SURA'S

CHEMISTRY

11th Standard

VOLUME - I & II

Based on the Updated New Textbook

Salient Features

- Prepared as per the updated new textbook for the year 2020 - 21
- Exhaustive Additional MCQs, VSA, SA, LA questions with answers are given in each chapter.
- All the objective type (1 Mark) questions, are given with 4 options.
  - (i) Choosing the correct option
  - (ii) Matching
  - (iii) Filling the blanks
  - (iv) Assertion & Reason
  - (v) Choosing the correct Statement
  - (vi) Choosing the Incorrect Statement
- Govt. Model Question Paper-2018 ***[Govt. MQP. 2018]***, First Mid-Term Test (2018) ***[First Mid. 2018]***, Quarterly Exam - 2018 ***[QY. 2018]***, Half Yearly Exam - 2018 ***[HY. 2018]***, March - 2019 ***[Mar. 2019]***, June - 2019 ***[June 2019]***, Quarterly Exam - 2019 ***[QY-2019]***, Half Yearly Exam - 2019 ***[HY. 2019]*** and Govt. Supply. Exam. September - 2020 ***[Sep.-2020]*** are incorporated in the appropriate sections.
- Govt. Supply. Exam. September 2020 question paper is given with answers.

SURA PUBLICATIONS
Chennai

2021-22 Edition

ISBN : 978-93-5330-063-0
Code No : SG 266

Authors :
Mrs. P. Thilagam PGT (Chemistry)
Chennai

Published by :
Mr. Subash Raj, B.E., M.S.

Head Office:
1620, 'J' Block, 16th Main Road,
Anna Nagar, **Chennai - 600 040.**
Phones: 044-4862 9977, 044-486 27755.
Mob : 81242 01000/ 81243 01000
e-mail : orders @surabooks.com
website : www.surabooks.com

NOTE FROM PUBLISHER

It gives me great pride and pleasure in bringing to you **Sura's Chemistry** guide Vol. I & II for **11th Standard**. A deep understanding of the text and exercises is rudimentary to have an insight into the subject. The students have to carefully understand the topics and exercises.

Sura's Chemistry 11th Standard Guide encompasses all the requirements of the students to comprehend the text and the evaluation of the textbook.

It will be a teaching companion to teachers and a learning companion to students.

- Chapter Snapshot, Concept Map, Formulae to Remember, Must know Definitions are given in almost each chapter.
- Exhaustive Additional MCQs, SA, LA questions with Answers are given in each chapter. Solved numerical problems are given wherever necessary.
- These features will help students practice and learn effectively all the sections of the textbook.

In order to learn effectively, I advise students to learn the subject sectionwise and practice the exercises given.

Though these salient features are available in our Sura's Chemistry Guide 11th Standard, I cannot negate the indispensable role of the teachers in assisting the student to understand the subject thoroughly.

I sincerely believe this guide satisfies the needs of the students and bolsters the teaching methodologies of the teachers.

I pray the almighty to bless the students for consummate success in their examinations.

Subash Raj, B.E., M.S.
- Publisher
Sura Publications

All the Best

TO ORDER WITH US

SCHOOLS and TEACHERS

We are grateful for your support and patronage to **'SURA PUBLICATIONS'**
Kindly prepare your order in your School letterhead and send it to us.
For Orders contact: 80562 94222 / 80562 15222

DIRECT DEPOSIT

A/c Name	: **Sura Publications**	A/c Name	: **Sura Publications**
Our A/c No.	: **36550290536**	Our A/c No.	: **21000210001240**
Bank Name	: **STATE BANK OF INDIA**	Bank Name	: **UCO BANK**
Bank Branch	: PADI	Bank Branch	: Anna Nagar West
IFSC	: SBIN0005083	IFSC	: UCBA0002100

A/c Name	: **Sura Publications**	A/c Name	: **Sura Publications**
Our A/c No.	: **6502699356**	Our A/c No.	: **1154135000017684**
Bank Name	: **INDIAN BANK**	Bank Name	: **KVB BANK**
Bank Branch	: ASIAD COLONY	Bank Branch	: Anna Nagar
IFSC	: IDIB000A098	IFSC	: KVBL0001154

After Deposit, please send challan and order to our address.
email : orders@surabooks.com / Whatsapp : 81242 01000.

DEMAND DRAFT / CHEQUE

Please send Demand Draft / cheque in favour of **'SURA PUBLICATIONS'** payable at **Chennai**.

The Demand Draft / cheque should be sent with your order in School letterhead.

STUDENTS

Order via Money Order (M/O) to

SURA PUBLICATIONS
1620, 'J' Block, 16th Main Road, Anna Nagar,
Chennai - 600 040.
Phones : 044-4862 9977, 044-486 27755.
Mobile : 80562 94222 / 80562 15222
E-mail : orders@surabooks.com Website : www.surabooks.com

CONTENTS

VOLUME - I

VOLUME - II

CHEMISTRY

Volume I

CONTENTS

01 BASIC CONCEPTS OF CHEMISTRY AND CHEMICAL CALCULATIONS

CHAPTER SNAPSHOT

PART I : IMPORTANCE OF CHEMISTRY- CHEMISTRY, THE CENTRE OF LIFE

Classification of matter
- Physical classification of matter
- Chemical Classification of matter

Elements and compounds: chemical classification
- Atom
- Element
- Molecule
- Compound

Atomic mass
- Average atomic mass
- Gram atomic mass

Molecular mass
- Relative atomic mass
- Relative molecular mass

Mole concept
- Avogadro's hypothesis
- Avogadro number
- Mole definition
- Molar mass
- Molar volume of a gaseous substance

Equivalent mass
- Equivalent mass of acid
- Equivalent mass of the base
- Equivalent mass of a salt
- Equivalent mass of an oxidising agent
- Equivalent mass of a reducing agent

Empirical formula

Molecular formula

Stoichiometric calculations
- Mole – mole relationship
- Mass - mass relationship
- Mass – volume relationship
- Volume – volume relationship

Limiting reagents

PART II : REDOX REACTIONS

Introduction

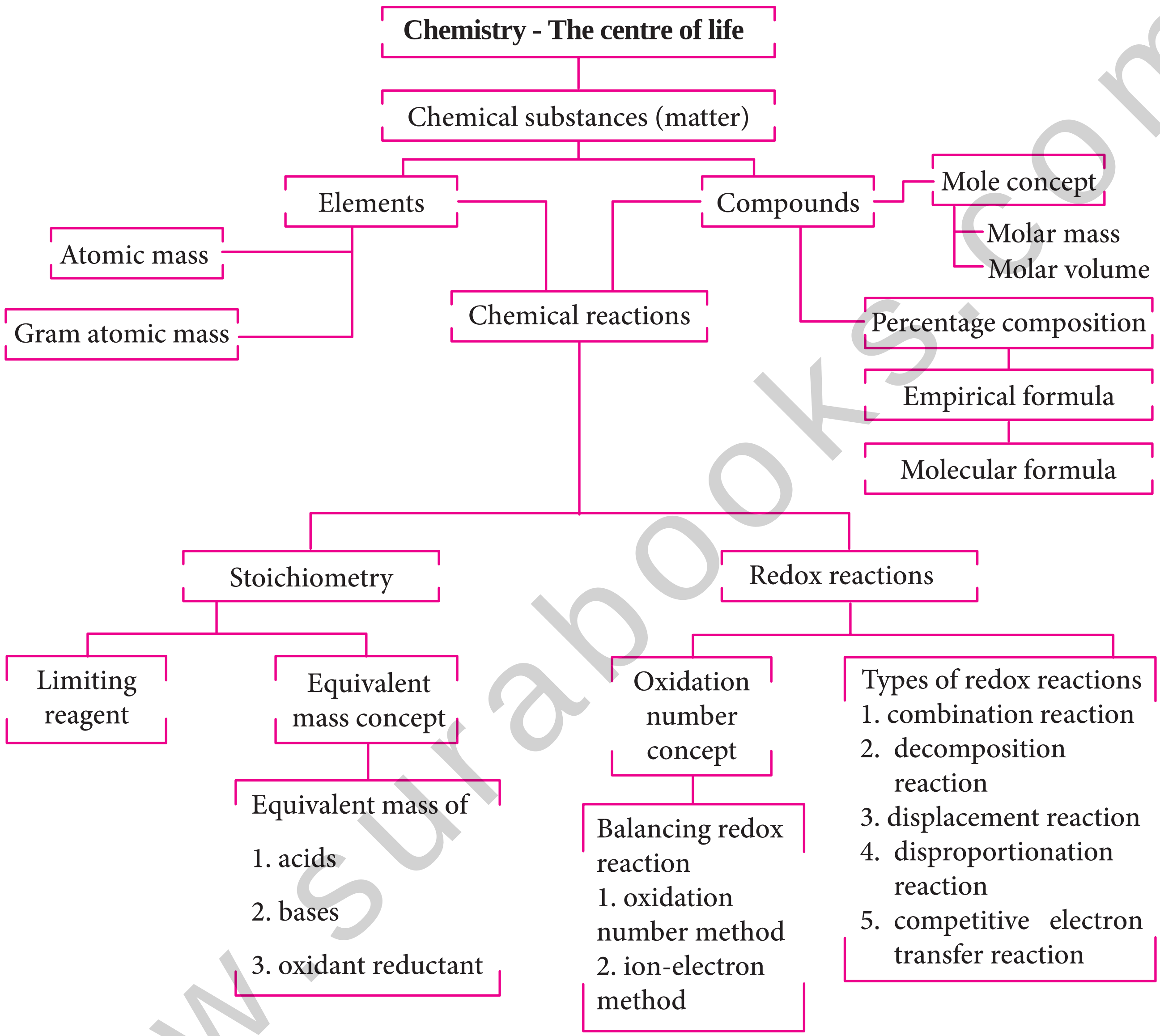
Electronic concept of oxidation and reduction

Oxidation number

Types of redox reactions
- Combination reactions
- Decomposition reactions
- Displacement reactions
- Disproportionation reactions
- Competitive electron transfer reactions

Balancing of redox reactions
- Oxidation number method
- Ion-electron method for balancing redox reactions

CONCEPT MAP


Chemistry - The centre of life
Chemical substances (matter)
Elements
Compounds
Mole concept
Molar mass
Molar volume
Atomic mass
Gram atomic mass
Chemical reactions
Percentage composition
Empirical formula
Molecular formula
Stoichiometry
Redox reactions
Limiting reagent
Equivalent mass concept
Equivalent mass of
1. acids
2. bases
3. oxidant reductant
Oxidation number concept
Balancing redox reaction
1. oxidation number method
2. ion-electron method
Types of redox reactions
1. combination reaction
2. decomposition reaction
3. displacement reaction
4. disproportionation reaction
5. competitive electron transfer reaction

FORMULAE TO REMEMBER

* $\text{Atomic mass} = \dfrac{\text{Mass of an atom}}{\left(\frac{1}{12}\right) \times \text{mass of carbon atom } ^{12}C}$
* Molecular Mass = n × Vapour Density
* $\text{Molar mass} = \dfrac{\text{Mass}}{\text{Mole}}$
* Molecular Formula = n × Empirical Formula
* $\text{Mass \% of an element} = \dfrac{\text{Mass of that element in the compound}}{\text{Molar mass of the compound}} \times 100$
* $\text{Equivalent Mass of Acid} = \dfrac{\text{Molar mass of the Acid}}{\text{Basicity of Acid}}$
* $\text{Equivalent Mass of Base} = \dfrac{\text{Molar mass of the Base}}{\text{Acidity of Base}}$
* $\text{Molarity} = \dfrac{\text{No. of moles of solute}}{\text{Volume of solution in litres}}$
* $\text{Molality} = \dfrac{\text{No. of moles of solute}}{\text{Mass of solvent in Kg}}$
* $\text{Normality} = \dfrac{\text{No. of gram equivalents of solute}}{\text{Volume of solution in litres}}$
* Mole fraction = In a solution of two components A & B

$$\text{Mole fraction of A} = \frac{\text{No. of moles of A}}{\text{Total no. of moles in solution}} = \frac{nA}{nA + nB}$$

$$\text{Mole fraction of B} = \frac{nB}{nA + nB}$$

MUST KNOW DEFINITIONS

Matter	:	Matter is defined as anything that has mass and occupies space. All matter is composed of atoms.
Mixtures	:	Mixtures consist of more than one chemical entity present without any chemical interactions.
Pure substances	:	Pure substances are composed of simple atoms or molecules. They are further classified as elements and compounds.
Element	:	An element consists of only one type of atom. Element can exist as monatomic or polyatomic units. The polyatomic elements are called molecules.

Compound	:	Compounds are made up of molecules which contain two or more atoms of different elements.
Relative atomic mass	:	The relative atomic mass is defined as the ratio of the average atomic mass factor to the unified atomic mass unit.
Relative molecular mass	:	Relative molecular mass is defined as the ratio of the mass of a molecule to the unified atomic mass unit. The relative molecular mass of any compound can be calculated by adding the relative atomic masses of its constituent atoms.
Mole	:	One mole is the amount of substance that contains as many elementary particles as the number of atoms in 12 g of carbon-12 isotope.
Avogadro Number	:	The total number of entities present in one mole of any substance is equal to 6.022×10^{23}. This number is called Avogadro number
Molar Mass	:	Molar mass is defined as the mass of one mole of a substance. The molar mass of a compound is equal to the sum of the relative atomic masses of its constituents expressed in g mol^{-1}.
Molar Volume	:	The volume occupied by one mole of any substance in the gaseous state at a given temperature and pressure is called molar volume.
Gram equivalent mass	:	Gram equivalent mass of an element, compound or ion is the mass that combines or displaces 1.008 g hydrogen or 8 g oxygen or 35.5 g chlorine.
Empirical formula	:	Empirical formula of a compound is the formula written with the simplest ratio of the number of different atoms present in one molecule of the compound as subscript to the atomic symbol.
Molecular formula	:	Molecular formula of a compound is the formula written with the actual number of different atoms present in one molecule as a subscript to the atomic symbol.
Stoichiometry	:	Stoichiometry is the quantitative relationship between reactants and products in a balanced chemical equation in moles. The quantity of reactants and products can be expressed in moles or in terms of mass unit or as volume.
Limiting reagent	:	when a reaction is carried out using non-stoichiometric quantities of the reactants, the product yield will be determined by the reactant that is completely consumed. It limits the further reaction from taking place and is called as the limiting reagent.
Oxidation Number	:	It is defined as the imaginary charge left on the atom when all other atoms of the compound have been removed in their usual oxidation states that are assigned according to set of rules.
Combination reactions	:	Redox reactions in which two substances combine to form a single compound are called combination reaction.
Decomposition reaction	:	Redox reactions in which a compound breaks down into two or more components are called decomposition reactions. These reactions are opposite to combination reactions.
Displacement reactions	:	Redox reactions in which an ion (or an atom) in a compound is replaced by an ion (or atom) of another element are called displacement reactions.
Disproportionation reaction	:	In some redox reactions, the same compound can undergo both oxidation and reduction. In such reactions, the oxidation state of one and the same element is both increased and decreased. These reactions are called disproportionation reactions.

Oxidation	:	Classical concept - Addition of oxygen (or) Removal of hydrogen. Electronic concept - Loss of electrons (or) Increase in oxidation number.
Reduction	:	Classical concept - Addition of Hydrogen (or) Removal of oxygen. Electronic concept - Gain of electrons (or) Decrease in oxidation number
Redox Reaction	:	The reaction that involve the oxidation and reduction as its two half reactions are called redox reactions.
Oxidising Agent	:	**Classical Concept :** In a redox reaction, the substance which oxidises the other (or) reduces itself is called oxidising agent. **Electron Transfer concept :** The substance that gains electrons.
Reducing Agent	:	**Classical Concept :** In a redox reaction, the substance which reduces the other (or) oxidises it self is called reducing agent. **Electron Transfer concept :** The substance that loss or donate electrons.

EVALUATION

I. Choose The Best Answer :

1. 40 ml of methane is completely burnt using 80 ml of oxygen at room temperature The volume of gas left after cooling to room temperature is

(a) 40 ml CO_2 gas
(b) 40 ml CO_2 gas and 80 ml H_2O gas
(c) 60 ml CO_2 gas and 60 ml H_2O gas
(d) 120 ml CO_2 gas **[Ans. (a) 40 ml CO_2 gas]**

Hint: $CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$

2. An element X has the following isotopic composition ^{200}X = 90%, ^{199}X = 8% and ^{202}X = 2%. The weighted average atomic mass of the element X is closest to

(a) 201 u (b) 202 u (c) 199 u (d) 200 u

[Ans. (d) 200 u]

Hint: $= \dfrac{(200\times 90)+(199\times 8)+(202\times 2)}{100}$
$= 199.96 = 200u$

3. Assertion : Two mole of glucose contains 12.044 × 10^{23} molecules of glucose

Reason : Total number of entities present in one mole of any substance is equal to 6.02 × 10^{22} ***[FIRST MID-2018]***

(a) both assertion and reason are true and the reason is the correct explanation of assertion
(b) both assertion and reason are true but reason is not the correct explanation of assertion
(c) assertion is true but reason is false
(d) both assertion and reason are false

[Ans. (c) assertion is true but reason is false]

Hint: Based on Avogadro's law. One mole of any substance is equal to 6.022 × 10^{23}.

4. Carbon forms two oxides, namely carbon monoxide and carbon dioxide. The equivalent mass of which element remains constant?

(a) Carbon (b) oxygen
(c) both carbon and oxygen
(d) neither carbon nor oxygen **[Ans. (b) oxygen]**

Hint: **React 1 :** $2C + O_2 \longrightarrow 2CO$
2 × 12g carbon combines with 32g of oxygen
$\therefore$ Equivalent mass of carbon $= \dfrac{2\times 12}{32}\times 8 = 6$

React 2 : $C + O_2 \longrightarrow CO_2$
12g carbon combines with 32g of oxygen
$\therefore$ Equivalent mass of carbon $\dfrac{12}{32}\times 8 = 3$

5. The equivalent mass of a trivalent metal element is 9 g eq^{-1} the molar mass of its anhydrous oxide is

(a) 102 g (b) 27 g (c) 270 g (d) 78 g

[Ans. (a) 102 g]

Hint: Atomic mass of the metal oxide is equal to 2 multiple atomic mass of metal + 3 multiple atomic mass of oxygen

6. The number of water molecules in a drop of water weighing 0.018 g is *[FIRST MID-2018]*

(a) 6.022×10^{26} (b) 6.022×10^{23}

(c) 6.022×10^{20} (d) 9.9×10^{22}

[Ans. (c) 6.022×10^{20}]

Hint: $0.001 \times 6.023 \times 10^{23}$

7. 1 g of an impure sample of magnesium carbonate (containing no thermally decomposable impurities) on complete thermal decomposition gave 0.44 g of carbon dioxide gas. The percentage of impurity in the sample is

(a) 0% (b) 4.4% (c) 16% (d) 8.4 %

[Ans. (c) 16%]

Hint: impurity is equal to 1 × 100/1.84.

8. When 6.3 g of sodium bicarbonate is added to 30 g of acetic acid solution, the residual solution is found to weigh 33 g. The number of moles of carbon dioxide is released in the reaction is

(a) 3 (b) 0.75 (c) 0.075 (d) 0.3

[Ans. (c) 0.075]

Hint: Number of moles of CO_2 is equal to given weight/ molecular weight.

9. When 22.4 litres of H_2 (g) is mixed with 11.2 litres of Cl_2(g), each at 273 K at 1 atm the moles of HCl (g), formed is equal to

(a) 2 moles of HCl (g) (b) 0.5 moles of HCl (g)

(c) 1.5 moles of HCl (g) (d) 1 moles of HCl (g)

[Ans. (d) 1 moles of HCl (g)]

Hint: $H_2(g) + Cl_2(g) \longrightarrow 2HCl$

1 mole of an ideal gas occupies at 22.4 *l*.

10. Hot concentrated sulphuric acid is a moderately strong oxidising agent. Which of the following reactions does not show oxidising behaviour?

(a) $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$

(b) $C + 2H_2SO_4 \longrightarrow CO_2 + 2SO_2 + 2H_2O$

(c) $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HCl$

(d) none of the above

[Ans. (c) $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HCl$]

11. Choose the disproportionation reaction among the following redox reactions.

(a) $3Mg_{(s)} + N_{2(g)} \longrightarrow Mg_3N_{2(s)}$

(b) $P_{4(s)} + 3\,NaOH + 3H_2O \longrightarrow PH_{3(g)} + 3NaH_2PO_{2(aq)}$

(c) $Cl_{2(g)} + 2KI_{(aq)} \longrightarrow 2KCl_{(aq)} + I_2$

(d) $Cr_2O_{3(s)} + 2Al_{(s)} \longrightarrow Al_2O_3(s) + 2Cr(s)$

[Ans. (b) $P_{4(s)} + 3\,NaOH + 3H_2O \longrightarrow PH_{3(g)} + 3NaH_2PO_{2(aq)}$]

12. The equivalent mass of potassium permanganate in alkaline medium is

$MnO_4^- + 2H_2O + 3e^- \longrightarrow MnO_2 + 4OH^-$

(a) 31.6 (b) 52.7

(c) 79 (d) None of these

[Ans. (b) 52.7]

Hint: The reduction reaction of the oxidising agent (MnO_4^-) involves gain of 3 electrons.

Hence the equivalent mass =

$$\frac{\text{Molar mass of } KMnO_4}{3} = \frac{158.1}{3} = 52.7.$$

13. Which one of the following represents 180g of water? *[QY. 2019]*

(a) 5 Moles of water (b) 90 moles of water

(c) $\dfrac{6.022 \times 10^{23}}{180}$ molecules of water

(d) 6.022×10^{24} molecules of water

[Ans. (d) 6.022×10^{24} molecules of water]

Hint: $10 \times 6.023 \times 10^{23}$

14. 7.5 g of a gas occupies a volume of 5.6 litres at 0° C and 1 atm pressure. The gas is *[HY. 2018]*

(a) NO (b) N_2O (c) CO (d) CO_2

[Ans. (a) NO]

Hint: $\dfrac{7.5g}{5.6l} \times 22.4l = 30g$

Molar mass of NO (14 + 16) = 30g.

15. Total number of electrons present in 1.7 g of ammonia is *[FIRST MID-2018]*

(a) 6.022×10^{23} (b) $\frac{6.022\times10^{22}}{1.7}$

(c) $\frac{6.022\times10^{24}}{1.7}$ (d) $\frac{6.022\times10^{23}}{1.7}$

[Ans. (a) 6.022×10^{23}]

Hint: Number of moles is equal to Atomic weight / valency

16. The correct increasing order of the oxidation state of sulphur in the anions SO_4^{2-}, SO_3^{2-}, $S_2O_4^{2-}$, $S_2O_6^{2-}$ is

(a) $SO_3^{2-} < SO_4^{2-} < S_2O_4^{2-} < S_2O_6^{2-}$

(b) $SO_4^{2-} < S_2O_4^{2-} < S_2O_6^{2-} < SO_3^{2-}$

(c) $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-} < SO_4^{2-}$

(d) $S_2O_6^{2-} < S_2O_4^{2-} < SO_4^{2-} < SO_3^{2-}$

[Ans. (c) $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-} < SO_4^{2-}$]

Hint: $\overset{+3}{S_2}O_4^{2-} < \overset{+4}{S}O_3^{2-} < \overset{+5}{S_2}O_6^{2-} < \overset{+6}{S}O_4^{2-}$

17. The equivalent mass of ferrous oxalate is

(a) $\frac{\text{molar mass of ferrous oxalate}}{1}$

(b) $\frac{\text{molar mass of ferrous oxalate}}{2}$

(c) $\frac{\text{molar mass of ferrous oxalate}}{3}$

(d) none of these **[Ans. (c)]**

Hint: $\overset{2+}{Fe}\overset{3+}{C_2}O_4 \xrightarrow{\text{Oxidising}} Fe^{3+} + CO_2^{4+}$

$n = 1 + 2(1) = 3$

18. If Avogadro number were changed from 6.022×10^{23} to 6.022×10^{20}, this would change

(a) the ratio of chemical species to each other in a balanced equation

(b) the ratio of elements to each other in a compound

(c) the definition of mass in units of grams

(d) the mass of one mole of carbon

[Ans. (d) the mass of one mole of carbon]

19. Two 22.4 litre containers A and B contains 8 g of O_2 and 8 g of SO_2 respectively at 273 K and 1 atm pressure, then

(a) Number of molecules in A and B are same

(b) Number of molecules in B is more than that in A.

(c) The ratio between the number of molecules in A to number of molecules in B is 2:1

(d) Number of molecules in B is three times greater than the number of molecules in A.

[Ans. (c) The ratio between the number of molecules in A to number of molecules in B is 2:1]

20. What is the mass of precipitate formed when 50 ml of 8.5 % solution of $AgNO_3$ is mixed with 100 ml of 1.865 % potassium chloride solution?

(a) 3.59 g (b) 7 g (c) 14 g (d) 28 g

[Ans. (a) 3.59 g]

Hint: Mass of $AgNO_3$ is equal to number of moles multiple molar mass.

21. The mass of a gas that occupies a volume of 612.5 ml at room temperature and pressure (25° c and 1 atm pressure) is 1.1 g. The molar mass of the gas is

(a) 66.25 g mol^{-1} (b) 44 g mol^{-1}

(c) 24.5 g mol^{-1} (d) 662.5 g mol^{-1}

[Ans. (b) 44 g mol^{-1}]

Hint:

$$= \frac{612.5\times10^{-3}\,l}{24.5\text{L mol}^{-1}} = -0.025 \text{ moles}$$

$$\text{Molar mass} = \frac{\text{mass}}{\text{No. of. moles}}$$

$$= \frac{1.1 \text{ g}}{0.025 \text{ mol}} = 44 \text{ g mol}^{-1}.$$

22. Which of the following contain same number of carbon atoms as in 6 g of carbon-12.

(a) 7.5 g ethane (b) 8 g methane

(c) both (a) and (b) (d) none of these

[Ans. (c) both (a) and (b)]

23. Which of the following compound(s) has /have percentage of carbon same as that in ethylene (C_2H_4) *[QY. 2019]*

(a) propene (b) ethyne

(c) benzene (d) ethane

[Ans. (a) propene]

24. Which of the following is/are true with respect to carbon -12.

(a) relative atomic mass is 12 u

(b) oxidation number of carbon is +4 in all its compounds.

(c) 1 mole of carbon-12 contain 6.022×10^{22} carbon atoms.

(d) all of these

[Ans. (a) relative atomic mass is 12 u]

25. Which one of the following is used as a standard for atomic mass. *[Govt. MQP-2018]*

(a) $_6C^{12}$ (b) $_7C^{12}$ (c) $_6C^{13}$ (d) $_6C^{14}$

[Ans. (a) $_6C^{12}$]

II. Write Brief Answer To The Following Questions.

26. Define relative atomic mass. *[FIRST MID-2018]*

Ans. The relative atomic mass of element is defined as the ratio of mass of one atom of the element to the mass of $1/12^{th}$ mass of one atom of carbon-12

Relative atomic mass (A_r)

$$= \frac{\text{Mass of one atom of the element}}{\text{Mass of } 1/12^{th} \text{ mass of one atom of Carbon-12}}$$

$$= \frac{\text{Mass of one atom of an element}}{1.6605 \times 10^{-27} \text{ Kg}}$$

27. What do you understand by the term mole. *[June 2019]*

The mole is defined as the amount of a substance which contains 6.023×10^{23} particles such as atoms, molecules or ions. It is denoted by the symbol "*n*".

28. Define equivalent mass. *[Govt. MQP-2018; QY. 2018 & 19]*

Ans. The equivalent mass of an element, compound or ion is the number of parts of mass of an element which combines with or displaces 1.008 parts of hydrogen or 8 parts of oxygen or 35.5 parts of chlorine.

29. What do you understand by the term oxidation number.

Ans. Oxidation number refers to the number of charges an atom would have in a molecule or an ionic compound, if electrons were transferred completely the oxidation numbers reflect the number of electron transferred.

30. Distinguish between oxidation and reduction. *[HY. 2019]*

Ans.

	Oxidation	Reduction
(i)	Addition of oxygen and removal of hydrogen	Additional of hydrogen and removal of oxygen
(ii)	This process involves loss of electrons $Fe^{2+} \longrightarrow Fe^{3+} + e^-$	This process involves gain electrons. $Cu^{2+} + 2e^- \longrightarrow Cu$
(iii)	Oxidation number increases	Oxidation number decreases
(iv)	$Ca + S \longrightarrow Ca^{2+} + 2e^-$	$Zn^{2+} + 2e^- \longrightarrow Zn$
(v)	Removal of Metal $2KI + H_2O_2 \longrightarrow 2KOH + I_2$	Addition of metal $HgCl_2 + Hg \longrightarrow Hg_2Cl_2$

31. Calculate the molar mass of the following compounds.

i) Urea [$CO(NH_2)_2$]

ii) Acetone [CH_3COCH_3]

iii) Boric acid [H_3BO_3]

iv) Sulphuric acid [H_2SO_4]

Ans. **(i) urea [$CO(NH_2)_2$] :**

C : 1 × 12.01 = 12.01
O : 1 × 16 = 16.00
N : 2 × 14.01 = 28.02
H : 4 × 1.01 = 4.04
60.07 g mol^{-1}

(ii) acetone [CH_3COCH_3]

C : 3 × 12.01 = 36.03
H : 6 × 1.01 = 6.06
O : 1 × 16 = 16.00
58.09 g mol^{-1}

(iii) boric acid [H_3BO_3] :

H : 3 × 1.01 = 3.03
B : 1 × 10 = 10.00
O : 3 × 16 = 48.00
61.03 g mol^{-1}

(iv) sulphuric acid [H_2SO_4] :

H : 2 × 1.01 = 2.02
S : 1 × 32.06 = 32.06
O : 4 × 16 = 64.00
98.08 g mol^{-1}

32. The density of carbon dioxide is equal to 1.965 kgm^{-3} at 273 K and 1 atm pressure. Calculate the molar mass of CO_2.

Ans. **Given :**

The density of CO_2 at 273 K and 1 atm pressure = 1.965 kgm^{-3}

Molar mass of CO_2 = ?

At 273 K and 1 atm pressure, 1 mole of CO_2 occupies a volume of 22.4 L

Mass of 1 mole of CO_2

$$= \frac{1.965\text{Kg}}{1\text{m}^3} \times 22.4\text{L}$$

$$= \frac{1.965 \times 10^3 \text{g} \times 22.4 \times 10^{-3} \cancel{\text{m}^3}}{1\cancel{\text{m}^3}}$$

$$= 44.01 \text{ g}$$

Molar mass of CO_2 = 44 gmol^{-1}.

33. Which contains the greatest number of moles of oxygen atoms

i) 1 mol of ethanol

ii) 1 mol of formic acid

iii) 1 mol of H_2O

Ans. (i) **1 mol of ethanol :** C_2H_5OH (ethanol) - Molar mass = 24 + 6 + 16 = 46

46g of ethanol contains 1 × 6.023 × 10^{23} number of oxygen atoms.

(ii) **1 mol of formic acid :** HCOOH (Formic acid) - Molar mass = 2 + 12 + 32 = 46

46g of HCOOH contains 2 × 6.023 × 10^{23} number of oxygen atoms

(iii) **1 mol of H_2O :** H_2O (Water) - Molar mass = 2 + 16 = 18

18g of water contains 1 × 6.023 × 10^{23} number of oxygen atoms.

∴ mol of formic acid contains the greatest number of oxygen atoms.

34. Calculate the average atomic mass of naturally occurring magnesium using the following data

Isotope	Isotopic atomic mass	Abundance (%)
Mg^{24}	23.99	78.99
Mg^{25}	24.99	10.00
Mg^{26}	25.98	11.01

Ans. Isotopes of Mg

$$\text{Atomic mass} = Mg^{24} = 23.99 \times \frac{78.99}{100} = 18.95$$

$$\text{Atomic mass} = Mg^{25} = 24.99 \times \frac{10}{100} = 2.499$$

$$\text{Atomic mass} = Mg^{26} = 25.98 \times \frac{11.01}{100} = 2.860$$

Average atomic mass = 24.309

Average atomic mass of Mg = 24.309.

35. In a reaction x + y + z_2 $\longrightarrow$ xyz_2 identify the Limiting reagent if any, in the following reaction mixtures.

(a) 200 atoms of x + 200 atoms of y + 50 molecules of z_2

(b) 1 mol of x + 1 mol of y + 3 mol of z_2

(c) 50 atoms of x + 25 atoms of y + 50 molecules of z_2

(d) 2.5 mol of x + 5 mol of y + 5 mol of z_2

Ans. **Reaction :** x + y + z_2 $\longrightarrow$ xyz_2

Question	Number of moles of reactants allowed to react			Number of moles of reactants consumed during reaction			Limiting reagent
	x	y	z_2	x	y	z_2	
(a)	200 atoms	200 atoms	50 molecules	50 atoms	50 atoms	50 molecules	z_2
(b)	1 mol	1 mol	3 mol	1 mol	1 mol	1 mol	x and y
(c)	50 atom	25 atom	50 molecules	25 atom	25 atom	25 molecules	y
(d)	2.5 mol	5 mol	5 mol	2.5 mol	2.5 mol	2.5 mol	x

36. Mass of one atom of an element is 6.645×10^{-23}g. How many moles of element are there in 0.320 kg.

Ans. **Given :**

mass of one atom = 6.645×10^{-23} g

∴ mass of 1 mole of atom

$= 6.645 \times 10^{-23} \text{ g} \times 6.022 \times 10^{23}$

$= 40$ g

∴ number of moles of element in 0.320 kg

$$= \frac{1 \text{ mole}}{40\text{g}} \times 0.320\text{kg}$$

$$= \frac{1 \text{ mol} \times 320\text{g}}{40\text{g}}$$

$= 8$ mol.

37. What is the difference between molecular mass and molar mass? Calculate the molecular mass and molar mass for carbon monoxide.

Ans.

	Molecular mass	Molar mass
(i)	Molecular mass is defined as the ratio of the mass of a molecule to the unified this is relative molecular mass atomic mass unit.	Molar mass is defined as the mass of one mole of a substance.
(ii)	The relative molecular mass of any compound is calculated by adding the relative atomic masses of its constituent atoms	The molar mass of a compound is equal to the sum of the relative atomic masses of its constituents.
(iii)	Its unit is u or amu	Its unit is g mol^{-1}
(iv)	**Molecular mass of CO :** (1 × at.mass of C) + (1 × at.mass of O) 1 × 12.01 amu + 1 × 16 amu = 28.01 amu	**Molar mass of CO :** 1 × 12.01 + 1 × 16 = 28.01 g mol^{-1}

38. What is the empirical formula of the following ?

i) Fructose ($C_6H_{12}O_6$) found in honey

ii) Caffeine ($C_8H_{10}N_4O_2$) a substance found in tea and coffee. *[FIRST MID-2018; QY-2018]*

Ans.

Compound	Molecular formula	Empirical formula
Fructose	$C_6H_{12}O_6$	CH_2O
Caffeine	$C_8H_{10}N_4O_2$	$C_4H_5N_2O$

39. The reaction between aluminium and ferric oxide can generate temperatures up to 3273 K and is used in welding metals. (Atomic mass of Al = 27 u Atomic mass of O = 16 u)

$2Al + Fe_2O_3 \longrightarrow Al_2O_3 + 2Fe$; If, in this process, 324 g of aluminium is allowed to react with 1.12 kg of ferric oxide.

i) Calculate the mass of Al_2O_3 formed.

ii) How much of the excess reagent is left at the end of the reaction? *[Govt. MQP-2018]*

Ans. i) $2Al + Fe_2O_3 \longrightarrow Al_2O_3 + 2Fe$

54g 160g 102g 112g

As per balanced equation 54g Al is required for 112g of Iron and 102g of Al_2O_3.

∴ 324g of Al will give $\frac{102}{54} \times 324 = 612\text{g}$ of Al_2O_3

ii) 54g of Al required 160g of Fe_2O_3 for welding reaction

∴ 324g of Al will require $\frac{160}{54} \times 324 = 960\text{g}$ of Fe_2O_3

∴ Excess Fe_2O_3 - unreacted Fe_2O_3 = 1120 – 960 = 160g.

40. How many moles of ethane is required to produce 44 g of $CO_{2(g)}$ after combustion. *[FIRST MID-2018; QY. 19]*

Ans. Balanced equation for the combustion of ethane

$$C_2H_6 + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$$

$$\Rightarrow \quad 2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$$

To produce 4 moles of CO_2, 2 moles of ethane is required

∴ To produce 1 mole (44 g) of CO_2 required number of moles of ethane

$$= \frac{2 \text{ mol ethane}}{4 \ \cancel{\text{mol } CO_2}} \times 1 \ \cancel{\text{mol } CO_2}$$

$$= \frac{1}{2} \text{ mole of ethane}$$

= 0.5 mole of ethane.

41. Hydrogen peroxide is an oxidising agent. It oxidises ferrous ion to ferric ion and reduced itself to water. Write a balanced equation.

Ans.

$$H_2\overset{-1}{O_2} + Fe^{2+} \longrightarrow Fe^{3+} + H_2\overset{-2}{O}$$

$$\uparrow \qquad \downarrow$$

$$(1e^- \times 2\ )\ 1e^-$$

$$1\ H_2O_2 + 2Fe^2 + \longrightarrow Fe^3 + H_2O$$

$$\Rightarrow \quad H_2O_2 + 2Fe^2 + 2H^+ \longrightarrow 2Fe^3 + 2H_2O$$

42. Calculate the empirical and molecular formula of a compound containing 76.6% carbon, 6.38 % hydrogen and rest oxygen its vapour density is 47. *[Mar. 2019; Sep.-2020]*

Ans.

Element	Percentage	Atomic mass	Relative number of atoms	Simple ratio	Whole no
C	76.6	12	$\frac{76.6}{12} = 6.38$	$\frac{6.38}{1.06} = 6$	6
H	6.38	1	$\frac{6.38}{1} = 6.38$	$\frac{6.38}{1.06} = 6$	6
O	17.02	16	$\frac{17.02}{16} = 1.06$	$\frac{1.06}{1.06} = 1$	1

Empirical formula = $C_6\,H_6\,O$

$$n = \frac{\text{Molar mass}}{\text{Calculated empirical formula mass}}$$

$$= \frac{2 \times \text{vapour density}}{94} = \frac{2 \times 47}{94} = 1, \text{ since Molar mass} = 2 \times \text{Vapour density}$$

molecular formula n × n empirical formula

$\therefore$ molecular formula $(C_6H_6O) \times 1 = C_6H_6O$.

43. A Compound on analysis gave Na = 14.31% S = 9.97% H = 6.22% and O = 69.5% calculate the molecular formula of the compound, if all the hydrogen in the compound is present in combination with oxygen as water of crystallization. (molecular mass of the compound is 322).

Ans.

Element	%	Relative number of atoms	Simple ratio
Na	14.31	$\frac{14.31}{23} = 0.62$	$\frac{0.62}{0.31} = 2$
S	9.97	$\frac{9.97}{32} = 0.31$	$\frac{0.31}{0.31} = 1$
H	6.22	$\frac{6.22}{1} = 6.22$	$\frac{6.22}{0.31} = 20$
O	69.5	$\frac{69.5}{16} = 4.34$	$\frac{4.34}{0.31} = 14$

$\therefore$ Empirical formula is $= Na_2\,S\,H_{20}O_{14}$

Empirical formula mass $= (23 \times 2) + (32 \times 1) + (20 \times 1) + (14 \times 6)$

$= 46 + 32 + 20 + 224 = 322$

$$n = \frac{\text{Molecular mass}}{\text{Emprical formula mass}} = \frac{322}{322} = 1$$

Molecular formula $= Na_2\,S\,H_{20}O_{14}$

44. Balance the following equations by oxidation number method

i) $K_2Cr_2O_7 + KI + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + I_2 + H_2O$

ii) $KMnO_4 + Na_2SO_3 \longrightarrow MnO_2 + Na_2SO_4 + KOH$

iii) $Cu + HNO_3 \longrightarrow Cu(NO_3)_2 + NO_2 + H_2O$ ***[QY. 2019]***

iv) $KMnO_4 + H_2C_2O_4 + H_2SO_4 \longrightarrow K_2SO_4 + MnSO_4 + CO_2 + H_2O$ ***[FIRST MID-2018]***

Ans. **(i)**

$$K_2\overset{+6}{Cr_2}O_7 + K\overset{-1}{I} + H_2SO_4 \longrightarrow K_2SO_4 + \overset{+3}{Cr_2}(SO_4)_3 + \overset{0}{I_2} + H_2O$$

$2 \times 3e^-$ $1e^-$

$\mathbf{K_2Cr_2O_7 + 6KI} + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + I_2 + H_2O$

$K_2Cr_2O_7 + 6KI + H_2SO_4 \longrightarrow K_2SO_4 + \mathbf{Cr_2(SO_4)_3 + 3I_2} + H_2O$

$K_2Cr_2O_7 + 6KI + \mathbf{7H_2SO_4} \longrightarrow \mathbf{4K_2SO_4} + Cr_2(SO_4)_3 + 3I_2 + \mathbf{7H_2O}$

(ii)

$$K\overset{+7}{M}nO_4 + Na_2\overset{+4}{S}O_3 \longrightarrow \overset{+4}{M}nO_2 + Na_2\overset{+6}{S}O_4 + KOH$$

$3e^-$ $2e^-$

$\Rightarrow$ $\mathbf{2KMnO_4 + 3Na_2SO_3} \longrightarrow MnO_2 + Na_2SO_4 + KOH$

$\Rightarrow$ $2KMnO_4 + 3Na_2SO_3 \longrightarrow \mathbf{2MnO_2 + 3Na_2SO_4} + KOH$

$\Rightarrow$ $2KMnO_4 + 3Na_2SO_3 + \mathbf{H_2O} \longrightarrow 2MnO_2 + 3Na_2SO_4 + 2KOH$

(iii)

$$\overset{0}{C}u + H\overset{+5}{N}O_3 \longrightarrow \overset{+2}{C}u(NO_3)_2 + \overset{+4}{N}O_2 + H_2O$$

$2e^-$ $1e^-$

$\mathbf{Cu + 2HNO_3} \longrightarrow Cu(NO_3)_2 + NO_2 + H_2O$

$Cu + 2HNO_3 + \mathbf{2HNO_3} \longrightarrow Cu(NO_3)_2 + \mathbf{2NO_2} + 2H_2O$

$Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

(iv)

$$K\overset{+7}{M}nO_4 + H_2\overset{+3}{C_2}O_4 + H_2SO_4 \longrightarrow K_2SO_4 + \overset{+2}{M}nSO_4 + \overset{+4}{C}O_2 + H_2O$$

$5e^-$ $1e^- \times 2$

$\mathbf{2KMnO_4 + 5H_2C_2O_4} + H_2SO_4 \longrightarrow K_2SO_2 + MnSO_4 + CO_2 + H_2O$

$2KMnO_4 + 5H_2C_2O_4 + H_2SO_4 \longrightarrow K_2SO_4 + \mathbf{2MnSO_4 + 10CO_2} + H_2O$

$2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$

45. Balance the following equations by ion electron method.

i) $KMnO_4 + SnCl_2 + HCl \longrightarrow MnCl_2 + SnCl_4 + H_2O + KCl$

ii) $C_2O_4^{2-} + Cr_2O_7^{2-} \longrightarrow Cr^{3+} + CO_2$ (in acid medium)

iii) $Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + NaI$

iv) $Zn + NO_3^- \longrightarrow Zn^{2+} + NO$ (in acid medium) *[FIRST MID-2018]*

Ans. **(i) Half reaction are :**

$$\overset{+7}{M}nO_4^- \longrightarrow Mn^{2+} \quad ......(1)$$

and $$Sn^{2+} \longrightarrow Sn^{4+} \quad ......(2)$$

$$(1) \Rightarrow MnO_4^- + 8H^- + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

$$(2) \Rightarrow Sn^{2+} \longrightarrow Sn^{4+} + 2e^-$$

$$(1) \times 2 \Rightarrow 2MnO_4^- + 16H^+ + \cancel{10e^-} \longrightarrow 2Mn^{2+} + 8H_2O$$

$$(2) \times 5 \Rightarrow 5Sn^{2+} \longrightarrow 5Sn^{4+} + \cancel{10e^-}$$

$$\Rightarrow 2MnO_4^- + 5Sn^{2+} + 16H^+ \longrightarrow 2Mn^{2+} + 5Sn^{4+} + 8H_2O$$

(ii)

$$\overset{+3}{C}_2O_4^{2-} \longrightarrow \overset{+4}{C}O_2 \quad ......(1)$$

$$\overset{+6}{C}r_2O_7^{2-} \longrightarrow Cr^{3+} \quad ......(2)$$

$$(1) \Rightarrow C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^- \quad ......(3)$$

$$Cr_2O_7^{2-} + 14H^+ \longrightarrow 2Cr^{3+} + 7H_2O \quad ......(4)$$

$$(3) \times 3 \Rightarrow 3C_2O_4^{2-} \longrightarrow 6CO_2 + \cancel{6e^-} \quad ......(5)$$

$$Cr_2O_7^{2-} + 14H^+ + \cancel{6e^-} \longrightarrow 2Cr^{3+} + 7H^2O \quad ......(4)$$

$$\Rightarrow Cr_2O_7^{2-} + 3C_2O_4^{2-} + 14H^+ \longrightarrow 2Cr^{3+} + 6CO_2 + 7H^2O$$

(iii)

$$S_2O_3^{2-} \longrightarrow S_4O_6^{2-} \quad ......(1)$$

half reaction $\Rightarrow$ $$I_2 \longrightarrow I^- \quad ......(2)$$

$$(1) \Rightarrow 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + \cancel{2e^-} \quad ......(3)$$

$$(2) \Rightarrow I_2 + \cancel{2e^-} \longrightarrow 2I^- \quad ......(4)$$

$$(3) + (4) \Rightarrow 2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$$

(iv)

$$\overset{0}{Z}n \longrightarrow Zn^{2+} \quad ......(1)$$

$$\overset{+5}{N}O_3^- \longrightarrow \overset{+2}{N}O \quad ......(2)$$

$$(1) \Rightarrow Zn \longrightarrow Zn^{2+} + 2e^- \quad ......(3)$$

$$(2) \Rightarrow NO_3^- + 3e^- + 4H^+ \longrightarrow NO + 2H_2O \quad ......(4)$$

$$(3) \times 3 \Rightarrow 3Zn \longrightarrow Zn^{2+} + \cancel{6e^-} \quad ......(5)$$

$$(4) \times 2 \Rightarrow 2NO_3^- + \cancel{6e^-} + 8H^+ \longrightarrow 2NO + 4H_2O \quad ......(6)$$

$$3Zn + 2NO_3^- + 8H^+ \longrightarrow 3Zn^{2+} + 2NO + 4H_2O$$

Evaluate Yourself

1. By applying the knowledge of chemical classification, classify each of the following into elements, compounds or mixtures.
(i) Sugar
(ii) Sea water
(iii) Distilled water
(iv) Carbon dioxide
(v) Copper wire
(vi) Table salt
(vii) Silver plate
(viii) Naphthalene balls

Ans. (i) **Element -** Copper wire, Silver plate
(ii) **Compound -** Sugar, distilled water, carbondioxide, Table salt, Naphthalene balls
(iii) **Mixture -** Sea water

2. Calculate the relative molecular mass of the following.
(i) Ethanol(C_2H_5OH)
(ii) Potassium permanganate ($KMnO_4$)
(iii) Potassium dichromate ($K_2Cr_2O_7$)
(iv) Sucrose ($C_{12}H_{22}O_{11}$)

Ans. (i) **C_2H_5OH :** (2 x 12) + (5 x 1) + (1 x 16) + (1 x 1) = **46 g**
(ii) **$KMnO_4$:** (1 x 39) + (1 x 55) + (4 x 16) = **158 g**
(iii) **$K_2Cr_2O_7$:** (2 x 39) + (2 x 52) + (7 x 16) = **294 g**
(iv) **$C_{12}H_{22}O_{11}$:** (12 x 12) + (22 x 1) + (11 x 16) = **342 g**

3. a) Calculate the number of moles present in 9 g of ethane.
b) Calculate the number of molecules of oxygen gas that occupies a volume of 224 ml at 273 K and 3 atm pressure.

Ans. (a) Molar mass of ethane, C_2H_6 = (2 x 12)+ (6 x 1) = 30 g mol-1
(b) At 273 K and 1 atm pressure 1 mole of a gas occupies a volume of 22.4 L

Therefore,
number of moles of oxygen, that occupies a volume of 224 ml at 273 K and 3 atm pressure

$$= \frac{1\,\text{mole}}{273\,\text{K} \times 1\,\text{atm} \times 22.4\,\text{L}} \times 0.224\,\text{L} \times 273\,\text{K} \times 3\,\text{atm}$$

= 0.03 mole

1 mole of oxygen contains 6.022 x 10^{23} molecules
0.03 mole of oxygen contains = 6.022 x 10^{23} x 0.03
= **1.807 x 10^{22} molecules of oxygen**

4. a) 0.456 g of a metal gives 0.606g of its chloride. Calculate the equivalent mass of the metal.

Ans. Mass of the metal = W_1 = 0.606g
∴ Mass of chlorine = W_2 = 0.606 – 0.456 = 0.15g
0.15 g of chlorine combine with 0.456 g of metal
∴ 35.46 g of chlorine will combine with

$$\frac{0.456}{0.15} \times 35.46 = 107.76\text{g eq}^{-1}$$

Mass of chloride = 0.606 – 0.456 = 0.146 g
0.146g of chlorine combines with 0.456 g of metal.
∴ 35.5 g of chlorine will combines with

$$= \frac{35.5 \times 0.456}{0.146}$$

= 110.8g of metal

∴ equivalent mass of metal = 110.8g equ $^{-1}$

b) Calculate the equivalent mass of potassium dichromate. The reduction half reaction in acid medium is,

[$K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3(O)$ 3 × 16 = 48 294 g]

Ans. 48 parts by mass of oxygen are made available from 294 parts by mass of $K_2Cr_2O_7$
∴8 parts by mass of oxygen will be furnished by

$$= \frac{294 \times 8}{48} = 49$$

Equivalent mass of $K_2Cr_2O_7$ = 49 g equiv^{-1}

5. A Compound on analysis gave the following percentage composition C=54.55%, H=9.09%, O=36.36%. Determine the empirical formula of the compound.

Ans.

Element	Percentage Composition	Atomic mass	Relative no. of atoms = $\frac{\text{Percentage}}{\text{Atomic mass}}$	Simple ratio
C	54.55 %	12	54.55/12 = 4.55	4.55 / 2.27 = 2
H	9.09 %	1	9.09 / 1 = 9.09	9.09 / 2.27 = 4
O	36.36 %	16	36.36/16 = 2.27	2.27/2.27 = 1
Empirical formula (C_2H_4O)				

6. Experimental analysis of a compound containing the elements x,y,z on analysis gave the following data. x = 32 %, y = 24 %, z = 44 %. The relative number of atoms of x, y and z are 2, 1 and 0.5, respectively. (Molecular mass of the compound is 400 g) Find out.
i) The atomic masses of the element x,y,z.
ii) Empirical formula of the compound and
iii) Molecular formula of the compound.

Ans.

Element	Percentage Composition	Relative no. of atoms = $\frac{\text{Percentage}}{\text{Atomic mass}}$	Atomic mass= $\frac{\text{Percentage}}{\text{Relative no. of atoms}}$	Simple ratio
X	32 %	2	16	4
Y	24 %	1	24	2
Z	44 %	0.5	88	1
Empirical formula (X_4Y_2Z)				

Calculated empirical formula mass

$= (16 \times 4) + (24 \times 2) + 88$

$= 64 + 48 + 88 = 200$

$$n = \frac{\text{molar mass}}{\text{calculated empirical formula mass}}$$

$$n = \frac{400}{200}$$

$= 2$

∴ **Molecular formula $(X_4Y_2Z)_2$** $= X_8Y_4Z_2$

7. The balanced equation for a reaction is given below

$$2x+3y \rightarrow 4l + m$$

When 8 moles of x react with 15 moles of y, then
i) Which is the limiting reagent?
ii) Calculate the amount of products formed.
iii) Calculate the amount of excess reactant left at the end of the reaction.

Ans.

Content	Reactant		Products	
	x	y	*l*	m
Stoichiometric coefficient	2	3	4	1
No. of moles allowed to react	8	15	–	–
No. of moles of reactant reacted and product formed	8	12	16	4
No. of moles of un-reacted reactants and the product formed	–	3	16	4

Limiting reagent : x
Product formed : 16 moles of *l* & 4 moles of m
Amount of excess reactant : 3 moles of y

8. Balance the following equation using oxidation number method

$$As_2S_3 + HNO_3 + H_2O \rightarrow H_3AsO_4 + H_2SO_4 + NO$$

Ans.

$$\overset{+3}{As_2}\,\overset{-2}{S_3} + H\overset{+5}{N}O_3 \rightarrow H_3\overset{+5}{As}O_4 + H_2\overset{+6}{S}O_4 + \overset{+2}{N}O$$

$$\frac{2\times 2e^-}{4e^-} + \frac{3\times 8e^-}{24e^-} = \underbrace{4e^- + 24e^-}_{28e^-} \qquad 3e^-$$

Equate the total no. of electrons in the reactant side by cross multiplying,

$\Rightarrow 3\,As_2S_3 + 28\,HNO_3 \rightarrow H_3AsO_4 + H_2SO_4 + NO$

Based on reactant side, balance the products

$\Rightarrow 3\,As_2S_3 + 28\,HNO_3 \rightarrow 6\,H_3AsO_4 + 9\,H_2SO_4 + 28\,NO$

Product side :36 hydrogen atoms & 88 oxygen atoms
Reactant side :28 hydrogen atoms & 84 oxygen atoms
Difference is 8 hydrogen atoms & 4 oxygen atoms
∴ Add 4 H2O molecule on the reactant side.
Balanced equation is,

$$3As_2S_3 + 28HNO_3 + 4H_2O \rightarrow 6H_3AsO_4 + 9H_2SO_4 + 28NO$$

Government Exam Questions and Answers

PART - I

Choose the Correct Answer 1 MARK

1. The equivalent mass of a divalent metal element is 10 g eq^{-1}. The molar mass of its anhydrous oxide is *[Govt. MQP-2018]*

(a) 46 g (b) 36 g
(c) 52 g (d) none of these

[Ans. (c) 52 g]

> ***Hint:*** Atomic mass of divalent metal is equal to 2 multiple of atomic mass of metal + 2 multiple of atomic mass of oxygen

2. Match the list I with List II correctly by using the code given below the list. *[QY. 2018]*

List I (no. of moles)		List II (Amount)	
A	0.1 mole	1	4480 *ml* of CO_2
B	0.2 mole	2	200 mg of hydrogen gas
C	0.25 mole	3	9 *ml* of water
D	0.5 mole	4	1.51×10^{23} molecules of oxygen

	A	B	C	D
(a)	2	3	4	1
(b)	4	3	1	2
(c)	3	1	4	2
(d)	2	1	4	3

[Ans. (d) 2 1 4 3]

> ***Hint:*** Number of moles is equal to Mass/ Molar mass
> Number of moles is equal to Volume/ molar volume

3. The oxidation number of chromium in dichromate lion is *[QY-2018]*

(a) +4 (b) +6 (c)+5 (d) 0

[Ans. (b) +6]

4. The empirical formula of glucose is : *[HY. 2019]*

(a) CH_2O (b) CHO
(c) CH_2O_2 (d) CH_3O_2

[Ans. (a) CH_2O]

5. The oxidation number of carbon in CH_2F_2 is ____. *[June 2019]*

(a) +4 (b) –4 (c) 0 (d) +2

[Ans. (c) 0]

6. The relative molecular mass of ethanol is *[Sep. 2020]*

(a) 0.46 g (b) 4.6 g
(c) 460 g (d) 46 g

[Ans. (d) 46 g]

PART - II

Answer the Questions 2 MARK

1. Write the electronic concept of oxidation and reduction reactions. *[QY. & HY. 2018]*

Ans. The process can be explained on the basis of electrons. The reaction involving loss of electron is termed oxidation

$Fe^{2+} \rightarrow Fe^{3+} + e^-$ (loss of electron-oxidation).

The reaction involving gain of electron is termed reduction.

$Cu^{2+} + 2e^- \rightarrow Cu$ (gain of electron-reduction)

2. How many moles of hydrogen is required to produce 10 moles of ammonia ? *[HY-2018]*

Ans. $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$

To produce 2 moles of ammonia, 3 moles of hydrogen are required

To produce 10 moles of ammonia

$$= \frac{3 \text{ moles of } H_2}{\cancel{2 \text{ moles of } NH_3}} \times \overset{5}{\cancel{10 \text{ moles of } NH_3}}$$

= 15 moles of hydrogen are required.

3. Calculate oxidation number of oxygen in H_2O_2. *[Mar. 2019]*

Ans. hydrogen peroxide (H_2O_2)

$2(+1) + 2x = 0; \Rightarrow 2x = -2; \Rightarrow x = -1$

4. What is combination reaction? Give example. *[HY. 2019]*

Ans. When two or more substance combine to form a single substance, the reactions are combination reactions.

$$A + B \longrightarrow C$$

$$\text{Ex} - 2Mg + O_2 \longrightarrow 2MgO$$

5. Calculate the oxidation states of oxygen in H_2O_2 and KO_2. *[QY. 2019]*

Ans. Hydrogen peroxide (H_2O_2) is –1.

$2(+1) + 2x = 0; \Rightarrow 2x = -2; \Rightarrow x = -1$

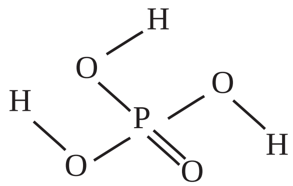
Super oxides such as KO_2 is = –1/2

$+1 + 2x = 0; \Rightarrow 2x = -1; \Rightarrow x = -1/2.$

6. Define basicity. Find the basicity of ortho-phosphoric acid. *[Sep. 2020]*

Ans. **(i) Basicity :** The number of replaceable hydrogen atoms present in a molecule of the acid is referred to as its basicity.

(ii) Basicity of ortho-phosphoric acid - H_3PO_4



The number of Hydrogen atoms bonded to the oxtgen atoms in this compound is 3. Therefore, the basicity of ortho-phosphoric acid is 3.

PART - III

ANSWER THE QUESTIONS — 3 MARK

1. Statement 1 : Two mole of glucose contains 12.044 × 10^{23} molecules of glucose

Statement 2 : Total number of entities present in one mole of any substance is equal to 6.02 × 10^{22}. *[Govt. MQP-2018]*

Whether the above statements are true? Is there any relation between these two statements?

Ans. The statements 1 & 2 are true. But there is no relation between statement 1 and statement 2.

2. Calculate the total number of electrons present in 17g of ammonia. *[Govt. MQP-2018]*

Ans. No. of electrons present in one ammonia (NH_3) molecule (7 + 3) = 10

No. of moles of $NH_3 = \dfrac{\text{Mass}}{\text{Molar mass}} = \dfrac{17g}{17g\ \text{mol}^{-1}} = 1\ \text{mol}$

No. of molecules present in 1 mol of NH_3
$= 6.023 \times 10^{23}$

No. of electrons present in 1 mol of NH_3
$= 10 \times 6.023 \times 10^{23}$
$= 6.023 \times 10^{24}$

3. Calculate the amount of water produced by the combustion of 32 g of methane. *[QY-2018]*

Ans. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

As per the stoichiometric equation,

Combustion of 1 mole (16 g) CH_4 produces 2 moles (2 × 18 = 36 g) of water.

CH_4
(12) + (4 ×1) = 16 g mol^{-1}

H_2O
(2×1) + (1 ×16) = 18 g mol^{-1}

Combustion of 32 g CH_4 produces

$$\frac{36\ g\ H_2O}{\cancel{16\ g\ CH_4}} \times \overset{2}{\cancel{32\ g\ CH_4}} = 72\ \text{g of water}$$

4. Calculate the equivalent mass of H_2SO_4. *[Mar. 2019]*

Ans.
H_2SO_4 basicity = 2eq mol^{-1}
Molar mass of H_2SO_4 = (2 × 1) + (1 × 32) + (4 × 16)
= 98 g mol^{-1}

Gram equivalent of $H_2SO_4 = \dfrac{98}{2} = 49\ \text{g eq}^{-1}$

5. $X_2 + 3Y_2 \rightarrow 2XY_3$ In this reaction 2 moles of X_2 and 4.5 moles of Y_2 react to give products. Which is the limiting agent and calculate the no. of moles of X_2. Y_2 and XY_3 in the reaction mixture? *[QY. 2019]*

Ans.

	X_2	+ $3Y_2$	→ $2XY_3$
No. of moles	2	4.5	?
SC	1	3	2
ratio	2/1	4.5/3	-
	2(ER)	1.5(LR)	-

mole-mole $= \dfrac{nX_2}{1} = \dfrac{nY_2}{3} = \dfrac{nXY_3}{2}$

$= \dfrac{2}{1} = \dfrac{4.5}{3} = \dfrac{nXY_3}{2}$

$\dfrac{4.5}{3} = \dfrac{nXY_3}{2} = 3\ \text{moles}$

No. of moles of $2XY_3$ = 3 moles

PART - IV

ANSWER ALL THE QUESTIONS — 5 MARK

1. Define oxidation number. Balance the following equation using oxidation number method.

$As_2S_3 + HNO_3 + H_2O \longrightarrow H_3AsO_4 + H_2SO_4 + NO$ *[Govt. MQP-2018]*

Ans. **Oxidation number :** It is defined as the imaginary charge left on the atom when all other atoms of the compound have been removed in their usual oxidation states that are assigned according to set of rules.

Solution :

Step 1 : $As_2S_3 + HNO_3 + H_2O \longrightarrow H_3AsO_4 + H_2SO_4 + NO$

Step 2 : Assign the oxidation numbers and identify the redox couples.

Decreased by 3

$\overset{+3}{As_2}\overset{-2}{S_3} + \overset{+1}{H}\overset{+5}{N}\overset{-2}{O_3} + \overset{+1}{H_2}\overset{-2}{O} \longrightarrow \overset{+1}{H_3}\overset{+5}{As}\overset{-2}{O_4} + \overset{+1}{H_2}\overset{+6}{S}\overset{-2}{O_4} + \overset{+2}{N}\overset{-2}{O}$

Increased by 2

Step 3 : Multiply As_2S_3 by 3 and HNO_3 by 2.

$3As_2S_3 + 2HNO_3 + H_2O \longrightarrow H_3AsO_4 + H_2SO_4 + NO$

Step 4 : Balance all the elements in the equation (As, S and N) except H and O.

$3As_2S_3 + 2HNO_3 + H_2O \longrightarrow 6H_3AsO_4 + 9H_2SO_4 + 2NO$

Step 5 : Balance the complete equation including O & H.

$3As_2S_3 + 28HNO_3 + H_2O \longrightarrow 6H_3AsO_4 + 9H_2SO_4 + 28NO$

2. What are disproportionation reaction. (or) What are auto redox reactions? Give an example. *[June 2019]*

Ans. **Disproportionation reaction (Auto redox reactions) :** In some redox reactions, the same compound can undergo both oxidation and reduction. In such reactions, the oxidation state of one and the same element is both increased and decreased. These reactions are called disproportionation reactions.

Oxidation

$2H_2\overset{-1}{O_2} \longrightarrow 2H_2\overset{-2}{O} + \overset{0}{O_2}$

Reduction

3. Define limiting reagent. *[Govt. MQP-2018; QY. 2018]*

Ans. **Limiting reagent :** When a reaction is carried out using non-stoichiometric quantities of the reactants, the product yield will be determined by the reactant that is completely consumed. It limits the further reaction from taking place and is called as the limiting reagent.

4. Calculate the empirical and molecular formula of the compound containing 80% Carbon, 20% Hydrogen. If the molecular mass of the compound is 30 then determine the molecular formula. *[QY. 2019]*

Ans. For C $\Rightarrow$ 80/12 = 6.6

for H $\Rightarrow$ 20/1 = 20 now divide 6.6 and 20 by 6.6 to get simple whole no. ratio of C and H which will come 1:3 so emperical formula is CH_3 and its mass is 15

Now to calculate n we have 30/15 = 2

so molecular formula is $CH_3 \times 2 = C_2H_6$

ADDITIONAL QUESTIONS

Additional Choose the Correct Answers — 1 MARK

1. Consider the following statements
1 Matter possesses mass.
2 22 carat gold is a mixture.
3 Dry ice is a compound.
Which of the following statement(s) given above is/ are correct?

(a) 1 & 3 (b) only 1
(c) 1 & 2 (d) 1, 2 & 3

[Ans. (d) 1, 2 & 3]

2. The solid state of matter is converted into gas by

(a) sublimation (b) deposition
(c) freezing (d) condensation

[Ans. (a) sublimation]

3. Match the list I with List II and select the correct answer using the code given below the list.

	List I		List II
A	Diamond	**1**	Heterogeneous mixture
B	Aerated drinks	**2**	Element
C	Distilled water	**3**	Homogeneous mixture
D	Sand	**4**	Compound

	A	B	C	D
(a)	2	3	4	1
(b)	4	3	1	2
(c)	3	1	4	2
(d)	2	1	4	3

[Ans. (a) 2 3 4 1]

4. The characteristic feature of orderly arrangement of molecules belongs to

(a) Solids (b) Liquid
(c) Gases (d) None of these

[Ans. (a) Solids]

5. The volume occupied by any gas at S.T.P. is ____ .

(a) 22.4 litres (b) 2.24 litres
(c) 224 litres (d) 0.224 litres

[Ans. (a) 22.4 litres]

6. What will be the basicity of H_3BO_3, which is not a protic acid?

(a) one (b) two (c) three (d) four

[Ans. (a) one]

7. Which form of based on physical characteristics possess neither definite volume nor definite shape?

(a) Solids (b) Liquids
(c) Gases (d) Both (a) and (b)

[Ans. (c) Gases]

8. Identify the incorrect statement about a compound.

(a) A molecule cannot be separated into its constituent elements by physical methods of separation
(b) A molecule of a compound has atoms of different elements
(c) A compound retains the physical properties of its constituent element
(d) The ratio of atoms of different elements in a compound is fixed

[Ans. (c) A compound retains the physical properties of its constituent element]

9. Which among the following statement(s) describe an element?

i) It is pure substance which could be split into two or more simpler substance.
ii) It is a pure substance which cannot be split into simpler substance
iii) It's composition is not uniform
iv) All the above

(a) only (iv) (b) only (ii)
(c) (ii) and (iii) (d) (i) and (iii)

[Ans. (b) only (ii)]

10. Atoms are too small with diameter of 10^{-10} m and weigh approximately

(a) 10^{-27} kg (b) 10^{-27} g
(c) 10^{-31} kg (d) 10^{-31} g

[Ans. (a) 10^{-27} kg]

11. 1 amu (or) 1u ≈

(a) 1.6605×10^{-25} kg (b) 1.6605×10^{-26} kg
(c) 1.6605×10^{-27} kg (d) 1.6605×10^{-28} kg

[Ans. (c) 1.6605×10^{-27} kg]

12. 12 g of carbon-12 contains _______ carbon atoms.

(a) 6.022×10^{23} (b) 6
(c) 12 (d) 12.022×10^{23}

[Ans. (a) 6.022×10^{23}]

13. Atomicity of nitrogen is

(a) 1 (b) 2
(c) 3 (d) zero **[Ans. (b) 2]**

Hint: Atomicity is defined as total number of atoms is present in the molecule

14. Unit of Avogadro's number is

(a) mol (b) g (c) mol^{-1}
(d) no unit **[Ans. (c) mol^{-1}]**

15. Statement I : Equivalent mass of Mg is determined by Oxide Method.
Statement II : Molecular mass is calculated using vapour density.

(a) Both the statements are individually true
(b) Both the statements are individually true and statement II is the correct explanation of statement I.
(c) Statement I is true but statement II is false.
(d) Statement I is false but statement II is true.

[Ans. (a) Both the statements are individually true]

16. Match list I with list II and identify the correct code.

List I		List II	
A	Bronze	1	Element
B	Table salt	2	Homogeneous mixture
C	Gold	3	Alloy
D	Petrol	4	Compound

	A	B	C	D
(a)	1	4	2	3
(b)	3	4	1	2
(c)	2	3	4	1
(d)	4	2	3	1

[Ans. (b) 3 4 1 2]

17. One mole of sulphuric acid contains ______ oxygen atoms.

(a) 4×10^{23} (b) $4 \times 6.023 \times 10^{-23}$
(c) $4 \times 6.023 \times 10^{23}$ (d) $4 \times 6.023 \times 10^{32}$

[Ans. (c) $4 \times 6.023 \times 10^{23}$]

18. Assertion : An element that has a fractional atomic mass.
Reason : An element exist as isotope.

(a) Both assertion and reason are correct and reason is the correct explanation for assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation for assertion
(c) Assertion is true but reason are false.
(d) Both assertion and reason are false.

[Ans. (a) Both assertion and reason are correct and reason is the correct explanation for assertion.]

19. The oxidation number of hydrogen in LiH is ___ .

(a) +1 (b) –1 (c) +2 (d) –2

[Ans. (b) –1]

20. The oxidation number of oxygen in O_2 is ______ .

(a) 0 (b) +1 (c) +2 (d) –2

[Ans. (a) 0]

21. The empirical formula and molecular mass of a compound are CH_2O and 180 g respectively. What will be the molecular formula of the compound?

(a) $C_9H_{19}O$ (b) CH_2O

(c) $C_6H_{12}O_6$ (d) $C_2H_4O_2$ **[Ans. (c) $C_6H_{12}O_6$]**

Hint: Molecular formula is equal to empirical formula multiple molecular weight

22. One 'U' stands for the mass of

(a) An atom of carbon-12

(b) 1/12th of the carbon-12

(c) 1/12th of hydrogen atom

(d) One atom of any of the element

[Ans. (b) 1/12th of the carbon-12]

23. In the reaction $NH_3 + H_2O \longrightarrow NH_4^+ + O\overline{H}$, NH_3 is acidic in nature. The reason for its acidity is ______.

(a) Acceptance of one H^+ from water

(b) Release of one OH^- ion

(c) Due to the nitrogen atom

(d) All the above.

[Ans. (a) Acceptance of one H^+ from water]

24. Calculate the percentage of N in ammonia molecule.

(a) 121.42% (b) 28.35%

(c) 82.35% (d) 28.53%

[Ans. (c) 82.35%]

Sol : Molar mass of NH_3 = $14 + 1 \times 3 = 17$ g mol^{-1}

Percentage of N = $\dfrac{\text{mass of N in } NH_3}{\text{molar mass of } NH_3} \times 100$

= $\dfrac{14}{17} \times 100 = 82.35\%$.

25. If a beaker holds 576 g of water, what will be the gram molecules of water in that beaker?

(a) 23 gram molecule (b) 23%

(c) 32% (d) 32 gram molecule

[Ans. (d) 32 gram molecule]

Sol : Molecular mass of H_2O = $2 \times 1 + 16$

= 18 g mol^{-1}

18 g of water = 1 gram molecule

$\therefore$ 576 g of water = $\dfrac{1 \times 576}{18}$

= 32 gram molecules.

26. Match the following prefixes with their multiples.

Equivalent Mass (E)		Molecular Mass (M)	
A	E_{KMnO_4} (Acidic)	1	M/2
B	E_{KMnO_4} (Neutral)	2	M
C	$E_{H_3PO_2}$	3	M/3
D	$E_{H_3PO_3}$	4	M/5

	A	B	C	D
(a)	4	3	2	1
(b)	4	2	1	3
(c)	3	4	2	1
(d)	3	1	4	2

[Ans. (a) 4 3 2 1]

27. The oxidation state of a element in its uncombined state is

(a) zero (b)+1 (c) –1 (d) none

[Ans. (a) zero]

28. $Fe^{2+} \longrightarrow Fe^{3+} + e^-$ is a _______ reaction.

(a) redox (b) reduction

(c) oxidation (d) decomposition

[Ans. (c) oxidation]

29. Assertion : The atomic masses of most of the elements are in fraction.

Reason : The atomic mass represents the ratio of the average mass of the atom to one avogram.

(a) Both assertion and reason are correct and reason is the correct explanation for assertion.

(b) Both assertion and reason are correct but reason is not the correct explanation for assertion

(c) Assertion is true but reason are false.

(d) Both assertion and reason are false.

[Ans. (b) Both assertion and reason are correct but reason is not the correct explanation for assertion]

30. Identify disproportionation reaction.

(a) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

(b) $CH_4 + 4Cl_2 \longrightarrow CCl_4 + 4HCl$

(c) $2F_2 + 2OH^- \longrightarrow 2F^- + OF_2 + H_2O$

(d) $2NO_2 + 2OH^- \longrightarrow NO_2^- + NO_3^- + H_2O$

[Ans. (d) $2NO_2 + 2OH^- \longrightarrow NO_2^- + NO_3^- + H_2O$]

31. The oxidation number of Cr in $Cr_2O_7^{2-}$ is _____ .

(a) +6 (b) –6 (c) +7 (d) –7

[Ans. (a) +6]

32. Assertion : The number of oxygen atoms in 16 g of oxygen and 16 g of ozone is same.
Reason : Each of the species represent 1 g atom of oxygen.

(a) Both assertion and reason are correct and reason is the correct explanation for assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation for assertion
(c) Assertion is true but reason are false.
(d) Both assertion and reason are false.

[Ans. (a) Both assertion and reason are correct and reason is the correct explanation for assertion.]

33. Assertion : The ash is produced by burning paper in air is lighter than the original mass of paper.
Reason : The residue is left after the combustion of a chemical reaction that entities is always lighter.

(a) Both assertion and reason are correct and reason is the correct explanation for assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation for assertion
(c) Assertion is true but reason are false.
(d) Both assertion and reason are false.

[Ans. (c) Assertion is true but reason are false.]

34. Assertion : Oxalic acid is a dibasic acid
Reason : It contains two basic radicals

(a) Both assertion and reason are correct and reason is the correct explanation for assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation for assertion
(c) Assertion is true but reason are false.
(d) Both assertion and reason are false.

[Ans. (c) Assertion is true but reason are false.]

35. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 moles of oxygen atoms?

(a) 0.02 (b) 3.125×10^{-2}
(c) 1.25×10^{-2} (d) 2.5×10^{-2}

[Ans. (b) 3.125×10^{-2}]

Sol : 8 mol of O = 1 mol of $Mg_3(PO_4)_2$

0.25 mol O $= \frac{1 \times 0.25}{8}$ mol of $Mg_3(PO_4)_2$

$= 3.125 \times 10^{-2}$ mol of $Mg_3(PO_4)_2$.

36. Assertion : Equal volumes of all the gases do not contain equal number of atoms.
Reason : Atom is the smallest particle which takes part in chemical reactions.

(a) Both assertion and reason are correct and reason is the correct explanation for assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation for assertion
(c) Assertion is true but reason are false.
(d) Both assertion and reason are false.

[Ans. (b) Both assertion and reason are correct but reason is not the correct explanation for assertion]

37. Assertion : Fluorine has an oxidation state of – 1 in all its compounds.
Reason : Fluorine is the most electronegative element of the periodic table .

(a) Both assertion and reason are correct and reason is the correct explanation for assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation for assertion
(c) Assertion is true but reason are false.
(d) Both assertion and reason are false.

[Ans. (a) Both assertion and reason are correct and reason is the correct explanation for assertion.]

38. The compound in which mass percentage of carbon is 75% and that of hydrogen is 25% is

(a) C_2H_6 (b) C_2H_2 (c) CH_4 (d) C_2H_4

[Ans. (c) CH_4]

39. Among the three metals, zinc, copper and silver, the electron releasing tendency decreases in the following order.

(a) zinc >silver>copper (b) zinc >copper >silver
(c) silver>copper >zinc (d) copper >silver>zinc

[Ans. (b) zinc >copper >silver]

40. Consider the following statements :

(i) Oxidation number of He = zero
(ii) Increase in oxidation number results in reduction.
(iii) The substance undergoing increase in oxidation number is reducing agent.

Which among the above statement(s) is/are correct?

(a) only (i) (b) (ii) and (iii)
(c) (i) and (iii) (d) only (ii)

[Ans. (c) (i) and (iii)]

41. What is the ratio of empirical formula mass to molecular formula mass of benzene?

(a) 1:6 (b) 6:1 (c) 2:3 (d) 3:2

[Ans. (a) 1:6]

42. Rusting of iron is an example of ...... reaction.

(a) Combustion
(b) decomposition
(c) reduction reaction and redox reaction
(d) hydrolysis

[Ans. (c) reduction reaction and redox reaction]

43. Maximum oxidation state is present in the central metal atom of which compound

(a) CrO_2Cl_2 (b) MnO_2
(c) $[Fe(CN)_6]^{3-}$ (d) MnO

[Ans. (a) CrO_2Cl_2]

44. Which of the following statement(s) is/are not true about the following decomposition reaction.

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

(i) Potassium is undergoing oxidation
(ii) Chlorine is undergoing oxidation
(iii) Oxygen is reduced
(iv) None of the species are under going oxidation and reduction.

(a) only (iv) (b) (i) and (iv)
(c) (iv) and (iii) (d) All of these

[Ans. (b) (i) and (iv)]

45. Identify the correct statement(s) with respect to the following reaction :

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

(i) Zinc is acting as an oxidant
(ii) Chlorine is acting as a reductant
(iii) Hydrogen is not acting as an oxidant
(iv) Zn is acting as a reductant

(a) only (ii) (b) only (iv)
(c) both (ii) and (iii) (d) both (ii) and (i)

[Ans. (b) only (iv)]

46. Match the list-I with list-II and select the correct answer using the code given below the list.

	List-I		List-II
A	$Cr_2O_7^{2-}$	1	+5
B	MnO_4^{2-}	2	+6
C	VO_3^{2-}	3	+3
D	FeF_6^{3-}	4	+7

	A	B	C	D
(a)	3	1	4	2
(b)	4	3	2	1
(c)	2	4	1	3
(d)	3	2	1	4

[Ans. (c) 2 4 1 3]

47. Identify the correct statements with reference to the given reaction

$$P_4 + 3OH^- + 3H_2O \longrightarrow PH_3 + 3H_2PO_2^-$$

(i) Phosphorous is undergoing reduction only
(ii) Phosphorous is undergoing oxidation only
(iii) Phosphorous is undergoing both oxidation and reduction.
(iv) Hydrogen is undergoing neither oxidation nor reduction.

(a) only (iii) (b) both (iii) and (iv)
(c) only (i) (d) None of these

[Ans. (b) both (iii) and (iv)]

48. Match the items in column list-I with relevant items in list-II.

	List-I		List-II
A	Ions having positive charge	1	anion
B	Ions having negative charge	2	–1
C	Oxidation number of fluorine in NaF	3	0
D	The sum of oxidation number of all atoms in a neutral molecule	4	cation

	A	B	C	D
(a)	3	4	2	1
(b)	1	2	3	4
(c)	2	3	4	1
(d)	4	1	2	3

[Ans. (d) 4 1 2 3]

51. The change in the oxidation number of S in H_2S and SO_2 in the following industrial reaction :

$$2H_2S_{(g)} + SO_{2(g)} \longrightarrow 3S_{(s)} + H_2O_{(g)}$$

(a) –2 to 0, +4 to 0 (b) –2 to 0, +4 to –1
(c) –2 to –1, +4 to 0 (d) –2 to –1, +4 to –2

[Ans. (a) –2 to 0, +4 to 0]

Sol :

Reduction (+4 to 0)

$$2H_2S + SO_2 \longrightarrow 3S + H_2O$$

Oxidation (–2 to 0)

52. Give an example of molecule in which the ratio of the molecular formula is six times the empirical formula.

(a) $C_6H_{12}O_6$ (b) CH_2O
(c) CH_4 (d) Na_2CO_3

[Ans. (a) $C_6H_{12}O_6$]

53. Assertion (A) : In the reaction between potassium permanganate and potassium iodide, permanganate ions act as oxidising agent.

Reason (R) : Oxidation state of manganese changes from +2 to +7 during the reaction.

(a) Both A and R are true and R explains A
(b) Both A and R are true but R does not explain A
(c) A is true but R is false
(d) Both A and R are false

[Ans. (c) A is true but R is false]

54. In which of the following reactions, hydrogen peroxide acts as an oxidising agent?

(a) $I_2 + H_2O_2 + 2OH^- \longrightarrow 2I^- + 2H_2O + O_2$
(b) $PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$
(c) $2MnO_4^- + 3H_2O_2 \longrightarrow 2MnO_2 + 3O_2 + 2H_2O + 2OH^-$
(d) $HOCl + H_2O_2 \longrightarrow H_3O^+ + Cl^- + O_2$

[Ans. (b) $PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$]

55. Two elements X and Y (atomic mass of X = 75; Y = 16) combine to give a compound having 76% of X. The formula of the compound is?

(a) XY (b) X_2Y (c) X_2Y_2 (d) X_2Y_3

[Ans. (d) X_2Y_3]

56. Assertion (A) : Among halogens fluorine is the best oxidant.

Reason (R) : Fluorine is the most electronegative atom.

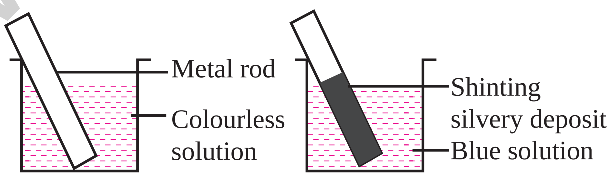
(a) Both A and R are true and R explains A
(b) Both A and R are true but R does not explain A
(c) A is true but R is false
(d) Both A and R are false

[Ans. (a) Both A and R are true and R explains A]

57. Equal volume of nitrogen and Hydrogen gases will react to form ammonia in favourable condition then the limiting reagent is

(a) H_2 (b) N_2 (c) NH_3
(d) No reactant is a limiting regent **[Ans. (b) N_2]**

58. Identify the redox reaction taking place in a beaker.



Initial stage *Final stage*

(a) $Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$
(b) $Cu_{(s)} + 2Ag^+_{(aq)} \longrightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$
(c) $Cu_{(s)} + Zn^{2+}_{(aq)} \longrightarrow Zn_{(s)} + Cu^{2+}_{(aq)}$
(d) $2Ag_{(s)} + Cu^{2+}_{(aq)} \longrightarrow 2Ag^+_{(aq)} + Cu_{(s)}$

[Ans. (d) $2Ag_{(s)} + Cu^{2+}_{(aq)} \longrightarrow 2Ag^+_{(aq)} + Cu_{(s)}$]

Reason : Since Cu is more reactive than Ag, it displaces Ag^+ ions from its salt solution. Which get deposited on the copper rod.

59. Match the list I with List II and select the correct answer using the code given below the list.

	List-I		List-II
A	n	1	6.02×10^{23} Ne atoms
B	Vapour density	2	0.01 moles of solute in one L of solution
C	22.4 L at S.T.P	3	Molecular mass/2
D	Centimolar solution	4	Molecular mass/ empirical formula mass

	A	B	C	D
(a)	2	3	4	1
(b)	4	3	1	2
(c)	3	1	4	2
(d)	2	1	4	3

[Ans. (b) 4 3 1 2]

62. A compound has an empirical formula C_2H_4O. If the value of n = 2 the molecular formula of the compound is _________ .

(a) C_2H_4O (b) CH_2O
(c) CH_2 (d) $C_4H_8O_2$

[Ans. (d) $C_4H_8O_2$]

63. If ten volumes of dihydrogen gases react with five volumes of dioxygen gases that, how many volumes of water vapour would be produced?

(a) 1 (b) 2 (c) 5 (d) 10

[Ans. (d) 10]

Hint : $2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(g)}$

64. Limiting reagent is in a chemical reaction is the reactant in which

(a) left some amount unreacted after the completion of reaction
(b) reacts completely in the reaction
(c) does not react in the reaction
(d) All of these

[Ans. (b) reacts completely in the reaction]

65. Assertion : When 4 moles of H_2 reacts with 2 moles of O_2, then 4 moles of water is formed.

Reason : O_2 will act as limiting reagent.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Only assertion is true but reason is false.
(d) Both assertion and reason are false.

[Ans. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.]

66. Match the list-I with list-II and select the correct answer using the code given below the list.

	List-I		List-II
A	Molecular formula	1	Completely consumed
B	Stoichiometric Equation	2	Left unreacted
C	Limiting reagent	3	$n \times$ Empirical formula
D	Excess reagent	4	Balanced equation

	A	B	C	D
(a)	3	4	2	1
(b)	3	4	1	2
(c)	4	3	2	1
(d)	4	3	1	2

[Ans. (b) 3 4 1 2]

69. Assertion : $K_{20}.Al_2O_3.SiO_2.6H_2O$ is the empirical formula of potash alum.

Reason : It is a double salt.

(a) Both assertion and reason are correct and reason is the correct explanation for assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation for assertion
(c) Assertion is true but reason are false.
(d) Both assertion and reason are false.

[Ans. (b) Both assertion and reason are correct but reason is not the correct explanation for assertion]

70. Anything that has mass and occupies space is called ________.

(a) matter (b) weight
(c) energy (d) system

[Ans. (a) matter]

71. The mass of one mole of a substance is ________.

(a) molecular mass (b) Atomic mass
(c) molar mass (d) Nuclear mass

[Ans. (c) molar mass]

72. Which of the following is correct?

(a) Elemental analysis of a compound gives the mass percentage of atoms present in the compound
(b) Using the mass percentage, we can determine the empirical formula of the compound
(c) Molecular formula of the compound can be arrived at from the empirical formula using the molar mass of the compound.
(d) All the above are correct

[Ans. (d) All the above are correct]

73. Which formula of a compound is a whole number multiple of the empirical formula?

(a) matter (b) mass
(c) energy (d) weight

[Ans. (a) matter]

74. All oxidation reactions are accompanied by ________ reactions.

(a) accession (b) addition
(c) reduction (d) decomposition

[Ans. (c) reduction]

75. During which reactions the oxidation number of elements changes?

(a) metabolic reactions
(b) reduction reactions
(c) exchange reactions
(d) redox reactions **[Ans. (d) redox reactions]**

76. An ion in a compound is replaced by an ion of another element are called ________ reactions.

(a) displacement (b) ionic
(c) chemical (d) physical

[Ans. (a) displacement]

Additional Short Answers

1. Mixture of salt and water is a solution while that of oil and water is not. Explain.

Ans. Solution is a homogeneous mixture of two or more components. Salt in water is homogeneous and therefore it is a solution. Whereas oil in water is heterogeneous or immiscible mixture and so is not a solution.

2. Why is air sometimes considered as a heterogeneous mixture?

Ans. Air sometimes considered as a heterogeneous mixture due to the presence of dust particles which form a separate phase.

3. By applying the knowledge of chemical classification, classify each of the following into elements, compounds or mixtures.

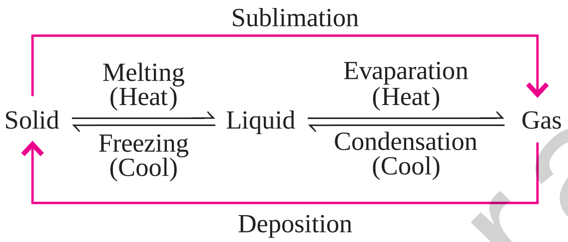
(i) Sugar
(ii) Sea water
(iii) Distilled water
(iv) Carbon dioxide
(v) Copper wire
(vi) Table salt
(vii) Silver plate
(viii) Naphthalene balls

Ans.

Element	Compound	Mixture
Copper wire (cu)	Sugar	Sea water
Silver plate (Ag)	distilled water carbon dioxide Table salt Naphthalene balls	

4. Matter is defined as anything that has mass and occupies space. All matter is composed of atoms.

Ans.



5. Define stoichiometry.

Ans. Stoichiometry is the quantitative relationship between reactants and products in a balanced chemical equation in moles.

6. List the differences between elements and compounds.

Ans.

	ELEMENTS	COMPOUNDS
(i)	An element consists of only one type of atom.	Compounds are made up of molecules which contain two or more atoms of different elements.
(ii)	Element can exist as monatomic or polyatomic units. The polyatomic elements are called molecules.	Properties of compounds are different from those of their constituent elements.
(iii)	**Eg : Monatomic unit** - Gold (Au), Copper (Cu); **Polyatomic unit** - Hydrogen (H_2)	**Eg :** Carbon dioxide (CO_2), Glucose ($C_6H_{12}O_6$)

7. Write a note on 'mixture' based on the chemical classification of matter.

Ans. Two or more substances mix together in any ratio without any chemical intraction is called mixture.

(i) Homogeneous mixture :
A mixture having uniform composition throughout is called homogeneous mixture. **Eg :** salt solution, air etc.,

(ii) Heterogeneous mixture :
A mixture in which the composition is not uniform throughout and different components can be observed is called heterogeneous mixture. **Eg :** Mixture of salt and sugar, cereals and pulse etc.,

8. How will you classify matter based on physical state?

Ans. **Physical Classification of Matter :** Matter can be classified as solids, liquids and gases based on their physical state. The physical state of matter can be converted into one another by modifying the temperature and pressure suitably.

9. Explain the classification of matter based on chemical composition.

Ans. **Chemical Classification :** Pure substances are composed of simple atoms or molecules. They are further classified as elements and compounds.

(a) Element :
- An element consists of only one type of atom.
- Element can exist as monatomic or polyatomic units. The polyatomic elements are called molecules.
- **Eg : Monatomic unit** - Gold (Au), Copper (Cu); **Polyatomic unit** - Hydrogen (H_2)

(b) Compound :
- Compounds are made up of molecules which contain two or more atoms of different elements.
- **Eg :** Carbon dioxide (CO_2), Glucose ($C_6H_{12}O_6$).

10. Define Avogadro number.

Ans. The total number of entities present in one mole of any substance is equal to 6.022×10^{23}.This number is called Avogadro number.

11. Define molar volume.

Ans. The volume occupied by one mole of any substance in the gaseous state at a given temperature and pressure is called molar volume. One mole of an Ideal gas is equal to 22.4 L (Or) 22400*ml* at STP conditions.

12. Which law co-relates the mass and volume of a gas?

Ans. Avogadro's law. It states equal volume of all gases under the same conditions of temperature and pressure contain equal number of molecules.

13. Does one gram mole of a gas occupy 22.4 L under all conditions of temperature and pressure.

Ans. No, one gram mole of a gas occupies 22.4 L only under STP conditions, i.e. at 273 K temperature and 760mm of pressure. (1.0315×10^{15} Pa)

14. Bring about the dissimilarities in mole concept and molar mass by clearly analysing them.

Ans.

Mole	Molar Mass
1. It is defined as the amount of the substance that contains as many specified elementary particles as the number of atoms in 12g of C^{12}.	It is defined as the mass of one mole of the substance.
2. 1 mole = 6.023×10^{23} particles	Molar mass $= \frac{\text{Mass}}{\text{mol}}$ g mol^{-1}

15. State Avogadro's hypothesis.

Ans. Equal volume of all gases under the same conditions of temperature and pressure contain equal number of molecules.

16. (i) If an acid is mono basic, how will you relate their equivalent mass and molecular mass.

(ii) What is the basicity of $H_4P_2O_7$?

(iii) Give any two examples for dibasic acids.

Ans. (i) If an acid is mono basic, then its equivalent mass = Molecular mass.

(ii) Basicity of $H_4P_2O_7$ is 4 (Tetrabasic acid)

(iii) Examples of dibasic acid are H_2SO_4, H_3PO_3.

17. Why are the atomic mass of most of the elements fractional?

Ans. It is because most of the elements occur in nature as a **mixture of isotopes** and their atomic masses are the average relative atomic masses of the isotopes depending in their abundance.

18. Write down the formulae for calculating the equivalent mass of an acid, base and oxidising agent.

Ans. **(i) Equivalent Mass of Acids :**

$$E = \frac{\text{Molar mass of the acid}}{\text{Basicity of the acid}}$$

(ii) Equivalent Mass of Bases :

$$E = \frac{\text{Molar mass of the base}}{\text{Acidity of the base}}$$

(iii) Equivalent Mass of Oxidising agent :

$$E = \frac{\text{Molar mass of the oxidising agent}}{\text{no. of moles of electrons gained by one mole of the oxidising agent}}$$

19. What do you understand by stoichiometric co-efficients in a chemical equation?

Ans. The co-efficients of reactants and products involved in a chemical equation represented by the balanced form are known as stoichiometric co-efficients.

Eg : $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

The stoichiometric co-efficients are 1, 3 and 2 respectively.

20. Write the simplest formula for the following.

(i) N_2O_4 (ii) $C_6H_{12}O_6$ (iii) H_2O (iv) H_2O_2

Ans. (i) NO_2 (ii) CH_2O

(iii) H_2O (iv) HO.

21. Categorise the redox reactions that occur in our daily life.

Ans.
- Fading of the colour of the clothes
- Burning of cooking gas, fuel, wood, etc.
- Rusting of Iron
- Extraction of Metals.

22. $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$

(i) In this reaction which substance is getting oxidised and which substance is getting reduced?

(ii) Name the oxidising and reducing agents.

Ans. (i) Oxygen is being added to Cu, (ie.,) Cu_2S is oxidised to Cu_2O and the other reactant O_2 is getting reduced.

(ii) Cu_2S is the a reducing agent.
O_2 is an oxidising agent.

23. How would you know whether a redox reaction is taking place in an acidic, alkaline or neutral medium.

Ans.
- If H^+ any acid appears on either side of the chemical equation, the reaction occurs in acidic solution.
- If OH^- or any base appears on either side of the chemical equation, the reaction occurs in basic solution.
- If neither H^+, OH^- nor any acid or base is present in the chemical equation, the solution is neutral.

24. Zn rod is immersed in $CuSO_4$ solution. What will you observe after an hour? Explain you observation in terms of redox reaction.

Ans.
- The blue colour of $CuSO_4$ solution will get discharged and reddish brown copper metal will be deposited on Zn rod.
- This is because blue colour Cu^{2+} (in $CuSO_4$) gets reduced to Cu by accepting two electrons from Zn, which gets oxidised to colourless $ZnSO_4$.

Reduction

$$\overset{0}{Zn}_{(s)} + \overset{+2}{Cu}SO_{4(aq)} \longrightarrow \overset{+2}{Zn}\overset{-2}{SO}_{4(aq)} + \overset{0}{Cu}_{(s)}$$

Oxidation

25. What is molar Volume?

Ans. Molar volume is the volume occupied by one mole of any substance in the gaseous state at STP. It is equal to 2.24×10^{-2} m^3 (22.4 L)

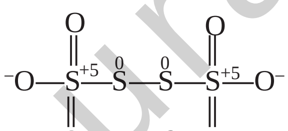
26. What will be oxidation number of sulphur in $S_2O_8^{2-}$ ion and $S_4O_6^{2-}$ ion? ***[HOTS]***

Ans. (i) In $S_2O_8^{2-}$, there is one peroxide bond (–O–O–) therefore, two oxygen atoms having oxidation number –1 (i.e., O_2^{2-}) and for the other six oxygen atoms, the oxidation number is –2.

$S_2O_8^{2-} = 2x + (-2 \times 6) + (-1 \times 2) = -2$

$2x = +12 \Rightarrow x = +6$

(ii) In $S_4O_6^{2-}$, two S-atoms have oxidation state +5 while another two S-atoms have 0 oxidation state.



$S_4O_6^{2-}$

27. Nitric acid is an oxidising agent and reacts with PbO but it does not react with PbO_2. Explain why? ***[HOTS]***

Ans. (i) Nitric acid in an oxidising agent. It oxidises an element from lower oxidation state to higher oxidation state. In PbO, lead is in lower oxidation state of +2. HNO_3 oxidises lead from Pb^{2+} to Pb^{4+}

$PbO + 2\,HNO_3 \rightarrow Pb\,(NO_3)_2 + H_2\,O$

(ii) In PbO_2, lead is in +4 oxidation state and cannot be oxidised further. Therefore no reaction takes place.

28. Which one of the two, ClO_2^- or ClO_4^- shows disproportionation reaction and why? ***[HOTS]***

Sol : The oxidation state of Cl in ClO_2^- is +3. So, chlorine can get oxidised as well as reduced and can act as reductant and oxidant.

The disproportionation reaction of ClO_2^- is

$$3\overset{+1}{Cl}O_2^- \longrightarrow Cl^- + \overset{+5}{Cl}O_3^-$$

In ClO_4^-, Cl is in its highest oxidation state, So it can only be an oxidant.

29. Identify the type of redox reaction taking place in the following.

(i) $3\overset{0}{Mg}_{(s)} + \overset{0}{N}_{2(g)} \longrightarrow \overset{+2}{Mg}_3\,\overset{-3}{N}_{2(s)}$

(ii) $\overset{+5}{V}_2\,\overset{-2}{O}_{5(s)} + 5\overset{0}{Ca}_{(s)} \longrightarrow 2\overset{0}{V}_{(s)} + 5\,\overset{+2}{Ca}\overset{-2}{O}_{(s)}$

(iii) $2\,\overset{+1}{K}\,\overset{+5}{Cl}\overset{-2}{O}_{3(s)} \longrightarrow 2\,\overset{+1}{K}\,\overset{-1}{Cl}_{(s)} + 3\overset{0}{O}_{2(g)}$

(iv) $\overset{0}{Ca}_{(s)} + 2\,\overset{+1}{H}_2\overset{-2}{O}_{(l)} \longrightarrow \overset{+2}{Ca}(\overset{-2+1}{OH})_{2(aq)} + \overset{0}{H}_{2(g)}$

(v) $Br_{2(l)} + 2I^-_{(aq)} \longrightarrow 2Br^-_{(aq)} + I_{2(s)}$

(vi) $\overset{0}{Cl}_{2(g)} + 2OH^-_{(aq)} \longrightarrow \overset{-1}{Cl}O^-_{(aq)} + \overset{-1}{Cl}^-_{(aq)} + H_2O_{(l)}$

Ans. (i) Combination reaction
(ii) Displacement reaction
(iii) Decomposition reaction
(iv) Metal displacement reaction
(v) Non-metal displacement reaction
(vi) Disproportionation reaction.

30. How can we say sugar has solid and water has liquid?

Ans. When a sugar dissolves into tea or coffee, the liquid transforms the sugar into a liquid. So it can fit in with the liquid and slide in with the molecules. If you try to evaporate the water for long enough, you will turn the sugar back into a solid.

31. Define Average atomic mass?

Ans. Average atomic mass is defined as the average atomic mass of all atoms in their naturally occurring isotopes.

Examples:

Chlorine consist of chlorine isotope ${}_{17}Cl^{35}$ and ${}_{17}Cl^{37}$ are in the ratio 77:23, the average atomic mass of chlorine A(– is bar) is equal to $A_1X_1 + A_2X_2 / X_1 + X_2$ is equal to 35 × 77 + 37 × 23/100 is equal to 35.46 u.

32. State Avogadro's Hypothesis.

Ans. It states that "Equal volume of all gases under the same conditions of temperature and pressure contain equal number of molecules."

33. The approximate production of Na_2CO_3 per month is 424×10^6 g while that of methyl alcohol is 320×10^6 g. Which is produced more in terms of moles?

Ans.

Na_2CO_3 mass $= 424 \times 10^6$ g

Molecular mass of Na_2CO_3 $= (23 \times 2) + 12 + (16 + 3)$

$= 46 + 12 + 18$

$= 106$ g

$$\text{No. of moles of } Na_2CO_3 = \frac{\text{Mass of } Na_2CO_3}{\text{molecular mass of } Na_2CO_3}$$

$$= \frac{424 \times 10^6 \text{ g}}{106\text{g}}$$

$$= 4 \times 10^6 \text{ moles}$$

Methyl alcohol mass = 320×10^6 g

34. How many moles of glucose and present in 720g of glucose?

Ans. Glucose = $C_6H_{12}O_6$

Molecular mass of glucose = $(12 \times 6) + (1 \times 12) + (16 \times 6)$

= $72 + 12 + 96 = 180$

$$\text{Number of mole of glucose} = \frac{\text{Mass of glucose}}{\text{Molecular mass of glucose}}$$

$$= \frac{720}{180} = 4 \text{ moles.}$$

35. What do you understand by the terms acidity and Basicity?

Ans. **Acidity :** The number of hydroxyl ions present in one mole of a base is known as the acidity of the base.

Basicity : The number of replaceable hydrogen atoms present in a molecule of the acid is referred to as its basicity.

36. What is meant by plasma state? Give an example.

Ans. Gaseous state of matter at very high temperature containing gaseous ions and free electron is referred to as the plasma state eg., Lightning.

37. What is meant by limiting agend?

Ans. A large excess of one reactant is supplied to ensure the more expensive reactant is completely converted to the desired product. The reactant use up first in a reaction is called the limiting reagent.

38. What is decomposition reaction? Give 2 example.

Ans. Chemical reactions in which a compound splits up into tow or more simpler substances are called decomposition reaction.

$$AB \longrightarrow A + B$$

$$\text{Ex} - 2KCl\,O_3 \longrightarrow 2KCl + 3O_2$$

$$PCl_5 \longrightarrow PCl_3 + Cl_2$$

39. What is displacement reactions? Give its types. Explain with example.

Ans. The reaction in which one ion or atom in a compound is replaced by an ion or atom of the other element are called displacement reactions.

$$AB + C \longrightarrow AC + B$$

Ex – Metal displacement

$$CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$$

Ex – Non-metal displacement

$$2KBr + Cl_2 \longrightarrow 2KCl + Br_2$$

40. What are competive electron transfer reaction? Give example.

Ans. These are the reaction in which redox reactions take place in different vessels and it is an indirect redox reaction. There is a competition for the release of electrons among different metals.

Eg : Zn releases electrons to Cu and Cu releases electrons to silver and SO on

$$Zn_{(s)} + Cu^{2+} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$$

(Here Zn oxidised Cu^{2+} – reduced)

$$Cu_{(s)} + 2Ag^{+} \longrightarrow Cu^{2+}_{(aq)} + 2Ag_{(g)}$$

(Here Cu oxidised Ag^{+} – reduced)

41. What is disproportionation reaction? Give example.

Ans. The reaction in which an element undergoes simultaneously both oxidation and reduction are called as disproportional reactions.

$$\text{Ex : } P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + 3NaH_2\,PO_2$$

$$2HCHO + H_2O \longrightarrow CH_3OH + HCOOH$$

42. Draw a flow chart to illustrate classification of matter.

Ans.

Matter
- Physical Classification
  - Solid — **Eg:** Ice
  - Liquid — **Eg:** Water
  - Gas — **Eg:** Water Vapour
- Chemical Classification
  - Mixtures
    - homogeneous — **Eg:** air
    - heterogeneous — **Eg:** Oil and Water
  - Pure Substances
    - Elements — **Eg:** Copper
    - Compounds — **Eg:** Copper Sulphate

43. An organic compound present in vinegar has 40 % carbon, 6.6 % hydrogen and 53.4 % oxygen. Find the empirical formula of the compound.

Ans.

Element	Percentage	Atomic mass	Relative No. of moles	Simple ratio mole	Simplest ratio (in whole no)
C	40	12	$\frac{40}{12} = 3.3$	$\frac{3.3}{3.3} = 1$	1
H	6.6	1	$\frac{6.6}{1} = 6.6$	$\frac{6.6}{3.3} = 2$	2
O	53.4	16	$\frac{53.4}{16} = 3.3$	$\frac{3.3}{3.3} = 1$	1

The Empirical formula is CH_2O.

44. Discuss the characteristic the properties of physical classification of matter. ***[LOTS]***

Ans.

S.No	PROPERTIES	SOLID	LIQUID	GAS
1.	Volume	definite	definite	indefinite
2.	Shape	definite	indefinite	indefinite
3.	Compressibility	cannot be compressed	can be compressed	can be highly compressed
4.	Arrangement of molecules	regular and close to each other	random or irregular but almost close to each other.	random and wide apart
5.	Bonding	strong intermolecular bonds	relatively strong intermolecular bonds; slightly weaker than solid	very weak intermolecular bonds.
6.	Fluidity	cannot flow	can flow from higher to lower level	can flow in all directions
	Example	Ice	Water	Water vapour

Additional Long Answers **5 MARK**

1. What is the condition for molar Volume?

Ans. The molar volume of any ideal gas at 273 degree kelvin and 1 atm pressure is equal to 22.4 L (or) 22400ml.

Ideal gas equation is PV is equal to nRT

where P is pressure at 1 atm. and temperature 273 degree kelvin is called Standard Temperature and Pressure.

R is the gas constant and is equal to 0.082 dm^3. atm. k^{-1}.mol^{-1}.

Hence V is equal to nRT/P.

V is equal to 22.4L.

2. Define auto-oxidation (disproportination) reaction and its examples.

Ans. **Displacement reaction :** Redox reactions in which an ion (or an atom) in a compound is replaced by an ion (or atom) of another element are called displacement reactions. They are further classified into (i) metal displacement reactions (ii) non-metal displacement reactions.

(i) Metal displacement reactions :

- Place a zinc metal strip in an aqueous copper sulphate solution taken in a beaker. Observe the solution, the intensity of blue colour of the solution slowly reduced and finally disappeared.
- The zinc metal strip became coated with brownish metallic copper. This is due to the following metal displacement reaction.

Oxidation

$$\overset{+2}{Cu}SO_4(aq) + \overset{0}{Zn}(s) \longrightarrow \overset{0}{Cu}(s) + \overset{+2}{Zn}SO_4(aq)$$

Reduction

(ii) Non-metal displacement :

Oxidation

$$\overset{0}{Zn} + 2\overset{+1}{H}Cl \longrightarrow \overset{+2}{Zn}Cl_2 + \overset{0}{H_2}$$

Reduction

3. Write any three rules assigning for the oxidation number?

Ans. ❑ The oxidation state of a free elements (i.e. in its uncombined state) is zero.

Example : each atom in H_2, Cl_2, Na, S_8 have the oxidation number of zero.

❑ For a monatomic ion, the oxidation state is equal to the net charge on the ion.

Example : The oxidation number of sodium in Na^+ is +1.

The oxidation number of chlorine in Cl^- is –1.

❑ The algebric sum of oxidation states of all atoms in a molecule is equal to zero, while in ions, it is equal to the net charge on the ion.

4. Distinguish between the following.

(i) Atomic and molecular mass **(ii) Atomic mass and atomic weight**

(iii) Empirical and molecular formula **(iv) Moles and molecules.**

Ans.

(i)	**Atomic Mass**	**Molecular Mass**
	Atomic mass is the mass of a single atom, which is its collective mass of neutron, proton and electrons.	Molecular weight is the mass of one molecule. Molecular mass can be calculated from the sum of atomic masses of all atoms present in a compound.
(ii)	**Atomic Mass**	**Atomic Weight**
	Atomic mass is the mass of a single atom, which is its collective mass of neutron, proton and electrons.	Atomic weight is the average weight of an elements with respect to all its isotopes and their relative abundance.
(iii)	**Empirical Formula**	**Molecular Formula**
	It represents the simplest whole number ratio of various atoms present in one molecule of the compound. Empirical formula of Benzene is CH	The molecular formula shows the exact number of different types of atoms present in a molecules of a compound. Molecular formula of Benzene is C_6H_6
(iv)	**Moles**	**Molecules**
	The amount of the substance that contains specified particles as the number of atoms in 12g of carbon - 12 isotope	Two or more atoms joint together by chemical bonds.

NUMERICAL PROBLEMS

1. Calculate the number of atoms in each of the following.

(i) 52 g of He and (ii) 52 moles of He.

Ans. (i) 1 mol of He ≡ 4g ≡ 6.022×10^{23} He atoms

(ie) 4g of He contains 6.022×10^{23} He atoms

$$\therefore \text{ 52g of He contains } = \frac{6.023 \times 10^{23} \times 52}{4}$$

$$= 7.83 \times 10^{24}$$

52g of He contains 7.83 × 10^{24} He atoms.

(ii) 1 mol of He contains 6.023×10^{23} He atoms

$$\therefore \text{ 52 moles of He contains } = \frac{6.023\times10^{23}\times52}{1}$$
$$= 3.132\times10^{25}$$

52 moles of He contains 3.132×10^{25} He atoms.

2. Calculate the mass of the following :
(i) 1 atom of silver (ii) 1 molecule of benzene
(iii) 1 molecule of water.

Ans. **(i)** Molecular mass of silver (Ag) = 107.87 u

Molar mass of Ag = 107.87 g mol^{-1}

$$\therefore \text{ Mass of 1 atom of Ag } = \frac{\text{Molar mass}}{\text{Avogadro's number}}$$
$$= \frac{107.87 \text{ g mol}^{-1}}{6.023\times10^{23} \text{ mol}^{-1}}$$
$$= 17.91 \times 10^{-23} \text{ g.}$$

Mass of 1 atom of Ag = 17.91×10^{-23} g.

(ii) Molecular mass of benzene (C_6H_6) = $(6 \times 12.01 \text{ u}) + (6 \times 1\text{u}) = 78.06$ u

Molar mass of benzene = 78.06 g mol^{-1}

Then, mass of 1 molecule of benzene

$$= \frac{\text{Molar mass of benzene}}{\text{Avogadro's number}}$$
$$= \frac{78.06 \text{ g mol}^{-1}}{6.023\times10^{23}\text{mol}^{-1}} = 12.96 \times 10^{-23} \text{ g}$$

Mass of 1 molecule of benzene = 12.94×10^{-23} g.

(iii) Molecular mass of water = $(2 \times 1\text{u}) + (1 \times 16\text{u})$
= 18 u

Molar mass of water = 18 g mol^{-1}

Mass of 1 molecule of water

$$= \frac{\text{Molar mass of water}}{\text{Avogadro's number}}$$
$$= \frac{18\text{g mol}^{-1}}{6.023\times10^{23} \text{ mol}^{-1}} = 2.99 \times 10\text{–}23 \text{ g}$$

Mass of 1 molecule of water = 2.99×10^{-23} g.

3. One million silver atoms weigh 1.79×10^{-16} g. Calculate the atomic mass of silver.

Ans. No. of silver atoms = 1 million = 1×10^6

Mass of one million Ag atoms = 1.79×10^{-16} g

Mass of 6.023×10^{23} atoms of silver

$$= \frac{1.79\times10^{-16}\text{g}}{1\times10^{6}}\times6.023\times10^{23}$$
$$= 107.8 \text{ g.}$$

Atomic mass of silver = 6.023×10^{23} atoms of Ag

$\therefore$ The atomic mass of Ag = 107.8 g.

4. How much mass (in gram units) is represented by the following?
(i) 0.2 mol of NH_3 (ii) 3.0 mol of CO_2
(iii) 5.14 mol of H_5IO_6

Ans. **(a)** Molar mass of NH_3 = $(1\times14 + 3\times1)$ = 17g mol^{-1}

Mass of 0.2 mol of NH_3 = 0.2 mol × 17g mol^{-1}
= **3.4 g**

(b) Molar mass of CO_2 = $(1\times12 + 2\times16)$
= 44 g mol^{-1}

Mass of 3 moles of CO_2 = 3 mol × 44g mol^{-1}
= **132 g**

(c) Molar mass of H_5IO_6 = $(5\times1 + 1\times127 + 6\times16)$
= **228 g mol^{-1}**

Mass of 5.14 mol of H_5IO_6 = 5.14 mol × 228g mol^{-1}
= **1171.9 g.**

5. What mass of N_2 will be required to produce 34g of NH_3 by the reaction, $N_2 + 3H_2 \longrightarrow 2NH_3$.

Ans. The reaction is

N_2	+	$3H_2$	$\longrightarrow$	$2NH_3$
1 mol		3 mol		2 mol
2 × 14				2(1×14 + 3×1)
28g				= 34g

Thus, to produce 34.0 g ammonia, 28g of N_2 is required.

6. Calculate the Formula Weights of the following compounds.
(a) NO_2 (b) Glucose ($C_6H_{12}O_6$) (c) NaOH
(d) $Mg(OH)_2$

Ans. **(a) NO_2**

1 × AW of N = 1×14 = 14 amu

2 × AW of O = 2×16 = 32 amu

Formula weight of NO_2 = 46 amu

(b) $C_6H_{12}O_6$ - Glucose

6 × AW of C = 6×12.01 = 72.06 amu

12 × AW of H = 12×1.008 = 12.096 amu

6 × AW of O = 6×16 = 96.0 amu

Formula weight of Glucose is = 180.156 amu

Formula weight of Glucose is = 180 amu

(c) NaOH

1 × AW of Na = 1× 22.99 = 22.99 amu

1 × AW of O = 1×16 = 16.00 amu

1 × AW of H = 1×1.008 = 1.008 amu

Formula weight of NaOH is = 39.998 amu

Formula weight of NaOH is = 40 amu.

(d) $Mg(OH)_2$

$1 \times$ AW of Mg = $1 \times 24.305 = 24.305$ amu

$2 \times$ AW of O = $2 \times 16 = 32.000$ amu

$2 \times$ AW of H = $2 \times 1.008 = 2.016$ amu

Formula weight of $Mg(OH)_2$ is = 58.321 amu

Formula weight of $Mg(OH)_2$ is = 58 amu.

7. Calculate the equivalent weight of H_3PO_4 and $Ca(OH)_2$ on the basis of given reaction.

$$H_3PO_4 + NaOH \longrightarrow NaH_2PO_4 + H_2O$$
$$Ca(OH)_2 + HCl \longrightarrow Ca(OH)Cl + H_2O$$

Sol : Equivalent weight of H_3PO_4

$$= \frac{\text{Molecular mass}}{\text{No. of replaceable } H^+} = \frac{98}{1} = 98$$

Equivalent weight of $Ca(OH)_2$

$$= \frac{\text{Molecular mass}}{\text{No. of replacement } OH^-} = \frac{74}{1} = 74$$

8. (i) Calculate the gram molecular mass of sugar having molecular formula $C_{12}H_{22}O_{11}$.

(ii) Calculate (a) The mass of 0.5g molecule of sugar and (b) Gram molecule of sugar in 547.2 g.

Ans. **(i)** Molecular mass of Sugar ($C_{12}H_{22}O_{11}$)

$= 12 \times 12 + 22 \times 1 + 11 \times 16 = 342$

(ii) (a) 1 gram molecule of sugar = 342 g

$\therefore$ 0.5 g molecule of sugar = 342×0.5

= 171 g

(b) 342 g of sugar = 1 gram molecule

$$547.2 \text{ of sugar} = \frac{1}{342} \times 547.2 = 1.6 \text{ gram molecule.}$$

9. Calculate the number of moles in the following.

(i) 7.85 g of copper (ii) 4.66 mg of silicon

(iii) 65.6 mg of oxygen.

Sol : **(i)** Moles of copper $= \dfrac{\text{Mass of copper}}{\text{atomic mass}}$

$$= \frac{7.85}{63.546} = 0.123 \text{ mol.}$$

(ii) Moles of silicon $= \dfrac{\text{Mass of silicon}}{\text{atomic mass}}$

$$= \frac{4.66 \times 10^{-3}}{28.1}$$

$= 1.658 \times 10^{-4}$ mol

(iii) Moles of oxygen $= \dfrac{\text{Mass of oxygen}}{\text{atomic mass}}$

$$= \frac{65.6 \times 10^{-6}}{16}$$

$= 4.1 \times 10^{-6}$ mol.

10. What will be the molecular formula for the compound, whose empirical formula is CH_2Cl and molar mass is 98.96 g?

Sol : Empirical formula = CH_2Cl;

Empirical formula mass = $12.01 + 2 \times 1.008 + 35.453$

$= 49.48\ g$

$$n = \frac{\text{molecular mass}}{\text{empirical formula mass}}$$

$$= \frac{98.96g}{49.48g} = 2(n)$$

Molecular formula = $n \times$ Empirical formula

$= 2 \times CH_2Cl = C_2H_4Cl_2$

11. Calculate the oxidation number of nitrogen in nitrous acid and nitric acid

Ans. **(i)** Nitrous acid : HNO_2

$+1 + x - 2 \times 2 = 0$

$x = +3$

(ii) Nitric acid : HNO_3

$+1 + x - 2 \times 3 = 0$

$x = +5.$

12. Balance the following reaction by oxidation number method.

Ans. $MnO_4^{-1} + H_2S + H^+ \longrightarrow Mn^{2+} + S$ (Acidic Medium)

(i) Write oxidation number of elements

$$\underset{(+7)(-2)}{MnO_4^{-1}} + \underset{(+1)(-2)}{H_2S} \longrightarrow \underset{+2}{Mn^{2+}} + \underset{0}{S}$$

(ii) Balance the number of atoms of the elements in which oxidation number changes

$$\underset{(+7)}{MnO_4^{-1}} + \underset{(-2)}{H_2S} \longrightarrow \underset{(+2)}{Mn^{2+}} + \underset{0}{S}$$

(iii) Decide the oxidation and reduction reaction on the basis of difference of oxidation number.

Increase in oxidation number by 2(Oxidation)

$$MnO_4^{-1} + H_2S + H^+ \longrightarrow Mn^{2+} + S$$

Decrease in oxidation number by 5(Reduction)

(iv) On multiplying oxidation reaction by 5 and reduction reaction by 2 to balance the change in oxidation number.

$$2MnO_4^{-1} + 5H_2S \longrightarrow 2Mn^{2+} + 5S$$

(v) Balance the electric charge and atoms which do not change in oxidation number (spectators).

$$2MnO_4^{-1} + 5H_2S + 6H^+ \longrightarrow 2Mn^{2+} + 5S + 8H_2O$$

$$2(-1)\ 5(0) + 6(+1) = 2(+2) + 5(0) + 8(0)$$
$$-2 + 6 = +4$$
$$+4 = +4$$

In the above reaction the reactants and products are balanced in terms of electric charge and mass equivalence.

13. A compound on analysis was found to contain C = 34.6%; H = 3.85% and O = 61.55%. Calculate its empirical formula.

Ans.

Element	%	$\frac{\text{Percentage mass}}{\text{At. mass}}$	Molar Ratio	Simplest Whole Number Ratio
C	34.6	$\frac{34.6}{12} = 2.88$	$\frac{2.88}{2.88} = 1$	3
H	3.85	$\frac{3.85}{1} = 3.85$	$\frac{3.85}{2.88} = 1.335$	4
O	61.55	$\frac{61.55}{16} = 3.85$	$\frac{3.85}{2.88} = 1.335$	4

The empirical formula of the compound = $C_3H_4O_4$.

14. Calculate the mass of the atom in amu.

Ans. Oxygen

Mass of Oxygen atom = 2.656×10^{-23}

1 a.m.u (or) 1 u is equal to 1.66075 multiple

The mass of oxygen atom in amu

$$= \frac{2.656 \times 10^{-23}}{1.66075 \times 10^{-24}} \approx 15.992 \text{ a.m.u}$$

15. How many moles of barium suphate is precipitated when 1 mole of aluminium sulphate reacts completely with barium chloride?

Ans. $Al_2(SO_4)_3 + 3\,BaCl_2 \rightarrow 3\,Ba\,SO_4 + 2\,AlCl_3$

When 1 mole of aluminium sulphate reacts with barium chloride, 3 moles of $BaSO_4$ is precipitated.

16. Calculate the molecular mass of the following:

a) $KMnO_4$ b) Crystalline Oxalic acid

c) Methane

***Ans.* (a) $KMnO_4$**

1 × atomic mass of K = 1 × 39 = 39

Mn = 1 × 55 = 55

O = 4 × 16 = 64

158

∴ Molecular mass of $KMnO_4$ = 158

(b) Crystalline Oxalic acid

COOH
| $.2H_2O$
COOH

$C \rightarrow 2 \times 12 = 24$

$O \rightarrow 4 \times 16 = 64$

H 2 × 1 = 2

90

4 × 1 = 4

2 × 16 = 32

126

∴ Molecular mass of oxalic acid = 126

(c) Methane CH_4

$C \rightarrow 1 \times 12 = 12$

$H \rightarrow 4 \times 1 = 4$

16

∴ Molecular mass of CH_4 = 16

17. Calculate the number of atoms/molecules present in the following:

a) 10g of Hg

b) 1.8g of water

c) 100g of sulpurdioxide

d) 1kg of acetic acid

***Ans.* (a) 10g of Hg**

Atomic mass of Hg = 200 g mol^{-1}

200 g of mercury contains 6.023× 10^{23} atoms of mercury.

$$10 \text{ g of mercury contains} = \frac{10 \times 6.023 \times 10^{23}}{200}$$
$$= 0.301 \times 10^{23}$$
$$= 3.01 \times 10^{24}$$

atoms of mercury.

(b) 1.8g of water

1 mole of water = 18 g mol^{-1}

18 g of water contains 6.023×10^{23} molecules of water

1.8g of water contains $= \frac{1.8 \times 6.023 \times 10^{23}}{18}$

$= 0.602 \times 10^{23}$

$= 6.02 \times 10^{24}$

Molecules of water

(c) 100g of sulphur dioxide

Molecular mass of SO_2 = 64

64g of sulphur dioxide contains = 6.023×10^{23} Molecules of SO_2

$\therefore$ 100g of SO_2 contains $= \frac{100 \times 6.023 \times 10^{23}}{64}$

$= 9.41$

molecules of SO_2

(d) 1Kg of acetic acid

Molecular mass of acetic acid = 60

60g of acetic acid contains = 6.023×10^{23} Molecules of acetic acid

$\therefore$ 1000g of acetic acid contains

$= \frac{1000 \times 6.023 \times 10}{60}$

$= 100 \times 10^{23}$

molecules of acetic acid

18. Calculate the number of moles present in the following:

a) 50 g of calcium chloride
b) 120 g of sodium hydroxide
c) 46 g of ethanol
d) 90 g of magnesium oxide
e) 19.5 g of potassium

***Ans.* (a) 50 g of calcium chloride**

Molar mass of calcium chloride = 111

No. of moles $= \frac{\text{Mass}}{\text{Molar mass}}$

No. of moles $= \frac{50}{111} = 0.450$ moles

(b) 120 g of sodium hydroxide

Molar mass of sodium hydroxide = 40

No. of moles $= \frac{\text{Mass}}{\text{Molar mass}}$

No. of moles (n) $= \frac{120}{40} = 3$ moles

(c) 46 g of ethanol

Molecular mass of ethanol = 46

No. of moles $= \frac{\text{Mass}}{\text{Molar mass}}$

No. of moles (n) $= \frac{46}{46} = 1$ mole

(d) 90 g of magnesium oxide

Molecular mass of MgO = 40

No. of moles $= \frac{\text{Mass}}{\text{Molar mass}}$

No. of moles $= \frac{90}{40} = 2.25$ moles

(e) 19.5 g of potassium

Atomic mass of pottassium = 39

No. of moles $= \frac{\text{Mass}}{\text{Molar mass}}$

No. of moles $= \frac{19.5}{39} = 0.5$ moles

19. Calculate the molar volume of the following:

a) 88 g of CO_2
b) 5 moles of methane
c) 460 g of formic acid
d) 3.0115×10^{23} molecules of SO_2 gas

***Ans.* (a) 88 g of CO_2**

Molar mass of CO_2 = 44 g

Molar volume of 44 g (1mole) of CO_2

$= 2.24 \times 10^{-2}$ m^3

The volume of 88g (2 moles) $= \frac{2.24 \times 10^{-2} \times 88}{44}$

$= 4.48 \times 10^{-2}$ m^3

(b) 5 moles of methane

Molar mass of methane = 16 g

Molar volume of 16 g (1mole) of methane

$= 2.24 \times 10^{-2}$ m^3

volume of 5 moles (80g) of methane

$= \frac{2.24 \times 10^{-2} \times 80}{16}$

$= 11.2 \times 10^{-2}$ m^3

(c) 460 g of formic acid

Molar mass of formic acid = 46 g

Molar volume of 46 g (1mole) of formic acid

$= 2.24 \times 10^{-2}$ m^3

Molar volume of 460g of (10 moles) of formic acid

$$= \frac{2.24 \times 10^{-2} \times 460}{46}$$

$= 22.4 \times 10^{-2}\ m^3$

(d) 3.0115×10^{23} molecules of SO_2 gas

6.023×10^{23} molecules $= 1$ mole

$$3.0115 \times 10^{23} \text{ molecules} = \frac{1}{6.023 \times \cancel{10^{23}}} \times 3.0115 \times \cancel{10^{23}}$$

$= 0.5$ moles

Molar volume of 1mole of $SO_2 = 2.24 \times 10^{-2} m^3$

Molar volume of 0.5 moles of SO_2

$= 2.24 \times 10^{-2} \times 0.5$

$= 1.12 \times 10^{-2}\ m^3$

20. Calculate the equivalent mass of the following

a) Zn b) Nitrate ion c) sodium

***Ans.* (a) Zn**

$$\text{Equivalent mass} = \frac{\text{Atomic mass}}{\text{Valency}}$$

$$= \frac{65}{2} = 32.5 \text{ g eq}^{-1}$$

(b) Nitrate ion (NO_3^-)

$$\text{Equivalent mass of an ion} = \frac{\text{Formula mass}}{\text{Change of ion}}$$

$$\text{Equivalent mass of } NO_3^- = \frac{62}{1} = 62$$

(c) Sodium

$$\text{Equivalent mass} = \frac{\text{Atomic mass}}{\text{Valency}}$$

$$\text{Equivalent mass of sodium} = \frac{23}{1} = 23$$

21. 1.05 g of a metal gives on oxidation 1.5g of its oxide. Calculate its equivalent mass.

Ans. Mass of oxygen $= 1.5 - 1.05$

$= 0.45$ g

0.45g of oxygen combines with 1.05 g of metal.

$$\therefore \text{8 g of oxygen combines with } \frac{8 \times 1.05}{0.45} \text{ g of metal}$$

$= 18.66$ g of metal

$\therefore$ equivalent mass of metal $= 18.66$g equ $^{-1}$

22. Calculate equivalent mass of the following

a) Sodium hydroxide

b) Aluminium hydroxide

c) ammonium hydroxide

d) Calcium hydroxide

e) Magnesium hydroxide

***Ans.* (a) NaOH**

$$\text{equivalent mass of NaOH} = \frac{40}{1} = 40$$

(b) Aluminium hydroxide

$$\text{equivalent mass of } Al(OH)_3 = \frac{78}{3} = 26$$

(c) Ammonium hydroxide

$$\text{equivalent mass of } NH_4OH = \frac{35}{1} = 35$$

(d) Calcium hydroxide

$$\text{equivalent mass of } Ca(OH)_2 = \frac{74}{2} = 37$$

(e) Magnesium hydroxide $Mg(OH)_2$

equivalent mass of Magnesium hydroxide

$$= \frac{58}{2} = 29$$

23. Calculate Equivalent mass of the following

a) Hydrochloric acid b) Nitric acid

c) Acetic acid

d) Crystalline oxalic acid

e) Phosphorous acid

***Ans.* (a) Hydrochloric acid**

equivalent mass of an acid

$$= \frac{\text{Molar mass of the acid}}{\text{Basicity of the acid}}$$

$$\text{Equivalent mass of HCl} = \frac{36.5}{1}$$

$= 36.5$

(b) Nitric acid

$$\text{equivalent mass of } HNO_3 = \frac{\text{Molar mass}}{\text{basicity}}$$

$$= \frac{63}{1} = 63$$

(c) Acetic acid (CH_3 COOH)

$$\text{equivalent mass of acetic acid} = \frac{\text{Molar mass}}{\text{basicity}}$$

$$= \frac{60}{1} = 60$$

(d) Crystalline oxalic acid

$$\text{equivalent mass of oxalic acid} = \frac{\text{Molar mass}}{\text{basicity}}$$

$$\text{equivalent mass} = \frac{126}{2} = 63$$

(e) Phosphorous acid ($H_3 PO_3$)

equivalent mass of phosphorous acid

$$= \frac{\text{Molar mass}}{\text{basicity}} = \frac{82}{2} = 41$$

$\therefore$ equivalent mass of $H_3PO_3 = 41$

24. 3.24 g of titanium reacts with oxygen to form 5.40 g of the metal oxide. Find the empirical formula of the metal oxide?

Ans. Weight of Titanium = 3.24 g; Weight of metal oxide = 5.40 g

Weight of Oxygen = (5.40 – 3.24) = 2.16 g

Element	Percentage	Atomic mass	Relative No. of moles	Simple ratio mole	Simplest whole Number Ratio
Ti	3.24	48	$\frac{3.24}{48} = 0.0675$	$\frac{0.067}{0.067} = 1$	1
O	2.16	16	$\frac{2.16}{16} = 0.135$	$\frac{0.135}{0.067} = 2$	2

∴ The empirical formula is TiO_2

25. A compound contains 11.99% N, 13.70% O, 9.25% B and 65.06% F. Find its empirical formula

Ans.

Element	Percentage	Atomic mass	Relative No. of moles	Simple ratio mole	Simplest whole Number Ratio
N	11.99	14	$\frac{11.99}{14} = 0.856$	$\frac{0.856}{0.856} = 1$	1
O	13.70	16	$\frac{13.70}{16} = 0.856$	$\frac{0.856}{0.856} = 1$	1
B	9.25	10	$\frac{9.25}{10} = 0.925$	$\frac{0.925}{0.856} = 1$	1
F	65.06	19	$\frac{65.06}{19} = 3.424$	$\frac{3.424}{0.856} = 4$	4

∴ Empirical formula of the compound in $NOBF_4$

26. A organic compound used for welding operation contains the following composition by mass: C = 92.3%, H= 7.7%. Find out the molecular formula of the compound. At STP, 10.0 L of this gas is found to weight 11.6g.

Ans. Determination of Molecular formula

Element	Percentage	Atomic mass	Relative No. of moles	Simple ratio mole	Simplest whole Number Ratio
C	92.3	12	$\frac{92.3}{12} = 7.7$	$\frac{7.7}{7.7} = 1$	1
H	7.7	1	$\frac{7.7}{1} = 7.7$	$\frac{7.7}{7.7} = 1$	1

Empirical formula is CH

Molecular formula = n × emprical formula

Emperical formula mass (1 × 12) + (1 ×1) 12 + 1 = 13

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}}$$

$$\text{Molar mass} = \frac{\text{wt. of the substance} \times \text{Molar volume}}{\text{vol.of the substance}} \text{ at STP}$$

Molar volume at STP = 2.24×10^{-2} m^3 = 22.4 l = 22400 ml

Molar mass of the gas at STP = $\frac{11.6 \times 22.4}{10}$ = 25.9 = 26

$n = \frac{26}{13} = 2$

Molecular formula = n × (emp. formula) = 2 × (CH) = C_2H_2

27. The organic compound Vitamin-C, has the following composition by mass: 40.92% C, 4.58% H, and the rest is oxygen. Determine its molecular formula. Molar mass of the substance is 176 g mol^{-1}.

Ans.

Element	Percentage	Atomic mass	Relative No. of moles	Simple ratio mole	Simplest whole Number Ratio
C	40.92	12	$\frac{40.92}{14} = 3.41$	$\frac{3.41}{3.406} = 1.001$	3
H	4.58	1	$\frac{4.58}{1} = 4.58$	$\frac{4.58}{3.406} = 1.344$	4
O	100 – [40.92 +458]	16	$\frac{54.5}{10} = 3.406$	$\frac{3.406}{3.406} = 1$	3

Empirical formula is $C_3H_4O_3$

Empirical formula mass = (12 × 3) + (1 ×4)+ (3 × 16) = 36 + 4 + 48 = 88

Molecular formula = n × empirical formula

$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{176}{88} = 2$

n = 2

∴ Molecular formula = n × (emp. formula) = 2 × ($C_3H_4O_3$) = $C_6H_8O_6$

REDOX REACTION ACTIVITY

1. A piece of cut apple becomes brown. Why? Can you prevent it by a simple method?

Ans. Apple turns brown when cut since the surface is exposed to air and undergoes oxidation. It can be prevented by dipping sliced apples in lemon juice. Lemon juice is an antioxidant which takes in all the available oxygen and prevents it from reaching the apple's tissues.

2. Place an iron piece in a moist atmosphere and observe it after two days. Is there any deposition of new substance? Why does it happen? What is this phenomenon called?

Ans. When iron is exposed to moist air, the iron reacts with oxygen in the presence of moisture to from a reddish - brown chemical compound, iron - oxide. This phenonaenon is called rusting. A new substance Iron (III) oxide is formed.

$4\,Fe(OH)_2 + O_2 + xH_2O \rightarrow 2\,Fe_2O_3\,(x+4)H_2O$

3. Calculate the oxidation number of underlined atoms of the following:

1. $K_2\underline{Mn}O_4$ 2. $K_2\underline{Cr}O_4$ 3. $\underline{N}O_3^-$ 4. $H_4\underline{P}_2O_7$
5. $\underline{Cl}O_3^-$ 6. $\underline{As}O_3^{3-}$

Ans. 1. $K_2\underline{Mn}O_4$

Oxidation number of Mn be x

$$\begin{aligned} 2(1) + x + 4(-2) &= 0 \\ 2 + x - 8 &= 0 \\ x - 6 &= 0 \\ x &= 6 \end{aligned}$$

Oxidation number of Mn in K_2MnO_4 is +6.

2. K_2CrO_4

$$2(1) + x + 4(-2) = 0$$
$$2 + x - 8 = 0$$
$$x - 6 = 0$$
$$x = +6$$

Oxidation number of Cr in K_2CrO_4 is +6.

3. NO_3^-

$$x + 3(-2) = -1$$
$$x - 6 = -1$$
$$x = -1 + 6 = +5$$

Oxidation number of N in NO_3^- is +5.

4. $H_4P_2O_7$

$$4(1) + 2x + 7(-2) = 0$$
$$4 + 2x - 14 = 0$$
$$2x - 10 = 0$$
$$2x = 10$$
$$x = 5$$

Oxidation number of P in $H_4P_2O_7$ is +5.

5. ClO_3^-

$$x + 3(-2) = -1$$
$$x - 6 = -1$$
$$x = +5$$

Oxidation number of Cl in ClO_3^- is +5.

6. AsO_3^{3-}

$$x + 3(-2) = -3$$
$$x - 6 = -3$$
$$x = -3 + 6$$
$$x = +3$$

Oxidation number of As in AsO_3^{3-} is +3.

4. An iron nail is placed in copper sulphate solution taken in the beaker. Observe it for some time? Find the changes that takes place and why?

Ans. When iron nail is dipped in copper sulphate solution, the colour of copper sulphate tuns from blue to light green and reddish brown deposits is formed on iron nail. This is because iron is more reactive than copper, so it displaces Cu from $CuSO_4$ solution.

The displacement reaction can be written as

$CuSO_4 + Fe \rightarrow FeSO_4 + Cu$

5. The approximate production of Na_2CO_3 per month is 424×10^6g while that of methyl alcohol is 320×10^6g. Which is produced more in terms of moles?

Ans.

Mass of Na_2CO_3 = 424×10^6g

No of moles (n) = $\dfrac{\text{Mass of the substance}}{\text{Molar mass of the substance}}$

$= \dfrac{424 \times 10^6}{106}$

$= 4 \text{ moles} \times 10^6$

Mass of CH_3OH = 320×10^6g

No of moles = $\dfrac{\text{Mass of the substance}}{\text{Molar mass of the substance}}$

$= \dfrac{320 \times 10^6}{32}$

$= 10 \times 10^6$ moles

Methyl alcohol is produced more.

6. Find the molecular mass of $FeSO_47H_2O$.

Ans. Molecular mass of $FeSO_47H_2O$

Atomic mass of Fe = 55.845

Atomic mass of S = 32.065

Atomic mass of O = $15.994 \times 11 = 63.304$

Atomic mass of H = $1.00794 \times 14 = 5.076$

Molecular mass of

$FeSO_4.7H_2O$ = $55.945 + 32.065 + (4 \times 15.994) + 7 \times (1.0079 \times 2 + 15.9994)$

= 278.014g/mol

7. The density of $CO_2 = 1.977$ kgm^{-3} at STP. Calculate the molecular mass of CO_2.

Ans.

Density of CO_2 = 1.977 Kgm^{-3}

$PV = nRT$

No of moles = $\dfrac{\text{Mass}}{\text{Molar Mass}}$

$PV = \dfrac{\text{Mass}}{\text{Molar Mass}} \times R \times T$

Molar Mass = $\dfrac{\text{Mass}}{V} \times \dfrac{R \times T}{P}$

$$\text{Density} = \frac{\text{Mass}}{V}$$

$$\text{Molar Mass of } CO_2 = \frac{D \times R \times T}{P}$$

Standard Temperature = 273 K

Standard Pressure = 760mm of Hg = 1 atm

$$= \frac{1.977 \times 0.0821 \times 273}{1}$$

$$= 44$$

8. How many moles of glucose are present in 720 g of glucose?

Ans. Mass of glucose = 720g

Molecular weight of glucose ($C_6H_{12}O_6$) = 180

$$\text{No. of moles} = \frac{\text{Mass}}{\text{Molar Mass}}$$

$$= \frac{720}{180} = 4 \text{ moles}$$

9. Calculate the weight of 0.2 mole of sodium carbonate.

Ans. No. of moles of Na_2CO_3 = 0.2 mole

Molar mass of Na_2CO_3 = 106g/mol

Mass = No of moles × molar mass of Na_2CO_3

= 0.2 × 106 = 21.2g

10. Calculate the equivalent mass of bicarbonate ion.

Ans. Bicarbonate ion = HCO^-_3

Molar of HCO^-_3 = 61

$$\text{Equivalent mass of ion} = \frac{\text{Molar mass}}{\text{Charge of ion}}$$

$$\text{Equivalent mass of } HCO^-_3 = \frac{61}{1} = 61$$

11. Calculate the equivalent mass of barium hydroxide

Ans. Equivalent mass of $Ba(OH)_2$

Molar mass of $Ba(OH)_2$ = 171.34 g/mol

Acidity of the $Ba(OH)_2$ = 2

Equivalent mass of the $Ba(OH)_2$

$$= \frac{\text{Molar mass of the base}}{\text{Acidity of the base}}$$

$$= \frac{171.34}{2} = 85.5$$

12. Boric acid, H_3BO_3 is a mild antiseptic and is often used as an eye wash. A sample contains 0.543 mol H_3BO_3. What is the mass of boric acid in the sample.

Ans. Formula mass of boric acid H_3BO_3 = 61.834 amu

1 mole of H_3BO_3 = Molar mass of H_3BO_3

= 61.834 g

0.543 mole of H_3BO_3 = 61.834 × 0.543

= 33.57 g of H_3BO_3

The mass of 0.543 moles of H_3BO_3 = 33.57g

13. (i) $K_2Cr_2O_7 + KI + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + I_2 + H_2O$

Ans.

Decrease in O.N (Reduction)

Decreases by +3

$$\underset{+6}{K_2Cr_2O_7} + \underset{-1}{KI} + H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + \underset{0}{I_2} + H_2O$$

Increases by +1

Increase in O N (oxidation)

Equalise the increase / decrease in O N by multiplying I species by 1

$$K_2Cr_2O_7 + 3KI + H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 3I_2 + H_2O$$

Balance all other atoms except H and O

$$K_2Cr_2O_7 + 6KI + 7H_2SO_4 \longrightarrow 4K_2SO_4 + Cr_2(SO_4)_3 + 3I_2 + H_2O$$

Balance O atom by adding H_2O on the the side falling short of oxygen

$$K_2Cr_2O_7 + 6KI + 7H_2SO_4 \longrightarrow 4K_2SO_4 + Cr_2(SO_4)_3 + 3I_2 + H_2O + 6H_2O$$

So the balanced equation is

$$K_2Cr_2O_7 + 6KI + 7H_2SO_4 \longrightarrow 4K_2SO_4 + Cr_2(SO_4)_3 + 3I_2 + 7H_2O$$

(ii) $KMnO_4 + Na_2SO_3 \longrightarrow MnO_2 + Na_2SO_4 +$ KOH (Alkaline medium)

Decrease in O.N (Reduction)

Decreases by +3

$$\underset{+7}{KMnO_4} + \underset{+4}{Na_2SO_3} \rightarrow MnO_2 + \underset{+6}{Na_2SO_4} + KOH$$

Increases by +2

Increase in O N (oxidation)

Equalise the increase / decrease in O N by multiplying Mn species by 2 and S species by 3

$$2KMnO_4 + 3Na_2SO_3 \longrightarrow 2MnO_2 + 3Na_2SO_4 + KOH$$

Balance all other atoms except H and O

$$2KMnO_4 + 3Na_2SO_3 \longrightarrow 2MnO_2 + 3Na_2SO_4 + 2KOH$$

Balance O atoms by adding H_2O molecules on the side falling short of oxygen atom.

$$2KMnO_4 + 3Na_2SO_3 + H_2O \longrightarrow 2MnO_2 + 3Na_2SO_4 + 2KOH$$

(iii) $\mathbf{K_2Cr_2O_7 + KCI + H_2SO_4 \longrightarrow KHSO_4 + CrO_2CI_2 + H_2O}$

It is not a redox reaction.

(iv) $\mathbf{Cu + HNO_3 \longrightarrow Cu(NO_3)_2 + NO_2 + H_2O}$

Increase in O N
(Oxidation)
Increases by +2

$$\underset{0}{Cu} + \underset{+5}{HNO_3} \rightarrow Cu(NO_3)_2 + \underset{+4}{NO_2} + H_2O$$

Decrease by +1
Decrease in O N
Reduction

Equalise the increase / decrease in O N by multiplying Cu species by +1 and N species by +2

$$Cu + 2HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + H_2O$$

Balance all other atoms except H and O atoms

$$Cu + 2HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + H_2O$$

Balance O atom by adding H_2O molecules on the side falling short of oxygen atoms.

$$Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + H_2O$$

The balanced equation in

$$Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$

(v) $\mathbf{P + HNO_3 \longrightarrow H_3PO_4 + NO_2 + H_2O}$

Increase in O N
(Oxidation)
Increases by +5

$$\underset{0}{P} + \underset{+5}{HNO_3} \rightarrow H_3PO_4 + \underset{+5}{NO_2} + H_2O \quad +4$$

Decrease by +1
Decrease in O N
Reduction

Equalise the increase / decrease in O N by multiplying P species by +1 and N species by +5

(vi) $\mathbf{P + 5HNO_3 \longrightarrow H_3PO_4 + 5NO_2 + H_2O}$

All atoms are balanced

Balanced Equation is

$$P + 5HNO_3 \longrightarrow H_3PO_4 + 5NO_2 + H_2O$$

(vii) $\mathbf{H_2C_2O_4 + KMnO_4 + H_2SO_4 \longrightarrow H_2SO_4 + MnSO_4 + CO_2 + H_2O}$

Increase in O N (Oxidation)
Increases by 1

$$\underset{+3}{H_2C_2O_4} + \underset{+7}{KMnO_4} + H_2SO_4 \rightarrow K_2SO_4 + \underset{+2}{MnSO_4} + \underset{+4}{CO_2} + H_2O$$

Decreases by 5
Decreases in O N Reduction

Equalise the increase / decrease in O N by multiplying Cu species by 5 and Mn species by 1

$$5H_2C_2O_4 + KMnO_4 + H_2SO_4 \longrightarrow K_2SO_4 + MnSO_4 + 5CO_2 + H_2O$$

Balance all other atoms except H and O atoms

$$5H_2C_2O_4 + 2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + H_2O$$

Balance O atom by adding H_2O on the side falling short of oxygen atoms.

$$5H_2C_2O_4 + 2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + H_2O + 7H_2O$$

The balanced equation in

$$5H_2C_2O_4 + 2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$$

(viii) $\mathbf{CuO + NH_3 \longrightarrow Cu + N_2 + H_2O}$

$CuO + NH_3 \longrightarrow Cu + N_2 + H_2O$

$Cu + 2e^- \longrightarrow Cu$ (Reduction) ......(1)

$N^{-3} \longrightarrow N^0_2 + 3e^-$ (oxidation) ......(2)

Multiply Equation (2) by 2 to balance nitrogen atom

$2N^{-3} \longrightarrow N^0_2 + 6e^-$ ......(3)

Multiply equation (1) by 3 to balance the number of electrons.

$3Cu^{2+} + 6e^- \longrightarrow 3Cu$ ......(4)

Add equation (3) and (4)

$3Cu^{2+} + 2N^{-3} \longrightarrow 3Cu + N_2$

Over all balanced equation

$3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + H_2O$

Balance O atom by adding H_2O on the side falling short of it.

$3CuO + 2NH_3 \longrightarrow 3Cu + N_2 + 3H_2O$

(ix) $\mathbf{Zn + HNO_3 \longrightarrow Zn\,(NO_3)_2 + NH_4NO_3 + H_2O}$

$Zn + HNO_3 \longrightarrow Zn\,(NO_3)_2 + NH_4NO_3 + H_2O$

$Zn^0 \longrightarrow Zn^{2+} + 2e^-$ ......(1)

$N^{+5} + 8e^- \longrightarrow N^{-3}$ ......(2)

Multiply Equation (1) by 4 to balance the electrons

$4Zn^0 \longrightarrow 4Zn^{2+} + 2e^-$ ......(3)

Add equation (3) and (2)

$4Zn^0 \longrightarrow 4Zn^{2+} + \cancel{8e^-}$

$N5+ + \cancel{8e^-} \longrightarrow N^{3-}$

$4Zn^0 + N^{5+} \longrightarrow 4Zn^{2+} + N^{3-}$

Overall equation

$4Zn + 10HNO_3 \longrightarrow 4Zn\,(NO_3)_2 + NH_4NO_3 + H_2O$

Balance all the atoms except O and H

$4Zn + 10HNO_3 \longrightarrow 4Zn\,(NO_3)_2 + NH_4NO_3 + H_2O$

Balance oxygen atom by adding H_2O on the side falling short of oxygen atom.

$4Zn + 10HNO_3 \longrightarrow 4Zn\,(NO_3)_2 + NH_4NO_3 + 3H_2O$

14. (i) $\mathbf{MnO^-_4 + Sn^{2+} \longrightarrow Mn^{2+} + Sn^{4+}}$

Ans.

Decrease in O.N
(Reduction)

Decreases by 5

$\underset{+7}{MnO^-_4} + \underset{2+}{Sn^{2+}} \rightarrow \underset{2+}{Mn^{2+}} + \underset{4+}{Sn^{4+}}$

Increases by 2

Increase in O.N
(oxidation)

Equalise the increase / decrease in O.N by multiplying the oxidant and reductant by suitable numbers.

$2MnO^-_4 + 5Sn^{2+} \longrightarrow 2Mn^{2+} + 5Sn^{4+}$

Balance all other atoms except O and H

$2MnO^-_4 + 5Sn^{2+} \longrightarrow 2Mn^{2+} + 5Sn^{4+}$

Balance O atom by adding water on the the side falling short of oxygen otoms.

$2MnO^-_4 + 5Sn^{2+} \longrightarrow 2Mn^{2+} + 5Sn^{4+} + 8H_2O$

Balance H atom by adding H+ on the side falling short of hydrogen atoms.

$2MnO^-_4 + 5Sn^{2+}\ 16H^+ \longrightarrow 2Mn^{2+} + 5Sn^{4+} + 8H_2O$

(ii) $\mathbf{C_2O_4^{2-} + Cr_2O_7^{2-} \longrightarrow Cr^{3+} + CO_2}$

Increase in O.N
(Oxidation)

Increases by +1

$\underset{+3}{C_2O_4^{2-}} + \underset{+6}{Cr_2O_7^{2-}} \rightarrow \underset{3+}{Cr^{3+}} + \underset{+4}{CO_2}$

Decreases by +3

Decrease in O.N
(Reduction)

$3C_2O_4^{2-} + Cr_2O_7^{2-} \longrightarrow 2Cr^{3+} + 6CO_2 + 7H_2O$

$3C_2O_4^{2-} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 2Cr^{3+} + 6CO_2 + 7H_2O$

(iii) $\mathbf{S_2O_3^{2-} + I_2 \longrightarrow S_2O_4^{2-} + I^-}$

Increase in O.N
(Oxidation)

Increases by 1

$$S_2O_3^{2-} + I_2 \rightarrow S_2O_4^{2-} + I^-$$

+2   0   +3   –1

Decreases by 1

Decrease in O.N
(Reduction)

$$S_2O_3^{2-} + I_2 \longrightarrow S_2O_4^{2-} + I^-$$

$$S_2O_3^{2-} + I_2 \longrightarrow S_2O_4^{2-} + 2I^-$$

$$S_2O_3^{2-} + I_2 + H_2O \longrightarrow S_2O_4^{2-} + 2I^-$$

$$S_2O_3^{2-} + I_2 + H_2O \longrightarrow S_2O_4^{2-} + 2I^- + 2H^+$$

(iv) $\mathbf{Sb^{3+} + MnO_4^- \longrightarrow Sb^{5+} + Mn^{2+}}$

Decrease in O.N
Reduction

Decrease by 5

$$Sb^{3+} + MnO_4^- \rightarrow Sb^{5+} + Mn^{2+}$$

+3   +7   +5   2+

Increase by 2

Increase in O.N
Oxidation

Equalise the increase / decrease in Oxidation number by multiplying with suitable numbers.

$$5Sb^{3+} + 2MnO_4^- \longrightarrow Sb^{5+} + Mn^{2+}$$

Balance all other atoms except O and H

$$5Sb^{3+} + 2MnO_4^- \longrightarrow 5Sb^{5+} + 2Mn^{2+}$$

Balance Oxygen atom by adding H_2O on the side falling short of oxygen.

$$5Sb^{3+} + 2MnO_4^- \longrightarrow 5Sb^{5+} + 2Mn^{2+} + 8H_2O$$

Balance hydrogen atom by adding H^+ on the side falling short of hydrogen atoms.

$$5Sb^{3+} + 2MnO_4^- \longrightarrow 5Sb^{5+} + 2Mn^{2+} + 8H_2O + 16H^+$$

(v) $\mathbf{MnO_4^{2-} \longrightarrow MnO_4^{2-} + MnO_2}$

$$MnO_4^{2-} \longrightarrow MnO_4^- + e^- \text{ (Oxidation)}$$
+6   +7   ......(1)

$$MnO_4^{2-} + 2e^- \longrightarrow MnO_2 \text{ (Reduction)}$$
+6   +4   ......(2)

Multiply equation (1) by (2)

$$2MnO_4^{2-} \longrightarrow 2MnO_4^- + 2e^- \quad ......(3)$$

Add equation (2) and (3)

$$3MnO_4^{2-} \longrightarrow MnO_2 + 2MnO_4^-$$

Balance O atoms by adding H_2O on the side falling short of oxygen atoms

$$3MnO_4^{2-} \longrightarrow MnO_2 + 2MnO_4^- + 2H_2O$$

Balance H atoms by adding H^+ on the side falling short of hydrogen atoms

$$3MnO_4^{2-} + 4H^+ \longrightarrow MnO_2 + 2MnO_4^- + 2H_2O$$

(vii) $\mathbf{MnO_4^- + Fe^{2+} \longrightarrow Mn^{2+} + Fe^{3+}}$

Decrease in O.N
Reduction

Decrease in +5

$$MnO_4^- + Fe^{2+} \rightarrow Mn^{2+} + Fe^{3+}$$

+7   +2   2+   +3

Increase by +1

Increase in O.N
Oxidation

Equalise the increase / decrease in Oxidation number by multiplying Mn species by 1 and Fe species by 5.

$$MnO_4^- + 5Fe^{2+} \longrightarrow Mn^{2+} + 5Fe^{3+}$$

Balance all other atoms except O and H

$$MnO_4^- + 5Fe^{2+} \longrightarrow Mn^{2+} + 5Fe^{3+}$$

Balance O atom by adding H_2O on the side falling short of hydrogen and equal number OH^- on the opposite side.

$$MnO_4^- + 5Fe^{2+} + 8H_2O \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O + 8OH^-$$

$$MnO_4^- + 5Fe^{2+} + 8H_2O \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O + 8OH^-$$

(viii) $S_2O_3^{2-} + I_2 \longrightarrow S_2O_6^{2-} + I^-$

Increase in O.N
Oxidation

Increases by 3   +5

$\underset{+2}{S_2O_3^{2-}} + \underset{0}{I_2} \rightarrow S_2O_6^{2-} + \underset{-1}{I^-}$

Decrease by 1
Decrease in O.N
Reduction

Equalise the increase / decrease in O.N by multiplying the S species by 1 and I species by 3.

$S_2O_3^{2-} + 3I_2 \longrightarrow S_2O_6^{2-} + 3I^-$

Balance all other atoms except O and H

$S_2O_3^{2-} + 3I_2 \longrightarrow S_2O_6^{2-} + 6I^-$

Balance O atom by adding H_2O on the side falling short of Oxygen.

$S_2O_3^{2-} + 3I_2 + 3H_2O \longrightarrow S_2O_6^{2-} + 6I^-$

Balance H atom by adding H+ ion on the side falling short of hydrogen.

$S_2O_3^{2-} + 3I_2 + 3H_2O \longrightarrow S_2O_6^{2-} + 6I^- + 6H^+$

Add equal number of OH– ion on the both side since the medium is alkaline

$S_2O_3^{2-} + 3I_2 + 3H_2O + 6OH^- \longrightarrow S_2O_6^{2-} + 6I^- + 6H^+ + 6OH^-$

$S_2O_3^{2-} + 3I_2 + 3H_2O + 6OH^- \longrightarrow S_2O_6^{2-} + 6I^- + 6H_2O$

15. A compound contains 50% of X (atomic mass 10) and 50% Y (atomic mass 20). Give its molecular formula.

Ans.

Element	Percentage	Atomic mass	Relative No. of moles	Simple Ratio Moles	Simplest whole number Ratio
X	50	10	$\frac{50}{10} = 5$	$\frac{5}{2.5} = 2$	2
Y	50	20	$\frac{50}{20} = 25$	$\frac{2.5}{2.5} = 1$	1

Its simplest formula = X_2Y

16. Determine the empirical formula of a compound containing K = 24.75%, Mn = 34.77% and rest is oxygen.

Ans.

Element	Percentage	Atomic mass	Relative No. of moles	Simple Ratio Moles	Simplest whole number Ratio
K	24.75	39	$\frac{24.75}{39} = 0.63$	$\frac{0.63}{0.63} = 1$	1
Mn	34.77	55	$\frac{34.77}{55} = 0.63$	$\frac{0.63}{0.63} = 1$	1
O	100 – (24.75 + 34.77) = 40.48	16	$\frac{40.48}{16} = 2.53$	$\frac{2.53}{0.63} = 4$	4

The empirical formula is $KMnO_4$

★ ★ ★