1 CHAPTER

STATES OF MATTER AND PHASE CHANGES

After studying this chapter, students will be able to:

- Define chemistry as the study of matter, its properties, composition, and interactions with other matter and energy. Or Study of earth (solids), Air (gasses), Sea (liquids) and sky (plasma) and their interaction with each other.
- Explain with examples that chemistry has many sub-fields and interdisciplinary fields.
  Some examples include
  - Biochemistry
  - Medicinal Chemistry
  - Polymer Chemistry
  - Geochemistry
  - Environmental Chemistry
  - Analytical Chemistry
  - Physical Chemistry
  - Organic Chemistry
  - Inorganic Chemistry
  - Nuclear Chemistry
  - Astro-chemistry
- Define matter as a substance having mass and occupying space.
- State the distinguishing macroscopic-properties of commonly: observed states of solids; liquids and gases in particular density, compressibility, and fluidity.
- Identify that state is a distinct form of matter (examples could include familiarity with plasma; intermediate states and exotic states e .g., BEC or liquid crystals).
- Explain the allotropic forms of solids (Some examples may include diamond, graphite, and fullerenes)
- Explain the difference between elements, compounds and mixtures.
- Identify solutions, colloids, and suspensions as mixtures and give an example of each.
- Explain the effect of temperature on solubility and formation of unsaturated and saturated solutions

1.1 WHAT IS CHEMISTRY

LONG QUESTIONS

Q.1 (A) Define chemistry. (U.B+K.B+A.B) (GRW 2017 G-I)(K.B)
(B) Describe the various branches of chemistry.
(DGK 2017, FSD 2016,17, SWL, MTN 2016, LHR 2017 G-I)

Ans:

CHEMISTRY

Definition

Chemistry is the science which deals with the properties, composition and the structure of substances. It also studies the physical and chemical changes in matter and the laws or principles which govern these changes.

Determination of composition

Determination of composition represents finding out percentages of elements and compounds in a sample of matter.

Structure of matter

Structure of matter means the arrangement of atoms in matter.

Physical and chemical changes

Both physical and chemical changes may be brought about by the interaction of energy.

BRANCHES OF CHEMISTRY

To understand the widely spread complex subject of chemistry and to concentrate on its specific aspects, chemistry is divided into many distinct branches.

Scope

These branches have distinct areas of study for the scientists to focus on and to achieve breakthroughs and advancements.

1.Physical Chemistry

Definition

*"The branch of chemistry that deals with the **relationship between the composition and physical properties of matter along with the changes in them** is called physical chemistry."*

Scope:

This branch investigates how substances behave at atomic or molecular levels. It provides clear explanation as to how fundamental physical laws governing our world cause atoms and molecules to show specific characteristics and in turn react to give huge structures related to life.

Physical chemistry is also used to predict and change the rates of reaction and thus optimize the conditions to carry out the reaction on industrial scale.

2.Inorganic Chemistry

Definition

It is the study of the synthesis and properties of compounds that do not contain carbon hydrogen bonds.

Composition of Organic Compound

An inorganic compound can be composed of metals, nonmetals or a mixture of these, salts, acids and bases.

Uses of inorganic compound

Inorganic compounds are used as fuels, medicines, catalysts, pigments, surfactants, coatings and much more.

3.Organic Chemistry

Definition

It is the branch of chemistry that deals with the carbon compounds other than its simple salts like carbonates, oxides and carbides.

Scope

In this branch, we study the structure, formation, properties, composition and reactions of carbon containing compounds.

Occurrence of organic compounds

Organic compounds are found in all forms of life and are also essential for life.

4. Environmental Chemistry

Definition

"The branch of chemistry that deals with the study about ***components of the environment and the effects of human activities on the*** **environment** *is called environmental chemistry."*

Applications/Scope:

It is the scientific study of the chemical and biochemical phenomena that occur in this planet.
In this subject, we study the sources, reactions, effects and fates of chemical species in the air, soil and water environments.

Importance

Without this, it would be impossible to study the effects humans have on the environment through the release of chemicals. It helps in understanding the causes, effects and solutions of different types of pollution.

5. Analytical Chemistry

Definition

This branch of chemistry deals with the analysis of different substances. It involves separation, identification and determination of the concentration of the material things.

Scope

Now a days the field of analytical chemistry generally involves the use of modern and sophisticated instruments to analyze the matter.

6. Biochemistry

Definition

It is the branch of chemistry in which we understand life through chemical processes. It is the study of chemical substances and vital processes occurring in living organisms.

Scope

Biochemistry provides insights into the structure and function of molecules such as proteins, carbohydrates, lipids and nucleic acids.

7. Nuclear Chemistry

Nuclear chemistry deals with the reactions taking place in the nucleus of an atom. It deals with radioactivity, nuclear processes and transformation in the nuclei of atoms.

Applications:

It has vast applications in medical treatment (radiotherapy), preservation of food and generation of electrical power through nuclear reactors.

8. Polymer Chemistry

Definition

Polymer chemistry focuses on the properties, structure and synthesis of polymers and macromolecules.

Polymers

Polymers are large molecules made by linking together a series of building blocks.

Examples

Many materials present in the living organisms including proteins, cellulose and nucleic acids are naturally occurring polymers.

9. Geochemistry

The study of chemical composition of Earth and its sources and minerals is called geo chemistry.

Scope

Apart from its use in minerals exploration, geochemical mapping today has applications in environmental monitoring, forestry and medical research.

10. Medicinal Chemistry

In this branch of chemistry, the chemist tries to design and synthesize a medicine or a drug which is beneficial for mankind.

Scope

It includes the discovery, delivery, absorption and metabolism of drugs in human body.

11. Astrochemsitry

It is the study of molecules and ions recurring in space and interstellar space.

Scope

In this discipline we study the abundance and reactions of molecules and ions in the universe and interaction of these species with radiation.

INTERESTING INFORMATION
GEOTHERMAL HEAT PUMP
Geothermal heat pump uses a pump to transfer underground water into the building during the winter to heat them and in summer to cool them

EXERCISE	
A lunar mission has recently brought samples from the Moon. The following experiments were then carried out on it. Point out the branch of chemistry these experiments are related to.	
Experiment	**Branch of Chemistry**
Formation	
. Determining its composition	Analytical chemistry
. Studying the physical properties of material it contain	Physical chemistry
. Carrying out chemical reactions with usual inorganic reagents	Inorganic chemistry

SHORT QUESTIONS

Q.1 **Define analytical chemistry.** **(K.B)**
Ans: Answer given on page # 4

Q.2 **What is the scope of polymer chemistry?** **(A.B)**
Ans: Answer given on page # 4

Q.3 **Write the application of inorganic chemistry.** **(A.B)**
Ans: Answer given on page # 3

Q.4 **Define industrial geochemistry.** **(K.B)**
(SGD 2017, D.G.K 2016, BWP 2016, SWL 2017, RWP 2017 G-I)
Ans: Answer given on page # 4

Q.5 **Define nuclear chemistry.** **(LHR 2016 G-I, MTN 2017)(K.B)**
Ans: Answer given on page # 4

Q.6 **Define biochemistry.** **(DGK 2016, GRW 2016 G-I, LHR 2016 G-I)(K.B)**
Ans: Answer given on page # 4

Q.7 **Define environmental chemistry.** **(K.B)**
Ans: Answer given on page # 4

Q.8 **Define physical chemistry.** **(K.B)**
Ans: Answer given on page # 3

Q.9 **In which branch of chemistry behavior of gases and liquids is studied?** **(A.B)**
Ans: Physical chemistry deals with the physical behavior and properties of gases and liquids.

Q.10 **Which branch of chemistry deals with preparation of paints and papers?** **(DGK 2016)(A.B)**
Ans: The preparation of paints and papers is studied in industrial chemistry.

Q.11 **In which branch of chemistry are the metabolic processes of carbohydrates and proteins studied?** **(A.B)**
Ans: The metabolic processes of carbohydrate and proteins are studied in biochemistry.

Q.12 Which branch of chemistry deals with energy of atoms and its uses in daily life? (A.B)

Ans: Nuclear chemistry is the branch of chemistry which deals with the atomic energy and its use in daily life.

Q.13 Which branch of chemistry deals with the structure and properties of naturally occurring molecules? (U.B+A.B)

Ans: Organic chemistry is the branch of chemistry which deals with the structure and properties of naturally occurring molecules.

MULTIPLE CHOICE QUESTIONS

1. The branch of science which deals with the composition, structure, properties and reactions of matter: (K.B)

(A) Physics (B) Analytical chemistry
(C) Physical chemistry (D) Chemistry

2. The branch of chemistry which deals with the study of all elements and their compounds except compound of carbon and hydrogen and their derivatives: (K.B)

(A) Organic chemistry (B) Physical chemistry
(C) Inorganic chemistry (D) Biochemistry

3. Which one of the following provides the identity of a substances? (U.B)

(A) Qualitative analysis (B) Clinical analysis
(C) Quantitative analysis (D) Chemical analysis

4. Which one of the following is applicable in chemical industry like metallurgy, ceramics and glass? (A.B)

(A) Organic chemistry (B) Inorganic chemistry
(C) Industrial chemistry (D) Nuclear chemistry

5. Industrial chemistry deals with the manufacturing of compound: (K.B)

(A) In laboratory (B) On micro scale
(C) On commercial scale (D) On economic scale

6. Metabolism of biomolecules is studied in: (U.B+K.B+A.B)

(A) Environmental chemistry (B) Biochemistry
(C) Physical chemistry (D) Analytical chemistry

1.2 STATES OF MATTER

LONG QUESTIONS

Q.1 Define matter. Explain different states of matter in detail. (K.B)

OR

Describe following states of matter.

(A) Primary states of matter (B) Plasma
(C)Intermediate States (D) Exotic states of matter

Ans:

MATTER

Definition

Anything other than energy which carries weight and occupies volume is called matter.

OR

Anything that has mass and occupies space is called matter.

We encounter material things everywhere in all sort of different and distinct forms.
This world is made up of matter and energy. Energy is non-material in nature.

States of matter

A state of matter is one of the many distinct forms in which matter can exist. Observe four states of matter in everyday life: solid, liquid, gas and plasma. Apart from these, there are more states of matter which we do not see in our everyday life.
Following are important states of matter:

A. Primary states of matter
B. Plasma
C. Intermediate States of Matter
D. Exotic states of matter

A. PRIMARY STATES OF MATTER

The three primary states of matter are:

1. Gases
2. liquids
3. solids

Properties of states of matter

They are different from each other due to different strength of intermolecular forces, the arrangement of particles and the distance between the particles.

1. Gases

- In gases, molecules are very widely apart with no order
- Very weak intermolecular forces. All these features make gases easily compressible. Their densities are obviously very low.

2. Liquids

- The liquids have molecules closely attached but randomly arranged
- There exist significant intermolecular forces between them.
- Liquids are therefore not easily compressible
- Their densities have higher values than those of gases.

3. Solids

Solids have a definite shape and a fixed volume.

Properties

- Particles in solids are closely packed and have very strong interatomic or intermolecular attractions.
- The particles in solids remains fixed at their positions where they can oscillate about their mean positions.
- Solids are incompressible and rigid.
- The densities of solids are very high.
- Solids are the only state of matter which do not need any container to be stored.
- In crystalline solids, particles are perfectly arranged and strongly bonded. This makes them almost incompressible. They are the most dense substances.

B. PLASMA

Plasma is not so generally seen form of matter. It is composed of particles with very high kinetic energy.

Occurrence

It exists in fluorescent tubes, lightning and welding arcs. Plasma can be considered as a partially ionized gas containing electrons, ions, photons, etc.

C. INTERMEDIATE STATES OF MATTER

Matter also exits in intermediate states where liquid meets gas and liquid meets solid

Example

a) Supercritical fluids,
b) liquid crystals
c) graphene

a) Supercritical fluids

Supercritical fluids are highly compressed states which show both properties of gases and liquids.

Uses

Chemical reactions which may not be carried out in conventional solvents, may possibly be carried out in supercritical carbon dioxide.

Examples

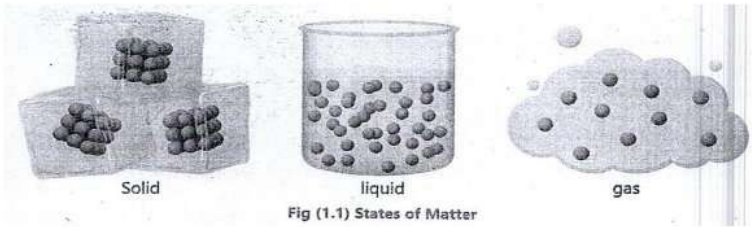


Fig (1.1) States of Matter

b) Liquid crystal

Liquid crystal is a state of matter whose properties are between those of conventional liquids and those of crystalline solids.

Uses

Liquid crystals are used in display devices including computer monitors, clocks, watches and navigation systems.

c) Graphene

Graphene is an example of two-dimensional crystal, a single layer of carbon atoms arranged in a hexagonal pattern.

Properties

Graphene is a tough, flexible and light material with a high resistance.

D. EXOTIC STATES OF MATTER

States of matter that are not commonly encountered are called exotic states of matter.

Example

- dark matter
- Bose-Einstein condensate
- nuclear matter
- quantum spin liquid
- many others

SHORT QUESTIONS

Q.1 Define matter and give examples. **(K.B+A.B)**

Ans: Answer given on page # 6

Q.2 Define substance. **(K.B)**

Ans: Answer given on page # 6

Q.3 Define mixture and give examples. **(K.B+A.B)**

Ans: Answer given on page # 10

Q.4 Write a short note on plasma. Give examples. **(K.B+A.B)**

Ans: Answer given on page # 7

Q.5 Write a short note on liquid crystals. **(K.B)**

Ans: Answer given on page # 8

MULTIPLE CHOICE QUESTIONS

1. Anything that has mass and occupies space is called: **(K.B)**

(A) Substance (B) Matter
(C) Element (D) Atomic mass

2. Piece of matter in pure form is called: **(K.B)**

(A) Mixture (B) Matter
(C) Substance (D) Compound

3. Which one of the following can be separated by physical mean? **(U.B)**

(A) Mixture (B) Element
(C) Compound (D) Radical

4. Impure matter is called: (K.B)
(A) Atom (B) Compound
(C) Substance (D) Mixture

5. Which one of the following is chemical property? (K.B)
(A) Color (B) Smell
(C) Taste (D) Composition

1.3 ELEMENT, COMPOUND AND MIXTURE

LONG QUESTIONS

Q.1 Define an element and classify the elements with examples. (K.B)

Ans:

ELEMENT

Definition

Element is the simplest form of matter. It is a pure substance containing the same kind of atoms. It cannot be broken down into simpler substances by ordinary chemical reactions.

Examples

Oxygen, carbon, iron, nitrogen etc

Matter in this world exists in the form of elements, compounds and mixtures.

Physical states of elements

Elements exist in all three forms; solid, liquid and gas.

(a) Solid

Most of the elements found in this world exist in solid form.

(b) Liquid

Liquid elements are very few in number as compared to solids

(c) Gas

Gaseous elements are very few in number as compared to solids

Classification of elements

Elements may be a:

- metal
- non-metal
- metalloid
- noble gas

Nature of particles

Elements can also exist in form of atoms, molecules, ions and isotopes.

Examples

Examples of important elements are sodium, potassium, magnesium, calcium, carbon, silicon, nitrogen, oxygen, chlorine, helium, copper, gold, zinc, silver nickel, cobalt, mercury, bromine iodine, etc.

Q.2 Describe the compound. Write its properties. (U.B+K.B)

Ans:

COMPOUND

Definition:

*"Substance made up of **two or more elements chemically combined together** in a **fixed ratio by mass** is called compound."*

OR

Compound is also a pure substance. It is made up of two or more different chemical elements combined in a fixed ratio.

Examples:

- **Carbon dioxide** is a compound formed by a chemical combination between carbon **(C)** and oxygen **(O)** in a fixed ratio of **12:32** or **3:8** by mass.

- **Water** is a compound formed by a chemical combination between **hydrogen** and **oxygen** in a fixed ratio of **1:8** by mass.

Formation

When elements come together, they react with each other and form chemical bonds that are not easy to break.

Classification of Elements

A. On basis of nature of Bond

Compound may be molecular, ionic, intermetallic and coordination complexes.

B. On basis of origin

Compounds may also be inorganic and organic in nature.

Examples

Important compounds are water, ammonia, methane, carbon dioxide, carbonates, chlorides, starch, proteins, carbohydrates, mineral acids, organic acids, etc.

Composition and properties of elements or a compound

The composition and properties of elements or a compound are uniform throughout a given sample and from one sample to another.

Q.3 What is a mixture? Explain its types. (SGD 2016,17, BWP, SWL 2017, MTN 2016) (U.B+K.B)

Ans: **MIXTURE**

Definition:

*"A **mixture** is made up of **two or more elements or compounds (substances) mixed up physically without any fixed ratio**."*

OR

A mixture is formed when more than one types of elements or compounds are mixed together in any ratio.

Example

Air, soil, milk and tap water are everyday examples of mixtures.

Types of Mixture:

A mixture may be:

(i) Homogeneous mixture (ii) Heterogeneous mixture

(ii) Homogeneous Mixture:

*"Mixture that has **uniform composition throughout** is called homogenous mixture".*

Examples:

A **solution of salt and water** is an example of homogeneous mixture because its concentration is uniform throughout. Other examples include **Air, Gasoline, Ice cream** etc.

(ii) Heterogeneous Mixture:

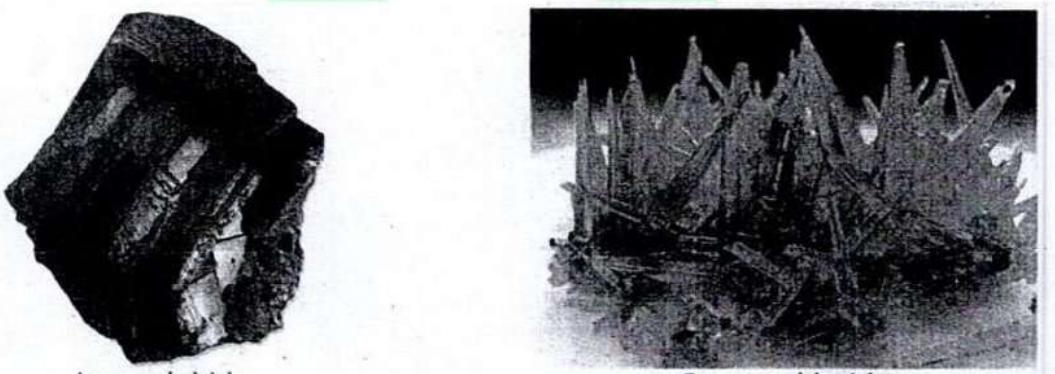
*"Mixture that **does not have uniform composition throughout** is called heterogeneous mixture".*

Examples:

A sample of rock is an example of heterogeneous mixture because the concentrations of its constituents is different in its different parts. Rocks are composed of different types of minerals such as granite, mica and limestone. Other examples include Soil, Rock, Wood etc.

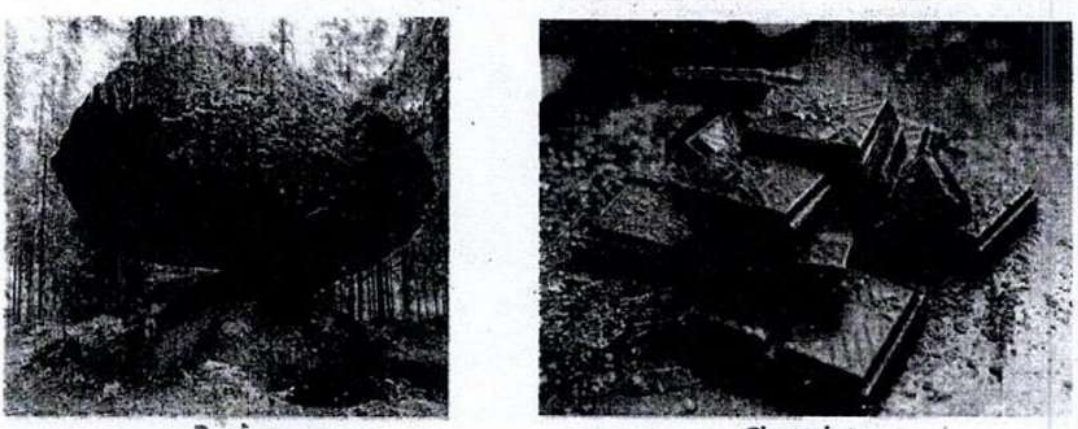
Iron rods Copper wire Screw and nuts of zinc

Fig (1.2): Elements



Iron sulphide Copper chloride

Fig (1.3): Compounds



Rock Chocolate

Fig (1.4): Mixtures

Q.4 Define Allotropy. Explain allotropes of oxygen, carbon and Sulphur. (U.B+K.B)

Ans:

ALLOTROPY

Definition

*"The **existence of an element in more than one form, in same physical state** is called allotropy".*

ALLOTROPIC FORMS OF SUBSTANCES

Both elements and compounds may exist in more than one structural forms which can exhibit quite different physical and chemical properties. These forms are called allotropic forms and phenomenon is called allotropy.

Examples

(i) Allotropes of oxygen

Element oxygen exists in two allotropic forms namely oxygen (O_2) and ozone (O_3).

(ii) Allotropes of carbon

Similarly, carbon exists in three main allotropic forms, diamond, graphite and Buckminster fullerene.

- Diamond has a giant macromolecular structure
- Graphite has a layered structure of hexagonal rings of carbon.
- Buckminster fullerene (C_{60}) consists of spheres made of atoms arranged in pentagons and hexagons.

Properties

- Fullerenes are stable at high temperatures and high pressures.
- Being covalent in nature, they are soluble in organic solvents.

Fullerene structure

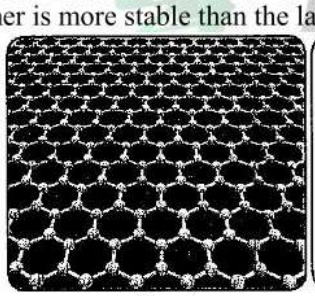
The fullerene structure is unique in that the molecule is not charged, has no boundaries and has no unpaired electrons. They have a cage like structure.

Example

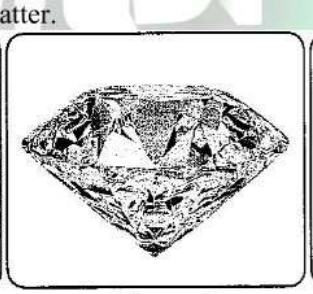
Fullerene C_{60} has a low melting point. It is soft and cannot conduct electricity.

(iii) Allotropes of Sulphur

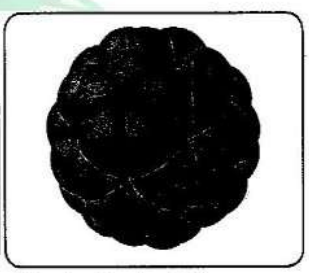
Element sulphur also exists in two crystalline allotropic forms i.e. rhombic and monocline; the former is more stable than the latter.



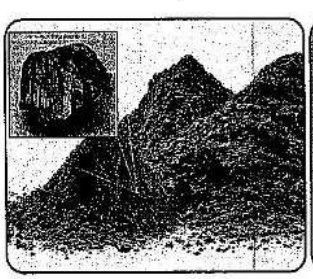
Graphene



Diamond



Buckminsterfullerene



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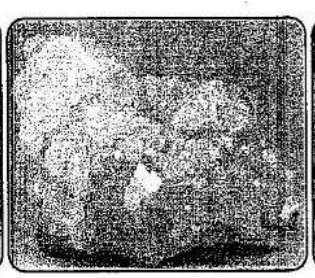


Rhombic Sulphur

Monoclimic Sulphur

Q.4 What is the difference between element, compound and mixture? (MTN 2016, SWL 2017)(U.B)

OR

List five characteristics by which compounds can be distinguished from mixtures. (GRW 2017 G-I, LHR 2016 G-II, RWP 2017 G-II, FSD 2017 G-II, BWP 2017 G-I)(Ex-(U.B)

Ans: **DIFFERENTIATION**

Element	Compound	Mixture
Definition		
*The substance made up of **same type of atoms, having same atomic number** and it **cannot be decomposed** into simple substances by ordinary chemical means.*	*Substance made up of **two or more elements chemically combined together** in a **fixed ratio by mass** is called compound.*	*A **mixture** is made up of two or **more elements or compounds (substances) mixed up physically without any fixed ratio.***
Composition		
An element is the simplest form of matter. It is a pure substance containing the same kind of atoms.	A compound is a pure substance. It is formed by the chemical combination of two or more atoms of different elements.	Mixture is an impure matter. A sample of matter having more than one type of elements or compounds mixed together in any ratio, is called a mixture.
Ratio by Weight and Properties		
It is not possible to break down an element into simpler particles by ordinary chemical reactions.	In a compound, the atoms of elements must combine together by a fixed ratio by weight. **Example** In water (H_2O) hydrogen and oxygen are present in a fixed ratio of 1 :8 by weight.	Each component of a mixture retains its identity and specific properties.
Representation		
When an element exists in the form of aggregate of atoms, it is represented by a symbol. **Example** Sodium and calcium are represented by their symbols Na and Ca.	It is possible to break a compound into its constituent elements by a chemical reaction. **Example** Ammonia can be converted back to nitrogen and hydrogen by a suitable chemical reaction.	A mixture may be homogeneous or heterogeneous. **Example** • The solution of common salt in water is a homogeneous mixture • A sample of rock is a heterogeneous mixture
Properties		

The properties of each element are unique.	The properties of a compound are always different from the elements from which it is formed. **Example** The properties of water are different from those of hydrogen and oxygen.	The properties of components of a mixture remain the same.
Existence		
Gaseous elements exist in the form of independent molecules **Example** • Nitrogen (N_2) • Oxygen (O_2) • Chlorine (C_{12}). Noble gases, however, exist as mono atomic molecules	**(a) As molecules** Compounds exist in the form of molecules. **Example** • Hydrogen chloride (HCl) • Ammonia (NH_3) • Water (H_2O) **(b) As network arrangement of atoms** Compounds may also exist as network arrangement of their atoms **Example** • Ionic compounds like NaCl • Covalent compounds like sand (SiO_2).	The components of a mixture are not chemically bound together and they can be separated by physical methods. The properties of a mixture are the sum of those of its components.
Separation of components		
The components cannot be separated by physical means.	The components cannot be separated by physical means.	The components can be separated by simple physical methods.
Melting Point		
A element has a sharp and fixed melting point.	A compound has a sharp and fixed melting point.	A mixture does not have a sharp and fixed melting point.

INTERESTING INFORMATION

Many elements are found in nature but some are artificial. Technetium was first element created by scientist in laboratory.

SHORT QUESTIONS

Q.1 Define an element. **(LHR 2016 G-I, BWP 2016 G-I)(K.B)**

Ans: Answer given on page # 9

Q.2 Name two elements (a metal and a non -metal) which exist in liquid state. **(K.B)**

Ans: Mercury (a metal), Bromine (a non- metal)

Q.3 Define the compound. **(K.B)**

Ans: Answer given on page # 9

Q.4 Write down the names of components which are present in: **(K.B)**

A. Air (B) Milk (C) Soil (D) Brass

Ans: **Air:**

Air is a mixture of nitrogen, oxygen, carbon dioxide, noble gases and water vapours.

Soil:

Soil is a mixture of sand, clay, mineral salts, water and air.

Milk:

Milk is a mixture of water, sugar, fat, proteins, mineral salts and vitamins.

Brass: Brass is a mixture of copper and zinc metals.

Q.7 Can you identify mixture, element or compound out of the followings? (U.B+A.B)
Coca cola, petroleum, sugar, table salt, blood, gun powder, urine, aluminium, silicon, tin, lime and ice cream.

Ans: Identification of mixture, element or compound is as follows:

Element	Compound	Mixture
Aluminium	Sugar	Petroleum
Silicon	Table salt	Blood
Tin	Lime	Gun powder
		Urine
		Ice cream
		Coca cola

Q.8 How can you justify that air is a homogeneous mixture? Identify substances present in it. (U.B+K.B)

Ans:

AIR IS A HOMOGENEOUS MIXTURE

Justification:

Air is a homogeneous mixture because it has uniform composition throughout. Air consists of different gases having a uniform composition i.e. 78% nitrogen, 21% oxygen, 0.9% argon, 0.037% carbon dioxide along with other noble gases and water vapours. These gases have their identity and can be separated.

Q.9 Name the elements represented by the following symbols: (K.B)
Hg, Au, Fe, Ni, Co, W, Sn, Na, Ba, Br, Bi

Ans:

Symbol	Name	Symbol	Name
Hg	Mercury	Sn	Tin
Au	Gold	Na	Sodium
Fe	Iron	Ba	Barium
Ni	Nickel	Br	Bromine
Co	Cobalt	Bi	Bismuth
W	Tungsten		

Q.10 Name a solid, a liquid and a gaseous element that exits at the room temperature. (K.B)

Ans: Names of elements in solid, liquid and gaseous state, at room temperature:

- Solid : Iron, gold, silver etc.
- Liquid : Mercury, bromine etc.
- Gas : Hydrogen, oxygen, nitrogen etc.

Q.11 What elements do the following compounds contain? Sugar, common salt, lime water and chalk. (K.B)

Ans:

Compound	Elements	Formula
Sugar	Carbon (C), Hydrogen (H), Oxygen (O)	$C_6H_{12}O_6$

Common Salt	Sodium (Na), Chlorine (Cl)	NaCl
Lime water	Calcium (Ca), Oxygen (O), Hydrogen (H)	$Ca(OH)_2$
Chalk	Calcium (Ca), Carbon(C), Oxygen (O)	$CaCO_3$

MULTIPLE CHOICE QUESTIONS

1. Piece of matter in pure form is called: (K.B)
(A) Mixture (B) Matter
(C) Substance (D) Compound

2. Which one of the following can be separated by physical mean? (U.B)
(A) Mixture (B) Element
(C) Compound (D) Radical

3. Impure matter is called: (K.B)
(A) Atom (B) Compound
(C) Substance (D) Mixture

4. Which one of the following is chemical property? (K.B)
(A) Color (B) Smell
(C) Taste (D) Composition

5. A substance whose atoms have the same atomic number is called: (K.B)
(A) Element (B) Substance
(C) Mixture (D) Compound

6. How many elements occur naturally? (LHR 2016 G-II)(K.B)
(A) 92 (B) 96
(C) 98 (D) 100

7. After gaining one electron chlorine atom becomes: (GRW 2015)(U.B)
(A) Cation (B) Anion
(C) Molecular cation (D) Molecular anion

8. The mixture which has uniform composition throughout is called: (K.B)
(A) Simple mixture (B) Homogeneous mixture
(C) Heterogeneous mixture (D) Compound, mixture

9. Which of the following has sharp and fixed melting point? (U.B)
(A) Compound (B) Mixture
(C) Both (D) None of these

10. Which is heterogeneous mixture? (K.B)
(A) Soil (B) Gasoline
(C) Sugar solution (D) Salt solution

11. A good example of homogenous mixture is: (A.B)
(A) Rock (B) Wood
(C) Soil (D) Ice cream

12. The most abundant element occurring in the ocean is (K.B)
(A) Nitrogen (B)Silicon
(C) Hydrogen (D) Oxygen

1.4 SOLUTION, COLLOIDAL SOLUTION AND SUSPENSION

LONG QUESTIONS

Q.1 Give five characteristics of true solution, colloidal solution and suspension.

Ans: **TRUE SOLUTION**

Defintion

A solution is such a mixture in which solute particles are completely homogenized in the solvent.

Example

- Dissolution (solution) of sodium chloride in water
- Copper sulphate in water

Properties

- The solute particles in such a solution cannot be seen by the naked eye.
- If solution is filtered, these particles pass through the pores of filter paper leaving no precipitate. Such a solution is called a true solution.

SUSPENSION

Definition

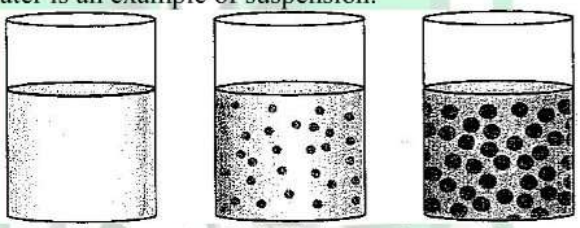
A suspension is a mixture in which solute particles do not dissolve in the solvent.

Properties

- We can actually see these particles.
- If a suspension is kept for some time, these particles settle down.
- Again, if this suspension is filtered, the particles in it cannot pass through the pores of filter paper and can be collected as a precipitate.

Example

A mixture of chalk in water is an example of suspension.



Solution Colloidal Suspension

COLLOIDAL SOLUTION

Definition

The type of solution in which solute particles are bigger than those of true solution but can not be seen with naked eye is called colloidal solution.

OR

Besides a true solution and a suspension, there is a third form of solution called colloidal solution.

Properties

- In this type, the solute particles do not homogenize with solvent.
- These particles are a little bit bigger than the solute particles present in the true solution but not big enough to be seen with a naked eye like the particles present in a suspension.
- If kept for some time, the particles of a colloidal solution do not settle down.
- On filtration, these particles pass through the filter paper like the particles of a true solution.

Examples

- Starch solution
- White of an egg

Q.2 What is saturated and unsaturated solution. Give their preparation.

Ans:

UNSATURATED SOLUTION

Definition

A solution which can dissolve more amount of a solute at a particular temperature is called an unsaturated solution.

Preparation

Take about 100 g of water in a beaker, add to it 5g of table sugar, and stir it. The sugar will dissolve in water. Then add another 5g of sugar and stir. This will also dissolve. This solution is called an unsaturated solution.

SATURATED SOLUTION

Definition

A solution in which the maximum amount of the solute has been dissolved in a particular amount of a solvent at a particular temperature is called a saturated solution.

Example

If the saturated solutions of table sugar and sodium chloride are prepared

- It is found that the concentration of sodium chloride saturated solution is 5.3 molar at room temperature
- Concentration of sugar solution is 3.8 molar at room temperature.

Preparation

Continue adding sugar in the above solution. As the quantity of sugar in water increases, its dissolution will become more difficult. A stage comes when no more sugar will dissolve in water at this temperature. Any more sugar added at this stage will settle down at the bottom of the beaker. This solution is called a saturated solution at a particular temperature of the process.

Stability of different solutes

Different solutes have different solubilities in a particular solvent.

Comparison of solubility of sodium chloride and sugar

In other words, the solubility of sodium chloride in water is far greater than that of sugar at room temperature.

Why solubility of sodium chloride is far greater than that of sugar?

This is due to the fact that the attraction of sodium and chloride ions with water are far stronger than the attractions between sugar molecules with water.

INTERESTING INFORMATION
Solution and everyday life Solutions are closely related to our everyday lives. • The air breath • The liquid and other food we consume • The fluid in our body • The solid like steel we use are solution

Q.3 Discuss the effect of temperature on solubility? (LHR 2016 G-II, RWP 2017 G-II)(U.B)

Ans:

EFFECT OF TEMPERATURE ON SOLUBILITY

Definition

The solubility of a solute is the amount of solute which can dissolve in 100g of a solvent at a particular temperature.

Effect of temperature

Change in temperature has different effects on the solubility of different compounds. Usually the solubility increases with the increase in temperature but it cannot be taken as a general rule.

(a) Increase in solubility with increase in temperature

There are a large number of compounds whose solubility in H_2O increases with the increase in temperature

Examples

- Potassium Nitrate (KNO_3)
- Silver nitrate ($AgNO_3$)

- Potassium chloride (KCI)

(b) No change in solubility with increase in tempterature

The solubility of sodium chloride in H_2O does not increase appreciably with the increase in temperature.

(c) Decrease in solubility wit increase in temperature

The solubility of compounds like lithium carbonate (Li_2CO_3) and calcium chromate ($CaCrO_4$) decreases with the increase in temperature. The solubility of gases in water also decreases with the increase in temperature.

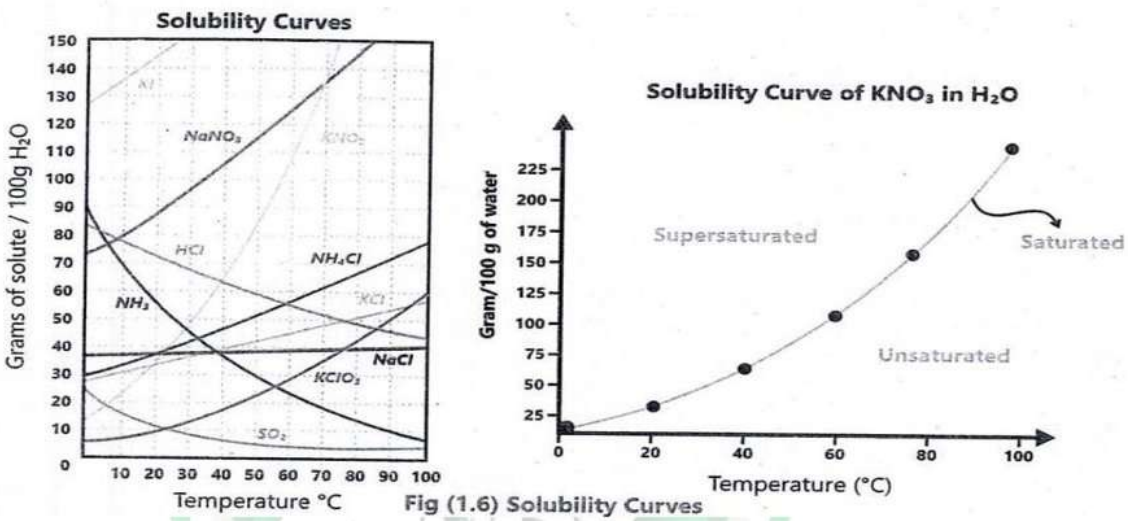


Fig (1.6) Solubility Curves

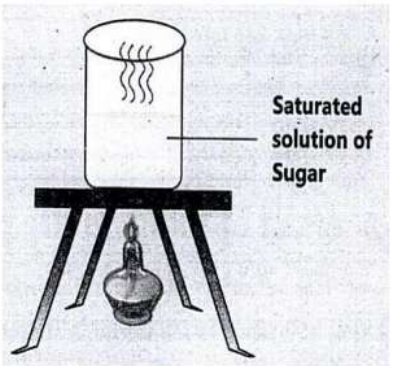
ACTIVITY

Procedure

- Take 100 g of water in a beaker and prepare saturated solution of sugar at room temperature.
- Heat the beaker on a spirit lamp.
- Add a little more sugar in it and stir it. Will this sugar be dissolved in it?

Observation

You will notice that by heating the solution the quantity of sugar dissolved in water has increased i.e. the solubility of sugar has increased.



- Similarly, the solubilities of copper sulphate and sodium nitrate also increase with increase in the temperature.
- However, the solubility of calcium hydroxide decreases with the increase in temperature.

INTERESTING INFORMATION

PURIFICATION OF SOLIDS

1. The increase in the solubility of solids in liquids with increase in temperature may be used to purify them. Pure solids commonly appear as beautifully shaped crystals.

Crystals of Potassium Nitrate

Soda water bottles

2. Generally, the solubility of gases decreases with increase in temperature. Carbon dioxide gas is also more soluble in water at low temperature. Soda water bottles are thus stored in the refrigerator to keep carbon dioxide gas dissolved in water for a longer period of time.

SHORT QUESTIONS

Q.1 Define solution. **(MTN, DGK, RWP 2016) (K.B)**

Ans:

SOLUTION

Definition:

"Solutions are **homogeneous mixtures** of **two or more components**".

Examples:

Salt in water in an example of solution.

Q.2 What are the physical states of solution? **(MTN 2017) (K.B)**

Ans:

PHYSICAL STATES OF SOLUTION

Generally, solutions are found in **three** physical states **depending** upon the **physical state of solvent**.

Examples:

Solid: **Alloy** is a solid solution

Liquid: **Sea water** is a liquid solution
Gas: **Air** is a gaseous solution

Q.3 What are the types of solutions? (K.B)

Ans:

TYPES OF SOLUTION

There are **nine** types of solution ranging from e.g. gas-gas, air we breathe, to solid-solid solution e.g. **dental amalgam** for **filling of tooth**.

Q.4 Define unsaturated solution with example. (K.B+A.B)

Ans:

UNSATURATED SOLUTION

Definition:

*"A solution which contains **lesser amount of solute than that which is required to saturate it at a given temperature**, is called unsaturated solution".*

Such solutions have the **capacity** to **dissolve more solute** to become a saturated solution.

Example

Less than 20.9 g of **sodium thiosulphate** in water **per 100 cm^3 of water** at **20°C.**

Q.5 Differentiate between dilute and concentrated solution with a common example. (LHR 2015,16) (U.B)

Ans:

DIFFERENTIATION

The differences between dilute and concentrated solution is given below:

Dilute Solution	Concentrated Solution
Definition	
• Dilute solutions are those which contain relatively small amount of dissolved solute in the solution.	• Concentrated solutions are those which contain relatively large amount of dissolved solute in the solution.
Examples	
• 1 g of sodium thiosulphate in water per 100 cm^3 of water at 20°C.	• More than 5 g of sodium thiosulphate in water per 100 cm^3 of water at 20°C.
Type of Solution	
• Unsaturated solution	• Supersaturated solution

Q.10 What will happen if the solute-solute forces are stronger than those of solute-solvent forces? (U.B)

Ans:

STRONGER SOLUTE-SOLUTE FORCES

When **solute-solute forces** are **stronger** than those of **solute-solvent forces**, the solute will **not dissolve** and will **not form solution**.

Q.11 When solute-solute forces are weaker than those of solute-solvent forces. Will solution form? (U.B)

Ans:

WEAKER SOLUTE-SOLUTE FORCES

It means when **solute-solute forces** are weaker than those of **solute-solvent forces** the solute solvent attractive forces will overcome the **solute forces**, then solute will dissolve and thus **solution will form**.

Q.12 What is difference between colloid and suspension? (DGK, BWP 2017, FSD, RWP 2016, LHR 2016 G-I)(U.B)

Ans:

DIFFERENTIATION

The differences between colloidal solution and suspension are as follows:

Colloid	Suspension
Composition	
• The particles are large consisting of many atoms, ions or molecules.	• The particles are of largest size. They are larger than 10^{-5}cm in diameter.
Visibility	
• Particles are large but can't be seen with naked eye.	• Particles are big enough to be seen with naked eye.
Passing Through Filter Paper	
• Although particles are big but they can pass through a filter paper.	• Solute particles cannot pass through filter paper.
Tyndall Effect	

• Particles scatter the path of light rays thus emitting the beam of light i.e. exhibit the Tyndall effect.	• Particles are so big that light is blocked and difficult to pass.

Q.13 Can colloids be separated by filtration, if not why? (U.B)

Ans:

SEPARATION OF COLLOIDS

Colloids cannot be separated by filtration because the particles in colloids are not so big. They can pass through a filter paper.

Q.14 Why are the colloids quite stable? (U.B)

Ans:

STABILITY OF COLLOID

The colloids are quite stable because particles do not settle down for a long time. Colloids are quite stable.

Q.15 Why does the colloid show Tyndall effect? (U.B)

Ans:

TYNDALL EFFECT OF COLLOID

Colloids show Tyndall effect because in colloids the particle size is suitable to scatter the path of light rays.

Q.17 Identify as colloids or suspensions from the following: (U.B+A.B)
Milk, milk of magnesia, soap solution and paint.

Ans:

IDENTIFICATION AS COLLOID ARE SUSPENSION

Colloids: Milk, soap solution
Suspensions: Paints, milk of magnesia

Q.18 How can you justify that milk is a colloid. (U.B)

Ans.

MILK IS COLLOID

Justification:

Milk (consists of big particles of carbohydrates, fats, proteins etc.) is a colloid because it shows Tyndall effect.

Milk particles are big but they can pass through a filter paper. Milk particles are larger but cannot be seen with naked eye. Milk particles scatter the path of light rays thus scattering the beam of light i.e. exhibit the Tyndall effect.

MULTIPLE CHOICE QUESTIONS

1. Air is an example of solution: (LHR 2016)(A.B)
(A) Solid in solid (B) Solid in gas
(C) Gas in gas (D) Liquid in gas

2. The concentrated solution of NaCl is called: (K.B)
(A) Fluid (B) Brass
(C) Brine (D) Plasma

3. Addition of more _____ will dilute the solution. (U.B)
(A) Solution (B) Solvent
(C) Solute (D) Solid

4. The solutions are classified as dilute and concentrated on the basis of relative amount of _____ present in them. (U.B)
(A) Solute (B) Solvent
(C) Solution (D) All of these

5. A solution containing maximum amount of solute at given temperature is called: (U.B)
(A) Saturated solution (B) Unsaturated solution
(C) Super saturated solution (D) Aqueous solution

6. Which one of the solutions is not stable? (U.B)
(A) Normal solutions (B) Supersaturated solutions
(C) Saturated solutions (D) Unsaturated solutions

7. Which one of the following will show negligible effect of temperature on its solubility?(LHR 2014)(U.B)

(A) KCl (B) KNO_3
(C) NaCl (D) $NaNO_3$

8. The ionic and polar compounds like NaCl and HCl are more soluble in water than non-polar covalent compounds like: (U.B)

(A) CCl_4 (B) Benzene
(C) CS_2 (D) All of these

9. Which one is not soluble in water? (FSD 2017 G-I)(K.B)

(A) C_6H_6 (B) KCl
(C) Na_2CO_3 (D) $CuSO_4$

10. Naphthalene is soluble in: (K.B)

(A) Water (B) Ether
(C) Carbon tetrachloride (D) Both B and C

11. Which one is soluble in water? (GRW 2017 G-II)(K.B)

(A) Benzene (B) Petrol
(C) Ether (D) Alcohol

12. Generally solutes are: (K.B)

(A) Liquids (B) Gases
(C) Solids (D) Solvents

13. Which one produces colloidal solution? (K.B)

(A) Blood (B) Copper sulphate solution
(C) Silver nitrate solution (D) None of these

14. Tyndall effect is shown by: (LHR 2016, RWP 2017 G-II, SGD 2017 G-II)(A.B)

(A) Sugar solution (B) Paint
(C) Jelly (D) Chalk solution

15. Which one of the following is heterogeneous mixture? (A.B)

(A) Milk (B) Ink
(C) Milk of magnesia (D) Sugar solution

16. Tyndall effect is due to: (U.B)

(A) Blockage of beam of light (B) Non-scattering of beam of light
(C) Scattering of beam of light (D) Passing through beam of light

17. Chalk in water is an example of: (A.B)

(A) Suspension (B) Colloid
(C) Solution (D) Solute

18. An example of colloidal solution is: (A.B)

(A) Drop of ink in water (B) Milk of magnesia
(C) Blood (D) Paint

19. Which one is also called false solution? (U.B)

(A) Colloidal solution (B) Suspension
(C) Paint (D) Water

ANSWER KEY

MULTIPLE CHOICE QUESTIONS

1.1 WHAT IS CHEMISTRY

1	D	**2**	C	**3**	A	**4**	B
5	C	**6**	B				

1.2 STATES OF MATTER

1	B	**2**	C	**3**	A	**4**	D
5	D						

1.3 ELEMENT, COMPOUND AND MIXTURE

1	C	**2**	C	**3**	B	4	D	5	A
6	A	**7**	B	**8**	B	9	A	10	A
11	D	**12**	D						

1.4 SOLUTION, COLLOIDAL SOLUTION AND SUSPENSION

1	C	**2**	C	**3**	B	4	A	5	A	6	B
7	C	**8**	D	**9**	A	10	D	11	D	12	C
13	A	**14**	C	**15**	C	16	C	17	A	18	C
19	A										

EXERCISE SOLUTION

MULTIPLE CHOICE QUESTIONS

1. Tick ( ) the correct answer.

1. Matter is present in neon signs in the state of:

(A)Supercritical fluid (B) Plasma
(C) Gas (D) Liquid crystal

2. Hazardous effects of shopping bags are studied in:

(A) Geochemistry (B) Inorganic chemistry
(C) Analytical Chemistry (D) Environmental chemistry

3. The man-made polymer is:

(A) Starch (B) Polystyrene
(C) Protein (D) Cellulose

4. The allotropic form of sulphur is:

(A) Brass (B) Bronze
(C) Rhombic (D) Graphite

5. 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

6. 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

7. 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

8. When the tiny particles of a substance are dispersed through a medium, the mixture is named as.

(A) True solution (B) Colloid
(C) Suspension (D) Heterogeneous mixture

9. A solution of $KClO_3$ has a solubility of about 13.2g per 100 cm at 40C. How its solubility will 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 it will decrease

10. You are studying the rate of hydrolysis of organic compound starch under different conditions of temperature. In which branch of chemistry this topic will fall?

(A) Organic Chemistry (B) Analytical Chemistry
(C) Biochemistry (D) Physical Chemistry

ANSWER KEY

1	B	**2**	D	**3**	B	**4**	C	5	A
6	D	**7**	A	**8**	C	9	B	10	D

QUESTIONS FOR SHORT ANSWERS

2. Questions for Short Answers

Q1. Why is there a need to divide Chemistry into many branches? Give three reasons:

Ans: **NEED TO DIVIDE CHEMISTR**

There is a need to divide Chemistry into many branches due to the following reasons:

(i) The vast scope of chemistry (Increase in knowledge of Chemistry)

(ii) Advancements in research and technology

(iii) The need for specialization in specific areas

(iv) Interdisciplinary nature of science

Q2. 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.

Ans: **REACTIONS OUTSIDE AND INSIDE OF NUCLEUS**

Reactions that may take place due to electrons present outside the nucleus are studied in physical chemistry. Similarly, reactions that take place inside the nucleus are studied in nuclear chemistry.

Q3. What types of problems are solved in analytical chemistry?

Ans: **PROBLEMS SOLVED BY ANALYTICAL CHEMISTRY**

Analytical chemistry solves the following type of problems:

- Identification and quantification of the components of a sample
- determination of the composition of a substance
- analysis of the purity of a substance
- measurement of the concentration of specific substance in a mixture
- diagnosis of the diseases
- medicines
- forensic science to identify pollutants
- environmental science
- food science (to check food safety and food quality etc.

Q4. Both graphite and graphene have hexagonal layered structures. What is the difference?

Ans: **DIFFERENTIATION**

The differences between graphite and graphene are as follows:

Graphene	Graphite
Number of Layers	
• Graphene is a single layer of carbon atoms arranged in a hexagonal pattern.	• Graphite consists of multiple layers of graphene stacked on top of each other.
Hardness	
• It is a very strong and thin sheet due to a single layer of carbon atoms.1	• weak forces of attraction between the layers allow them to slide easily over each other and thus graphite is soft.

Q5. Why are supercritical fluids important?

Ans: **IMPORTANCE OF SUPERCRITICAL FLUIDS**

Supercritical fluids are important due to the following reason:

(i) Solvent for Chemical Reactions

Supercritical fluids are important because the chemical reactions which may not be carried out in conventional solvents, may possibly be carried out in supercritical carbon dioxide.

(ii) Separation Processes

They are effective solvents for extraction and separation processes in various industries.

(iii) Environment Friendly

They are environmentally friendly due to their ability to replace hazardous organic solvents.

Q6. In which state does matter exist in the Sun?

Ans: **EXISTENCE OF MATTER IN SUN**

Most of the matter in the Sun and other stars exists in the state of plasma.

Q7. What is the importance of graphene?

Ans: **IMPORTANCE OF GRAPHENE**

Graphene is a tough, flexible, light material with a high resistance and due to these properties it is used in various fields like:

- Electronics
- energy storage
- composites
- medicine etc.

Q8. Which form of matter do most of the material things in this world belong to?

Ans: **FORM OF MOST OF THE MATERIAL THINGS**

Most of the material things in this world belong to solid state of matter

CONSTRUCTED RESPONSE QUESTIONS

3. Constructed Response Questions

Q1. How does a supercritical state look like?

Ans: **SUPERCRITICAL STATE LOOK LIKE**

A supercritical state looks like a very thin vapor. It has no distinct phase boundary between a liquid and a gas. It is not a solid, a liquid or a gas.

Example

It looks like boiling water on the stove.

Q2. In what way is plasma created in a fluorescent tube?

Ans: **CREATION OF FLUORESCENT TUBE**

Plasma is created in a fluorescent tube, when an electric current is passed through the tube. The electrons collide with gas atoms/molecules and ionize the gas atoms inside. In this way a mixture of gaseous atoms, ions, electrons and photons is obtained which is called plasma.

Q3. Most of the molecules we study in biochemistry are organic in nature. Where does the difference exist in organic and biochemistry branches of Chemistry?

Ans: **DIFFERENTIATION**

The differences between organic and biochemistry branches of chemistry are as follows:

Organic Chemistry	Biochemistry
Definition	
It is the branch of chemistry that deals with the carbon compounds other than its simple salts like carbonates, oxides and carbides.	It is the branch of chemistry in which we understand life through chemical processes. It is the study of chemical substances and vital processes occurring in living organisms.
Applications	
In this branch, we study the structure, formation, properties, composition and reactions of carbon containing compounds.	Biochemistry provides insights into the structure and function of molecules such as proteins, carbohydrates, lipids and nucleic acids.

Q4. Give the reason of brilliance shown by diamond. Can you improve it?

Ans: **BRILLIANCE OF DIAMOND**

The brilliance of diamond is due to a phenomenon called "total internal reflection". It is due to its high refractive index.

This brilliance of diamond is improved by cutting of the diamond to optimize the reflection of light.

Q5. Explain the dissolution of NaCl in water.

Ans: **DISSOLUTION OF NaCl IN WATER**

When NaCl is added in water it dissolves readily because the **attractive interaction between the ions of NaCl and polar molecules of water are strong** enough to overcome the attractive forces between Na^+ and Cl^- ions in solid NaCl crystal. In this process the positive end of the water dipole is oriented towards the Cl^- ions and the negative end of water dipole is oriented towards the Na^+ ions. These **ion-dipole attractions between Na^+ ions and water molecules, Cl^- ions and water molecules are so strong** that they pull these ions from their positions in the crystal and thus NaCl dissolves.

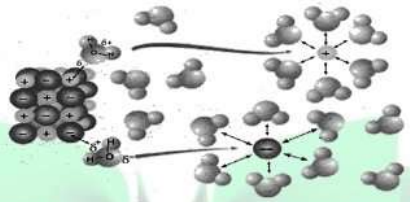


Figure: Inter-action of Solute and Solvent to Form Solution

Q6. Why do different compounds have different solubilities in water at a particular temperature?

Ans: **DIFFERENT COMPOUNDS HAVE DIFFERENT SOLUBILITIES**

Different compounds have different solubilities in water at a particular temperature because of the different strength of intermolecular forces between the solute molecules and water molecules.

Q7. Why NaCI can be crystallized from water just like KNO_3?

Ans: **CRYSTALLIZATION OF NaCl FROM WATER**

NaCI can be crystallized from water just like KNO_3 because both are ionic in nature. Anyhow KNO_3 is more soluble in water than NaCl.

Q8. Why graphite is slippery to touch? Which property of graphite enables it to be used as lubricant?

Ans: **GRAPHITE AS LUBRICANT**

Graphite has layered structure. The layers are held together by weak Vander Waal's forces. The layers can slide over each other due to weak Vander Waal's forces. Thus graphite is slippery to touch. This property of graphite make enables it to be used as lubricant.

GRAPHITE AS LUBRICANT

The layered structure of graphite enables it to be used as lubricant.

DESCRIPTIVE QUESTIONS

4. Descriptive Questions

Q1. Mention the name of the branch of Chemistry in which you will study each of the following topics.

a) Rate of a reaction
b) Digestion of food in human body
c) Properties of plasma
d) Ecosystem
e) Reactions taking place during fire works
f) Measurement of the absorption of wavelength with the help of ultraviolet spectrometer.

Ans: **NAME OF BRANCH**

(a) Physical Chemistry

b) Biochemistry
c) Physical Chemistry
d) Environmental Chemistry
e) Inrganic Chemistry
f) Analytical Chemistry

Q2. What are allotropic forms? Explain the allotropic forms of carbon and sulphur. How does coal differ from diamond?

Ans: Answer given on page #

Q3. What are supercritical fluids. How are they different from ordinary liquids?

Ans:

SUPERCRITICAL FLUIDS

Supercritical fluids are highly compressed states which show both properties of gases and liquids.

DIFFERENTIATION

The differences between supercritical fluids and ordinary liquids are as follows:

Supercritical Fluids	Ordinary Liquids
Definition	
Supercritical fluids are highly compressed states which show both properties of gases and liquids.	Ordinary liquids have definite volume but indefinite shape.
Phase Distinction	
A supercritical fluid has no distinct liquid-gas phase boundary	It exists as a separate phase from its vapor.
Existence	
It exists above a substance's critical temperature and pressure	it exists below a substance's critical temperature and pressure
Properties	
properties of both a gas and a liquid	properties of both a gas and a liquid
Physical Properties	
much lower viscosity, higher diffusivity, and can readily penetrate solids like a gas	Comparatively high viscosity, low diffusivity, and can't readily penetrate solids like a gas.
Example	
Supercritical carbon dioxide ($scCO_2$)	Water Benzene

Q4. Define solubility of a solute. How does the solubility of solutes change with the increase in temperature?

Ans: Answer given on page # 18

Q5. What types of movements are present in gaseous and liquid molecules?

Ans:

MOVEMENTS IN GASEOUS AND LIQUID MOLECULES

Gaseous and liquid molecules exhibit all three types of molecular motion:

- vibrational
- rotational
- translational

Gas molecules move much faster and more randomly due to the larger spaces between them, whereas liquid molecules move slowly due to stronger intermolecular forces.

Q6. Differentiate between the areas which are studied under inorganic and organic chemistry.

Ans:

DIFFERENTIATION

The differences between organic and biochemistry branches of chemistry are as follows:

Inorganic Chemistry	Organic Chemistry
Definition	

It is the study of the synthesis and properties of compounds that do not contain carbon hydrogen bonds.	It is the branch of chemistry that deals with the carbon compounds other than its simple salts like carbonates, oxides and carbides.
Applications	
In this branch, we study the textile, ceramics, glass, metallurgy etc.	In this branch, we study the structure, formation, properties, composition and reactions of carbon containing compounds.

INVESTIGATIVE

Investigative Questions

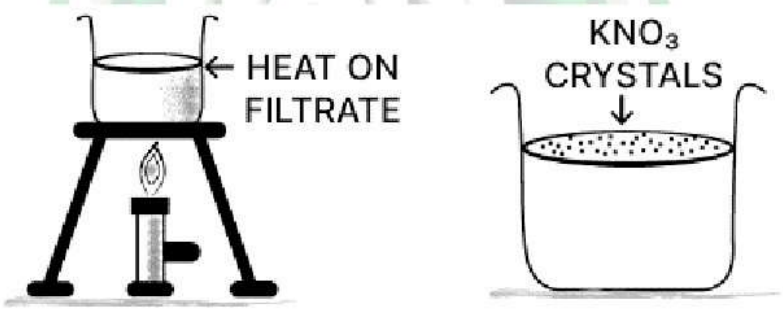
Q1. Preparation of solutions leads to an important process in chemistry which enables us to purify a compound through crystallization. Describe a process in which potassium nitrate is purified by crystallizing it in water.

Ans: **PURIFICATION OF KNO_3 BY CRYSTALLIZATION**

Potassium nitrate (KNO_3) is purified by crystallization in water by a process called re-crystallization. This process can be carried out for purification because potassium nitrate is very soluble in hot water, but less soluble in cold water.

Steps Involved

(i) Dissolve impure potassium nitrate in a small amount of hot water to prepare saturated solution.
(ii) Heat the solution to evaporate water.
(iii) Let the remaining solution to cool.
(iii) Crystals of pure potassium nitrate will be formed and settle down at the bottom.
(iv) Separate the crystals from the remaining liquid and dissolved impurities by filtration.
(v) Wash the crystals in ice cold water.
(vi) Dry the crystals of potassium nitrate between folds of filter paper.



Q2. Purification of Low-grade Potassium Nitrate - Richard Nakka's
Process Description Recrystallization is the process whereby contaminated potassium nitrate is dissolved in a minimal amount of ho...
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Richard Nakka's Experimental Rocketry Site

Q3. Graphene is called a miracle material and it is the material of the future. Which of its many properties makes it very useful in electronics?

Ans: **PROPERTIES OF GRAPHENE USEFUL FOR ELECTRONICS**

Graphene has following unique properties which make it very useful in electronics:

- high electrical conductivity
- high tensile strength
- high flexibility
- light in weight

ADDITIONAL CONCEPTUAL QUESTIONS

Q.1 Differentiate between solute and solvent. **(U.B)**

Ans: **DIFFERENTIATION**

The differences between solute and solvent are as follows:

Solute	Solvent
Definition	
The component of solution which is present in smaller quantity is called solute.	The component of a solution which is present in larger quantity is called solvent.
Example	
In sugar solution, sugar is solute.	In sugar solution, water is solvent
Dissolution	
Solute always dissolve in solvent.	Solvent always dissolve solutes.

Q.2 What type of solution of fog and brass are? (K.B+A.B)

Ans: **TYPE OF SOLUTION OF FOG AND BRASS**

(i) Fog: It is an example of liquid in gas solution.

(ii) Brass: Metal alloy of Cu & Zn.

Q.3 How we can prepare solute crystals? (U.B+A.B)

Ans: **FORMATION OF SOLUTE CRYSTALS**

Prepare super-saturated solution of particular solute by preparing saturated solution of that solute at high temperature. It is then cool to a temperature where excess solute crystallize out and leaves behind saturated solution.

Q.4 How we can prepare 2M solution of glucose? (U.B+A.B)

Ans: We can prepare 2M of glucose solution by dissolving ($2\times180g = 360g$) of glucose in $1dm^3$ of a solution.

Q.5 Why concentration of bulk solution and its sample is same? (U.B)

Ans: Because concentration does not depend upon the total volume or total amount of the solution.

Q.6 How the solubility of salt decreases with the increase of temperature? (U.B)

Ans: **DECREASE OF SOLUBILITY WITH TEMPERATURE**

In some salts solubility decrease with the increase of temperature.

Example:

When salts like Li_2SO_4 and $Ce_2(SO_4)_3$ are dissolved in water, the test tube become warm because heat is released during this dissolution.

$$\text{Solvent + solute} \rightarrow \text{solution + heat}$$

TERMS TO KNOW

Terms	Definitions
Chemistry	**Chemistry** is that branch of science which deals with the composition of matter, changes in matter and the laws which govern these changes.
Branches of Chemistry	To understand the vast and complex subject of Chemistry it is divided into many branches Physical chemistry, inorganic chemistry and organic chemistry are its main branches among so many others.
States of Matter	Matter exists mainly in three states: solid, liquid and gas. They are different from each other due to different characteristics of particles which they contain.
Plasma	Plasma is regarded as the fourth state of matter which is not normally observed in this world: Most of the matter present in the rest of the universe exists in this state.
Intermediate states of Matter	Matter also exists the intermediate states which are at the borderline of its two principal states between liquid and' gas or between liquid and solid. Supercritical fluids and liquid crystals are some examples of such states.
Distinct entities of Matter	Matter exists in the form of distinct entities called elements, compounds and mixtures. Elements, compounds and mixture-s have distinct properties individually and they are very different form one another.

Solutions, suspensions and colloids	Solutions, suspensions and colloidal solutions are different forms in which the mixtures usually exist. They have their own characteristic properties