Chapter: 04

Liquids and solids

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Objective

1. London dispersion forces are the only forces present among them:
   - (A) Atoms of helium in gaseous state at high T
   - (B) Molecules of hydrogen chloride gas
   - **(C) Molecules of solid iodine**
   - (D) Molecules of water in liquid state

2. Amorphous solids:
   - (A) Have perfect arrangement of atoms
   - (B) Undergo clean cleavage when cut with knife.
   - (C) Have sharp points.
   - **(D) Can possess small regions of orderly arrangement of atoms.**

3. Dipole-dipole interaction are present in the:
   - (A) Molecules of NH_3
   - (B) Atoms of the He gas
   - (C) Molecules of solid iodine
   - **(D) Molecules of CCl_4**

4. The structure of NaCl crystal is:
   - (A) Octahedral
   - (B) Square planar
   - **(C) Face centered cubic lattice**
   - (D) Body centered cubic lattice

5. Which of the following liquid has highest boiling point:
   - (A) Br_2
   - **(B) H_2O**
   - (C) HBr
   - (D) HCl

6. The strongest acid among Halogen acids is:
   - (A) HF
   - (B) Hl
   - (C) HBr
   - **(D) HCl**

7. Which of the hydrogen halides has the highest percentage of ionic character?
   - **(A) HF**
   - (B) HBr
   - (C) Hl
   - (D) HCl

8. H-bonding is maximum:
   - (A) Diethyl ether
   - (B) Benzene
   - **(C) Water**
   - (D) Ethanol

9. Density of ice is maximum at 4 ^{0}C due to:
   - (A) Lager bond lengths
   - (B) Oxidation potential
   - **(C) Empty spaces in structure of ice**
   - (D) Cell voltage

10. Acetone and chloroform are soluble in each other due to:
    - (A) Ion dipole forces
    - (B) Instantaneous dipoles
    - (C) Dipole-dipole interaction
    - **(D) Intermolecular hydrogen bonding**

11. When water freezes at 0^{0}C, its density decreases due to:
    - **(A) Empty spaces present in the structure of ice**
    - (B) Change of bond length
    - (C) Change of bond angles
    - (D) Cubic structure of ice

12. The repulsions of electronic clouds of molecules are responsible for the attractive forces among the molecules. These forces are:
    - (A) Ion-dipole forces
    - **(B) Instantaneous dipole-induced dipole force**
    - (C) Dipole-induced dipole forces
    - (D) Dipole-dipole forces

13. Which of the given has hydrogen bonding:
    - **(A) NH_3**
    - (B) NaCl
    - (C) CCl_4
    - (D) CH_3

14. The force which are present between the ions and the polar molecular of the solvent are:

(A) Dipole-dipole forces
(B) Dipole-induced dipole forces
(C) London dispersion forces
(D) Ion-dipole forces

15. Hydrogen bonding is extensively present in proteins between:

(A) Carbon and hydrogen atoms
(B) Nitrogen and hydrogen atoms
(C) Oxygen and hydrogen atoms
(D) Nitrogen and oxygen

16. Ice floats on water because:

(A) Not empty spaces in ice
(B) Empty spaces are present in ice
(C) Ice has two-dimensional structure
(D) The hydrogen bonding in ice is stronger

17. The long chains of amino acids are coiled about one another into a spiral by:

(A) Van der Waal's forces
(B) Overlapping of orbitals
(C) Ionic bond
(D) Hydrogen bonding

18. The weakest intermolecular forces present in a liquid may be:

(A) Dipole-dipole forces
(B) Electrostatic forces between ions in ionic
(C) London Dispersion forces
(D) Dipole-induced dipole force

19. Which of the following has strongest hydrogen bonding?

(A) HF (B) HC (C) NH_3 (D) CH_4

20. Van-der Waal's forces are weak intermolecular forces, they include:

(A) Ion-Dipole forces only
(B) All of the these
(C) Dipole-induced dipole forces only
(D) Dipole-Dipole forces only

21. The London forces becomes stronger if:

(A) Density of molecules is large
(B) Molecules are homo atomic
(C) Number of atoms in a molecule are large
(D) Size of atom is smaller

22. Which of the following forces exist in noble gases?

(A) Dipole-induced Dipole forces
(B) Hydrogen bonding
(C) Dipole-dipole forces
(D) London dispersion

23. Which of the following is not a type of liquid crystal?

(A) Smectic **(B) Enteric** (C) Nematic (D) Cholesteric

24. Liquid crystals are used to find the point of ..... in electrical circuits.

(A) Potential failure
(B) Both A & D
(C) None
(D) Potential difference

25. Liquid crystals can diffract .....

(A) Heat (B) Both A & D (C) None **(D) Light**

26. In chromatography liquid crystal are used as .....

(A) Solvent (B) Substrate (C) Solute (D) None of these

27. The transition temperature of KNO_3 is:

(A) 32.02 ^{0}C (B) 95.5 ^{0}C (C) 13.2 ^{0}C **(D) 128 ^{0}C**

28. The solid which has no definite crystalline shape:

(A) Dry ice **(B) Glass** (C) Salt (D) Sugar

29. Isomorphism is present in K_2SO_4 and K_2CrO_4. These two compounds:

Ⓐ 100% equal ionic Character.
Ⓑ Have difference ration of the atoms in them.
Ⓒ Show same physical and chemical properties.
Ⓓ The shapes of both SO_4^{2-} and CrO_4^{2-}.

30. The allotropes are those solids, which have:

Ⓐ Same physical & chemical properties
Ⓑ Same chemical properties
Ⓒ Same physical but different chemical properties
Ⓓ Same physical properties

31. Which of the following substances is amorphous in nature?

Ⓐ Graphite Ⓑ KCl Ⓒ Sugar **Ⓓ Plastic**

32. Plastics are amorphous solids and:

Ⓐ Possess orderly arrangement over long distances
Ⓑ Do not undergo clean cleavage
Ⓒ Undergo clean cleavage when cut with knife
Ⓓ Have sharp melting point

33. Which among the following will show anisotropy:

Ⓐ Paper Ⓑ Glass Ⓒ Wood **Ⓓ $BaCl_2$**

34. The existence of an element in more than one form is called:

Ⓐ Symmetry Ⓑ Polymorphism **Ⓒ Allotropy** Ⓓ Isomorphism

35. Variation of a physical property in a crystal in different directions is called:

Ⓐ Anisotropy Ⓑ Absence of symmetry Ⓒ Isomorphism Ⓓ Polymorphism

36. The crystals of Na_2SO_4 and Na_2SeO_4 should be:

Ⓐ Isomorphs and allotropes of each other
Ⓑ Isomorphs of each other
Ⓒ Polymorphs of each other
Ⓓ Allotropes

37. The pure crystalline substance on heating becomes turbid liquid. On further heating turbidity disappears. The substance is:

Ⓐ Isomeric crystal
Ⓑ Isomorphic crystal
Ⓒ Liquid crystal
Ⓓ Allotropic crystal

38. The crystals which show different physical properties from different directions is called:

Ⓐ Anisotropy Ⓑ Habit of crystal Ⓒ Polymorphism Ⓓ Symmetry

39. Crystals can be classified into:

Ⓐ 3 crystal system
Ⓑ 14 crystal systems
Ⓒ 4 crystal systems
Ⓓ 7 crystal systems

40. Most crystals show good cleavage because their atoms , ions and molecules are:

Ⓐ Strongly bounded together
Ⓑ Weakly bounded together
Ⓒ Arranged in planes
Ⓓ Spherically symmetrical

41. The number of Cl^- ions per unit cell of NaCl are:

Ⓐ 4 Ⓑ 6 Ⓒ 8 Ⓓ 2

42. The Cl^- ions present at the corner of the unit cell and NaCl crystal , contributes:

Ⓐ $\frac{1}{2}$th
Ⓑ $\frac{1}{8}$th
Ⓒ $\frac{1}{4}$th
Ⓓ 1

43. NaCl has face centered cubic structure. The Na^+ ion at the faces of the unit cell is shared by:

Ⓐ Only one unit cell Ⓑ 2 unit cells Ⓒ 4 unit cells Ⓓ 8 unit cells

44. The number of Na^+ ions which surround each Cl ion in the NaCl crystal lattice is:

Ⓐ 12 Ⓑ 6 Ⓒ 8 Ⓓ 4

45. Transition temperature of S_8 (monoclinic) $\rightleftharpoons$ S_8 (Rhombic) is:

Ⓐ 95.5 ^{0}C Ⓑ 128 ^{0}C Ⓒ 110 ^{0}C Ⓓ 13.2 ^{0}C

46. Which of the following metals shows hexagonal geometry?

Ⓐ Zn Ⓑ Na Ⓒ Ag Ⓓ Cu

47. Graphite belongs to the crystal system?

Ⓐ Hexagonal Ⓑ Cubic Ⓒ Tetragonal Ⓓ Monoclinic

48. Which of the following crystal systems represent the structure of sugar:

Ⓐ Tetragonal Ⓑ Cubic Ⓒ Triclinic Ⓓ Monoclinic

49. Which crystal system is found in $AgNO_3$?

Ⓐ Cubic and orthorhombic Ⓑ Monoclinic and hexagonal
Ⓒ Cubic and tetragonal Ⓓ Orthorhombic and rhombohedral

50. London dispersion forces are the only forces present among them:

Ⓐ Atoms of helium in gaseous state at high Ⓑ Molecules of hydrogen chloride gas
Ⓒ Molecules of water in liquid state Ⓓ Molecules of solid iodine

51. Acetone and chloroform are soluble in each other due to:

Ⓐ Instantaneous dipole Ⓑ All of the above
Ⓒ Intermolecular hydrogen bonding Ⓓ Ion-dipole interaction

52. NH, shows a maximum boiling point among the hydrides of V_{th} group elements due to:

Ⓐ Enhanced electronegative character of nitrogen Ⓑ Oxidation potential
Ⓒ lone pair of electrons present on nitrogen Ⓓ Pyramidal structure of NH_3

53. Dipole-induced dipole forces are also called:

Ⓐ Debye Forces Ⓑ Hydrogen bounding
Ⓒ Huckel Forces Ⓓ London Dispersion Forces

54. Polarizability is responsible for the intermolecular forces and it:

Ⓐ Almost remains the same Ⓑ Decrease down the group
Ⓒ Increases along a period Ⓓ Increases down the group

55. The order of acidic strength:

Ⓐ HBr>HF>HI>HCI Ⓑ HCI>HF>H>HBr
Ⓒ HF > HCI> HBr>HI Ⓓ HI>HBr> HCI> HF

56. Which one of the following is an example of cubic system?

Ⓐ lodine Ⓑ Graphite Ⓒ Borax Ⓓ Diamond

57. The angle between sides 'b' and 'c' is:

Ⓐ Alpha Ⓑ Theta Ⓒ Gamma Ⓓ Beta

58. Density of ice is minimum at 4°C due to:

Ⓐ Empty spaces in structure of ice Ⓑ Large bond lengths

Ⓒ Tetrahedral shape of crystal of Ⓓ Large bond angles

59. A-ring has 6.0 g of diamond in it. Calculate the number of atoms of Carbon in it:

Ⓐ 1.8×10^{24} Ⓑ 9.03×10^{23} Ⓒ 6.02×10^{3} **Ⓓ 3.01×10^{23}**

60. Liquid hydrocarbon is:

Ⓐ Hexane Ⓑ Ethane Ⓒ Propane Ⓓ Methane

Fill in the blanks

Q1: The polarizability of noble gases ……. down the group and results in the increase in their boiling points.

Q2: ……. is developed in acetone and chloroform when they are mixed together.

Q3: The concept of dynamic equilibrium is the ultimate …… of all reversible systems.

Q4: $\triangle H_v$ of C_6H_{14} should be …… than that of C_2H_6.

Q5: The concept of dynamic equilibrium is the ultimate …… of all reversible systems.

Q6: During the formation of ice from liquid water there is a …… % increase in volume.

Q7: A layer of ice on the surface of water ……. the water underneath for further heat loss.

Answers

1. **Increases**	2. **H-bounding**	3. **Acidic strength**
4. **Greater**	5. **Result / goal**	6. **9**
7. **Insulates or prevents**		

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Subjective

Q1: **Intermolecular forces are weaker than interamolecular forces why?**

Ans: The force present among the atoms of a molecule is called intermolecular forces. These are true chemical bonds while the forces of attraction present among particle of a substance that close them together. These are weak attractions as compare with intermolecular forces.

Q2: **What are London Dispersion forces?**

Ans: The momentary forces of attraction created between instantaneous dipole and the induced dipole is called dipole- induced dipole interaction or London force. It is very short lived attraction because the electrons keep moving. This movement of electrons causes the dipole to vanish as quickly as they are formed.

Q3: **Write down two applications of hydrogen bonding?**

Ans: Applications of hydrogen bonding:

- Helical structure of proteins is stable due to hydrogen bonding.
- Double helix of DNA molecule is linked together through H-bond.
- Large protein molecules in living organisms are stabilized due to H-bonding.

Q4: **Density of ice is less than liquid water. Explain with reason?**

Ans: In liquid water the molecules are extensively associated with each other due to strong H-bonding. But this association is irregular, when temperature dropped to 0°C. The molecules of water arrange themselves in a regular pattern.
Due to these empty spaces among H_2O molecules increases and hence density of ice decreases.

Q5: **Ice floats on H_2O. Give reason?**

Ans: When the temperature of liquid water decreases the arrangement of molecules also changes. In case of ice hexagonal arrangements of H_2O molecules are formed with large empty spaces than liquid. About 9 % expansions in volume take place. Due to lesser density of ice, it floats over water.

Q6: **Water is liquid at room temperature while H_2S is a gas. Comment?**

Ans: In H_2O strong H-bonding is present which make it liquid. But H_2S have weak intermolecular force. Due to this H_2S is a gas at room temperature.

Q7: **Describe the importance of vacuum distillation?**

Ans: Some compounds decompose at their boiling point. Such compounds are distilled under reduced pressure. In this process, a liquid is made to boil at lower temperature by decreasing pressure, e.g. glycerin.

Q8: **Why HF is weaker acid than HCI?**

Ans: Strength of an acid depends upon the ionization of an acid. Ionization of HF is low because H^+ is entrapped between two fluorine atoms. From one side it is covalently bonded while from other side strong hydrogen bond is present. That's why HF is a weaker acid than HCl.

Q9: **Define dipole-dipole forces with example? Or**

Describe solubility of hydrogen bonded molecules.

Ans: The positive end of the molecule attracts the negative end of the other molecule and these electrostatic forces of attraction are called dipole-dipole forces. The examples of molecules which show dipole- dipole attractions are numerous. Two of these are HCl and $CHCl_3$.

$$H^{+\delta} - Cl^{-\delta} \text{ ..... } H^{+\delta} - Cl^{-\delta} \text{ ..... } H^{+\delta} - Cl^{-\delta}$$
$$Cl_3\ Cl^{+\delta} - H^{+\delta} \text{ ..... } Cl_3\ Cl^{+\delta} - H^{+\delta} \text{ ..... } Cl_3\ Cl^{+\delta} - H^{+\delta}$$

Q10: **What is the role of Hydrogen Bonding in Biological Compounds?**

Ans: Hydrogen bonding exists in the molecules of living system. In proteins like hair, silk and muscles consists of long chains of amino acids due to hydrogen bonding. These long chains are coiled about one another into a spiral. This spiral is called a helix.

Such a helix may either be right handed or left handed. DNA has two spiral chains due to hydrogen bonding these are linked together.

Q11: **Define hydrogen bonding and give one example.**

Ans: Hydrogen bonding is the force of attraction between a highly electronegative atom and partial positively charged hydrogen atom.

The hydrogen bonding present in the molecules of ammonia and those of hydro fluoric acid is the example of hydrogen bonding.

Q12: **Describe cleaning action of soaps and detergents on the basis of H-bonding.**

Ans: Soap and detergents perform the cleansing action because the polar part of their molecules are water soluble due to hydrogen-bonding and the non-polar parts remain outside water, because they are alkyl or benzyl portion and are insoluble in water.

Q13: **What type of intermolecular forces will dominate in the following liquid?**

(a) CH_3COCH_3 (propanone) (b) C_8H_{18} (Octane)

Ans: (a) CH3COCH3 (propanone):

Dipole-dipole forces.

(b) C8H18 (Octane):

Instantaneous dipole-induced dipole forces or London dispersion forces.

Q14: **Define vapour pressure. Write down two factors that effect vapour pressure of a liquid?**

Ans: **Vapour pressure:**

The pressure exerted by vapours in equilibrium with its pure liquid at given temperature is called vapour pressure.

Following factors affect vapour pressure:

- Temperature.
- Intermolecular forces.

Q15: **Why the heat of vapourization of water is greater than that of CH_4?**

Ans: Water has strong intermolecular force in it and more energy is required to break these forces and convert into yapour state. While CH_4 is a non-polar molecule. These molecules are linked together by weak forces so its heat of vaporization is low.

Q16: **Water freezes from surface to downward direction in ponds and lakes. Explain it?**

Ans: Due to H-bonding the density of ice is less than liquid water. In cold climate when temperature falls below 4°C cold water being lighter comes to the surface. That's why H_2O freezing start from surface.

Q17: **Earthenware vessels keep water cool. Explain?**

Ans: Earthenware vessels have small pores. When water is placed on earthenware vessel it evaporates through pores. Due to continuous evaporation of water from the whole surface its temperature decreases.

Q18: **Evaporation causes cooling. Justify it?**

Ans: In a liquid, all the molecules have not same energy. The molecules of high energy come at the surface and escape out As a result; the average energy of remaining molecules decreases and temperature also decreases.

Q19: **Why do we feel cooling affect after taking bath?**

Ans: Under fan, the rate of evaporation of water from the body is increased. Water vapours take heat from body and evaporate. As a result one feel's cooling under fan after bath.

Q20: **Justify that evaporation take place at all temperatures?**

Ans: Evaporation is due to the K.E of molecules of a liquid and K.E is directly related to temperature. Whatever the value of temperature is, the molecules do have some K.E. That's why evaporation takes place at all temperature.

Q21: **What is evaporation? How does it cause cooling?**

Ans: The spontaneous change of a liquid into vapours is called evaporation. The particles present at surface have higher K.E are escape and others have lower in K.E cause cooling.

Q22: **Name the factors which affect the London forces.**

Ans: These factors in which affect in the London forces:

- Number of atoms in a non-polar molecule.
- Size of the electronic.
- Polarizability.

Q23: **What is meant by geometrical shape of solid?**

Ans: All the crystalline solids have a definite, distinctive geometrical shape due to definite and orderly arrangement of atoms, ions or molecules in three-dimensional space. For a given

crystal, the interfacial angles, at which the surfaces intersect, are always the same no matter in which shape they are grown.

The faces and angles remain characteristic even when the material is ground to a fine powder.

Q24: **What is role of hydrogen bonding in paints, dyes, and textile materials?**

Ans: One of the most important properties of paints and dyes is their adhesive action. This property is developed due to hydrogen bonding. Similar type of hydrogen bonding makes glue and honey as sticky substances.

We use cotton, silk or synthetic fibers for clothing. Hydrogen bonding is of vital importance in these thread making materials. This hydrogen bonding is responsible for their rigidity and the tensile strength.

Q25: **Define Evaporation. Name the factors which effect Evaporation.**

Ans: The spontaneous change of a liquid into its vapours is called evaporation and it continues at all temperatures.

There are many factors which control the rate of evaporation of a liquid. Since evaporation occurs from liquid surface, so if surface area is increased then more molecules are able to escape, and liquid evaporates more quickly. It increases on increasing temperature and vice vers. Strength of intermolecular forces also affects the rate of evaporation.

Q26: **Define boiling point?**

Ans: **Boiling point:**

The temperature at which vapour pressure of a liquid become, equal to the atmospheric pressure or external pressure to which it is subjected is called boiling point.

Q27: **Why different liquids possess different boiling points?**

Ans: The physical properties of substances depend upon the strength of intermolecular forces. Stronger the intermolecular forces higher the boiling point of liquid and vice versa.

Q28: **The boiling point of water is different at Murree hills and at Mount Everest. How?**

Ans: On Murree hills external atmospheric pressure is round about 700 mm Hg which is lower than normal. Hence water boils at a lower temperature of 98°C.

At further higher altitude on Mount Everest external pressure is further decreased up to 323 mm Hg. Hence water boils at 69°C.

Q29: **Vacuum distillation can be used to avoid decomposition of sensitive liquid, Why?**

Ans: The decomposition of many compounds can be avoided e.g. glycerin boils at 290^0C at 760 tort pressure but decomposes at this temperature.

Hence, glycerin cannot be distilled at 290°C. Under vacuum, the boiling temperature of glycerin decreases to 210°C at 50 torr. It is distilled at this temperature without decomposition and hence can be purified easily.

Q30: **The vapour pressure of diethyl ether is higher than that of water at same temperature. Give reason?**

Ans: The difference in the strength of intermolecular forces in different liquids is directly related to their vapour pressures at a particular temperature. The stronger the intermolecular forces the lower the vapour pressure.

Diethyl ether has vapour pressure 422.2 torr at 20°C while water has 43.9 torr at 20°C. Water is more polar compound than diethyl ether, so having strong inter-molecular forces and contains less vapour pressure.

Q31: **Why the values of boiling points of noble gases increases from top to bottom within a group?**

Ans: In noble gases electronic cloud size increase down the group due to increase in atomic size. Thus atoms are easily polarized down the group and develop a strong London forces. That's why boiling point of noble gases increase down the group.

The process in which a solid is directly converted into vapors without passing through the liquid phase, and then it can be condensed to obtain solid again is called sublimation.

Q32: **Why the temperature of a boiling liquid does not rise even if heat is continuously supplied to it?**

Ans: When a liquid boils, its vapour pressure becomes equal to the external pressure or atmospheric pressure. When further heat is supplied to the liquid, it is used to break intermolecular forces. There is no increase in kinetic energy of liquid molecules any further, so boiling point remains constant.

Q33: **Explain the working of pressure cooker?**

Ans: Pressure cooker is a closed container. The vapours formed are not allowed to escape. In this way more pressure is developed inside the cooker and therefore, boiling point is increased. As more heat is absorbed in water so food is cooked more quickly.

Q34: **How the increase of polarizability down the group in noble gases is responsible for increase in melting and boiling points?**

Ans: In noble gases electronic cloud size increase down the group due to increase in atomic size. Thus atoms are easily polarized down the group and develop a strong London forces. That's why melting points and boiling points of noble gases increase down the group.

Q35: **Explain why the melting points, boiling points heat of vaporization and heat of sublimations of electrovalent compounds are higher than covalent compound?**

Ans: lonic solids are stable compounds. In ionic crystals ions are held together by strong electrostatic forces, while in covalent compounds atoms are arranged in three dimensional networks. Therefore considerable free space is present among them.

That's why covalent compounds have low melting point and boiling point as compared with ionic.

Q36: **Why boiling point of water varies from sea-level to higher places?**

Ans: When external pressure is changed, its boiling point will also change. When the external pressure is high liquid require greater amount of heat to equalize its vapour pressure to the external pressure and vise verse.

For example:

Water boils at sea level at 100°C due to external pressure 760 torr. while water boils at 98°C at Murree hills due to external pressure 700 torr at top of, Mount Everest at 69°C at 323 torr pressure.

Q37: **How liquid crystals act as temperature sensors?**

Ans: Liquid crystals can diffract light, when one of the wavelengths of white light is reflected from a liquid crystal it appears colored. As the temperature, changes the distance between the layers of the molecules of liquid crystals changes.

Therefore the colour of the reflected light changes. Thus liquid crystal can be used as temperature sensors.

Q38: **Give two important uses of liquid crystals?**

Ans: The important uses of liquid crystals:

- In chromatographic separations these are used as solvent.
- Liquid crystals are used to find the point of potential failure in electrical circuits.
- These are used as temperature sensors.

Q39: **What do you mean by solvent extraction? Which law controls it?**

Ans: A liquid crystalline state exists between two temperatures. i.e. melting temperature and clearing temperature. Those substances which exhibit this liquid crystalline state are called liquid crystals.

For example:

Cholesteryl benzoate, this compound turns milky liquid at 145 °C and becomes clear liquid at 179 "C.

Q40: **Define isomorphism with two examples?**

Ans: **Isomorphism:**

The phenomenon in which two different substances exist in the same crystalline form is called Isomorphism.

Examples:

- $NaNO_3$, KNO_3 : Rhombohedral
- K_2SO_4, K_2CrO_4 : Orthorhombic

Q41: **Define polymorphism with example?**

Ans: **Polymorphism:**

The phenomenon in which a substance exists in more than one crystalline form is called polymorphism.

Examples:

$AgNO_3$ exists in Rhombohedral and Orthorhombic forms.

Q42: **Define crystallites and crystalline solid.**

Ans: **Crystallites:**

The crystalline part of otherwise amorphous, solids are called crystallites.

Crystalline solids:

Those solids in which atoms, ions or molecules are arranged in a definite three dimensional pattern are called crystalline solid. This recurring regular geometrical pattern of structure extends three dimensionally.

Q43: **Define the terms (a). Debye Forces. (b). Helix.**

Ans: **Debye Forces:**

Sometimes, we have a mixture of substances containing polar and non- polar molecules. The positive end of the polar molecule attracts the mobile electrons of the nearby non-polar molecule. In this way polarity is induced in non-polar molecule, and both molecules become dipoles. These forces are called dipole-induced dipole forces or as Debye forces.

Helix:

Proteins are the important part of living organisms. Fibers like those found in the hair, silk and muscles consist of long chains of amino acids. These long chains are coiled about one another into a spiral. This spiral is called a helix. Such a helix may either be right handed or left handed.

Q44: **Describe crystallographic elements?**

Ans: **Crystallographic elements:**

In a unit cell the length and angles of a unit cell are called crystallographic elements. There are six crystallographic elements. Lengths 'a', 'b' and 'c' and angles α, β and γ

Q45: **Explain cleavage of the crystals and cleavage plane?**

Ans: **Cleavage crystals:**

Cleavage is a directional property because division of a crystal from one direction may be easy as compared to other. This is due to different arrangement of particles.

Cleavage planes:

When forces are applied on a crystalline solid it breaks along definite planes called cleavage planes.

Q46: **Transition temperature is the term used for elements as well as compounds. Explain?**

Ans: Transition temperature is a temperature at which two crystalline forms of the same substance can co-exist in equilibrium with each other. At this temperature, one crystalline form (elemental or compound) of a substance changes to another.

For example:

- KNO_3 (rhombohedral) $\rightleftharpoons$ KNO_3 (rhombohedral) Transition temperaute =128 °C.
- Gery tin (cubic) $\rightleftharpoons$ White tin (Tetragonal) Transition temperaute = 13.2 °C.

Q47: **Define molar heat of fusion and molar heat of vapourization?**

Ans: Molar heat of fusion is the amount of heat absorbed by one mole of a solid when it melts into liquid form at its melting point. The pressure, during the change is kept one atmosphere.

Molar heat of vapourization is the amount of heat absorbed when one mole of a liquid is changed into vapours to its boiling point. The pressure, during the change is kept one atmosphere.

Q48: **Define transition temperature with two examples?**

Ans: **Transition temperature:**

The temperature at which two crystalline forms of the same substances can co-exist in equilibrium with each other is called transition temperature.

Example:

Sulphur (Rhombic)	95.5C	Sulphur (Monoclinic)
Grey tin (Cubic)	13.2C	White tin (Tetragonal)

Q49: **Differentiate between an amorphous solid and crystalline solid?**

Ans: Difference between an amorphous solid and crystalline solid:

Amorphous solid	Crystalline solid
❖ In these solids the particles are not arranged in definite three dimensional patterns. ❖ These have not sharp melting. ❖ Example: Glass, plastic etc.	❖ In these solids the atoms, ions and molecules are arranged in a definite three dimensional patterns. ❖ These have sharp melting points. ❖ Example: NaCl, KNO_3

Q50: **Differentiate between isotropy and anisotropy?**

Ans: Difference between isotropy and anisotropy:

Isotropy	Anisotropy
The properties which do not depend upon direction are called isotropic, e.g. melting point.	Some of crystals show variation in physical properties depends upon direction. Such properties are called anisotropic properties.

Q51: **Why amorphous solids like glass are also called super cooled liquids?**

Ans: A liquid can exist below its freezing point is said to be undercooled or super-cooled liquid. Liquid glass when cooled cannot move readily into the position of a regular crystal lattice and they formed amorphous solid with irregular arrangement.

Q52: **Define anisotropy. Give an example?**

Ans: Some of the crystals show variation in physical properties depending upon the direction: Such properties are called anisotropic properties and the phenomenon is referred to as anisotropy. For example the physical properties like refractive index, coefficient of

thermal expansion, electrical and thermal conductivities are sometimes anisotropic in nature of some crystals.

For example:

Electrical conductivity of graphite is greater in one direction than in another.

Q53: **Cleavage of the crystal is itself anisotropic. Give reason?**

Ans: Cleavage of a crystal is a directional property because breakage of a crystal from one direction may be easy as compared to other. This is due to the different arrangement of particles in different direction.

For example:

Mica crystal can be cleavage parallel to the sheets easily.

Q54: **Define allotropy with an example?**

Ans: **Allotropy:**

The phenomenon in which an element exists in more than one crystalline form is called allotropy.

For example:

Carbon (i). Diamond (ii). Graphite

Q55: **Ionic compounds do not show the phenomenone of isomerism. Why?**

Ans: Captions and anions are arranged in a well-defined geometrical pattern, so they are crystalline solids at room temperature. Ionic crystals are very stable compounds. lonic crystals don't exist as individual neutral independent molecules, therefore ionic compounds do not show the phenomena of isomerism.

Q56: **Why sodium is softer than copper but both are good conductors of electricity?**

Ans: Both sodium and copper are metals and have free electrons in them. Due to movement of these free electrons, they are good conductor.

However, strength of metallic bond depends upon the number of valence electrons. Copper has greater number of valence electrons than sodium, so it is harder than sodium.

Q57: **Define unit cell with example?**

Ans: **Unit cell:**

The smallest part of a crystal lattice: Showing all the characteristics features of the whole crystal is called unit cell.

For example:

Cubic unit cell

Q58: **Why the metals are malleable and ductile?**

Ans: Malleable means metals can be beaten into sheets. Ductile means metal can be squeezed into wires. When stress is applied on metal, their layers slip passes over each other but the strength of metallic bond remain same. Therefore metals are malleable and ductile.

Q59: **Ionic solids are insulators in solids state, but become conductors when dissolved in water. Explain?**

Ans: Ionic crystals do not conduct electricity in solid state because ions are held tightly in a crystal lattice. But when dissolve in water then these, ions are free to move.

Hence ionic crystals conduct electricity in solution form.

Q60: **Ionic crystals are highly brittle. Why?**

Ans: Ionic crystals are brittle when some stress is applied to ionic crystals, the layers of ions move and similar ions come in front of each other. These same charges repel to each other and solid break into pieces.

Q61: **One of the unit cell angles of Hexagonal crystal is 120°?**

Ans: In hexagonal system two axis are of equal length and are in one plane making an angle of 120°, with each other. The third axis which is different in length than the other two is at right angle to these two axes.

Q62: **Explain why sodium chloride and cesium chloride have different structures?**

Ans: Coordination number is the number of negative ions around the positive ions. In case of NaCl, 6 Cl^- ions are presence around Na^+ ion while in case of CsCl eight Cl^- the ions are present around the Cs^+ ion Coordination number of an ion depends upon the radius ratio of cation to anion, r^+/r^-. The radius ratio of Cs^+ ion is greater than Na^+ ion, therefore its coordination number is high.

Q63: **Sodium is a good conductor of electricity but $NaCl_{(s)}$ is not. Give reasons?**

Ans: Metals are good conductors of electricity due to movement of free electrons. When electric field is applied these mobile electrons begin to flow and conduction takes place. On the other hand, ionic solids, do not conduct electricity because ions are held tightly in crystal lattice.

Q64: **Ionic solids do not conduct electricity in solid state. Give reason.**

Ans: In ionic crystals, positive and negative ions are present at their fixed position. These ions can only vibrate at their positions. Solid ionic crystals are not conductor of electricity because ions cannot move from one place to another place and crystals have no free electrons.

Q65: **What is Lattice and Lattice energy?**

Ans: **Lattice:**

The location of position of atoms, ions or molecules in solid is called lattice.

Lattice energy:

The amount of energy required to break one mole of an ionic solid into ions is called lattice energy.

For example:

$$NaCl \longrightarrow Na^+ + Cl^- \quad \triangle H^0 = +787\ KJ/mol$$

Q66: **Graphite is conductor but diamond is insulator. Give reason?**

Ans: Carbon has four valence electrons. In graphite only three electrons are used for bond formation and fourth electron remains free which is responsible for the conduction of current.

While in case of diamond all the four electrons are utilized for bond formation. Hence there is no free electron. Therefore, diamond is an insulator.

Q67: **Write two properties of covalent crystals?**

Ans: Two properties of covalent crystals are:

- Covalent solids are hard and lot of energy is required to break them.
- These crystals have a three dimensional network of atoms joined together by covalent bond.

Q68: **Justify that diamond is non-conductor of electricity?**

Ans: Due to absence of free electrons and ions diamond is bad conductors of electricity. Diamond is allotropic modification of carbon, it contain four electrons in outermost shell. The four atomic orbitals (one 2s and three 2p) undergo sp^3 hybridization to give four sp^3 hybridized orbitals.

That is directed in space along the four corners of a tetrahedron. Whole lattice of diamond is continuous and because of the continuity of C-C covalent bonding. The entire diamond crystal behaves as a huge or giant three dimensional carbon molecule.

Q69: **Why diamond is hard and an electrically insulator?**

Ans: Diamond crystals are covalent in nature. Diamond has network of covalent bonds and is hardest substance. Covalent crystals are very hard and considerable amount of energy is required to break them. Thus diamond is hard.

Each carbon atom is linked with four carbon atoms in tetrahedral arrangement. Valence electrons cannot move from one place to another. Due to absence of free electrons and ions diamond is bad conductors of electricity.

Q70: **Write four properties of molecular solids?**

Ans: Four properties of molecular solids are:

- ❖ They are bad conductor of electricity, have low densities and sometimes transparent to light. Polar molecular crystals are mostly soluble in polar solvents. while non-polar molecular crystals are usually soluble in non-polar solvents.
- ❖ They are mostly volatile and have low melting and boiling points.
- ❖ The forces, which hold the molecules together in molecular crystals, are very weak so they are soft and easily compressible.
- ❖ X ray analysis has shown the regular arrangements of atoms in constituent molecules of these solids, and we get the exact positions of all the atoms.

Q71: **Heat of sublimation of iodine is very high. Justify?**

Ans: The amount of energy required to convert one mole of a solid into vapours is called heat of sublimation.

Due to increases in size from top to bottom in a group polarizability also increases. London forces in, I_2 is very strong that's why its heat of sublimation is very high.

Q72: **Iodine dissolves readily in tetra chloromethane. Justify.**

Ans: lodine is a non-polar molecular solid. It is almost insoluble in water but soluble in tetra chloromethane CCl_4 which is also non polar. lodine is 85 times more soluble in CCl_4 as compared to water.

Q73: **How electrical conductivity of the metals decreases by increasing temperature?**

Ans: When the temperature is increased the positive ions begin to vibrate about their mean positions. These vibrations hinder the movement of free electrons in metals and therefore electrical conductivity is reduced.

Q74: **Why metals behave as good conductors of electricity?**

Ans: Metals are good conductors of electricity due to the presence of free electrons. These free electrons can move from one place to other. Hence metals show conductivity.

Q75: **State electron pool theory?**

Ans: **Electron pool theory:**

According to this theory all the atoms of the metallic crystal lose their valence electrons. These electrons form an electron pool or electron gas in which positively charged nuclei are present at definite positions at measurable distance.

Q76: **In the closest packing of atoms of metals, only 74% space is occupied. Give reason?**

Ans: If the atoms of metals are treated as hard spherical balls. In closest possible packing of atoms, each atom is surrounded by six other atoms in a layer. Due to circular nature of metallic atoms. The whole surface area of one atom cannot be in contact with other atoms. Therefore almost 26% empty spaces left in the crystal.

Q77: **Boiling needs a constant supply of heat, give reason.**

Ans: At boiling point intermolecular forces break abruptly. Molecules get freedom. Convert to bubbles and come out of the liquid. In order to continue this process, continuous heating is required for continuous boiling.

Q78: **How rate of evaporation depends on surface area?**

Ans: Rate of evaporation means no. of molecules leaving liquid phase per second. If we increase surface area of liquid', the number of molecules leaving the liquid phase increases so therefore rate of evaporation also increases.

Q79: **How is dynamic equilibrium established during evaporation of a liquid in a closed vessel at contant temperature?**

Ans: when the molecules of a liquid leave the open surface. they are mixed up with air above the liquid. This process is called evaporation. But if we close the system the molecules of liquid start gathering above the surface. These molecules do not only collide with the walls of the container, but also with the surface of the liquid as well. There are chances that these molecules are recaptured by the surface of liquid. This process is called condensation.

The two-processes i.e., evaporation and condensation continue till a stage reaches when the rate of evaporation becomes equal to the rate of condensation. This is called the state of dynamic equilibrium.

$$\text{Liquid} \rightleftharpoons \text{Vapour}$$

Q80: **Write down any four properties of Ionic solids.**

Ans: Properties of Ionic Solids are:

Crystal formation:

- Ionic solids do not exist as individual neutral independent molecules. Their cations and anions attract each other in all directions and these forces are non-directional. The close packing of the ions enables them to occupy minimum space. A crystal lattice is developed when the ions arrange themselves systematically in an alternate manner.

Hard solids with high melting point:

- Jonic crystals are very stable compounds. Very high energy is required to separate the cations and anions from each other against the forces of attraction. That is why ionic crystals are very hard, have low volatility and high melting and boiling point.

Radius ratio and Structure:

- The structure of the ionic crystals depends upon the radius ratio of cations and anions.

For example:

- NaCl and C_5F have the same geometry because the radius ratio in both the cases is the same.

Physical State:

- The cations and anions are arranged in a well-defined geometrical pattern, so they are cyrtalline solids at room temperature. Under ordinary conditions of temperature: and pressure they never exist in the form of liquids or gases.

Q81: **How are liquid crystals used to locate veins, arteries infections and tumors?**

Ans: Liquid crystalline substances are used to locate the veins, arteries, infections and tumors. The reason is that these parts of the body are warmer than the surrounding tissues. Specialists can use the techniques of skin thermography to detect blockages in veins and arteries.

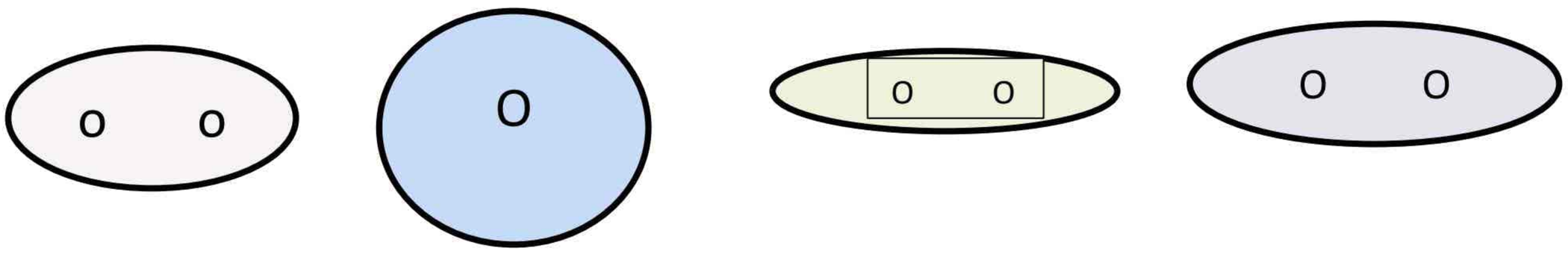
When a layer of liquid crystal is painted on the surface of the breast, a tumor shows up as a hot area which is coloured blue. This technique has been successful in the early diagnosis of breast cancer.

Q82: **What are Debye forces? Or**

What are "dipole-induced dipole forces"?

Ans: Sometimes, we have a mixture of substances containing polar and non-polar-molecules. The positive end of the polar molecule attracts the mobile electrons of the nearby non-polar molecule. In this way polarity is induced in non-polar molecule, and both

molecules become dipoles. These forces are called dipole-induced dipole forces or as Debye forces. The following figure makes the idea clear.



Permanent polar molecule | Non polar molecule | Permanent dipole | Induced dipole

Q83: **Lower alcohols are soluble in water but hydrocarbons are insoluble. Give reason. Or Why ethyl alcohol is soluble in water? Or**

Why water and ethanol can mix easily and in all proportions.

Ans: Water is the best example of H-bonded system. Similarly, ethyl alcohol (C_2H_5OH) also has the tendency to form hydrogen bonds. So, ethyl alcohol can dissolve in water because both can form hydrogen bonds with each other.
Similarly, Carboxylic acids are also soluble in water, if their sizes are small. Hydrocarbons are not soluble in water at all, because they are non-polar compounds and there are no chances of hydrogen bonding between water and hydrocarbon molecules.

Q84: **Why vapour pressure of CCl_4 is 87 torr while isopentane is 580 torr at 20 °C?**

Ans: The difference in the strength of intermolecular forces in different liquids is directly related to their vapour pressures at a particular temperature. The stronger the intermolecular forces the lower the vapour pressure at 20°C Isopentane has the highest vapour pressure, while. CCl_4 has the lowest.

Q85: **Why ice occupies 9% more volume than liquid water.**

Ans: When water is converted to ice. the molecules become more regular and 9% more empty spaces are created. Thus ice occupies 9% more volume. Density of ice decreases and it floats on water.

Q86: **Why heat of sublimation of iodine is very high than other halogens.**

Ans: Due to greater size of I_2 molecule, it has large polarizability, and stronger London forces are produced between I_2 molecules in solid form. To break these forces heat is required.

Q87: **What is polarizability. How it affects London forces.?**

Ans: Polarizability is an extent to which electronic cloud of a molecule is distorted or polarized. Large the size of electronic clouds, greater would be its polarizability and stronger would be the London forces.

Q88: **What is meant by symmetry? Give clements of symmetry. Or**

Define Symmetry of Crystal.

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

There are three elements of symmetry.

- ❖ Plane of symmetry.
- ❖ Center of symmetry.
- ❖ Plane of symmetry.

Q89: **A Freshly cut metal has a shiny look. Justify it.**

Ans: It is because when light falls on freshly cut metallic surface, the incident light collides with the mobile electrons and they are excited. These electrons when de- excited give off some energy is the form of light. It gives metals a shiny look.

Q90: **What is habit of crystal. Give one example.**

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

Example:

Habit of NaCl is cubic.

Q91: **Why do fish and plants in ponds survive under blanket of ice during cold winters.**

Ans: Ice protects water for further heat loses as it is heat insulator. Due to this reason the fish and plants survive under blanket of ice.

Q92: **Lower alcohols are soluble in H_2O but hydrocarbons are insoluble. Give reason.**

Ans: Lower alcohols (like methyl alcohol and ethyl alcohol) develop hydrogen bonding with water. Therefore, they are water soluble. No such hydrogen bonding of water is produced with nonpolar hydrocarbons. Thus hydrocarbons are water insoluble.

Q93: **Boiling points of halogens increase down the group. Give reason.**

Ans: Moving down the group, molecular size and polarizability increases, thus stronger London forces are developed, so boiling points of halogens increase down the group.

Q94: **Give reason for lowest boiling point of hydrides of group IV A elements.**

Ans: Group IVA hydrides (CH_4, SiH_4, GeH_4, SnH_4) are non-polar molecules which have weak London forces. Therefore, their boiling points are lowest. Their boiling points increase down the group.

Q95: **Ethane and hexane has Boiling Points, -88.6°C and 68.7°C respectively. Comment on it.**

Ans: Hexane has greater molecular size. It has molecule with large chain length than ethane. There are more places along its length, where they can be attracted to other molecules. Thus hexane molecules experience stronger London forces. Due to this reason, it has greater boiling point than ethane.

Q96: **NaCl and C_SF have same geometry. Justify.**

Ans: It is because the radius ratio in both cases is same. Therefore both NaCl and C_SF have cubic geometries.

Q97: **Name the factors which affect the London forces.**

Ans: These factors in which affect in the London forces:

- Number of atoms in a non-polar molecule.
- Size of the electronic.
- Polarizability.

Q98: **What is meant by geometrical shape of solid?**

Ans: All the crystalline solids have a definite, distinctive geometrical shape due to definite and orderly arrangement of atoms, ions or molecules in three-dimensional space. For a given crystal, the interfacial angles, at which the surfaces intersect, are always the same no matter in which shape they are grown.

The faces and angles remain characteristic even when the material is ground to a fine powder.

Q99: **What is role of hydrogen bonding in paints, dyes, and textile materials?**

Ans: One of the most important properties of paints and dyes is their adhesive action. This property is developed due to hydrogen bonding. Similar type of hydrogen bonding makes glue and honey as sticky substances.

We use cotton, silk or synthetic fibers for clothing. Hydrogen bonding is of vital importance in these thread making materials. This hydrogen bonding is responsible for their rigidity and the tensile strength.

Q97: **Explain that Vapour pressures of Solids are far less than those of liquids?**

Ans: Vapour pressure of solids depends upon the intermolecular forces. Solids have greater intermolecular forces than liquids and have less vapour pressure than liquids.

Q98: **Why heat of sublimation is greater than heat of vapourization?**

Ans: The amount of energy required to convert one mole of solid into vapours is called heat of sublimation and the amount of heat required to convert one mole of liquid into vapour is called heat of vaporization.

There are two steps involved in conversion of solid into vapour, so greater heat is required for sublimation as compare with vaporization.

Q99: **How vapour pressure is related to intermolecular forces of attraction?**

Ans: The difference in strength of intermolecular forces in different liquids is directly related to their vapour pressures at a particular temperature. The stronger the intermolecular forces the lower the vapour pressure.

Q100: **Why HF has lower boiling point than H_2O?**

Ans: The reason is that the fluorine atom can make only one hydrogen bond with electropositive hydrogen of a neighboring molecule. Water can form two hydrogen bonds per molecule, as it has two hydrogen atoms and two lone pairs on oxygen atom.

Q101: **The crystals showing isomorphism mostly have the same atomic ratios; explain.**

Ans: A crystalline form is independent of the chemical nature of the atoms and depends only on the number of atoms and their way of combinations.

Mostly the ratio of atoms in various compounds is such that isomorphism is possible. Their physical and chemical properties are quite different from each other. Anyway, isomorphic substances crystallize together in all proportions in homogeneous mixtures. $NaNO_3$, KNO_3 both have rhombohedral shape and atomic ratio of 1:1:3

Q102: **Distinguish between Isomorphism and polymorphism.**

Ans: **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.

For example:

$NaNO_3$, KNO_3 both have rhombohedral shape and atomic ratio of 1:1:3.

Polymorphism:

Polymorphism is a phenomenon in which a compound exists in more than one crystalline forms. That compound which exists in more than one crystalline form is called a polymorphic, and these forms are called polymorphs, and these forms are called polymorphs of each other.

For example:

- $CaCO_3$ has Trigonal and orthorhombic crystalline shape.
- $AgNO_3$ have Rhombohedral, Orthorhombic crystalline shape.

Q103: **Why do crystals change their habit?**

Ans: Crystals are usually obtained by cooling the saturated solution or by slow cooling of the liquid substance. These are formed by growing in various directions. If the conditions for growing a crystal are maintained, then the shape of the crystal always remains the same. If the conditions are changed the shape of the crystal may change.

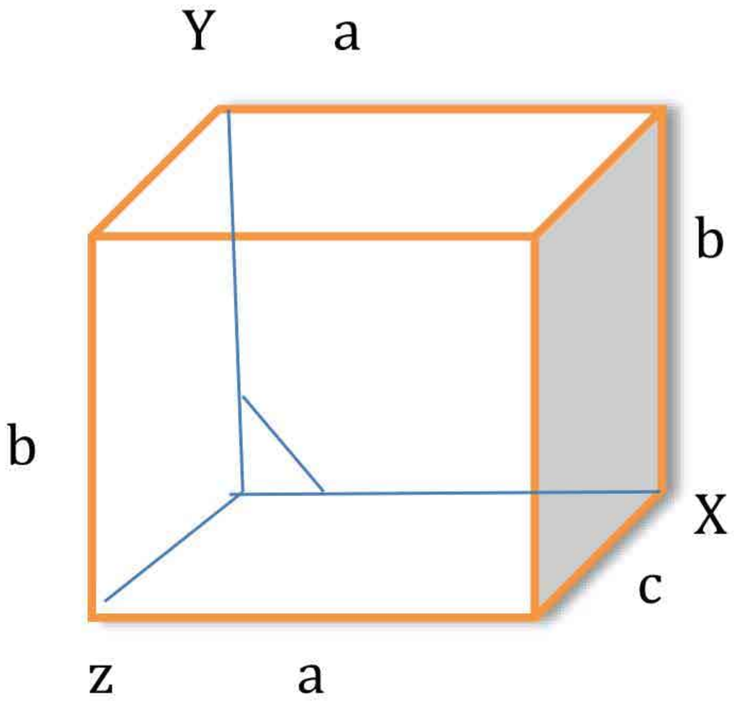
For example:

A cubic crystal of NaCl becomes needle like when 10% urea is present in its solution as an impurity.

Q104: **What are crystallographic elements? Explain with diagram.**

Ans: **Crystallographic elements:**

In a unit cell the length and angles of a unit cell are called crystallographic elements. There are six crystallographic elements.



'a' edge length along x-axis
'b' edge length along y-axis
'c' edge length along z-axis C angle between
'b' and 'c' Bangle between 'a' and 'c'
y angle between 'a' and 'b'

Chapter : 04	Liquids and solids

Imp.Long Questions

1. Define and explain London forces. Describe the factors affecting the London dispersion forces.
2. Explain the term dipole-dipole and dipole induces dipole forces.
3. What are intermolecular forces? Write the names of different types of their forces and explain instantaneous dipole-induced dipole forces.
4. What is H-bonding? Discuss H-bonding in biological compounds. (v.imp)
5. Define hydrogen bonding. How it is helpful in explaining the structure of ice.
6. What is hydrogen bonding? Explain role of hydrogen bonding in food and biological material.
7. Explain hydrogen bonding in NH_3, H_2O and HF. How it is helpful in explaining the structure of ice.
8. How does the hydrogen bonding explain the formation of ice lesser density than liquid water?
9. Define vapour pressure. 'Write down manomatric method for its diagram. (v.imp)
10. Explain the structure of ice of the basis of H-bonding.
11. Define liquid crystals. Discuss important uses of liquid crystal. (v.imp)
12. What is the effect of external pressure on the boiling point of a substance? Give example.
13. Define Hydrogen bonding. Explain any three applications of H-bonding. (v.imp)
14. How Hydrogen bonding explains the following. (a) Structure of ice (b) Structure of DNA.
15. Differentiate between isomorphism and polymorphism with suitable example.
16. Explain seven crystal systems with angles and edges.
17. What are ionic solids? Give three properties of ionic solids. (v.imp
18. Classify solids on the basis of bonding. How ionic solids are formed? Give two properties of ionic solids
19. What are covalent crystals? Give their two types. Write properties of covalent crystals.
20. What are covalent solids? Discuss their properties in detail. (v.imp)

21. What are covalent solids? Discuss the structure of diamond.
22. What are molecular solids? What types of forces are present in them? Write down their properties. (v.imp)
23. Explain the electron gas theory of metals and discuss the conductivity of metals.
24. What is electron pool theory regarding to metallic solids? Also give its four- properties.
25. Describe four crystal systems.
26. Give uses of liquid crystal.
27. What are liquid crystals? Give their uses in daily life.
28. Explain the structure of ice on the basis of hydrogen bonding.