.
- **Developing new technologies:** From biofuels to artificial enzymes, advances in biochemistry have applications in diverse fields like medicine, agriculture, and energy production.
- **Unlocking the secrets of life:** By understanding the intricate biochemistry of cells, we gain a deeper appreciation for the complexity and wonder of life itself.



# What is Physical chemistry

- Physical chemistry is a fascinating branch of science that bridges the gap between chemistry and physics, delving into the microscopic and macroscopic phenomena of chemical systems using the principles of physics. Think of it as using the "laws" of physics, like motion, energy, and force, to explain and predict the behavior of molecules and atoms in chemical reactions.



# Here are some key features of physical chemistry:

- **Thermodynamics:** Explains the energy changes and spontaneity of chemical reactions, helping us understand processes like heat transfer, equilibrium, and efficiency.
- **Kinetics:** Focuses on the rates of chemical reactions, exploring how fast molecules collide and react under different conditions.
- **Quantum mechanics:** Applies the principles of quantum theory to understand the structure and behavior of atoms and molecules, explaining their properties and bonding.
- **Statistical mechanics:** Connects the microscopic behavior of individual molecules to the macroscopic properties we observe, like pressure, temperature, and volume.
- **Spectroscopy:** Analyzes the interaction of light with molecules, providing information about their structures, energy levels, and dynamics.



# Why physical chemistry is important

- **Developing new materials:** Understanding the properties of materials at the atomic level helps design advanced materials with specific functionalities, like stronger alloys or more efficient solar cells.
- **Understanding chemical processes:** From designing drugs to predicting environmental changes, physical chemistry provides crucial insights into various chemical phenomena.
- **Unraveling complex systems:** Its quantitative approach is key to tackling challenging problems in fields like nanotechnology, energy conversion, and atmospheric chemistry.





# Applications of physical chemistry:

- **Developing batteries and fuel cells:** Understanding electrochemistry, a subfield of physical chemistry, is crucial for optimizing these energy storage and conversion technologies.
- **Investigating climate change:** Analyzing atmospheric processes like gas absorption and transport requires the detailed knowledge provided by physical chemistry.
- **Designing drugs and medical treatments:** Understanding how molecules interact with biological systems is vital for developing effective drugs and diagnostics.



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