

Chapter	5 States and Phases of Matter	Class	1 st Year	Subject	Chemistry
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Give Short Answers of the Following Questions

1. Write any four properties of gases.

Ans. Properties of Gases:

- (i) **Indefinite Volume:** Gases have an indefinite volume and occupy all the available space. The volume of a gas is the volume of the container.
- (ii) **Indefinite Shape:** They don't have a definite shape and take the shape of the container just like liquids.
- (iii) **Low Densities:** Due to low densities of gases, as compared to those of liquids and solids but gases bubble through liquids and tend to rise up.
- (iv) **Diffusion and Effusion:** Gases can diffuse and effuse. This property is negligible in solids but operates (works) in liquids as well.

2. Write any four properties of liquids.

Ans. Properties of Liquids:

- (i) **Volume:** Liquids have a fixed volume. The intermolecular forces in liquids are strong enough to maintain a fixed volume.
- (ii) **Shape:** Liquids do not have a fixed shape. They always take the shape of the container in which they are placed. The intermolecular forces are present in liquids but they are not so strong that a liquid called have a fixed shape.
- (iii) **Evaporation:** Due to constant movement and collisions between the liquid molecules, the high energy molecules leave the surface of liquid and the liquid is changed into its vapours. This process is called evaporation. Liquids evaporate at all temperatures.
- (iv) **Diffusion:** A liquid can diffuse into another liquid with which it is miscible. However, the rate of diffusion liquids is slower than in gases. This is due to less empty spaces between the liquid molecules.

3. Give two statements of Boyle's law.

Ans. Boyle's law:

Statement: "The volume of a given mass of a gas at constant temperature is inversely proportional to the pressure applied to the gas".

Mathematically: $V \propto \frac{1}{p}$ (at constant temperature and number of moles)

$$V = \frac{k}{p} \text{ Here 'k' is proportionality constant}$$

$$PV = k \text{ (when 'T' and 'n' are constant)}$$

The value of k is different for the different amounts of the same gas.

Another statement: "The product of pressure and volume of a fixed amount of a gas at constant temperature is a constant quantity".

So, $P_1V_1 = k \text{ and } P_2V_2 = k$

Hence, $P_1V_1 = P_2V_2$

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P_1V_1 are the initial values of pressure and volume while P_2V_2 are the final values of pressure and volume.

4. State Charles's law and write its mathematical form.

Ans. Charles's law: "The volume of the given mass of a gas is directly proportional to the absolute temperature and constant pressure".

Mathematically:

$$V \propto T \text{ (at constant pressure and number of moles)}$$

Or $V = kT$

Or $\frac{V}{T} =$

If temperature is changed from T_1 to T_2 , and volume change from V_1 to V_2 , then

$$\frac{V_1}{T_1} = k \text{ and } \frac{V_2}{T_2} = k$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Another Statement:

"The ratio of volume to temperature remains constant for same amount of gas at same pressure."

5. What is Avogadro's law (of gases)? Give an example.

Ans. Avogadro's law:

"Equal volume of all the ideal gases at the same temperature and pressure contains equal number of molecules."

At STP, one mole of all gases have volume 22.414 dm^3 and $N_A = 6.022 \times 10^{23}$ molecules.

Examples:

At STP,

$$\text{H}_2 = 2\text{g} = 1 \text{ mole} = 22.414 \text{ dm}^3 = 6.02 \times 10^{23} \text{ molecules}$$

$$\text{O}_2 = 32\text{g} = 1 \text{ mole} = 22.414 \text{ dm}^3 = 6.02 \times 10^{23} \text{ molecules}$$

6. Derive molecular mass of a gas by general gas equation.

Ans. We can determine the molecular mass as follows:

Derivation:

$$PV = nRT \quad (\text{general gas equation})$$

Where $n = \frac{\text{mass of gas}}{\text{molecular mass}} = \frac{m}{M}$

So $PV = \frac{m}{M}RT$

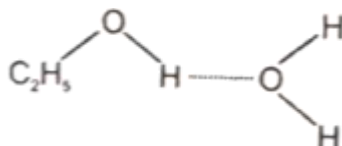
$$M = \frac{m}{V \times P}RT$$

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So by knowing m, V, P, T for a gas, one can determine its molecular mass.

7. Show hydrogen bonding in alcohol and water.

Ans. Lower alcohols like Ethyl alcohol (C_2H_5OH) has the tendency to form hydrogen bonds so they are soluble in water because both can form hydrogen bonds with each other.



8. What do you mean by liquid crystal? Write down any two uses of it.

Ans. Liquid Crystal:

“The turbid liquid phase of a solid that exists in between the melting and clearing temperature is called liquid crystal.”

Crystal $\rightleftharpoons$ Liquid Crystal $\rightleftharpoons$ Liquid

Example: Cholesteryl benzoate.

- It is discovered by Frederick Reinitzer in 1888.

Uses of Liquid Crystals:

- 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 layer of molecules of liquid crystals change. Therefore, the reflected light changes accordingly. Thus liquid crystals can be used as temperature sensors.
- 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.

9. Why ice occupies more volume than liquid water?

Ans. Ice Floats Over the Surface of Water:

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

10. Evaporation takes place at all temperatures. Justify.

Ans. Evaporation:

The spontaneous change of a liquid into its vapours at all temperatures is called evaporation."

Evaporation Takes Place at All Temperatures:

- Rate of evaporation is directly proportional to temperature. At high temperature, the kinetic energy of the molecules increases, so evaporation also increases.

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- At low temperature, the kinetic energy of molecules is less, so rate of evaporation slows down. Thus evaporation continues at all temperatures whether low or high.

11. Why are the vapour pressure of solids far less than those of liquids?

Ans. The magnitude of vapour pressure is inversely proportional to the strength of intermolecular attractive. These forces are stronger in solids as compared to the liquids. Hence, vapour pressure of solids is less than liquids.

12. Define point and molar heat of vaporization.

Ans. Boiling Point: "The temperature at which the vapour pressure of a liquid becomes equal to the atmospheric/external pressure is called boiling point".

Molar Heat of Vaporization: "The amount of heat absorbed when one mole of a liquid is change into vapours dat its boiling point, is called heat of vaporization." The pressure during the change is kept one atmosphere.

Example: Molar heat of vaporization of $H_2O = 40.7 \text{ kJ/mol}$.

13. What are ionic solids? Give two examples.

Ans. Ionic Solids:

"The crystalline solids in which the particles forming the crystal are positively and negatively charged ions which are held together by strong electrostatic forces of attraction (ionic bond) are called ionic solids."

14. Differentiate between intermolecular and intramolecular forces.

Ans.

Intramolecular Forces	Intermolecular Forces
Those forces which are present within the molecules between atoms are called intramolecular forces.	Those forces which are present between two molecules are called intermolecular forces.
Nature of substance is determined by intramolecular forces.	State of a substance (solid, liquid and gas) is determined by intermolecular forces.
Chemical properties of a substance are related to its intermolecular forces.	The physical properties of a substance are related to its intermolecular forces.
These are comparatively strong forces.	These are relatively weak forces.
Examples: - Covalent bond - Ionic bond - Coordinate covalent bond	Examples: - Dipole-dipole forces - Dipole-induced dipole forces - London dispersion forces - Hydrogen bonding

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15. Explain, at a molecular level, why evaporation leads to a cooling effect.

Ans. Evaporation causes a cooling effect because of the loss of high-energy molecules from a liquid's surface 1.

1. Molecules in a Liquid Have Varying Energies

- In any liquid, molecules are in constant motion and have different kinetic energies.
- Some have high energy, others less - this distribution is random.

2. Only the Fastest Molecules Escape

- The highest energy molecules (with enough kinetic energy to overcome intermolecular force escape from the liquid surface and become gas (vapour).
- This process is evaporation.

3. Loss of High-Energy Molecules Lowers Average Energy

- When these high-energy molecules leave, the average kinetic energy of the remaining molecules decreases.
- Since temperature is a measure of average kinetic energy, the temperature of the liquid drops.

16. Explain why liquids with stronger intermolecular forces tend to have lower rates of evaporation at a given temperature compared to liquids with weaker intermolecular forces.

Ans. Liquids with stronger intermolecular forces (like hydrogen bonds or dipole-dipole forces) require more energy for molecules to escape the surface and become vapour.

At a given temperature, fewer molecules have enough energy to overcome these forces, so the rate of evaporation is lower compared to liquids with weaker intermolecular forces, where molecules escape more easily.

17. One feels sense of cooling under the fan after bath. Explain.

Ans. Evaporation is a cooling process and speed of air increases the rate of evaporation. After bath, a thin layer of water is formed on body. When one sits under the fan, the water gets energy from body and Increase in the rate of evaporation is facilitated by speed of air. As a result, one feels sense of due to decrease in body temperature.

18. How a dynamic equilibrium is established during evaporation of a liquid in a closed vessel at constant temperature.

Ans. When a liquid is placed in a closed container at constant temperature:

- **Evaporation starts:** Molecules at the surface escape into the vapour phase.
- **Condensation also begins:** Vapour molecules collide with the liquid surface and re-enter the liquid.

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19. The boiling point of water is different at Lahore and Murree hills.

Ans. The boiling point of a liquid can be decreased by decreasing the external pressure.

Boiling Point of Water at Lahore:

At Lahore, the atmospheric pressure is 750.1 torr and boiling point of water is 99.1 °C (approx.) at this pressure.

Boiling Point of Water at Murree Hills:

At Murree Hills the pressure is 700 torr and boiling point of water is 98°C at this pressure.

20. Discuss two significant consequences of the lower density of ice compared to liquid water in natural environments?

Ans. Two key consequences of ice being less dense than liquid water.

- **Ice Floats on Water:** This insulates lakes and ponds in winter, allowing aquatic life to survive beneath the frozen surface.
- **Prevention of Complete Freezing:** Since ice forms at the surface and floats, it prevents water bodies from freezing solid from the bottom up, preserving ecosystems

21. Why boiling point (B.P) of a liquid increases when the external pressure rises?

Ans. The boiling point of a liquid increases with external pressure because:

Boiling occurs when the vapour pressure of the liquid equals the external pressure.

When the external pressure rises, the liquid must reach a higher temperature to produce enough vapour pressure to match it, thus raising the boiling point

22. Mention four items in which liquid crystals are used.

Ans. Four common items that use liquid crystals:

- Digital watches and clocks
- Laptop and TV screens (LCDs)
- Thermometers (liquid crystal thermometers)
- Mobile phone displays

23. How do you different between crystalline solids and amorphous solids?

Ans. Difference between crystalline and amorphous solids

Property	Crystalline solids	Amorphous solids
Definition	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 substances are those whose constituent atoms, ions or molecules do not possess a regular orderly arrangement.
Shape	They have definite characteristic geometrical shape.	They have irregular shape (word Amorphous means shapeless).
Melting point	They melt at a sharp and characteristic temperature.	They gradually soften over a range of temperature.

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Cleavage plane	When cut with a sharp edged tool, they into two pieces and the newly generated surfaces are plain and smooth.	When cut with a sharp edged tool, they into two pieces with irregular surfaces.
Heat of fusion	They have a definite and characteristic heat of fusion.	They do not have definite heat of fusion.
Anisotropy	These are anisotropic in nature	These are isotropic in nature.
Nature	They are true solids.	They are pseudo solids or super cooled liquids or highly viscous liquids.
Examples	NaCl, Sugar, Ice, Diamond etc.	Rubber, Plastic, Glue, Glass, Paper etc.

24. Propanone (CH_3COCH_3), propanol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$) and butane ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$) have very similar relative molecular masses. List them in the expected order of increasing boiling points. Explain your answer.

Ans. Boiling Point:

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

Order of boiling points is:

Butane < Propanone < Propanol

0°C 56°C 97°C

- Butane is non-polar and it has London dispersion forces.
- Propanone has dipole-dipole forces.
- Propanone has dipole-dipole forces. iii. Propanol has hydrogen bonding.

The strongest intermolecular forces are hydrogen bonding and weakest are London forces, so order of boiling point is same as given above.

25. Discuss how hydrogen bonding is responsible for the relatively high surface tension of water.

Ans. Hydrogen bonding is responsible for the relatively high surface tension of water due to the strong intermolecular attractions between water molecules. Each water molecule can form up to four hydrogen bonds with neighboring water molecules. At the surface, water molecules have fewer neighboring molecules, so they form stronger bonds with the ones beside and below them. This creates an inward cohesive force, pulling surface molecules more tightly together. As a result, water's surface resists external leading to high surface tension.

In Short, Hydrogen bonding causes strong cohesive forces among water molecules, especially at the surface, resulting in high surface tension.

26. What type of intermolecular forces will dominate in the following liquids?

i) NH_3

ii) Ar

iii) CH_3COCH_3

iv) CH_3OH

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- Ans. (i) **NH₃ (Ammonia)**: Hydrogen bonding is present in ammonia molecules.
(ii) **(Ar) (Argon)**: London dispersion forces are present in argon (which is a noble gas).
(iii) **CH₃COCH₃ (Acetone)**: Hydrogen bonding is present in acetone molecules.
(iv) **CH₃OH (Methanol)**: Hydrogen bonding is present in methanol molecules.

13. The boiling point and molar masses of hydrides of some first-row elements are tabulated below:

Substance	Boiling point (K)	Molar Mass (g mol ⁻¹)
CH ₄	112	16
NH ₃	240	17
H ₂ O	373	18

Suggest reasons for the difference in their boiling points in terms of the type of molecules involved and the nature of the forces present between them.

- Ans. • **CH₄**: Methane is a symmetrical and non-polar molecule. It has **London dispersion forces**. Which are very weak so it has low bonding point.
- **NH₃**: Ammonia is a polar molecule. It has **hydrogen bonding** between its molecules. These intermolecular forces are stronger than London forces. Due to these forces, ammonia has high boiling point and heat of vaporization than methane.
 - **H₂O**: Water is a polar molecule. In water molecule strong **hydrogen bonding** is present. Water forms two H-bonds per molecule as a result the affect of hydrogen bonding in water is more than in ammonia. Due to this, boiling point and heat of vaporization of water is very high as compared to methane and ammonia.