Chemistry 9th Class

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Definition: Chemistry is the branch of science that deals with the properties, composition, structure of matter, and the physical & chemical changes it undergoes.

Example: Freezing of water (physical change), burning of wood (chemical change).

1. Physical Chemistry

Definition: Study of how substances behave at atomic and molecular levels and how physical laws govern chemical reactions.

Example: Controlling reaction rates, optimizing industrial reaction conditions.

2. Inorganic Chemistry

Definition: Study of elements and compounds that contain little or no carbon.

Example: Table salt (NaCl), sulfuric acid, fertilizers, pigments.

3. Organic Chemistry

Definition: Study of carbon compounds (hydrocarbons and their derivatives) except simple carbon salts like carbonates, bicarbonates, oxides, and carbides.

Example: Petrol, plastics, sugar, proteins, DNA.

4. Environmental Chemistry

Definition: Scientific study of chemical and biochemical phenomena occurring in air, soil, and water environments.

Example: Causes and solutions of pollution, effects of industrial chemicals on the environment.

5. Analytical Chemistry

Definition: Branch dealing with separation, identification, and determination of concentration of components in a sample.

Example: Measuring toxins in water, blood sugar test, drug analysis.

6. Biochemistry

Definition: Study of chemical substances and vital processes occurring in living organisms.

Example: Structure and function of proteins, carbohydrates, lipids, nucleic acids (DNA/RNA).

7. Nuclear Chemistry

Definition: Study of reactions taking place in the nucleus of an atom, radioactivity, and nuclear transformations.

Example: Nuclear power plants, cancer radiotherapy, carbon dating.

8. Polymer Chemistry

Definition: Study of the properties, structure, and synthesis of large molecules (polymers and macromolecules).

Example: Plastics, rubber, nylon, natural polymers like cellulose and proteins.

9. Geochemistry

Definition: Study of the chemical composition of Earth, its sources, and minerals.

Example: Mineral exploration, environmental monitoring, forestry research.

10. Medicinal Chemistry

Definition: Branch focused on designing, synthesizing, and studying the absorption and metabolism of drugs in the human body.

Example: Painkillers, antibiotics, cancer drugs, drug delivery systems.

11. Astrochemistry

Definition: Study of molecules, atoms, and ions in space and interstellar space, including their reactions with radiation.

Example: Carbon compounds in galaxies, chemical reactions around stars.

States of Matter

1. Solids

Characteristics:

Definite shape and fixed volume.

Particles are closely packed with strong intermolecular forces.

Incompressible and rigid; particles only oscillate about mean positions.

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2. Liquids

Characteristics:

No definite shape but fixed volume.

Particles are close but move randomly.

Not easily compressible; densities higher than gases.

3. Gases

Characteristics:

No definite shape or volume.

Particles far apart with negligible intermolecular forces.

Easily compressible; very low density.

4. Plasma

Characteristics:

Partially ionized gas containing electrons, ions, photons.

Particles have very high kinetic energy.

Not commonly seen; exists in fluorescent tubes, lightning, welding arcs.

5. Liquid Crystal

Characteristics:

Properties between conventional liquids and crystalline solids.

Used in display devices (monitors, watches, navigation systems).

Molecules can flow like liquid but maintain some order like solid.

6. Supercritical Fluid

Characteristics:

Highly compressed state showing both gas and liquid properties.

Can perform chemical reactions not possible in conventional solvents.

Example: Supercritical carbon dioxide.

7. Graphene

Characteristics:

Single layer of carbon atoms in hexagonal pattern.

Two-dimensional crystal; tough, flexible, light, high electrical resistance.

Example of an exotic but useful state of matter.

8. Exotic States of Matter

Definition: States of matter not commonly encountered in everyday life.
Examples: Dark matter, Bose-Einstein condensate, nuclear matter, quantum spin liquid.

Properties of Elements, Compounds & Mixtures

1. Element

Simplest form of matter; a pure substance containing the same kind of atoms.

Cannot be broken down into simpler particles by ordinary chemical reactions.

Represented by a symbol (e.g., Na for sodium, Ca for calcium).

Gaseous elements exist as independent molecules (e.g., N_2, O_2, Cl_2). Noble gases exist as monatomic molecules (e.g., He, Ar).

2. Compound

A pure substance formed by chemical combination of two or more different elements.

Atoms combine in a fixed ratio by weight (e.g., H_2O has H:O = 1:8 by weight).

Can be broken into constituent elements by chemical reactions.

Properties are different from its constituent elements.

Exist as molecules (HCl, NH_3, H_2O) or network arrangements (NaCl, SiO_2).

3. Mixture

An impure substance; contains more than one type of element or compound mixed in any ratio.

Each component retains its own identity and properties.

Can be homogeneous or heterogeneous (e.g., salt solution = homogeneous; rock = heterogeneous).

Components are not chemically bonded.

Can be separated by physical methods.

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Properties are the sum of the properties of its components.

Exercise

Which elements are found in pure state on Earth?

Which elements are present in very small amounts on Earth?

Elements found in pure state on Earth:
Noble gases (e.g., Helium, Neon, Argon), Gold (Au), Platinum (Pt), Copper (Cu), Silver (Ag), Sulfur (S), Carbon (as diamond or graphite).

Elements present in very small amounts on Earth:
Trace elements such as Iodine (I), Cobalt (Co), Selenium (Se), Radon (Rn), and many radioactive elements like Uranium (U) and Thorium (Th) are found in very small quantities.

1. True Solution

Particles are completely homogenized (dissolved) in the solvent.

Particles cannot be seen with the naked eye.

Particles do not settle down on keeping.

Particles pass through filter paper, leaving no residue.

Example: Sodium chloride (salt) in water.

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2. Colloidal Solution

Particles are bigger than true solution but smaller than suspension.

Particles cannot be seen with the naked eye.

Particles do not settle down on keeping.

Particles pass through filter paper (like true solution).

Example: Starch solution or white of an egg.

3. Suspension

Particles do not dissolve in the solvent.

Particles can be seen with the naked eye.

Particles settle down when kept for some time.

Particles do NOT pass through filter paper; remain as residue.

Example: Chalk powder in water.

Unsaturated, saturated and supersaturated solution

1. Unsaturated Solution

Definition: A solution in which more solute can be dissolved at a given temperature.

Example from text: Adding 5 g of sugar to 100 g of water – it dissolves easily. More sugar can still be added.

2. Saturated Solution

Definition: A solution in which the maximum amount of solute has been dissolved in a given amount of solvent at a particular temperature.

Example from text: After adding enough sugar to 100 g of water at room temperature, a stage comes when no more sugar dissolves. Extra sugar settles at the bottom.

3. Supersaturated Solution

Definition: A solution that contains more dissolved solute than a saturated solution at the same temperature. It is unstable.

Formation: Usually made by heating a saturated solution, adding more solute, then carefully cooling it without disturbance.

Effect of temperature on solubility

Solubility Definition

Amount of solute that dissolves in 100g of solvent at a given temperature.

General Effect of Temperature

Solubility increases with temperature for many solids (e.g., KNO_3, $AgNO_3$, KCl).

Exceptions (Solids)

Sodium chloride (NaCl) – solubility increases very slightly.

Lithium carbonate (Li_2CO_3), Calcium chromate ($CaCrO_4$) – solubility decreases with temperature.

Gases

Solubility of gases in water decreases as temperature increases.

Examples of Increase with Temp

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Copper sulphate ($CuSO_4$), Sodium nitrate ($NaNO_3$).

Example of Decrease with Temp

Calcium hydroxide ($Ca(OH)_2$).

Solubility Curve

Graph showing grams of solute / 100g water vs temperature (°C).

Exercise

1. Mark the correct answer with a (✓).

(i) In which state does matter exist in neon signs?

(a) Supercritical fluid (b) Plasma (c) Gas (d) Liquid crystal

Answer: (b) Plasma

(ii) The harmful effects of shopping bags are studied in which branch?

(a) Geochemistry (b) Inorganic Chemistry (c) Analytical Chemistry (d) Environmental Chemistry

Answer: (d) Environmental Chemistry

(iii) Which is a man-made polymer?

(a) Starch (b) Polystyrene (c) Protein (d) Cellulose

Answer: (b) Polystyrene

(iv) Which substance has crystals of rhombic shape?

(a) Brass (b) Sulfur (c) Graphite (d) Bronze

Answer: (b) Sulfur

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

(a) Milk (b) Slaked lime used for whitewashing (c) Vinegar solution (d) Mixture of AgCl in water

Answer: (a) Milk

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

(a) Solution of calcium hydroxide in water (b) Solution of potassium nitrate in water (c) Hot chocolate (d) Concrete mixture

Answer: (d) Concrete mixture

(vii) The state of matter whose properties are between liquids and crystalline solids:

(a) Liquid crystal (b) Supercritical fluid (c) Plasma (d) Dark matter

Answer: (a) Liquid crystal

(viii) When small visible particles of a substance are dispersed in a medium, the mixture is called:

(a) Solution (b) Colloid (c) Suspension (d) Saturated solution

Answer: (c) Suspension

(ix) The solubility of $KClO_3$ solution at 40°C is approximately 13.2g per 100 cm^3. If you decrease the temperature, what effect will it have on its solubility?

(a) Solubility will increase (b) Solubility will decrease (c) Solubility will remain the same (d) Solubility will first increase with temperature and then decrease

Answer: (b) Solubility will decrease (because the solubility of $KClO_3$ decreases with decreasing temperature).

(x) You are studying the rate of hydrolysis of carbohydrates at different temperatures. Which branch of chemistry does this topic fall under?

(a) Organic Chemistry (b) Analytical Chemistry (c) Biochemistry (d) Physical Chemistry

Answer: (c) Biochemistry (because the hydrolysis of starch is a biological process).

2. Short Answer Questions

i. Why is it necessary to divide chemistry into several branches? Give three reasons.

1. The scope of chemistry is very vast, so dividing it is necessary to understand it systematically.

2. Each branch focuses on specific topics, making research and education easier.

3. This division improves the application of chemistry.

ii. Reactions can occur due to electrons outside the nucleus or within the nucleus. Which branches of chemistry cover these two types of reactions?

(I) Reactions due to electrons outside the nucleus: Inorganic Chemistry and Organic Chemistry.

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(II) Reactions occurring within the nucleus: Nuclear Chemistry.

iii. What types of problems are solved in Analytical Chemistry?

Analytical Chemistry involves the identification, structural determination, and quantitative analysis of substances. For example, determining the amount of metals in a sample, quality testing of medicines, etc.

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

Graphite: Thick layers of carbon atoms bonded by weak van der Waals forces.

Graphene: A single layer of carbon atoms, which is extremely strong and very thin.

v. Why are supercritical fluids important?

Supercritical fluids are important because they have high diffusion ability like a gas and dissolving properties like a liquid. This makes them very effective for chemical processes where conventional liquids or gases are less efficient, such as:

Using supercritical carbon dioxide to extract caffeine from coffee or aromatic compounds from hops.

They are very effective for cleaning electronic device components.

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

Matter in the Sun exists in a plasma state (because at extremely high temperatures, atoms become ionized).

vii. What is the importance of graphene?

Graphene is the world's strongest, thinnest, and an excellent conductor, which can be used in electronics and energy storage.

viii. Which form of matter relates to most material things in this world?

Most material things exist in the solid state.

3. Constructed Response Questions

i. What does the supercritical state look like?

Supercritical fluids are highly compressed states that exhibit properties of both gases and liquids. Chemical reactions that cannot be carried out in conventional solvents can potentially be carried out in supercritical carbon dioxide.

ii. How is plasma formed in a fluorescent tube?

A high voltage is passed through a fluorescent tube, which ionizes the gas inside (such as mercury vapor), forming plasma. This plasma emits ultraviolet light, which strikes the phosphor coating on the tube, producing visible light.

iii. Most molecules we study in Biochemistry are organic in nature. Where does the difference lie between the branches of Organic and Biochemistry?

Organic Chemistry: Involves the study of the preparation, structure, properties, and chemical reactions of carbon-based compounds (organic compounds).

- Biochemistry: Involves the study of chemical processes occurring in living organisms, such as metabolism and enzyme reactions.

iv. What is the reason for the shine of a diamond? Can you improve it?

The shine of a diamond is due to its high refractive index and total internal reflection of light. It can be improved by cutting and polishing to maximize light reflection.

v. Explain the dissolution of sodium chloride in water.

Sodium chloride dissolves in water to form Na^+ and Cl^- ions. The polar water molecules surround (hydrate) these ions, forming a solution.

vi. Why does the solubility of different compounds in water vary at different temperatures?

Solubility depends on pressure, temperature, solute-solvent attractive forces, and crystal structure. The internal forces of different compounds affect their solubility.

vii. Why can't NaCl be crystallized from water like KNO_3?

The solubility of NaCl changes very little with temperature, whereas the solubility of KNO_3 increases significantly with increasing temperature. Therefore, KNO_3 can be crystallized by dissolving it

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in hot water and then cooling, whereas evaporation is a better method for NaCl.

viii. Why is graphite slippery to touch? Which property of graphite makes it usable as a lubricant?

The layers of graphite are held together by weak van der Waals forces, allowing them to slide easily. This slippery property makes it a good lubricant.

4. Detailed Questions

i. Name the branch of chemistry related to the study of the following topics:

(a) Rate of reaction: Physical Chemistry

(b) Digestion of food in the human body: Biochemistry

(c) Properties of plasma: Physical Chemistry

(d) Environmental systems: Environmental Chemistry

(e) Reactions occurring during fireworks: Inorganic Chemistry

(f) Measurement of wavelength absorption using an ultraviolet spectrometer: Analytical Chemistry

ii. What are allotropic forms? Explain the allotropic forms of carbon and sulfur. How is coal different from diamond?

- Allotropic forms: Different forms of the same element that possess different physical and chemical properties.

Allotropes of carbon: Diamond, Graphite.

Allotropes of sulfur: Monoclinic and Rhombic.

Coal is an amorphous form of carbon, while diamond is a crystalline form of carbon. Coal has lower purity and a different structure.

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

A supercritical fluid is a substance at a temperature and pressure above its critical point, where it exhibits properties between those of a gas and a liquid. Compared to ordinary liquids, they have lower viscosity and higher diffusion.

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

Solubility: The maximum amount of solute that can dissolve in a given amount of solvent at a specific temperature to form a saturated solution.

Solubility of most solids increases with an increase in temperature.

Solubility of some solids increases only slightly with temperature (e.g., NaCl).

Solubility of gases decreases with an increase in temperature.

v. What types of motion occur in molecules of gases and liquids?

Molecules of gases: Random translational motions, rotational motions, and vibrational motions.

Molecules of liquids: Translational motions, rotational motions, and vibrational motions, but more limited compared to gases.

vi. Differentiate between the areas studied under Inorganic and Organic Chemistry.

Inorganic Chemistry: Study of non-hydrocarbons (metals, acids, bases, and minerals).

Organic Chemistry: Study of hydrocarbons, biochemicals, polymers, and their derivatives.

5. Investigative Questions

i. The preparation of solutions leads to an important process in chemistry that allows us to purify a compound through crystallization. Describe a process in which potassium nitrate is purified by crystallization from water.

1. Dissolve potassium nitrate in hot water to make a saturated solution.

2. Filter the solution to remove insoluble impurities.

3. Allow the solution to cool slowly, causing pure KNO_3 crystals to form.

4. Filter the crystals and dry them.

ii. Graphene is called a miraculous material and is the material of the future. Which properties make it very important in electronics?

High electrical conductivity: For fast electron transfer in electronic devices.

Flexibility: For use in electrodes and flexible displays.

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High thermal conductivity: For heat management in materials and devices.

Strength and thinness: For making durable and miniaturized components.

Exercise

Experiments conducted on samples from missions that landed on the Moon:

1. Chemical Composition | Analytical Chemistry 2. Physical Properties of Materials | Physical Chemistry

3. Reaction with Inorganic Reagents Inorganic Chemistry

Exercise

1. Which elements are found in a pure state on Earth?

Gold, silver, platinum, copper (native state), etc., are found in a pure state.

2. Which elements are present in small quantities on Earth?

Cesium, bismuth, tungsten, etc., are found in small quantities.

How can different solubilities at different temperatures be beneficial for us?

Different solubilities at different temperatures are used in crystallization and industrial processes such as purifying sugar and adjusting the solubility of medicines.

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