# Class: 9th

# Subject: Chemistry

# Chapter 1: States of Matter and Phase Changes

## 1. Exercise MCQs:

**(i) Matter is present in neon signs in the state of:**

(a) Supercritical fluid

(b) Plasma ✅

(c) Gas

(d) Liquid crystal

**(ii) Hazardous effects of shopping bags are studied in:**

(a) Geochemistry

(b) Inorganic Chemistry

(c) Analytical Chemistry

(d) Environmental Chemistry ✅

**(iii) The man-made polymer is:**

(a) Starch

(b) Polystyrene ✅

(c) Protein

(d) Cellulose

**(iv) The crystals of which substance has rhombic shape?**

(a) Brass

(b) Sulphur ✅

(c) Graphite

(d) Bronze

**(v) Which liquid among the following is a colloidal solution?**

(a) Milk ✅

(b) Slaked lime used for white wash

(c) Vinegar solution

(d) Mixture of AgCl in water

**(vi) Which of the following is a heterogeneous mixture?**

(a) A solution of calcium hydroxide in water

(b) A solution of potassium nitrate in water

(c) Hot chocolate

**(d)** Concrete mixture ✅

**(vii) A state of matter whose properties are between those of liquids and crystalline solids:**

**(a)** Liquid crystal ✅

(b) Supercritical fluid

(c) Plasma

(d) Dark matter

**(viii) When the tiny visible particles of a substance are dispersed through a medium, the mixture is named as:**

(a) True solution

(b) Colloid

**(c)** Suspension ✅

(d) Saturated solution

**(ix) A solution of $KClO_3$ has a solubility of about 13.2g per 100 $cm^3$ at 40°C. How will its solubility be affected if you decrease the temperature?**

(a) The solubility will increase

(b) The solubility will decrease ✅

(c) The solubility will remain the same

(d) The solubility will first increase with temperature and then decrease

**(x) You are studying the rate of hydrolysis of starch under different conditions of temperature. In which branch of chemistry does this topic fall?**

(a) Organic Chemistry

(b) Analytical Chemistry

(c) Biochemistry

(d) Physical Chemistry ✅

## Important MCQs

**1. What does chemistry primarily study?**

(A) Social behavior

(B) The human body

(C) Properties, composition, and changes in matter ✅

(D) Laws of motion

**2. What does the structure of matter refer to?**

(A) Shape of the object

(B) Weight of the object

(C) Arrangement of atoms in matter ✅

(D) Size of molecules

**3. Which branch of chemistry explains atomic and molecular behavior?**

(A) Organic Chemistry

(B) Physical Chemistry ✅

(C) Analytical Chemistry

(D) Biochemistry

**4. Inorganic chemistry deals with substances having:**

(A) Only carbon

(B) No atoms

(C) Little or no carbon ✅

(D) Living cells

**5. Organic chemistry is mainly concerned with:**

(A) Salts and acids

(B) Elements from the Earth

(C) Carbon compounds ✅

(D) Radioactive substances

**6. Which branch studies pollution and chemical effects on the environment?**

(A) Medicinal Chemistry

(B) Environmental Chemistry ✅

(C) Nuclear Chemistry

(D) Astrochemistry

**7. The analysis and identification of substances is**

done in:

(A) Biochemistry

(B) Analytical Chemistry ✅

(C) Geochemistry

(D) Organic Chemistry

8. Which branch deals with chemical reactions inside living organisms?

(A) Biochemistry ✅

(B) Physical Chemistry

(C) Inorganic Chemistry

(D) Polymer Chemistry

9. Nuclear chemistry studies:

(A) Chemical bonding

(B) Reactions outside the atom

(C) Reactions in the nucleus of atoms ✅

(D) Crystal structure

10. What are polymers made of?

(A) Random molecules

(B) Linked building blocks ✅

(C) Single atoms

(D) Ions

**11. The branch focused on Earth's chemical composition is:**

(A) Astrochemistry

(B) Organic Chemistry

(C) Geochemistry ✅

(D) Physical Chemistry

**12. Medicinal chemistry aims to:**

(A) Create building materials

(B) Study animals

(C) Design and synthesize useful drugs ✅

(D) Analyze soil samples

**13. Which branch studies molecules in space?**

(A) Geochemistry

(B) Astrochemistry ✅

(C) Biochemistry

(D) Environmental Chemistry

**14. What does determination of composition involve?**

(A) Measuring weight

(B) Observing shape

(C) Finding percentages of elements in matter ✅

(D) Calculating speed

**15. Which of the following is NOT studied in inorganic chemistry?**

(A) Metals

(B) Acids

(C) Hydrocarbons ✅

(D) Salts

**16. Which of the following is NOT one of the three primary states of matter?**

(A) Solid

(B) Liquid

(C) Plasma

(D) Gas ✅

**17. Why are gases easily compressible?**

(A) They have high density

(B) Their molecules are widely apart and have weak intermolecular forces ✅

(C) Their particles are closely packed

(D) They have a fixed volume

**18. Which state of matter has definite shape and volume?**

(A) Gas

(B) Liquid

(C) Plasma

(D) Solid ✅

**19. Plasma exists in which of the following?**

(A) Ice cubes

(B) Rain

(C) Fluorescent tubes ✅

(D) Paper

**20. What is a supercritical fluid?**

(A) A solid with liquid properties

(B) A compressed state with both gas and liquid properties ✅

(C) A type of plasma

(D) A crystal that conducts electricity

**21. What is the simplest form of matter?**

(A) Compound

(B) Mixture

(C) Atom

(D) Element ✅

**22. Which of the following cannot be broken down into simpler substances by ordinary chemical reactions?**

(A) Compound

(B) Mixture

(C) Element ✅

(D) Solution

**23. Most of the elements found in nature exist in which physical state?**

(A) Gas

(B) Liquid

(C) Solid ✅

(D) Plasma

**24. Which of the following is an example of a noble gas?**

(A) Nitrogen

(B) Oxygen

(C) Helium ✅

(D) Chlorine

**25. A compound is made up of:**

(A) Only one type of atom

(B) Two or more different elements combined chemically ✅

(C) Molecules of same element

(D) A single kind of ion

**26. Which of the following is a compound?**

(A) Helium

(B) Ammonia ✅

(C) Sodium

(D) Oxygen

**27. What type of substance is air?**

(A) Element

(B) Compound

(C) Homogeneous mixture ✅

(D) Atom

**28. A heterogeneous mixture is one in which:**

(A) The composition is the same throughout

(B) Different parts have different compositions ✅

(C) All particles are identical

(D) Only gases are present

**29. Which of the following is an example of a homogeneous mixture?**

(A) Air ✅

(B) Soil

(C) Rock

(D) Granite

**30. Compounds can be classified into:**

(A) Metals and non-metals

(B) Solutions and suspensions

(C) Organic and inorganic ✅

(D) Elements and isotopes

**31. What is the phenomenon called when an element exists in more than one structural form?**

(A) Isomerism

(B) Crystallization

(C) Allotropy ✅

(D) Polymerization

**32. Which of the following are allotropic forms of carbon?**

(A) Graphite, Ozone, Diamond

(B) Diamond, Graphite, Buckminster Fullerene ✅

(C) Graphite, Carbon dioxide, Charcoal

(D) Buckminster Fullerene, O2, CO

**33. Which carbon allotrope has a layered hexagonal ring structure?**

(A) Diamond

(B) Graphite ✅

(C) Fullerene

(D) Carbon monoxide

**34. Buckminster Fullerene ($C_{60}$) has what kind of structure?**

(A) Sheet-like

(B) Chain-like

(C) Cage-like ✅

(D) Ring-like

**35. Which crystalline allotrope of sulphur is more stable?**

(A) Monoclinic

(B) Rhombic ✅

(C) Amorphous

(D) Liquid sulphur

**36. In which type of mixture are solute particles completely dissolved in the solvent?**

(A) Suspension

(B) Colloidal Solution

(C) True Solution ✅

(D) Emulsion

**37. Which mixture shows visible particles that settle down over time?**

(A) True Solution

(B) Colloidal Solution

(C) Suspension ✅

(D) Homogeneous Mixture

**38. Which type of solution allows solute particles to pass through filter paper but are not completely**

**dissolved?**

(A) Suspension

(B) Colloidal Solution ✅

(C) True Solution

(D) Solid Mixture

**39. An example of a suspension is:**

(A) Sugar in water

(B) Starch in water

(C) Chalk in water ✅

(D) Salt in water

**40. Which statement is true about colloidal solutions?**

(A) Particles settle down when kept undisturbed

(B) Particles can be seen with naked eye

(C) Particles pass through filter paper ✅

(D) Particles are smaller than in true solution

**41. What is an unsaturated solution?**

(A) A solution that cannot dissolve any more solute

(B) A solution in which solute settles at the bottom

(C) A solution that can dissolve more solute at a given temperature ✅

(D) A solution with insoluble particles

**42. When no more solute can dissolve in a solution at a particular temperature, it is called:**

(A) Colloidal solution

(B) Homogeneous solution

(C) Unsaturated solution

(D) Saturated solution ✅

**43. What happens to the extra solute when added to a saturated solution?**

(A) It dissolves instantly

(B) It reacts with the solvent

(C) It remains suspended in solution

(D) It settles down at the bottom ✅

**44. At 20°C, which solute has higher solubility in water?**

(A) Sodium chloride

(B) Table sugar ✅

(C) Chalk

(D) Copper sulfate

**45. Why can more sugar dissolve in water compared to salt?**

(A) Sugar has smaller molecules

(B) Salt is more soluble

(C) Water molecules surround large sugar molecules more easily ✅

(D) Sugar forms weak bonds with water

**46. What is the general effect of increasing temperature on the solubility of most solid solutes in water?**

(A) Solubility decreases

(B) Solubility remains constant

(C) Solubility increases ✅

**47. Which of the following compounds shows a decrease in solubility with an increase in**

**temperature?**

(A) Potassium nitrate ($KNO_3$)

(**B**) Calcium chromate ($CaCrO_4$) ✅

(C) Sodium nitrate ($NaNO_3$)

(D) Silver nitrate ($AgNO_3$)

**48. What happens to the solubility of gases in water when temperature increases?**

(A) It increases

(**B**) It decreases ✅

(C) It remains unchanged

(D) Gas turns into liquid



## 2. Exercise Short Questions:

**i. Why is there a need to divide Chemistry into many branches? Give three reasons.**

**Answer**:

- Chemistry is divided into branches for the following reasons:

1. Complexity of the subject – Chemistry covers a vast range of topics which are easier to understand when categorized.

2. Specialization – Scientists can focus on specific fields (e.g., organic, physical, environmental) to make deeper advancements.

3. Practical applications – Different branches deal with different real-world applications like medicines, environment, industries, and agriculture.

**ii. Reactions may take place due to electrons present outside the nucleus or they may take place inside the nucleus. Which branches of Chemistry cover these two types of reactions?**

**Answer**:

Reactions due to outer electrons are studied in General Chemistry (especially Organic, Inorganic, and Physical Chemistry).

Reactions inside the nucleus are studied in Nuclear Chemistry.

**iii. What types of problems are solved in Analytical**

**Chemistry?**

**Answer:**

- **Analytical Chemistry solves problems related to:**
  - Identifying unknown substances
  - Determining the composition of mixtures
  - Measuring the concentration of elements or compounds in a sample
  - Ensuring product quality in industries

**iv. Both graphite and graphene have hexagonal layered structures. What is the difference?**

**Answer:**

Graphite is made up of multiple layers of hexagonally arranged carbon atoms.

Graphene consists of only a single layer of carbon atoms arranged in a hexagonal pattern.

**v. Why are supercritical fluids important?**

**Answer:**

- **Supercritical fluids are important because:**

- They show properties of both gases and liquids.
- They can dissolve substances that are hard to dissolve otherwise.
- They are used in environmentally friendly chemical processes, like extracting caffeine or carrying out reactions in supercritical $CO_2$.

**vi. In which state does matter exist in the Sun?**

**Answer**:

Matter in the Sun exists in the plasma state, which consists of highly energetic ions and electrons.

**vii. What is the importance of graphene?**

**Answer**:

**Graphene is important because:**

- It is light, strong, and flexible.
- It has excellent electrical and thermal conductivity.
- It is used in electronics, sensors, batteries, and display technologies.

**viii. Which form of matter do most of the material**

**things in this world belong to?**

**Answer:**

Most of the material things in this world exist in the solid state of matter.

## Important Short Questions:

**1. What is Chemistry?**

**Answer:**

Chemistry is the branch of science that deals with the properties, composition, and structure of substances, along with the physical and chemical changes they undergo and the laws governing these changes.

**2. What is meant by the structure of matter?**

**Answer:**

The structure of matter refers to the arrangement of atoms or molecules in a substance.

**3. What is the difference between physical and chemical changes in Chemistry?**

**Answer:**

- Physical change affects only the physical state or appearance without changing the chemical composition.
- Chemical change results in the formation of new substances with different properties.

**4. Why is Chemistry divided into branches?**

**Answer:**

Due to its vastness and complexity, Chemistry is divided into branches to allow focused study, enable specialization, and promote scientific advancements in specific areas.

**5. What does Physical Chemistry study?**

**Answer:**

Physical Chemistry studies atomic and molecular behavior, reaction rates, and how physical laws govern chemical processes.

**6. What is Inorganic Chemistry?**

**Answer**:

Inorganic Chemistry is the study of the composition, structure, and properties of substances that contain little or no carbon, such as metals, salts, acids, and bases.

**7. Define Organic Chemistry.**

**Answer**:

Organic Chemistry is the study of carbon compounds (excluding simple salts like carbonates and oxides) including their structure, properties, formation, and reactions.

**8. What is the importance of Environmental Chemistry?**

**Answer**:

Environmental Chemistry helps in understanding the chemical reactions occurring in the air, water, and soil, and studies the causes and solutions of pollution.

**9. What is the role of Analytical Chemistry?**

**Answer:**

Analytical Chemistry deals with the separation,

identification, and determination of the composition of substances, often using modern instruments.

**10. What is the function of Medicinal Chemistry?**

**Answer:**

Medicinal Chemistry focuses on the design, synthesis, and study of medicines, including how drugs are absorbed and metabolized in the human body.

**11. What is matter?**

**Answer:**

Matter is anything that has mass and occupies space. It is different from energy and exists in various physical forms like solids, liquids, gases, and plasma.

**12. Name the four common states of matter observed in everyday life.**

**Answer:**

- **The four common states of matter are:**

1. Solid

2. Liquid

3. Gas

4. Plasma

**13. Why are gases easily compressible compared to solids and liquids?**

**Answer:**

Gases are easily compressible because their molecules are widely spaced, have weak intermolecular forces, and can move freely in all directions.

**14. What is plasma and where is it found?**

**Answer:**

Plasma is a state of matter consisting of high-energy particles like electrons and ions. It is found in fluorescent tubes, lightning, and welding arcs.

**15. What are supercritical fluids?**

**Answer:**

Supercritical fluids are highly compressed states of

matter that exhibit both gas and liquid properties. They are used in chemical reactions and industrial processes, such as supercritical carbon dioxide in solvent extraction.

**16. What is an element?**

**Answer**:

An element is the simplest form of matter that contains only one kind of atom. It cannot be broken down into simpler substances by ordinary chemical reactions.

**17. Give two examples each of solid, liquid, and gaseous elements.**

**Answer**:

- **Solid elements:** Gold, Iron
- **Liquid elements**: Mercury, Bromine
- **Gaseous elements**: Oxygen, Nitrogen

**18. What is a compound?**

**Answer**:

A compound is a pure substance made of two or

more different elements chemically combined in a fixed ratio, forming strong chemical bonds.

**19. What is the difference between a homogeneous and a heterogeneous mixture?**

**Answer**:

- A homogeneous mixture has uniform composition throughout (e.g., salt in water).
- A heterogeneous mixture has non-uniform composition (e.g., soil, rock).

**20. Give two examples each of compounds and mixtures.**

**Answer:**

Compounds: Water ($H_2O$), Carbon dioxide ($CO_2$)

Mixtures: Air, Milk

**21. What is meant by allotropy?**

**Answer**:

Allotropy is the phenomenon in which an element exists in two or more different structural forms in the same physical state, showing different physical

and chemical properties.

**22. Name three allotropic forms of carbon and describe one.**

**Answer**:

- **The three allotropic forms of carbon are:**

1. Diamond – a hard substance with a macromolecular structure.

2. Graphite – composed of layers of hexagonal carbon rings.

3. Buckminster fullerene ($C_{60}$) – a soft, spherical molecule made of pentagons and hexagons.

**23. Which two allotropic forms of sulphur are known, and which one is more stable?**

**Answer**:

Sulphur exists in two allotropic forms: rhombic sulphur and monoclinic sulphur.

Rhombic sulphur is the more stable form.

**24.. What is a true solution?**

**Answer:**

A true solution is a homogeneous mixture in which the solute particles are completely dissolved in the solvent. The particles cannot be seen with the naked eye and pass through filter paper without leaving any residue.

**Example**: Salt in water.

**25. What is a suspension?**

**Answer**:

A suspension is a heterogeneous mixture in which the solute particles do not dissolve in the solvent. These particles are visible, and if left undisturbed, they settle down. They do not pass through filter paper.

**Example**: Chalk in water.

**26. What is a colloidal solution?**

**Answer**:

A colloidal solution is a mixture in which the solute particles are larger than those in a true solution but smaller than those in a suspension. They do not settle down on standing and pass through filter

paper, though they are not completely dissolved.

**Example**: Starch solution, white of an egg.

**27. What is an unsaturated solution?**

**Answer:**

An unsaturated solution is a solution that can dissolve more solute at a given temperature. No solute settles at the bottom in this state.

**28. What is a saturated solution?**

**Answer:**

A saturated solution is a solution in which the maximum amount of solute has been dissolved in a given amount of solvent at a specific temperature. Any extra solute added remains undissolved.

**29.. Why does sugar dissolve in greater amounts in water than salt?**

**Answer**:

Sugar dissolves more than salt in water because sugar molecules are larger, allowing more water molecules to surround each sugar molecule,

increasing its solubility.

**30. What is solubility?**

**Answer**:

Solubility is the amount of solute that can dissolve in 100 grams of a solvent at a specific temperature to form a saturated solution.

**31. How does temperature affect the solubility of most solids in water?**

**Answer**:

For most solid solutes, solubility increases with an increase in temperature, such as $KNO_3$, $AgNO_3$, and KCl.

**32. What happens to the solubility of gases in water when temperature increases?**

The solubility of gases in water decreases as the temperature increases.

## Important Long Questions:

🌟 **Q1: What is Chemistry? Write a detailed note**

on its importance and major branches.

- **Introduction:**

Chemistry is the branch of science that deals with the properties, composition, structure, and changes of matter. It helps us understand how substances interact, how new substances are formed, and how energy is transferred during these changes.

- **Importance of Chemistry:**
  - Chemistry is involved in daily life: cooking, cleaning, medicines, fuel, etc.
  - It plays a key role in industries, agriculture, and environmental protection.
  - Chemistry helps develop new materials, such as plastics, medicines, and electronics.
- **Major Branches of Chemistry:**

1. Physical Chemistry

Studies the physical structure of matter, energy changes, and reaction rates.

2. Inorganic Chemistry

Deals with non-carbon compounds like salts, acids, and bases.

### 3. Organic Chemistry

Concerned with carbon-containing compounds like fuels, plastics, and pharmaceuticals.

### 4. Environmental Chemistry

Focuses on the chemical processes in the environment and studies pollution and its control.

### 5. Analytical Chemistry

Involves the identification and measurement of substances using modern instruments.

### 6. Biochemistry

Studies the chemical processes in living organisms, like DNA, proteins, and enzymes.

### 7. Nuclear Chemistry

Deals with radioactivity and nuclear reactions, such as those in nuclear energy and medicine.

### 8. Polymer Chemistry

Studies large molecules (polymers) like plastics and

natural proteins.

### 9. Geochemistry

Studies the chemical composition of the Earth and its minerals.

### 10. Medicinal Chemistry

Focuses on designing and developing medicines for human use.

### 11. Astrochemistry

Studies the chemistry of space, such as molecules in stars and planets.

💡 **Summary**:

Chemistry is a vital science that explains the material world around us. Its different branches help in understanding nature, solving global challenges, and improving human life in all aspects.

🌟 **Q2: Describe any six major branches of Chemistry and explain their scope with examples.**

🔹 **Introduction**:

Chemistry has a wide scope. To make it easier to

study, it is divided into various branches, each focusing on specific aspects of matter and its behavior.

- **Six Major Branches and Their Scope:**

### 1. Physical Chemistry

Studies physical changes, energy flow, and molecular structure.

Example: Rate of reactions, equilibrium, thermodynamics.

### 2. Organic Chemistry

Studies carbon-based compounds.

Example: Fuels, plastics, medicines, alcohols.

### 3. Inorganic Chemistry

Deals with compounds that are not carbon-based.

Example: Acids, bases, salts, metals.

### 4. Analytical Chemistry

Identifies components of mixtures and compounds.

Example: Blood testing, food quality testing.

5. Biochemistry

Studies chemical processes in living things.

Example: DNA, hormones, enzymes, digestion.

6. Environmental Chemistry

Studies chemicals in the air, water, and soil.

Example: Pollution control, wastewater treatment.

💡 **Summary**:

Each branch of chemistry plays a unique role in science and society. From solving health problems to protecting the environment, chemistry helps in understanding and shaping the modern world.

🌟 **Q3: How is Chemistry divided into different branches and why is this division important? Explain with examples.**

- **Introduction:**

Chemistry is a vast subject. To study it efficiently, it is divided into specialized branches, each focusing on a particular type of material or method.

- **Importance of Division:**

- Helps in focused research.
- Allows scientists to specialize in a particular field.
- Makes it easier to solve specific problems (e.g. medicine, pollution, energy).

## Branches with Examples:

1. Physical Chemistry – Studies energy and physical properties.

**Example**: Studying reaction rates.

2. Organic Chemistry – Studies carbon-based compounds.

**Example**: Making synthetic drugs.

3. Inorganic Chemistry – Non-carbon substances.

**Example**: Analysis of metals and salts.

4. Analytical Chemistry – Identifies substances.

**Example**: Testing water quality.

5. Environmental Chemistry – Studies pollution and its control.

**Example**: Analyzing air pollution.

6. Biochemistry – Studies chemistry in living organisms.

**Example**: Understanding enzymes.

7. Polymer Chemistry – Studies plastics and synthetic fibers.

**Example**: Making plastic bottles.

💡 **Summary**:

Dividing chemistry into branches makes it easier to explore deeply into specific areas of interest. It leads to better understanding, scientific innovation, and solution of real-world problems.

🌟 **Q4: Define matter. Explain in detail the main states of matter with their properties and differences.**

**Answer:**

**1. Introduction:**

Matter is anything that occupies space and has mass. Everything around us that is not energy is considered matter. It exists in different physical forms called states of matter.

## 2. Definition of Matter:

Matter is defined as any substance that has mass and occupies volume.

## 3. Main States of Matter:

### (i) Solid:

- Particles are tightly packed.
- They have strong intermolecular forces.
- Fixed shape and volume.
- Incompressible and rigid.
- High density.

### (ii) Liquid:

- Particles are less tightly packed than solids.
- Moderate intermolecular forces.
- No fixed shape but fixed volume.
- Slightly compressible.
- Medium density.

### (iii) Gas:

- Particles are far apart.

- Very weak intermolecular forces.
- No fixed shape or volume.
- Highly compressible.
- Low density.

**4. Differences Between Solid, Liquid, and Gas:**

| Property | Solid | Liquid | Gas |
|---|---|---|---|
| Shape | Fixed | Not fixed | Not fixed |
| Volume | Fixed | fixed | Not fixed |
| Particle Motion | Vibrate in place | Move freely within | Move freely in all directions |
| Density | High | Medium | Low |
| Compressibility | Not compressible | Slightly compressible | Highly compressible |
| Intermolecular Forces | Strong | Moderate | Weak |

🌟 **Q5: Define element, compound, and mixture with examples. Also explain the difference between them.**

- **Introduction**:

Matter is anything that has mass and occupies space. It exists in three basic forms: elements, compounds, and mixtures. Understanding the difference between them is essential in chemistry because their structure, composition, and behavior differ greatly.

- **Element:**

An element is the simplest form of a pure substance that cannot be broken down into simpler substances by ordinary chemical means. All atoms in an element are of the same type.

**Examples**:

- Hydrogen ($H_2$) — a gaseous element
- Oxygen ($O_2$) — essential for respiration
- Iron (Fe) — solid metal used in construction
- Chlorine ($Cl_2$) — a greenish-yellow poisonous

gas used in water treatment

**Types of Elements:**

- Metals: e.g., Iron, Copper
- Non-Metals: e.g., Oxygen, Nitrogen
- Metalloids: e.g., Silicon
- Noble Gases: e.g., Helium, Neon

🔹 **Compound**:

A compound is a pure substance formed by the chemical combination of two or more different elements in a fixed ratio. The atoms in a compound are bonded together chemically.

**Examples:**

- Water ($H_2O$) – formed by hydrogen and oxygen
- Carbon dioxide ($CO_2$) – used in soft drinks
- Sodium chloride (NaCl) – common table salt
- Methane ($CH_4$) – a gas used as fuel

**Types of Compounds:**

- Molecular compounds (e.g., water)

- Ionic compounds (e.g., sodium chloride)
- Organic compounds (contain carbon, e.g., proteins)
- Inorganic compounds (e.g., HCl, $KNO_3$)

### Mixture:

A mixture is a combination of two or more substances (elements or compounds) that are not chemically bonded. The components retain their individual properties.

**Examples**:

**Air** – a mixture of nitrogen, oxygen, carbon dioxide, etc.

**Soil** – a mixture of minerals, organic matter, and microorganisms

**Milk** – a colloidal mixture

**Salt water** – a homogeneous mixture of salt in water

### Types of Mixtures:

Homogeneous mixture – uniform composition (e.g.,

sugar in water)

Heterogeneous mixture – non-uniform composition (e.g., sand in water)

🌟 **Q6: What is a solution? Explain its characteristics with examples.**

- **Definition:**

A solution is a homogeneous mixture in which one substance (called the solute) is completely dissolved in another substance (called the solvent). The particles of solute are so small that they are not visible to the naked eye and cannot be separated by filtration.

- **Characteristics of a True Solution:**

**1. Homogeneous Mixture**

A solution is uniform throughout. Its components cannot be distinguished by looking at it.

**2. Very Small Solute Particles**

The size of the particles is less than 1 nanometer. Hence, they do not scatter light.

### 3. Stable Mixture

The solute does not settle down even after long periods of standing.

### 4. Invisible Particles

The particles of solute cannot be seen through the naked eye or microscope.

### 5. Passes Through Filter Paper

A true solution can easily pass through any filter paper without leaving any residue.

### 6. No Tyndall Effect

A true solution does not scatter light, hence no Tyndall effect is observed.

- **Examples**:
  - Salt in water (Sodium chloride solution)
  - Sugar in water
  - Copper sulphate in water
- **Everyday Applications:**
  - In pharmaceuticals to make liquid medicines

- In chemistry laboratories for titration
- In cooking for making tea or saltwater

🌟 **Q7: Differentiate between True Solution, Colloidal Solution, and Suspension (Point-wise Detailed Answer)**

🔹 **1. Nature of Mixture**

**True Solution:**

- Completely homogeneous mixture.
- Solute particles are fully dissolved and evenly distributed.

**Colloidal Solution:**

- Apparently homogeneous but actually heterogeneous.
- Solute particles are dispersed but not completely dissolved.

**Suspension:**

- Clearly a heterogeneous mixture.
- Solute particles remain distinct and separate from the solvent.

### 2. Particle Size

**True Solution:**

- Particle size is less than 1 nanometer (nm).

**Colloidal Solution:**

- Particle size is between 1 nm and 1000 nm.

**Suspension:**

- Particle size is greater than 1000 nm.

### 3. Visibility of Particles

**True Solution:**

- Particles are not visible to the naked eye.

**Colloidal Solution:**

- Particles are not visible, but can be seen under a microscope.

**Suspension:**

- Particles are clearly visible to the naked eye.

### 4. Stability

**True Solution:**

- Very stable, particles do not settle down.

**Colloidal Solution**:

- Fairly stable, particles do not settle on standing.

**Suspension:**

- Unstable, particles settle down if left undisturbed.

### 5. Filtration

**True Solution:**

- Particles pass through filter paper, no residue left.

**Colloidal Solution:**

- Particles also pass through filter paper.

**Suspension**:

- Particles do not pass through filter paper, residue is collected.

### 6. Tyndall Effect (Light Scattering)

**True Solution:**

- Does not show Tyndall effect.

**Colloidal Solution:**

- Shows Tyndall effect due to scattering of light.

**Suspension**:

- May show Tyndall effect only for a short time.

🔹 **7. Examples**

**True Solution:**

- Sugar in water, salt in water, copper sulfate in water.

**Colloidal Solution:**

- Milk, starch solution, egg white.

**Suspension**:

Chalk in water, muddy water, flour in water.

🌟 **Q8: Explain the Effect of Temperature on the Solubility of Solutes. Give Examples.**

**Answer**:

🔹 **Introduction**

Solubility is defined as the amount of solute that can dissolve in 100g of solvent at a specific temperature to form a saturated solution. It is an important physical property of substances and is

influenced by several factors, with temperature being one of the most significant.

- **Effect of Temperature on Solubility**

Generally, the solubility of most solids in liquids increases with temperature, but this is not a universal rule.

➤ **Different compounds show different behavior when temperature changes.**

- **1. Solubility Increases with Temperature**

Some compounds become more soluble as temperature increases because higher temperature provides energy for solute-solvent interaction.

**Examples**:

- Potassium nitrate ($KNO_3$)
- Silver nitrate ($AgNO_3$)
- Potassium chloride ($KCl$)
- Copper sulfate ($CuSO_4$)
- Sodium nitrate ($NaNO_3$)

These salts dissolve better in hot water than in cold

water.

### 2. Solubility Remains Almost Constant

Some compounds are less affected by temperature change.

**Example**:

**Sodium chloride (NaCl):** Its solubility does not increase appreciably with rise in temperature.

### 3. Solubility Decreases with Temperature

Some compounds actually become less soluble at higher temperatures. This is due to exothermic dissolution processes.

**Examples**:

- Lithium carbonate ($Li_2CO_3$)
- Calcium chromate ($CaCrO_4$)
- Calcium hydroxide ($Ca(OH)_2$)

### 4. Gases in Liquids

- The solubility of gases in water decreases with the increase in temperature.
- This is because increased kinetic energy

causes gas molecules to escape from the solvent.

**Example**:

Carbon dioxide ($CO_2$) is less soluble in warm water than in cold water.

💡 **Summary**:

The solubility of solutes is greatly influenced by temperature, but the effect varies from one substance to another. Understanding these variations is essential in chemical industries, pharmaceuticals, food processing, and environmental science.

## 3. Constructed Response Questions

### ✨ i. How does a supercritical state look like?

A supercritical state is not exactly a gas or a liquid — it is a hybrid of both. It occurs when a substance is at a temperature and pressure above its critical point, where the liquid and gas phases merge into

one phase.

- In this state, the fluid has density like a liquid and flows like a gas.
- It does not have a distinct boundary between gas and liquid.
- Supercritical fluids look like a dense fog or vapor, and they can dissolve substances like a liquid but also move through materials like a gas.

✨ **ii. In what way is plasma created in a fluorescent tube?**

❖ **Plasma in a fluorescent tube is created when:**

- An electric current is passed through a low-pressure gas, such as mercury vapor.
- This energizes the gas atoms, causing them to lose electrons and become ionized.
- The result is a mixture of ions, electrons, and photons — this is plasma.
- The excited atoms release ultraviolet (UV) light, which strikes the phosphor coating inside the

tube, making it glow and produce visible light.

✨ **iii. Most of the molecules we study in biochemistry are organic in nature. Where does the difference exist in organic and biochemistry branches of Chemistry?**

Organic Chemistry focuses on carbon-containing compounds (hydrocarbons and their derivatives), whether natural or synthetic.

- **Biochemistry**, on the other hand, focuses specifically on chemical processes in living organisms.
- The main difference is that biochemistry is life-centered, studying molecules like proteins, enzymes, nucleic acids, while organic chemistry can include non-living substances like plastics, fuels, or synthetic drugs.

✨ **iv. Give the reason of brilliance shown by diamond. Can you improve it?**

- Brilliance of diamond is due to its crystalline structure, which causes maximum internal

reflection of light.

- Light enters the diamond, reflects off internal surfaces, and exits after multiple bounces — this creates a shiny, sparkling effect.

**It can be improved by:**

- Cutting the diamond in a way that maximizes light reflection.
- Polishing the surface for smoothness and clarity.

✨ **v. Explain the dissolution of sodium chloride in water.**

Sodium chloride (NaCl) is an ionic compound made of $Na^+$ and $Cl^-$ ions.

**When NaCl is added to water:**

- Water molecules surround the $Na^+$ and $Cl^-$ ions.
- The positive side (H) of water attracts $Cl^-$ ions, and the negative side (O) attracts $Na^+$ ions.
- These forces overcome the ionic bond in salt, causing it to dissolve.

- This process is called hydration of ions.

✨ **vi. Why do different compounds have different solubilities in water at a particular temperature?**

❖ **Different compounds have different solubilities because:**

- They have different intermolecular forces (ionic, covalent, hydrogen bonding).
- Size and structure of molecules affect how well they interact with water.
- Endothermic or exothermic nature of dissolution affects solubility:
- Endothermic (heat absorbed) ⇒ solubility increases with temperature.
- Exothermic (heat released) ⇒ solubility decreases with temperature.

✨ **vii. Why NaCl can not be crystallized from water just like $KNO_3$?**

❖ **NaCl has very low change in solubility with temperature.**

- Increasing temperature doesn't dissolve much more NaCl in water.
- $KNO_3$, however, becomes much more soluble as temperature increases.
- So, if you cool a hot solution of $KNO_3$, crystals easily form.
- This crystallization method does not work well for NaCl.

✨ **viii. Why graphite is slippery to touch? Which property of graphite enables it to be used as lubricant?**

- Graphite is slippery because its structure has layers of carbon atoms arranged in hexagons.
- These layers are held together by weak van der Waals forces, allowing them to slide over each other easily.
- This sliding property makes graphite an excellent dry lubricant, especially for machines and locks.

## 4. Descriptive Questions

✨ **Question 1: Mention the name of the branch of Chemistry in which you will study each of the following topics.**

**(a) Rate of a reaction**

The study of the rate of chemical reactions is done under Physical Chemistry. This branch deals with how fast or slow a reaction occurs, the factors affecting the speed of reaction, and how energy changes during the reaction.

**(b) Digestion of food in human body**

This topic is studied in Biochemistry. It focuses on the chemical processes that take place inside the human body. Digestion is a biochemical process in which large food molecules are broken down into simpler ones using enzymes.

**(c) Properties of plasma**

The properties of plasma, such as ionization, conductivity, and high-energy particles, are studied in Physical Chemistry. Plasma is a high-energy

state of matter found in lightning and fluorescent tubes.

**(d) Ecosystem**

The study of chemical reactions and the effects of chemicals on the environment (such as pollution, soil contamination, etc.) is done in Environmental Chemistry. This includes the chemical aspects of ecosystems.

**(e) Reactions taking place during fireworks**

This is studied under Inorganic Chemistry, because the explosions and colorful lights in fireworks involve metal salts and non-carbon-based compounds, which are part of this branch.

**(f) Measurement of the absorption of wavelength with the help of ultraviolet spectrometer**

This is studied under Analytical Chemistry. It focuses on techniques and instruments used to analyze substances, including UV-visible spectroscopy to determine concentrations or the presence of compounds.

✨ **Question 2: What are allotropic forms? Explain the allotropic forms of carbon and sulphur. How does coal differ from diamond?**

**Definition of Allotropic Forms:**

Allotropic forms are the different structural forms of the same element in the same physical state. These forms have different physical and chemical properties due to the variation in atomic arrangements. The phenomenon is called allotropy.

❖ **Allotropic Forms of Carbon:**

**1. Diamond**

- It has a strong three-dimensional macromolecular structure.
- Each carbon atom is covalently bonded to four other carbon atoms.
- It is extremely hard, transparent, and a non-conductor of electricity.
- Used in cutting tools and jewelry.

**2. Graphite**

- It has a layered structure made of hexagonal rings.
- Each carbon atom is bonded to three other atoms.
- Layers can slide over one another, making graphite soft and slippery.
- It conducts electricity due to free electrons. Used as a lubricant and in pencils.

### 3. Buckminster Fullerene ($C_{60}$)

- It is a spherical molecule with a structure of pentagons and hexagons.
- It is soft, soluble in organic solvents, and has a low melting point.
- Used in nanotechnology and electronics.

## ❖ Allotropic Forms of Sulphur:

### 1. Rhombic Sulphur

- It is yellow in color and more stable at room temperature.
- Crystals have a rhombic shape.

2. Monoclinic Sulphur

- It is less stable and converts to rhombic form on standing.
- It forms needle-shaped crystals.

**How Coal Differs from Diamond:**

- Diamond is a pure allotrope of carbon with a fixed and strong atomic arrangement.
- Coal is not a pure form of carbon; it is an impure mixture containing carbon along with hydrogen, sulfur, nitrogen, ash, and other materials.
- Diamond is transparent and extremely hard, while coal is black, brittle, and used mainly as a fuel.

✨ **iii. What are supercritical fluids? How are they different from ordinary liquids?**

❖ **Supercritical Fluids:**

- A supercritical fluid is a state of matter that occurs when a substance is above its critical temperature and critical pressure.

- In this state, the substance exhibits properties of both liquids and gases.
- It can diffuse like a gas and dissolve substances like a liquid.

➤ **Differences from Ordinary Liquids:**

**1. State:**

Supercritical fluids are neither clearly liquid nor gas. Ordinary liquids are well-defined in volume and shape under given conditions.

**2. Solvent Properties:**

Supercritical fluids have enhanced solvent properties and are often used for special chemical reactions and extractions (e.g. decaffeination of coffee).

**3. Compressibility:**

Supercritical fluids are more compressible than normal liquids.

**4. Application:**

They are used in green chemistry and industrial

processes due to their unique properties.

✨ **iv. Define solubility of a solute. How does the solubility of solutes change with the increase in temperature?**

**Definition of Solubility:**

Solubility is the maximum amount of solute that can dissolve in 100g of a solvent at a specific temperature to form a saturated solution.

❖ **Effect of Temperature on Solubility:**

**1. Solids in Liquids:**

- For most solid solutes, solubility increases with temperature (e.g., $KNO_3$, $CuSO_4$).
- Some exceptions exist, such as $Ca(OH)_2$ and $Li_2CO_3$, where solubility decreases with increasing temperature.

**2. Gases in Liquids:**

- The solubility of gases decreases as temperature increases.
- This is because gases escape more easily from

the liquid at higher temperatures.

**3. Different Compounds Behave Differently:**

**For example**, sugar has higher solubility than NaCl because its larger molecules are surrounded by more water molecules.

✨ **v. What types of movements are present in gaseous and liquid molecules?**

❖ **Movements in Gaseous Molecules:**

**1. Random Motion:**

Gas molecules move freely in all directions with high speed.

**2. Translational Motion:**

They travel in straight lines until they collide with each other or container walls.

**3. Very Weak Forces:**

Due to weak intermolecular forces, they are far apart and easily compressible.

❖ **Movements in Liquid Molecules:**

**1. Random Movement (Less Free):**

Molecules move randomly, but remain close to one another.

**2. Vibrational and Rotational Motion:**

They vibrate and rotate around each other.

**3. Intermediate Forces:**

Intermolecular forces are stronger than gases but weaker than solids, giving liquids their fluidity but limited compressibility.

✨ **vi. Differentiate between the areas which are studied under inorganic and organic chemistry.**

❖ **Inorganic Chemistry:**

1. Studies elements and compounds that do not contain carbon-hydrogen (C-H) bonds.

2. Focuses on metals, salts, acids, bases, oxides, and minerals.

3. Used in fields like industrial chemistry, catalysis, and materials science.

**4. Examples**: HCl, NaCl, $NH_3$, $Fe_2O_3$.

❖ **Organic Chemistry:**

1. Studies carbon-based compounds, mainly containing C-H, C-C, and C-O bonds.

2. Involves hydrocarbons and their derivatives.

3. Essential in biological systems, medicine, fuels, and polymers.

4. **Examples**: Methane ($CH_4$), Glucose ($C_6H_{12}O_6$), Ethanol ($C_2H_5OH$).



## Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

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**Purpose**: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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