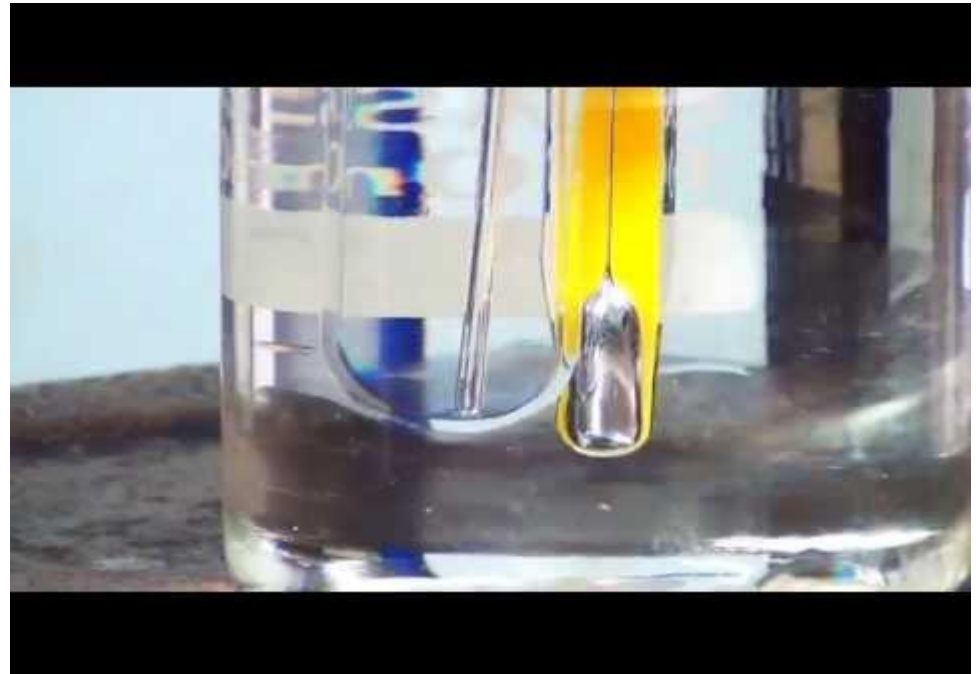
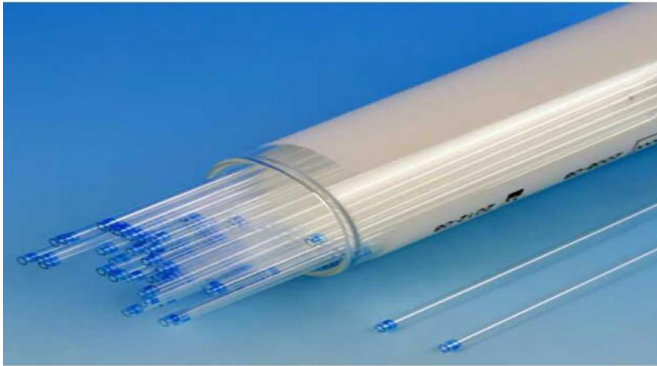


# Dental Industry Techniques Department

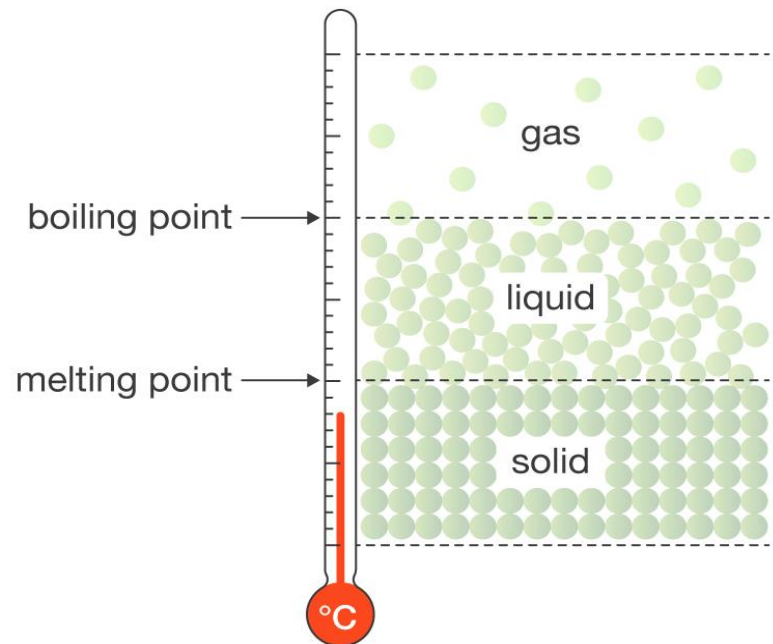
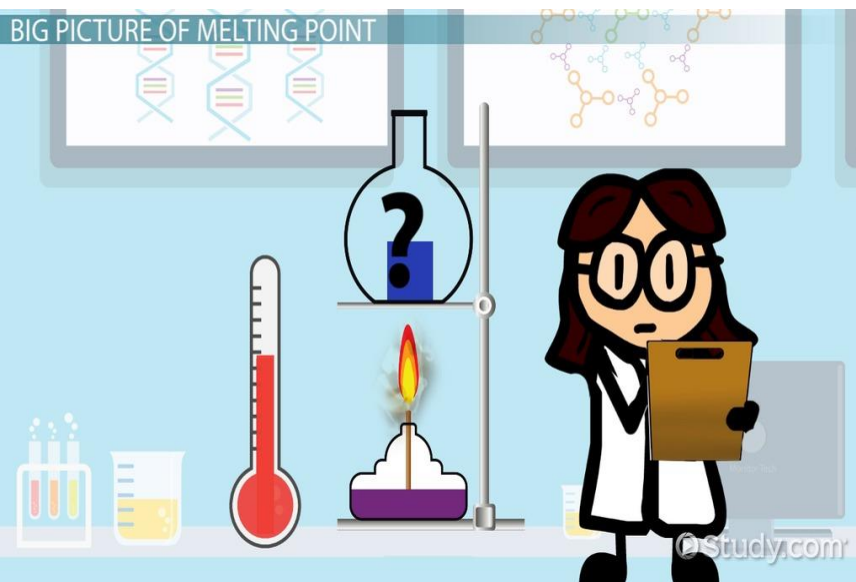
## The first stage



## Determination of melting and boiling points



- Determine the melting point of solids.
- Determine the boiling point of liquid substances.
- Comparison of boiling point and melting point.

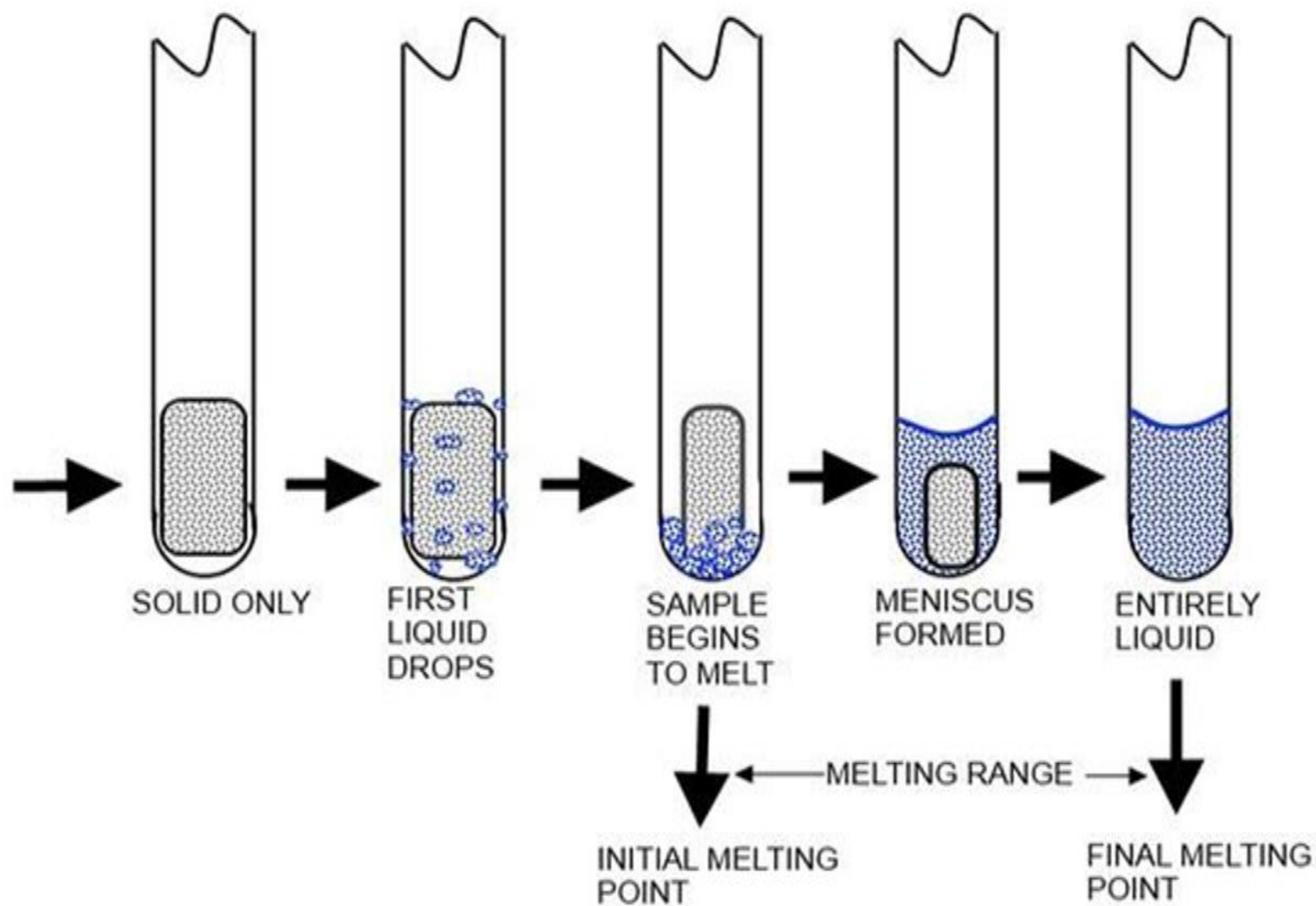


# MELTING POINT

Melting point is the temperature at which it changes state from solid to liquid at atmospheric pressure.

At the melting point, the solid and liquid phases exist in equilibrium.

**Experimentally** melting point is actually recorded as the range of temperatures in which the first crystal starts to melt( $T_1$ ) until the temperature at which the last crystal just disappears( $T_2$ ).





## Reasons for determining melting points:

### 1. Get an indication of the purity samples

pure crystalline compound usually possesses a sharp melting point and it melts completely over a **narrow range** of temperature of not more than  $0.5-1^{\circ}\text{C}$ .

An impure compound melts over a **wider range** of temperatures, usually greater than 2 degrees, and a marked increase in the width of the melting point range.

### 2. Help in identification of samples

Example: melting point of following are

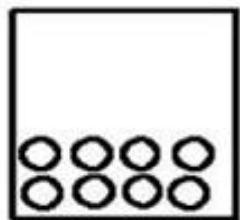
$\text{NaCl} = 801^{\circ}\text{C}$

$\text{CH}_3\text{COOH} = 16.6^{\circ}\text{C}$

$\text{CH}_3\text{COONa} = 324^{\circ}\text{C}$

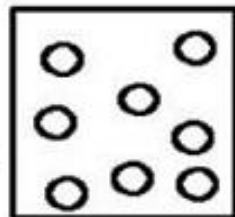
# BOILING POINT

Boiling point is the temperature At which it changes state from liquid to gas when the saturated vapor pressure of a liquid is equal to the surrounding atmospheric pressure.

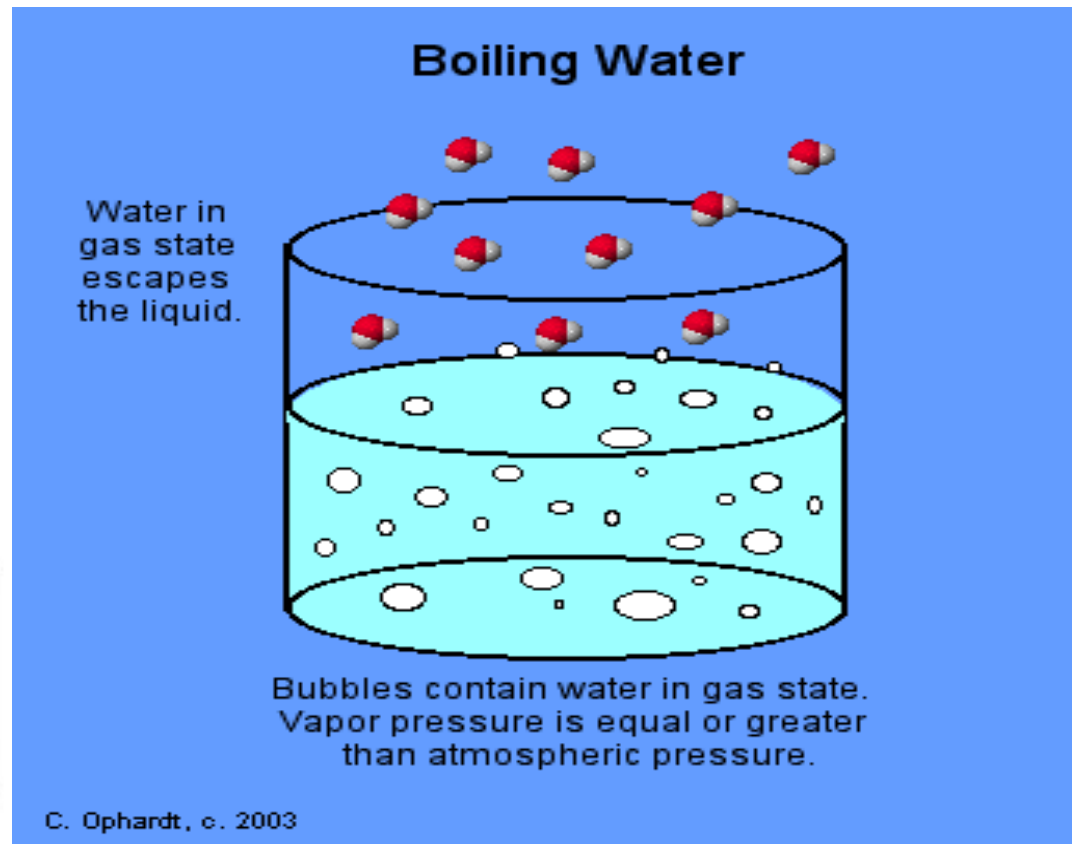


Liquid

Heat  
→  
To b.p temperature



Gas



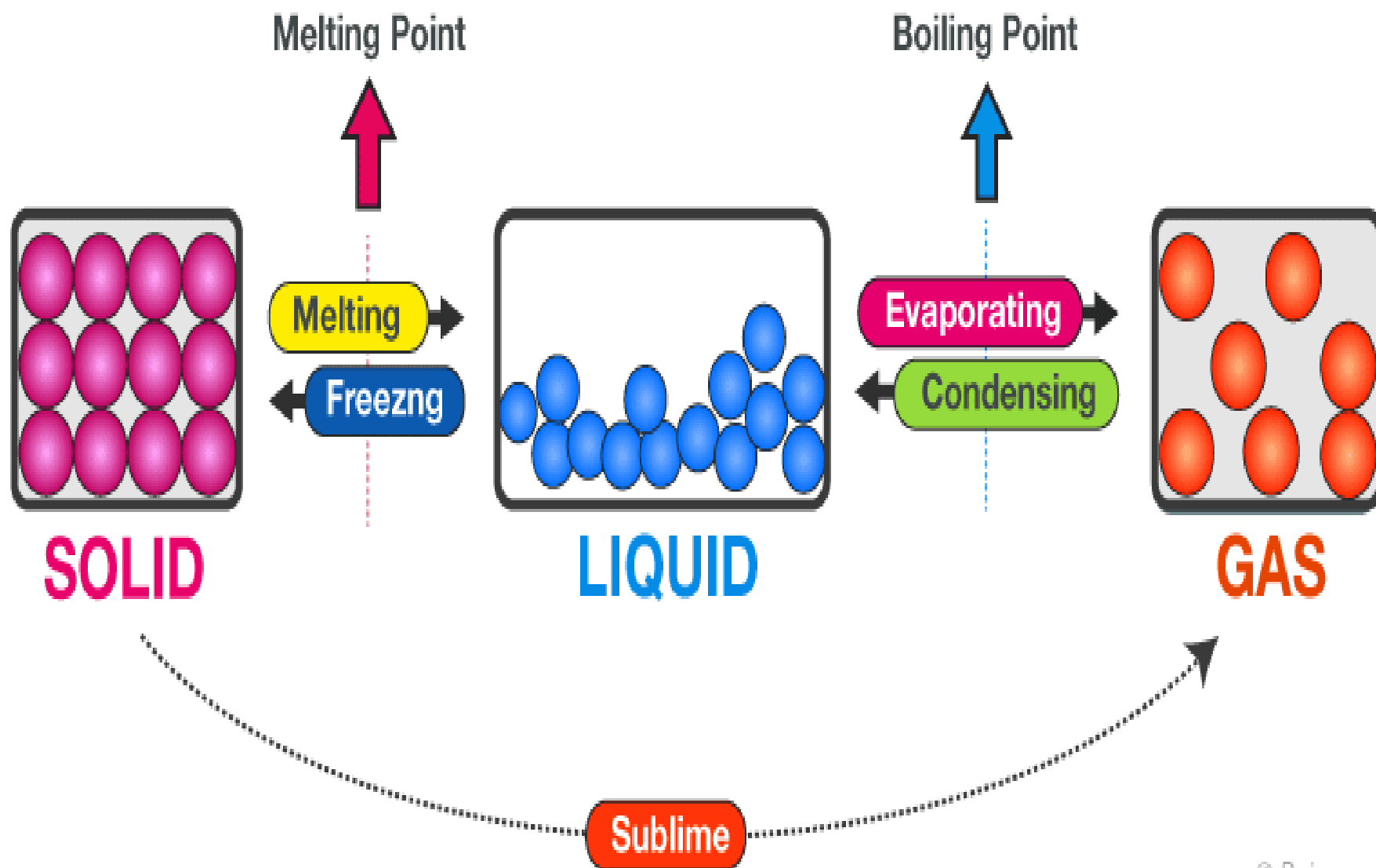
# What is the importance of knowing the boiling point of organic compounds?

1. The boiling point of organic compounds can give important information about their physical properties and structural characteristics.
2. Boiling point helps identify and characterise a compound.

# Noticeable

- ❖ With an increase temperature, there is an increase in the kinetic energy of the molecules, and therefore, in order to break the attractions between the molecules of the compound in the liquid state, it is necessary to increase the kinetic energy by raising the temperature of the sample to its boiling point.
- ❖ The atmosphere pressure plays an important role in the determination of the boiling point correctly, reduction of the pressure leads to a decrease in the boiling point and vice versa.
- ❖ Similar to the melting point the boiling point may be sharp or may vary over a temperature range. Pure liquids have a sharp boiling point while mixtures show a boiling point range.

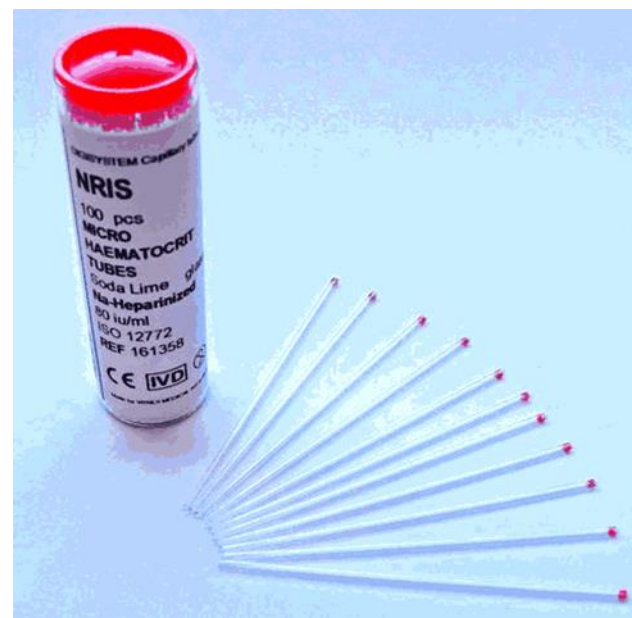
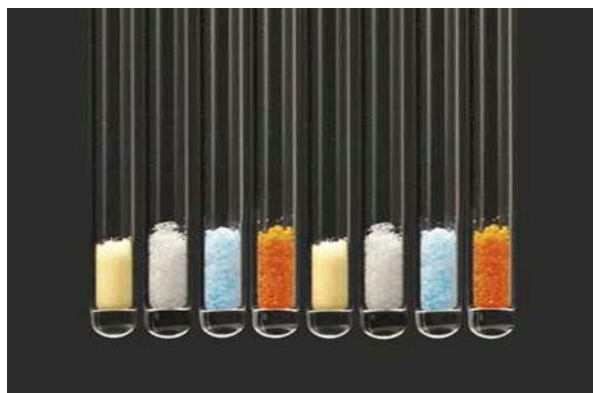
# MELTING AND BOILING POINT



# Experiment name: Determination of melting point

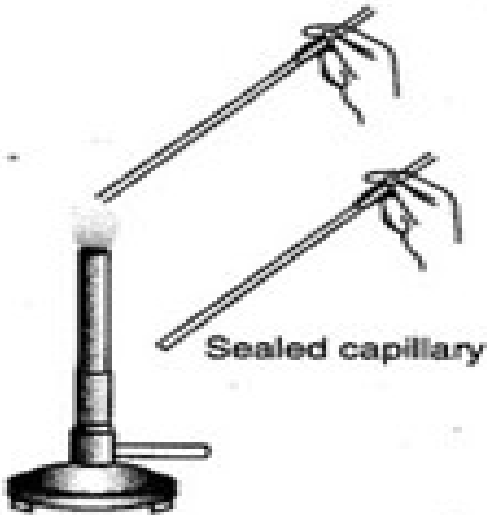
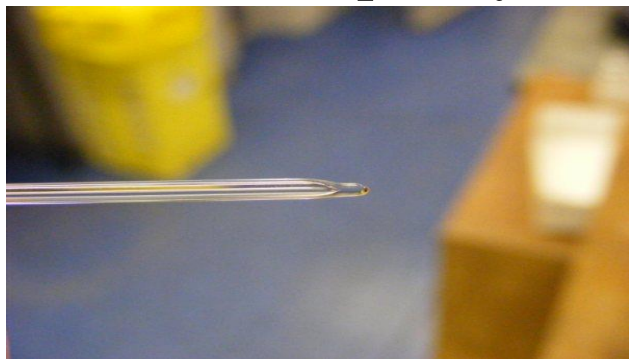
## EQUIPMENT/MATERIALS:

- Mel-Temp apparatus
- Organic compound, unknown
- Capillary tubes

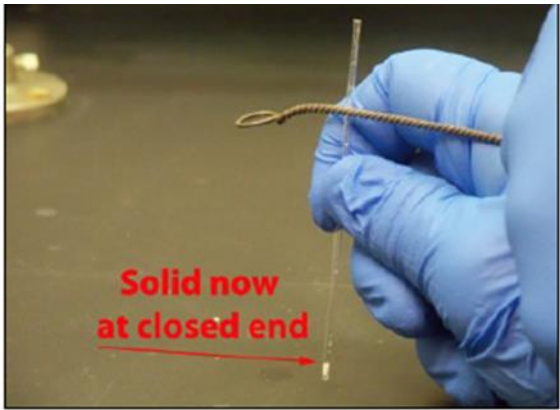
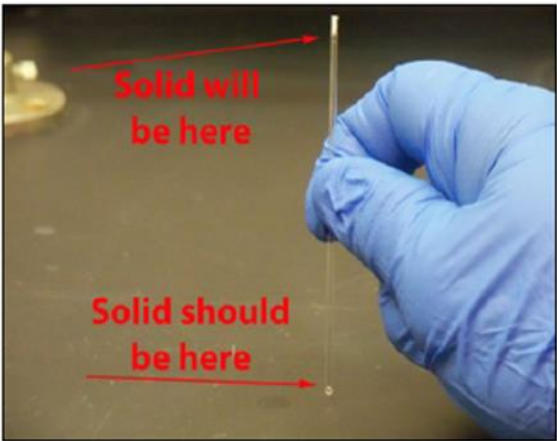
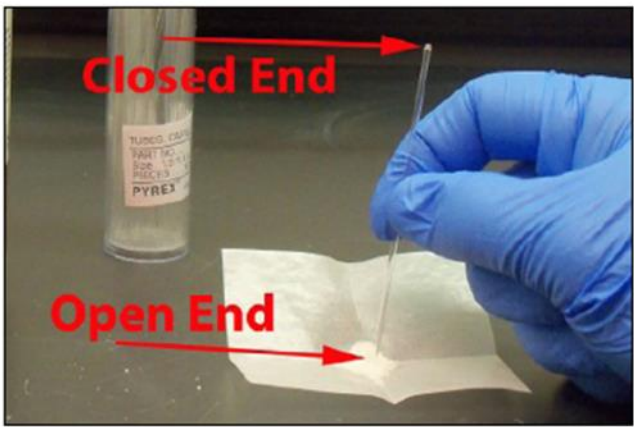


# Procedure:

1. Close one end of the capillary tube by heating.



2. Place a small amount of the known compound in to capillary tube . Push the open end of the capillary tube into the compound to load sample into tube. Load only 1-2 mm of sample into the tube. Larger samples will heat unevenly.



*Invert the capillary tube and pack the solid into the end of the capillary.*

*The solid should now be solidly packed into the top of the capillary.*

*Either by gently tapping the bottom of the capillary onto a hard surface or by rubbing the side of the capillary, move the solid to the bottom of the tube.*



4. Place the capillary melting point tube in the Mel-Temp apparatus chamber, with the closed end pointed down.



*Place the capillary into the slot. Up to four tubes can fit in the mp apparatus at one time.*



*Use the heat control dial to speed up or slow down the heating process.*

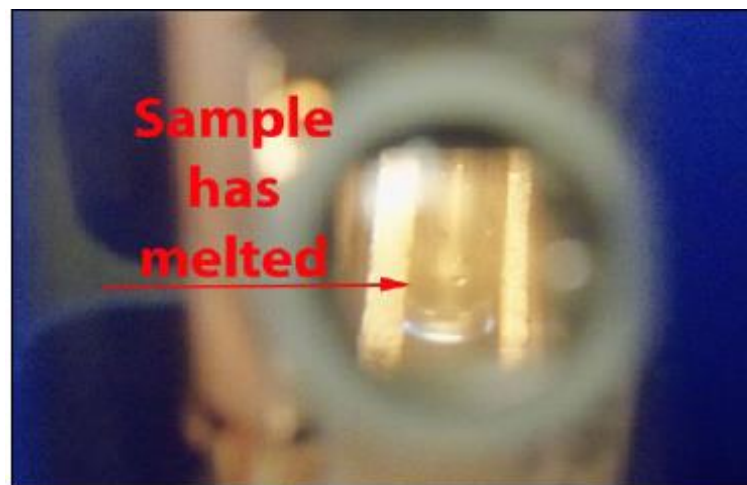
5. Turn power switch ON.

6. Set the power level to obtain the desired heating rate. Start with a setting of 40, and adjust if needed to control the rate of temperature increase. The sample should be observed continuously, so that the melting point of the sample is not missed. **Heat slowly to acquire the most accurate results.**

7. Record the melting range, which begins when the sample first starts to melt( $T_1$ ) and ends when the sample is completely melted( $T_2$ )..



*This is an example of a solid that is not yet melted.*



*This is complete melting. Record the temperature range that it takes to get to this point.*

8. Turn off the Melt-Temp to allow it to cool.

## Result

$$\text{Melting point} = \frac{T_1 + T_2}{2} = \frac{118 + 123}{2} = 120.5^\circ \text{C}$$

$$T_2 - T_1 = 123 - 118 = 5^\circ \text{C} \text{ (Impure substance)}$$

## H.W:

- 1) What two effects do impurities have on the melting point of an organic compound?
- 2) For what two purposes are melting points routinely used?
- 3) what effect has a change in the atmospheric pressure on the boiling point?
- 4) what is the purpose of determining the boiling point?
- 5) How in order to break the attractions between the molecules of the compound in the liquid state and reach to boiling point.





# Periodic table

## Types of Chemical Bonds

Dental techniques Department

Lecture 2

The periodic table displays elements from Hydrogen (1) to Oganesson (118). Elements are color-coded by group: 1 (green), 2 (orange), 13 (yellow), 14 (light green), 15 (green), 16 (light blue), 17 (blue), 18 (pink), 19-20 (red), 21-22 (blue), 23-24 (light blue), 25-26 (dark blue), 27-28 (purple), 29-30 (dark purple), 31-32 (light purple), 33-34 (light blue), 35-36 (blue), 37-38 (orange), 39-40 (yellow), 41-42 (light green), 43-44 (green), 45-46 (light blue), 47-48 (blue), 49-50 (light purple), 51-52 (purple), 53-54 (pink), 55-56 (orange), 57-71 (light blue), 72-73 (green), 74-75 (light green), 76-77 (yellow), 78-79 (orange), 80-81 (light blue), 82-83 (blue), 84-85 (light green), 86-87 (green), 88-89 (orange), 90-103 (light blue), 104-105 (light green), 106-107 (green), 108-109 (light blue), 110-111 (blue), 112-113 (light purple), 114-115 (purple), 116-117 (pink), 118 (light blue).

**Callout for Hydrogen (H):**

- Atomic Number: 1
- Symbol: H
- Name: Hydrogen
- Atomic Weight: 1.008
- Electrons per shell: 1

**Callout for Aluminum (Al):**

- Atomic Number: 13
- Symbol: Al
- Name: Aluminium
- Atomic Weight: 26.982
- Electrons per shell: 2-8-3

**Legend:**

- State of matter (color of name): GAS, LIQUID, SOLID, UNKNOWN
- Subcategory in the metal-metalloid-nonmetal trend (color of background):
  - Alkali metals (red)
  - Alkaline earth metals (orange)
  - Transition metals (blue)
  - Lanthanides (light blue)
  - Actinides (light green)
  - Post-transition metals (green)
  - Metalloids (yellow)
  - Reactive nonmetals (light blue)
  - Noble gases (pink)
  - Unknown chemical properties (grey)



# Sections of the periodic table of the elements

Periodic Table of the Elements																		18																											
1A																	8A																												
1 H Hydrogen 1.008	2 He Helium 4.003																																												
3 Li Lithium 6.941	4 Be Beryllium 9.012															5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180																								
11 Na Sodium 22.99	12 Mg Magnesium 24.305	3 Al Aluminum 26.982	4 Si Silicon 28.086	5 P Phosphorus 30.974	6 S Sulfur 32.065	7 Cl Chlorine 35.453	8 Ar Argon 39.948											13 K Potassium 39.098	14 Ca Calcium 40.078	15 Sc Scandium 44.956	16 Ti Titanium 47.887	17 V Vanadium 50.942	18 Cr Chromium 51.996	19 Mn Manganese 54.938	20 Fe Iron 55.845	21 Co Cobalt 58.933	22 Ni Nickel 58.693	23 Cu Copper 63.546	24 Zn Zinc 65.38	25 Ga Gallium 69.723	26 Ge Germanium 72.631	27 As Arsenic 74.922	28 Se Selenium 78.971	29 Br Bromine 79.904	30 Kr Krypton 83.799										
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.96	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294											31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.799												
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]											37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.96	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
87 Fr Francium [223]	88 Ra Radium [226]	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [282]	112 Cn Copernicium [285]	113 Nh Nihonium [284]	114 Fl Flerovium [289]	115 Mc Moscovium [288]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]											55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209]	85 At Astatine [210]	86 Rn Radon [222]
			57 La Lanthanum 138.905	58 Ce Cerium 140.118	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967											87 Fr Francium [223]	88 Ra Radium [226]	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [282]	112 Cn Copernicium [285]	113 Nh Nihonium [284]	114 Fl Flerovium [289]	115 Mc Moscovium [288]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]
			89 Ac Actinium [227]	90 Th Thorium [232]	91 Pa Protactinium [231]	92 U Uranium [238]	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm Curium [247]	97 Bk Berkelium [247]	98 Cf Californium [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]	103 Lr Lawrencium [262]											57 La Lanthanum 138.905	58 Ce Cerium 140.118	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967			
			Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide																																	

The **periodic table of elements which:** is widely used in the field of Chemistry is used to quickly refer some important physical parameters of chemical elements as they are arranged in a manner that displays periodic trends of their chemical properties also. However, the Periodic Table generally displays only the **symbol of the element and not its entire name.**

The **periodic table**, also known as the periodic table of the elements, is a **rows** and **columns** arrangement of the chemical elements. It is widely used in chemistry, physics, and other sciences, and is generally seen as an icon of chemistry.

This list contains the **118** elements of chemistry. For chemistry students and teachers: The tabular chart on the right is arranged by Atomic number. The first chemical element is **Hydrogen** and the last is **Ununoctium**.

**Groups**: The vertical column of the periodic table that signifies the number of valence electrons in an element.

**Periods**: The horizontal rows in the periodic table that signify the number of electron shells in an element.

**Families**: Elements that have the same number of valence electrons and therefore similar properties.



# How to Read the Periodic Table

Group→	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
↓Period																		
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu			
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr			

This is a list of the **118** chemical elements that have been identified as of 2023. A chemical element, often simply called an element, is a type of atom which has the same number of protons in its atomic nucleus (i.e., the same atomic number, or  $Z$ ).



# Chemical bonding

**Chemical bonding**: refers to the formation of a chemical bond between two or more atoms, molecules, or ions to give rise to a chemical compound. these chemical bonds are what keep the atoms together in the resulting compound.

## Types of chemical bonding

- 1.** Ionic bonds.
- 2.** Covalent bonds.
- 3.** Coordinate covalent bonds.
- 4.** Metallic bonds.

### Weak bonding:

- A.** Hydrogen bonds.
- B.** Van der Waals forces.

# Types of Chemical Bonds

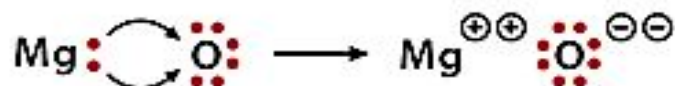
## 1. Ionic Bond

Metal atom loses electron(s) to nonmetal atom



Sodium Chlorine

Sodium chloride

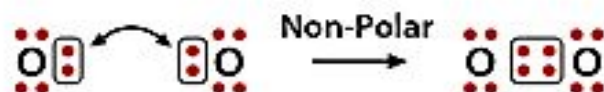


Magnesium Oxygen

Magnesium oxide

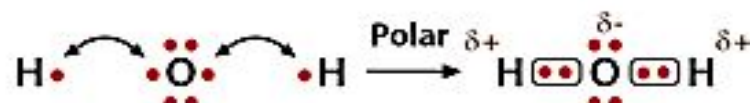
## 2. Covalent Bond

Two nonmetal atoms share electrons



Oxygen atoms

Oxygen molecule

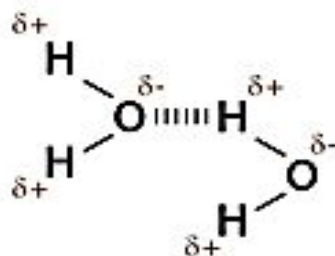


Hydrogen Oxygen Hydrogen

Water

## 3. Hydrogen Bond

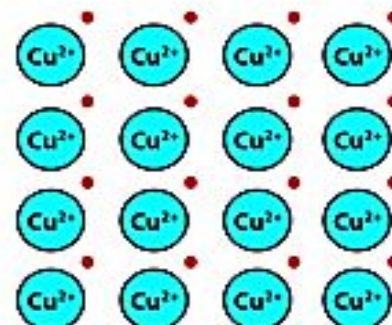
Hydrogen attracts an electronegative atom electrostatically



Two water molecules

## 4. Metallic Bond

Positive metal ions attract conducting electrons



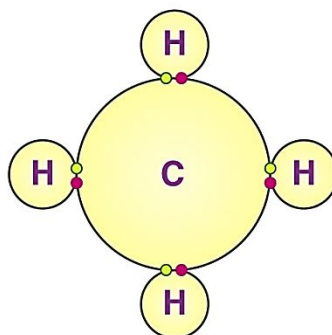
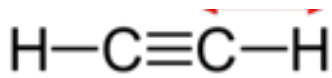
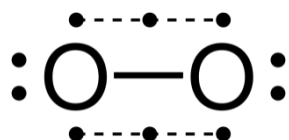
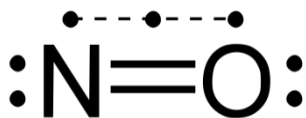
Copper ions immersed in an electron cloud



# Covalent bonds

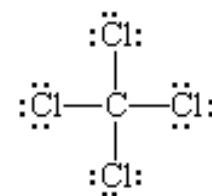
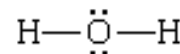
## Covalent Bonds:

A covalent bond indicates the sharing of electrons between atoms. Compounds that contain carbon (**also called organic compounds**) commonly exhibit this type of chemical bonding. The pair of electrons which are shared by the two atoms now extend around the nuclei of atoms, leading to the creation of a molecule.



● Electron from Hydrogen | ● Electron from Carbon

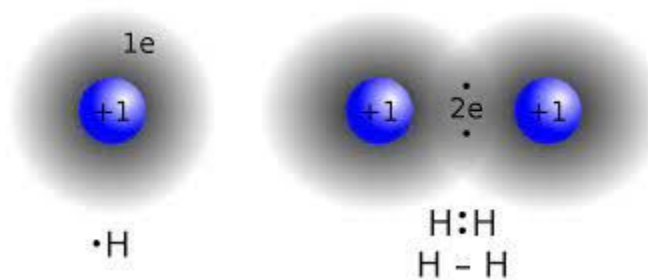
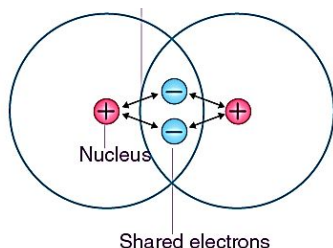
Covalent Bonding in CH<sub>4</sub>



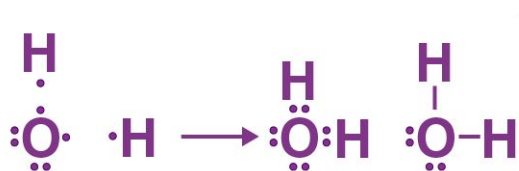


# Covalent bonds

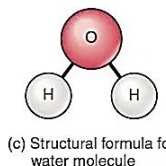
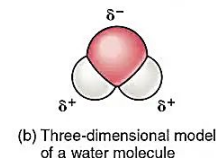
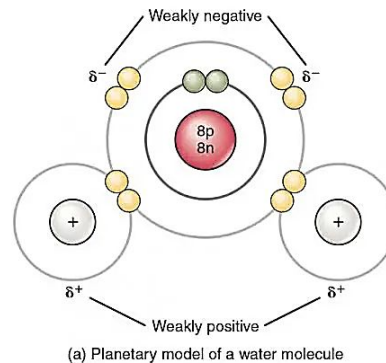
A covalent bond is a chemical bond that involves the sharing of electrons to form electron pairs between atoms. These electron pairs are known as shared pairs or bonding pairs. The stable balance of attractive and repulsive forces between atoms, when they share electrons, is known as covalent bonding.



## Hydrogen molecule H<sub>2</sub>



## Water molecule H<sub>2</sub>O





# Bonds

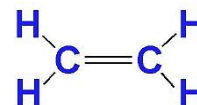
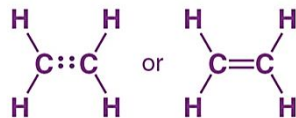
# Types of Covalent

Based on the number of shared electron pairs:

## 1) Single Bond



## 2) Double Bond



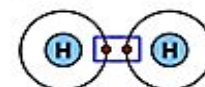
Ethylene

## 3) Triple Bond



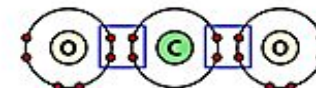
Based on the number of shared electron pairs

### Single Bond



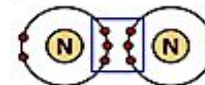
Hydrogen (H<sub>2</sub>)

### Double Bond



Carbon dioxide (CO<sub>2</sub>)

### Triple Bond



Nitrogen (N<sub>2</sub>)



# **Types of covalent bond**

**Based on the polarity and coordination of the atoms:**

**1) Polar Bond**

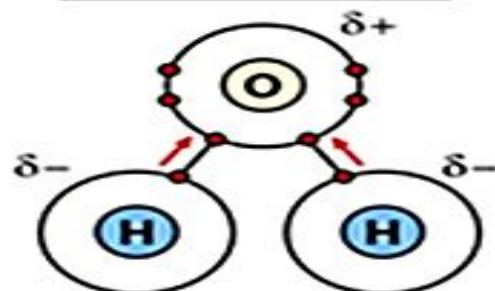
**2) Nonpolar Bond**

**3) Coordinate Bond**



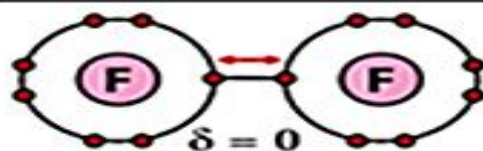
Based on the polarity and coordination of the atoms

### Polar Bond



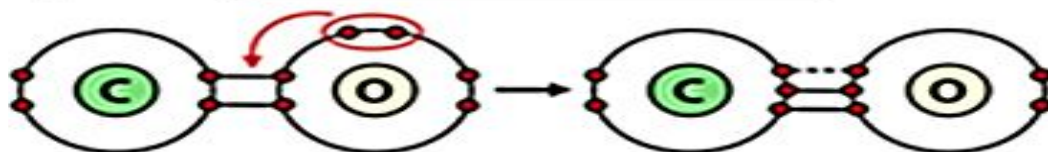
Water ( $\text{H}_2\text{O}$ )

### Nonpolar Bond



Fluorine ( $\text{F}_2$ )

### Coordinate Bond



Carbon monoxide ( $\text{CO}$ )



# Ionic bonds

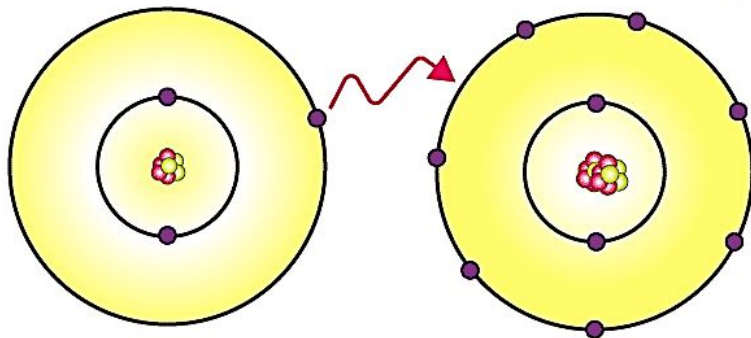
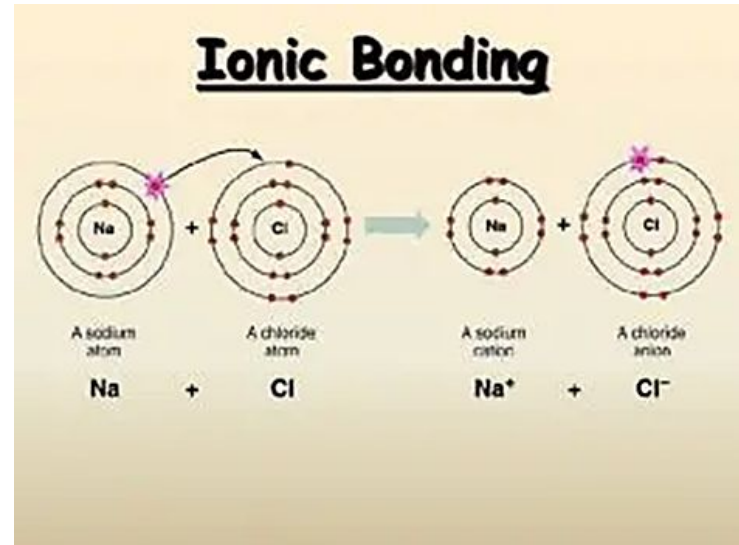
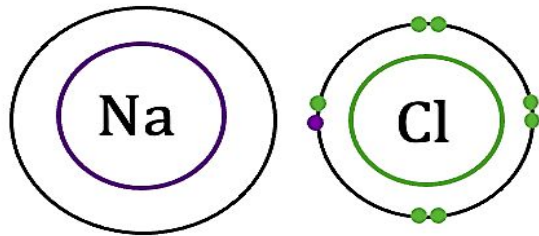
## Ionic Bonds::

Ionic bonding is a type of chemical bonding which involves a transfer of electrons from one atom or molecule to another. Here, an atom loses an electron which is in turn gained by another atom. When such an electron transfer takes place, one of the atoms develops a negative charge and is now called the anion.

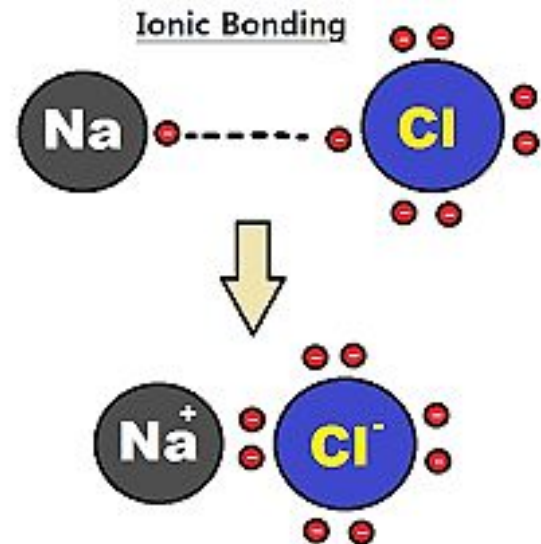
The other atom develops a positive charge and is called the cation. The ionic bond gains strength from the difference in charge between the two atoms, i.e. the greater the charge disparity between the cation and the anion, the stronger the ionic bond.

# Ionic Bonds

Ionic Bond



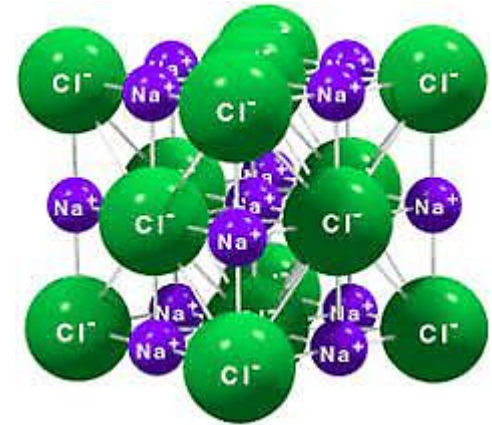
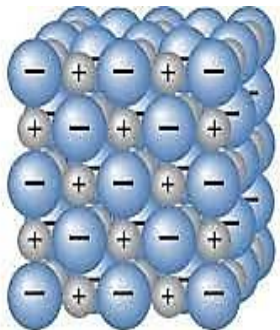
© Byjus.





# Properties of ionic bonding

Ionic bonding can form vast networks of ions attracted to one another, causing them to form crystals—which can be quite strong. These ionic network bonds are why most ionic compounds are solids with very high melting points. Sodium chloride, for example, melts at almost 1500° Fahrenheit, or about 800° Celsius because of its strong network of ionic bonds.





# Differences between ionic and covalent compounds

There are primarily two forms of bonding that an atom can participate in: **Covalent and Ionic**. Covalent bonding involves the sharing of electrons between two or more atoms. Ionic bonds form when two or more ions come together and are held together by charge differences.

- 1. Ionic bonds tend to transfer electrons, covalent bonds share them more easily**
- 2. Ionic compounds tend to have higher melting and boiling points, covalent compounds have lower melting & boiling points.**
- 3. Ionic compounds tend to have more polar molecules, covalent compounds less so**

**Organic compounds tend to have covalent bonds.**

- 4. Ionic compounds are usually between a metal and a non-metal. Non-metal with a non-metal compounds are covalent.**
- 5. Ionic compounds have ions in solution or in the molten state and conduct electricity**
- 6. Ionic bonds are much stronger than covalent bonds.**
- 7. Ionic compounds tend to be a solid with a definite shape at room temperature, covalent compounds are usually gases, liquids or soft solids.**
- 8. Ionic compounds often do not dissolve in organic solvents, while covalent compounds often do.**

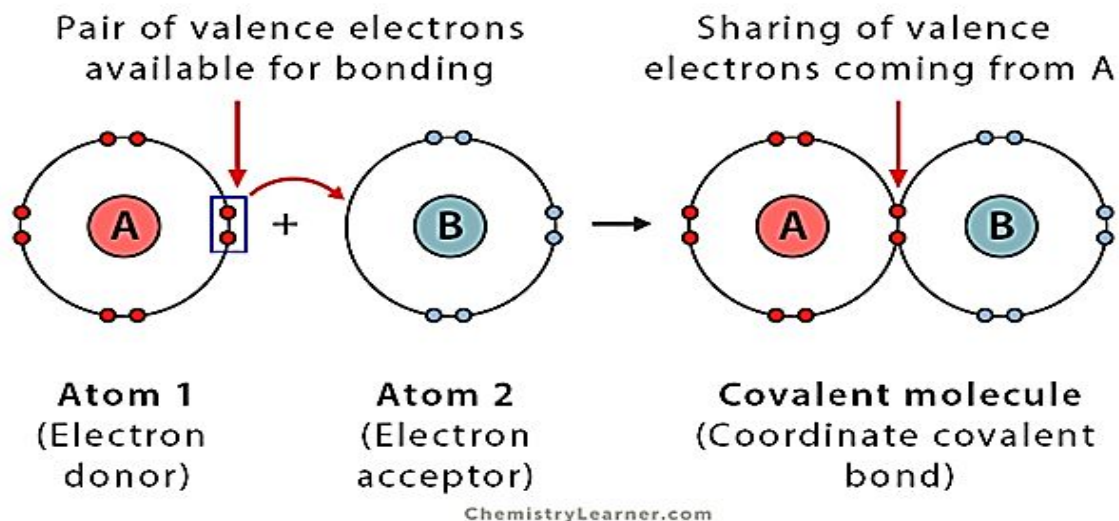


# Coordinate Bonds

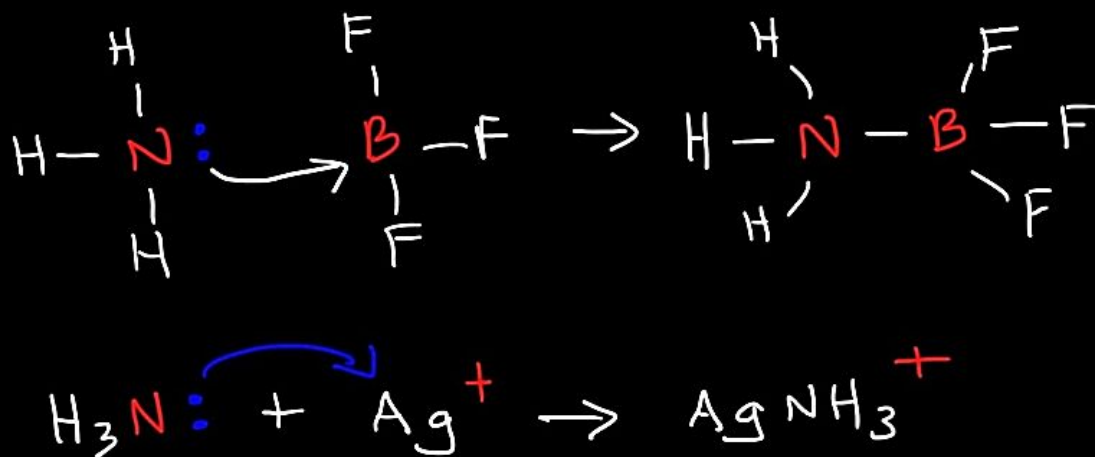
A coordinate bond is a type of covalent bond where both of the electrons that form the bond originate from the same atom (more generally, a "dative" covalent bond).

Coordinate bonds form between a central electrophile (low electron density, such as metal cations) and one or more nucleophiles (high electron density, such as the hydroxide anion) oriented around the former. Nucleophiles act as "ligands" by supplying two electrons per coordinate bond to the electrophile to satisfy the octet rule. A "polydentate" (from Latin "dēns": tooth) ligand molecule may form multiple coordinate bonds.

# Coordinate Covalent Bond



## Coordinate Covalent Bonds





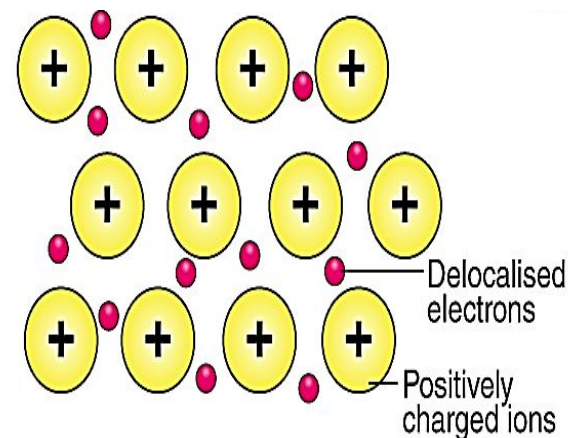
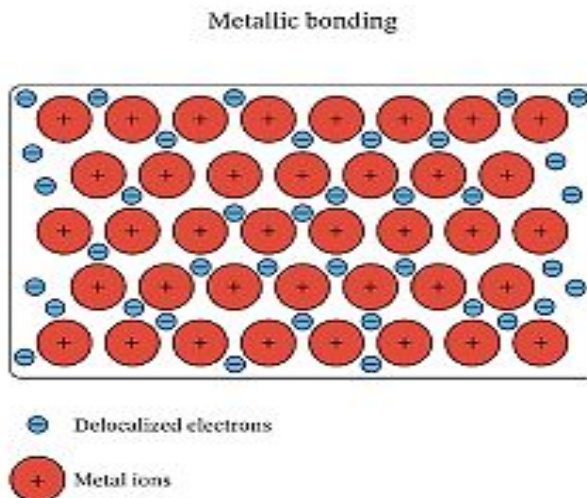
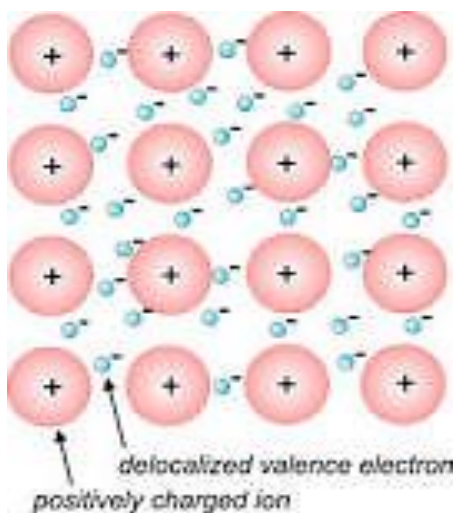


# Metallic Bonds

**'Metallic bond'** is a term used to describe the collective sharing of a sea of valence electrons between several positively charged metal ions.

Metallic solids are solids composed of metal atoms that are held together by metallic bonds.

Gold, silver, and copper are examples of minerals with metallic bonds. Because valence electrons move easily throughout the structure, metallically bonded compounds are good conductors of heat and electricity.



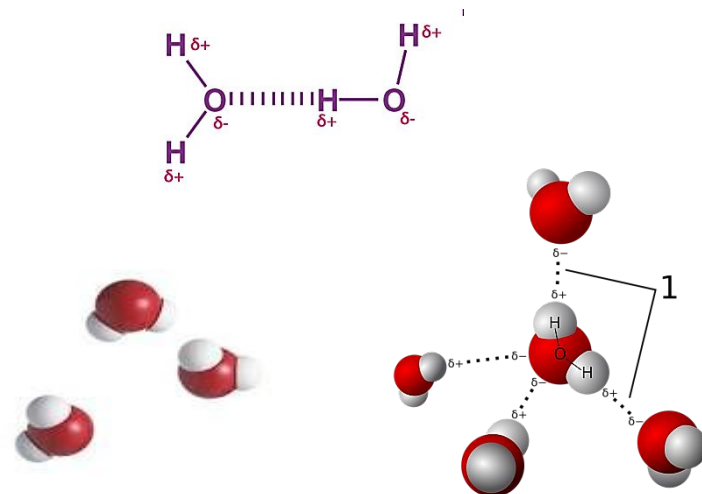
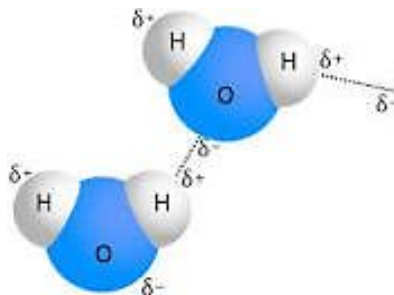
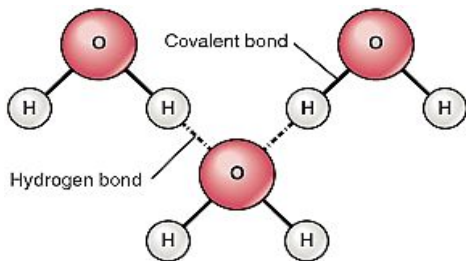
Metallic Bonding in Sodium



# Hydrogen bonds

**Hydrogen bond:** is a primarily electrostatic force of attraction between a hydrogen atom which is covalently bound to a more electronegative "donor" atom or group, and another electronegative atom bearing a lone pair of electrons—the hydrogen bond acceptor.

A hydrogen bond is an attraction between two atoms that already participate in other chemical bonds. One of the atoms is hydrogen, while the other may be any electronegative atom, such as oxygen, chlorine, or fluorine. Hydrogen bonds may form between atoms within a molecule or between two separate molecules.



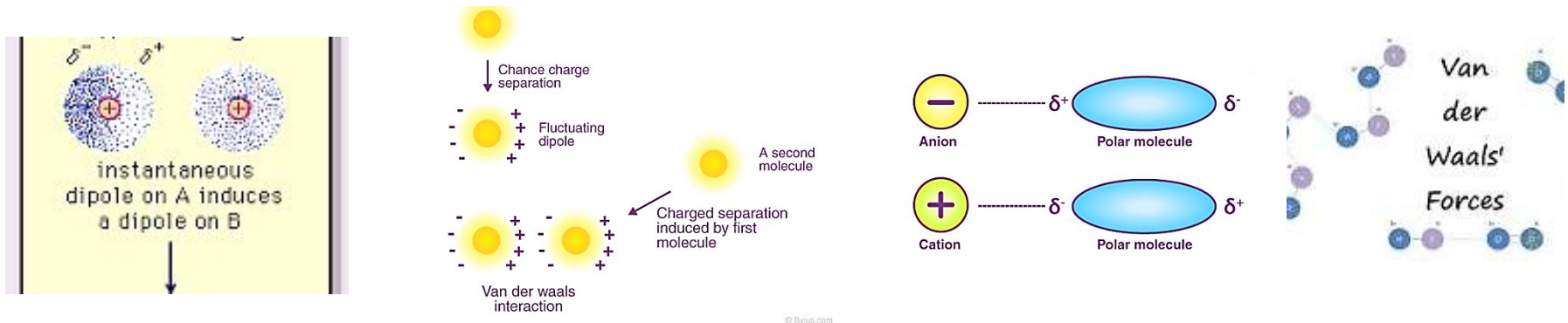


# Van Der Waals Forces

**Van der Waals forces:** are weak electrostatic forces that attract neutral molecules to one another. Particles in liquid or air vibrate and move constantly. Thus, they collide with other particles, including the media's particles such as water molecules—the process known as Brownian motion

Van der Waals forces are weak intermolecular forces that are dependent on the distance between atoms or molecules. These forces arise from the interactions between uncharged atoms/molecules.

For example, Van der Waals forces can arise from the fluctuation in the polarizations of two particles that are close to each other.





# Introduction to General Chemistry(Matter) Classification, Atom, Isotopes & Atomic mass

**Dental Industry Techniques**

**lecture 1**

# General Chemistry

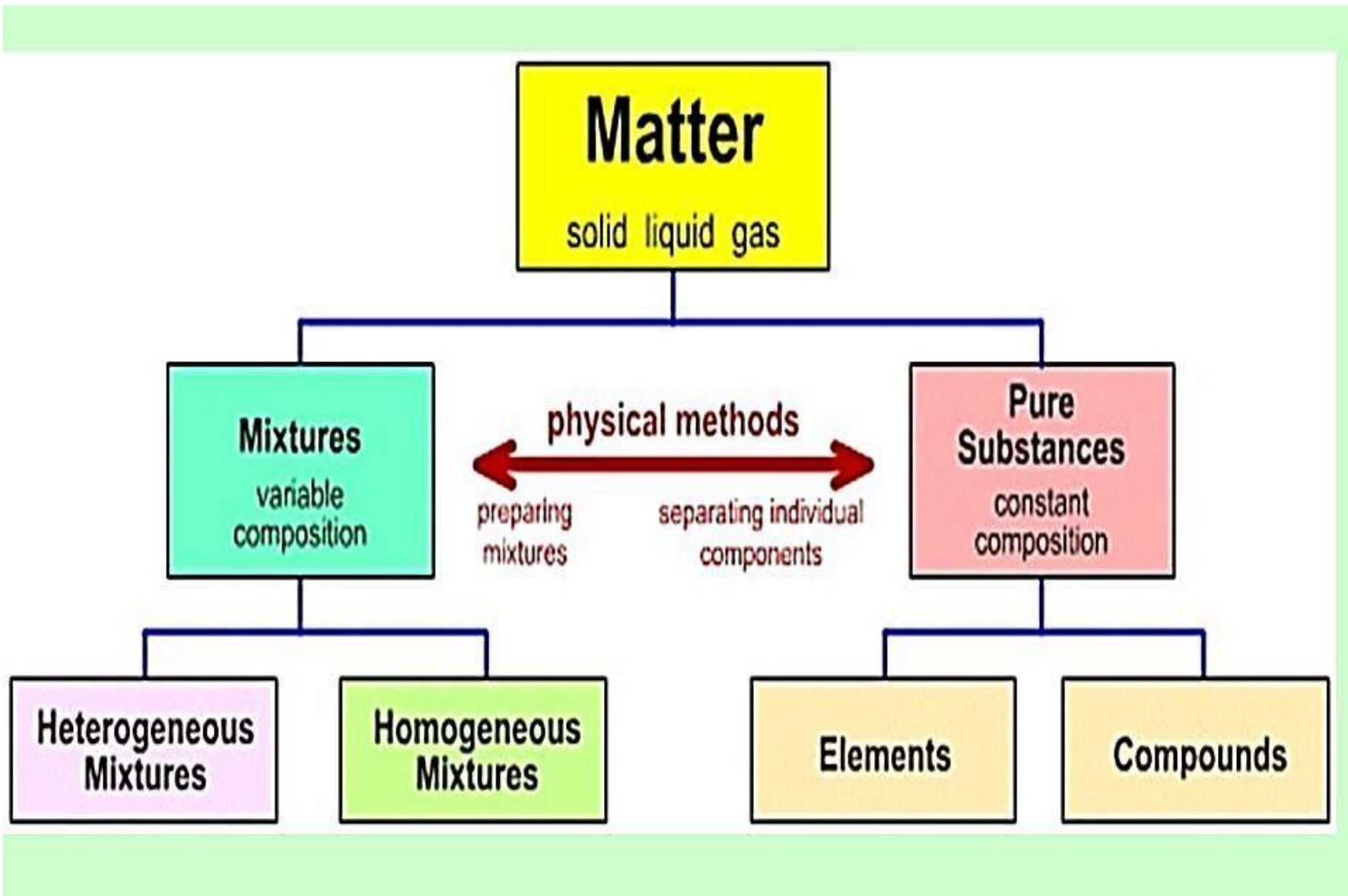
Chemistry: is the study of Matter — its characteristics, behavior and structure. Chemists are interested in the way materials act and react in certain situations, so they produce and observe these reactions, both in nature and artificially in a lab setting.

Matter: is defined as anything that occupies space and has mass, and it is all around us. ...

**Solids**, **liquids**, and **gases** are the three states of matter commonly found on earth.

A fourth state of matter, **plasma**, occurs naturally in the interiors of stars.

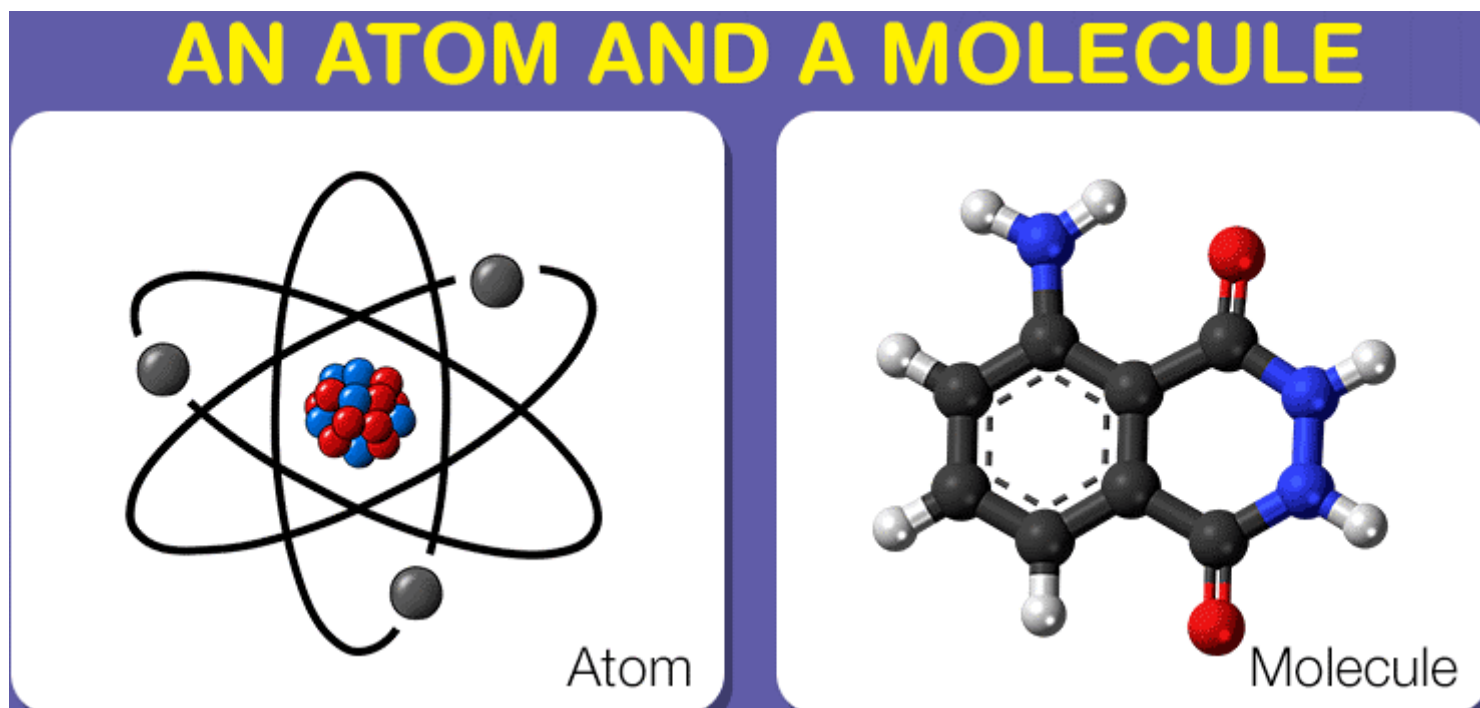
A physical change involves the conversion of a substance from one state of matter to another, without changing its chemical composition.





# Atom and molecular

Atom: refers to the smallest constituent unit of a chemical element. Molecule: refer to a group of two or more atoms that are held together due to chemical bonds



# Energy levels of an atom

Energy levels: (also called electron shells) are fixed distances from the nucleus of an atom where electrons may be found. Electrons are tiny, negatively charged particles in an atom that move around the positive nucleus at the center. Energy levels are a little like the steps of a staircase.

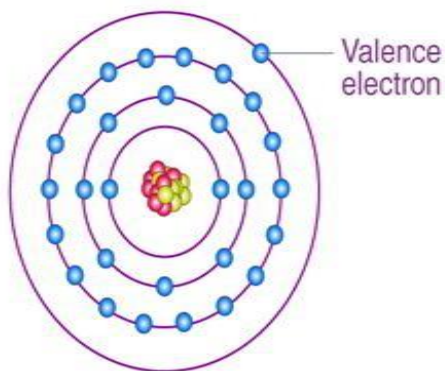
Regardless of its shape, each orbital can hold a maximum of **two** electrons. Energy level I has just one orbital, so two electrons will fill this energy level. Energy level II has four orbitals, so it takes **eight** electrons to fill this energy level.

Q: Energy level III can hold a maximum of **18** electrons. How many orbitals does this energy level have?

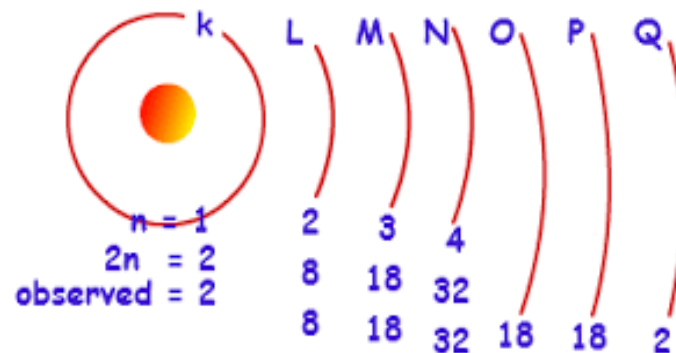
A: At two electrons per orbital, this energy level must have **nine** orbitals.

# Valence electrons

- **Valence electrons:** are the **s and p electrons in the outermost shell**. The electrons present in the inner shell are core electrons. When we study and observe the atom of an element, we come across tiny subatomic particles called valence electrons.



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The Learning App



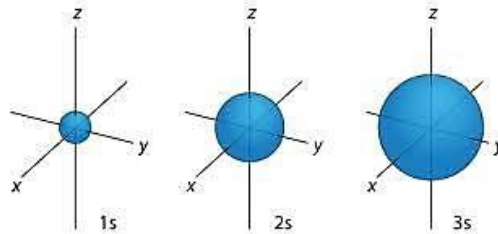
A diagram of an atom with a central nucleus made of red and yellow spheres. Surrounding the nucleus are four concentric purple circles representing electron shells. Blue dots representing electrons are placed on these shells. The outermost shell contains eight blue dots. A line points from the text "Valence electron" to one of these dots.

	k	L	M	N	O	P	Q
$n = 1$							
$2n = 2$	2	8	18	32	18	18	2
observed = 2	2	8	18	32	18	18	2

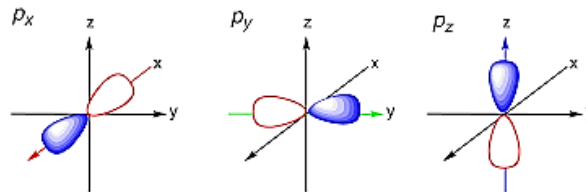
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# Shapes of orbitals

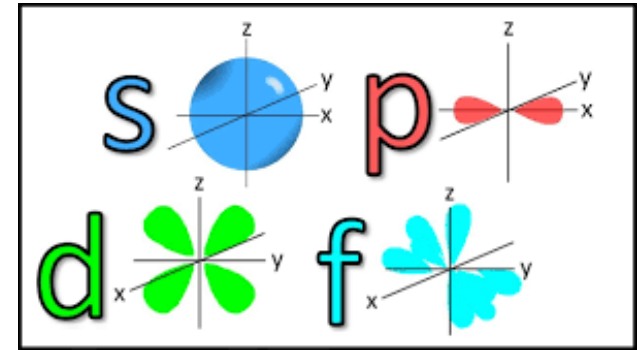
## Orbital s



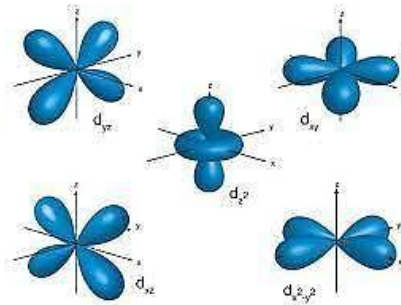
## Orbital p



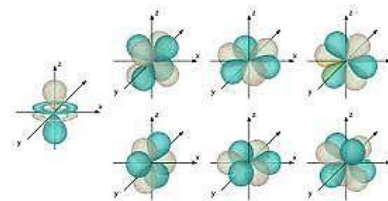
The three p orbitals are aligned along perpendicular axes



## Orbital d



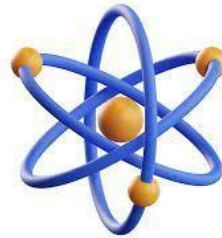
## Orbital f



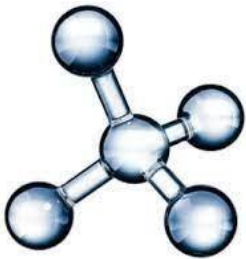
# Difference between Atom and Molecule

An atom: is the smallest component of an element whereas a molecule: is made up of two or more atoms.

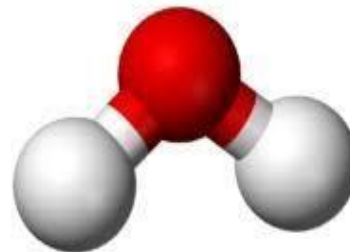
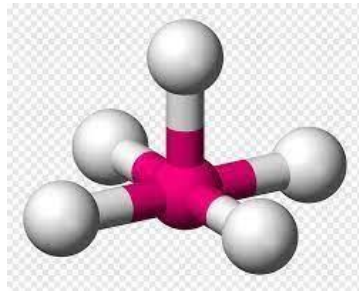
**Atoms** are spherical whereas **molecules** can be **triangular**, **angular** and **linear** in shape.



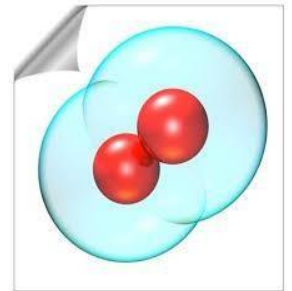
Atom:



triangular

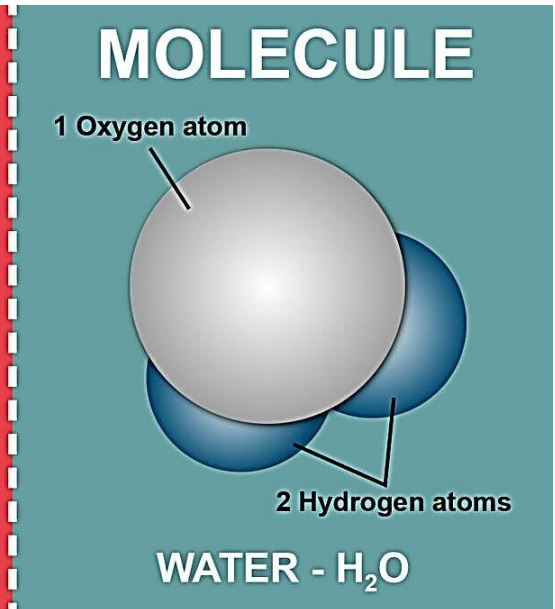
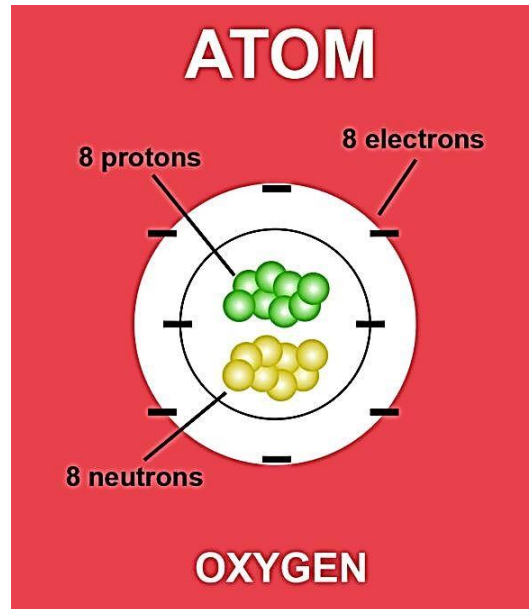
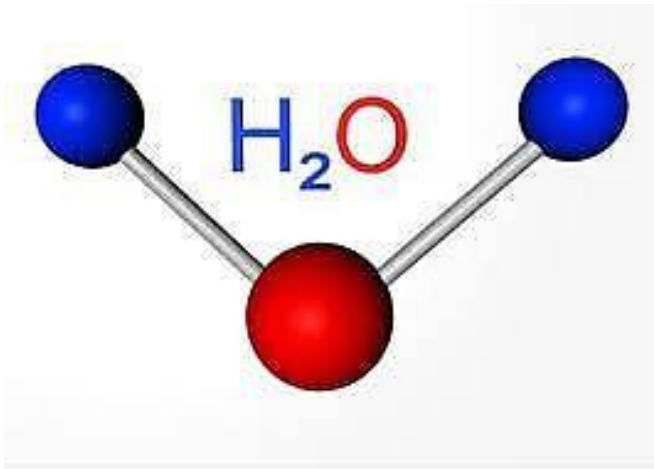
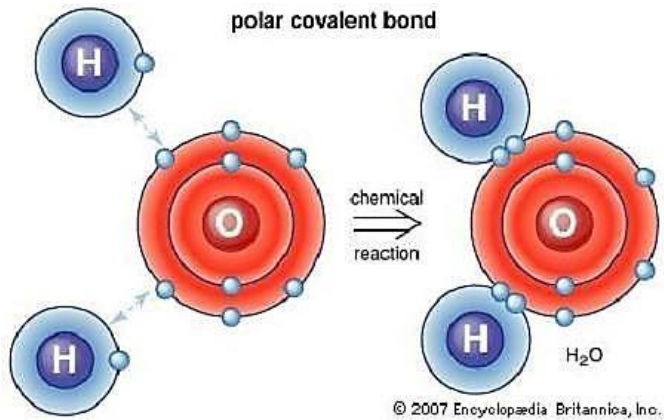


angular



linear

# Atom and molecular



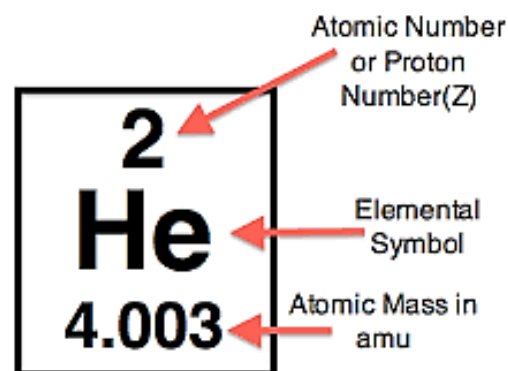


# Atomic number

The atomic number is the number of protons in the nucleus of an atom. The number of protons define the identity of an element (i.e., an element with 6 protons is a carbon atom, no matter how many neutrons may be present).

Periodic Table of the Elements

The periodic table shows elements arranged by atomic number. Hydrogen (H) is at the top left, and Helium (He) is at the top right. The table is color-coded by groups: alkali metals (red), alkaline earth metals (orange), transition metals (various blues and greys), metalloids (yellow), nonmetals (green), halogens (purple), and noble gases (pink). The lanthanide and actinide series are shown at the bottom.



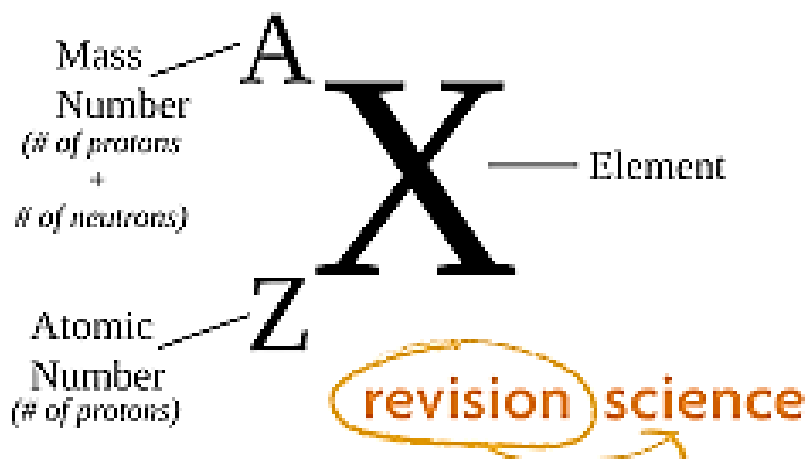
## mass number

mass number: in nuclear physics, the sum of the numbers of protons and neutrons present in the nucleus of an atom.

The mass number, also called atomic mass number or nucleon number, is the total number of protons and neutrons in an atomic nucleus. It is approximately equal to the atomic mass of the atom expressed in atomic mass units.

The atomic mass number refers to total number of protons and neutrons in a nucleus.

## Atomic Symbol



# Isotopes

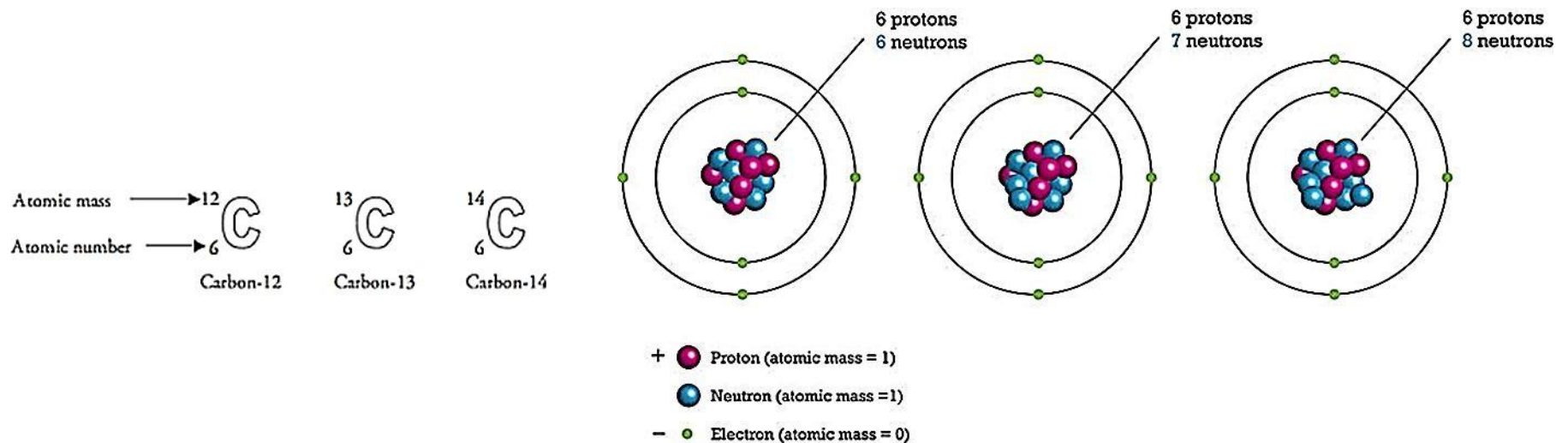
Isotopes: are atoms with **different atomic masses** which have the same atomic number.

The atoms of each chemical element have a defining and same number of protons and electrons, but – crucially – not neutrons, whose numbers can vary. Atoms with the same number of protons but **different numbers of neutrons** are called **isotopes**.

All elements are isotopes. Although all atoms of a given element have the same atomic number (number of protons), the **atomic weight** (number of protons and neutrons together) varies. The term "isotope" refers to this variation in atomic weight -- two atoms with the same number of protons and a different number of neutrons are two **isotopes** of the same element.

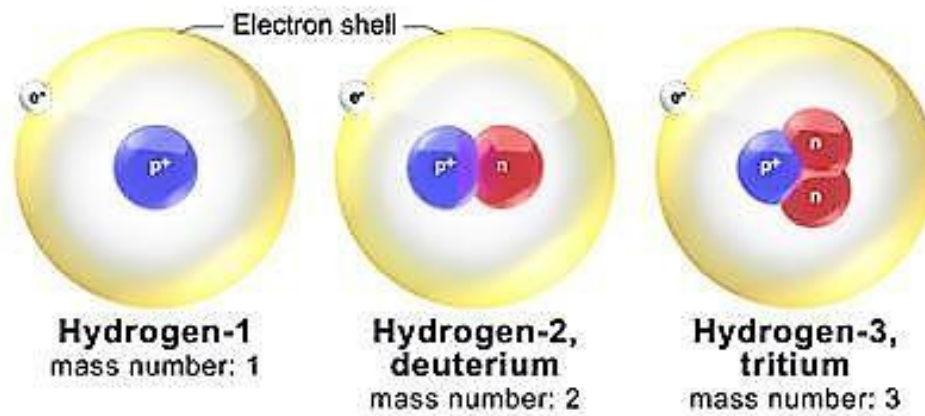
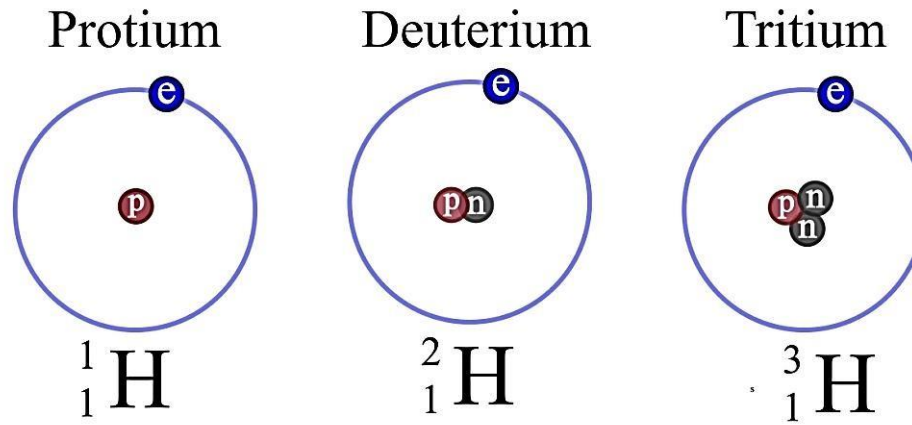
# Isotopes of carbon

Carbon: has two stable isotopes, **carbon-12** and **carbon-13**, which find use in determining origins of carbon-containing gases associated with hydrates. An unstable isotope, **carbon-14**, has traditionally been used for archaeological dating.



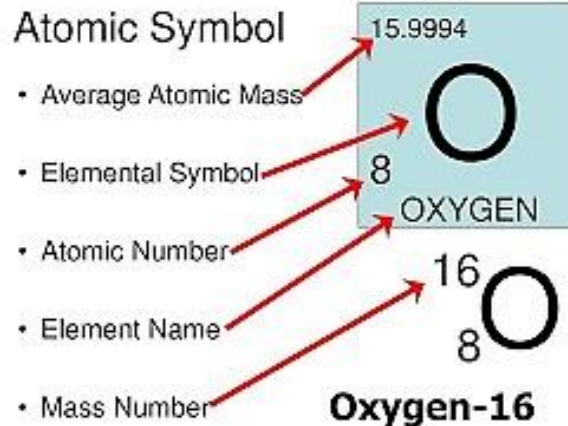
# Isotopes of hydrogen

Each isotope of hydrogen is made up of only one proton, but these isotopes differ in the number of neutrons the atoms contain. The extra neutrons make the isotopes heavier: **Deuterium** is twice as heavy as ordinary hydrogen (sometimes called **Protium**), while **Tritium** is three times as heavy.



# Isotopes of oxygen

There are three known stable isotopes of oxygen (8O): **16O** , **17O** , and **18O**.



## Isotopes of Oxygen



Oxygen 16

- 8 Electrons
- 8 Protons
- 8 Neutrons

Nuclear Number  
 $= 8 + 8 = 16$



Oxygen 17

- 8 Electrons
- 8 Protons
- 9 Neutrons

Nuclear Number  
 $= 8 + 9 = 17$



Oxygen 18

- 8 Electrons
- 8 Protons
- 10 Neutrons

Nuclear Number  
 $= 8 + 10 = 18$



## Isotopes of Iron

Iron: has four naturally occurring isotopes, with  $^{56}\text{Fe}$  (91.754%) and  $^{54}\text{Fe}$  (5.845%) being the most abundant and  $^{57}\text{Fe}$  (2.119%) and  $^{58}\text{Fe}$  (0.282%) being relatively rare.

<b><math>^{54}\text{Fe}</math></b> 53.93961 5.85% Stable	<b><math>^{56}\text{Fe}</math></b> 55.93494 91.75% Stable	<b><math>^{57}\text{Fe}</math></b> 56.93539 2.12% Stable	<b><math>^{58}\text{Fe}</math></b> 57.93328 0.28% Stable
---	--	---	---

atomic mass or most stable mass number	55.845	26	atomic number
1st ionization energy in kJ/mol	762.5	1.83	electronegativity
chemical symbol	Fe	+6 +5 +4 <b>+3</b> <b>+2</b> +1	oxidation states most common are bold
name	Iron	-1 -2	
electron configuration	[Ar] 3d <sup>6</sup> 4s <sup>2</sup>		

# Atomic mass

Group ↓

Atomic Number →

Period ↓

1.008 ← Atomic Mass

H ← Symbol

Hydrogen ← Element's Name

1	2											13	14	15	16	17	18												
1 H Hydrogen												5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon												
3 Li Lithium	4 Be Beryllium											13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon												
11 Na Sodium	12 Mg Magnesium											19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon												
55 Cs Caesium	56 Ba Barium	57-71 Lanthanoids*	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 (209) Po Polonium	85 (210) At Astatine	86 (222) Rn Radon												
87 Fr Francium	88 (226) Ra Radium	89-103 Actinoids**	104 (267) Rf Rutherfordium	105 (268) Db Dubnium	106 (269) Sg Seaborgium	107 (270) Bh Bohrium	108 (277) Hs Hassium	109 (278) Mt Meitnerium	110 (281) Ds Darmstadtium	111 (282) Rg Roentgenium	112 (285) Cn Copernicium	113 (286) Nh Nihonium	114 (289) Fl Flerovium	115 (290) Mc Moscovium	116 (293) Lv Livermorium	117 (294) Ts Tennessine	118 (294) Og Oganesson												

\*Lanthanoids

57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 (145) Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
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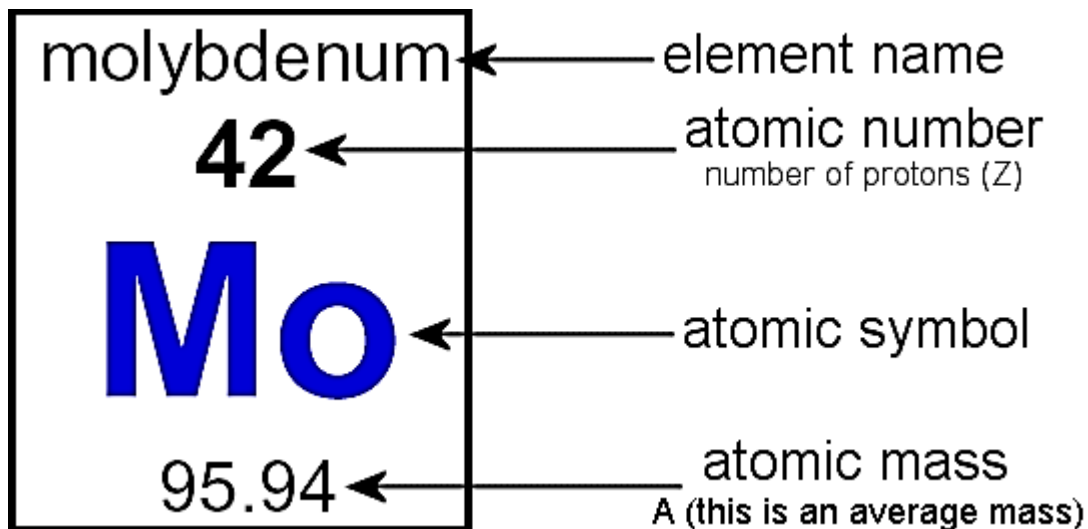
\*\*Actinoids

89 (227) Ac Actinium	90 (232.037) Th Thorium	91 Pa Protactinium	92 U Uranium	93 (237) Np Neptunium	94 (244) Pu Plutonium	95 (243) Am Americium	96 (247) Cm Curium	97 (247) Bk Berkelium	98 (251) Cf Californium	99 (252) Es Einsteinium	100 (257) Fm Fermium	101 (258) Md Mendelevium	102 (259) No Nobelium	103 (266) Lr Lawrencium
-------------------------------	----------------------------------	--------------------------	--------------------	--------------------------------	--------------------------------	--------------------------------	-----------------------------	--------------------------------	----------------------------------	----------------------------------	-------------------------------	-----------------------------------	--------------------------------	----------------------------------

Alkali Metals	Alkaline Earth Metals	Lanthanide	Actinide	Transition Metals
Post-Transition Metals	Metalloid	Polyatomic nonmetal	Diatomic nonmetal	
Noble gas	Unknown Chemical Properties			

## Atomic mass

The **atomic mass** of an element is the average mass of the atoms of an element measured in atomic mass unit (Amu, also known as Daltons, D). The **atomic mass** is a weighted average of all of the **isotopes** of that element, in which the mass of each isotope is multiplied by the abundance of that particular isotope. (Atomic mass is also referred to as atomic weight, but the term "mass" is more accurate.)





# Introduction to Organic chemistry

Hydrocarbons

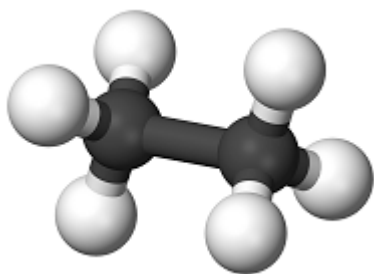
Alkanes , alkenes, alkynes

Dental Industry Techniques

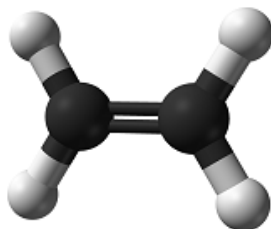
5<sup>h</sup> lecture

## Hydrocarbons

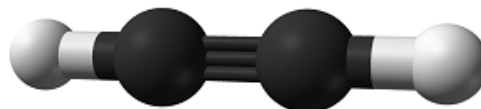
**Hydrocarbons:** are organic compounds that are entirely made up of only two kinds of atoms – carbon and hydrogen. Typically, hydrocarbons are colorless gases that have very weak odours. Hydrocarbons can feature simple or relatively complex structures and can be generally classified into four subcategories, namely alkanes, alkenes, alkynes, and aromatic hydrocarbons. The study of hydrocarbons can provide insight into the chemical properties of other functional groups and their preparation. Furthermore, hydrocarbons such as propane and butane are used for commercial fuel purposes in the form of **Liquefied Petroleum Gas (LPG)**. Benzene, one of the simplest aromatic hydrocarbons, serves as the raw material for the synthesis of many synthetic drugs.



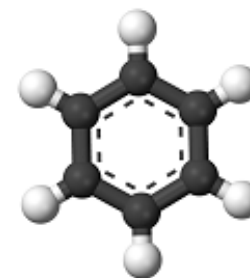
Alkanes



Alkenes



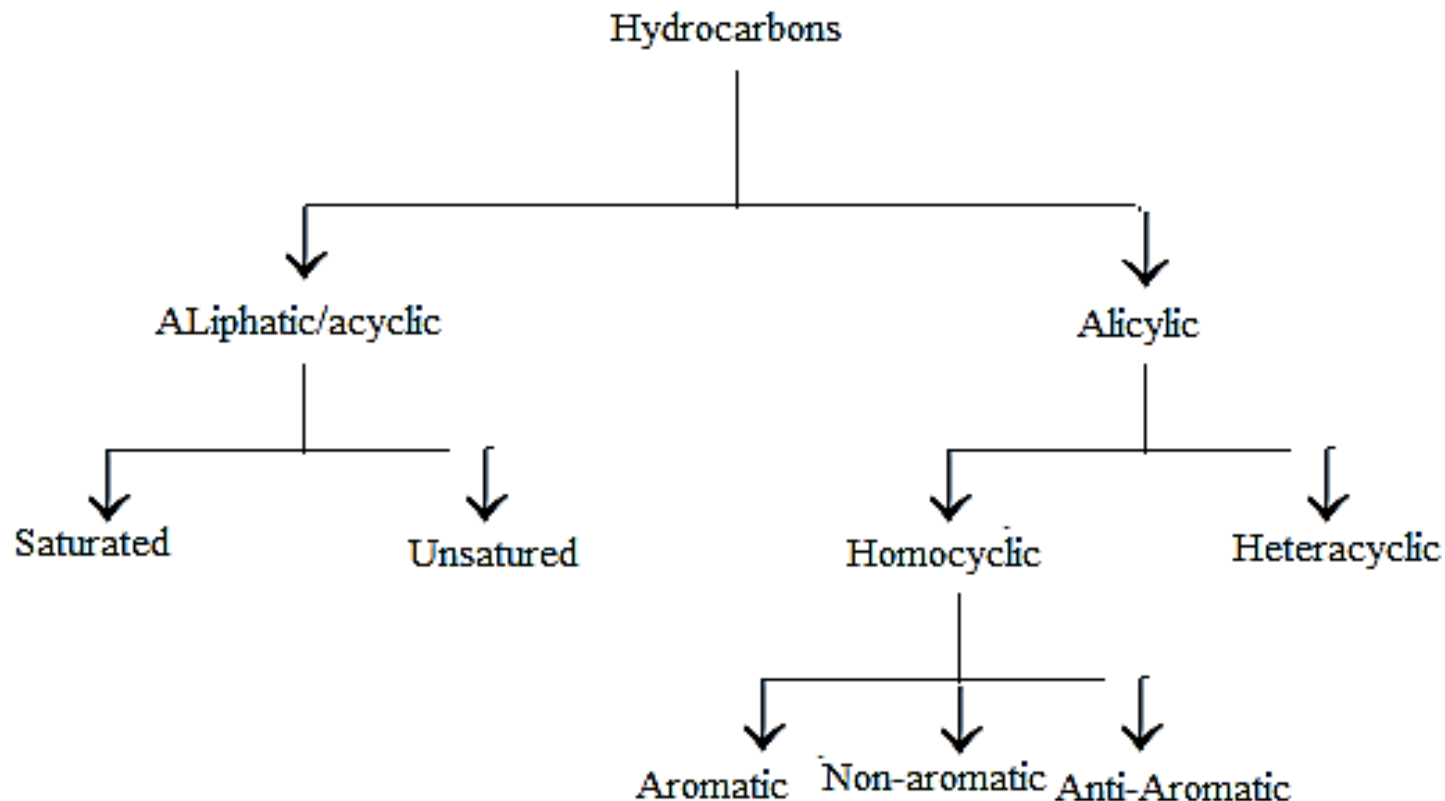
Alkynes



Arenes

Aromatic hydrocarbons

**Hydrocarbons:** are made up of the elements carbon and hydrogen. These compounds are dominant in crude oil, coal tar and waste products of pyrolysis.



Alkanes have only single bonds between carbon atoms and are called saturated hydrocarbons. Alkenes have at least one carbon-carbon double bond. Alkynes have one or more carbon-carbon triple bonds. Alkenes and alkynes are called as unsaturated hydrocarbons.



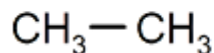
## Properties of Hydrocarbons:

Due to their different molecular structures, the empirical formula of hydrocarbons is also different from each other. For instance, **alkanes, alkynes or alkenes**, the amount of bonded hydrogen decreases in alkenes and alkynes. This is mainly due to the “self-bonding” or catenation of carbon that prevents the complete saturation of the hydrocarbon by the formation of double or triple bonds. The ability of hydrocarbons to bond to themselves is known as catenation. With such capabilities, they can form more complex molecules like cyclohexane and in rare instances, aromatic hydrocarbons like benzene.

Meanwhile, cracking of Hydrocarbons is a process in which heavy organic molecules are broken down into lighter molecules. This is accomplished by supplying an adequate amount of heat and pressure. Sometimes **catalysts** are used to speed up the reaction. This process plays a very important role in the commercial production of diesel fuel and gasoline.

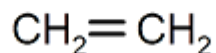
## types of hydrocarbons:

Alkanes, Alkenes, Alkynes and Aromatic hydrocarbons are the 4 types of hydrocarbons.



etano

(saturado)



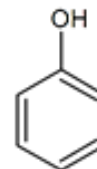
eteno

(insaturado)

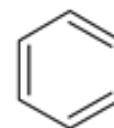


etino

(insaturado)



fenol



benceno

## Uses of Hydrocarbons:

Hydrocarbons are widely used as fuels. For example LPG (liquefied petroleum gas), CNG (Liquefied natural gas).

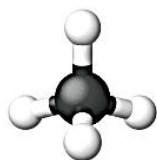
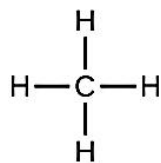
They are used in the manufacturing of **polymers** such as polyethene, polystyrene etc. These organic compounds find their application in the manufacturing of **drugs** and **dyes** as a starting material. They serve **as lubricating** oil and grease.

## Alkanes:

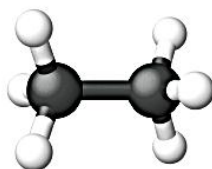
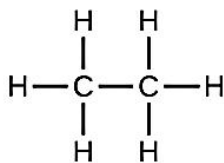
Alkanes, or saturated hydrocarbons, contain only single covalent bonds between carbon atoms. Each of the carbon atoms in an alkane has  $sp^3$  hybrid orbitals and is bonded to four other atoms, each of which is either carbon or hydrogen. The Lewis structures and models of methane, ethane, and pentane are illustrated in Figure 1

. Carbon chains are usually drawn as straight lines in Lewis structures, but one has to remember that Lewis structures are not intended to indicate the geometry of molecules. Notice that the carbon atoms in the structural models (the ball-and-stick and space-filling models) of the pentane molecule do not lie in a straight line. Because of the  $sp^3$  hybridization, the bond angles in carbon chains are close to  $109.5^\circ$ , giving such chains in an alkane a zigzag shape.

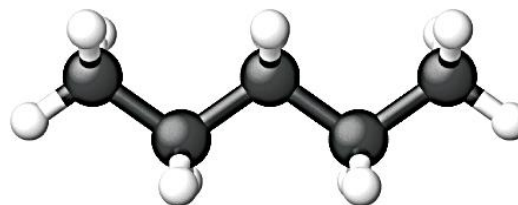
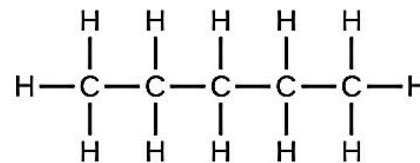
The structures of alkanes and other organic molecules may also be represented in a less detailed manner by condensed structural formulas (or simply, condensed formulas). Instead of the usual format for chemical formulas in which each element symbol appears just once, a condensed formula is written to suggest the bonding in the molecule. These formulas have the appearance of a Lewis structure from which most or all of the bond symbols have been removed. Condensed structural formulas for ethane and pentane are shown at the bottom of Figure 2



methane  
 $\text{CH}_4$



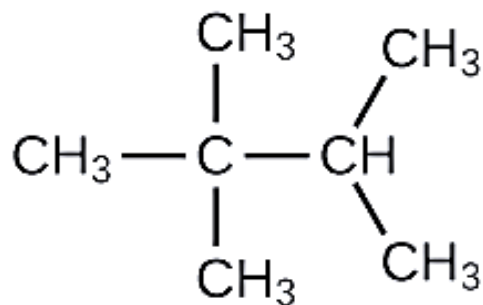
ethane  
 $\text{CH}_3\text{CH}_3$  or  $\text{C}_2\text{H}_6$



pentane  
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$  or  $\text{C}_5\text{H}_{12}$

Figure 1 : Pictured are the Lewis structures, ball-and-stick models, and space-filling models for molecules of methane, ethane, and pentane.

Drawing Skeletal Structures Draw the skeletal structures for these two molecules:



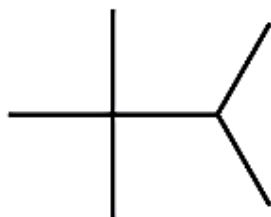
(a)



(b)

Solution

Each carbon atom is converted into the end of a line or the place where lines intersect. All hydrogen atoms attached to the carbon atoms are left out of the structure (although we still need to recognize they are there):

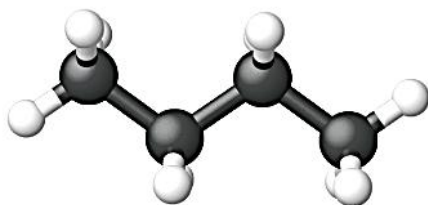
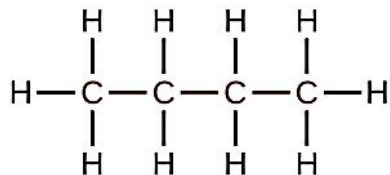


(a)

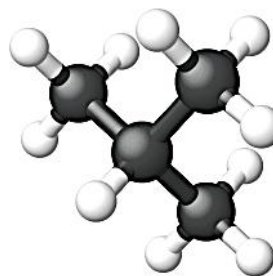
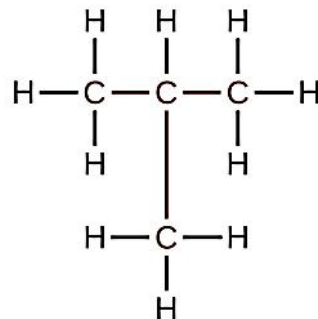


(b)

Hydrocarbons with the same formula, including alkanes, can have different structures. For example, two alkanes have the formula **C<sub>4</sub>H<sub>10</sub>**: They are called **n-butane** and **2-methylpropane** (or isobutane), and have the following Lewis structures:



*n*-butane

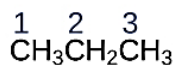


2-methylpropane

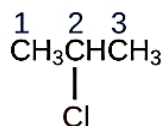


## The Basics of Organic Nomenclature: Naming Alkanes:

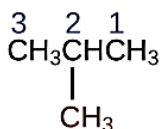
The **International Union of Pure and Applied Chemistry (IUPAC)** has devised a system of nomenclature that begins with the names of the alkanes and can be adjusted from there to account for more complicated structures. The nomenclature for alkanes is based on two rules:



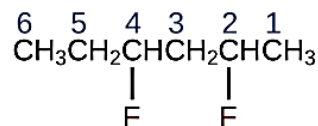
propane



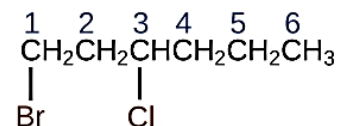
2-chloropropane



2-methylpropane



2,4-difluorohexane



1-bromo-3-chlorohexane

# Alkenes

**Alkenes:** are a class of hydrocarbons (containing only carbon and hydrogen) unsaturated compounds with at least one carbon-to-carbon double bond. Another term used to describe alkenes is olefins. Alkenes are more reactive than alkanes due to the presence of the double bond.

## List of Alkenes

Propene	(C <sub>3</sub> H <sub>6</sub> )
Butene	(C <sub>4</sub> H <sub>8</sub> )
Pentene	(C <sub>5</sub> H <sub>10</sub> )
Hexene	(C <sub>6</sub> H <sub>12</sub> )
Heptene	(C <sub>7</sub> H <sub>14</sub> )
Octene	(C <sub>8</sub> H <sub>16</sub> )
Nonene	(C <sub>9</sub> H <sub>18</sub> )

Saturated hydrocarbon



An alkane

Unsaturated hydrocarbons



An alkene



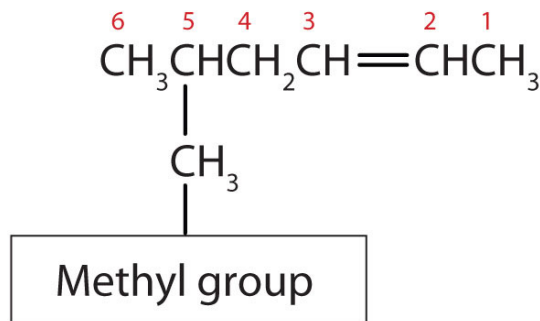
An alkyne

## Preparation of Hydrocarbons – Alkenes:

General formula:  $C_n H_{2n}$

## Preparation Methods

Most of the reactions involving the preparation of alkenes involve elimination process. There are 3 mechanisms suggested for the elimination reactions. All these eliminations are  $\beta$ - eliminations.



Here are some basic rules for naming alkenes from the **International Union of Pure and Applied Chemistry (IUPAC)**:

1. The longest chain of carbon atoms containing the double bond is considered the parent chain. It is named using the same stem as the alkane having the same number of carbon atoms but ends in -ene to identify it as an alkene. Thus the compound  $\text{CH}_2=\text{CHCH}_3$  is propene.
2. If there are four or more carbon atoms in a chain, we must indicate the position of the double bond. The carbon atoms are numbered so that the first of the two that are doubly bonded is given the lower of the two possible numbers. The compound  $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$ , for example, has the double bond between the second and third carbon atoms. Its name is 2-pentene (not 3-pentene).
3. Substituent groups are named as with alkanes, and their position is indicated by a number

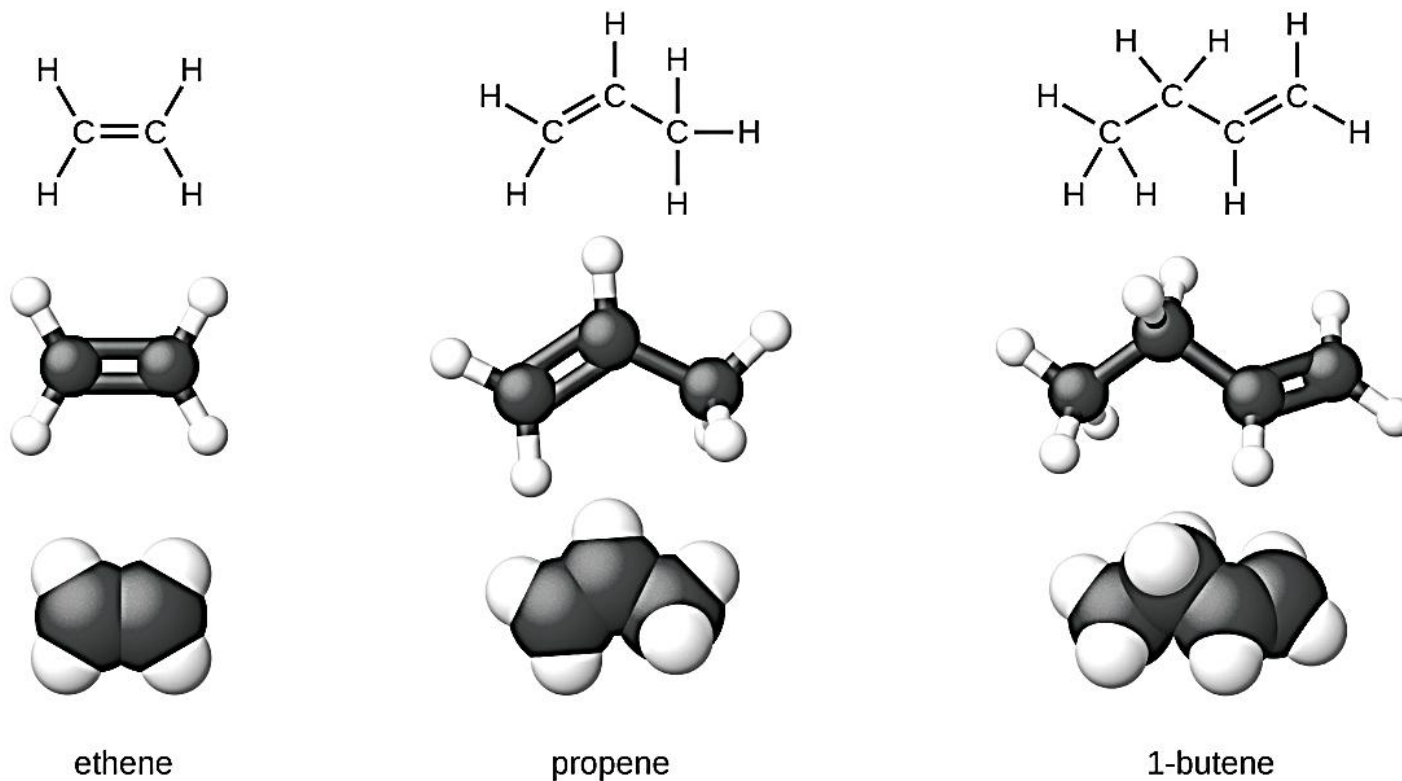
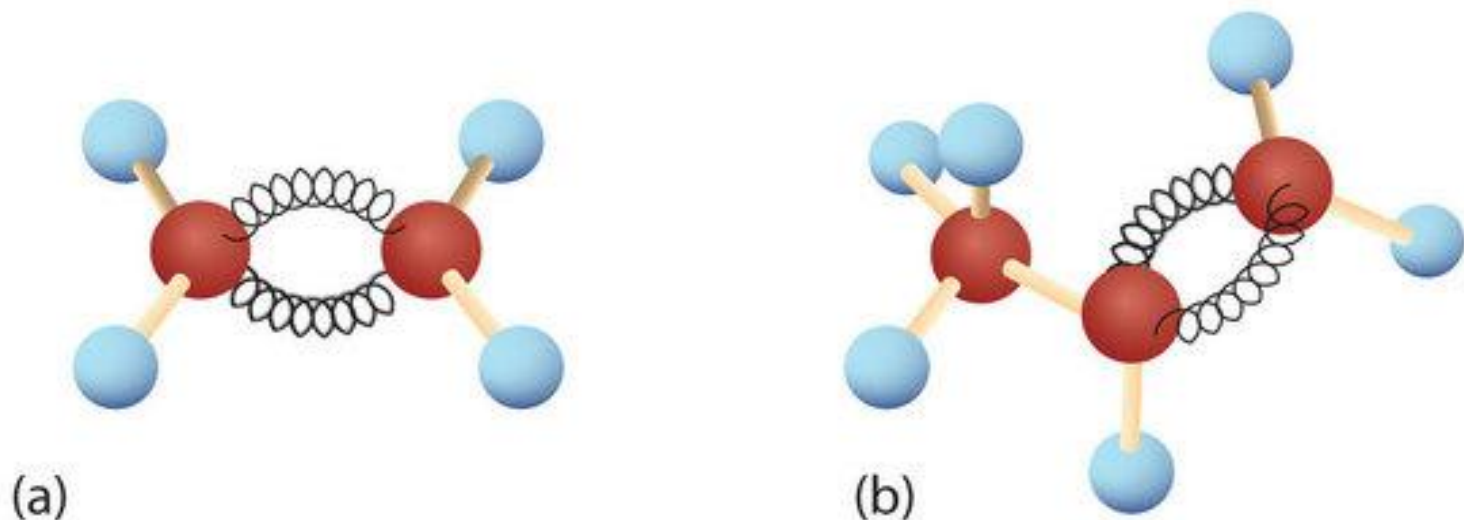


Figure 3 : Expanded structures, ball-and-stick structures, and space-filling models for the alkenes ethene , propene, and 1-butene are shown.



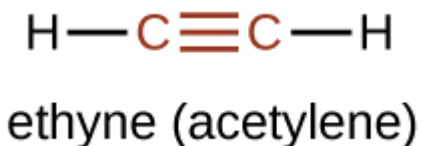
**Ethene and Propene**. The ball-and-spring models of ethene /ethylene (a) and propene/propylene (b) show their respective shapes, especially bond angles.

Although there is only one alkene with the formula  $C_2H_4$  (ethene) and only one with the formula  $C_3H_6$  (propene), there are several alkenes with the formula  $C_4H_8$ .

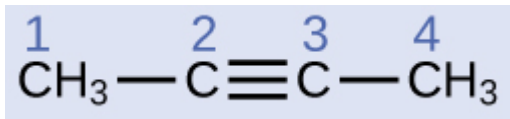
## Alkynes:

**Hydrocarbon molecules with one or more triple bonds are called alkynes; they make up another series of unsaturated hydrocarbons.** Two carbon atoms joined by a triple bond are bound together by one  $\sigma$  bond and two  $\pi$  bonds. The  $sp$ -hybridized carbons involved in the triple bond have bond angles of  $180^\circ$ , giving these types of bonds a linear, rod-like shape.

The simplest member of the alkyne series is ethyne,  $C_2H_2$ , commonly called acetylene. The Lewis structure for ethyne, a linear molecule, is:



Describe the geometry and hybridization of the carbon atoms in the following molecule:



### Solution

Carbon atoms 1 and 4 have four single bonds and are thus tetrahedral with  $sp^3$  hybridization. Carbon atoms 2 and 3 are involved in the triple bond, so they have linear geometries and would be classified as  $sp$  hybrids.



## Aromatic hydrocarbons

Aromatic hydrocarbons: are a special class of unsaturated hydrocarbon based on a six carbon ring moiety called benzene.

Aromatic hydrocarbons are compounds that contain benzene as part of their structure, also known as aromatic compounds. Benzene, with formula  $C_6H_6$ , is a cyclic hydrocarbon.

Aromatic compounds with two or more fused aromatic benzene rings are called polycyclic aromatic hydrocarbons (PAH) and they have the general formula  $C_{4r+2}H_{2r+4}$  for rings without substituents

### Aromatic Compounds Examples:

Aromatic hydrocarbon, are hydrocarbons containing sigma bonds and delocalized pi electrons between carbon atoms in a ring. For example, benzene. They are known as aromatic due to their pleasant smell.

Aromaticity is a property in organic chemistry of cyclic (chain-shaped), planar (flat) structures with a ring of resonance bonds that gives greater stability compared to other geometric or connective arrangements with the same collection of atoms.

## Summary

Strong, stable bonds between carbon atoms produce complex molecules containing chains, branches, and rings. The chemistry of these compounds is called **organic chemistry**. Hydrocarbons are organic compounds composed of only carbon and hydrogen. The alkanes are saturated hydrocarbons—that is, hydrocarbons that contain only single bonds. Alkenes contain one or more carbon-carbon double bonds. Alkynes contain one or more carbon-carbon triple bonds. Aromatic hydrocarbons contain ring structures with delocalized  $\pi$  electron systems.



# **Method of analysis, Solution Standard Solution (Molarity , molality , Normality & dilution)**

## **Lecture 3**

**Normality**: in chemistry is one of the expressions used to measure the concentration of a solution. It is abbreviated as 'N' and is sometimes referred to as the equivalent concentration of a solution. It is mainly used as a measure of reactive species in a solution and during titration reactions or particularly in situations involving acid-base chemistry.

As per the standard definition, normality is described as the number of gram or mole equivalents of solute present in one liter of a solution. When we say equivalent, it is the number of moles of reactive units in a compound.

There are certain tips that students can follow to calculate normality.

1. The first tip that students can follow is to gather information about the equivalent weight of the reacting substance or the solute.
2. The second step involves calculating the no. of gram equivalent of solute.
3. Students should remember that the volume is to be calculated in liters.
4. Finally, **normality** is calculated using the formula and replacing the values.

**How to convert Molarity to Normality?** For some chemical solutions, Normality and Molarity are equivalent or  $N=M$ . This typically occurs when  $N=1$  - converting molarity to normality matters only when the number of equivalents changes by ionization.

## Formulas for Normality:

**N** is equal to the number of gram equivalents divided by the liters volume of the solution.

denoted by the symbols N, eq/L, or m<sub>eq</sub>/L (= 0.001 N).

$$\begin{aligned} N &= \frac{\text{Gram eq. of Solute}}{\text{Volume of sol. in litre}} \\ &= \frac{\text{Weight}}{\text{Equivalent weight}} \times \frac{1000}{V \text{ ml}} \end{aligned}$$

$$\text{Equivalent Weight} = \frac{\text{Molar Mass}}{n}$$

**Normality** = Number of gram equivalents × [volume of solution in liters]<sup>-1</sup>. Number of gram equivalents = weight of solute × [Equivalent weight of solute]<sup>-1</sup>.

**N** = Weight of Solute (gram) × [Equivalent weight × Volume (L)]<sup>-1</sup>

**N** = **Molarity** × **Molar mass** × [Equivalent mass]<sup>-1</sup>.

## Calculation of Normality in Titration:

Titration is the process of gradual addition of a solution of a known concentration and volume with another solution of unknown concentration until the reaction approaches its neutralization. To find the normality of the acid and base titration:

$$N_1 V_1 = N_2 V_2$$

Where,

**N<sub>1</sub>** = Normality of the Acidic solution

**V<sub>1</sub>** = Volume of the Acidic solution

**N<sub>2</sub>** = Normality of the basic solution

**V<sub>2</sub>** = Volume of the basic solution

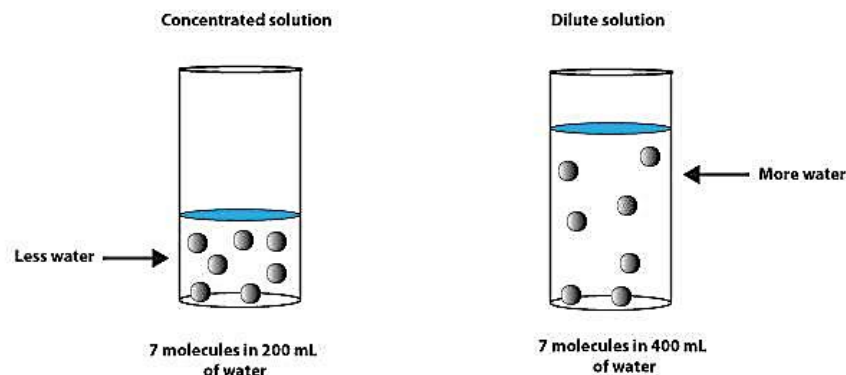
### How do you calculate 1N

1. Preparation of 1N solution in 100 ml.
2. We know that the Normality of is 12N.
3. Therefore, If we add 8.33mL to 100 L of water we get 1 N

$$\text{Wt.} \times 1000$$

$$N = \frac{\text{Wt.} \times 1000}{\text{Eq.Wt.} \times \text{Vol. (ml)}}$$

$$\text{Eq.Wt.} \times \text{Vol. (ml)}$$



$$M_1 V_1 = M_2 V_2$$



**Analysis:** : Qualitative and quantitative

characteristics of chemical analytes.

**Analytes:** Components of a sample that are to be determined.

**A solutions:** Homogeneous mixture of two or more substance produce from dissolved solute (ions, atoms, molecules) (lesser amount) in the solvent (larger amount)

**Solute (lesser amount) + Solvent (larger amount) → Solution**

**NaCl s) + H<sub>2</sub>O l) → SaltSolution**

**Solvent:** the substance in which a solute dissolves to produce a homogeneous mixture.

**Solute:** the substance that dissolves in a solvent to produce a homogeneous.

**Concentrated** :Solution has a large amount of solute.

**Dilute Solution:** has a small amount of solute.

## A solution can be qualitatively described as:

Dilute:: a solution that contains a small proportion of solute relative to the solvent.

concentrated: a solution that contains a large proportion of solute relative to solvent.

**sold**      
$$M = \frac{Wt(g) * 1000}{M.wt(g/mol) * V(ml)}$$

**Liquid**      
$$M = \frac{\% * d * 1000}{M.wt(g/mol)}$$

**Molarity(M)**: is the number of moles of solute dissolved in one liter of a solution and the unit for molarity is moles/L.

**Molality( m )**: is the number of moles per kilogram of solvent. It is determined by dividing the number of moles (n) of the solute by the mass of the solvent in kg.

**Normality:**

The normality formula is used to measure the concentration of a solution like molarity and molality. Normality is a measure of the number of grams equivalent to solute present given volume of the solution. Redox reactions, precipitation reactions, and acid-base chemical reactions all often make use of normality

**Molarity (M )** is defined as the number of moles of solute per liter of solution.

**Molality (m )** is defined as the number of moles of solute per kilogram of solvent.

**Normality (N )** is defined as the number of equivalents per liter of solution.

**Molality:** is defined as the “total moles of a solute contained in a kilogram of a solvent.” Molality is also known as molal concentration. It is a measure of solute concentration in a solution.

There is a very close relation between molarity and normality. **Normality can be described as a multiple of molarity. While Molarity refers to the concentration of a compound or ion in a solution, normality refers to the molar concentration only of the acid component or only of the base component of the solution.**

A solution is prepared by dissolving **10.2g** of glucose, **C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>**, in **405g** of water. The final volume of the solution is **414mL**. Find the concentration of the solution in units of molality.

Explanation:

$$\text{Molality} = \frac{\text{moles of solute}}{\text{kg of solvent}}$$

First, start by finding the moles of glucose that we have. The molar mass of glucose is **180.16g/mol**.

$$10.2 \text{ g of glucose} * \frac{1 \text{ mole glucose}}{180.16 \text{ g of glucose}} = 0.0566 \text{ moles of glucose}$$

Next, convert the grams of water into kilograms.

$$405 \text{ g} \cdot 1 \text{ kg} / 1000 \text{ g} = 0.405 \text{ kg}$$

Now, plug in the moles of glucose and kilograms of water into the equation for molality.

$$\text{Molality} = \frac{0.0566}{0.405} = 0.140 \text{ m}$$

What is the molarity of a solution in which **211g** sodium hydrogen carbonate is dissolved in a **10.0L** solution?

Explanation:

**211g** sodium hydrogen carbonate dissolved in a **10.0L** solution has **0.251M**.

The first step is to calculate how many moles of **NaHCO<sub>3</sub>** are present.

$$211\text{gNaHCO}_3 \frac{1\text{molNaHCO}_3}{84.006\text{gNaHCO}_3} = 2.51 \text{ mole NaHCO}_3$$

We calculate molarity with the following equation:

$$M = \frac{\text{moles of solute}}{\text{liters of solution}}$$

$$M = \frac{2.51 \text{ moles NaHCO}_3}{10\text{L}} = 0.251\text{M}$$

# Standard solution

a standard solution: is a solution containing a precisely known concentration of an element or a substance. A known mass of solute is dissolved to make a specific volume. It is prepared using a standard substance, such as a primary standard.

Standard solutions (called **titrants** or **titrates**) are used to determine the concentrations of other substances, such as solutions in titration. The concentrations of standard solutions are normally expressed in units of moles per liter (mole/L, often abbreviated to M for molarity), moles per cubic decimeter (mol/dm<sup>3</sup>), kilo moles per cubic meter (k mol/m<sup>3</sup>) or in terms related to those used in particular titrations (such as titers).

A standard solution is a a solution of accurately known concentration prepared from a primary standard (a compound which is stable, of high purity, highly soluble in water and of a high molar mass to allow for accurate weighing) that is weighed accurately and made up to a fixed volume.



Some examples of primary standard solutions include: **Sodium chloride – table salt** is used as a primary standard solution for reactions involving **silver nitrate**. **Powdered zinc** – powdered zinc is often used to standardize **ethylene di amine tetra acetic acid** or **EDTA**, which acts as a stabilizer in many pharmaceutical products



There are two types of standard solutions known as **primary solution** and **secondary solution**. A **primary standard solution** is a solution with a high purity and less reactivity. A **secondary standard** is not that pure and is chemically reactive than primary standards.

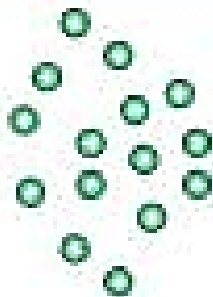


# Polymers , Classification and their Properties

Dental Industry Techniques

Lecture4

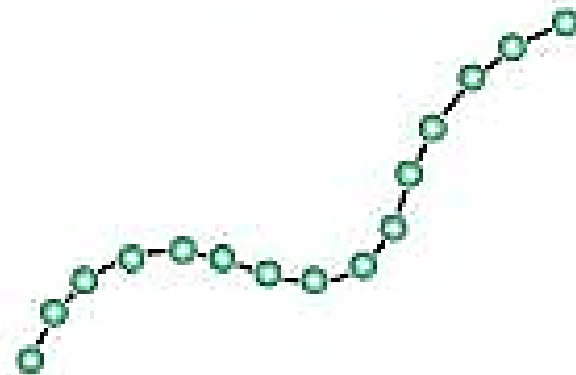
Monomers



Many Small  
Molecule



Polymer



One Large  
Molecule

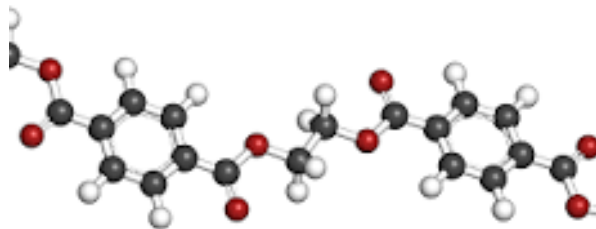
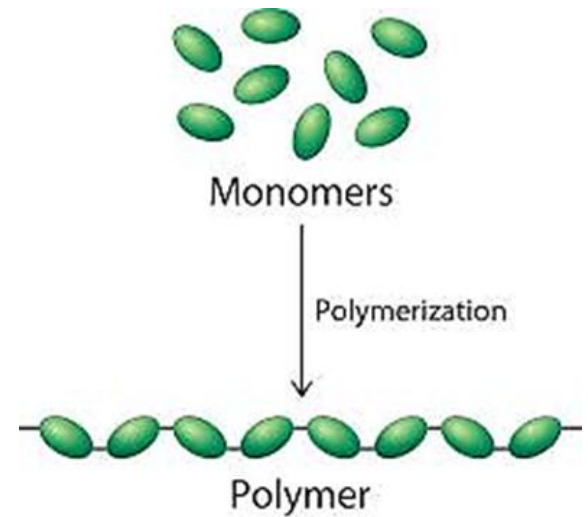
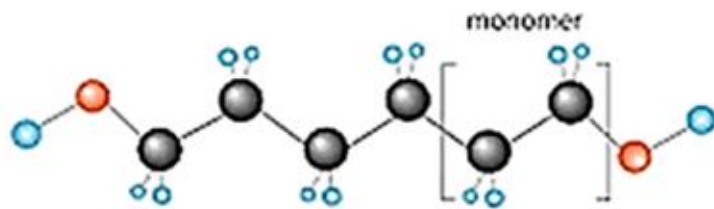
# Polymers

A **polymer** is a large molecule or a macromolecule which essentially is a combination of many subunits. The term polymer in Greek means 'many parts'. **Polymers** can be found all around us. From the strand of our DNA, which is a naturally occurring biopolymer, to polypropylene which is used throughout the world as plastic.

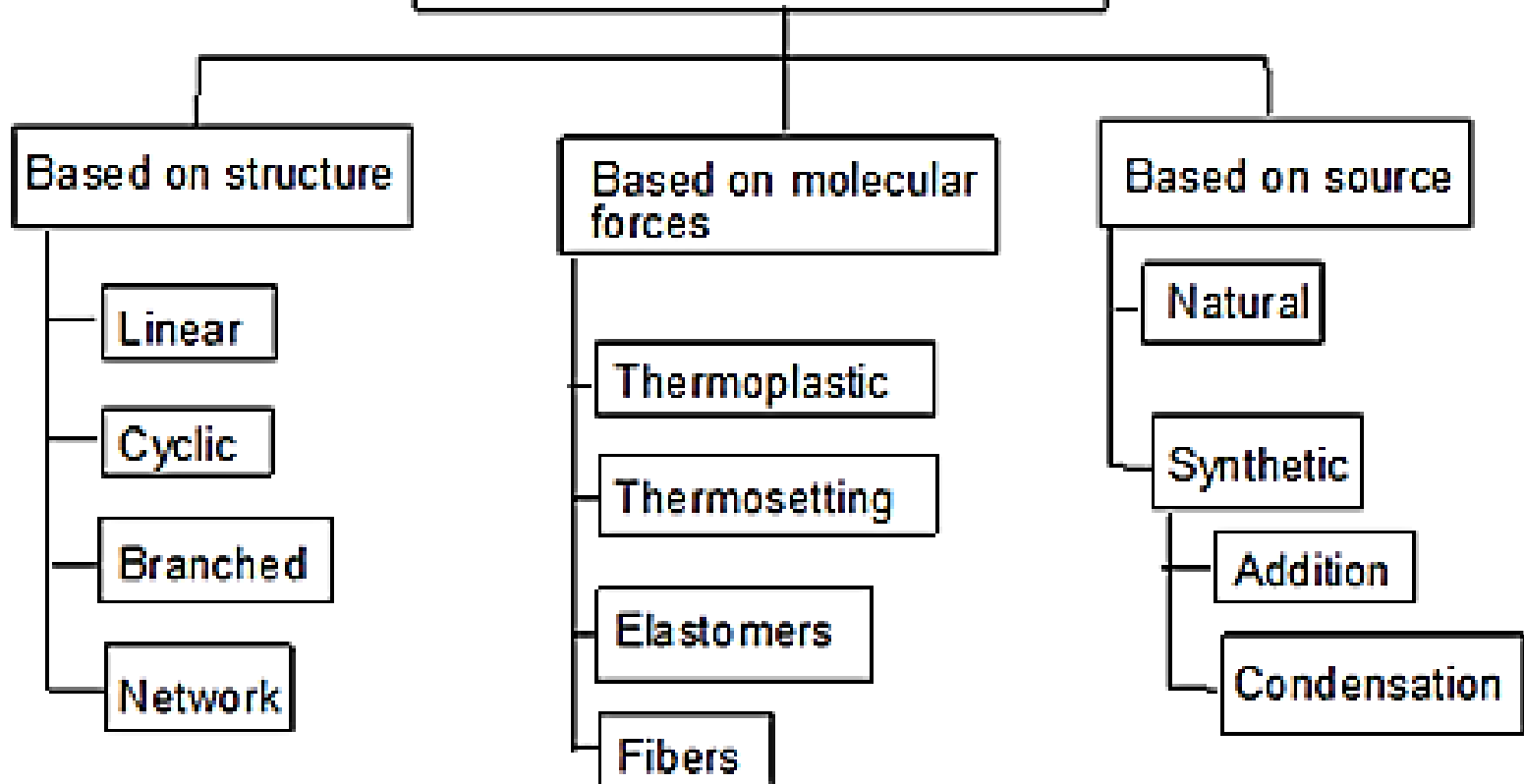
**Polymer** is a large molecule (macromolecule) composed of repeating structural units typically connected by covalent chemical bonds. One **polymer** molecular consists of thousands to millions of atoms, so its molecular weight is large. **Polymers** are mainly classified as **chain polymers** and **net polymers**.

**Polymers** may be naturally found in plants and animals (**natural polymers**) or may be man-made (**synthetic polymers**). Different polymers have a number of unique physical and chemical properties, due to which they find usage in everyday life.

Varying the molecular structure and length of polymer chains or networks results in different polymers with different properties—such as strength, flexibility, heat resistance and recyclability



# CLASSIFICATION OF POLYMER



# Classification of Polymers

**Polymers** cannot be classified under one category because of their complex structures, different behaviors and vast applications. We can, therefore, classify polymers based on the following considerations.

There are **3** principal classes of polymers : **thermoplastics**, **thermosets**, and **elastomers**.

**Types of polymers**. There are several types of polymers. Among the main ones are: **natural**, **synthetic**, **addition**, **condensation** and **rearrangement**.

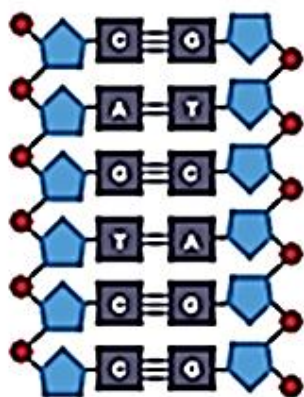


Natural polymers



Synthetic Polymers

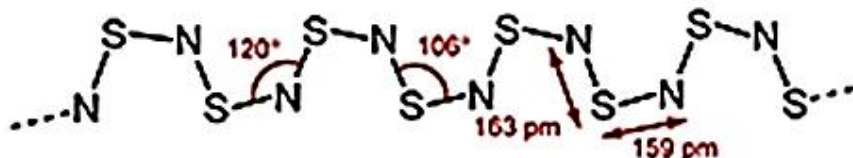
# DIFFERENT TYPES OF POLYMERS



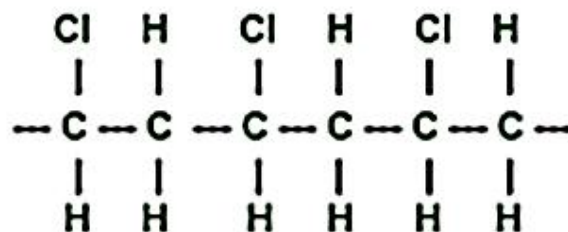
**NATURAL POLYMERS**



**SYNTHETIC POLYMERS**



**INORGANIC POLYMERS**



**ORGANIC POLYMERS**

## types of polymers

### Addition polymers:

This compound is obtained by successively adding monomers. As examples of these polymers we have polysaccharides, which are formed by monomers of monosaccharides, and proteins, which are produced by amino acid monomers.

### Condensing polymers:

The condensing polymers are obtained by adding two different monomers with the elimination of a molecule of acid, alcohol or water during the polymerization process.



### **Rearrangement polymers:**

The rearrangement polymers are the result of the reaction between the monomers that undergo rearrangement and their chemical structures throughout polymerization. An example of this is polyurethane.

### **Biodegradable polymers:**

Finally, biodegradable polymers degrade into biomass, water and carbon dioxide as a result of the action of enzymes or living organisms. Under favorable conditions, they can be degraded in a few weeks.

Like the previous options, these compounds can be synthetic or natural. The biodegradable polymers properties come from the following sources:

## Types of Polymers: (backbone chain)

On the basis of the type of the backbone chain, polymers can be divided into:

Organic Polymers: Carbon backbone.

Inorganic Polymers: Backbone constituted by elements other than carbon.

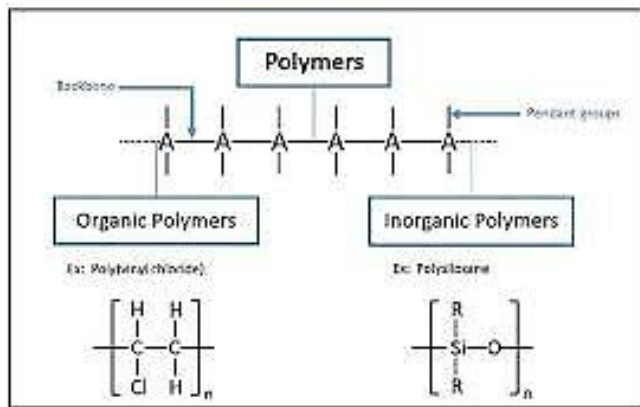
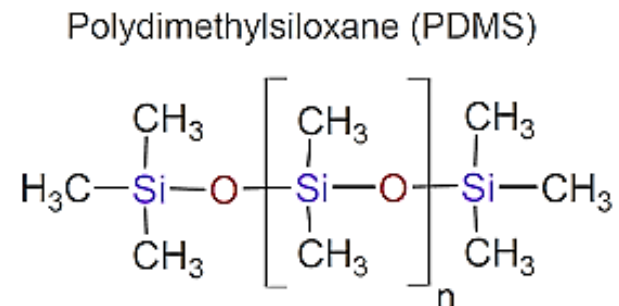
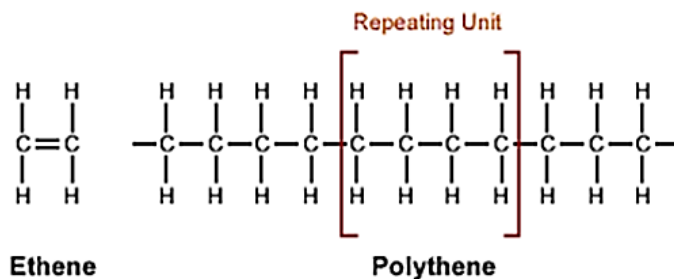
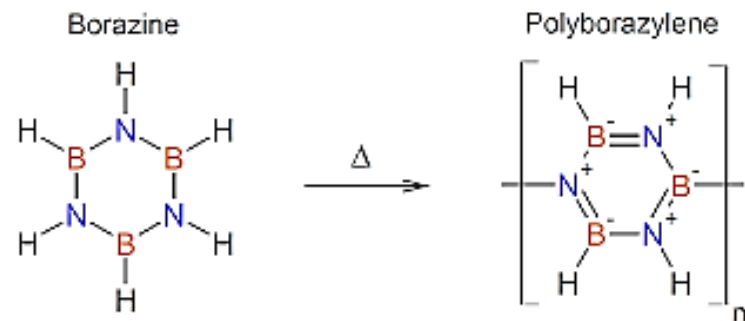


Figure 4 – Classification based on backbone of the polymer chain



## Classification of Polymers based on the Source of Availability:

There are three types of classification under this category, namely, **Natural**, **Synthetic**, and **Semi-synthetic Polymers**.

### Natural Polymers:

They occur naturally and are found in plants and animals. For example, proteins, starch, cellulose, and rubber. To add up, we also have biodegradable polymers called biopolymers.

### Semi-synthetic Polymers:

They are derived from naturally occurring polymers and undergo further chemical modification. For example, cellulose nitrate, and cellulose acetate.

### Synthetic Polymers:

These are man-made polymers. Plastic is the most common and widely used synthetic polymer. It is used in industries and various dairy products. For example, nylon-6, 6, polyether's etc.

# Classification of Polymers based on the Structure of the Monomer Chain

## Linear Polymers:

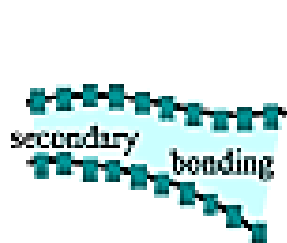
The structure of polymers containing long and straight chains falls into this category. PVC, i.e. poly-vinyl chloride, is largely used for making pipes and electric cables is an example of a linear polymer.

## Cross-linked Polymers:

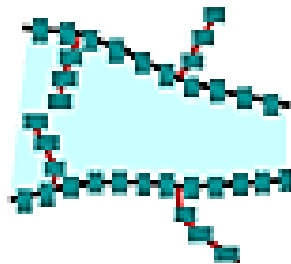
They are composed of **bi functional** and **tri functional** monomers. They have a stronger covalent bond in comparison to other linear polymers. Bakelite and melamine are examples in this category.

## Branched-chain Polymers:

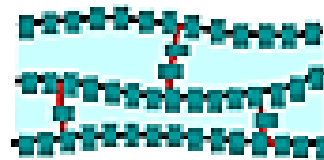
When linear chains of a polymer form branches, then such polymers are categorized as branched chain polymers. For example, Low-density polythene.



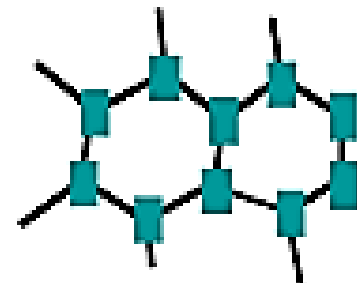
Linear



Branched

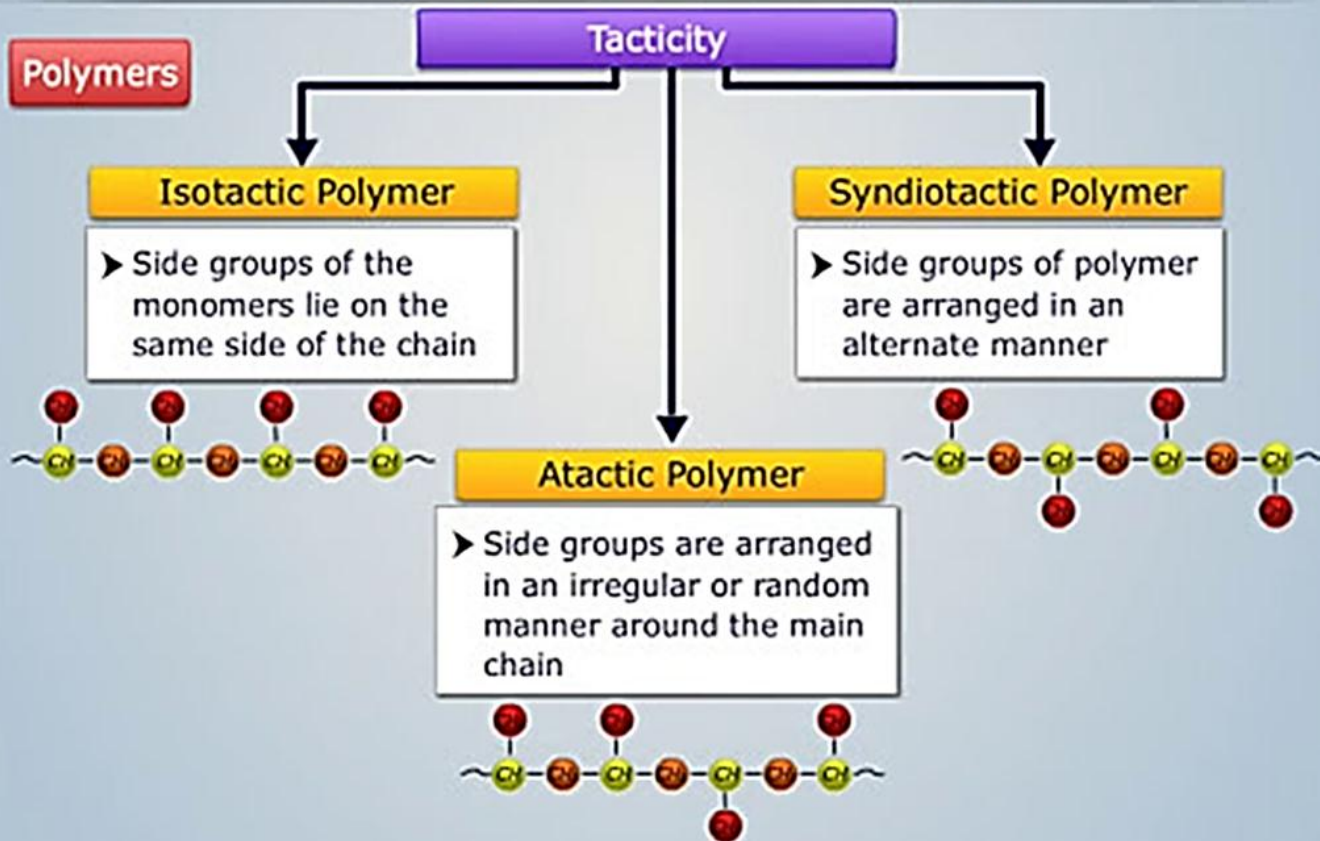


Cross-Linked



Network

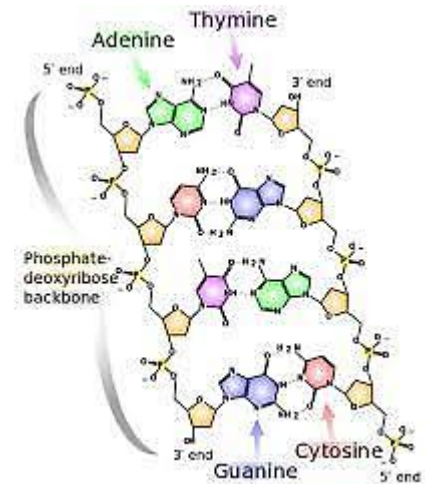
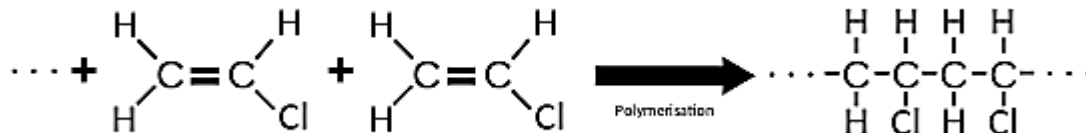
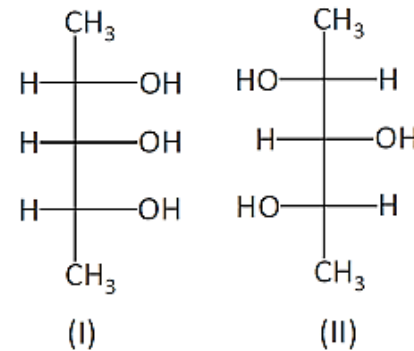
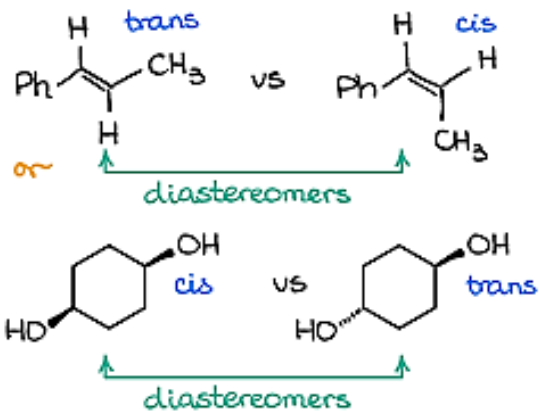
## Explain **Polymers** and their **Classification**



## Classification Based on Monomers

**Homomer:** In this type, a single type of monomer unit is present. For example, Polyethene

**Heteropolymer:** or co-polymer: It consists of different types of monomer units. For example, nylon -6, 6



# HOMOPOLYMER VERSUS HETEROPOLYMER

Homopolymer is a type of polymer that is made from identical monomers

---

A single type of monomer is used for the production of homopolymers

---

Homopolymers are produced by homopolymerization

Heteropolymer is a type of polymer that is made of two or more different types of monomers

---

More than one type of monomer is used for the production of heteropolymers

---

Heteropolymers are produced by copolymerization

Visit [www.pediaa.com](http://www.pediaa.com)

## Classification Based on Molecular Forces

**Elastomers polymers:** These are rubber-like solids weak interaction forces are present. For example, Rubber.

**Fibers polymers:** Strong, tough, high tensile strength and strong forces of interaction are present. For example, nylon -6, 6.

**Thermoplastics polymers:** These have intermediate forces of attraction. For example, polyvinyl chloride.

**Thermosetting polymers:** These polymers greatly improve the material's mechanical properties. It provides enhanced chemical and heat resistance. For example, phenolics, epoxies, and silicones.







Thermoplastic



Elastomer



Thermoset



ARNTINEL



HYTREL



KRATON



RITEFLEX



STYROFLEX



## THERMOPLASTICS



(Can be melted repeatedly)

## THERMOSETS



(Once shaped, cannot be melted)

Buzzie.com

## Thermoplastics



Exam tip: You DON'T need to know the names & technical details of specific polymers but you DO NEED TO know the type of polymer from a description of its properties or uses. You also need to explain why polymers have replaced other materials.

## THERMOSET OR THERMOSET?



Vulcanised rubber



Nylon clothes



Plastic toys



Bakelite



Chocolate box only



Epoxy resin glue

HOW DO THEIR PROPERTIES LINK TO THEIR USES?

GCSE Core Chemistry

# **Properties of Polymers**

## **Physical Properties:**

Physical properties of polymers include molecular weight, molar volume, density, degree of polymerization, crystallinity of material.

As chain length and cross-linking increase, the tensile strength of the polymer increases.

Polymers do not melt, and they change state from crystalline to semi-crystalline.

## **Chemical Properties:**

Compared to conventional molecules with different side molecules, the polymer is enabled by hydrogen bonding and ionic bonding resulting in better cross-linking strength.

Dipole-dipole bonding side chains enable the polymer for high flexibility.

Polymers with Van der Waals forces linking chains are known to be weak but give the polymer a low melting point.

## **Optical Properties:**

Due to their ability to change their refractive index with temperature, as in the case of PMMA and HEMA: MMA, they are used in lasers for applications in spectroscopy and analytical applications.

## Some Polymers and their Monomers:

**Polypropene:** also known as polypropylene, is made up of monomer propene.

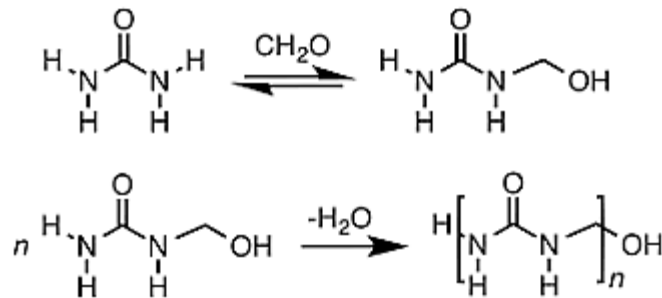
Polystyrene is an aromatic polymer, naturally transparent, made up of monomer styrene.



**Polyvinyl chloride:** (PVC) is a plastic polymer made of monomer vinyl chloride.

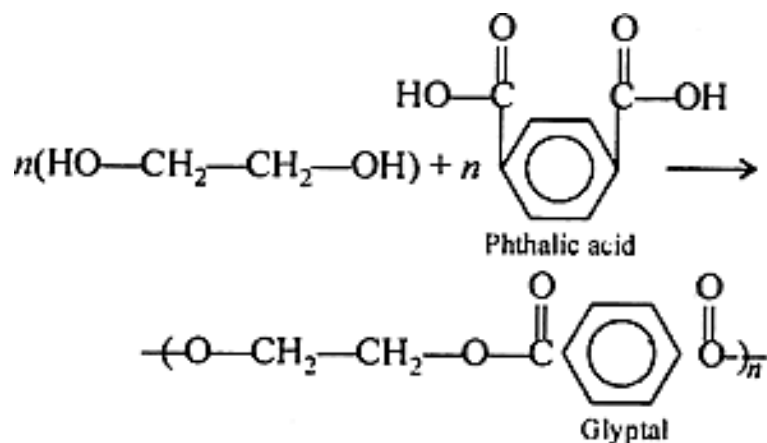


The urea-formaldehyde: resin is a non-transparent plastic obtained by heating formaldehyde and urea.

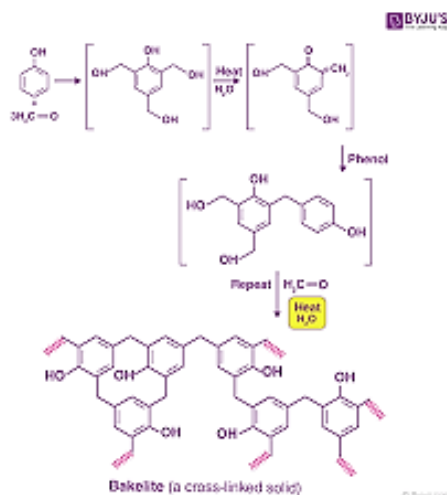


Glyptal: is made up of monomers ethylene glycol and phthalic acid.  
 Bakelite: or polyoxybenzylmethyleneglycolanhydride is a plastic which is made up of monomers phenol and aldehyde

**Glyptal:** is made up of monomers ethylene glycol and phthalic acid.



**Bakelite:** or polyoxybenzylmethyleneglycolanhydride is a plastic which is made up of monomers phenol and aldehyde





# Uses of Polymers

Here we will list some of the important uses of polymers in our everyday life.

**Polypropene:** finds usage in a broad range of industries such as textiles, packaging, stationery, plastics, aircraft, construction, rope, toys, etc.

**Polystyrene:** is one of the most common plastic actively used in the packaging industry. Bottles, toys, containers, trays, disposable glasses and plates, TV cabinets and lids are some of the daily-used products made up of polystyrene. It is also used as an insulator.

**polyvinyl chloride:** the most important use is the manufacture of sewage pipes. It is also used as an insulator in electric cables.

Polyvinyl chloride is used in clothing and furniture and has recently become popular for the construction of doors and windows as well. It is also used in vinyl flooring.

**Urea-formaldehyde resins:** are used for making adhesives, moulds, laminated sheets, unbreakable containers, etc.

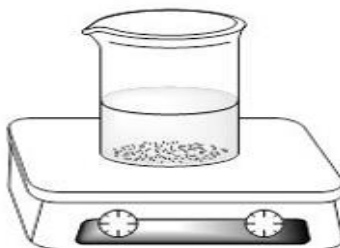
**Glyptal:** is used for making paints, coatings, and lacquers.

Bakelite is used for making electrical switches, kitchen products, toys, jewelry, firearms, insulators, computer discs, etc.

# (Recrystallization , Filtration)

## Practical Aspects

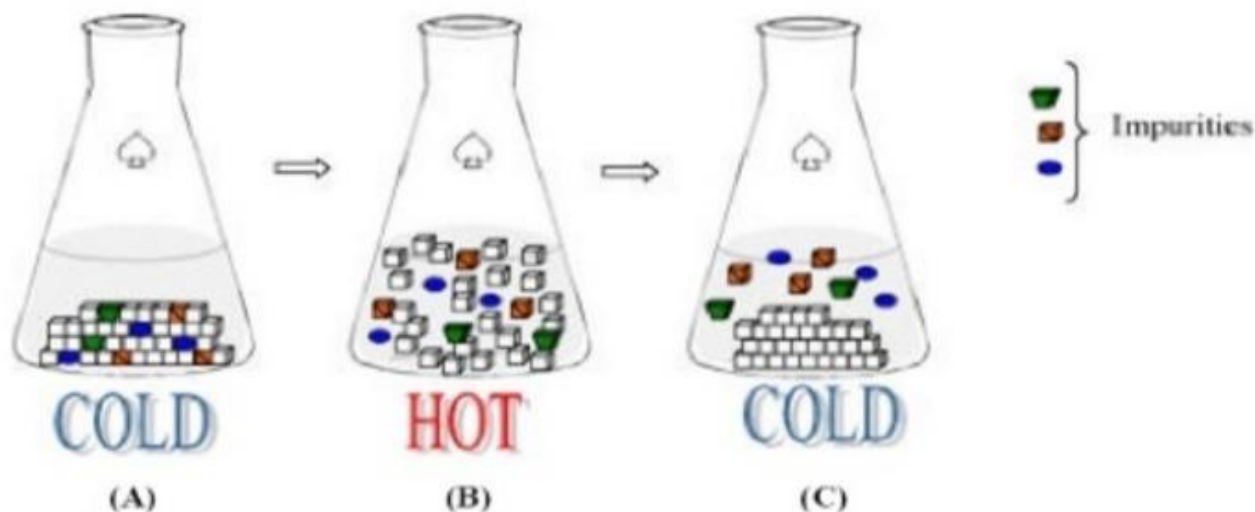
Impure Solid → Dissolve → Recrystallize → Filter





# Definition

- **Recrystallization:** purification process used to remove impurities from organic compounds which are solid at room temperature.
- **Principle:**
  - Solubility of a compound in a solvent increases with temperature.
  - As the solution cools, crystals form and grow.
  - Molecules in a crystal have a greater affinity for molecules of the same kind than for impurities.





# An Ideal Recrystallization Solvent Should

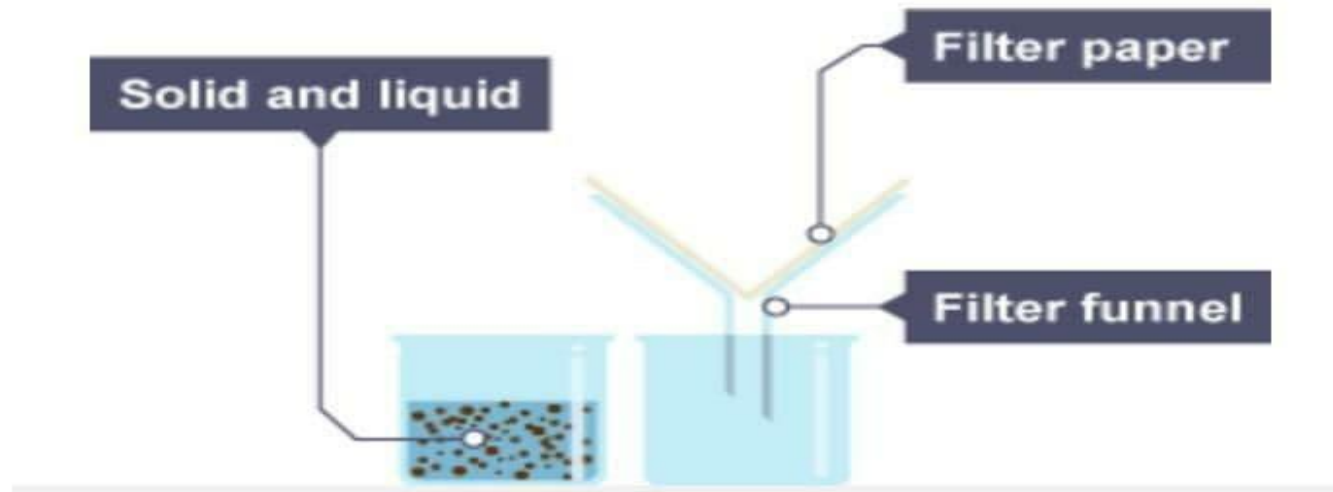
- should dissolve **all** of the compound when the solvent is hot (boiling).
- should dissolve **none** of the compound when the solvent is at room temperature.
- should have different solubilities for the compound and the impurities.
- should have a lower boiling point than the melting point of the compound.
- should have a fairly low boiling point
- should be cheap, non-toxic, non-reactive, and non-smelly

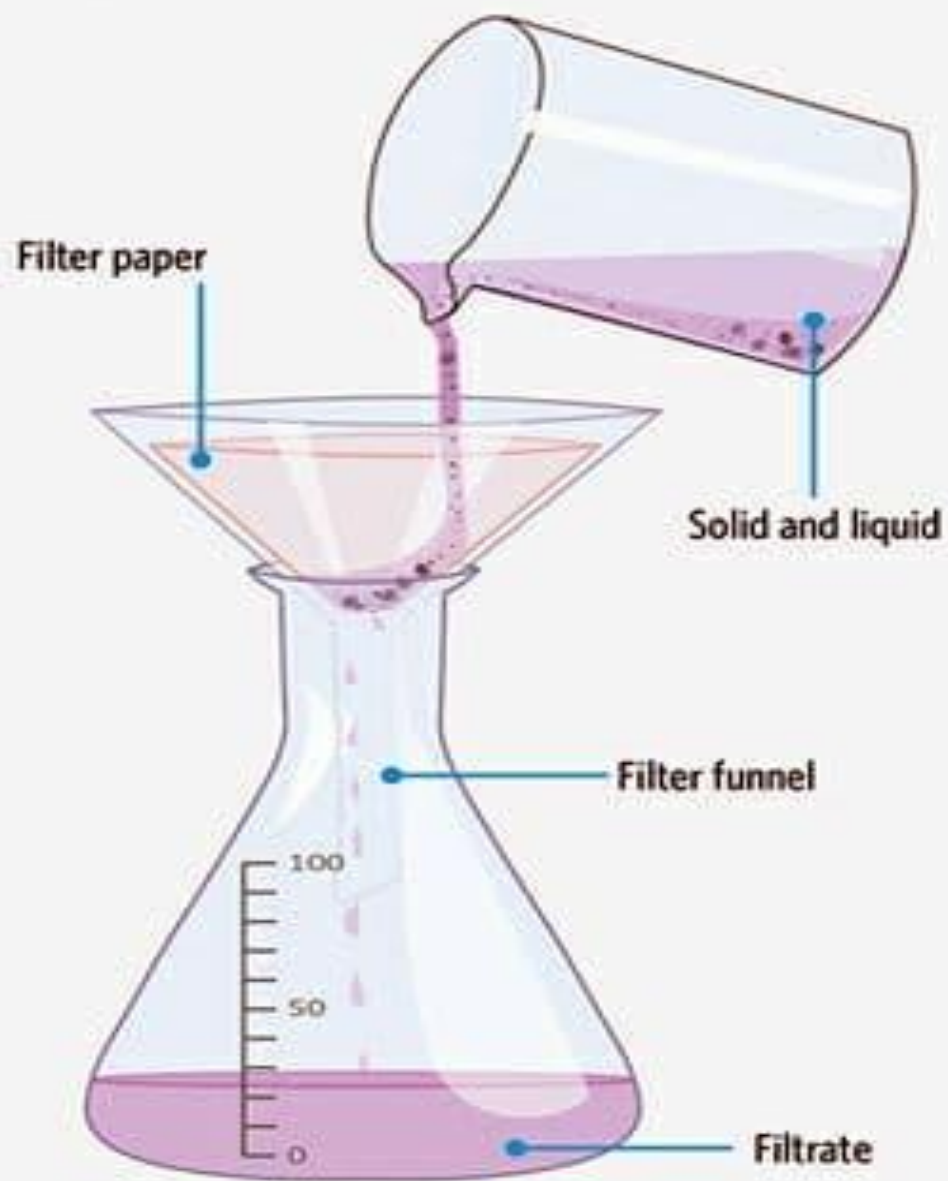
# Filtration

**Filtration** is a method for separating an insoluble solid from a liquid. When a mixture of sand and water is filtered:

- the sand stays behind in the filter paper (it becomes the **residue**)
- the water passes through the filter paper (it becomes the **filtrate**)

The slideshow shows how filtration works:

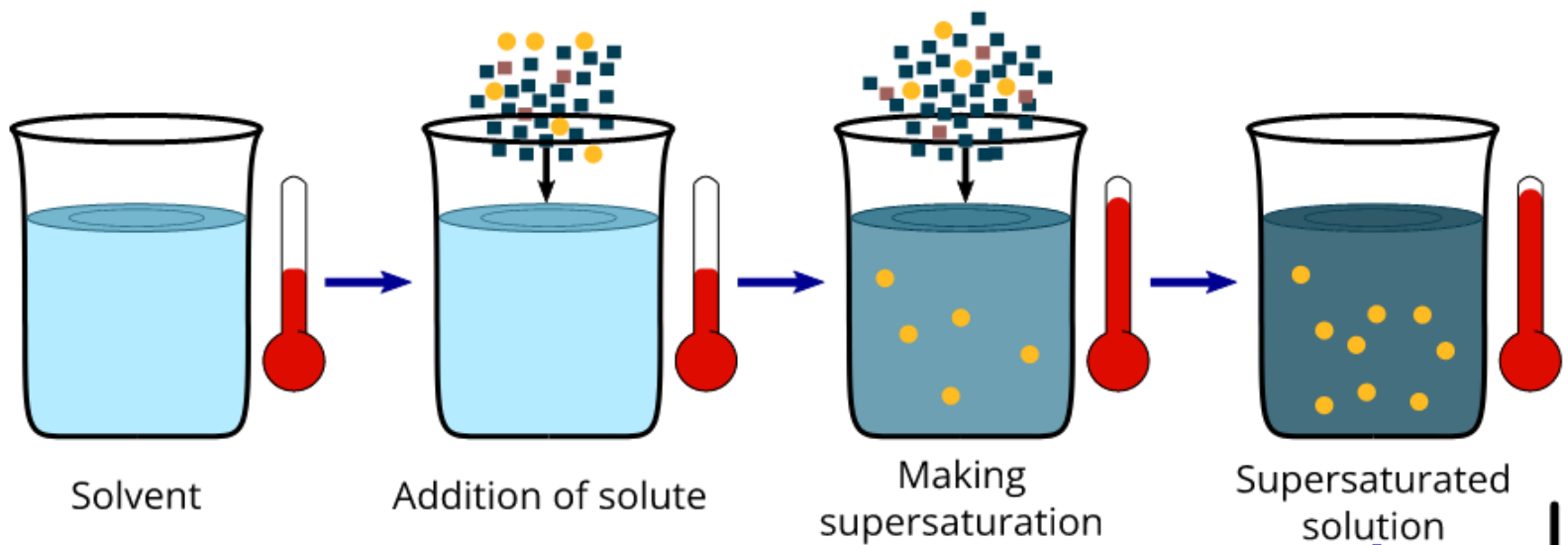




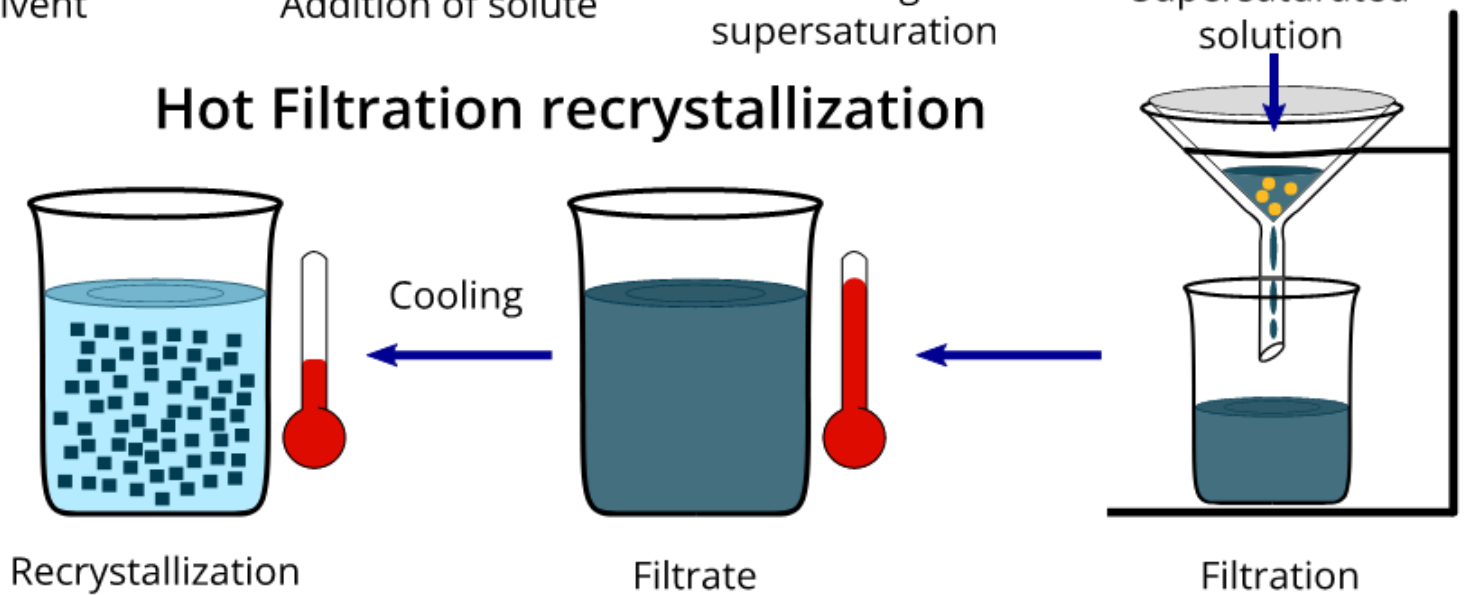
# Recrystallization Procedure

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- **Dissolve sample in a minimal amount of an appropriate solvent.**
- **Sample should be insoluble in solvent at room temperature, but soluble at elevated (boiling point) temperature.**
- **If solution is colorized, it is sometimes necessary to add a decolorizing agent (activated charcoal - Norite)**
- **Colorized solutions are first filtered through a fluted filter or a column containing alumina or silica gel.**



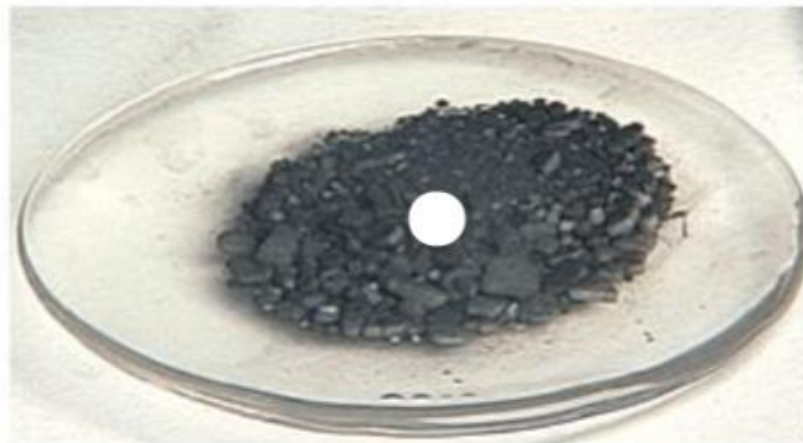
## Hot Filtration recrystallization





# Recrystallization

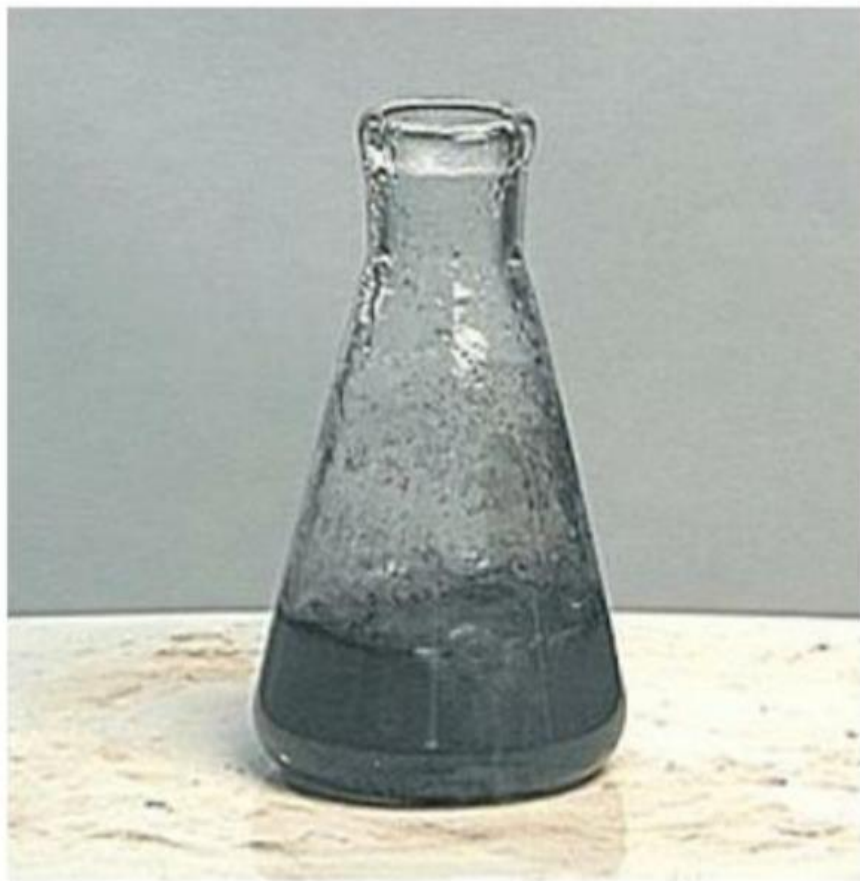
**Impure benzoic acid**



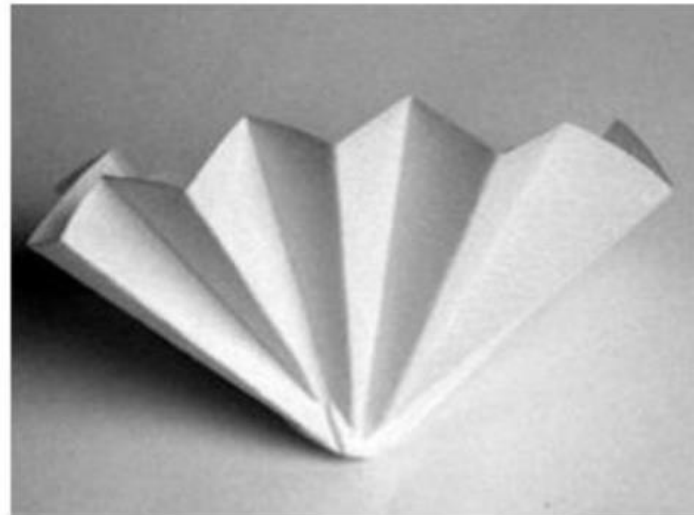
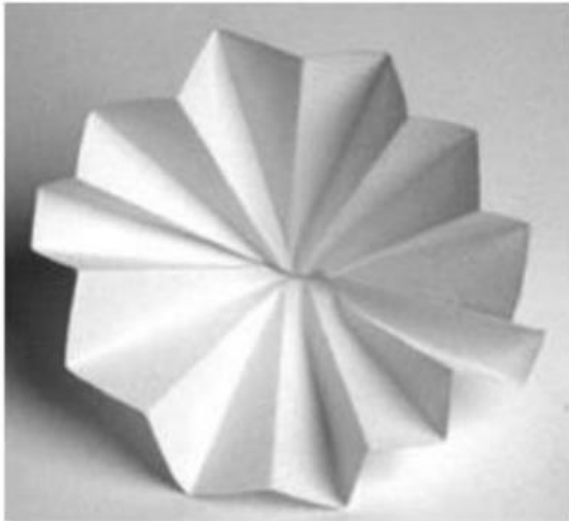
**Benzoic acid after  
recrystallization**



# Impure benzoic acid in hot water



**Use fluted filter paper to  
maximize surface area.**





**To avoid  
crystallization  
in the funnel:**



**Use GLASS funnel.**

**Put flask on hot plate.**

**The hot solution is filtered to  
remove insoluble impurities**



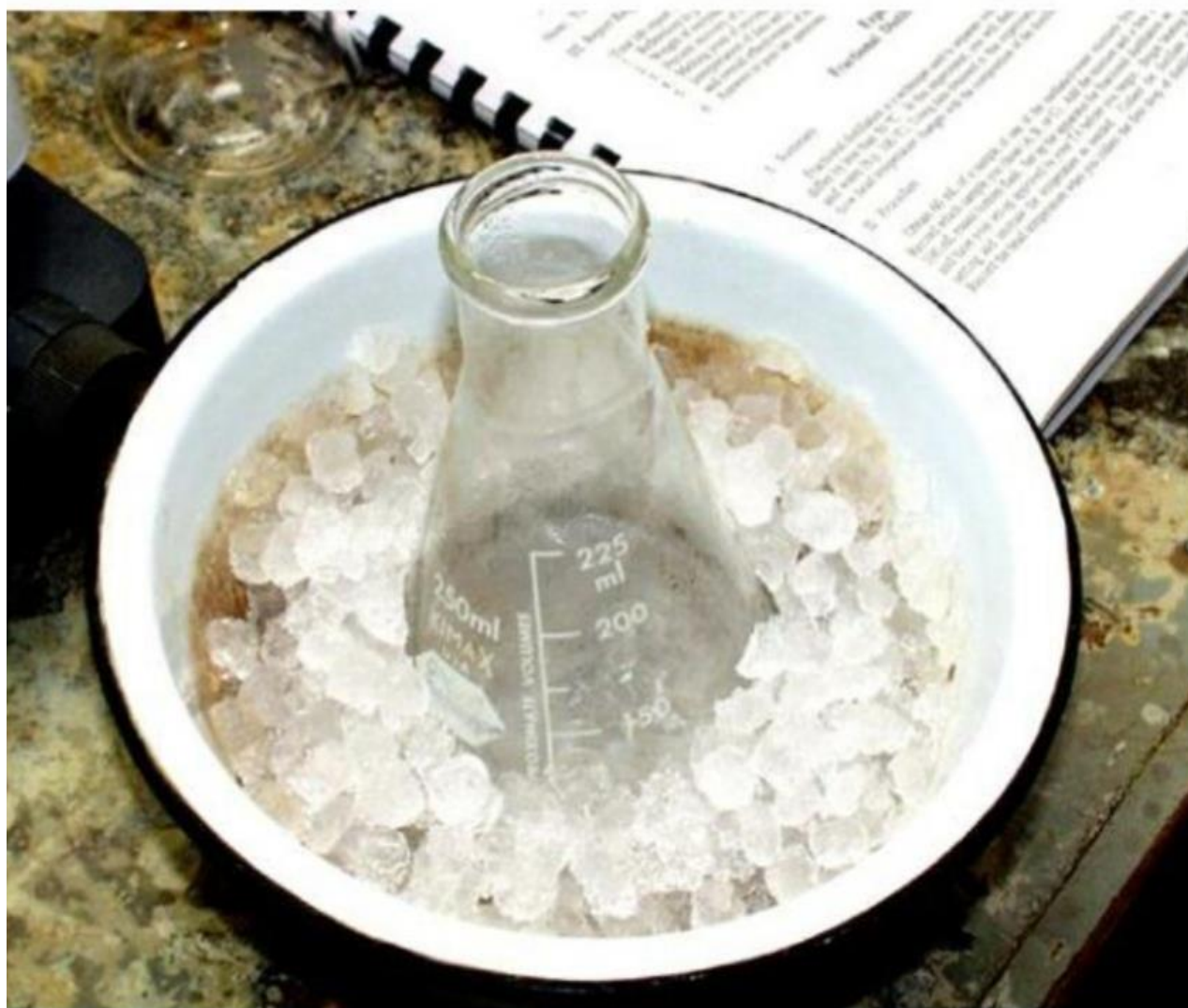
**Crystals form in the warm solution**



**Next:**

**Cool, filter, wash, dry, weigh, mp**

# Cool in ice bath



## ***The Result***

Weight of the benzoic acid ( before the crystallization ) =

Weight of the filter paper =

Weight of the filter paper +pure crystals =



Good luck everyone

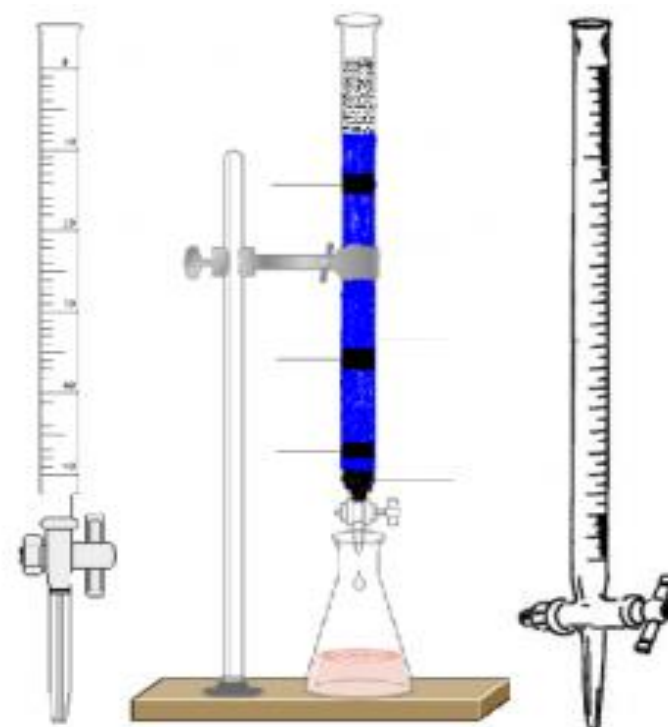


# Dental Industry Techniques Department

## The First Stage



## Volumetric analysis, titration and neutralization reaction.



**ASS-LEC. Israa Al-Abbasi**



**Volumetric analysis:** is a quantitative analytical method which is used widely.

As the name suggests, **this method involves** measurement of the volume of a solution whose concentration is known and applied to determine the concentration of the analyte(unkown).

### **Some vocabulary used in volumetric analysis:**

- **Titration** -is a laboratory process in the analytical chemistry of quantitative analysis used to find a concentration of an unknown acidic solution by adding a basic solution of a known concentration, or vice versa.
- **Titrant** – the volume of solution added from the burette.

- **Equivalence point** –The point at which the titrant is chemically equivalent to the analyte in the sample.
- **End point** – signalled by a change in colour of an indicator (indicators are chosen so they change colour as close as possible to the equivalence point)
- **Indicators** - They are weak organic acids or bases that change color or cause turbidity that are used to know the endpoint during the titration process.

# Endpoint vs Equivalence Point

Endpoint	Equivalence Point
Point where the indicator changes colour	The point at which the titrant is chemically equivalent to the analyte in the sample
Comes after the equivalence point	Comes before the endpoint
Weak acids can have only one endpoint	Weak acids can have multiple equivalence point

## **Type of Titrations Classified into four types based on type of reaction involved:**

- 1- Neutralization reaction (acid-base titration).
- 2- Oxidation-reduction reactions.
- 3- Precipitation reactions.
- 4- Complex formation reactions.

**1-Neutralization reaction** refers to acid and base reaction producing salt and water.

The equivalent amounts of acid react with base to form equivalent amounts of salt and water.

When the reaction is complete, acid and base are said to neutralize each other.

Since water is produced, neutralization reaction is also referred as water forming reaction.

**The general rule:** **acid + base**  $\longrightarrow$  **salt + water**

**Example:**



**Name of experiment:** Neutralization reaction  
(Prepare a standard base).

**Aim of experiment:** Find the concentration of the base unknown (NaOH)

**Procedure:-**

**Titration of standardized ( HCl ) against ( NaOH ) solution**

- 1- Fill the burette with (0.1N). Hydrochloric acid HCl.
- 2- Transfere 5 ml of NaOH solution to a conical flask .
- 3- add 1-2 drops of Phenolphthalein indicator.
- 4-add HCl drop by drop into the conical flask until the color of solution change from pink to colorless.
- 5-Read and record volume.

6- Calculate the exact normality of unknown from the following

$$N_1 \times V_1 \text{ (Standardized HCl)} = N_2 \times V_2 \text{ (NaOH)}$$

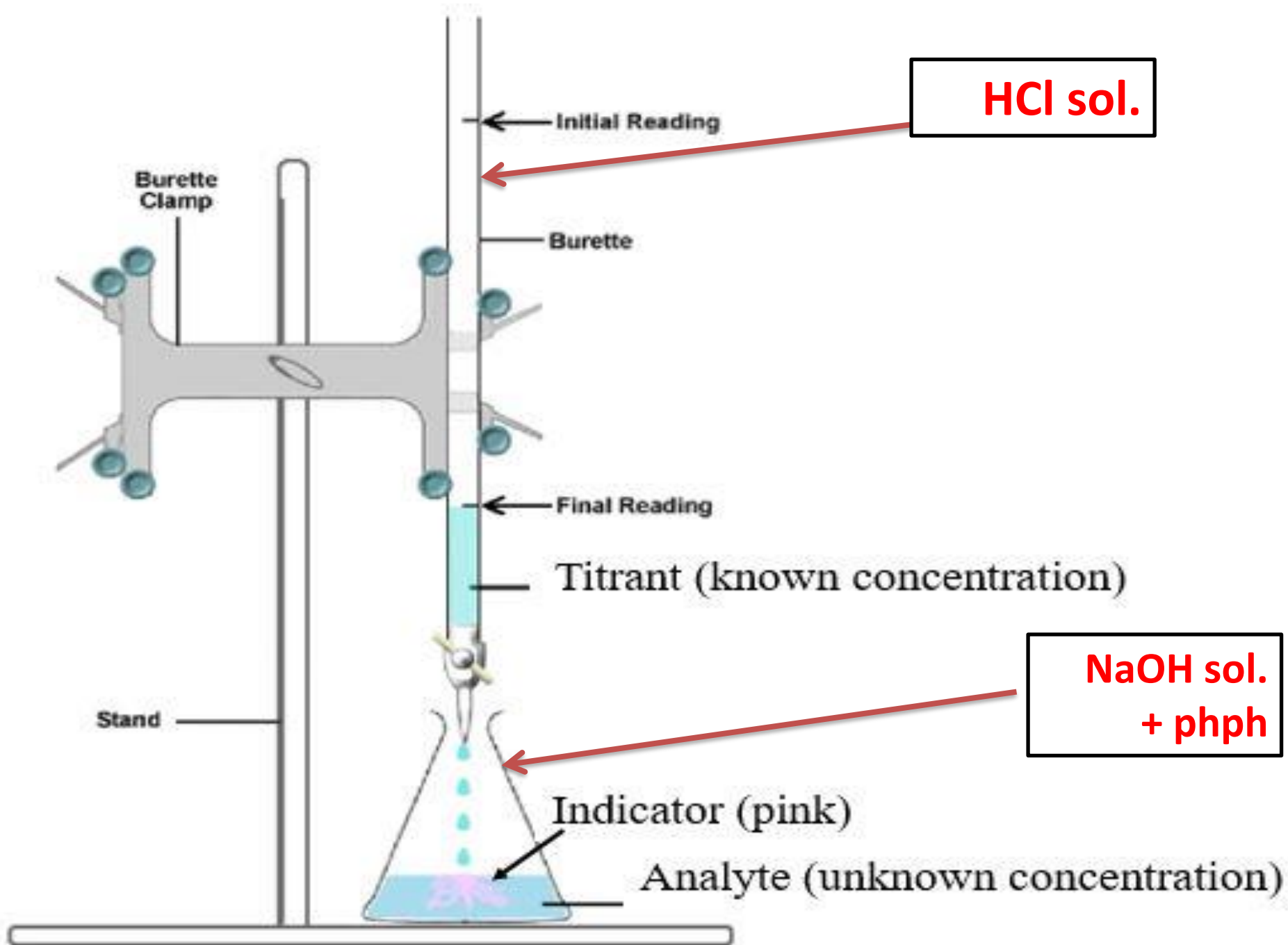
$N_1$  = The normality of HCl = 0.1 N

$V_1$  = The volume of HCl (from burette).

$N_2$  = The normality of unknown base ( NaOH )?

$V_2$  = The volume of unknown NaOH sol. = 5 ml





## H.W

1- When titrating equivalent quantities of strong acid and strong base, the solution formed at the equivalence point is .....

2- If 30 ml of phosphoric acid solution is equivalent with 75 ml of 0.4N NaOH, according to the formula



The acid concentration is equal to ..... M.

3-What is the benefit of the Indicators?

4-Why is phenolphthalein indicator used in this type of titration?

5-A salt of formula ( $\text{NaHSO}_4$ ) is produced when reacting (100ml) from a solution of (NaOH) its concentration (0.1M) with sulfuric acid ( $\text{H}_2\text{SO}_4$ ), its volume is (100ml) and its concentration is equal to ....M.

# Dental Industry Techniques Department

## The first stage



## Laboratory instruction, safety rule and equipment.



**Dr. Muwafaq khazaal**  
**ASS-LEC. Israa Alabbasi**

# Basic Safety Rules:

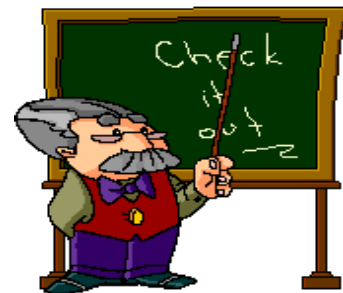
1. When entering the laboratory, you must wear (lab coat, gloves if you come into contact with potentially contaminated or dangerous materials, safety glasses if the experiment requires it, Shoes must completely cover the foot. No sandals allowed on lab days)
2. Labels and equipment instructions must be read carefully before use
3. If a chemical should splash in your eye(s) or on your skin, immediately flush with running water for at least 20 minutes. Immediately yell out the teacher's name to get the teacher's attention.



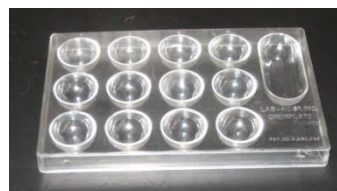
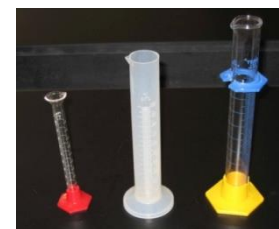
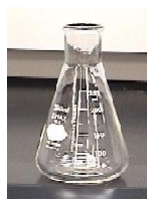
4. Check the label on all chemical bottles twice before removing any of the contents. Take only as much chemical as you need.
5. Use volatile and flammable compounds only in a fume hood to prevent inhalation of hazardous material.
6. Never return unused chemicals to their original container.
7. Avoid adding solids to hot liquids.
8. All chemicals in the laboratory are to be considered dangerous. Avoid handling chemicals with fingers. Always use a gloves . Do not taste, or smell any chemicals.
9. Keep hands away from face, eyes, mouth, and body while using chemicals or lab equipment. Wash your hands with soap and water after performing all experiments.
10. Examine glassware before each use. Never use chipped, cracked, or dirty glassware.



11. Heated glassware remain very hot for a long time. They should be set aside in a place to cool. Use tongs or heat protective gloves if necessary.
12. Do not eat or drink in the lab.
13. Contact lenses may be not be worn in the laboratory.
14. Avoid wearing jewelry in the lab as this can pose multiple safety hazards.
15. Avoid smelling or tasting chemicals.



# ***Common Chemistry Laboratory equipments***





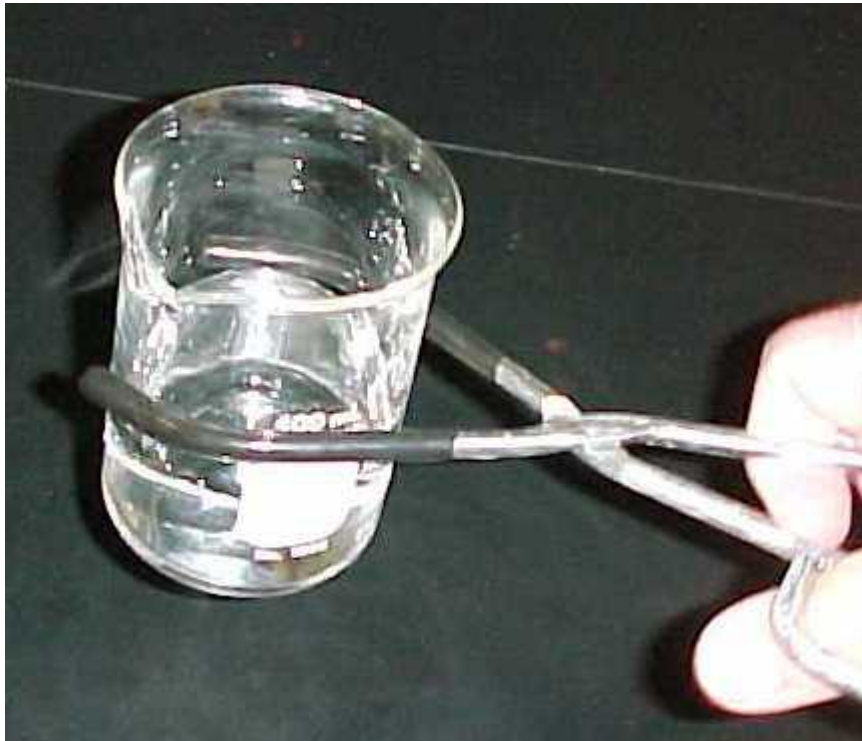
# Beaker

Measures liquids  
(but not very  
accurately)  
May be heated  
Used to hold or mix  
chemicals



# Beaker Tongs

Used to handle hot beakers  
Do not work well for very small  
beakers or very large beakers

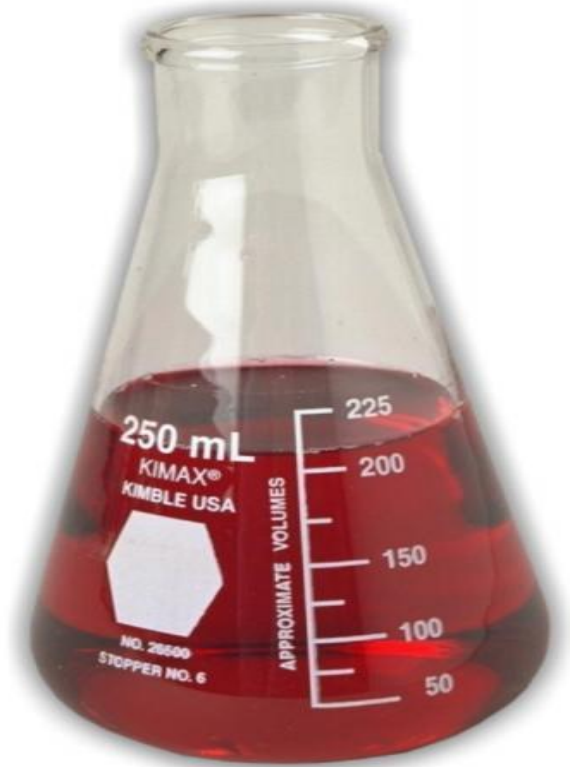


# conical Flask

hold solids or liquids that may release gases during a reaction .

Measures liquids (but not accurately)

- May be heated
- Used for mixing
- Used in titrations



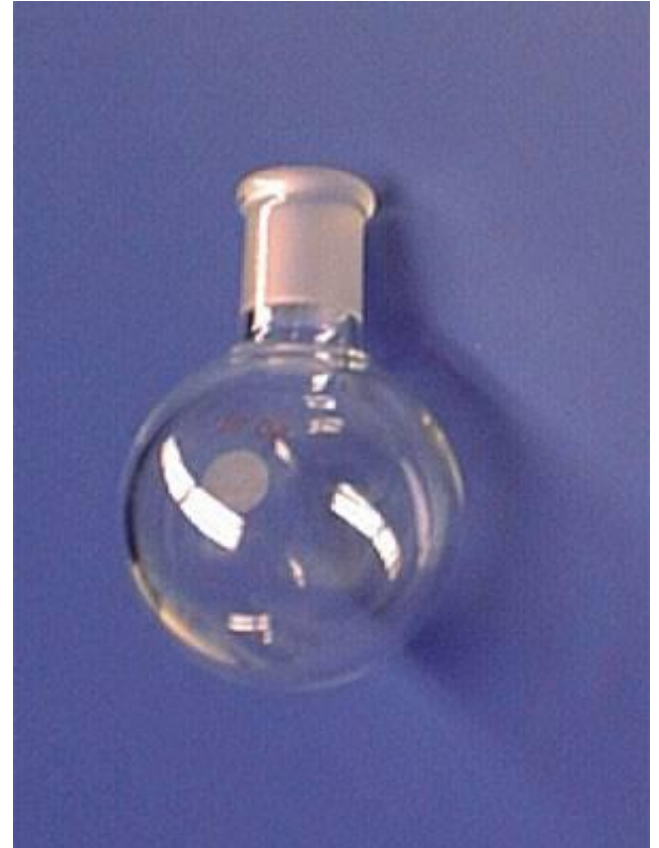
# Volumetric Flask

used for precise  
dilutions and  
preparation of  
standard solutions.



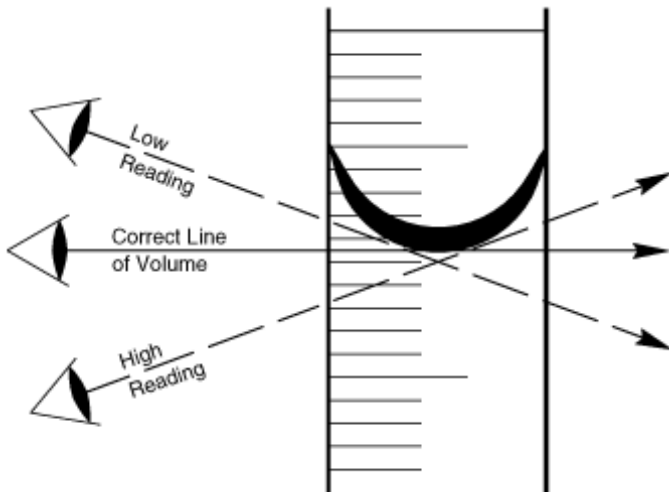
# round bottom flask

- The **round bottom flask** is used as:
- reaction flask
- distilling flask
- collection flask



# Graduated Cylinder

A graduated cylinder is used to measure volumes of liquids.



Volume of Liquids  
Reading a Meniscus

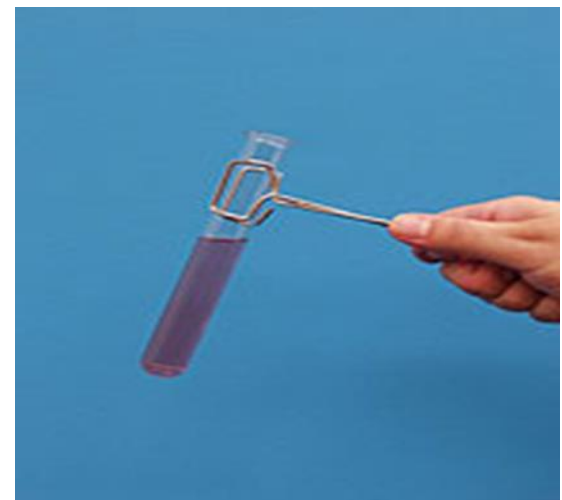
# Test Tubes



- May be heated
- Mix chemicals
- Holding small amounts of chemicals

## Test Tube Holder

A test tube holder is useful for holding a test tube which is too hot to handle.





# Test Tube Brushes

Test tube brushes are used to clean test tubes and graduated cylinders.

Forcing a large brush into a small test tube will often break the tube.



# Test Tube Racks

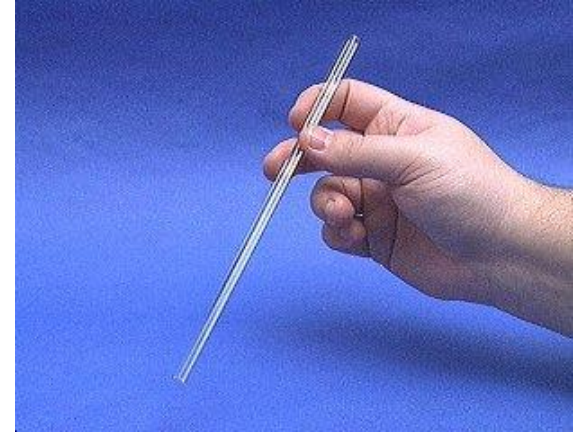


- Holds test tubes in a vertical position.
- Allows for clear sight.

# Glass Stir Rod

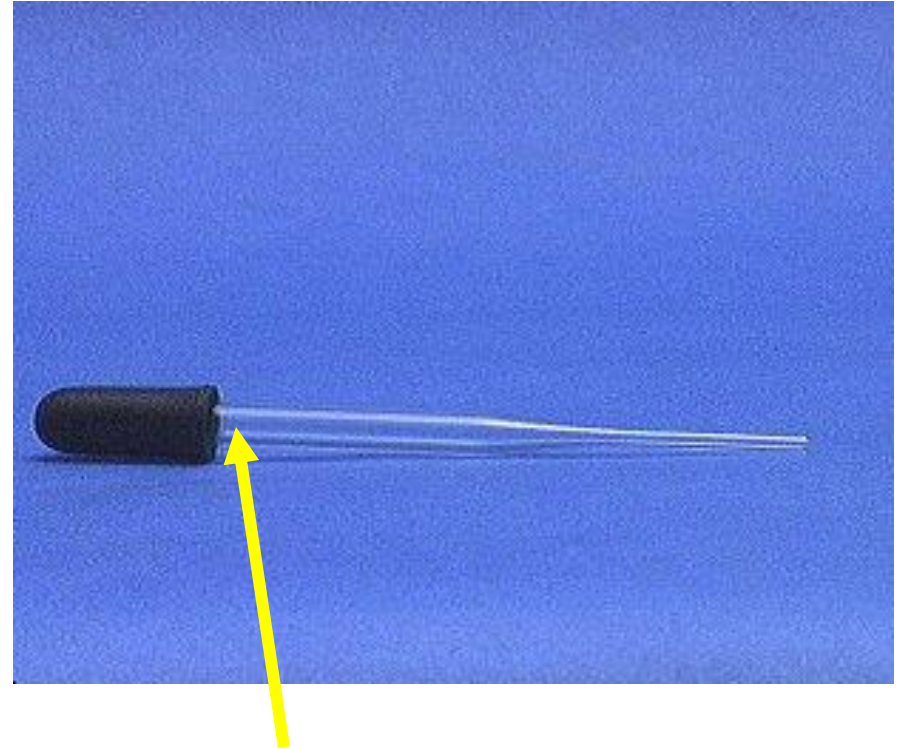
A glass rod is used to manually stir solutions. It can also be used to transfer a single drop of a solution.

**BE CAREFUL!**  
They break easily



# Medicine Dropper

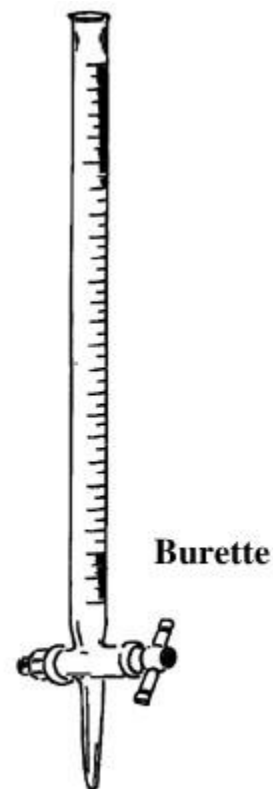
A medicine dropper is used to transfer a small volume of liquid (less than one mL).



On top of each medicine dropper is a “rubber bulb”

# Burette & Burette Clamp

Very specialized piece of glassware used to accurately measure the volume of liquid that is dispensed.



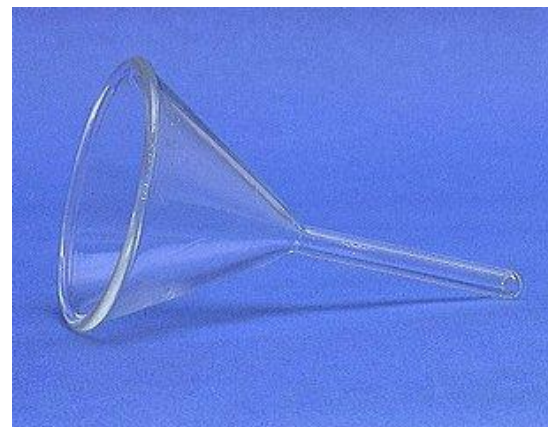
# Ring stands and their Components

Multi-purpose, mostly used as a support to heat chemicals and hold burettes.



## Funnel(glasses)

A funnel is used to aid in the transfer of liquid from one vessel to another.



## Reagent Bottle

Used to store, transport, or view reagents such as acids or bases.



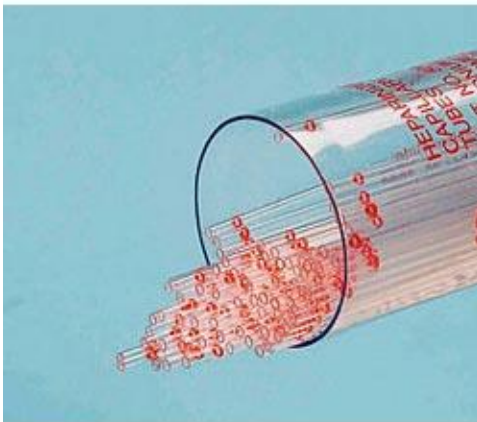


# Graduated Pipettes



A graduated pipet measures and delivers exact volumes of liquids – uses a rubber bulb for suction.

# Capillary Tubes



Used to collect liquid through the process of capillary action.



# Wash Bottle

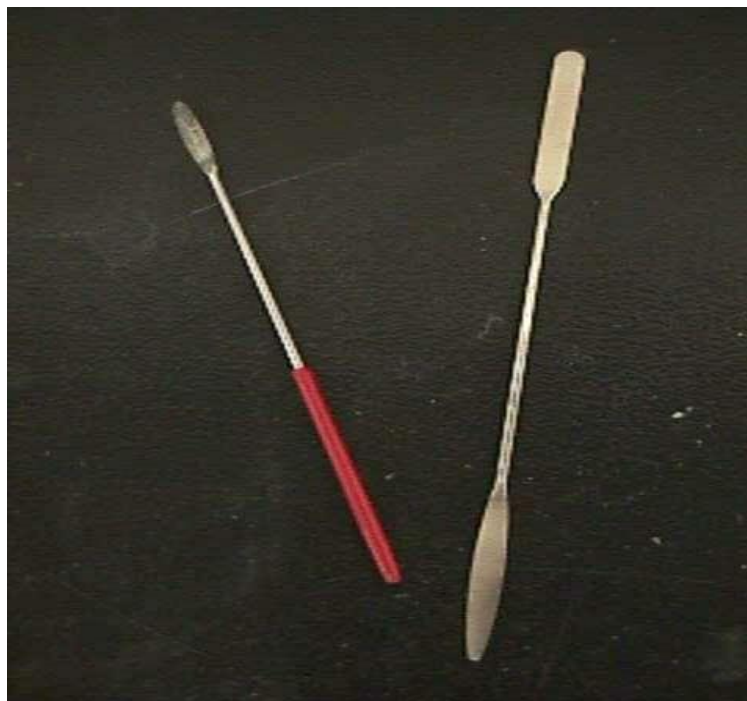
A wash bottle has a spout that delivers a wash solution to a specific area. Distilled water is the only liquid that should be used in a wash bottle.



# Spatulas

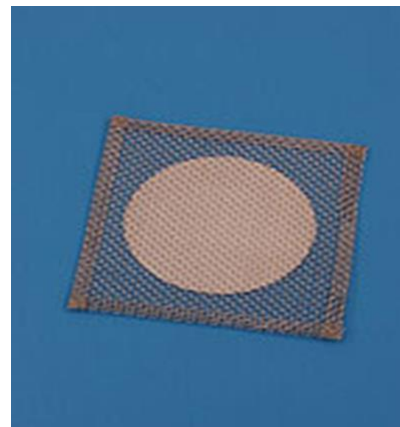
Used to transfer solids from one container to another

**Note :** Chemicals should never be transferred with your bare hands.



# Wire Gauze

Spreads out the heat produced by a Bunsen burner



# Bunsen Burner



Bunsen burners are used for the heating of nonvolatile liquids and solids. Used to heat substances quickly or if  $> 400^{\circ}\text{C}$  is needed. Do not use with flammable substances.

# Rubber Tubing

Used for a variety of things.

Example:

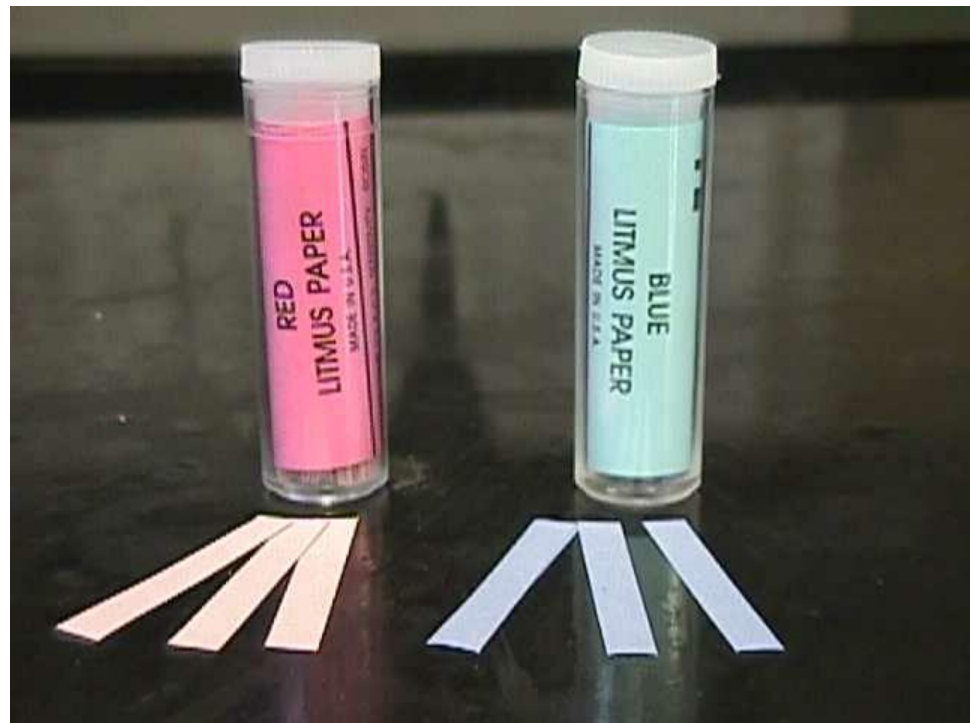
1. Connecting Bunsen burner to gas valve stem.
2. Connecting glass tubing together.



# Litmus Paper

Red litmus paper is used to identify bases.

Blue litmus paper is used to identify acids.





**Electronic Balance**

Usually used to weigh solids



**Hot Plate**

Usually used to heating.

# Centrifuge

Used to separate suspensions (solids from liquids).



# Digital Balance



Digital Balance is device used to precisely measure the mass of an chemicals

# Water Bath



A water bath is an ideal heat source for heating flammable chemicals rather than other sources to prevent ignition. Different types of water baths are also used depending on the type of application



# Note:

1. Always ADD ACID to water



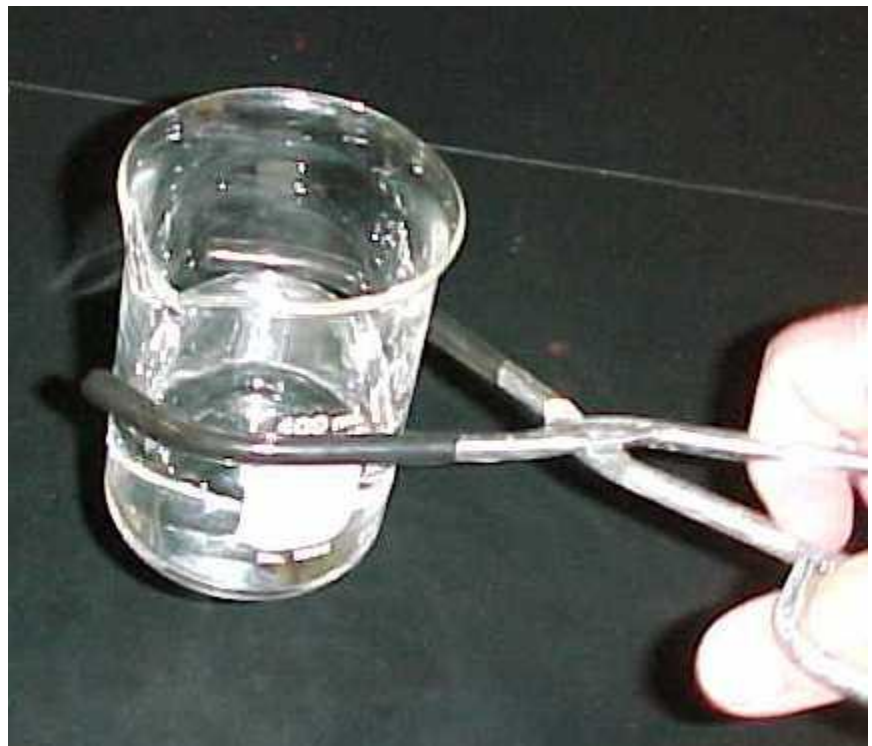
2. Work with volatile chemicals under a fume hood, General purpose: prevent exposure to toxic, disturbing, or noxious chemical vapors and gases



3.Heat test tubes at an angle, directing the opening oppositely to you and other people in the laboratory.



4. Handle hot glassware with gloves or beaker tongs.



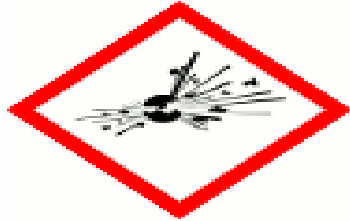
## 5. Do not pipet solutions by mouth!



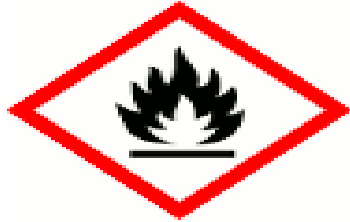
- Use :  
a rubber suction bulb  
, a pipette bulb  
or other pipette filling device.



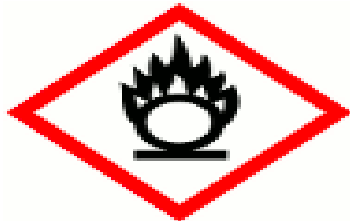
# Hazard pictograms (symbols)



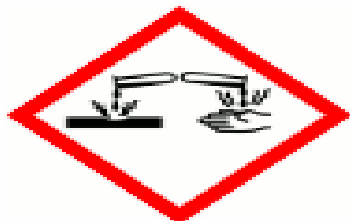
Explosive (Symbol: exploding bomb)



Flammable (Symbol: flame)



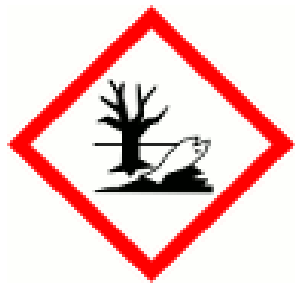
Oxidising (Symbol: flame over circle)



Corrosive (Symbol: corrosion)



Acute toxicity (Symbol: skull and crossbones)



Hazardous to the environment (Symbol: environment)



Health hazard/Hazardous to the ozone layer (Symbol: exclamation mark)



Serious health hazard (Symbol: health hazard)



Gas under pressure (Symbol: gas cylinder)



## ***Before leaving the lab:***

- ❖ Return equipment and chemicals to their proper places
- ❖ Be sure to replace the lids to all containers
- ❖ Clean up your work area

Thank you for listening



# Dental Industry Techniques Department

## The first stage



**Preparation of solutions, normal solution,  
molar solution, dilution and percentage.**

**ASS-LEC. Israa Al-Abbasi**



# Analytical chemistry



```
graph TD; A[Analytical chemistry] --> B[Qualitative analysis]; A --> C[Quantitative analysis]; C --> D[instrumental methods:]; C --> E[Classical analysis]; E --> F[Volumetric (titrimetric) analysis]; E --> G[Gravimetric analysis];
```

The diagram is a hierarchical flowchart. At the top is 'Analytical chemistry'. A red arrow points down to a horizontal line, from which two arrows branch out to 'Qualitative analysis' and 'Quantitative analysis'. Under 'Qualitative analysis' is a description. Under 'Quantitative analysis' is a description. A red arrow points down from 'Quantitative analysis' to another horizontal line, from which two arrows branch out to 'instrumental methods:' and 'Classical analysis'. Under 'instrumental methods:' is a description. Under 'Classical analysis' is a red arrow pointing down to another horizontal line, from which two arrows branch out to 'Volumetric (titrimetric) analysis' and 'Gravimetric analysis'.

## Qualitative analysis

The determination of the identity of chemical species present in a sample

## Quantitative analysis

An examination to determine how much of a chemical species is present in a sample

### instrumental methods:

use device to measure physical quantities of an analyte such as conductivity, fluorescence light, absorption

### Classical analysis

**Volumetric (titrimetric) analysis**

**Gravimetric analysis**

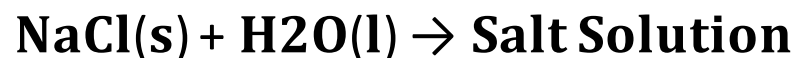
# DEFINITIONS

**Analysis:** Qualitative and quantitative characteristics of chemical analytes.

**Analytes:** Components of a sample that are to be determined.

**A solutions:** Homogeneous mixture of two or more substance produce from dissolved solute (ions, atoms, molecules) (lesser amount) in the solvent (larger amount).

Solute (lesser amount) + Solvent (larger amount) → Solution

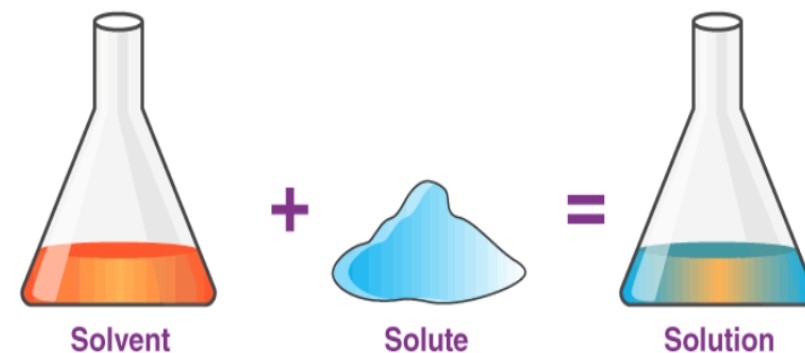
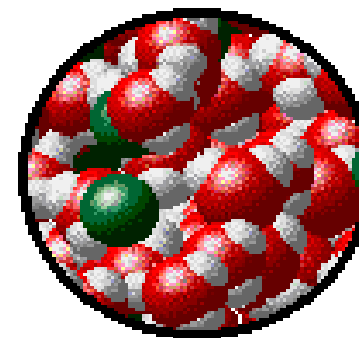


**Solvent:** the substance in which a solute dissolves to produce a homogeneous mixture.

**Solute:** the substance that dissolves in a solvent to produce a homogeneous mixture.

**Concentrated Solution** has a large amount of solute.

**Dilute Solution** has a small amount of solute.



# A solution can be qualitatively described as

**1-dilute:** a solution that contains a small proportion of solute relative to the solvent.

**2-concentrated:** a solution that contains a large proportion of solute relative to solvent.

## How Do We Express Concentrations of Solutions?

- Molarity
- Normality
- PPm
- %



# Molarity

Number of moles of solute present one liter of solution.

For Solid:

$$M = \frac{Wt(g) * 1000}{M.wt(g/mol) * V(ml)}$$

**Wt(g)**=The weight of the dissolved or (the weight of the dissolved substance).

**M.wt(g/mol)**= molecular weight.

**V(ml)**= volume.

For Liquid:

$$M = \frac{\% * d * 1000}{M.wt(g/mol)}$$

**d**= density.

## molecular weight of the substance:

its unit (**gram / mol**), and It is defined as **the sum of the atomic weights** of the elements that make up the chemical, taking into account **the number of atoms** of each element.

**Example.** Calculate the molecular weight of **sodium carbonate and phosphoric acid** if you know the atomic weight (Na = 23, C = 12, O = 16, P = 31, H = 1)

### The solution:-

The chemical formula for sodium carbonate **Na<sub>2</sub>CO<sub>3</sub>**

molecular weight =  $(23 \times 2) + 12 + (16 \times 3) = 106 \text{ g /mol}$

The chemical formula of phosphoric acid **H<sub>3</sub>PO<sub>4</sub>**

molecular weight =  $(1 \times 3) + 31 + (16 \times 4) = 98 \text{ g/ mol}$

knowing and understanding this simple definition it is possible to calculate the molecular weight of any chemical.

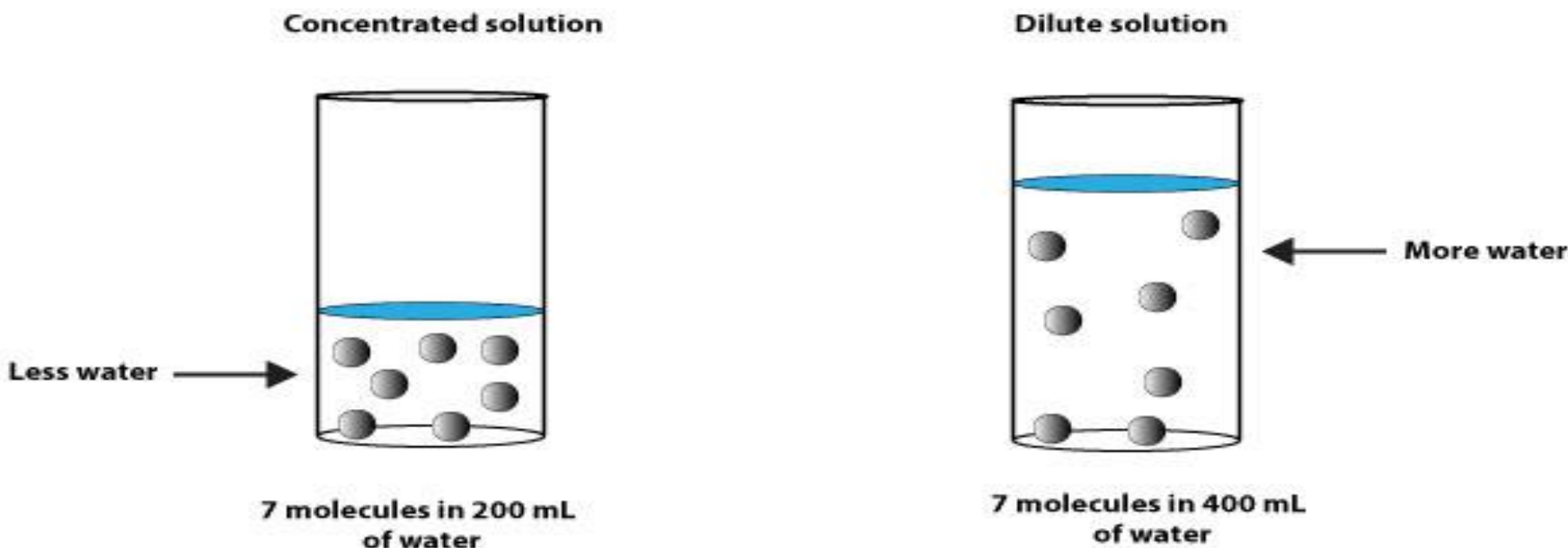


## Normality

is defined as the number of grams (equivalent weight) of solute per liter solution

$$N = \frac{\text{Wt.} \times 1000}{\text{Eq.Wt.} \times \text{Vol. (ml)}}$$

## Dilution Of Solution



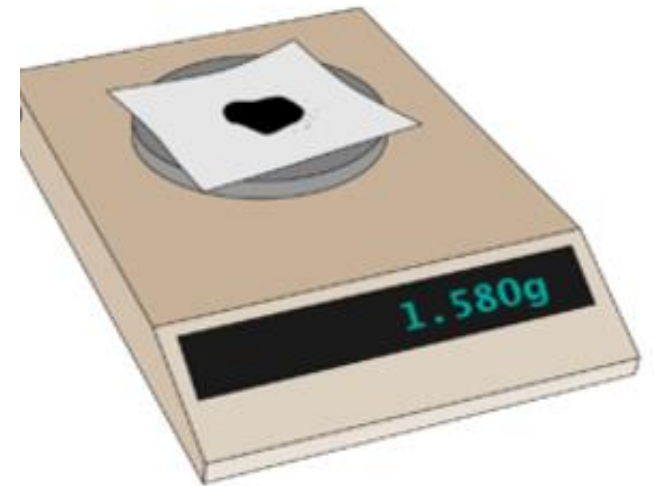
no. of moles of concentrated = no. of moles of diluted

$$M1 V1 = M2 V2$$

# WEIGHING

**The balance** is the most accurate and expensive instrument used by the beginner in a laboratory and it must always be treated with care.

- 1- Always weight materials by difference if that is possible
- 2- Hot objects should not be put on the pan.
- 3- Record the masses involved immediately .
- 4-Respect the mass limit of a balance.



**Name of Experiment:** Preparation of molar solution and the dilution.

**Aim of experiment:** preparation of Molar solutions of solids and the dilution process.

**1-**Prepare 0.3 M of NaCl in 100 ml D.W.

Procedure : Dissolve (X) gm from NaCl in D.W and then complete the volume to 100 ml.



2- Prepare 0.05 M of the above prepared solution in (100) ml of the distilled solution

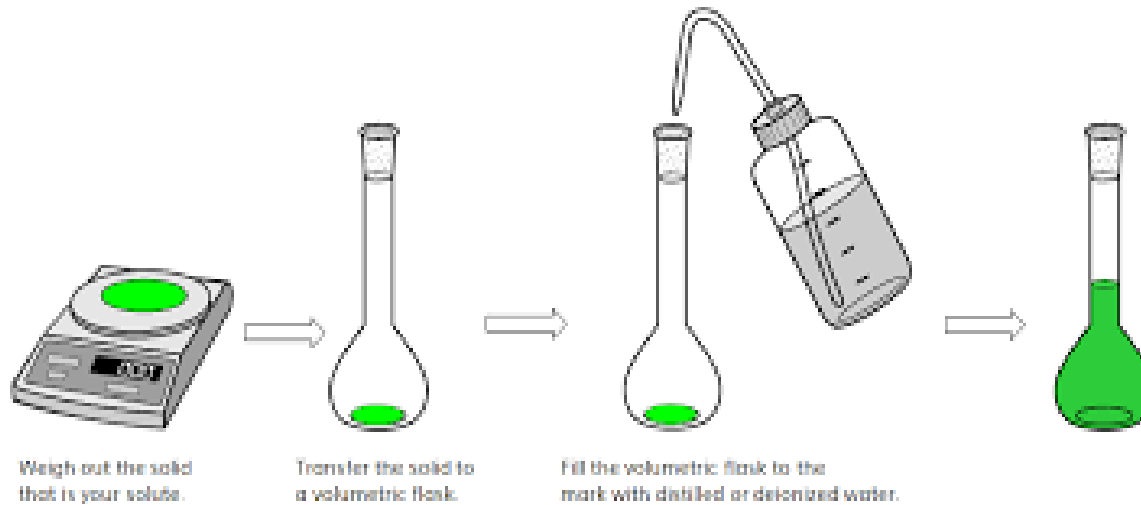
Procedure :

take (X) volume from the prepared solution above . And complete volume to (100)ml

no.of moles of concentrated = no.of moles of diluted

$$M_1 V_1 = M_2 V_2$$

**ATOMIC MASS:** Na=23g/mol , Cl =35.5g/mol



## H.W

1. Preparation 0.2 N NaOH solution in 200 ml.
2. Preparation 0.5 M Na<sub>2</sub>CO<sub>3</sub> solution in 250 ml.
3. How many grams per milliliter of NaCl are contained in a 0.250 M solution.
4. You wish to prepare 500 mL of 0.1 M K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> solution from a 0.250 M solution. What volume of the 0.250 M solution must be diluted to 500 ml.

