

UNIT-I

**INTERMOLECULAR FORCES
&
SURFACE TENSION**

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What are these??..



Everything is MATTER...!

Any thing that occupies space and has mass is called matter.



Even the air
we breathe is
matter.



How do you identify Matter..?

We identify matter by its Properties.

- How it looks?(shiny,dull,colourfull,etc.)
- How it feels?(hard,soft,rough,smooth,etc.)
- How it smells?(sweet,fruity,terrible,no smell,etc.)
- How it sounds?(loud,soft,echo,no sound,etc.)
- What it does?(bounce,stretch,tear,break,etc.)
& so many other parameters.

States/Forms of Matter..

Matter appears in 4 different forms

Solids

Liquids

Gases

Plasma

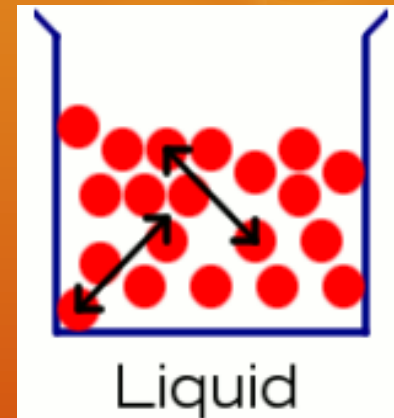
Solids

- Have a definite shape.
- Have a definite volume.
Eg.-book in a bag,a bucket,etc.
- Particles are arranged in tight regular pattern i.e. locked into place.
- They move very little as there is very less space between them.
- Solids do not flow as particles cannot slide over one-another.
- Eg.-Cheese,Bricks,Wood,Book Pen,etc.



Liquids

- Have no fixed shape.
Eg.-Water in a jug, glass etc.
will take the shape of container.
- Have a definite volume.
- Particles are fairly close, but not in a neat even arrangement as the particles in a solids are. There is some free space between the particles.
- Particles move/slide past one-another easily, that is why liquids can flow easily.
- Eg.-Water, Milk, Juices, Soft-Drinks, etc.



Gases

- Have no fixed shape.
- Have no fixed volume.

Eg.-Blow air in a balloon. Air will take the shape & size of the balloon.

- Particles have large spaces between them in comparison to solids & liquids.
- Particles move rapidly past one-another.

So, gases flow easily and can be compressed.

- Eg.-Steam, Oxygen, Carbon-dioxide, Smog, Helium, etc.



Plasma

- ❑ Has no definite shape.
- ❑ Has no definite volume.
- ❑ Plasma is an ionised gas.
- ❑ Particles can move past one-another as there is a great deal of free space between particles.
- ❑ Plasma is composed of ions(-vely charged electrons & +vely charged nuclei).So,it is a good conductor of electricity.
- ❑ Eg.-Lightning,Fluorescent light bulbs and neon light.



Classification of 4 states of matter is based upon....

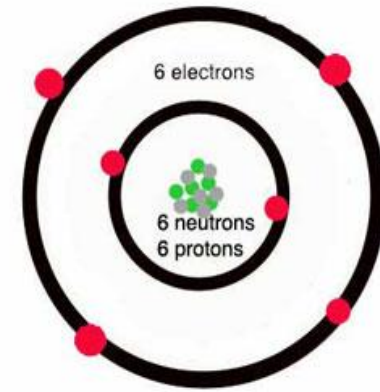
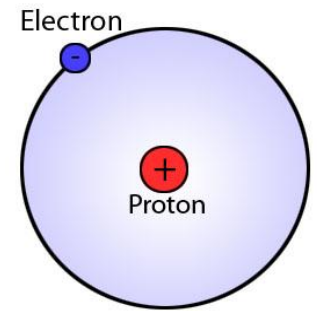
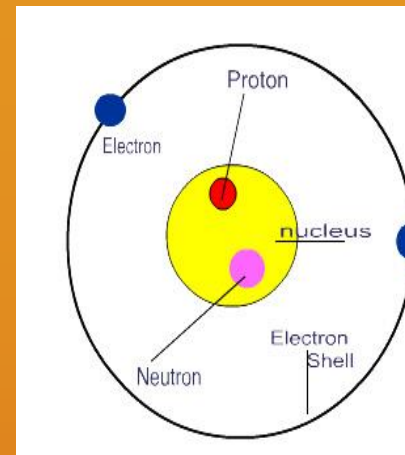
- Particle arrangement.
- Energy of particles.
- Distance between particles.

Phases of Matter....

- matter is made up of atoms.
- The atoms move because of forces acting between them.
- The phases of matter are determined by the arrangement of atoms.

Atoms

- The building blocks of matter.
- Consist of protons(+),neutrons(n), and electrons(-).
- Eg.-Hydrogen atom,Carbon atom.

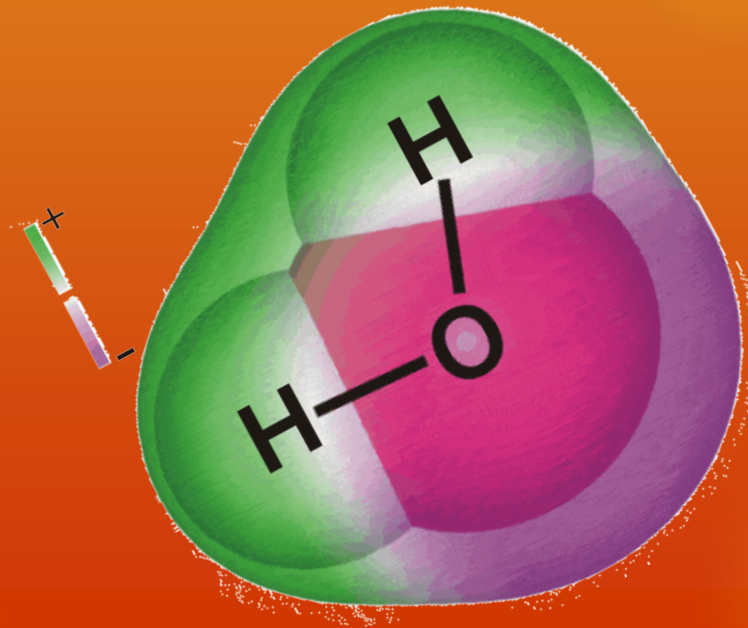


Elements

- Consist of only one kind of atom.
- Cannot be broken down into simpler type of matter by either physical or chemical means.
- Can exist as either atoms or molecules.

Molecules

- ❑ A molecule consists of 2 or more atoms of the same or different elements that are chemically bound together.
- ❑ Eg.-(1) Two oxygen atoms make one oxygen molecule.
(2) Two hydrogen atoms & one oxygen atom make one water molecule



What kind of forces hold the atoms together..??

➤ Interatomic Forces..

Inter=between

Interatomic=between atoms

What kind of forces hold the molecule together..??

➤ Intermolecular Forces..

The maximum distance upto which a molecule can attract some other molecule is known as the range of inter molecular force.

What determines if a substance is solid, liquid or gas...??

Intermolecular Forces

- ❑ Solids-The intermolecular attractive forces are strong enough to lock molecules in place.(high order)
- ❑ Liquids-The Intermolecular Forces are strong enough to hold the molecules close together but without much order.
- ❑ Gases-The Intermolecular Forces are much less(negligible)to hold the molecules together at all.

Types of intermolecular forces of attraction...

COHESION:

- ❖ Force of attraction between molecule of the same substance. Also called Cohesive Force.
- ❖ Maximum in solids, lesser in liquids and least in gases.
- ❖ For this reason solids have a definite shape and resist all deforming forces.

Eg.-Dip clean glass rod in mercury and remove it. Mercury does not stick to the glass rod

ADHESION:

- ❖ Forces of attraction between molecules of different substances. Also called Adhesive Force.

Eg.-Sticking of glue to the wood, paint to wall, chalk particles to black-board, water into the container.

What do you see in the following figures...??



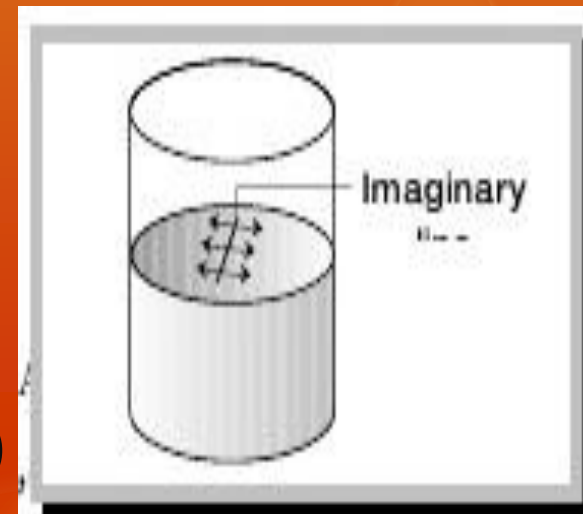
Why and How does this happen???

The property of a liquid by virtue of which, it behaves like an elastic stretched membrane with a tendency to contract, so as to occupy minimum surface area is called..... Surface Tension.

How can we measure it..??

Surface Tension of a liquid can be measured as the force per unit length on an imaginary line drawn on the liquid surface, which acts perpendicular to the line on its either side at every point and tangentially to the liquid surface.

Surface Tension = F/ℓ dyne/cm (C.G.S)
newton/m (S.I.)



Illustrations of Surface Tension..

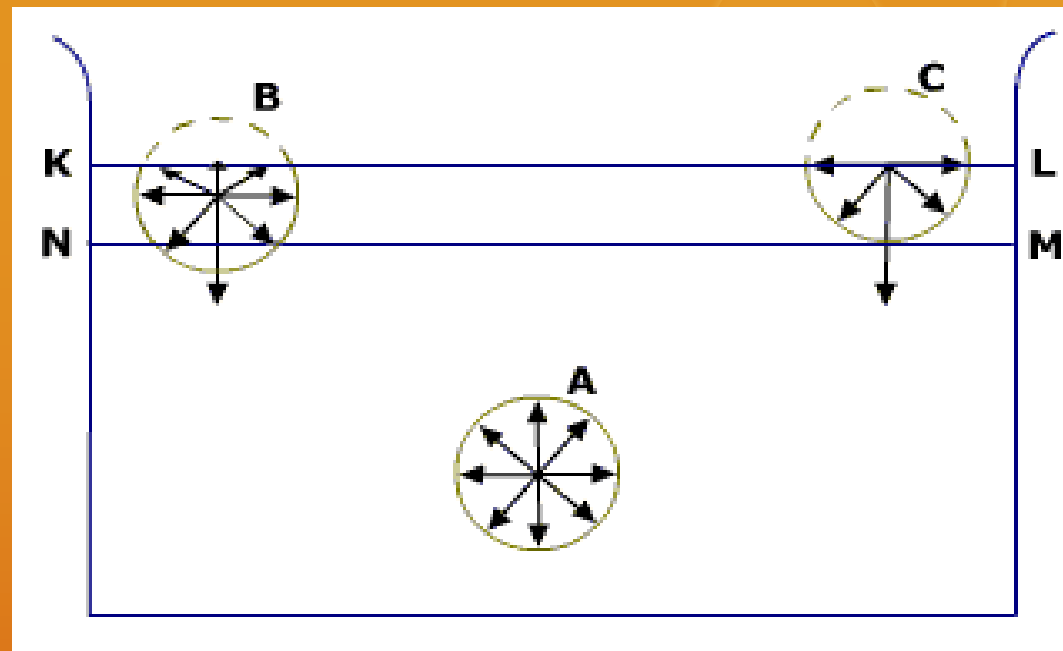
- Oil spreads on water but water remains as drops on oily surface.
- Rain drops are spherical
- Hot soup tastes better than cold soup.
- Antiseptics used for cuts and wounds have low surface tension.
- Its easier to wash clothes in hot water soap solution.

Molecular Theory of Surface Tension

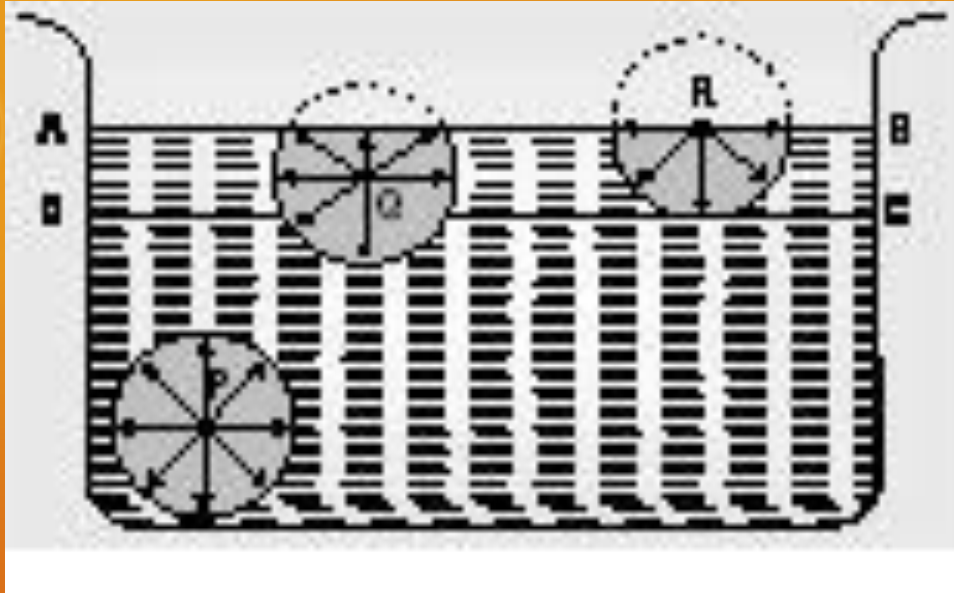
Some Basic Points:-

- On an average, molecules are separated by a distance of the order of 10^{-10} m and exert a force of attraction of the order of 10^{-11} N on each-other.
- The force of attraction between the molecules is due to electrical interaction between the charges. Molecular forces do not obey Inverse Square Law.
- Molecular Forces are short range forces.
- Maximum distance up to which a molecule can attract other molecules is known as Range of Intermolecular Forces.
- A sphere of radius equal to the range of molecular force about a given molecule as centre is called its Sphere of Influence.
- A thin film of liquid near its surface and having thickness equal to the molecular range for that liquid is called Surface Film.
- It is the surface film which is responsible for the phenomenon of surface tension.

Consider the adjoining figure



- 1) Liquids, according to molecular theory, are made up of molecules.
- 2) KLMN represents a surface film of thickness LM; which is equal to molecular range.
- 3) Consider 3 molecules-A, B & C at different positions.
- 4) Circle represents sphere of influence.
- 5) Molecule A experiences force of attraction equally in all directions.
- 6) So, net force acting on A is 0.
- 7) Unlike A, molecule B experiences a net pull downward.
- 8) Molecule C experiences greater, downward pull.
- 9) Downward pull experienced by molecules B & C is called the force of Cohesion.

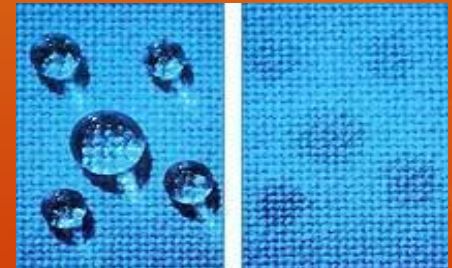


10) Work done against this force of cohesion is stored as Potential Energy.

11) For stable equilibrium, surface film should have minimum P.E., due to which film contracts and acts like a stretched membrane

Detergents & Surface Tension

- Process of thinly spreading a liquid on a surface is called Spraying.
- When pure water is sprayed on a surface, it may stay there as droplets and may not spread on it.
- This happens on account of Surface Tension of water.
- Addition of soap/detergent lowers surface tension of water and it spreads on surface.
- Secondly, molecules of detergents are like hair pins in shape.
- When detergent added to water, heads of hair pin shaped molecules get attached to water molecules and pointed ends to dirt/grease molecules.
- Water-grease/dirt inter faces are formed.
- On rinsing, dirt is washed away by running water.
- Thus, detergents reduce surface tension of water and increase its wetting power.



Assignment

(Short answer questions)

Give reasons/Explain the following :-

- Oil is poured to calm sea waves
- Hot soup tastes better than cold soup
- Antiseptics used for cuts and wounds have low surface tension
- Why are rain drops spherical ?
- What is the effect of temperature on surface tension of a liquid?
- Paints and lubricating oils have low surface tension
- It is easier to spray water to which some soap is added
- End of glass tube becomes round on heating
- It is not possible to separate two pieces of paper joined by glue
- It is easier to wash clothes in hot water than cold water

Contd.....

- Why a small drop of mercury is spherical but bigger drops are oval in shape ?
- We wet the end of the thread before passing it through the eye of the needle. Why ?
- A small boat with wax sticking to its end, when placed on water starts moving. Why ?
- Small insects/needle/paper clip can move/float on surface of still water

END OF CHAPTER 1