SAMPLE CONTENT

Challenger

NEET-UG & JEE (Main)

CHEMISTRY Vol - I

As per latest syllabus issued by NMC

1000+ MCQs with Hints

For all Medical and Engineering Entrance Examinations held across India.

Gas laws and Henry's law

Scuba diving is an example of how these laws apply when a scuba diver is exposed to changes in pressure.

Prof. Santosh Yadav
M. Sc., SET, NET

Prof. Anil Thomas
M.Sc., Chemistry

Mr. Mukesh Paradiya
M.Tech - IIT Bombay

Ms. Trupti Kurkute
M.Sc. Chemistry, SET

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Challenger

NEET (UG) & JEE (Main)

Chemistry Vol. I

Now with more study techniques

Salient Features

- Concise theory for every topic
- Eclectic coverage of MCQs under each sub-topic
- Exhaustive coverage of questions including selective questions from previous years' NEET (UG) and JEE (Main) examinations updated upto **year 2024**:
  - **1400+** MCQs
  - **60+** Numerical Value type (NVT)
  - Solutions to the questions are provided for better understanding
- Inclusion of '**Problems To Ponder**' to engage students in scientific enquiry
- Includes Smart Keys: Multiple study techniques to enhance understanding and problem solving:
  - ***Smart code***
  - ***Smart tip***
  - ***Caution***
  - ***Think out of the box***
- Includes Question Paper and Answer Keys (Solution through Q.R. code) of:
  - JEE (Main) 2024 31^{st} Jan (Shift - I)
  - NEET (UG) 2024
- Q.R. codes provide:
  - Video links for boosting conceptual retention
  - Solution of JEE (Main) 2024 31^{st} Jan (Shift - I) Question Paper
  - Solution of NEET (UG) 2024 Question Paper

Printed at: **India Printing Works,** Mumbai

P.O. No. 13420

TEID: 3745

PREFACE

'Challenger Chemistry Vol - I' is a compact guidebook, extremely handy for preparation of various competitive exams like NEET (UG), JEE (Main). This edition provides an unmatched comprehensive amalgamation of theory with MCQs. The chapters are aligned with the latest syllabus for **NEET (UG) and JEE (Main) 2024** examinations. Although the alignment runs parallel to NCERT curriculum, the structure of the chapters prioritizes knowledge building of the students. The book provides the students with scientifically accurate context, several study techniques and skills required to excel in these examinations.

In this book the Theoretical Concepts are presented in the form of pointers, tables, charts and diagrams that form a vital part of preparation of any competitive examination.

Multiple Choice Questions have been specially created and compiled with the following objective in mind – to help students solve complex problems which require strenuous effort and understanding of multiple-concepts. The assortment of MCQs is a beautiful blend of questions based on higher order thinking, theory, and multiple concepts.

MCQs in each chapter are segregated into following sections.

- **Concept Building Problems** section is designed to boost prerequisite understanding of concepts.
- **Practice Problems** section contains questions crafted for thorough revision .
- **Numerical Value Type** section caters to newly added NVT questions in JEE (Main).
- **Problems to Ponder** section offers questions of diverse pattern created to instil the attitude of concentrating on the problems and to understand the application of various concepts in Chemistry.

All the questions included in a chapter have been specially created and compiled to enable students solve complex problems which require strenuous effort with promptness.

All the features of this book pave the path of a student to excel in examination.The features are designed keeping the following elements in mind: Time management, easy memorization or revision and non-conventional yet simple methods for MCQ solving.

Exhaustive coverage of questions, including selective questions from previous years' NEET (UG) and JEE (Main) examinations is updated up to the **year 2024.**
Question Papers along with Answers and Solutions (through Q.R. code) of **JEE (Main) 2024 31st Jan (Shift -I) & NEET (UG) 2024** have been provided to offer students glimpse of the complexity of questions asked in entrance examination. These papers has been split unit-wise to let the students know which of the units were more relevant as per latest Question papers.

We hope the book benefits the learner as we have envisioned.

A book affects eternity; one can never tell where its influence stops.

Publisher

Edition: Fifth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

Please write to us on: mail@targetpublications.org

KEY FEATURES

Formulae
Smart Keys
Caution
Smart Tips
Think out of the box
Smart Code

Formulae

'Formulae' includes all of the key formulae in the chapter.
This is our attempt to offer students tools of formulae accessible while solving problems and last minute revision at a glance.

Smart Keys

'Smart Keys' comprise a set of remarkable study techniques contrived to benefit students.

Caution

'Caution' apprises students about mistakes which are made while solving an MCQs.
This is our attempt to make a student aware of possible common mistakes.

Smart Tips

'Smart tips' comprise important theoretical or formula based short tricks considering their usage in solving MCQ.
This is our attempt to highlight content that would come handy while solving questions.

Think out of the box

'Think out of the box' reveals quick witted approach to crack the specific question.
This is our attempt to develop skill of lateral thinking in students.

Smart Code

'Smart Code' showcases simple and smart mnemonic created for selected concepts.
This is our attempt to offer students a memory technique that facilitates easy recollection.

KEY FEATURES

QR Codes

'QR code' provides:

i. Access to a video/PDF in order to boost understanding of a concept or activity

ii. Solution of JEE (Main) 2024 31st Jan (Shift - I) Question Paper

iii. Solution of NEET (UG) 2024 Question Paper

Clock Symbol

'Clock Symbol' instructs students that given MCQ can be solved apace by applying either smart tips, learning pointers, timesaver or Think out of the box.

This is our attempt to make students attentive towards their perception of approaches possible for solving an MCQ.

Miscellaneous

'Miscellaneous' MCQs covers concept of different sub-topics of same chapter or from different chapters.

This is our attempt to develop cognitive thinking in the students essential to solve questions involving fusion of multiple key concepts.

Problems to Ponder

'Problems to Ponder' contains MCQs of higher order thinking.

This is our attempt to help students understand the application of difficult concepts of Chemistry.

Frequently Asked Questions

- **Why Challenger Series?**

  Gradually, every year the nature of competitive entrance exams is inching towards conceptual understanding of topics. Moreover, it is time to bid adieu to the stereotypical approach of solving a problem using a single conventional method.

  To be able to successfully crack the NEET examinations, it is imperative to develop skills such as data interpretation, appropriate time management, knowing various methods to solve a problem, etc. With *Challenger Series,* we are sure, you'd develop all the aforementioned skills and take a more holistic approach towards problem solving. The way you'd tackle advanced level MCQs with the help of solutions, Smart tips, Smart codes and Think out of the box section would give you the necessary practice that would be a game changer in your preparation for the competitive entrance examinations.

- **What is the intention behind the launch of Challenger Series?**

  The sole objective behind the introduction of Challenger Series is to severely test the student's preparedness to take competitive entrance examinations. With an eclectic range of critical and advanced level MCQs, we intend to test a student's MCQ solving skills within a stipulated time period.

- **What do I gain out of Challenger Series?**

  After using Challenger Series, students would be able to:

  a. Assimilate the given data and apply relevant concepts with utmost ease.

  b. Tackle MCQs of different pattern such as match the columns, diagram based questions, statement based questions, multiple concepts and assertion-reason efficiently.

  c. Garner the much needed confidence to appear for competitive exams.

  d. Easy and time saving methods to tackle tricky questions will help ensure that time consuming questions do not occupy more time than you can allot per question.

- **How to derive the best advantage of the book?**

  To get the maximum benefit of the book, we recommend :

  a. Go through brief theory given at the beginning of a chapter for a quick revision. Commit Smart Tips into memory and pay attention to Caution.

  b. Know all the Formulae compiled at the end of theory by heart.

  c. Using subtopic wise segregation as a leverage, complete the Concept Building Problems at your own pace. Questions from JEE (Main), NEET (UG) examinations are tagged and placed along the flow of subtopic. Mark these questions specially to gauge the trends of questions in various exams.

  d. Be extra receptive to Think out of the box, Alternate Method and application of Smart Tips. Assimilate them into your thinking.

  e. After mastering stimulating questions, take up Practice Problems as self-assessment and verify answers as well as methods. Check if you could apply smart tips, alternate method, etc., as mentioned in hint. Find out if you have invented ingenious solution mapping to Think out of the box explicated in hints.

  f. Watch the linked video for an efficient revision of chapter theory.

  g. Ruminate over questions from Problems To Ponder and appreciate aesthetics of the concepts.

- ***Can the Questions presented in Problems to Ponder section be a part of the NEET Examination?***

  No, the questions would not appear as it is in the NEET Examination. However, there are fair chances that these questions could be covered in parts or with a novel question construction.

Best of luck to all the aspirants!

CONTENTS

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General introduction – Importance and scope of chemistry

➢ **Chemistry:** It is the study of composition, structure and properties of matter and the reactions by which one form of matter may be converted into another form.

Chemistry plays a very important role in our everyday lives. In fact, Chemistry is the single branch of science which profoundly influences the existence of human beings, plants, animals as well as their habitat. Thus, mankind owes much to chemistry because it has improved the quality of life.

➢ **Some important branches of chemistry:**
- Physical chemistry
- Organic chemistry
- Inorganic chemistry
- Analytical chemistry

Classification of matter

➢ **Matter:**

Matter
Anything that has mass and occupies space is called as **matter**.

→ **Physical classification**
Solids, liquids and gases

→ **Chemical classification**
Pure substances and mixtures

➢ **Pure substances:**

Pure substances
- It comprises of a single type of particle.
- All the constituent particles are same in their chemical nature.

E.g. Silver (Ag), Water, glucose, sodium chloride, etc.

→ **Elements**
Pure substances which are made up of only one type of atom.
E.g. Ag, Au, Cu, etc.

→ **Compounds**
Pure substances which are made up of two or more atoms of different elements.
E.g. Water, ammonia, etc.

➢ **Mixtures:**

Mixtures

It comprises of two or more substances (components) present in any ratio in which the constituent substances retain their separate identities.
E.g. Air, Tea, Brass (an alloy of copper and zinc), etc.

Homogeneous mixture

It comprises of a single phase in which components are completely mixed with each other and its composition is uniform throughout.
E.g. Mixture of salt and water.

Heterogeneous mixture

It comprises of two or more phases present in the mixture and its composition is not uniform throughout.
E.g. Phenol-water system, silver chloride-water system, etc.

UNITS OF MEASUREMENT

➢ **Properties of matter:** The properties of matter can be classified as:

- Physical properties: **E.g.** Colour, density, melting point, boiling point, etc.
- Chemical properties: **E.g.** Acidity, basicity, combustibility, etc.

➢ **Units:** These are the arbitrarily decided and universally accepted standards used in the measurement of physical quantities**.**
Derived units: The units of physical quantities (other than seven mentioned above) can be derived from the seven fundamental SI units. These units are known as **derived units**.
The tables given below show seven fundamental SI units and some common derived units:

Fundamental quantity	SI unit	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	K
Amount of substance	Mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

Physical quantity	Relationship with fundamental unit	Units
Area	Length squared	m^2
Volume	Length cubed	m^3
Density	Mass per unit volume	$kg\ m^{-3}$
Velocity	Distance travelled in unit time	$m\ s^{-1}$
Acceleration	Velocity change per unit time	$m\ s^{-2}$
Force	Mass × acceleration	$kg\ m\ s^{-2}$ (newton, N)
Pressure	Force per unit area	$kg\ m^{-1}\ s^{-2}$
Electric charge	Current × time	A s (coulomb, C)
Electric potential or Potential difference	Energy per unit charge	$kg\ m^2 s^{-2} A^{-1}$ (volt V or $J\ C^{-1}$)
Energy (work or heat)	Force × distance travelled	$kg\ m^2\ s^{-2}$ (J)
Concentration	Mole per cubic metre	$mol\ m^{-3}$
Heat capacity	$C_p = dH/dT$ $C_v = dU/dT$	$kg\ m^2\ s^{-2}\ K^{-1}\ mol^{-1}$ ($J\ K^{-1}\ mol^{-1}$)
Electrochemical equivalent	Z = E/F	$kg\ C^{-1}$ (kg/coulomb)

➢ **Some physical quantities of matter:**

Substance			
Mass	**Weight**	**Volume**	**Density**
Amount of matter present in a substance.	Force exerted by gravity on a substance.	Space that a substance occupies.	Amount of mass per unit volume.

- Relation between different units of volume: $1\ L = 1\ dm^3 = 1000\ mL = 1000\ cm^3 = 1000\ cc = 0.001\ m^3$

- **Temperature:**

Three common scales to measure temperature

- Degree Celsius [°C]
- Degree Fahrenheit [°F]
- Kelvin [K]

- **Formulae for interconversions:**

$°F = \frac{9}{5}(°C) + 32$; $K = °C + 273.15$

UNCERTAINTY IN MEASUREMENT

➢ **Scientific notation:**

Any number can be represented in scientific notation as: $\boxed{\mathbf{N \times 10^n}}$ **E.g.**

Where N – can vary between 1 to 10

n – is an exponent having positive or negative value.

Number	Scientific notation
907.5	9.075×10^2
0.00012	1.2×10^{-4}

➢ **Mathematical operations on numbers expressed in scientific notations:**

Multiplication	Division
Multiply the numbers and **add** the exponents $(8.0 \times 10^4) \times (5.0 \times 10^2) = (8.0 \times 5.0)(10^{4+2})$ $= 40 \times 10^6$ $= 4.0 \times 10^7$	Divide the numbers and **subtract** the exponents $\frac{8.5 \times 10^4}{5.0 \times 10^9} = \frac{8.5}{5.0} \times 10^{4-9} = 1.7 \times 10^{-5}$
Addition	**Subtraction**
First the numbers are written in such a way that they have the same exponent. Then add the numbers but the exponent remains the same. $(4.31 \times 10^4) + (3.9 \times 10^3) = (4.31 \times 10^4) + (0.39 \times 10^4)$ $= 4.70 \times 10^4$	First the numbers are written in such a way that they have the same exponent. Then subtract the numbers but the exponent remains the same. $(2.22 \times 10^{-2}) - (4.10 \times 10^{-3}) = (2.22 \times 10^{-2}) - (0.41 \times 10^{-2})$ $= 1.81 \times 10^{-2}$

➢ **Precision:** Precision refers to the closeness of various measurements for the same quantity.

➢ **Accuracy:** Accuracy refers to degree of closeness of a particular value to the true value of the result.

➢ **Significant figures:** Significant figures are meaningful digits which are known with certainty plus one uncertain digit in a measurement.

There are certain rules for determining the total number of significant figures.

- All non-zero digits are significant.
- Zeros preceding to first non-zero digit are not significant. Such zero indicates the position of decimal point.
- Zeros between two non-zero digits are significant.
- Zeros at the end or right of a number are taken as significant digits provided they are on the right side of the decimal point.
- Counting numbers possess infinite number of significant figures.

➢ **Addition and subtraction of significant figures:** The maximum number of digits to the right of the decimal point in the result should not be greater than either of the original numbers.

E.g.

$$\begin{array}{r} 15.541 \\ 12.10 \\ +\ 18.5 \\ \hline 46.141 \end{array}$$

The final answer should be reported only up to one digit after the decimal point (since 18.5 has only one digit after the decimal point).

So, the answer is **46.1**.

➢ **Multiplication and division of significant figures:** The result is reported with the same number of significant figures as there are in the measurement with the few significant figures.

➢ **Rules for limiting the result to the required number of significant figures:**

- The preceding number is increased by one if the rightmost digit to be removed in the result is more than 5.
- The preceding number remains unchanged if the rightmost digit to be removed in the result is less than 5.
- If the rightmost digit to be removed in the result is equal to 5 then the preceding number remains unchanged if it is an even number and it is increased by one if it is an odd number.

➢ **Dimensional analysis:** The dimensional analysis or factor label method or unit factor method is basically used to convert units from one system to other.

E.g.

Converting 5 inch to cm	Converting 5 cm to inch
Unit factor: $\frac{2.54\,\text{cm}}{1\,\text{inch}}$ 5 inch = 5 inch × $\frac{2.54\,\text{cm}}{1\,\text{inch}}$ = 12.7 cm	Unit factor: $\frac{1\,\text{inch}}{2.54\,\text{cm}}$ 5 cm = 5 cm × $\frac{1\,\text{inch}}{2.54\,\text{cm}}$ = 1.97 inch

Laws of chemical combination

➢ **Law of conservation of mass:**

Statement: *Mass is neither created nor destroyed during chemical combination of matter.*

E.g. $$\underbrace{\underset{1.70\text{g}}{AgNO_3} + \underset{0.555\text{g}}{NaCl}}_{2.255\text{ g}} \longrightarrow \underbrace{\underset{1.435\text{g}}{AgCl} + \underset{0.82\text{g}}{NaNO_3}}_{2.255\text{ g}}$$

➢ **Law of definite composition:**

Statement: *Any pure compound always contains the same elements in a definite proportion by weight irrespective of its source or method of preparation.*

➢ **Law of multiple proportions:**

Statement: *If two elements, combine chemically with each other forming two or more compounds with different compositions by weight, then the masses of the two interacting elements in the two compounds are in the ratio of small whole numbers.*

E.g. The masses of oxygen which combine with same mass of hydrogen in H_2O and H_2O_2 bear a simple ratio 1 : 2.
H_2O : 2 parts of Hydrogen, 16 parts of Oxygen
H_2O_2 : 2 parts of Hydrogen, 32 parts of Oxygen.

➢ **Law of reciprocal proportions:**

Statement: *When two different elements combine separately with the same weight of a third element, the ratio in which they do so will be the same or some simple multiple of the ratio in which they combine with each other.*

E.g. Hydrogen combines with sodium and chlorine to form compounds NaH and HCl respectively.

NaH :	23 parts of sodium,	1 part of Hydrogen
HCl :	35.5 parts of chlorine,	1 part of Hydrogen

Sodium and chlorine also combine to form NaCl in which 23 parts of sodium and 35.5 parts of chlorine are present. These are the same parts which combine with one part of hydrogen in NaH and HCl respectively.

➢ **Gay-Lussac's law of combining volumes of gases:**

Statement: *When gases react together to produce gaseous products, the volumes of reactants and products bear a simple whole number ratio with each other, provided volumes are measured at same temperature and pressure.*

E.g. Under similar conditions of temperature and pressure, 1 volume of hydrogen reacts with 1 volume of chlorine to give 2 volumes of hydrogen chloride.

$$\underset{\text{1 volume}}{H_2} + \underset{\text{1 volume}}{Cl_2} \longrightarrow \underset{\text{2 volumes}}{2HCl}$$

Thus, the volume ratio of hydrogen: chlorine: hydrogen chloride is 1 : 1 : 2.

- **Avogadro's law:**

> **Statement:** *Equal volumes of all gases, under identical conditions of temperature and pressure, contain equal number of molecules.*
> **OR**
> *At constant pressure and temperature, volume of a gas is directly proportional to the number of molecules.*

$\therefore$ V $\propto$ number of molecules (P and T are constant)

Dalton's atomic theory

- **Dalton's atomic theory:** According to Dalton, atom is the smallest indivisible particle of any matter.

- **Postulates:**

i. Matter consists of indivisible atoms.
ii. All the atoms of a given element have identical mass and properties. Atoms of different elements have different properties.
iii. Atoms of different elements combine in a fixed ratio to form compounds.
iv. Chemical reactions involves reorganization of atoms. These atoms are neither created nor destroyed in a chemical reaction.

Concept of elements, atoms and molecules

- **Elements:** A substance which cannot be separated into simpler substances by any chemical process.
  Elements are further classified as metals, non-metalloids and noble gases.
- **Compounds:** Substances of definite compositions which can be decomposed into two or more substances by a simple chemical process.
- **Atoms:** The smallest indivisible particle of an element is called **atom**.
- **Molecules:** An aggregate of two or more atoms of definite composition which are held together by chemical bonds.
  The total number of atoms present in a molecule of a substance is called **atomicity**.

Atomic and molecular masses

- **Atomic mass:** It is the relative mass of an atom of an element as compared to the mass of an atom of carbon (C^{12}) taken as 12.

  $$\text{Atomic mass} = \frac{\text{Mass of an atom}}{\frac{1}{12^{th}} \text{ mass of an atom of } C^{12}}$$

- **1 amu:** One atomic mass unit (amu) is defined as a mass exactly equal to one-twelfth of the mass of one C-12 atom.
  1 amu = 1.66056×10^{-24} g
  Recently the unit of atomic mass 'amu.' is been replaced by 'u' known as unified mass.
- **Gram atomic mass:** It is the atomic mass of an element expressed in grams.
  E.g. The atomic mass of oxygen = 16 u. Therefore, gram atomic mass of oxygen = 16 g
- **Average atomic mass:** The best way to define the atomic mass of the elements is to determine the atomic mass of each isotope separately and then combine them in the ratio of their proportion of occurrence. This is called **average atomic mass.**
  E.g. Chlorine has two isotopes, ^{35}Cl and ^{37}Cl, present in 75 % and 25 % proportion respectively. Hence, the atomic mass of chlorine is the weighed average of these two isotopic masses.
  i.e., $(35.0 \times 0.75) + (37.0 \times 0.25) = 35.5$ u
- **Molecular mass:** It is the algebraic sum of atomic masses of constituent atoms present in the molecule.
  Molecular mass can be calculated from vapour density as: **Molecular mass = Vapour density × 2**

- **Gram molecular mass:** It is the molecular mass expressed in grams.
  E.g. Molecular mass of CO_2 = 44 u. Therefore, gram molecular mass of CO_2 = 44 g
- **Formula mass:** It is the sum of atomic masses of all the atoms as present in the simple formula of the compound. Formula mass is used in case of ionic compounds such as NaCl, KCl, etc., which do not have discrete molecules as their constituent units.

Mole concept and molar mass

- **Mole:**

  *A **mole** is defined as the amount of substance that contains the same number of entities (atoms, molecules, ions or other particles), as present in 12 g (or 0.012 kg) of the ^{12}C isotope.*

  The quantity of a substance equal to its atomic mass or molecular mass in grams is referred as 1 mole of a substance.
  E.g. Gram molecular mass of CO_2 = 44 g. Therefore, 1 mole of CO_2 = 44 g
- **Avogadro number (N_A):** The number of atoms, molecules, ions, or electrons etc. present in 1 mole of a substance is found to be equal to $\mathbf{6.022 \times 10^{23}}$, which is called **Avogadro number (N_A).**
  Thus, $N_A = 6.022 \times 10^{23}$ molecules or ions or electrons per mol.
- **Avogadro's molar volume:**

i. The volume of 1 mole of any ideal gas at standard temperature and pressure is always constant and is equal to **22.414 L** or $\mathbf{0.022414\ m^3}$. This value is called as **Avogadro's molar volume** or **molar gas volume** at STP.
   E.g. 1 mole of chlorine gas at STP = 22.4 L or 0.0224 m^3
ii. Volume of 'n' moles of an ideal gas at STP = $\mathbf{n \times 22.4\ L}$

Smart tip - 1

The following formula gives the total number of atoms in 'n' moles of a substance.
Number of atoms = $n \times N_A \times$ Atomicity

- **Molar mass:** It is the mass of one mole of a substance. It is expressed in g mol^{-1}.

• Number of moles of a substance = $\dfrac{\text{Mass of the substance}}{\text{Molar mass of the substance}}$

• Mass of one atom = $\dfrac{\text{Mass of the substance}}{\text{Molar mass of the substance}}$

• Mass of one molecule = $\dfrac{\text{Gram molecular mass}}{6.022 \times 10^{23}}$

Percentage composition, empirical and molecular formulae

- **Percentage composition:** It refers to the relative mass of each of the constituent element in 100 parts of it.

  Mass percentage of an element = $\dfrac{\text{Mass of the element in 1 mole of the compound} \times 100}{\text{Molar mass of the compound}}$
- **Empirical and molecular formulae:**

Empirical formula	Molecular formula
It is the simplest whole number ratio of atoms present in a compound.	It refers to the exact number of different types of atoms present in a molecule of a given compound.
E.g. Molecular formula of benzene = C_6H_6	**E.g.** Empirical formula of benzene = CH

Molecular formula and **empirical formula** are related as:
Molecular Formula = r × Empirical formula
where 'r' is a simple whole number and may have values 1, 2, 3 …..

$r = \dfrac{\text{Molecular mass}}{\text{Empirical mass}}$

Chemical reactions, stoichiometry and calculations based on stoichiometry

- **Chemical reactions:**

  *A **chemical reaction** is a process in which a single substance or many substances interact with each other to produce one or more substances.*

  A chemical reaction is represented in terms of **chemical equation**, which is the brief representation of a chemical change in terms of symbols and formulae of substances involved in it.

- **Stoichiometry:** Stoichiometry deals with the quantitative relationship among the reactants and the products in a chemical reaction.

- **Calculations based on stoichiometry:** Using stoichiometric calculations, the amounts of one or more reactants needed to produce a required quantity of product can be determined and vice-versa.
  The problems based upon chemical equations may be classified as:

- **Mole to mole relationships:** In these problems, the moles of one of the reactants/products is to be calculated if that of other reactants/products are given.
- **Mass-mass relationships:** In these problems, the mass of one of the reactants/products is to be calculated if that of the other reactants/products are given.
- **Mass-volume relationship:** In these problems, the mass or volume of one of the reactants or products is calculated from the mass or volume of other substances.
- **Volume-volume relationship:** In these problems, the volume of one of the reactants/products is given and that of the other is to be calculated.

- **Limiting reactant:** Limiting reactant is a substance which gets completely consumed in the reaction and limits the amount of product formed

.

Students can scan the adjacent Q.R. code in *Quill - The Padhai App* to get conceptual clarity on **limiting reactant** with the aid of a relevant video.

- **Reactions in solutions:** The concentration of a solution or amount of substance present in a given volume can be expressed in any of the following ways:

	Concentration	Definition	Formula
i.	Percentage by mass (W/W %)	Mass of solute in gram dissolved in solvent to form 100 gram of solution.	Percentage by mass $= \frac{\text{Mass of solute}}{\text{Mass of solute + Mass of solvent}} \times 100$
ii.	Mole fraction (x)	Ratio of number of moles of a particular component (whose mole fraction is to be calculated) present in the solution, to the total number of moles of all the components of the solution. It is a unitless expression.	For binary solution: Mole fraction of solvent, $x_1 = \frac{n_1}{n_1 + n_2}$ Mole fraction of solute, $x_2 = \frac{n_2}{n_1 + n_2}$ (Where n_1 = Number of moles of solvent, n_2 = Number of moles of solute) $x_1 + x_2 = 1$
iii.	Molarity (M)	Number of moles of solute present in 1 dm^3 volume of the solution. Units: mol L^{-1} It depends upon temperature because volume of a solution is temperature dependent.	Molarity (M) $= \frac{\text{Number of moles of solute}}{\text{Volume of solution in litres}}$

iv.	Molality (m)	Number of moles of solute present in 1 kg of solvent. Units: mol kg^{-1} It does not change with temperature since mass remains unaffected with temperature.	Molality (m) $= \dfrac{\text{Number of moles of solute}}{\text{Mass of solvent in kg}}$

➢ **Different expressions for concentrations:**

i. **Volume by volume percent (V/V %):** Milliliter of solute in 100 mL of solution.
ii. **Mass by volume percent (W/V %):** Grams of solute in 100 mL of solution.
iii. **Volume by mass percent (V/W %):** Milliliter of solute in 100 g of solution.
iv. **Parts per million (ppm):** Mass of solute in 1 millionth part of the mass of solution.
v. **Normality (N):** The number of gram equivalent of solute per litre of solution.
Gram equivalent = Mass of solute / Equivalent mass of solute
Equivalent mass of solute = Molar mass of solute / n
Where n = basicity of an acid or acidity of a base or total positive/negative charge of an ionic compound or number of electrons involved in a redox reaction
Normality = n × Molarity

➢ **Some formulae for calculating concentration of solutions:**

- **Molarity of a solution after dilution:**
For dilution, $\underset{\text{(Before dilution)}}{M_1V_1} = \underset{\text{(After dilution)}}{M_2V_2}$

- **Molarity (M) of a mixture of two solutions of same substance:** $M = \dfrac{M_1V_1 + M_2V_2}{V_1 + V_2}$

Formulae

1. **To convert Celsius to Fahrenheit:** $°F = \frac{9}{5}(°C) + 32$
2. **Avogadro's law,** $V \propto n$ (At constant T and P)
3. **Atomic mass unit (1 amu) =** $\frac{1}{12}$ th of a ^{12}C-atom $= 1.66 \times 10^{-27}$ kg
4. **Average atomic mass =** $\dfrac{\text{Sum of (Isotopic mass} \times \text{its \% abundance)}}{100}$
5. **1 Mole =** 6.022×10^{23} particles (atoms/molecules/ions/electrons)
6. **Number of moles (n) =** $\dfrac{\text{Mass of the substance}}{\text{Molar mass of the substance}}$
7. **Mass of an atom =** $\dfrac{\text{Atomic mass}}{6.022 \times 10^{23}}$
8. **Mass of a molecule =** $\dfrac{\text{Molecular mass}}{6.022 \times 10^{23}}$
9. **Number of molecules =** n × Avogadro number (N_A)
10. **Atomicity =** number of atoms in a molecule
11. **Total number of atoms in a given amount of substance =** $n \times N_A \times$ Atomicity
12. **Volume occupied by one mole of a gas at STP =** 22.4 L = 22.4 dm^3
13. **Molecular mass =** Vapour density × 2
14. **Molecular formula =** r × Empirical formula
15. **r =** $\dfrac{\text{Molecular mass}}{\text{Empirical mass}}$

16. **Mass percentage of an element =** $\frac{\text{Mass of the element in 1 mole of compound}}{\text{Molar mass of the compound}} \times 100$

17. **Percentage by mass (W/W) =** $\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100 = \frac{W_B}{W_A + W_B} \times 100$

where, W_A = mass of solvent, W_B = mass of solute.

18. **Percentage by volume (V/V) =** $\frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100 = \frac{V_B}{V_A + V_B} \times 100$

where, V_A = volume of solvent, V_B = volume of solute.

19. **Mole fraction:** For a solution containing i number of components, mole fraction, x_i, will be

$x_i = \frac{n_i}{(n_1 + n_2 + ... + n_i)}$

For a binary solution, $x_B = \frac{n_B}{n_A + n_B}$

where, n_A = number of moles of solvent, n_B = number of moles of solute.

20. **Molarity (M) =** $\frac{\text{Number of moles of solute}}{\text{Volume of solution in dm}^3} = \frac{\text{Mass of solute (in kg)}}{\text{Molar mass of solute (in kg mol}^{-1}) \times \text{Volume of solution (in dm}^3 \text{ or L)}}$

21. **Molality (m) =** $\frac{\text{Number of moles of solute}}{\text{Mass of solvent in kg}} = \frac{\text{Mass of solute in kg}}{\text{Molar mass of solute (in kg mol}^{-1}) \times \text{Mass of solvent (in kg)}}$

22. **Parts per million (ppm) =** $\frac{\text{Mass or volume of solute}}{\text{Total mass or volume of solution}} \times 10^6$

Concept Building Problems

General Introduction – Importance and Scope of Chemistry

1. The collective study of separation, identification and quantitative determination of the composition of different substances is dealt under _______ chemistry.
(A) analytical
(B) organic
(C) inorganic
(D) bio

2. The application of chemical research, techniques to the synthesis of pharmaceuticals is studied under which branch of chemistry?
(A) Inorganic chemistry
(B) Medicinal chemistry
(C) Green chemistry
(D) Nano chemistry

Classification of Matter

1. _______ comprises of a single type of particle present in a fixed ratio in which all the constituent particles are same in their chemical nature.
(A) Homogeneous mixture
(B) Heterogeneous mixture
(C) Pure substance
(D) Mixture

2. Identify the CORRECTLY matched pair.
(A) Bronze – Pure substance
(B) Iron – Compound
(C) Sea water – Mixture
(D) Naphthalene – Mixture

3. Which out of the following is a heterogeneous mixture?
(A) Air
(B) Solution of salt in water
(C) Solution of sugar in water
(D) Smoke

Units of Measurement

1. The force exerted by gravity on an object is called as _______.
(A) mass (B) density
(C) weight (D) volume

2. S. I. unit of luminous intensity is _______.
(A) candela (B) ampere
(C) coulomb (D) Kelvin

3. 240 K is equal to ______ °C.
(A) 33.15 (B) 513.15
(C) −33.15 (D) −513.15

Uncertainty in Measurement

1. The mass of an iron cube having density 7.87 g cm^{-3} is 787 g. Its volume expressed in scientific notation is _______ cm^3.
(A) 1.0×10^1 (B) 1.00×10^2
(C) 1.00×10^3 (D) 100

Page no. **10** to **16** are purposely left blank.

To see complete chapter buy **Target Notes** or **Target E-Notes**

9. 5.00 g sample containing NaCl and $CaCl_2$ was treated with appropriate reagents to precipitate all the Ca-atoms as $CaCO_3$. This $CaCO_3$ precipitate was heated and quantitatively converted to CaO. The amount of CaO obtained was 1.0 g. The percentage of NaCl in the mixture is _______.
(A) 30.2% (B) 39.6%
(C) 60.4% (D) 79.2%

10. While preparing tea, 2 table spoon of sugar was used. Calculate how many moles of sucrose are present in the prepared tea. Given that the amount of sugar that a table spoon contains is 3.85 g.
(A) 11.2×10^{-3} mol (B) 0.342×10^{-3} mol
(C) 3.85×10^{-3} mol (D) 22.5×10^{-3} mol

11. An 18 carat gold ornament has a purity of 75% (W/W). Suppose an 18 carat gold ring of 4 g is purchased from a jeweller, then calculate how many atoms of gold (Au) would be present in that ring. [At mass of Au = 197]
(A) 0.45×10^{23} (B) 0.60×10^{23}
(C) 0.092×10^{23} (D) 6.022×10^{23}

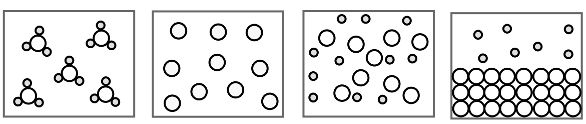
12. A water drop weighing 0.075 g, evaporates in half an hour. The number of molecules that evaporated per second is _______.
(A) 2.89×10^{17} (B) 3.89×10^{17}
(C) 1.39×10^{18} (D) 2.78×10^{18}

13. 3.2% W/W magnesium is present in the green pigment which is used by plants during photosynthesis. Number of magnesium atoms present in 5 g of that pigment is _______.
(A) 1.59×10^{21} atoms (B) 2.50×10^{21} atoms
(C) 4.01×10^{21} atoms (D) 1.59×10^{23} atoms

14. If 10^{21} molecules are removed from 400 mg of CO_2, then the number of moles of CO_2 left are _______.
(A) 0.742 (B) 7.42×10^{-3}
(C) 74.2×10^{-3} (D) 742×10^{-2}

Diagram Based Problems

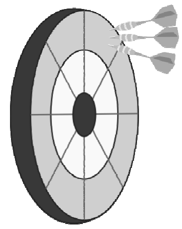
1. Choose the CORRECT option for the below given molecular representations of matter. Each circle indicates an atom or an ion.



(I) (II) (III) (IV)

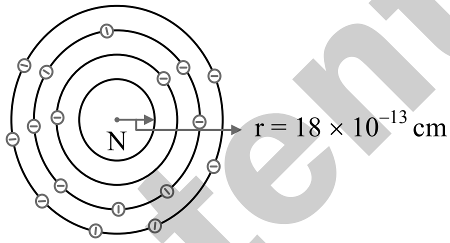
(A) I, II and III are homogeneous mixtures.
(B) II and IV are pure substances.
(C) I is an element.
(D) IV is a heterogeneous mixture.

2. The distribution of darts shows the difference between accuracy and precision. Based on the figure provided, choose the CORRECT option for the distribution of darts.



(A) Good precision and good accuracy
(B) Good precision but poor accuracy
(C) Poor precision but good accuracy
(D) Poor precision and poor accuracy

3.

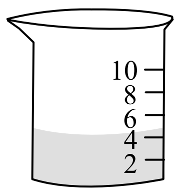


Cl atom

Calculate the density of the above given atom. Assume that nucleus is a sphere and mass of electrons is negligible.
(A) 1.16×10^{11} g mL^{-1}
(B) 2.41×10^{12} g mL^{-1}
(C) 3.36×10^{13} g mL^{-1}
(D) 4.46×10^{14} g mL^{-1}

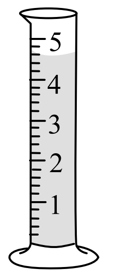
4. Which of the following apparatus would you use to measure 4.6 mL of ethyl alcohol required for an experiment?

(A)



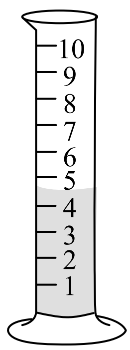
10 mL beaker

(B)



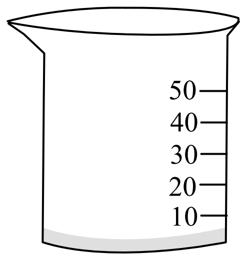
5 mL measuring cylinder

(C)



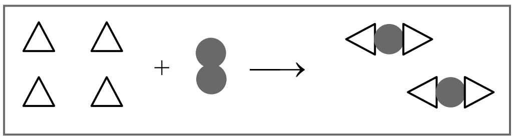
10 mL measuring cylinder

(D)



50 mL beaker

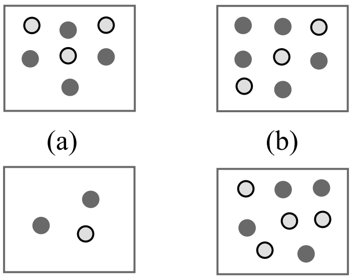
5. Consider the following schematic representation of a balanced chemical reaction, where △ denotes a monoatomic gas and ● denotes a diatomic gas molecule.



5 moles of △ and 3 moles of ● will produce how many moles of ◁●▷?

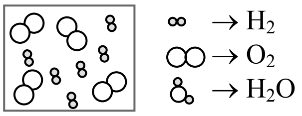
(A) 1.5 (B) 2.5 (C) 6 (D) 8.5

6. Arrange the following diagrams in the order of increasing mole fraction of ●, where both ● and ○ represent diatomic gaseous molecules.

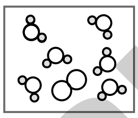
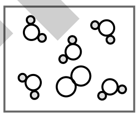


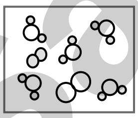
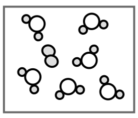
(A) d < a < b < c (B) b < a < c < d
(C) c < b < a < d (D) d < c < a < b

7.

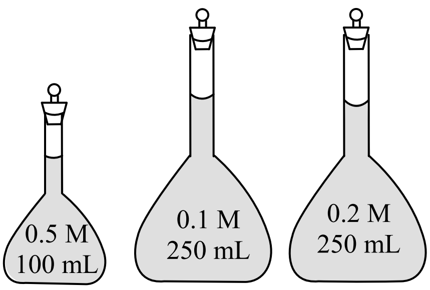


In the above given representation, a mixture of hydrogen gas and oxygen gas in a sealed container is shown. Which of the following representations is CORRECT if the reaction goes to completion?

(A)  (B) 

(C)  (D) 

8. A chemist prepares three different solutions of sodium chloride to be used for standardisation of silver nitrate solutions.



(P) (Q) (R)

Which of the following is CORRECT with respect to these solutions?

(A) 250 mL of solution 'Q' contains 0.2 moles of NaCl.
(B) Number of moles of NaCl in solution 'P' = Number of moles of NaCl in solution 'Q'.
(C) Number of moles of NaCl in solution 'P' = Number of moles of NaCl in solution 'R'.
(D) 10 mL of solution 'P' when diluted to 1 L contains 0.05 moles of NaCl.

Numerical Value Type Questions

1. In an acid-base titration, student records burette readings as 10.1 mL, 10.20 mL, 10.3 mL. The number of significant figures in average burette reading is _______ mL.

2. The number of molecules present in 0.0032 mg of O_2 is given as 6.022×10^X. Find 'X'.

3. The percentage composition of Cr in $K_2Cr_2O_7$ is _______ %.
(At. mass: K = 39 u; Cr = 52 u; O = 16 u)

4. If 10 g H_2 is mixed with 28 g of N_2 for the following reaction:
$N_2 + 3H_2 \longrightarrow 2NH_3$
At the end, mass of H_2 left unreacted is _____ g.

5. 12.8 g of unknown gas at STP occupies volume of 4.48 dm^3. Its molar mass is _______ g mol^{-1}.

6. Mass of methane required to produce 22 g of CO_2 after complete combustion is _____ g.
(Given Molar mass in g mol^{-1} C = 12.0
H = 1.0
O = 16.0)

[JEE (Main) Jan 2024]

Problems To Ponder

1. The cost of table sugar and table salt is ₹ 40 per kg and ₹ 16 per kg respectively. What are the costs of one mole of these substances?

(A) 936 and 136.8 Paise
(B) 286.8 and 18.89 Paise
(C) 1368 and 93.6 Paise
(D) 386.8 and 19.39 Paise

2. A person went to USA and during his stay in USA, he checked for blood sugar level. The report indicated blood sugar level of 15 mmol L^{-1}. He became confused whether he is diabetic or not. What is the sugar level of that person in mg/dL as shown in Indian blood sugar report?
[Person is diabetic if blood sugar level is 160 mg/dL after meal.]

Page no. **19** to **310** are purposely left blank.

To see complete chapter buy **Target Notes** or **Target E-Notes**

1. Some Basic Concepts of Chemistry

Smart Keys

Smart Tip

1. The following formula gives the total number of atoms in 'n' moles of a substance.
Number of atoms = n × N_A × Atomicity

Answers and Solutions

Concept Building Problems

General Introduction – Importance and Scope of Chemistry

1. **(A)** **2.** **(B)**

Classification of Matter

1. **(C)**

2. **(C)**
Bronze – Mixture, Iron – Pure substance (element), Naphthalene – Pure substance (compound)

3. **(D)**

Units of Measurement

1. **(C)** **2.** **(A)**

3. **(C)**
Kelvin scale is related to celsius scale as follows:
K = °C + 273.15
∴ °C = 240 – 273.15
= –33.15 °C

Uncertainty in Measurement

1. **(B)**

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{787\ \text{g}}{7.87\ \text{g cm}^{-3}}$$
$$= 1.00 \times 10^2\ \text{cm}^3 \text{ (In scientific notation)}$$

2. **(D)**
Student A and C have reported values that are neither precise nor accurate. Student B has reported values that are precise but not accurate. Student D has reported the values that are both precise and accurate.

3. **(B)** **4.** **(D)**

5. **(D)**
(A) 4.008 has four significant figures because the zeros between the non-zero digits are significant.
(B) 6.022×10^{23} has four significant figures because only the first term gives the significant figures and exponential term is not considered.
(C) 7555 has four significant figures as all are non-zero digits.
(D) 0.0034 has two significant figures because the zeros on the left of the first non-zero digit are not significant.

6. **(B)**
(2.0 × 2.303) + 20.00

$= \boxed{4.606} + 20.00$ — Value without rounding. The exact value with rounding to 2 significant figures is 4.6 .

$= \boxed{24.606}$ — Value without rounding

$= \boxed{24.6}$ — Final answer, Since 4.6 has 1 digit after the decimal point.

Laws of Chemical Combination

1. **(C)**

(A) $$\underbrace{\underset{12\ g}{Mg} + \underset{32\ g}{O_{2(g)}}}_{44\ g} \rightarrow \underset{28\ g}{MgO}$$

(B) $$\underbrace{\underset{44\ g}{C_3H_{8(g)}} + \underset{32\ g}{O_{2(g)}}}_{76\ g} \rightarrow \underbrace{\underset{44\ g}{CO_2} + \underset{18\ g}{H_2O}}_{62\ g}$$

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To see complete chapter buy **Target Notes** or **Target E-Notes**

4. **(B)**
The measured quantity cannot be more precise than the least precision of the instrument. In the 5 mL graduated measuring cylinder, the markings on the scale differ by 0.2 mL. Hence, the 5 mL graduated measuring cylinder is the most appropriate apparatus that can be used for measuring 4.6 mL (two significant figures) of ethyl alcohol.

5. **(B)**
According to the balanced chemical reaction,
4 mol $\triangle$ reacts with 1 mol to give 2 mol $\triangleleft\!\bullet\!\triangleright$

$$\therefore \quad 5\text{ mol }\triangle \times \frac{2\text{ mol }\triangleleft\!\bullet\!\triangleright}{4\text{ mol }\triangle} = 2.5\text{ mol }\triangleleft\!\bullet\!\triangleright$$

$$\therefore \quad 3\text{ mol }\bullet\!\bullet \times \frac{2\text{ mol }\triangleleft\!\bullet\!\triangleright}{1\text{ mol }\bullet\!\bullet} = 6\text{ mol }\triangleleft\!\bullet\!\triangleright$$

$\triangle$ is the limiting reactant. Hence, only 2.5 mol of $\triangleleft\!\bullet\!\triangleright$ will be produced.

6. **(A)**
Mole fraction of $\bullet$

$$= \frac{\text{Number of moles of }\bullet}{\text{Moles of }\bullet + \text{moles of }\circ}$$

Consider figure (a):
Moles of $\bullet$

$$= 4 \text{ molecules of }\bullet \times \frac{1\text{ mol }\bullet}{N_A \text{ molecules of }\bullet} = \frac{4}{N_A}$$

Moles of $\circ$

$$= 3 \text{ molecules of }\circ \times \frac{1\text{mol }\circ}{N_A \text{ molecules of }\circ} = \frac{3}{N_A}$$

$$\text{Mole of fraction of }\bullet = \frac{\frac{4}{N_A}}{\frac{4}{N_A}+\frac{3}{N_A}} = \frac{\frac{4}{N_A}}{\frac{7}{N_A}} = 0.57$$

Similarly,

Figure	Mole fraction of $\bullet$
(b)	$\frac{5}{8} = 0.625$
(c)	$\frac{2}{3} = 0.66$
(d)	$\frac{3}{8} = 0.375$

7. **(A)**
$2H_2 + O_2 \longrightarrow 2H_2O$
For the given mixture, H_2 is the limiting reagent.
Hence, $6H_2 \Rightarrow 6H_2O$
The excess oxygen (one O_2) remains as it is.

8. **(C)**

Solutions	Solution P	Solution Q	Solution R
Concentration	0.5 M	0.1 M	0.2 M
No. of moles of NaCl in 1000 mL	0.5 moles	0.1 moles	0.2 moles
Given volume	100 mL	250 mL	250 mL
No. of moles of NaCl in the given volume	0.05 moles	0.025 moles	0.05 moles

10 mL of solution 'P' contains 0.005 moles of NaCl. When this solution is diluted to 1 L, it will contain 0.005 moles of NaCl.

Numerical Value Type Questions

1. **(3)**
In addition, the maximum number of digits to the right of the decimal point in the result should not be greater than any of the numbers taking part in calculations.
Hence, $(10.1 + 10.20 + 10.3)/3 = \frac{30.6}{3} = 10.2$

2. **(16)**
Molar mass of $O_2 = 32\text{ g mol}^{-1}$
Amount of $O_2 = 0.032\text{ mg} = 3.2 \times 10^{-6}\text{ g}$
Number of moles of $O_2 = \frac{3.2\times10^{-6}}{32}$
$= 1 \times 10^{-7}\text{ mol}$
1 mole of $O_2 = 6.022 \times 10^{23}$ molecules
$\therefore$ 1×10^{-7} mole of O_2 contains
$= 1 \times 10^{-7} \times 6.022 \times 10^{23}$
$= 6.022 \times 10^{16}$ molecules
$\therefore$ Value of 'X' is 16.

3. **(35)**
Molar mass of $K_2Cr_2O_7$
$= 2 \times (39) + 2 \times (52) + 7 \times (16)$
$= 78 + 104 + 112 = 294\text{ g mol}^{-1}$
Percentage of Cr $= \frac{104}{294} \times 100 = 35.37\% \approx 35\%$

4. **(4)**
$n_{H_2} = \frac{10}{2} = 5\text{ mol}$
$n_{N_2} = \frac{28}{28} = 1\text{ mol}$
$N_2 + 3H_2 \longrightarrow 2NH_3$
1 mole of N_2 reacts with 3 moles of H_2
$\therefore$ n_{H_2} unreacted $= 5 - 3 = 2$ mol
1 mol $H_2 = 2\text{ g } H_2$
$\therefore$ 2 mol $H_2 = 4\text{ g } H_2$

5. **(64)**
Let 'x' be the molar mass of unknown gas.
Molar volume of a gas = 22.4 dm^3 mol^{-1}
Volume occupied by 12.8 g of unknown gas at S.T.P = 4.48 dm^3
Volume occupied by 'x' g of unknown gas at S.T.P = 22.4 dm^3
∴ $x = \frac{22.4 \times 12.8}{4.48} = 64$ g mol^{-1}

6. **(8)**
$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
1 mol of methane (16 g) gives 1 mol (44 g) of CO_2 on combustion.
∴ 22 g of CO_2 is produced by $\frac{16}{2}$ g i.e. 8 g of methane.

Problems To Ponder

1. **(C)**
1 mole of NaCl = 58.5 g
∴ Cost of NaCl per mole = $\frac{16}{1000} \times$ ₹ 58.5
= ₹ 0.936 = Paise 93.6
1 mole of table sugar ($C_{12}H_{22}O_{11}$) = 342 g
∴ cost of sugar per mole = $\frac{40}{1000} \times 342$
= ₹ 13.68 = Paise 1368

2. **(C)**
Molar mass of blood sugar (Glucose)
= 180 g/mol
1 mol = 180 g
1 mmol = 180 mg or 1 mmol L^{-1} = 18 mg/dL
15 mmol L^{-1} = 15 × 18 mg/dL = 270 mg/dL
So, the person is diabetic.

3. **(D)**
The equation for neutralization of HCl by $Al(OH)_3$ is:
$$\underset{78g}{Al(OH)_3} + \underset{109.5g}{3HCl} \rightarrow AlCl_3 + 3H_2O$$
HCl produced from 2.4 Litre of gastric juice
= 2.9 × 2.4 = 7 g.
109.5 HCl is neutralized by $Al(OH)_3$ = 78 g
So 7 g HCl is neutralized by $Al(OH)_3$
$= \frac{78}{109.5} \times 7$
= 4.986 g = 4986 mg.
Number of tablets required = $\frac{4986}{300}$
= 16.62 tablet
≈ 17 tablets

4. **(C)**
56 g Fe is present in 1 mole of the compound.
0.329 g of Fe is present in 100 g of the compound.
∴ 56 g of Fe will be present in $\frac{100}{0.329} \times 56$
= 17021 g mol^{-1}
Approximate molecular mass
= 17,000 g mol^{-1}

5. **(C)**
3 μg KI = 3× 10^{-6} g KI
∴ Number of moles of KI = $\frac{3 \times 10^{-6}}{166}$
= 1.8 × 10^{-8}
1.8 × 10^{-8} mol KI contain same 1.8 × 10^{-8} mol I^- ion
Number of Iodide Ions
= 1.8 × 10^{-8} × 6.023 × 10^{23}
= 10.84 × 10^{15} Ions

6. **(B)**
0.90 % w/v means 9 g of NaCl per litre. It is isotonic with Normal saline (NS) means NS also have 9 g of NaCl per litre.
So, 2 Litres of NS = 2 × 9 = 18 g of NaCl
Number of molecules present
= Number of moles × Avogadro's Number
$= \frac{18}{58.5} \times 6.023 \times 10^{23}$
= 1.85 × 10^{23} molecules

7. **(D)**
Amount of sucrose in the drink
$= \frac{12 \text{ g sucrose}}{100 \text{ g cola}} \times 330$ g cola
= 39.6 g sucrose
Energy produced by 39.6 g sucrose
= 39.6 g sucrose × $\frac{16.2 \text{ kJ energy}}{1 \text{ g sucrose}}$
= 641.5 kJ

8. **(B)**
Mass of gold in a gold crown
= 9.17 × 10^{21} gold atoms
$\times \frac{1 \text{ mol gold}}{6.022 \times 10^{23} \text{ gold atoms}} \times \frac{197 \text{ g of gold}}{1 \text{ mol gold}}$
= 2.99 g of gold ≈ 3 g of gold
Cost of 3 g gold = 3 g gold × $\frac{₹\ 30{,}000}{8 \text{ g gold}}$ = ₹ 11,250

9. **(C)**
Molecular formula of caffeine = $C_8H_{10}N_4O_2$
Molar mass of caffeine = 194.12 g
100 g coffee = 40 mg caffeine = 0.04 g caffeine
Number of molecules of caffeine in 100 g coffee
= 0.04 g caffeine
$\times \frac{1 \text{ mol caffeine}}{194.12 \text{ g caffeine}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol caffeine}}$
= 1.24 × 10^{20} molecules of caffeine

NEET (UG) 2024
QUESTION PAPER & ANSWER KEY

[Note: The following questions belong to chapters of Absolute Chemistry Vol. I]

Section A

Some Basic Concepts of Chemistry

1. 1 gram of sodium hydroxide was treated with 25 mL of 0.75 M HCl solution, the mass of sodium hydroxide left unreacted is equal to
   (A) Zero mg (B) 200 mg
   (C) 750 mg (D) 250 mg

2. The highest number of helium atoms is in
   (A) 4 g of helium
   (B) 2.271098 L of helium at STP
   (C) 4 mol of helium
   (D) 4 u of helium

Structure of Atom

3. The energy of an electron in the ground state (n = 1) for He^+ ion is $-x$ J, then that for an electron in n = 2 state for Be^{3+} ion in J is:
   (A) $-4x$ (B) $-\frac{4}{9}x$
   (C) $-x$ (D) $-\frac{x}{9}$

4. Match List I with List II.

List I Quantum Number		List II Information provided	
i.	m_l	a.	Shape of orbital
ii.	m_s	b.	Size of orbital
iii.	l	c.	Orientation of orbital
iv.	n	d.	Orientation of spin of electron

   Choose the correct answer from the options given below:
   (A) i–c, ii–d, iii–b, iv–a
   (B) i–b, ii–a, iii–d, iv–c
   (C) i–a, ii–c, iii–b, iv–d
   (D) i–c, ii–d, iii–a, iv–b

Classification of Elements and Periodicity in Properties

5. Arrange the following elements in increasing order of first ionization enthalpy:
   Li, Be, B, C, N
   Choose the correct answer from the options given below:
   (A) Li < Be < C < B < N
   (B) Li < Be < N < B < C
   (C) Li < Be < B < C < N
   (D) Li < B < Be < C < N

6. Arrange the following elements in increasing order of electronegativity:
   N, O, F, C, Si
   Choose the correct answer from the options given below:
   (A) O < F < N < C < Si
   (B) F < O < N < C < Si
   (C) Si < C < N < O < F
   (D) Si < C < O < N < F

Chemical Bonding and Molecular Structure

7.

List I (Compound)		List II (Shape/Geometry)	
i.	NH_3	a.	Trigonal pyramidal
ii.	BrF_5	b.	Square planar
iii.	XeF_4	c.	Octahedral
iv.	SF_6	d.	Square pyramidal

   Choose the correct answer from the options given below:
   (A) i – c, ii – d, iii – a, iv – b
   (B) i – b, ii – c, iii – d, iv – a
   (C) i – a, ii – d, iii – b, iv – c
   (D) i – b, ii – d, iii – c, iv – a

Thermodynamics

8. In which of the following processes entropy increases?
   I. A liquid evaporates to vapour.
   II. Temperature of a crystalline solid lowered from 130 K to 0 K.
   III. $2NaHCO_{3(s)} \longrightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$
   IV. $Cl_{2(g)} \longrightarrow 2Cl_{(g)}$
   Choose the correct answer from the options given below:
   (A) I, III and IV (B) III and IV
   (C) I and III (D) I, II and IV

9. Match List I with List II.

List I (Process)		List II (Conditions)	
i.	Isothermal process	a.	No heat exchange
ii.	Isochoric process	b.	Carried out at constant temperature
iii.	Isobaric process	c.	Carried out at constant volume
iv.	Adiabatic process	d.	Carried out at constant pressure

Choose the correct answer from the options given below:
(A) i – a, ii – b, iii – c, iv – d
(B) i – b, ii – c, iii – d, iv – a
(C) i – d, ii – c, iii – b, iv – a
(D) i – d, ii – b, iii – c, iv – a

Equilibrium

10. For the reaction $2A \rightleftharpoons B + C$, $K_c = 4 \times 10^{-3}$. At a given time, the composition of reaction mixture is: $[A] = [B] = [C] = 2 \times 10^{-3}$ M. Then, which of the following is correct?
(A) Reaction has a tendency to go in backward direction.
(B) Reaction has gone to completion in forward direction.
(C) Reaction is at equilibrium.
(D) Reaction has a tendency to go in forward direction.

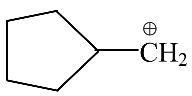
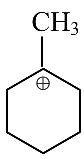
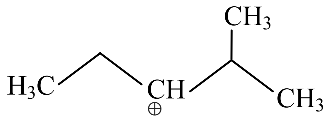
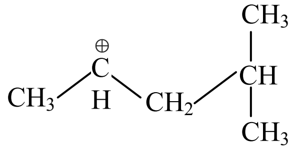
11. In which of the following equilibria, K_p and K_c are **NOT** equal?
(A) $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$
(B) $2BrCl_{(g)} \rightleftharpoons Br_{2(g)} + Cl_{2(g)}$
(C) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$
(D) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

Redox Reactions

12. Which reaction is **NOT** a redox reaction?
(A) $H_2 + Cl_2 \longrightarrow 2HCl$
(B) $BaCl_2 + Na_2SO_4 \longrightarrow BaSO_4 + 2NaCl$
(C) $Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$
(D) $2\,KClO_3 + I_2 \longrightarrow 2KIO_3 + Cl_2$

Organic Chemistry – Some Basic Principles and Techniques

13. On heating, some solid substances change from solid to vapour state without passing through liquid state. The technique used for the purification of such solid substances based on the above principle is known as
(A) Distillation
(B) Chromatography
(C) Crystallization
(D) Sublimation

14. The most stable carbocation among the following is:
(A) 
(B) 
(C) 
(D) 

15. A compound with a molecular formula of C_6H_{14} has two tertiary carbons. Its IUPAC name
(A) 2,3-dimethylbutane
(B) 2,2-dimethylbutane
(C) n-hexane
(D) 2-methylpentane

Hydrocarbons

16. Match List I with List II.

List I (Molecule)		List II (Number and types of bond/s between two carbon atoms)	
i.	Ethane	a.	One σ-bond and two π-bonds
ii.	Ethene	b.	Two π-bonds
iii.	Carbon molecule, C_2	c.	One σ-bonds
iv.	Ethyne	d.	One σ-bond and one π-bond

Choose the correct answer from the options given below:
(A) i – c, ii – d, iii – b, iv – a
(B) i – c, ii – d, iii – a, iv – b
(C) i – a, ii – d, iii – b, iv – c
(D) i – d, ii – c, iii – b, iv – a

17. **Statement I:** The boiling point of three isomeric pentanes follows the order n-pentane > isopentane > neopentane
Statement II: When branching increases, the molecule attains a shape of sphere. This results in smaller surface area for contact, due to which the intermolecular forces between the spherical molecules are weak, thereby lowering the boiling point
In the light of the above statements, choose the *most appropriate* answer from the options given
(A) Statement I is correct but Statement II is incorrect.
(B) Statement I is incorrect but Statement II is correct.
(C) Both Statement I and Statement II are correct.
(D) Both Statement I and Statement II are incorrect.

Section B

Some Basic Concepts of Chemistry

18. A compound X contains 32% of A, 20% of B and remaining percentage of C. Then, the empirical formula of X is:
(Given atomic masses of A = 64: B = 40, C = 32 u)
(A) AB_2C_2 (B) ABC_4
(C) A_2BC_2 (D) ABC_3

Chemical Bonding and Molecular Structure

19. Identify the correct answer.
(A) Dipole moment of NF_3 is greater than that of NH_3.
(B) Three canonical forms can be drawn for CO_3^{2-} ion.
(C) Three resonance structures can be drawn for ozone.
(D) BF_3 has nonzero dipole moment.

Thermodynamics

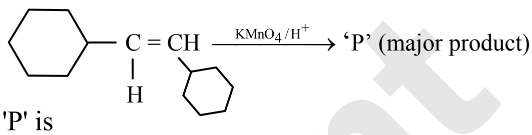
20. The work done during reversible isothermal expansion of one mole of hydrogen gas at 25 °C from pressure of 20 atmospheres to 10 atm is:
(Given R= 2.0 cal K^{-1} mol^{-1})
(A) 413.14 calories
(B) 100 calories
(C) 0 calorie
(D) –413.25 calories

Equilibrium

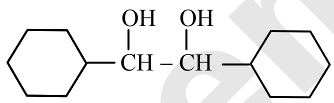
21. Consider the following reaction in a sealed vessel at equilibrium with concentrations of $N_2 = 3.0 \times 10^{-3}$ M, $O_2 = 4.2 \times 10^{-3}$ M and $NO = 2.8 \times 10^{-3}$ M.
$$2NO_{(g)} \rightleftharpoons N_{2(g)} + O_{2(g)}$$
If 0.1 mol L^{-1} of $NO_{(g)}$ is taken in a closed vessel, what will be degree of dissociation (α) of $NO_{(g)}$ at equilibrium?
(A) 0.8889 (B) 0.717
(C) 0.00889 (D) 0.0889

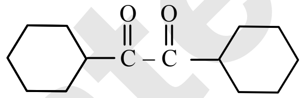
Hydrocarbons

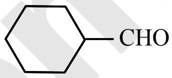
22. For the given reaction:

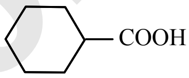


'P' is

(A) 

(B) 

(C) 

(D) 

Answer Key

1.	(D)	2.	(C)	3.	(C)	4.	(D)
5.	(D)	6.	(C)	7.	(C)	8.	(A)
9.	(B)	10.	(A)	11.	(C)	12.	(B)
13.	(D)	14.	(B)	15.	(A)	16.	(A)
17.	(C)	18.	(D)	19.	(B)	20.	(D)
21.	(B)	22.	(D)	.			