

Chapter 4

LIQUIDS AND SOLIDS

SHORT QUESTION WITH ANSWERS

Q.1 what is difference between

- (i) Intermolecular forces and intermolecular forces
- (ii) Polar molecules and non-polar molecules
- (iii) Induce and dipole and instantaneous dipole
- (iv) Dipole

Ans. (i) Intermolecular Forces:

The forces of attraction between two different atoms ions and molecules are **called intermolecular** forces.

For example $\text{H}-\text{Cl}\cdots\cdots\text{H}-\text{Cl}\cdots\cdots\text{H}-\text{Cl}$

Intermolecular Forces:

The forces of attraction between two atoms or group of atoms present with in the same molecule, **are called intermolecular forces**. e.g covalent bond, ionic bond etc

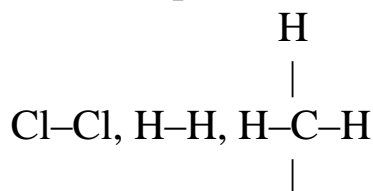
(ii) Polar molecules:

A molecule which has partial +ve and partial -ve charges on it due to difference of electro negativity between bonded atoms **is called polar molecules**. For example $\text{H}^{\delta+} - \text{Cl}^{\delta-}$

Non-polar molecules:

A molecule in which bonded atoms have zero or negligible electro negativity difference **is called non-polar molecules**.

For example



H

Important point to remember: All molecules having same atoms (Homoatomic) are non polar

(iii) Induced Dipole:

A molecule in which polarity is created due to other polar molecule is **called induced dipole**.

Instantaneous Dipole:

The temporary dipole (polarity) produced in a non-polar molecule at a certain instant is **called instantaneous dipole**.

(iv) Dipole

A molecule which has two poles i.e. two charges partial +ve and partial -ve is **known as dipole**. e.g. $\text{H}^{\delta+} - \text{Cl}^{\delta-}$

Q.2 Define intermolecular forces, and the types of intermolecular forces?

Ans. Intermolecular Forces:

The forces of attraction that exist between all kinds of atoms, molecules, when they are sufficiently close to each other **are called** intermolecular forces.

Types of intermolecular forces:

There are four types of intermolecular forces.

- (a) Dipole-dipole forces
- (b) Ion-dipole forces
- (c) Dipole-induced dipole forces (Debye forces)
- (d) Instantaneous dipole-induced dipole forces or (London dispersion forces).

(a) Dipole-dipole forces:

The forces of attraction between the positive end of one polar molecule and the negative end of other polar molecule **are known as dipole-dipole forces**.

Example is of HCl.



(b) Ion-Dipole forces:

The forces of attraction in which the negative ends of polar molecules are attracted towards the cation (+ve ion) and positive ends towards anion (– ion) are called ion–dipole forces. Ionic compounds like Mx are normally soluble in polar solvent like water. Water molecules break the crystal lattice and the ions are set free. These positive and negative ions are then surrounded by water molecules. The negative ends of the dipole of the water are attracted towards the cation (M^+) while the positive ends are attracted towards the anion (X^-). The dissolution of most of the ionic compounds in water is due to this reason. The forces of attraction between ions and water molecules **are known as Ion–dipole forces.**

- (c) The forces of attraction that exist between already polar molecules and the molecule having induced dipole forces. The forces are **also called Debye forces.**
- (d) Instantaneous Dipole–Induced Dipole forces. (**London dispersion forces**).

The momentary forces of attraction that exist between instantaneous dipole and the induced dipole **are called instantaneous dipole–induced dipole forces.**

The momentary force of attraction between instantaneous dipole and the induced dipole **is known as instantaneous–induced dipole forces.**

Q.3 Explain the factors affecting the London forces.

Ans.

The strength of these forces depends upon the following two factors.

1. **Size of electronic cloud:**

As the size of electronic cloud of atoms or molecules increases, dispersion becomes easier and these forces are more permanent.

The elements of zero group are monoatomic gases due to their complete outermost shells, they do not form covalent bonds. Their boiling points increase from top to bottom in a group.

2. **Polarizability:**

The quantitative measurement of the extent to which the electronic cloud can be polarized or distorted is called polarizability.

The boiling points of halogens increase from top to bottom i.e. from fluorine to iodine.

3. **Number of atoms:**

As the number of atoms in non-polar molecule increases polarizability of the molecule increases and London forces become stronger.

The boiling points of saturated hydrocarbons increase as the number of atoms increases.

Q.4 Define and explain hydrogen bonding./ What is the origin of intermolecular forces in water?

Ans. Hydrogen bonding:

“The electrostatic force of attraction between electronegative atom and partial positive hydrogen atom is called hydrogen bonding.”

Explanation:

Consider water molecules to understand hydrogen bonding oxygen is more electronegative than hydrogen. So water is polar molecule. There will be dipole-dipole forces of attraction between water molecules. The electrostatic force of attraction between electronegative oxygen of one molecule and partial positive hydrogen of other molecule is called hydrogen bonding.

Strength of H-Bonding:

Hydrogen bonding is stronger than simple dipole-dipole forces. This is due to the following reasons.

1. There are two lone pairs on oxygen atom. Oxygen forms coordinate covalent bond with hydrogen.

2. There is sufficient partial positive charge on hydrogen. Both positively charged hydrogen of water molecules produce strong electric field due to their small size.

Hydrogen bonding in water molecules acts like a bridge between two electronegative oxygen atoms.

Generally, the strength of H-bonding is twenty times less than that of covalent bond.

Q.5 Give the properties of compounds containing hydrogen bonding.

Ans.

1. There are dynamic properties of covalent compounds.
2. Solubility of Hydrogen bonded molecules.
3. Cleansing action.
4. Application of hydrogen bonding in biological compounds.
5. Surface tension.
6. Effect of hydrogen bonding on viscosity.
7. Hydrogen bonding in paints and dyes.
8. Clothing.
9. Food material.
10. Structure of ice.

Q.6 Explain the following with reasons.

- (a) In the hydrogen bonded structure of H-F, which is stronger bond, the shorter covalent bond or the longer hydrogen between different molecules?
- (b) In a very cold winter fish in garden ponds owe their lives to hydrogen bonding.
- (c) Water and ethanol can mix easily and in all proportions.

Ans.

- (a) There is sufficient hydrogen bonding in H-F molecules and it gives zig zag structure. Fluorine atom is present at the end while H atoms are entrapped between two strong electronegative atoms. The covalent bond between H and F is stronger because it is

produced by the overlapping of orbital's and two electrons have been shared to give sigma bond.

The bond which is shown by the dotted line is the hydrogen bond due to electrostatic forces of attraction so, it is a weaker bond.

- (b) When water is frozen at 0°C, then it expands. This is due to the fact that due to H-bonding in ice the molecules become arranged density of ice is decreased. That's why ice floats on water.
- (c) Water (H-OH) and ethanol (C₂H₅OH) have both are polar solvents and having OH groups. So, they can do the hydrogen bonding extensively. That is they can mix with each other in all proportions.

Q.7 Why H₂S is a gas while H₂O is liquid at room temperature?

Ans:

This is due to high electro negativity of oxygen as compared to sulphur. Water has hydrogen bonding, but H₂S does not have. Due to absence of hydrogen bonding in H₂S at room temperature, it is a gas.

Q.8 Earthen ware vessels keep water cool?

Ans:

Earthen ware vessels are porous- water molecules come out from these pores and evaporate. Heat of the atmosphere can not enter into the liquid. So temperature of the liquid in earthenware's remains less.

Q.9 one feels sense of cooling under the fan after bath?

Ans:

When one takes bath and sits in front of a fan, water on the surface of body evaporates with greater rate. The high energy molecules escape from surface of the body and one feels sense of cooling.

Q.10 Why the heat of vapourization of water is greater than that of CH₄?

Ans:

Water is a polar liquid and due to strong hydrogen bonding high energy is required to separate the molecules from each other at its boiling point. CH₄ is a non-polar and has weak London dispersion forces.

Q.11 Define and explain evaporation is a cooling process. Give reason.

Ans. Evaporation: The spontaneous change of liquid into its vapours is called evaporation. It continues at all temperature. Evaporation increases with the increase of temperature.

Explanation: The molecules of liquid are not motionless. The energy of the molecules is not equally distributed. The molecules which have low kinetic energy move slowly while others with high kinetic energy move faster. If one of the higher speed molecules reaches the surface, it may escape the attractions of its neighboring molecules and leaves the bulk of the liquid. This spontaneous change of liquid into its vapours is called **evaporation**

Evaporation causes cooling:

The reason is that when high energy molecules leave the liquid and low energy molecules are left

behind, the temperature of the liquid falls and heat moves from the surrounding to the liquid and

the temperature of the surrounding also falls. So evaporation is a cooling process.

Q.12 H-bonding is present in chloroform and acetone-justify it?

Ans:

Chloroform is a polar compound. Acetone is also a polar compound. When chloroform and acetone are mixed with each other, than they create the forces of attractions due to hydrogen bonding.

Q.13 Evaporation of a liquid takes place at all temperatures give reason?

Ans:

Evaporation takes place due to the K.E of the molecules since the K.E of the molecules can not be zero at any temperature therefore evaporation takes place at all temperatures.

Q.14 What are the factors that affect the rate of evaporation?

Ans.

1. Surface Area:

Evaporation takes place from liquid surface. If area of the surface of liquid increases the rate of evaporation will also increase.

2. Temperature:

Temperature also affects rate of evaporation Higher the temperature faster will be the rate of evaporation.

3. Intermolecular forces:

Stronger the intermolecular attractive forces slower is the value of evaporation and vice versa.

Q.15 Define and explain the vapour pressure.

Ans. Vapour Pressure:

The pressure exerted by the vapours on the surface of liquid at equilibrium state at a given temperature is called vapour pressure.

Explanation:

Consider a liquid closed in container at a certain temperature. High energy molecules leave the surface of liquid and gather above the surface in the empty space in the form of vapours. These molecules collide with the walls of container as well as with the surface of liquid. In this way they lose some their kinetic energy and there is a chance that these molecules are recaptured by the liquid surface. This process is known as condensation. Both the process i.e. condensation and evaporation continue, till rates of both processes become equal. This state is called dynamic equilibrium, and the pressure exerted by the vapours at this state on the liquid surface at particular temperature is called vapour pressure. Vapour pressure does not depend upon amount or volume of liquid and surface area.

Q.16 What are the factors affecting vapour pressure.

Ans.

1. Nature of liquid
2. Strength of intermolecular forces
3. Size of molecules
4. Temperature.

Q.17 Define boiling point.

Ans.

The temperature at which the vapour pressure of liquid becomes equal to the external atmospheric pressure is called boiling point of liquid.

Q.18 Give variation of vapour pressure and boiling point.

Ans.

Vapour pressure is closely related to boiling point. Variation in vapour pressure depends upon the following factors.

1. **Temperature:**

vapour pressure of a liquid increases by increasing temperature. Higher the temperature more will be the vapour pressure and vice versa. Liquids boil at that temperature when their vapour pressures are equal to 760 torr at sea level. By increasing external pressure boiling point can be increased.

2. **Strength of intermolecular forces:**

Stronger the intermolecular forces lower will be vapour pressure and higher will be the boiling point.

Q.19 What is the effect of external pressure on boiling point?

Ans.

A liquid boils when its internal pressure becomes equal to external atmospheric pressure so, by changing external pressure, a liquid can be boiled at any temperature. If external pressure is greater, the liquid needs more heat to equalize the internal pressure to external atmospheric pressure. Similarly if external pressure is lower, liquid needs less amount of heat to equalize its vapour pressure, the external pressure. under 700 torr (at Murree hills) water boils at 98°C.

Q.20 Why boiling point of water is 98⁰C at Murree?

Ans:

At high altitudes the atmospheric pressure becomes low therefore B.P of water at Murree is 98⁰C.

Q.21 Why boiling point of water is 120⁰C at 1489 torr why?

Ans:

The normal B.P of H₂O is 100⁰C at 760 torr since B.P increases by increasing pressure therefore B.P of H₂O is 120⁰C at 1489 torr.

Q.22 Why the boiling points of the hydrides of second period in group IV-A,V-A,VI-A and VII-A are greater than the B.P of hydrides of third period?

Ans:

The elements of second period are more electronegative than the respective element third period. So, the polarities of the bonds with hydrogen are greater than the third period elements.



Q.23 Define molar heat of vapourization?

Ans:

The amount of heat required to vapourize one mole of liquid at its boiling point is called molar heat of vapourization.

Q.24 What is vacuum distillation? Explain.

Ans. Definition:

The process in which liquid is heated under reduced pressure, to convert it into its vapours at low temperature and then to condense these vapours into liquid is known as vacuum distillation.

Explanation:

In vacuum distillation boiling point of liquid decreases by reducing the pressure. This is done by connecting the distillation apparatus to the vacuum pump. In this way liquids with high boiling points can be boiled at low temperature.

Q.25 Define enthalpy change.

Ans.

If physical or chemical change occurs at constant pressure then it is known as enthalpy change.

Q.26 What are types of enthalpy changes?

Ans.

There are three types of enthalpy changes.

1. **Molar Heat of Fusion (ΔH_f):**

The amount of heat absorbed by one mole of a solid to melt it into liquids at its melting point at atmospheric pressure is called molar heat of fusion. It is denoted by ΔH_f .

2. **Molar Heat of vapourization (ΔH_v):**

The amount of heat absorbed by one mole of a liquid to convert it into one mole of vapours at its boiling point at 1 atmospheric pressure is called molar heat of vapourization. It is denoted by ΔH_v .

3. **Molar Heat of sublimation (ΔH_s):**

The amount of heat absorbed by one mole of a solid to convert it directly into one mole of its vapours at particular temperature at 1 atmospheric pressure is called molar heat of sublimation. It is denoted by ΔH_s .

Q.27 What are liquid crystals? Give their types.

Ans.

The molecules which are large somewhat rigid and linear having some of structures of solids showing optical properties and some of the freedom of motion of liquids are called liquid crystals.

Types of liquid crystals:

- (a) Smectic liquid crystals.
- (b) Nematic liquid crystals.
- (c) Cholesteric liquid crystals.

Q.28 What are solids?

Ans.

Solids are those substances which are rigid, hard, have definite shape and definite volume. The atoms, ions, and molecules, that

make up a solid are close packed. They are held together by strong cohesive forces.

Q.29 Crystals have their own habits justify it?

Ans:

The shape of a crystal in which it usually grows called habit of a crystal. The shape of the crystal remains same if its conditions remain same. For example When 10% urea is added in NaCl then needle like crystals are formed instead of cubic crystals

Q.30 Justify that solids are rigid?

Ans:

The solids are very rigid. This rigidity is due to the fixed positions of the particles. The presence of strong cohesive forces makes particles unable to change their positions. This rigidity of solids can be changed under stress

Q.31 Give types of solids?

Ans.

There are two types of solids:

- (i) Crystalline solids
- (ii) Amorphous solids

Crystalline solids:

Those solids in which atoms, ions or molecules are arranged to a definite three dimensional pattern, are called crystalline solids.

Amorphous solids:

Those solids whose constituent atoms, ions or molecules do not possess a regular orderly arrangement are called amorphous solids. The best examples are glass, plaster and rubber, glue, etc.

Q.32 Define the following:

- (i) Cleavage planes.
- (ii) Anisotropy
- (iii) Symmetry
- (iv) Habit of a crystal

Ans.

- (i) **Cleavage planes:**

whenever the crystalline solids are broken they do so along definite planes. These planes are called the cleavage planes.

(ii) **Anisotropy:**

Some of the crystals show variation in physical properties depending upon the direction; such properties are called anisotropic properties and the phenomenon is called anisotropy.

(iii) **Symmetry:**

The repetition of faces angles or edges when a crystal is rotated by 360° along its axis is called symmetry.

(v) **Habit of a crystal:**

The shape of a crystal in which it usually grows is called habit of crystal.

Q.32 Define the following:

(i) **Isomorphism**

(ii) **Polymorphism**

(iii) **Allotropy**

(iv) **Transition temperature**

(v) **Crystal lattice**

(vi) **Unit cell**

Ans.

(i) **Isomorphism:**

Isomorphism is the phenomenon in which two different substances exist in the same crystalline form. These different substances are called isomorphs of each other.

Examples of isomorphs are NaNO_3 , CaCO_3 , K_2SO_4 , K_2CrO_4 .

(ii) **Polymorphism:**

Polymorphism is a phenomenon in which a substance exists in more than one crystalline forms. The substance which exists in more than one crystalline forms is called polymorphic, and these forms are called polymorphs of each other. Polymorphs have same chemical properties but they differ in the physical properties. AgNO_3 , CaCO_3 are polymorphs.

(iii) **Allotropy:**

The existence of an element in more than one crystalline form is known as allotropy and these forms of the element are called allotropes or allotropic forms.

Element	Crystalline forms
Carbon	Cubic (Diamond)

Hexagonal (Graphite).

(iv) **Transition Temperature:**

It is that temperature at which two crystalline forms of the same substance can coexist in equilibrium with each other. At this temperature one crystalline form of substance changes to one another. 95.50

Sulphur S₈ (rhombic) sulphur S₈ (monoclinic)

(v) **Crystal lattice:**

A crystal lattice is defined as an array of points representing atoms, ions or molecules of a crystal arranged at different sites in three dimensional space.

(vi) **Unit cell:**

The smallest part of crystal lattice has all the characteristic features of the entire crystal is called unit cell.

The simplest unit cell is a cubic unit cell.

Q.33 Name the crystal systems.

Ans. (Cu T Or T He Mo Tri)

1. Cubic system
2. Tetragonal system
3. Orthorhombic or Rhombic system
4. Monoclinic system
5. Hexagonal system
6. Trigonal system
7. Triclinic system

Q.34 Define lattice energy.

Ans.

The energy released when one mole of the ionic crystal is formed from the gaseous ions. It is also defined as the energy required to break one mole of solid into isolated ions in the gas phase. It is expressed in kJ mol^{-1} .



or



Q.35 Describe the types of crystalline solids.

Ans.

There are four types of crystalline solids, depending upon the type of bond present in them.

1. Ionic solids.
2. Covalent solids.
3. Metallic solids.
4. Molecular solids.

1. **Ionic Solids:**

Crystalline solids in which the particles forming the crystals are positively and negatively charged ions are called ionic solids. These ions are held together by strong electrostatic forces of attraction. These attractive forces are also called **ionic bonds**. The crystals of NaCl, KBr etc. are ionic solids.

2. **Covalent solids:**

The crystalline solids in which atoms of similar or different elements are held together by covalent bonds are known as **covalent solids**. They are also called atomic solids.

There are two types of covalent solids.

Type 1:

When covalent bonds give joint molecules like diamond, silicon carbide or Aluminum nitride.

Type 2:

When atoms join to form the covalent bonds and separate layers are produced like that of graphite, cadmium iodide and boron nitride.

3. **Molecular solids:**

The solid substance in which the particles forming the crystals are polar or non-polar molecules or atoms, are called molecular solids. In solidified noble gases, there are non-polar atoms. Two types of intermolecular forces hold them together.

1. Dipole-dipole interactions
2. Vander Waal's forces

These intermolecular forces are much weaker than the forces of attraction between the cations and the anions in ionic crystals and between the atoms in the covalent crystals. Ice and the sugar are the best example of crystals having polar molecules, whereas iodine sulphur and carbon dioxide form crystals containing non-polar molecules.

4. **Metallic solids:**

The crystalline solids in which the metal atoms are held together by metallic bonds are known as metallic solids.

Metallic Bond:

The force of attraction that binds positive metal ion to the number of electrons within its sphere of influence is called **metallic bond**.

Theories of metallic bond:

1. Electron gas theory
2. Valence bond theory
3. Molecular orbital theory

Q.36 Iodine dissolves readily in tetrachloromethane. Give reason.

Ans.

We know that "like dissolve like". Iodine is a non-polar substance. So it becomes solvable in non-polar solvent CCl_4 .

Q.37 Justify molecular solids are soft and compressible?

Ans:

The forces which hold the molecules together in molecular structure are weak so, they are soft and compressible

Q.38 What is crystallite?

Ans:

The small regions in amorphous solids where particles have a regular arrangement are called crystallites.

Q.39 Why diamond is bad conductor of electricity?

Ans:

In diamond each carbon is SP^3 hybridized there is no free electron to conduct electricity therefore it is bad conductor.

Q.40 Why metals have shiny surface?

Ans:

When light falls on the surface of metals then the electrons are excited after de-excitation they emit energy in the form of light therefore they show shiny surface.

Q.41 Why Na is soft while Cu is hard?

Ans:

In sodium only one mobile electron is present while in copper two mobile electrons are present due to strong metallic bond in copper it is hard.

Q.42 Why ionic crystals are brittle?

Ans:

Because ionic solids are composed of parallel layers which contain cations & anions in alternate positions, so that the opposite ions in the various parallel layers lie over each other. When an external force is applied one layer of the ions slide pass over other layer. In this way due to repulsion of similar ions the crystals show brittleness.

Q.43 Electrical conductivity of metals decreases by increasing temperature?

Ans:

With the increases in temperature the positive ions of metals also vibrate which hinders the motion of mobile electrons due to this hindrance electrical conductivity also decreases.

Q.44 What is coordination no. of an ion? What is the coordination no of the cation in (a)NaCl, and(b)CsCl?

Ans:

The no. of positive ions which surround the anion called coordination no. of anion (a) Coordination no. Na in NaCl is 6 (b) Coordination no of Cs in CsCl is 8 (due to the greater size of Cs)

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