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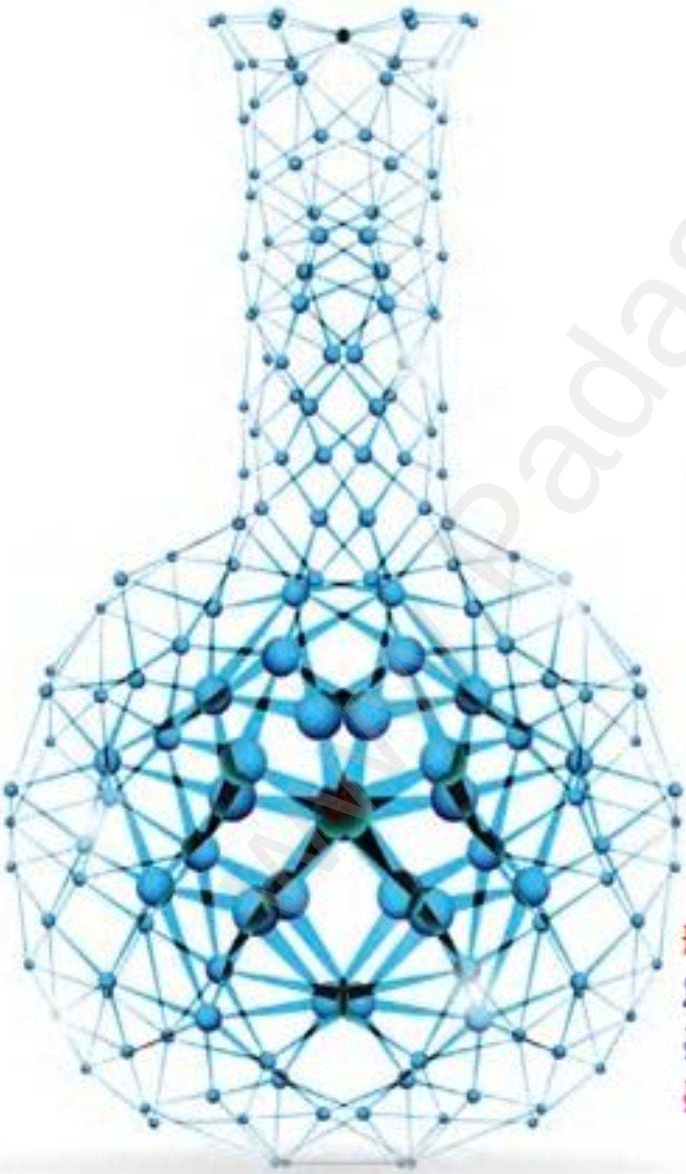
CHEMISTRY

A COMPLETE GUIDE



BOOK BACK
- ONE MARK
- SHORT ANSWERS
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ADDITIONAL QUESTIONS
- TOPIC WISE Q /A
- PUBLIC EXAM Q/A

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CHEMISTRY

A COMPLETE GUIDE

- ***BOOK BACK***
- ***PTA QUESTIONS***
- ***PUBLIC QUESTIONS***
- ***CREATIVE QUSTIONS***

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PG ASSISTANT IN CHEMISTRY

Dear students!

- ***VJ*** *11th std chemistry 1 ,2 , 3 & 5 marks questions has been thoroughly revised and updated as per the new syllabus.*
- *This book provides complete tutorial to students in such a way that they can confidently all questions in their examination.*
- *This booklet series is prepared effectively keeping in mind the scoring aspects of the students.*
- *We wish the student to score high marks using this 1 , 2 ,3 & 5 marks question of booklet.*

CONTENT

என் ஆசிரியருக்கு நான் மாணவன்,

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+1 CHEMISTRY PUBLIC EXAM BLUE PRINT

	MARCH 2019					JULY 2019					SEPTEMBER 2020					MAY 2022					JUNE -2022				
Ln	**1 M**	**2 M**	**3 M**	**5M**	**T**	**1 M**	**2 M**	**3 M**	**5M**	**T**	**1 M**	**2 M**	**3 M**	**5M**	**T**	**1 M**	**2 M**	**3 M**	**5M**	**T**	**1 M**	**2 M**	**3 M**	**5M**	**T**
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4	1		1	1(2)	**6**	1	1		1(3)	**6**	1	1	1	1(3)	**9**	1	1			**3**	**1**	**1**			**3**
5	1		1	1(3)	**7**	1	1	1	1(2)	**8**	1			1(3)	**4**	2			1(2) 1(3)	**7**	**2**		**1**	**1(5)**	**10**
6	1	1		1(2)	**5**	1	1	1	1(3)	**9**	1			1(2) 1(2)	**5**	1		1		**4**	**1**		**1**		**4**
7	1	1		1(3) 1(2)	**9**	1		**1**	1(2)	**6**	1	1	1	1(3) 1(2)	**11**	1	2		1(5)	**10**	**1**	**1 1 C**		1(3) 1(2)	**10**
8	1		1	1(2)	**6**	1	1		1(3)	**6**	1	1		1(2)	**5**	1	1	1 C		**6**	**1**	**1**	**1**	**1(5)**	**11**
9	1		1	1(3)	**7**	1		1	1(3) 1(2)	**9**	1		**1**	1(2)	**6**	1	1	1	1(5)	**11**	**1**	**1**	**1**		**6**
10	1	1	1	1(2)	**8**	1	1	1	1(3) 1(2)	**8**	1	1	1	1(3)	**9**	1		1	1(3) 1(2) 1(1) 1(5)	**15**	**1**		**1**	**2(5)**	**14**
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13	1	1		1(2) 1(3)	**8**	1	1	1	1(3)	**9**	1		1	1(2) 1(3)	**9**	-	**1**	1	1(5)	**10**	**1**	**1**	**1**	**1(5)**	**11**
14	1		1	1(2) 1(3)	**9**	1			1(3) 1(2)	**6**	2	1		1(5)	**9**	1	1 C		1(5)	**8**	**1**	**1**		**1(5)**	**8**
15	1	1			**3**	1	1		1(2)	**3**	1		1	1(3)	**7**	-	-	-	-	-	-	-	-	-	-
	15	9	9	50 M	**110**	15	9	9	50 M	**110**	15	9	9	50 M	**110**	15	9	9	50 M	**110**	15	9	9	50 M	**110**

	Inorganic unit – 1, 2 ,3 , 4 ,5		**Physical unit – 6 , 7 , 8 , 9 , 10**		**Organic unit – 11 , 12 , 13 , 14,15**	
Part (I) 1 M	5 x 1	5	5 x 1	5	5 x 1	5
Part (II) 2 M	3 x 2	6	3 x 2	6	3 x 2	6
Part (III) 3 M	3 x 3	9	3 x 3	9	3 x 3	9
Part (IV) 5 M	3 x 5	15	3 x 5	15	4 x 5	20
Total marks	**35**		**35**		**40**	

Unit 1 Basic Concepts of Chemistry and Chemical Calculations

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

2. An element X has the following isotopic composition ^{200}X= 90 %, ^{199}X= 8 % and 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**

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}

a) both assertion and reason are true and the reason is the correction 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.

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

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

6. The number of water molecules in a drop of water weighing 0.018 g is

a) 6.022×10^{26} b) 6.022×10^{23} **c) 6.022×10^{20}** d) 9.9×10^{22}

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%

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

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

9. When 22.4 liters of H_2 (g) is mixed with 11.2 liters of Cl_2 (g), each at 273 K at 1 atm the molecules 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)**

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

a) $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$ b) $C + 2H_2SO_4 \rightarrow CO_2 + 2SO_2 + 2H_2O$

c) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$ d) none of the above

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

a) $3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$ **b) $P_4(s) + 3 NaOH + 3H_2O \rightarrow PH_3(g) + 3NaH_2PO_2(aq)$**

c) $Cl_2(g) + 2KI(aq) \rightarrow 2KCl(aq) + I_2$ d) $Cr_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Cr(s)$

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

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

a) 31.6 **b) 52.7** c) 79 d) None of these

13. Which one of the following represents 180 g of water?

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

c) $\frac{6.022x10^{22}}{180}$ molecules of water **d) 6.022×10^{24} molecules of water**

14. 7.5 g of a gas occupies a volume of 5.6 litres at 0^0C and 1 atm pressure. The gas is **(M-22)**

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

15. Total number of electrons present in 1.7 g of ammonia is **(June-2022)**

a) 6.022×10^{23} b) $\frac{6.022x10^{22}}{1.7}$ c) $\frac{6.022x10^{24}}{1.7}$ d) $\frac{6.022x10^{23}}{1.7}$

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

17. The equivalent mass of ferrous oxalate is

a) $\frac{molar\ mass\ of\ ferrous\ oxalate}{1}$ b) $\frac{molar\ mass\ of\ ferrous\ oxalate}{2}$

c) $\frac{molar\ mass\ of\ ferrous\ oxalate}{3}$ d) none of these

18. If Avogadro number were changed from 6.022 x 10^{23} to 6.022 x 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.

19. Two 22.4 liter containers A and B contains 8 g of CO_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.

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

21. The mass of a gas that occupies a volume of 612.5 ml at room temperature and pressure (25^0C 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}

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

23. Which of the following compound(s) has/have percentage of carbon same as that in ethylene (C_2H_4) **(Mar-19)**

a) propene b) ethyne c) benzene d) ethane

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 x 10^{22} carbon atoms

d) all of these

25. Which one of the following is used as a standard for atomic mass.

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

MODEL AND YEAR QUESTIONS:

1. The oxidation number of carbon in CH_2F_2 is **(June– 2019)**

a) +4 b) -4 **c) 0** d)+2

2. The relative molecular mass of ethanol is : **(Sep-20)**

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

BOOK BACK – 2 AND 3 MARKS

26. Define 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 atomic mass (A_r) = $\frac{\text{Average mass of the atom}}{\text{Unified atomic mass}}$

27. What do you understand by the term mole? (JUNE -19)

- One mole is the amount of substance of a system, which contains as many elementary particles as there are atoms in 12 g of carbon -12 isotopes. The elementary particles can be molecules, atoms, ions, electrons or any other specified particles.
- 1mole = 6.022x10^{23} entities.

28. Define equivalent Mass (or) Define Gram equivalent mass (May-22)

- Equivalent mass of an element, compound or ion is the number of parts of mass of an element combines or displaces 1.008 g hydrogen or 8 g oxygen or 35.5g chlorine.
- $Gram\ equivalent\ mass = \frac{molar\ mass\ (g\ mol^{-1})}{Equivalence\ factor\ (eq\ mol^{-1})}$

29. What do you understand by the term 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.
- Oxidation number of Na = +1

30. Distinguish between oxidation and reduction

S.no	Oxidation	Reduction
1	Addition of oxygen	Removal of oxygen
2	Removal of hydrogen	Addition of hydrogen
3	Loss of electrons	Gain of electrons
4	Oxidation number increases	Oxidation number decreases

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]

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

Molar mass of [$CO(NH_2)_2$] = C + O + 2N + 4H

= 12 + 16 + (2 x 14) + (4 x 1)

= 12 + 16 + 28 + 4

= 60 g mol^{-1}

(ii) acetane [CH_3COCH_3]

Molar mass of CH_3COCH_3 = 3C + 6H + O

= (3 x 12) + (6 x 1) + 16

= 36 + 6 + 16

= 58 g mol^{-1}

(iii) boric acid [H_3BO_3]

Molar mass of H_3BO_3 = 3H + B + 3(O)

= (3 x 1) + 11 + (3 x 16)

= 3 + 11 + 48

= 62 g mol^{-1}

(iv) sulphuric acid [H_2SO_4]

Molar mass of H_2SO_4 = 2H + S + 4(O)

= (2 x 1) + 32 + (4 x 16)

= 2 + 32 + 64

= 98 g mol^{-1}

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

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

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

Mass of 1 mole of CO_2 = $\frac{1.965Kg}{1m^3} \times 22.4L$

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

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**

Compound	Given no. of moles	No. of oxygen atoms
Ethanol (C_2H_5OH)	**1**	$1 \times 6.022 \times 10^{23}$
Formic acid (HCOOH)	**1**	$2 \times 6.022 \times 10^{23}$
Water (H_2O	**1**	$1 \times 6.022 \times 10^{23}$

- The Formic acid (HCOOH) contains the greatest number of moles 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^{26}	24.99	10.00
Mg^{25}	25.98	11.01

Average atomic mass = $\frac{(78.99 \times 23.99)+(10 \times 24.99)+(11.01 \times 25.98)}{100} = \frac{2430.9}{100}$

= 24.31u.

35. Mass of one atom of an element is 6.645×10^{-23}g. How many moles of element are there in 0. 320 kg?

Given: Mass of one atom = 6.645×10^{-23} g

∴ Mass of 1 mole of atom = 6.645×10^{-23} g $\times 6.022 \times 10^{23}$

= 40g

∴ Number of moles of element in 0.320 kg

Number of moles $= \frac{mass}{atomic\ mass}$

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

$= \frac{1mole\ x\ 320\ g}{40g}$

= 8 mol.

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

S.no	Molecular mass	Molar mass
1	The sum of atomic masses of the elements present in a molecule.	The mass of one mole of a substance.
2	Its unit is u or amu	Its unit is g mol^{-1}
3	Molecular mass of CO: =(1 × mass of C) + (1 × Mass of O) = 1×12.01 amu + 1 × 16 amu = 28. 01 amu	Molar mass of CO: = 1×12.01+ 1× 16 = 28.01g mol^{-1}

37. 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.

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

38. How many moles of ethane is required to produce 44 g of CO_2(g) after combustion.

Balanced equation for the combustion of ethane

$C_2H_6 + 3\frac{1}{2}\ O_2 \rightarrow 2CO_2 + 3H_2O$

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

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

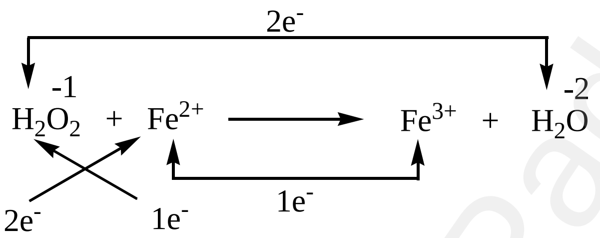
To produce 1 mole (44 g) of CO_2 required number of moles of ethane

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

= ½ mole of ethane

= 0.5 mole of ethane

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



Step 1 : $H_2O_2 + 2Fe^{2+} \longrightarrow Fe^{3+} + H_2O$

Step 2 : $H_2O_2 + 2Fe^{2+} + 2H^{+} \longrightarrow 2Fe^{3+} + 2H_2O$

BOOK BACK – 5 MARKS

40. In a reaction $x + y + z_2 \rightarrow xyz_2$ 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

Reaction : $x + y + z_2 \rightarrow xyz_2$

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 atoms	50 atoms	50 atoms	50 atoms	z_2
b	1 mol	1 mol	3 mol	1 mol	1 mol	1 mol	x an 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

41. The reaction between aluminium and ferric oxide can generate temperatures up to 3273 K and is used in welding metals. (Atomic mass of Al = 27u Atomic mass of O = 16u) $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$; 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?

Given: $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$

	Reactants		Products	
	Al	**Fe_2O_3**	**Al_2O_3**	**Fe**
Amount of reactant allowed to react	324 g	1.12 kg	-	-
Number of moles allowed to react	$\frac{324}{27} = 12\ mol$	$\frac{1.12 \times 10^3}{160} = 7$ mol	-	-
Stoichiometric co-efficient	2	1	1	2
Number of moles consumed during reaction	12 mol	6 mol	-	-
Number of moles of reactant unreacted and number of moles of product formed	-	1 mol	6 mol	12 mol

Molecular mass of Al_2O_3 = 2 (Al) + 3 (O) = [2x27] +[3x16]

= 102 g mol^{-1}

Molar mass os Al_2O_3 formed = Number of moles x molecular mass

= 6 mol x 102 g mol^{-1} = 612 g

Excess reagent = Fe_2O_3

Molecular mass of Fe_2O_3 = 2 (Fe) + 3 (O)

= [2x56] +[3x16] = 160 g mol^{-1}

Amount of excess reagent left at the end of the reaction = 1 mol x 160 g mol^{-1}

= 160 g

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. (Sep-20 , June-22)

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 = $C_6 H_6 O$

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

$$= \frac{2\ x\ vapour\ density}{94} = \frac{2x47}{94} = 1$$

Molecular Formula $(C_6H_6O) \times 1 = C_6H_6O$

43. A Compound o 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).

Element	Percentage	Atomic mass	Relative number of atoms	Simple ratio	Whole no
Na	14.31	23	$\frac{14.31}{23} = 0.62$	$\frac{0.62}{0.31} = 2$	2
S	9.97	32	$\frac{9.97}{32} = 0.31$	$\frac{0.31}{0.31} = 1$	1
H	6.22	1	$\frac{6.22}{1} = 6.22$	$\frac{6.22}{0.31} = 20$	20
O	69.5	16	$\frac{69.5}{16} = 4.34$	$\frac{4.34}{0.31} = 14$	14

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

Empirical formula mass = 2(Na) + S + 20(H) + 14 (O)

= [2x23] + 32 + [20 x1] + [14x16]

= 46 + 32+20+224 = 322

$$n = \frac{molecular\ mass}{calculated\ empirical\ formula\ mass} = \frac{322}{322} = 1$$

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

Since all the hydrogen in the compound present as water

Molecular formula = $Na_2 SO_4 . 10H_2O$

44. Balance the following equations by oxidation number method

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

+6   -1   +3   0

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

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

Step 1 : $K_2Cr_2O_7$ + 6KI + $H_2SO_4 \rightarrow K_2SO_4 + Cr_2 (SO_4)_3 + I_2 + H_2O$

Step 2 : $K_2Cr_2O_7 + 6KI + H_2SO_4 \rightarrow K_2SO_4$ **+ $Cr_2 (SO_4)_3$ +3 I_2** + H_2O

Step 3 : $K_2Cr_2O_7$ + 6 KI + **$7H_2SO_4 \rightarrow 4K_2SO_4$** + $Cr_2 (SO_4)_3 + 3I_2$ + **$7H_2O$**

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

+7   +4   +4   +6

$KMnO_4 + Na_2SO_3 \rightarrow MnO_2 + Na_2SO_4 + KOH$

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

Step 1: $2KMnO_4$ + $3Na_2SO_3$ $\rightarrow MnO_2 + Na_2SO_4 + KOH$

Step 2: $2KMnO_4 + 3Na_2SO_3 \rightarrow$ **$2MnO_2$ + $3Na_2SO_4$** + KOH

Step 3: $2KMnO_4 + 3Na_2SO_3$ + **H_2O** $\rightarrow 2MnO_2 + 3 Na_2SO_4$ + **2KOH**

iii) $Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO_2 + H_2O$

0   +5   +2   +4

$Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO_2 + H_2O$

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

Step 1 : Cu + **$2HNO_3$** $\rightarrow Cu(NO_3)_2 + NO_2 + H_2O$

Step 2 : Cu + $2HNO_3$ + **$2HNO_3$** $\rightarrow Cu(NO_3)_2$ + **$2NO_2$** + H_2O

Step 3 : $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2 H_2O$

iv) $KMnO_4 + H_2C_2O_4 + H_2SO_4 \rightarrow K_2SO_4 + MnSO_4 + CO_2 + H_2O$

$$\overset{+7}{KMnO_4} + H_2\overset{+3}{C_2}O_4 + H_2SO_4 \rightarrow K_2SO_4 + \overset{+2}{MnSO_4} + \overset{+4}{CO_2} + H_2O$$

$5e^-$ $2x1e^-$

Step 1 : $\mathbf{2KMnO_4} + \mathbf{5H_2C_2O_4} + H_2SO_4 \rightarrow K_2SO_4 + MnSO_4 + CO_2 + H_2O$

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

Step 3: $KMnO_4 + H_2C_2O_4 + \mathbf{3H_2SO_4} \rightarrow K_2SO_4 + 2\,MnSO_4 + 10CO_2 + \mathbf{8H_2O}$

45. Balance the following equations by ion electron method.

a) $KMnO_4 + SnCl_2 + HCl \rightarrow MnCl_2 + SnCl_4 + H_2O + KCl$

Half reaction are

$\overset{+7}{Mn}O_4^- \longrightarrow Mn^{2+}$ .... (1)

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

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

b) $C_2O_4^{2-} + Cr_2O_7^{2-} \rightarrow Cr^{3+} + CO_2$ **(acid medium)**

$\overset{+3}{C_2}O_4^{2-} \longrightarrow \overset{+4}{C}O_2$ .... (1)

$\overset{+6}{Cr_2}O_7^{2-} \longrightarrow Cr^{3+}$ .... (2)

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

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

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

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

$Cr_2O_7^{2-} + 3\,C_2O_4^{2-} + 14\,H^+ \longrightarrow 2\,Cr^{3+} + 6\,CO_2 + 7\,H_2O$

c) **$Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + NaI$ (acid medium)**

half reaction ⇒

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

$$I_2 \longrightarrow I^- \quad \text{.............. (2)}$$

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

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

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

d) **$Zn + NO_3^- \rightarrow Zn^{2+} + NO$**

Half reactions are

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

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

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

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

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

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

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

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) CO_2 (v) Copper wire (vi) Table salt (vii) Silver plate (viii) Naphthalene balls**

1	**Element**	Copper wire, Silver plate
2	**Compound**	Sugar, distilled water, carbon dioxide, Table salt, Naphthalene balls
3	**Mixture**	Sea water

2. **Calculate the molar mass of the following.**

(i) Ethanol(C_2H_5OH) **(ii) Potassium permanganate ($KMnO_4$)**

(iii) Potassium dichromate ($K_2Cr_2O_7$) **(iv) Sucrose ($C_{12}H_{22}O_{11}$)**

(i) molar mass of C_2H_5OH = 2(C) +6(H)+O

= (2 x 12) + (5 x 1) + (1 x 16) + (1 x 1)

= 46 g

(ii) molar mass of $KMnO_4$ = K + Mn + 4(O)

= (1 x 39) + (1 x 55) + (4 x 16)

= 158 g

(iii) molar mass of $K_2Cr_2O_7$ = 2(K) + 2(Cr) + 7 (O)

= (2 x 39) + (2 x 52) + (7 x 16)

= 294 g

(iv) molar mass of $C_{12}H_{22}O_{11}$ = 12(C) + 22(H) + 11(O)

= (12 x 12) + (22 x 1) + (11 x 16)

= 342 g

3. a) Calculate the number of moles present in 9 g of ethane.

Molar mass of ethane, C_2H_6 = (2 x 12)+ (6 x 1)

= 30 g mol^{-1}

$$n = \frac{mass}{molar\ mass}$$

$$= \frac{9\ g}{30 g\ mol^{-1}}$$

= 0.3 mole

b) Calculate the number of molecules of oxygen gas that occupies a volume of 224 ml at 273 K and 3 atm pressure.

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

$$= \frac{(1\ mole)}{273\ K\ x\ 1\ atm\ x\ 22.4\ L} \text{ x 0.224 L x 273 K x 3 atm}$$

=0.03mole

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 0.606 g of its chloride. Calculate the equivalent mass of the metal.

Mass of the metal = 0.456 g

Mass of the metal chloride = 0.606 g

0.456 g of the metal combines with 0.15 g of chlorine.

Mass of the metal that combines with 35.5 g of chlorine = $\frac{0.456}{0.15}$ x 35.5

= 107.92 g eq^{-1}.

a) **Calculate the equivalent mass of potassium dichromate. The reduction half-reaction in acid medium is, $Cr_2O_7^{2-}$ + $14H^+$ +$6e^-$ → 2 Cr^{3+} +$7H_2O$**

$$\text{Equivalent mass of a oxidising agent} = \frac{molar\ mass}{\begin{array}{c}number\ of\ moles\ of\ electrons\ gained\ by\\ one\ mole\ of\ the\ reducing\ agent\end{array}}$$

$$= \frac{292.2\ g\ mol^{-1}}{6\ eq\ mol^{-1}}$$

= 48.7 g eq^{-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.

Elements	Percentage composition	Atomic mass	Relative no.of.atoms = $\frac{percentage}{Atomic\ mass}$	Simple ratio
C	54.55 %	12	$\frac{54.55}{12} = 4.55$	$\frac{4.55}{2.27} = 2$
H	9.09 %	1	$\frac{9.09}{1} = 9.09$	$\frac{9.09}{2.27} = 4$
O	36.36 %	16	$\frac{36.36}{16} = 2.27$	$\frac{2.27}{2.27} = 1$
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

iii) Molecular formula of the compound.

Elements	Percentage composition	Relative no.of.atoms = $\frac{percentage}{Atomic\ mass}$	Atomic mass = $\frac{percentage}{Relative\ no.of.atoms}$	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 x 4) + (24 x 2) + 88

= 64 + 48 + 88 = 200

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

$$= \frac{400}{200} = 2$$

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.

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

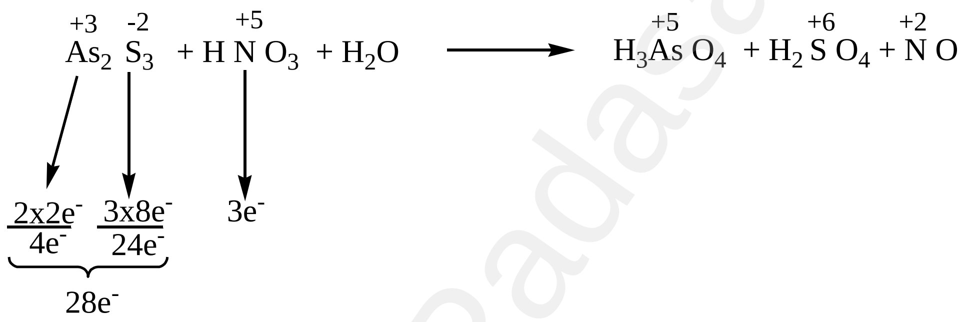
Limiting reagent : x

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

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



$\mathbf{3}\ As_2S_3 + \mathbf{28}\ HNO_3 + H_2O \rightarrow H_3AsO_4 + H_2SO_4 + NO$

$3\ As_2S_3 + 28\ HNO_3 + H_2O \rightarrow \mathbf{6}\ H_3AsO_4 + \mathbf{9}\ H_2SO_4 + \mathbf{28}\ NO$

- ❖ Difference is 8 hydrogen atoms & 4 oxygen atoms
- ❖ Multiply H_2O molecule on the reactant side by '4'.Balanced equation is,

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

ADDITIONAL QUESTIONS:

1. Define 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.

2. What is 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 $g\ mol^{-1}$.
- ❖ **Examples:** Molar mass of hydrogen atom = 1.008 $g\ mol^{-1}$

3. Calculate relative molecular mass of glucose ($C_6H_{12}O_6$)

- Relative molecular mass of glucose ($C_6H_{12}O_6$) = (6 × 12) + (12 ×1.008) + (6 ×16)
  = 72+12.096+96
  = 180.096 u

4. Define 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.
- 273 K and 1 atm pressure (STP) – 22.4 L

5. Define : Basicity. Find the basicity of ortho-phosphoric acid. (Sep-20)

- The number of moles of ionisable H^+ ions present in 1 mole of the acid

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

- Basicity of H_3PO_4 = 3

6. Define : Acidity

- The number of moles of ionisable OH^- ion present in 1 mole of the base

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

- Acidity of KOH = 1

7. How will you find out the equivalent mass of an acid? Give example

$$E = \frac{Molar\ mass\ of\ the\ acid}{Basicity\ of\ the\ acid (or)\ equivalent\ Factor}$$

Basicity = no.of moles of ionisable H^+ ions present in 1 mole of the acid

Example : Gram equivalent of H_2SO_4 = 49 g eq^{-1}

8. How will you find out the equivalent mass of an base? Give example

$$E = \frac{Molar\ mass\ of\ the\ acid}{Acidity\ of\ the\ base\ (or)\ equivalent\ Factor}$$

Acidity = no.of moles of ionisable OH^- ions present in 1 mole of the base

Example : Gram equivalent of KOH = 56 g eq^{-1}

9. How will you find out the equivalent mass of an oxidizing agent?

$$E = \frac{Molar\ mass\ of\ the\ Oxiding\ agent}{no\ of\ moles\ of\ electron\ gained\ by\ one\ mole\ of\ the\ oxiding\ agent}$$

10. How will you find out the equivalent mass of an reducing agent?

$$E = \frac{Molar\ mass\ of\ the\ reducing\ agent}{no\ of\ moles\ of\ electron\ gained\ by\ one\ mole\ of\ the\ reducing\ agent}$$

11. Define – Whole number (n)

$$\text{Whole number (n)} = \frac{molar\ mass\ of\ the\ compound}{calculated\ empirical\ formula\ mass}$$

12. What is the empirical formula of the following ?

(i) Benzene (ii) Tartaric acid (iii) Lactic acid (iv) Hydrogen peroxide (v) Acetic acid

S .no	Compound	Molecular Formula	Empirical Formula
1	**Benzene**	C_6H_6	CH
2	**Tartaric acid**	$C_4H_6O_6$	$C_2H_3O_3$
3	**Lactic acid**	$C_3H_6O_3$	CH_2O
4	**Hydrogen peroxide**	H_2O_2	HO
5	**Acetic acid**	$C_2H_4O_2$	CH_2O

13. What is Empirical formula?

- 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.
- Empirical formula of acetic acid is CH_2O

14. Differentiate b/w empirical formula and molecular formula.

S .no	Empirical formula	Molecular formula
1	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 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.
2	Empirical formula of acetic acid is CH_2O	molecular formula of acetic acid is $C_2H_4O_2$

15. What do you understand by stoichiometry calculations? (or) Define 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.

16. What is meant by limiting agent? (June-22)

- 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.

17. What is excess agent? (or) What is meant by excess agent?

- The reactant other than the limiting reagents which are in excess are called the excess reagents.

18. What is the electronic concept of oxidation and reduction reactions?

- **Oxidation reactions** : It is defined as a reaction in which one or more electrons is lost, by atom, ion or molecule.

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

- **Reduction reactions** : It is defined as a reaction in which one or more electrons is gained by an atom, ion or molecule.

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

19. Define redox reaction. Give an example

- The reaction involving loss of electron is oxidation and gain of electron is reduction. Both these reaction take place simultaneously and are called as redox reaction.
- **Example** : $C + O_2 \rightarrow CO_2$

20. Write note on Combination reaction

- Redox reactions in which two substances combine to form a single compound are called combination reaction.
- **Example** : $C + O_2 \rightarrow CO_2$

21. Write note on 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.
- $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

22. Write note on displacement

- 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.
- **Metal displacement reactions:**

  $CuSO_4$ (aq) + Zn (s) $\rightarrow$ Cu (s) + $ZnSO_4$ (aq)

- **Non-metal displacement**

  $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

23. What are disproportionate reactions (or) What are Auto redox reaction? Give an example (JUNE -19)

- 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.
- $2H_2O_2 \rightarrow 2H_2O + O_2$

24. Predict the spontaneity of the reaction when a copper strip placed in zinc sulphate solution. Justify your answer.

- Place a metallic copper strip in zinc sulphate solution. If copper replaces zinc from zinc sulphate solution, Cu^{2+} ions would be released into the solution and the colour of the solution would change to blue. But no such change is observed.
- Therefore, we conclude that among zinc and copper, zinc has more tendency to release electrons and copper to accept the electrons.

25. Predict the type of Following reactions:

a) $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$

b) $C + O_2 \rightarrow CO_2$

c) $H_2O_2 \rightarrow 2\ H_2O + O_2$

a	**$2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$**	Decombination reaction
b	**$C + O_2 \rightarrow CO_2$**	Combination reaction
c	**$H_2O_2 \rightarrow 2\ H_2O + O_2$**	Disproportionate reactions

26. Arrange the following based on their reactivity – Justify. $ZnSO_4$, $AgNO_3$ and $CuSO_4$ (or) Arrange the order of following metals by electron releasing tendency. Copper, silver, zinc. (or) write the descending order of electron releasing tendencies of the Zn,Cu and Ag metals. Arrange the metals Zn , Cu and Ag in the descending order of their electron releasing tendency.

- The correct order is $ZnSO_4 > CuSO_4 > AgNO_3$ (or) Zinc > Copper > Silver

5 MARKS

1. Explain determination of Empirical Formula from Elemental Analysis Data.

- **Step 1:** Since the composition is expressed in percentage, we can consider the total mass of the compound as 100 g and the percentage values of individual elements as mass in grams.
- **Step 2:** Divide the mass of each element by its atomic mass. This gives the relative number of moles of various elements in the compound.
- **Step 3:** Divide the value of relative number of moles obtained in the step 2 by the smallest number of them to get the simplest ratio.
- **Step 4:** (only if necessary) in case the simplest ratios obtained in the step 3 are not whole numbers then they may be converted into whole number by multiplying by a suitable smallest number.

2. What is oxidation number? State the rules to find the 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. A term that is often used interchangeably with oxidation number is oxidation state

- The oxidation state of a free element (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.
- Hydrogen has an oxidation number of +1 in all its compounds except in metal hydrides where it has – 1 value.

  Example: Oxidation number of hydrogen in hydrogen chloride (HCl) is + 1.

  Oxidation number of hydrogen in sodium hydride (NaH) is –1.
- Fluorine has an oxidation state of – 1 in all its compounds.
- The oxidation state of oxygen in most compounds is –2. Exceptions are peroxides, super oxides and compounds with fluorine. **Example :** Oxidation number of oxygen in water (H_2O) is –2.
- Alkali metals have an oxidation state of + 1 and alkaline earth metals have an oxidation state of + 2 in all their compounds.

Problems related to Mole concept:

1. **How many moles of H_2 is required to produce 10 moles of NH_3?**

The balanced stoichiometric equation for the formation of ammonia is

$$N_2(g) + 3\,H_2\,(g) \rightarrow 2\,NH_3\,(g)$$

$$2\;moles\;of\;NH_3 = 3\;moles\;of\;H_2$$

$$2 \text{ x } 10\;moles\;of\;NH_3 = 3\;3\;moles\;of\;H_2\;x\;10\;moles\;of\;NH_3$$

∴ to produce 10 moles of ammonia $= \frac{3\;moles\;of\;H_2}{2\;moles\;of\;NH_3}\,x\;10\;moles\;of\;NH_3$

= 15 moles of hydrogen are required.

2. **Calculate the amount of H_2O produced by combustion of 32 g CH_4.**

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

As per the stoichiometric equation, Combustion of 1 mole (16 g) CH_4 produces 2 moles (2 × 18 = 36 g) of water.

Molar mass of CH_4 = 12 + (4 x 1) = 16 g mol^{-1}

Molar mass of H_2O = (2 x 1) + 16 = 18 g mol^{-1}

Combustion of 32 g CH_4 produces = $\frac{36\;g\;H_2O}{16\;g\;CH_4}\;x$ 32 g CH_4

= 72 g of water

3. How much volume of carbon dioxide is produced when 50 g of solid calcium carbonate is heated under standard conditions?

The balanced chemical equation is, $CaCO_3 (s) \rightarrow CaO(s) + CO_2 (g)$

As per the stoichiometric equation, 1 mole (100g) $CaCO_3$ on heating produces 1 mole CO_2

Molar mass of $CaCO_3$ = 40 +12 + (3 x 16) = 100 g mol^{-1}

At STP, 1 mole of CO_2 occupies a volume of 22.7 litres

∴ At STP, 50 g of $CaCO_3$ on heating produces $= \frac{22.7\ litres\ of\ CO_2}{100\ g\ CaCO_3} \ x$ 50 g $CaCO_3$

= 11.35 litres of CO_2

4. How much volume of chlorine is required to form 11.2 L of HCl at 273 K and 1 atm. pressure?

The balanced equation for the formation of HCl is $H_2 (g) + Cl_2 (g) \rightarrow 2\ HCl (g)$

As per the stoichiometric equation, under given conditions,

To produce 2 moles of HCl, 1 mole of chlorine gas is required

To produce 44.8 litres of HCl, 22.4 litres of chlorine gas are required.

∴ To produce 11.2 litres of HCl = $\frac{22.4\ litres\ of\ Cl_2}{44.8\ L\ of\ HCl} \ x$ 11.2 L of HCl

== 5.6 litres of chlorine are required.

5. Calculate the percentage composition of the elements present in magnesium carbonate. How many kilogram of CO_2 can be obtained by heating 1 kg of 90 % pure magnesium carbonate?

The balanced chemical equation is $MgCO_3 \xrightarrow{\Delta} MgO + CO_2$

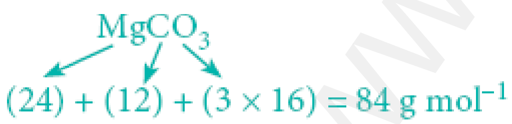
Molar mass of $MgCO_3$ is 84 g mol^{-1}.

84 g $MgCO_3$ contain 24 g of Magnesium.

∴ 100 g of $MgCO_3$ contain = $\frac{24\ g\ Mg}{84\ g\ MgCO_3} \ x$ 100 g $MgCO_3$

= 28.57 g Mg.

i.e. percentage of magnesium = 28.57 %.



∴ 100 g $MgCO_3$ contain = $\frac{12\ g\ C}{84\ g\ MgCO_3} \ x$ 100 g $MgCO_3$

= 14.29 g of carbon.

∴ Percentage of carbon = 14.29 %.

84 g $MgCO_3$ contain 48 g of oxygen

∴ 100 g $MgCO_3$ contains = $\frac{48\ g\ O}{84\ g\ MgCO_3} \ x$ 100 g $MgCO_3$

= 57.14 g of oxygen.

∴ Percentage of oxygen = 57.14 %.

As per the stoichiometric equation, 84 g of 100 % pure $MgCO_3$ on heating gives 44 g of CO_2.

∴ 1000 g of 90 % pure $MgCO_3$ gives = $\frac{44\ g\ O}{84\ g\ MgCO_3}$ x 90 % x 1000 g

= 471.43 g of CO_2

= 0.471 kg of CO_2

Problems related to Equivalent Mass:

1. **Calculate the equivalent mass of H_2SO_4 (Mar-19)**

   H_2SO_4 basicity = 2 eq mol^{-1}

   Molar mass of H_2SO_4 = (2x1) + (1x32) + (4x16)

   = 98 g mol^{-1}

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

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

2. **Calculate the equivalent mass of KOH.**

   KOH basicity = 1 eq mol^{-1}

   Molar mass of KOH = (1x39) + (1x16) + (1x1)

   = 56 g mol^{-1}

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

   Gram equivalent of KOH = $\frac{56}{2}$ = 56 g eq^{-1}

3. **Calculate the equivalent mass of Mn in $KMnO_4$ (in acid medium). (or) calculate the equivalent mass of potassium permanganate .The reduction Half reaction is acid medium is $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$.**

   $KMnO_4$ is an oxidizing agent,

   Molar mass of $KMnO_4$ = (1x39) + (1 x 55) + (4x16)

   = 158 g mol^{-1}

   $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

   n = 5 eq mol^{-1}

   $$E = \frac{Molar\ mass\ of\ the\ Oxiding\ agent}{\begin{matrix} no\ of\ moles\ of\ electron\ gained \\ by\ one\ mole\ of\ the\ oxiding\ agent \end{matrix}}$$

   Equivalent mass of $KMnO_4$ = $\frac{158}{5}$ = 31.6 g eq^{-1}

Problems related to Molecular and Empirical formula:

1. **An acid found in tamarinds on analysis shows following percentage composition: 32% Carbon; 4% Hydrogen; 64% Oxygen. Find the empirical formula of the compound.**

Element	%	Molar mass	Relative no.of moles	Simplest ratio	Simplest ratio (in whole number)
C	32	12	$\frac{32}{12} = 2.66$	$\frac{2.66}{2.66} = 1$	2
H	4	1	$\frac{4}{1} = 4$	$\frac{4}{2.66} = 1.5$	3
O	64	16	$\frac{64}{16} = 4$	$\frac{4}{2.66} = 1.5$	4

The empirical formula is $C_2H_3O_3$

2. **An organic compound present in vinegar has 40 % carbon, 6.6 % hydrogen and 53.4 % oxygen. Find its Empirical formula.**

Element	%	Atomic mass	Relative no.of moles	Simplest ratio	Simplest ratio (in whole number)
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

3. **A compound having the empirical formula C_6H_6O has the vapour density 47. Find its Molecular formula. (Mar-19)**

Empirical formula = $C_6 H_6 O$

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

$$= \frac{2\ x\ vapour\ density}{94}$$

$$= \frac{2x47}{94} = 1$$

Molecular Formula $(C_6H_6O) \times 1 = C_6H_6O$

Problems related to Oxidation state:

1. **Calculate oxidation number of oxygen in H_2O_2. (Mar-19)**

S.No	Oxidation number of the element	Compound	Calculation
1	O	H_2O_2	2(+1) + 2x = 0 2x = -2 x = -1

2. **Calculate the oxidation number of underlined elements. a) $\underline{C}O_2$ b) $H_2\underline{S}O_4$ (May-22)**

S.No	Oxidation number of the element	Compound	Calculation
1	C	CO_2	x + 2 (– 2) = 0 x = +4
2	S	H_2SO4	2 (+ 1) + x + 4 (– 2) = 0 2 + x – 8 = 0 x = +6

3. **Find the oxidation state of underlined element:**

a) $\underline{Cr}_2O_7{}^{2-}$ b) $\underline{C}H_2F_2$ c) $\underline{S}O_2$ d) $\underline{Mn}O_4^-$ e) $\underline{O}F_2$ f) $K\underline{O}_2$ g) $Na_2\underline{S}_2O_3$ h) $K\underline{Cl}O_3$

i) $H\underline{N}O_3$ j) $\underline{Cr}_2O_3$

S.No	Oxidation number of the element	compound	Calculation
1	Cr	$Cr_2O_7^{2-}$	2x + 7(-2) = -2 2x-14 = -2 x = +6
2	C	CH_2F_2	x+ 2(+1) + 2(-1) = 0 x = 0
3	S	SO_2	x+ 2(-2) = 0 x = +4
4	Mn	MnO_4^-	x + 4 (-2) = -1 x = -1 +8 x= +7
5	O	OF_2	x + 2 (-1) = 0 x = +2
6	O	KO_2	+1 + 2x = 0 2x = -1 x = - ½

7	S	$Na_2S_2O_3$	2(+1) + 2x + 3(-2) = 0 2x + 2-6=0 2x = +4 x =+2
8	Cl	$KClO_3$	(+1) + x + 3(-2) = 0 x +1 -6=0 x = +5
9	N	HNO_3	+1 + x + 3(-2)= 0 x+1-6=0 x = +5
10	Cr	Cr_2O_3	2x + 3(-2) = 0 2x -6 = 0 2x= 6 x =3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