CHEMISTRY (XI)

Chapter 4

Liquids and Solids

Short Questions

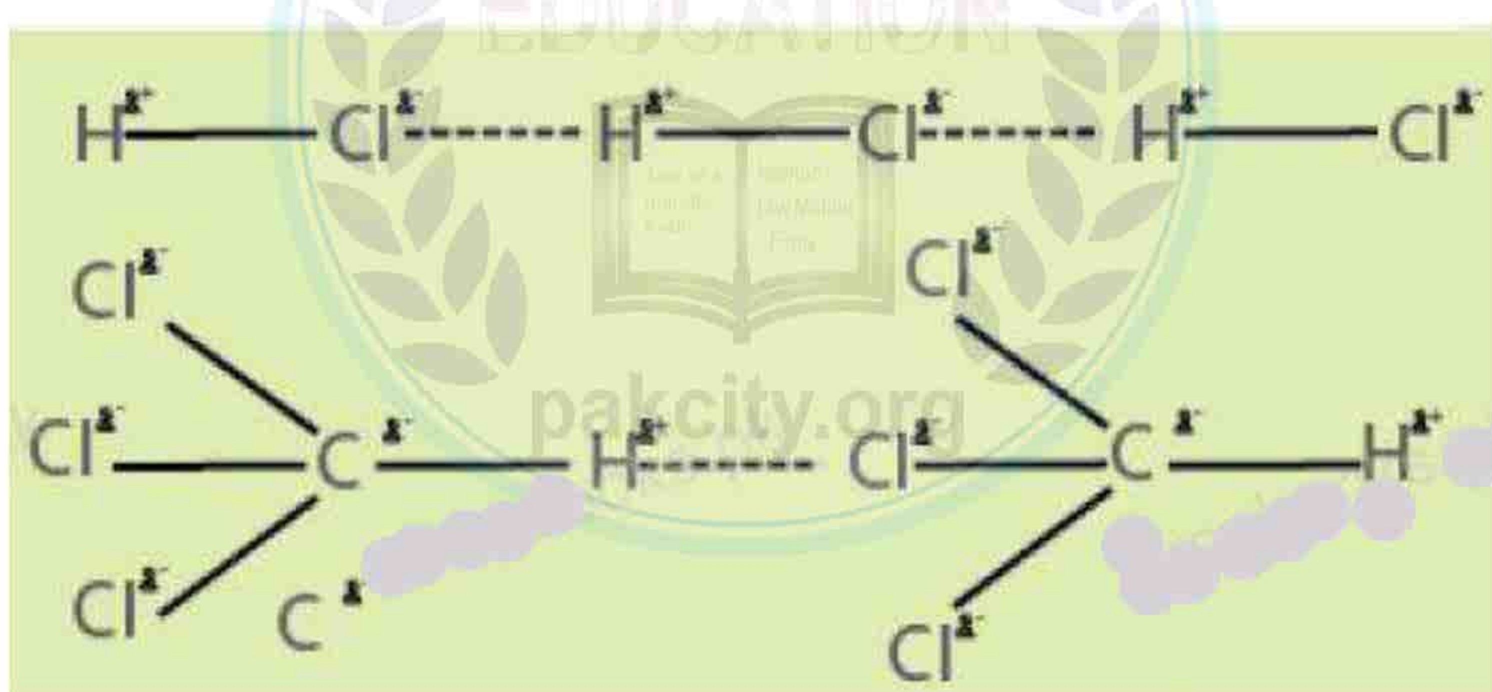
1. Describe various types of intermolecular forces.

Ans: The forces holding the molecules together are called intermolecular forces. They are as follows:

1. Dipole-dipole forces
2. Ion-dipole forces
3. Dipole-induced dipole forces
4. Instantaneous dipole-induced dipole forces or London dispersion forces

2. Define intramolecular forces.

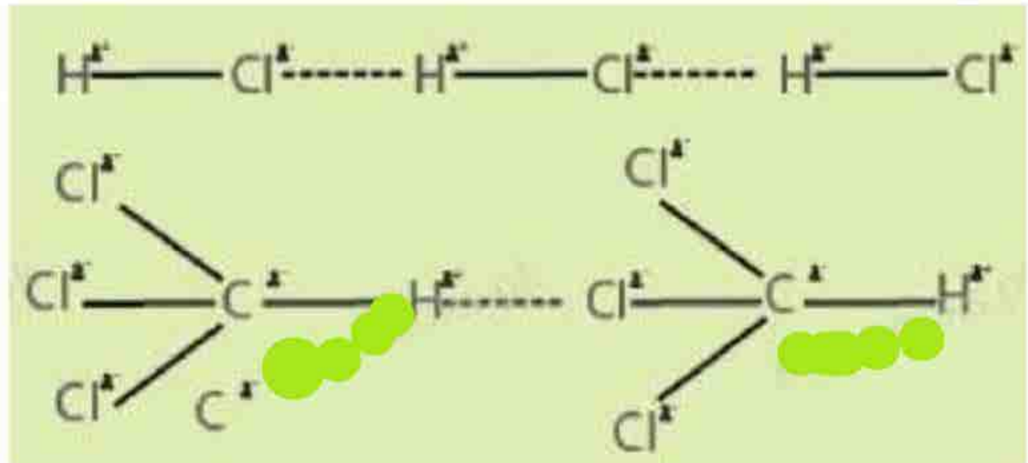
Ans: The forces present between atoms of a molecule are called intramolecular forces. For example, the two bonds in molecule of water are intramolecular forces.



The solid lines are intramolecular forces, whereas, the dotted lines are intermolecular forces.

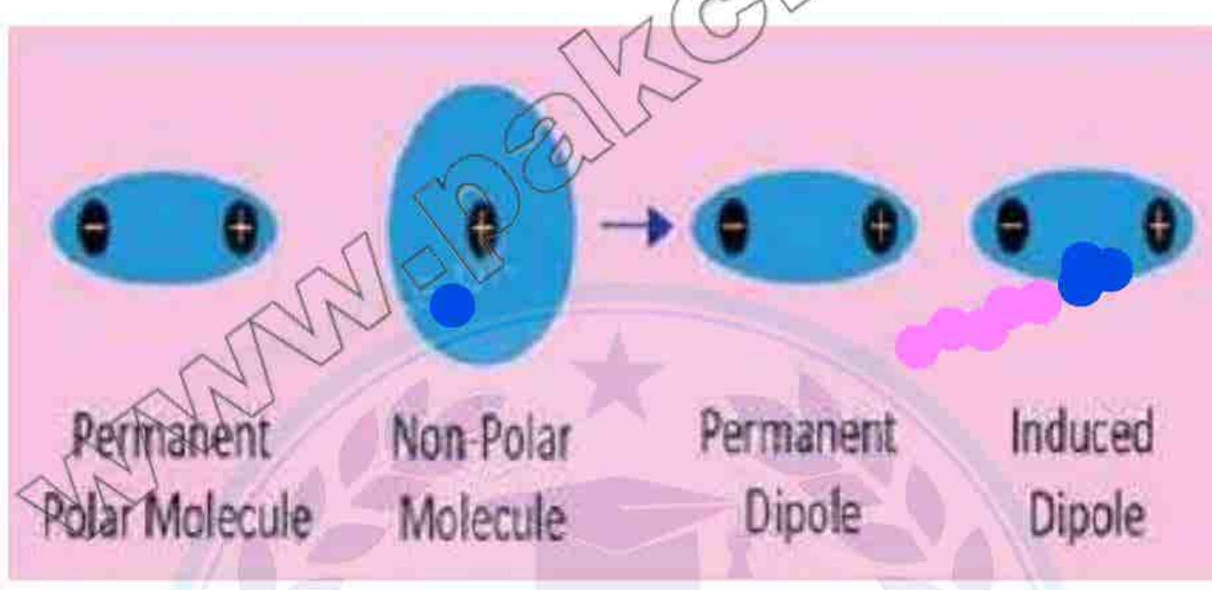
3. What are dipole-dipole forces? Give an example.

Ans: When the positive end of one molecule attracts the negative end of the other molecule then these electrostatic forces of attraction are called dipole-dipole forces. For example, dipole-dipole forces are present in HCl and $CHCl_3$



4. What are dipole-induced dipole forces or Debye 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 Debye forces.



5. What are instantaneous dipole-induced dipole forces or London dispersion forces?

Ans: The momentary force of attraction created between instantaneous dipole and the induced dipole is called instantaneous dipole-induced dipole interaction or London force.

London forces are present in all types of molecules whether polar or non-polar but they are very significant for non-polar molecules like Cl_2, H_2 and noble gases (helium, neon, *etc.*)

6. Define polarizability.

Ans: Polarizability is the quantitative measurement of the extent to which the electronic cloud can be polarized or distorted.

7. Why the boiling point of halogens increase down the group?

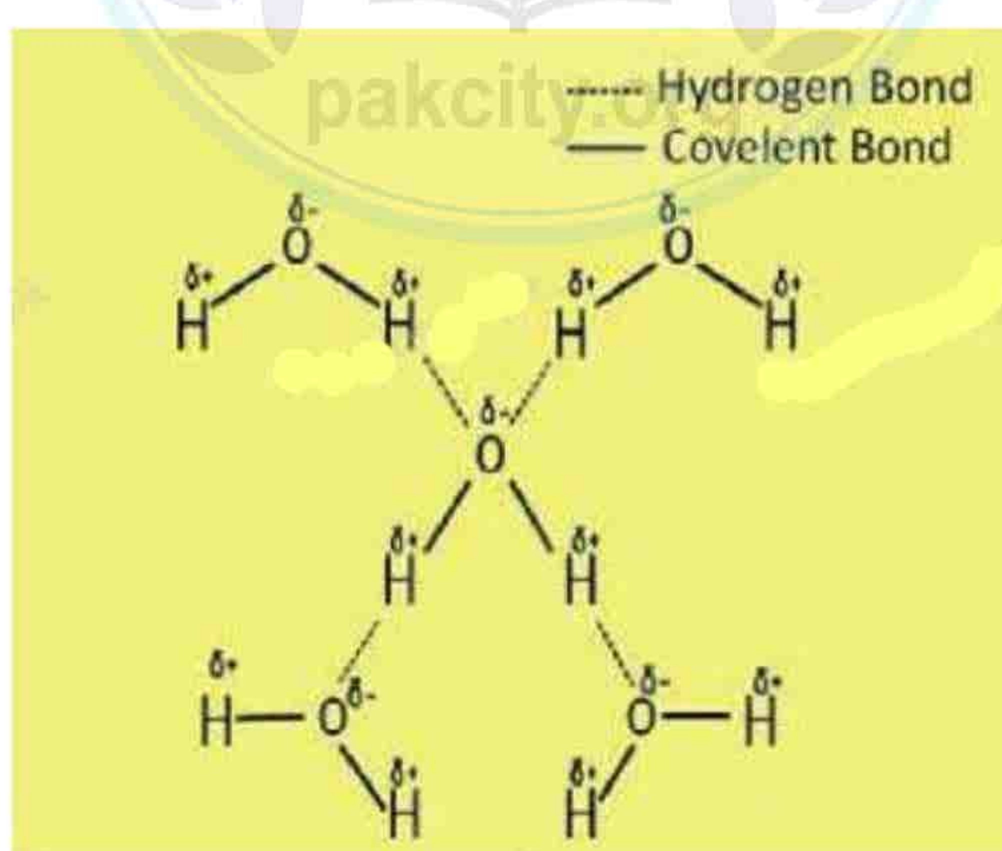
Ans: The increased distortion of electronic cloud creates stronger London forces and hence the boiling points are increased down the group VII-A. All the halogens are non-polar diatomic molecules, but there is a big difference in their physical states at room temperature. Fluorine is a gas and boils at -188.1 °C, while iodine is a solid at room temperature which boils at +184.4 °C. The polarizability of iodine molecule is much greater than that of fluorine.

8. How the number of atoms affect London forces?

Ans: Greater the number of atoms in a molecule, greater is its polarizability. For example, in saturated hydrocarbons the hydrocarbons have chain of carbon atoms linked with hydrogen atoms. Compare the length of the chain for C_2H_6 and C_6H_{14}. They have the boiling points - 88.6 °C and 68.7 °C, respectively. This means that the molecule with a large chain length experiences stronger attractive forces. The reason is that longer molecules have more places along its length where they can be attracted to other molecules. With the increasing molecular mass of hydrocarbons they change from gaseous to liquid and then finally become solids.

9. Define hydrogen bonding.

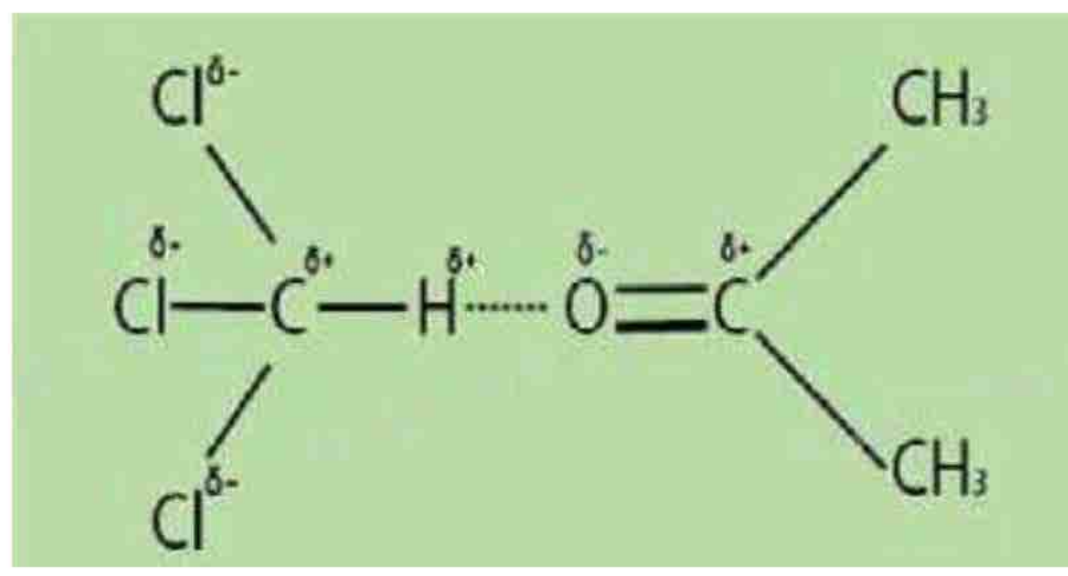
Ans: The electrostatic force of attraction between a highly electronegative atom and partial positively charged hydrogen atom. For example, hydrogen bonding is present in water.



The electronegative atoms responsible for creating hydrogen bonding are fluorine, oxygen, nitrogen and rarely chlorine. The strength of hydrogen bond is generally twenty times less than that of a covalent bond.

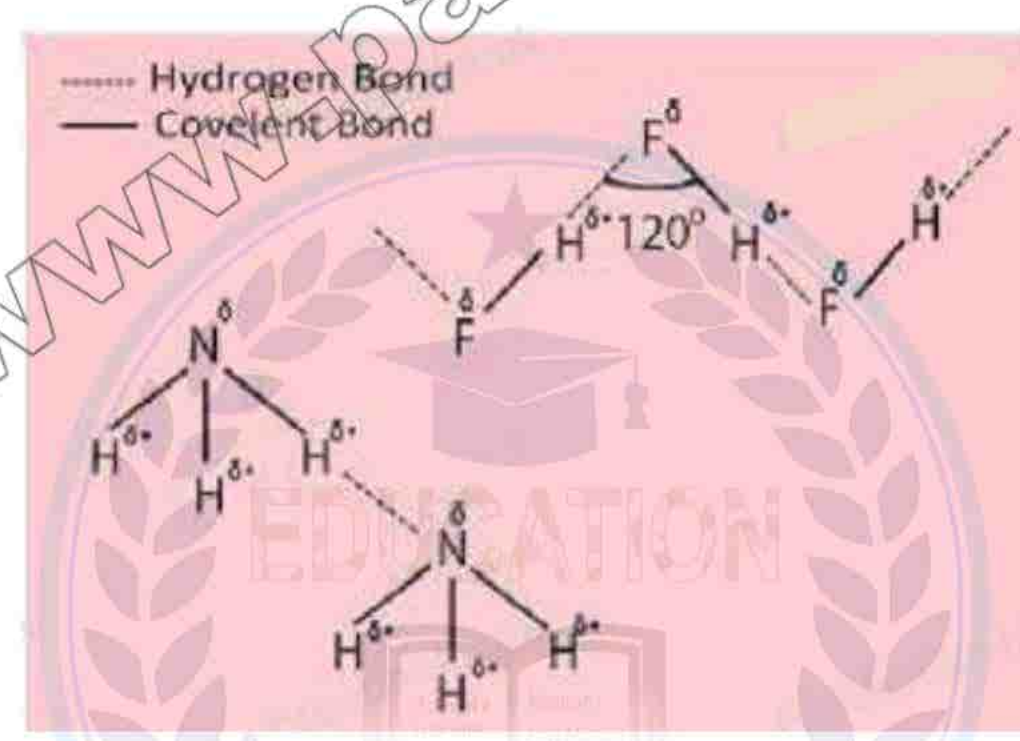
10. Show hydrogen bonding between acetone and chloroform.

Ans: Following is the structure showing hydrogen bonding between acetone and chloroform



11. Show hydrogen bonding in HF and NH_3

Ans: Following is the structure showing hydrogen bonding in HF and NH_3



12. Why HF is a weak acid?

Ans: Low acidic strength of HF molecule as compared to HCl, HBr and HI is due to strong hydrogen bonding, because the partial positively charged hydrogen is entrapped between two highly electronegative atoms.

13. The hydrides of group IV-A have low boiling points as compared to hydrides of group V-A, VI-A and VII-A. Justify.

Ans: The hydrides of group IV-A have low boiling points as compared to hydrides of group V-A, VI-A and VII-A because these elements are least electronegative. CH_4 has the lowest boiling point because it is a very small molecule and its polarizability is the least.

14. Why water is liquid but H_2S and H_2Se are gases?

Ans: Oxygen has enhanced electronegative character due to which water shows hydrogen bonding and it is liquid. There is no hydrogen bonding in H_2S and H_2Se as S and Se are not electronegative due to which they are gases.

15. Why HF has lower boiling point than H_2O?

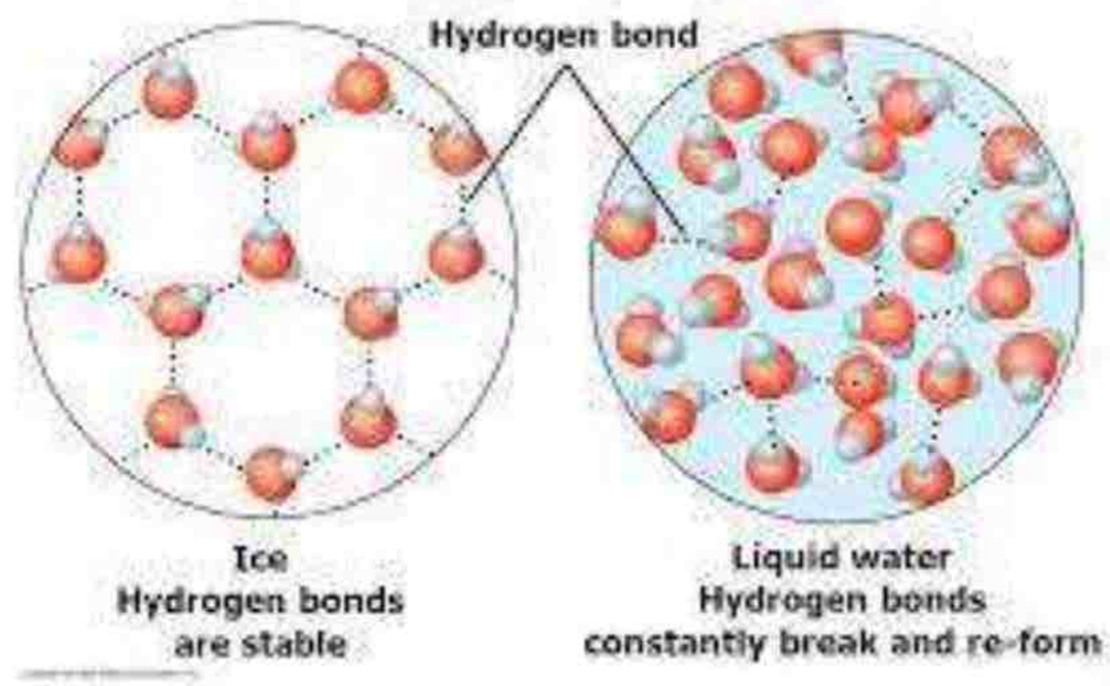
Ans: Fluorine atom can make only one hydrogen bond with electropositive hydrogen of a neighboring molecule. Water can form two hydrogen bonds per molecule, as it has two hydrogen atoms and two lone pairs on oxygen atom.

16. Why ice floats on water?

Ans: When water freezes it occupies 9% more space and its density decreases. The result is that ice floats on water.

17. Ice occupies more space than water. Give reason.

Ans: The molecules of water have tetrahedral structure. When the temperature of water is decreased and ice is formed then the molecules become more regular and this regularity extends throughout the whole structure and empty spaces are created in the structure. The structure of ice is just like that of a diamond and that is why when water freezes into ice it occupies 9% more space and its density is decreased with increase in volume. Hence, ice occupies more space than water.



18. Why fish survive in winter in frozen ponds?

Ans: The lower density of ice than liquid water at 0°C causes water in ponds and lakes to freeze from surface to the downward direction. Water attains the temperature of 4°C by the fall of temperature in the surrounding. As the outer atmosphere becomes further cold, the water at the surface becomes less dense. This less dense water below 4 °C stays on the top of slightly warm water underneath. A stage reaches when it freezes. This layer of ice insulates the water underneath for further heat loss. Fish and plants survive under this blanket of ice for months.

19. How the size of electronic cloud affects London forces?

Ans: When the size of the atom or molecule is large then the dispersion becomes easy and these forces become more prominent. The elements of the zero group in the periodic table are all mono-atomic gases. They don't make covalent bonds with other atoms because their outermost shells are complete.

20. Define liquid crystals. Give an example.

Ans: A liquid crystalline state exists between two temperatures i.e. melting temperature and clearing temperature. Example is cholesteryl benzoate.

21. Mention the types of liquid crystals.

Ans: Depending upon the nature of ordering, liquid crystals can be divided into nematic, smectic and cholesteric.

22. How liquid crystal acts as temperature sensor?

Ans: Like solid crystals, liquid crystals can diffract light. When one of the wavelengths of white light is reflected from a liquid crystal it appears coloured. As the temperature changes, the distances between the layers of the molecules of liquid crystals changes. Therefore, the colour of the reflected light changes accordingly. Thus, liquid crystals can he used as temperature sensors.

23. Mention the biological applications of liquid crystals.

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.

24. What are the types of solid?

Ans: Solids can be classified on the basis of the regular arrangements of constituent atoms, ions or molecules. There are two types of solids in this respect:

1. Crystalline solids
2. Amorphous solids

25. Define crystalline solids.

Ans: Those solids in which atoms, ions or molecules are arranged in a definite three dimensional pattern are called crystalline solids. This recurring regular geometrical pattern of structure extends three dimensionally. Example, sodium chloride crystal.

26. Define amorphous solids.

Ans: Amorphous substances are those whose constituent atoms, ions, or molecules do not possess a regular orderly arrangement. The best examples are glass, plastics, rubber, glue, etc. These substances have solid state properties and virtually complete maintenance of shape and volume. But they do not have an ordered crystalline state.

27. What are crystallites?

Ans: Long range regularity does not exist in amorphous solids but they can possess small regions of orderly arrangements. These crystalline parts of otherwise amorphous solids are known as crystallites.

28. Define crystal lattice.

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

29. Define unit cell.

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

30. What are unit cell dimensions or crystallographic elements?

Ans: There are three unit cell lengths a, b, c and three unit cell angles α, β and γ. These six parameters of the unit cell are called unit cell dimensions or crystallographic elements.

31. Define crystal system.

Ans: A crystal system may be identified by the dimensions of its unit cell along its three edges or axes, a, b, c and three angles between the axes α, β, γ. There are seven crystal systems.

32. How the cleansing action of soaps and detergents is due to hydrogen bonding?

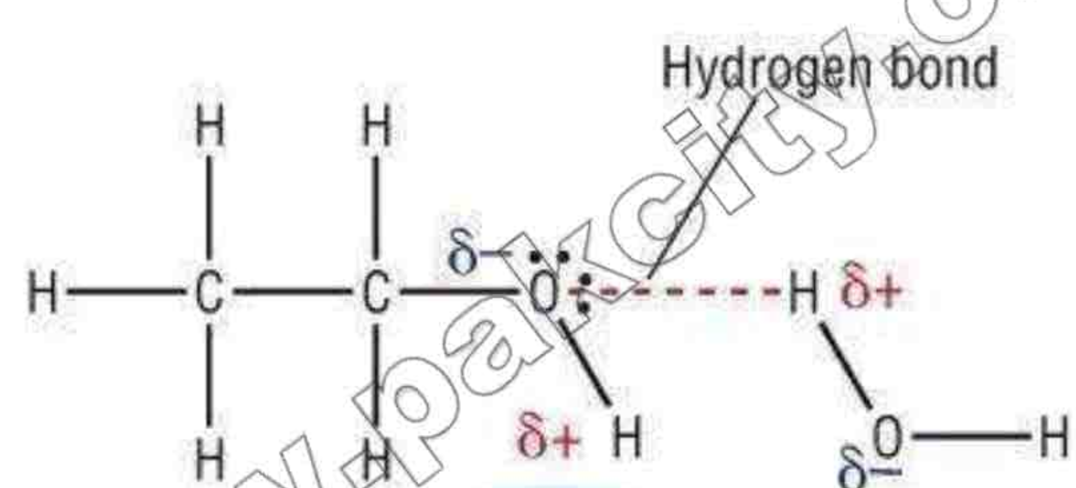
Ans: Soaps and detergents perform the cleansing action because the polar part of their molecules are water soluble due to hydrogen-bonding and the non-polar parts remain outside water, because they are alkyl or benzyl portions and are insoluble in water.

33. Justify that structure of ice is just like that of diamond.

Ans: Oxygen in water molecule is sp^3 hybridized just like the carbon atom in diamond and each atom of carbon in diamond is at the center of tetrahedron just like the oxygen of water molecule in ice.

34. Water and ethanol can mix easily in all proportions. Justify.

Ans: Water (H_2O) and ethanol (C_2H_5OH) can mix easily in all proportions due to hydrogen bonding as both have OH group in them.



35. Lower alcohols are water soluble but corresponding alkanes are insoluble in water. Why?

Ans: In alcohols –OH group is present due to which lower alcohols are soluble in water due to hydrogen bonding but alkanes do not have any functional group due to which they are not soluble in water due to lack of hydrogen bonding.

36. Why intramolecular forces are stronger than intermolecular forces?

Ans: Intramolecular forces are stronger than intermolecular forces because they are formed by sharing of electrons, whereas, intermolecular forces do not involve sharing of electrons.

37. Lower alcohols are soluble into water but hydrocarbons are not. Give reason.

Ans: Lower alcohols are soluble in water as they can form hydrogen bonds with water.

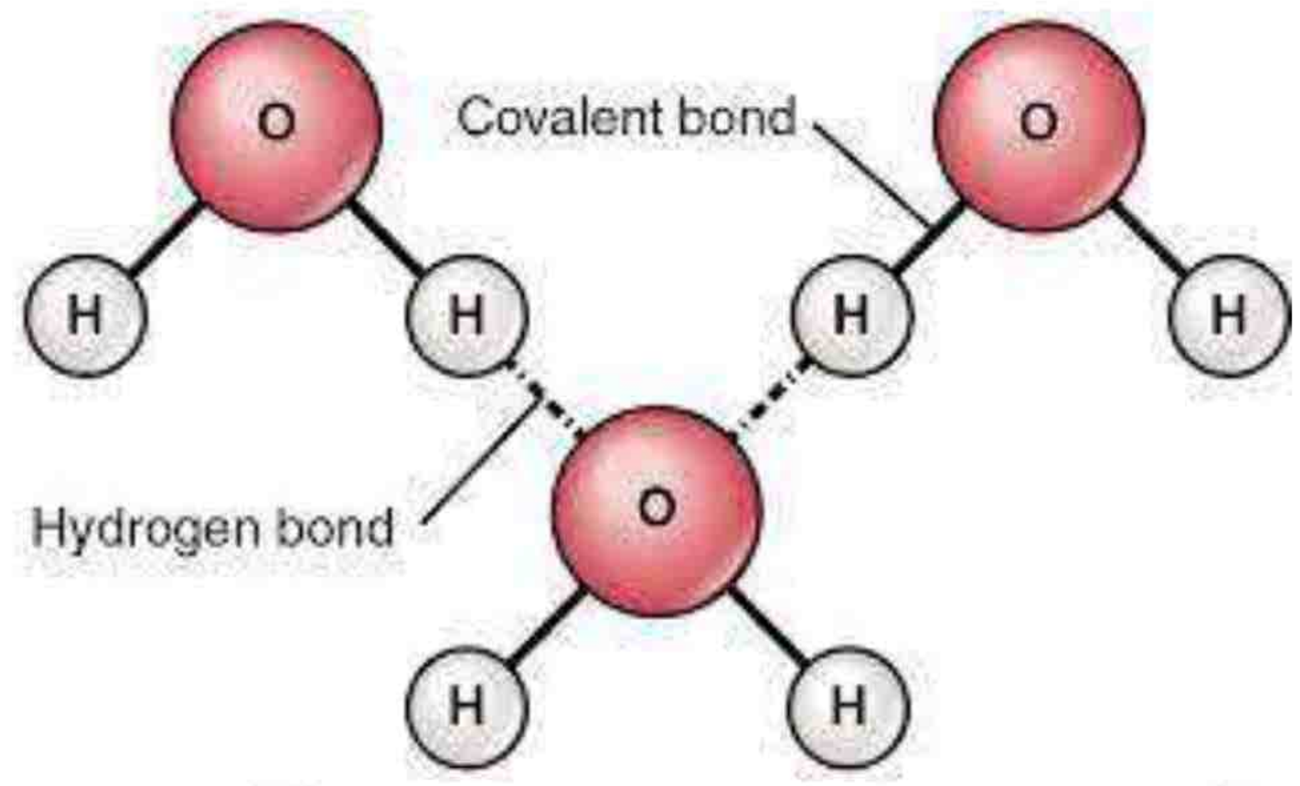
Hydrocarbons are not soluble in water because they are non- polar compounds and there is no chance of hydrogen bonding between water and hydrocarbon molecules.

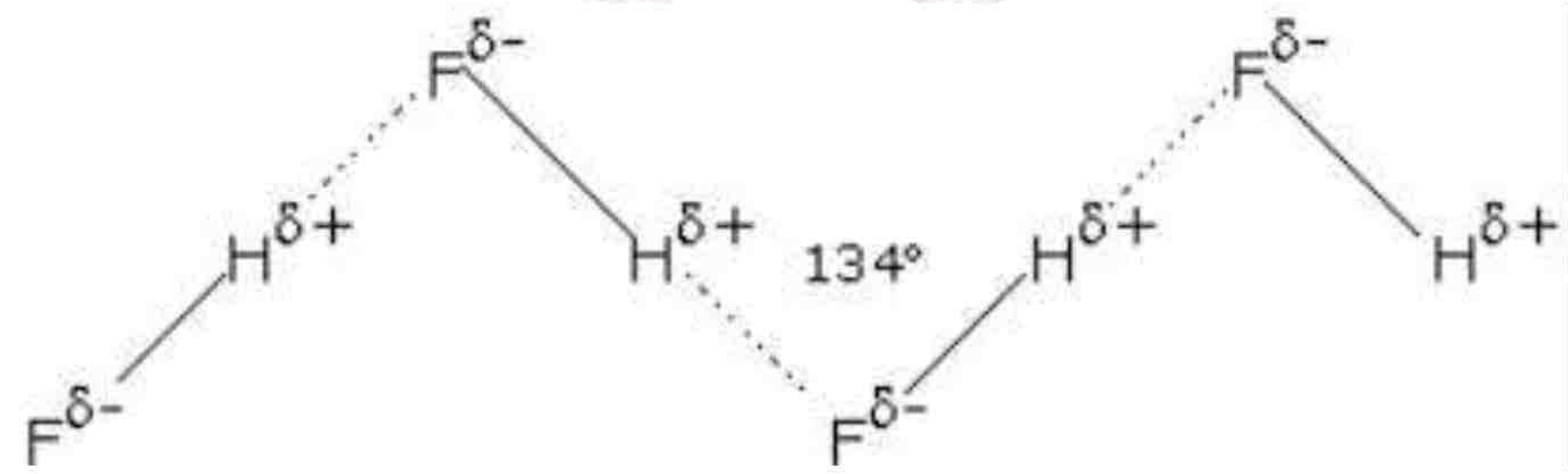
38. Write a brief note on solubility of hydrogen bonded molecules.

Ans: Water is the best example of hydrogen bonded molecules. Similarly, ethyl alcohol 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 because they are non- polar compounds and there is no chance of hydrogen bonding between water and hydrocarbon molecules.

39. Why boiling point of water is greater than HF?

Ans: HF and water both are liquid at room temperature as both have strong hydrogen bonds among their molecules. However, water has two hydrogen bonds per molecule and HF has one hydrogen bond per molecule. Thus, water has stronger forces of attractions between its molecules and has higher boiling point than HF.





40. Earthen ware vessels keep water cool. Explain.

Ans: Earthen ware vessels are porous in nature. Water molecules come out from the pores and evaporate. These molecules of water need energy to overcome their intermolecular forces of attraction. They get this energy from other molecules of water and get evaporated. This evaporation process lowers the energy of water molecules left behind. Thus, water has low temperature in earthen ware vessels and is kept cool.

41. Why evaporation causes cooling?

Ans: Evaporation of a liquid causes cooling because high energy molecules escape and change into vapours during evaporation. So the temperature of liquid falls. To compensate this heat loss, heat flows from surrounding to the region of lower temperature. This causes the temperature of surroundings to decrease. Hence, evaporation causes cooling.

42. Explain why evaporation takes place at all temperatures?

Ans: The molecules whose kinetic energies are greater than the average kinetic energies of the molecules, escape from the surface of the liquid. If temperature is increased, rate of evaporation also increases. Thus, evaporation takes place at all temperatures and only the rate of evaporation differs with temperature change.

43. Why boiling point of water is different at Murree Hills and at Mount Everest?

Ans: When vapor pressure of a liquid becomes equal to the external pressure then the liquid boils, so when external pressure is changed, boiling point will also be changed. Therefore, water boils at 98 ^{o}C at Murree hills due to external pressure of 700 torr while at the top of Mount Everest, water boils at only 690 ^{o}C at 323 torr.

44. Why different liquids evaporate at different rates even at the same temperature?

Ans: There are many factors which control the rate of evaporation of the liquids even at the same temperature. These factors include attractive forces among molecules of the liquid and surface area of the liquid. If attractive forces are weak, the rate of evaporation is faster, e.g. gasoline having weaker forces of attraction than water evaporates much faster than water. Similarly, if surface area is increased, then more molecules are able to escape and liquid evaporates more quickly.

45. Vacuum distillation can be used to avoid decomposition of sensitive liquids. Explain.

Ans: The decomposition of many compounds can be avoided by vacuum distillation. For example glycerin boils at 290 ^{o}C at 760 torr pressure but it decomposes at this temperature. Hence, glycerin cannot be distilled at this temperature. Under vacuum, the boiling temperature of glycerin decreases to 210 ^{o}C at 50 torr. It is distilled at this temperature without decomposition and hence can be purified easily.

46. Heat of sublimation of iodine is very high. Justify it.

Ans: In the solid state the molecules of iodine align in the form of layer lattice with I-I bond distance 271.5 pm. Thus, heat of sublimation of iodine is very high.

47. Ionic solids do not conduct electricity in solid state. Give reason.

Ans: Ionic solids do not conduct electricity in solid state because on account of electrostatic force existing between them, the cations and anions remain tightly held together and hence occupy fixed positions. Ionic crystals conduct electricity when they are in the molten state.

48. Write down applications of liquid crystals (Write any two as an answer to short question)

Ans: Following are the two applications of liquid crystals:

(i) Like solid crystals, liquid crystals can diffract light. When one of the wavelengths of white light is reflected from a liquid crystal it appears coloured. As the temperature changes, the distances between the layers of the molecules of liquid crystals change. Therefore, the colour of the reflected light changes accordingly. Thus, liquid crystals can be used as temperature sensors.

(ii) Liquid crystals are used to find the point of potential failure in electrical circuits. Room thermometers also contain liquid crystals with a suitable temperature range. As the temperature changes, figures show up in different colours.

(iii) 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.

(iv) Liquid crystals are used in the display of electrical devices such as digital watches, calculators and laptop computers. These devices operate due to the fact that temperature, pressure and electro-magnetic fields easily affect the weak bonds, which hold molecules together in liquid crystals.

(v) In chromatographic separations, liquid crystals are used as solvents.

(vi) Oscillographic and TV displays also use liquid crystal screens.

49. Define isomorphism and polymorphism with examples.

Ans:

Isomorphism is the phenomenon in which two different substances exist in the same crystalline form. These different substances are called isomorphs of each other. 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. For example, $NaNO_3$ and KNO_3 have rhombohedral crystals, whereas, Cu and Ag have cubic crystals.

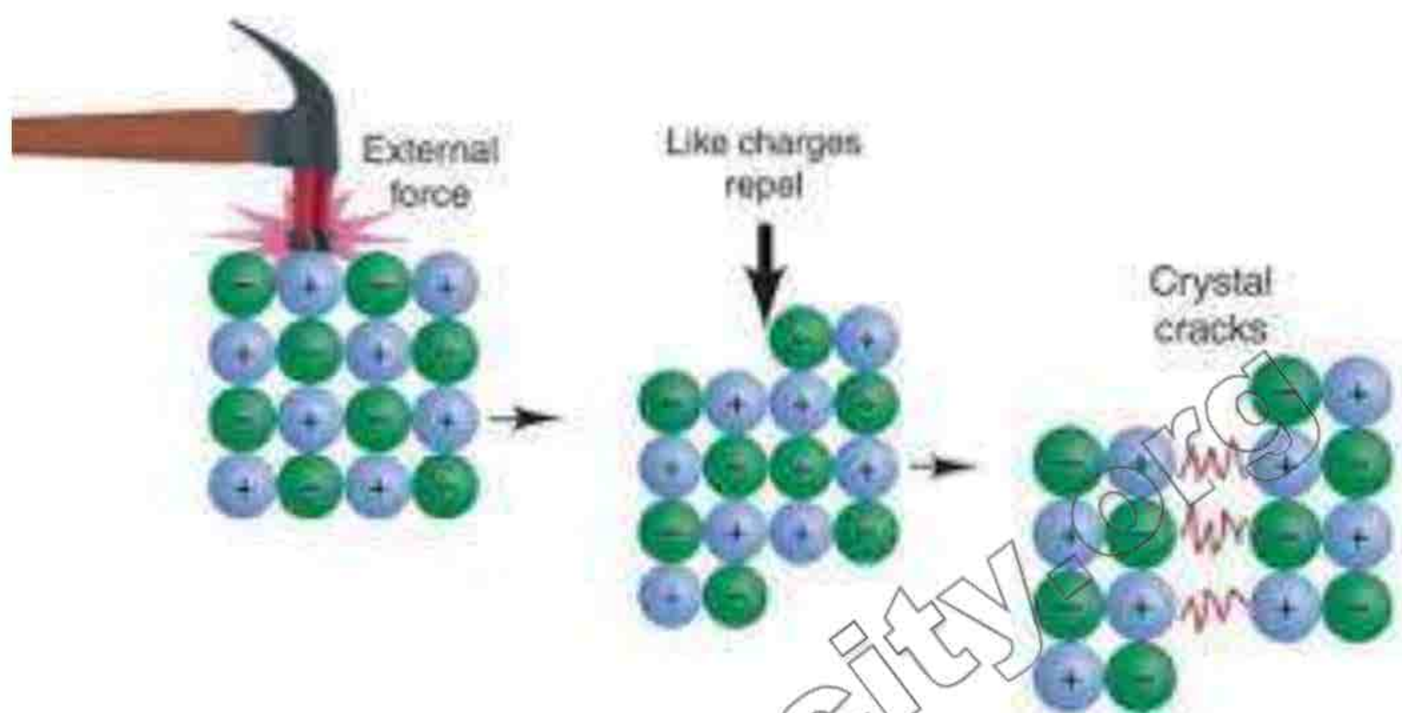
Polymorphism is a phenomenon in which a compound exists in more than one crystalline forms and such compounds are called polymorphic and these forms are called polymorphs of each other. For example, $AgNO_3$ has rhombohedral and orthorhombic crystalline forms.

50. Define polymorphism. Give an example.

Ans: Polymorphism is a phenomenon in which a compound exists in more than one crystalline forms and such compounds are called polymorphic and these forms are called polymorphs of each other. For example, $AgNO_3$ has rhombohedral and orthorhombic crystalline forms.

51. Why ionic solids are highly brittle?

Ans: Ionic crystals are highly brittle because ionic solids are composed of parallel layers which contain cations and 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 slides a bit over the other layer along a plane. In this way, the like ions come in front of each other and begin to repel. So, the application of a little external force develops repulsion between two layers causing brittleness.



52. Why heat of sublimation of iodine is very high?

Ans: In the solid state the molecules of iodine align in the form of layer lattice with I-I bond distance 271.5 pm. Thus, heat of sublimation of iodine is very high.

53. Define transition temperature with an example.

Ans: It is the temperature at which two crystalline forms of the same substance can co-exist in equilibrium with each other. At this temperature, one crystalline form of a substance changes to another. Above and below this temperature, only on form exists. For example, transition temperature of tin is 13.2 ^{0}C at which Grey tin having cubic crystals and White tin having tetragonal crystals co-exist. Similarly, transition temperature of Sulphur rhombic and monocliniccrystals is 95.5 ^{o}C.

54. Cleavage is an anisotropic behaviour. Explain it.

Ans: Whenever the crystalline solids are broken they do so along definite planes. This is called cleavage. Cleavage is an isotropic behavior because solids show cleavage depending upon direction and solids have orderly arrangements of their particles in different directions.

55. How the liquid crystals help in the detection of blockages in veins and arteries. OR How are liquid crystals used to locate veins, arteries, infections and tumors?

Ans: Liquid crystals are used to locate veins, arteries, infections and tumors. The reason is that these parts of the body are warmer than the surrounding tissues. Specialists can use the technique of skin thermography to detect blockages in veins and arteries. When a layer of liquid crystals 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.

56. What is relationship between polymorphism and allotropy?

Ans:

Polymorphism: Polymorphism is a phenomenon in which a compound exists in more than one crystalline form and such compounds are called polymorphic and these forms are called polymorphs of each other. For example, $AgNO_3$ has rhombohedral and orthorhombic crystalline forms.

Allotropy: The existence of an element in more than one crystalline form is called allotropy and these forms are called allotropes of each other. For example, carbon has allotropic forms of diamond (cubic) and graphite (hexagonal).

Relationship between Polymorphism and Allotropy:

The relationship between both phenomenae i.e polymorphism and allotropy is that both describe the existence of the substances in more than one crystalline form. However, polymorphism tells about compounds and allotropy describes about elements.

57. Transition temperature is the term used for elements as well as compounds. Explain.

Ans: It is the temperature at which two crystalline forms of the same substance can co-exist in equilibrium with each other. At this temperature, one crystalline form of a substance changes to another. Above and below this temperature, only on form exists. For example, transition temperature of tin is 13.2 ^{0}C at which Grey tin having cubic crystals and White tin having tetragonal crystals co-exist. Similarly, transition temperature of Sulphur rhombic and monoclinic crystals is 95.5 ^{0}C. There are many compounds which show transition temperature. For example, KNO_3 has transition temperature of 32.38 ^{0}C having orthorhombic and rhombohedral crystals. Thus transition temperature is the term used for elements as well as compounds.

58. Define transition temperature. Give two examples.

Ans: It is the temperature at which two crystalline forms of the same substance can co-exist in equilibrium with each other. At this temperature, one crystalline form of a substance changes to another. Above and below this temperature, only one form exists. For example, transition temperature of tin is 13.2 ^{o}C at which Grey tin having cubic crystals and White tin having tetragonal crystals co-exist. Similarly, transition temperature of sulphur rhombic and monoclinic crystals is 95.5 ^{o}C.

59. The vapor pressure of diethyl ether is higher than water at same temperature?

Ans: The forces of attraction are weaker in diethyl ether, whereas, water has strong hydrogen bonding between its molecules. Thus, diethyl ether evaporates more quickly than water and its vapor pressure is higher than water.

60. Give properties of molecular solids.

Ans: Following are the four properties of molecular solids:

1. Molecular solids have weak forces of attraction among their molecules.

2. They are soft and easily compressible.

3. They are mostly volatile and have low melting and boiling points.

4. They are bad conductors of electricity.

61. Define molar heat of fusion and molar heat of vaporization.

Ans:

Molar Heat of Fusion: It 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 constant.

Molar Heat of Vaporization: It is the amount of heat absorbed when one mole of a liquid is changed into vapors at its boiling point. The pressure during the change is kept constant.

62. Describe that heat of sublimation is greater than heat of vaporization.

Ans: The heat of sublimation is greater than heat of vaporization because vaporization is a single stage phase change whereas sublimation is a double stage phase change as solid changes to vapors.

63. Why the electrical conductivity of metals decrease by increasing temperature?

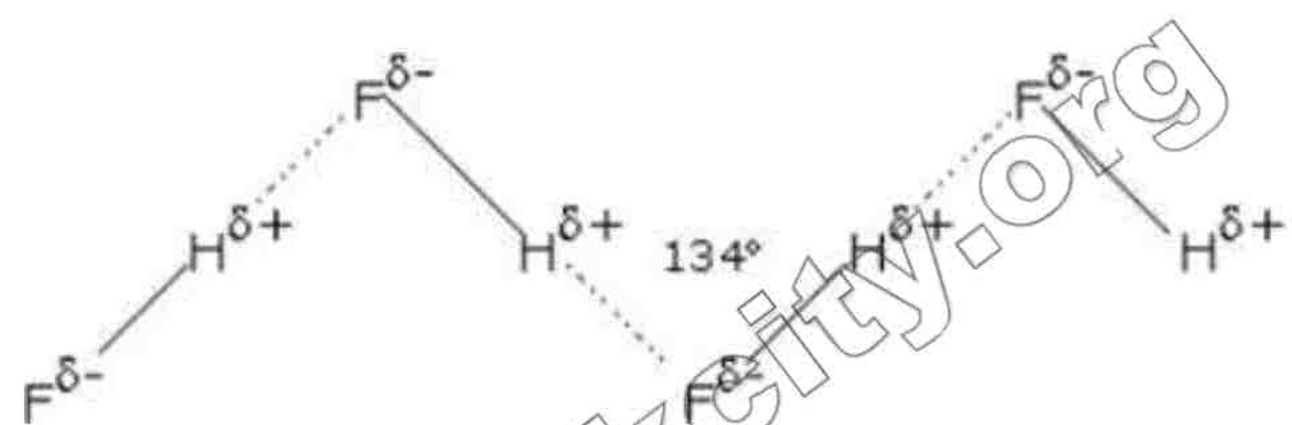
Ans: Metals are good conductors of electricity. Sometimes, the electrical conductivity of metals decreases with increase in temperature. The reason is that with the increase in temperature the positive metal ions also begin to oscillate and the motion hinders the free movement of mobile electrons between the positive ions. This hindrance decreases the electrical conductivity.

64. What is meant by dynamic equilibrium? Give an example.

Ans: Whenever a change of state occurs, the system moves towards the condition of dynamic equilibrium. Dynamic equilibrium is a situation when two opposing changes occur at equal rates. For example, at 0 ⁰C, solid water (ice) exists in dynamic equilibrium with liquid water.

65. HF is weaker acid than HCl. Why?

Ans: HF has strong hydrogen bonding among its molecules and its H atoms are trapped between F atoms. Due to this HF does not release its proton H^+ easily as compared to HCl which donates its proton H^+ easily. Thus, HF is a weaker acid than HCl.

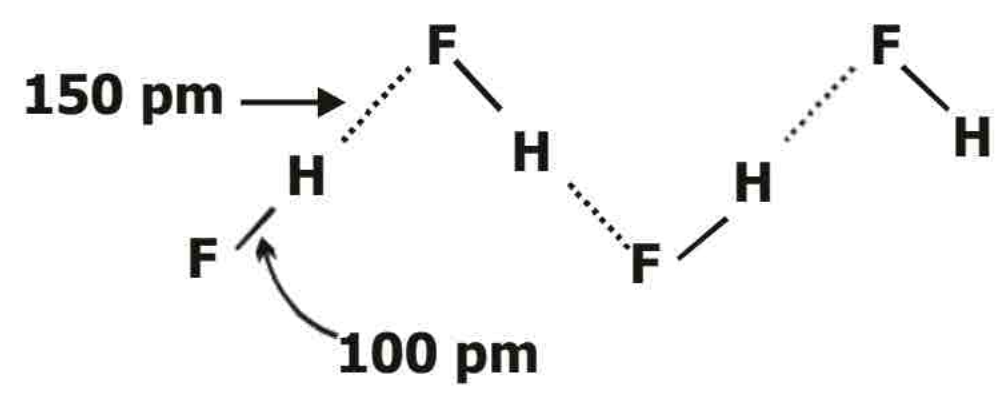


66. Diamond is hard and an electrical insulator. Give reason?

Ans: There is sp^3- sp^3 overlapping of the carbon atoms in diamond and it has tetrahedral structure with 1.54 ⁰A bond lengths most suitable for effective packing of atoms, thus, diamond is hard. As there are no free electrons present in any of the carbon atoms which could conduct electricity, therefore, diamond is an electrical insulator.

67. In the hydrogen bonded structure of HF, which is stronger bond? The shorter covalent bond or the longer hydrogen bond between different molecules.

Ans: A covalent bond is formed by the mutual sharing of electrons. Hence, it is true chemical bond and very strong, Whereas, hydrogen bond is not true chemical bond. It is formed due to polarity of H – F molecules.



Therefore, hydrogen bond is weaker. It just adds to the strength of bonding. Real strength is because of covalent bond.

68. In a very cold winter the fish in garden ponds owe their lives to hydrogen bonding?

Ans: When the temperature of surrounding drops to 0 ºC, ice is formed on the surface of water only. This layer of ice insulates the water underneath from further cooling. Fish and other aquatic life can live under this layer of ice easily. Moreover fresh air containing oxygen easily dissolves in water by passing through air spaces of ice.

69. What is the origin of intermolecular forces in water?

Ans: **Origin of Dipole-Dipole Forces:**

Due to greater electronegativity of oxygen atoms, the shared election pair is closer to oxygen atom creating partial –ve charge on it and corresponding partial +ve charge on covalently bonded hydrogen atoms. Water molecules become polar and dipole-dipole forces start operating.

Origin of Hydrogen bonding:

Smaller size of hydrogen atom and presence of two lone pairs on oxygen atom makes possible the origin of hydrogen bonding in which lone pairs of oxygen are donated to hydrogen atoms of nearby molecules.

70. Boiling needs a constant supply of heat. Justify.

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.

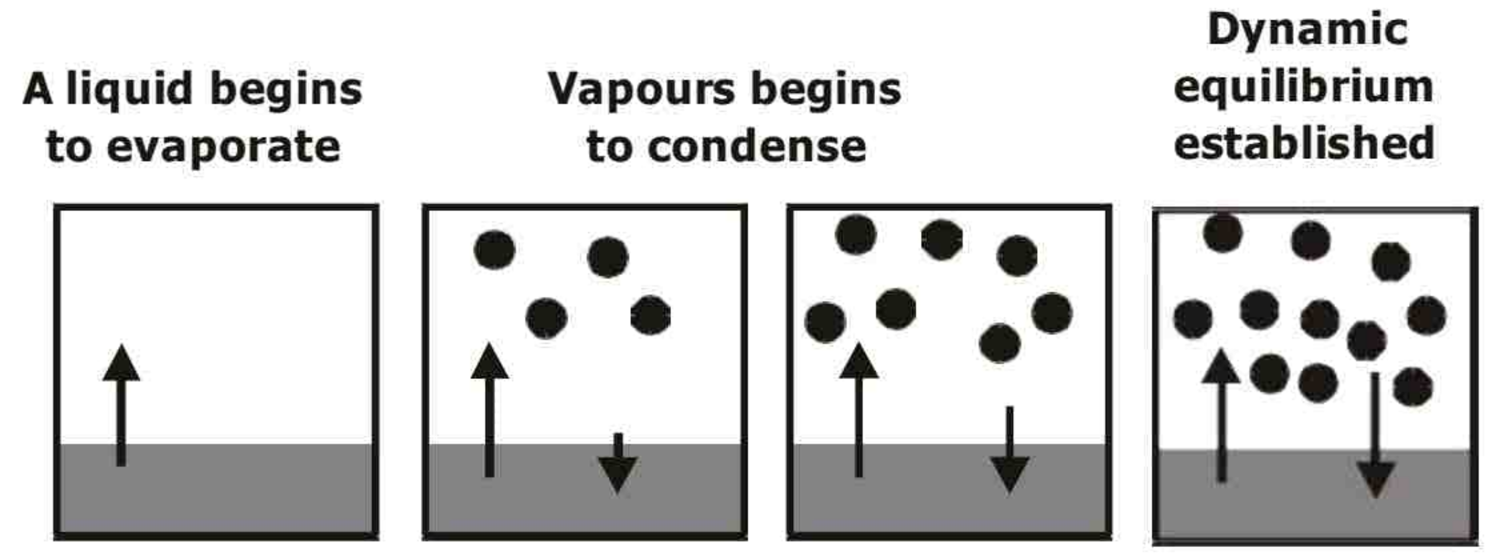
71. Earthenware vessels keep water cool. Justify.

Ans: Earthenware vessels have very small pores in them. Evaporation of high energy molecules of water takes place through these pores as a result of which temperature of liquid falls. Earthen ware vessel is made of clay which keeps that water cool and does not absorb heat energy from surrounding.

72. Dynamic equilibrium is established during evaporation of liquid in a closed vessel at constant 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. 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.

$$\text{Liquid} \rightleftharpoons \text{Vapor}$$



73. Crystals of salts fracture easily, but metals are deformed under stress without fracturing. Explain the difference.

Ans: Crystals of salt fracture easily because salt crystals are mostly ionic in nature and when some stress is applied then same ions come in front of each other. Hence, forces of repulsion are developed between same ions and crystals are broken down showing brittleness. On the other hand, metals have metallic bonding with each other which is very strong and does not allow the metal to break and only deformation occurs.

74. Name the two forms of metal packing.

Ans: Following are the two forms of metal packing:

i. Cubic close packing

ii. Hexagonal close packing

75. What is the difference between cubic close packing and hexagonal close packing?

Ans: Cubic close packing is also called face-centered cubic cell. Closest packed means that the atoms are packed together as closely as possible. In hexagonal close packing layers of spheres are packed so that spheres in alternating layers overlie one another.

76. What happens to conduction of metals with temperature?

Ans: As the temperature increases the conduction of metals decreases as the positive spheres start vibrating about their fixed position, thereby, preventing the flow of free moving electrons.

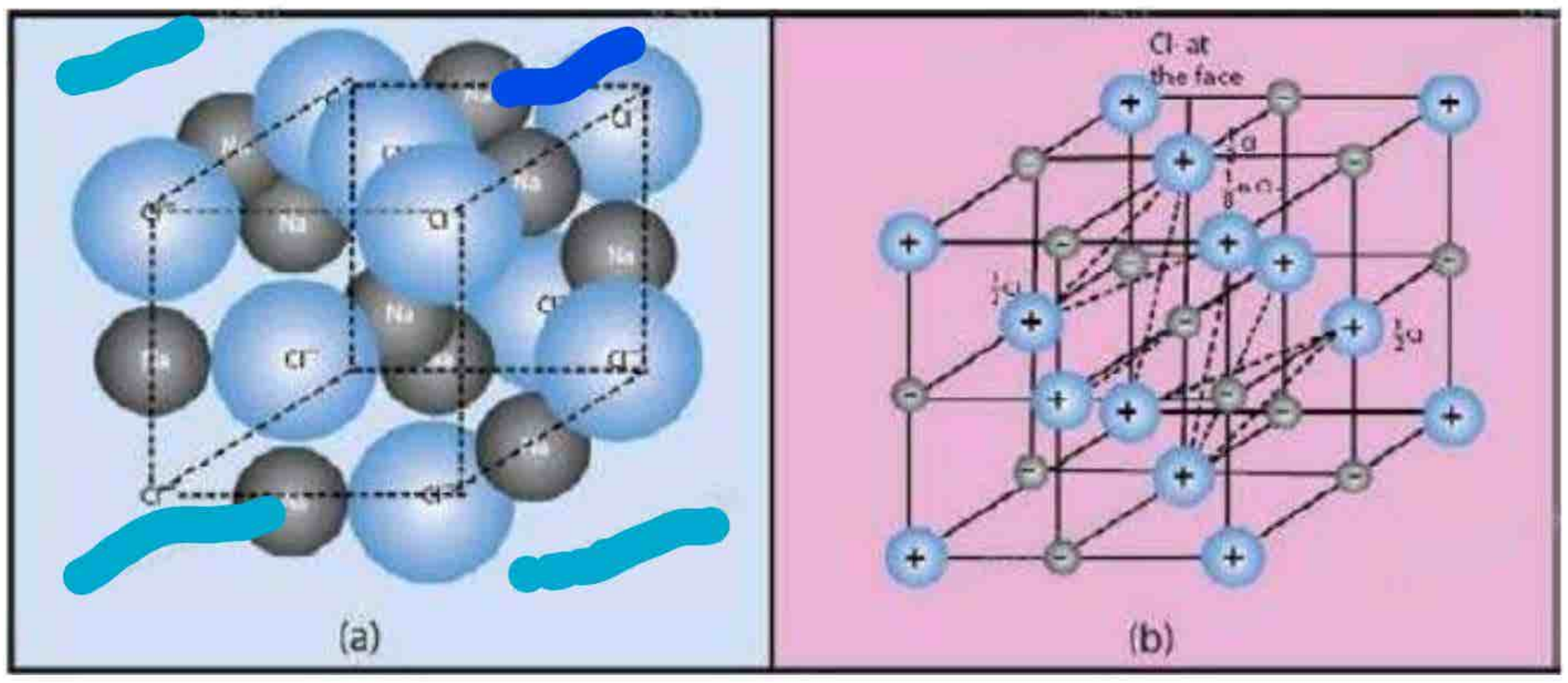
77. Define lattice energy. Give an example.

Ans: The lattice energy is 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/mole. For example, lattice energy of sodium chloride is -787 kJ/mol.

78. Explain structure of sodium chloride.

Ans: In the structure of NaCl each Na^+ ion is surrounded by six chloride ions. The distance between two nearest ions of the same kind i.e., Cl^- ions is 5.63 Å. So the distance between two adjacent ions of different kind is 5.63/2 = 2.815 Å.

The location of Na^+ and Cl^- is such that each Na^+ is surrounded by six Cl^- placed at the corners of a regular octahedron. So the coordination number of each Na^+ is six. Similarly, each Cl^- is also surrounded by six Na^+ ions. There are eight Cl^- at the corners of the cube, and each is being shared amongst eight cubes. $1/8^{th}$ part of each Cl^- ion is considered for this unit cell. So, one complete Cl^- is contributed by eight corners. Similarly, six chloride ions are present at the face centres and each is being shared between two cells. Thus, per unit cell there are 8/8 + 6/2 = 4 Cl^- ions. The presence of 4 Na^+ can be justified if you take a unit cell having $8Na^+$ at eight corners and $6Na^+$ at faces. So, there is equal number of Na^+ ions and four NaCl units are present per unit cell.



79. Define crystal system.

Ans: A crystal system may be identified by the dimensions of its unit cell along its three edges or axes, a, b, c and three angles between the axes α, β , γ. There are seven crystal systems.

80. Explain cubic, tetragonal, orthorhombic, monoclinic, hexagonal, rhombohedral and triclinic system.

Ans:

Sr. No	Crystal system	Axes	Angles	Examples
1.	cubic	$a=b=c$	$\alpha=\beta=\gamma=90^\circ$	Fe, Cu, Ag, Au, NaCl, NaBr, Dimond
2.	Tetragonal	$a=b\neq c$	$\alpha=\beta=\gamma=90^\circ$	Sn, SnO_2, MnO_2, NH_4Br
3.	Orthorhombic	$a\neq b\neq c$	$\alpha=\beta=\gamma=90^\circ$	Idoine, Rhombic, Sulphur, $BaSO_4$, K_2SO_4
4.	Monoclinic	$a\neq b\neq c$	$\alpha=\gamma=90^\circ, \beta\neq 90^\circ$	Sugar, Sulphur, Borax, $NaSO.10H_2O$
5.	Hexagonal	$a=b\neq c$	á=â=90° , â=120°	Graphite, ZnO, CdS, Ice, Zn, Cd
6.	Rhombohedral or Trignol	$a=b=c$	$\alpha=\beta$ ≮ 90° and 120°	Bi, Al_2O_3, $NaNO_3$, KNO_3
7.	Triclinic	$a\neq b\neq c$	$\alpha\neq\beta\neq\gamma\neq 90^\circ$	H_3BO_3, $K_2Cr_2O_7$, $CuSO_4.5H_2O$

(Use this table to write about each type in your own words)

81. Define enthalpy change.

Ans: If a physical or a chemical change takes place at constant pressure, then the heat change during this process is also called enthalpy change. This is denoted by ΔH.

82. Define molar heat of fusion.

Ans: It 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. It is denoted by ΔH_f.

83. Define molar heat of vaporization.

Ans: It is the amount of heat absorbed when one mole of a liquid is changed into vapours at its boiling point. The pressure, during the change is kept one atmosphere. It is denoted by ΔH_v.

84. Define molar heat of sublimation.

Ans: It is the amount of heat absorbed when one mole of a solid sublimes to give one mole of vapours at a particular temperature and one atmospheric pressure. It is denoted by ΔHs.

85. Define molar heat of vaporization.

Ans: The amount of heat required to vapourize one mole of a liquid at its boiling point is called its molar heat of vapourization. The molar heat of vapourization of water is 40.6 $kJmol^{-1}$.

86. Name the method used to determine vapour pressure. Mention the mathematical expression applied.

Ans: The method which is used to determine vapour pressure is called manometric method. Following mathematical equation is used to calculate vapour pressure:

$P = P_a + \Delta h$

P = Vapour pressure of the liquid at one atm pressure.

P= Atmospheric pressure.

Δh = Difference in the heights of the mercury levels in the two limbs of the manometer, giving us the vapour pressure of liquid.

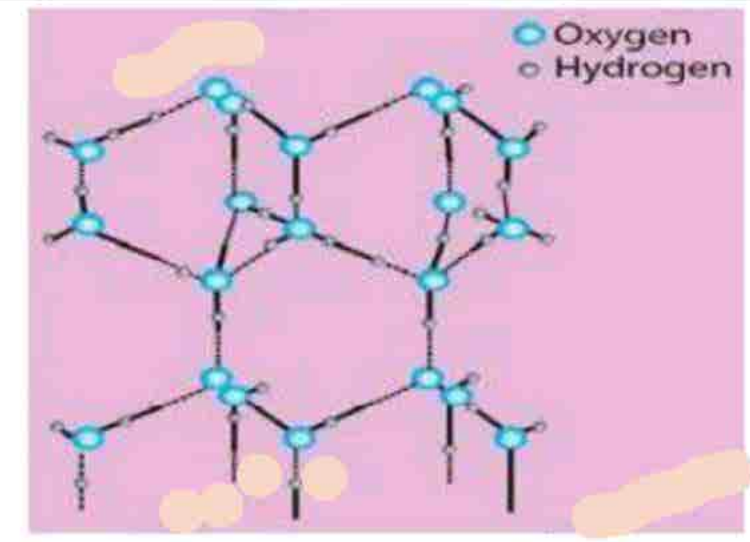
87. Mention the applications of hydrogen bonding.

Ans: Following are the applications of hydrogen bonding:

1. Thermodynamic properties of covalent hydrides
2. Solubility of hydrogen bonded molecules
3. Structure of ice
4. Cleansing action of soaps and detergents
5. Hydrogen bonding in biological compounds and food materials

89. Explain structure of ice.

Ans: The molecules of water have tetrahedral structure. Two lone pairs of electrons on oxygen atom occupy two corners of the tetrahedron. In the liquid state, water molecules are extensively associated with each other and these associations break and are reformed because the molecules of water are mobile. When the temperature of water is decreased and ice is formed then the molecules become more regular and this regularity extends throughout the whole structure. Empty spaces are created in the structure. That is why when water freezes it occupies 9% more space and its density decreases. The result is that ice floats on water. The structure of ice is just like that of a diamond because each atom of carbon in diamond is at the center of tetrahedron just like the oxygen of water molecule in ice.



90. Tell about hydrogen bonding in DNA helical structure and proteins.

Ans: Fibres 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. In the case of right handed helix the groups like >NH and >C=0 are vertically adjacent to one another and they are linked together by hydrogen bonds. These H-bonds link one spiral to the other. X-ray analysis has shown that on the average there are 27 amino acid units for each turn of the helix. Deoxyribonucleic acid (DNA) has two spiral chains. These are coiled about each other on a common axis. In this way, they give a double helix. This is 18-20 Å in diameter. They are linked together by H-bonding between their sub-units.

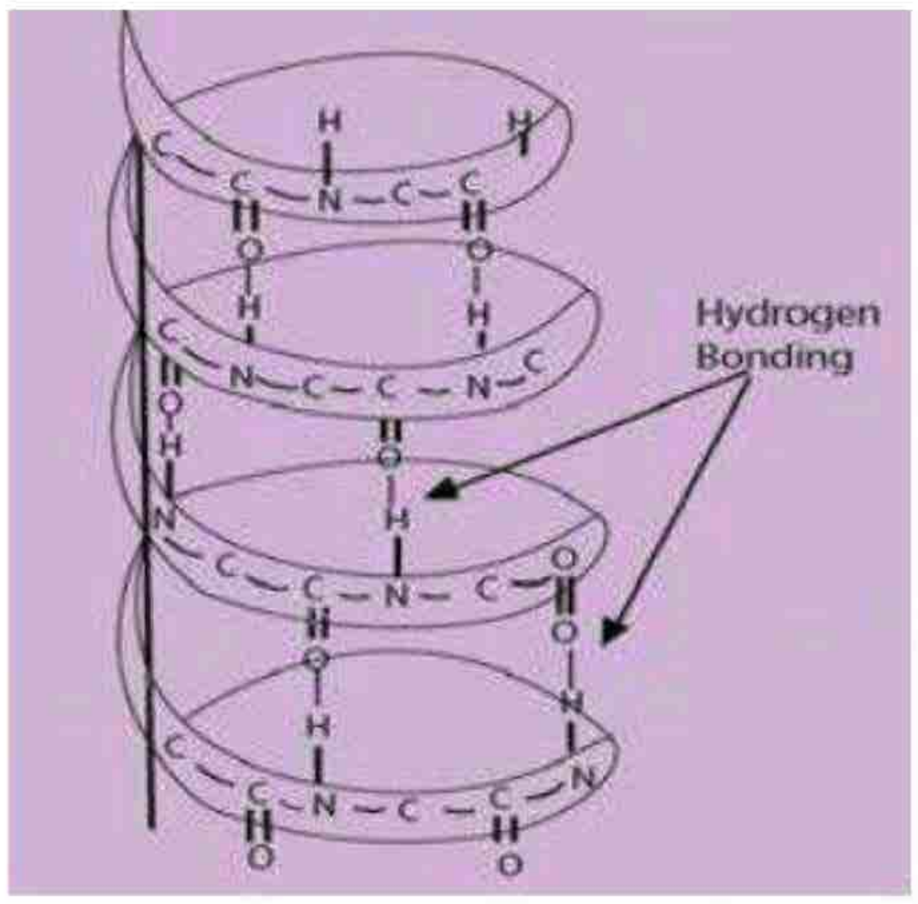


Fig (4.9 a) Hydrogen bonding

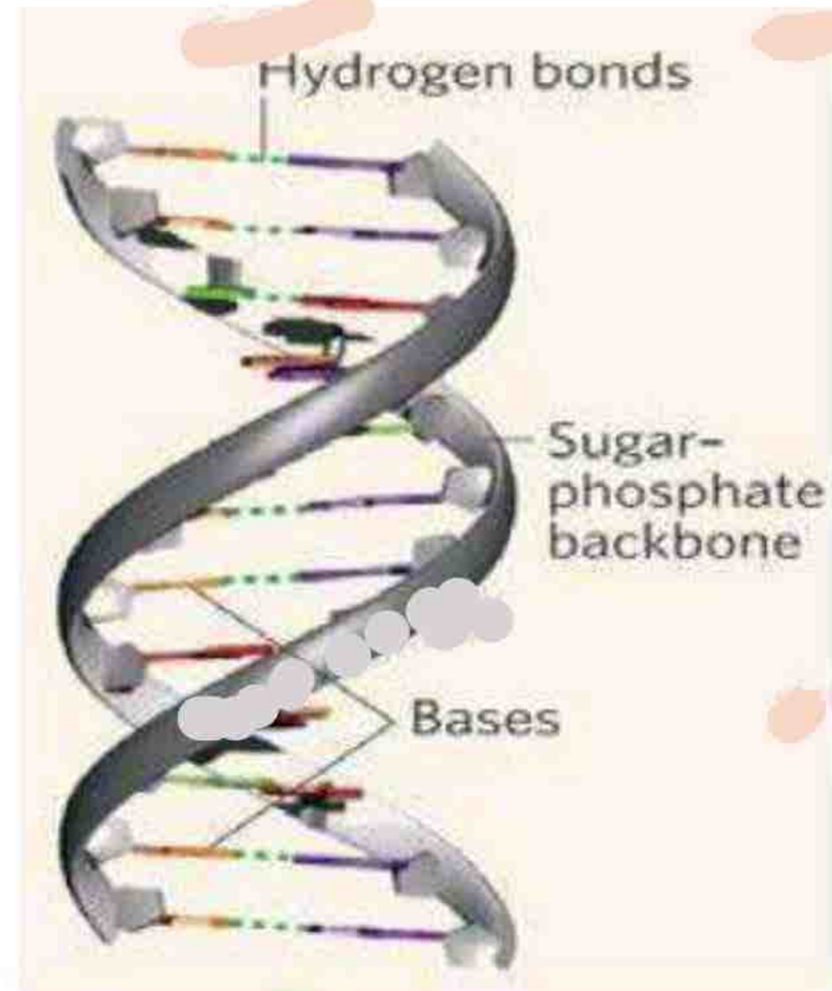


Fig (4.9 b) Hydrogen bonding in DNA double helix

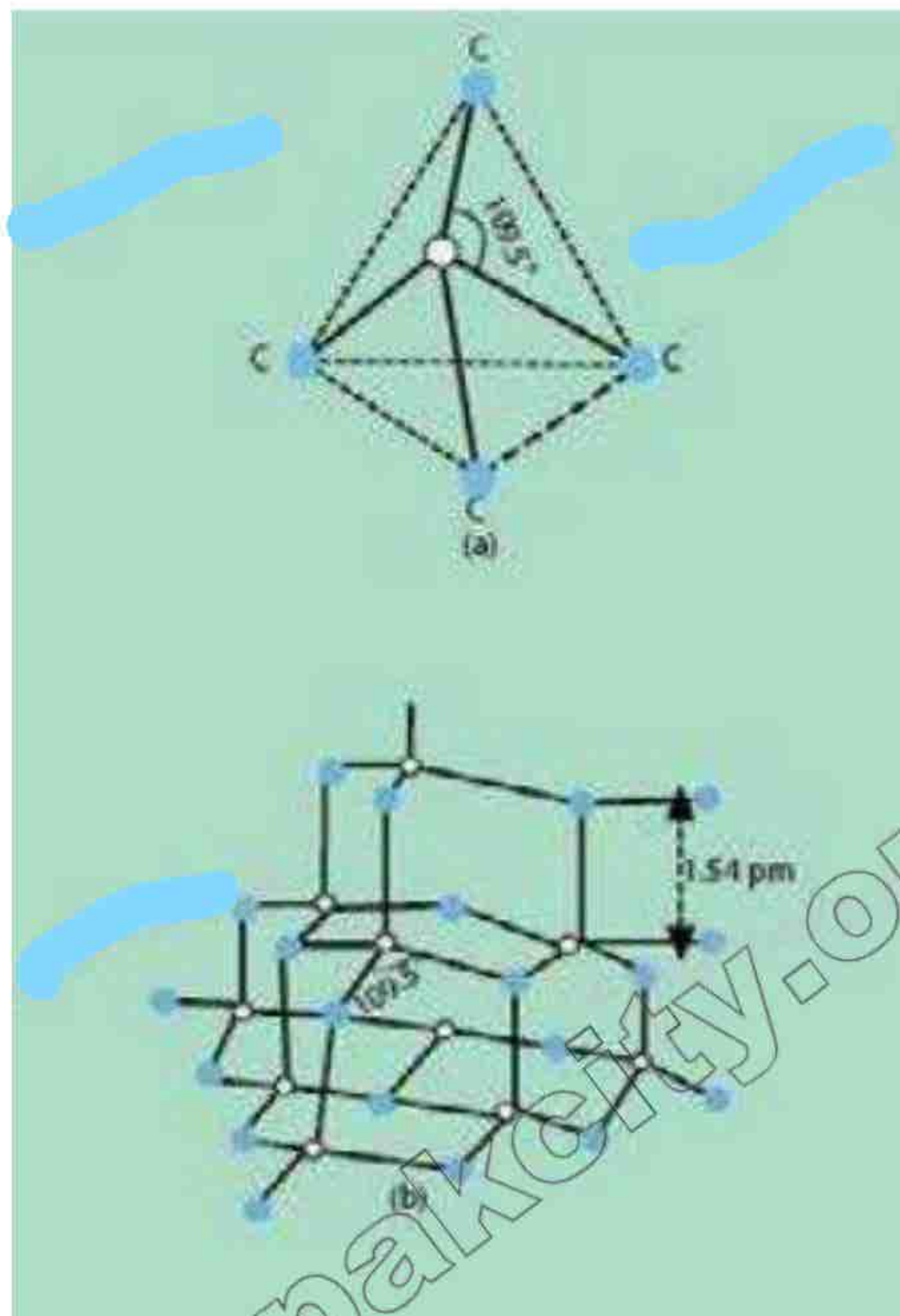
91. Tell about structure of iodine.

Ans: In the solid state the molecules of iodine align in the form of layer lattice. I -I bond distance is 271.5 pm and it is appreciably longer than in gaseous iodine (266.6 pm). As expected from its structure, iodine is a poor conductor of electricity. (draw structure from PTB)

92. Tell about structure of diamond.

Ans: Diamond is one of the allotropic modifications of carbon. It is best understood by taking into consideration the number of electrons in the outermost shell of carbon, which are four. The four atomic orbitals (one 2s and three 2p) undergo sp^3 hybridization to give four sp^3 hybridized orbitals. They are directed in space along the four corners of a tetrahedron. This is the unit cell of diamond and a large number of such unit cells undergo sp^3 -sp^3 overlapping to form a huge structure. Each carbon atom is linked with four other carbon atoms. The bonds between carbon atoms are covalent which run through the crystal in three-dimensions. All the bond angles are 109.5° and the bond lengths are 154 pm.

The whole lattice is, therefore, 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. This is also called a macromolecule. The overall structure of diamond looks face centred-cubic.



93. Ionic crystals don't conduct electricity in the solid state. Justify.

Ans: Current is only carried by moving charged particles. In solid state of the ionic solid, all the ions are held together strongly by strong ionic bonding so they are unable to move and carry electrical current.

94. In the closest packing of atoms of metals, only 74% space is occupied. Justify.

Ans: Cubic close packing is also called ABCABC packing. Although it is close packing even vacant spaces, also called interstices, are left behind which never fill up and occupy 26% empty space in a crystal and only 74% is occupied by atoms.

95. The number of positive ions surrounding the negative ions in the ionic crystal lattice depends upon the sizes of the two ions.

Ans: The crystal structure of ionic compounds depends upon the coordination number of cations. Na^+ ion has smaller size and its coordination number is six because in its neighbor, six Cl^- ions are present. Cs^+ ion has bigger size and its coordination number is eight. In the neighborhood of Cs^+ eight Cl^- ions are present. NaCl has face-centered cubic structure whileCsCl has body centered cubic structure

96. The crystals showing isomorphism mostly have the same atomic ratios. Justify.

Ans: If different substances have same crystalline shape they are called isomorphic substances. Isomorphic substances have same atomic ratio. The crystalline form is independent of chemical nature and depends upon the atomic ratio.

Substance	Crystalline	Atomic ratio
$NaNO_3$, $CaCO_3$	Rhombohedral	1 : 1 : 3
K_2SO_4, K_2CrO_4	Orthorhombic	2 : 1 : 4

97. Cleavage of the crystals is itself anisotropic behavior. Justify.

Ans: The crystals showing different intensities of a given property in different directions are called anisotropic. This phenomenon is called 'Anisotropy'. Cleavage of crystals is an anisotropic property. Crystals have specific cleavage planes and can be divided only in those planes. Example: Mica sheets can be cleaved only parallel to length of sheet and not in any other direction.

98. Amorphous solid like glass is also called super cooled liquid. Justify.

Ans: An amorphous solid like glass has random structure like a liquid which has disarranged structure. Amorphous solid (glass) is formed initially in liquid state afterwards it freezes and becomes hard and rigid but microscopically it looks like just as liquid because of random arrangement of particles. Some of the particles are also in the state of motion, whereas, particles of normal solids can't move. That is why, it is also called super cooled liquid.

99. The vapour pressures of solids are far less than those of liquids. Justify.

Ans: The vapor pressures of solids are lesser than those of liquids because of relatively stronger intermolecular forces among their particles. Due to stronger forces, molecules of solids can't escape easily from the solid.

100. Iodine dissolves readily in teterachloromethane. Justify.

Ans: Iodine is more soluble in CCl_4 because both are non-polar in nature. Non-polar solutes are more soluble in non-polar solvent.

101. Sodium chloride and Caesium chloride have different structures. Justify.

Ans: The crystal structure of ionic compounds depends upon the coordination number of cations. Na^+ ion has smaller size and its coordination number is six because in its neighbor, six Cl^- ions are present. Cs^+ ion has bigger size and its coordination number is eight. In the neighborhood of Cs^+ eight Cl^- ions are present. NaCl has face-centered cubic structure while CsCl has body centered cubic structure.

102. Diamond is hard and electrical insulator. Justify.

Ans: Diamond is an example of covalent solids based on carbon atoms. It is hard because of close packing of sp^3 hybrid carbon atoms which are tightly connected to each other with covalent bonds and form a three dimensional macromolecule. It is non-conductor (insulator) because all the valence electrons of each carbon take part in the bond formation and no one is free to move in the crystal.

103. Sodium is softer than copper, but both are very good electrical conductors. Justify.

Ans: Both sodium and copper have large number of mobile electrons and hence are good conductors. The atomic number (number of protons in nucleus) of copper is 29 and that of sodium is 11. The strength of metallic bonds in Copper is greater due to greater nuclear charge as compared with sodium. So copper is harder than sodium.

104. Define the following:

Ans:

Crystalline Solids

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

Amorphous Solids

The word amorphous means shapeless. Amorphous substances are those whose constituent atoms, ions, or molecules do not possess a regular orderly arrangement. The best examples are glass, plastics, rubber, glue, etc

Cleavage Planes

Whenever the crystalline solids are broken they do so along definite planes. These planes are called the cleavage planes and they are inclined to one another at a particular angle for a given crystalline solid. The value of this angle varies from one solid to another solid.

Anisotropy

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. The physical properties of crystalline solids like refractive index, coefficient of thermal expansion, electrical and thermal conductivities are sometimes anisotropic in nature for some crystals.

Symmetry

The repetition of faces, angles or edges when a crystal is rotated by 360° along its axis is called symmetry. This an important property of the crystal and there are various types of symmetry elements found in crystals like, center of symmetry, plane of symmetry and axis of symmetry, etc.

Habit of a Crystal

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

105. Mention the properties of metallic solids.

Ans: Following are the properties of metallic solids:

1. Metals are good conductor of electricity.

2. The electrical conductivity of metals decrease with the increase in temperature.

3. The thermal conductivity is another property associated with metallic solids.

4. Whenever the metals are freshly cut, most of them possess metallic luster which means that they have a shining surface.

5. Metals are malleable and ductile whenever stress is applied on them.

106. Why do metals have metallic luster?

Ans: When light falls on the metallic surface, the incident light collides with the mobile electrons and they are excited. These electrons when de-excited give off some energy in the form of light. This light appears to be reflected from the surface of the metal which gives a shining look and so metals have a metallic luster.