Chapter 1

Some Basic Concepts of Chemistry

Solutions

SECTION - A

Objective Type Questions (One option is correct)

1. 1.16 g of Metal M react with excess of O_2 and convert all metal M into M_3O_2(s). The maximum amount of M_3O_2(s) produced is (atomic mass of M = 58 g/mol)

   (1) 1.16 g (2) 1.37 g

   (3) 1.64 g (4) 2.2 g

Sol. Answer (2)

Mol of M = $\frac{1.16}{58} = 0.02$

$3M + O_2 \rightarrow M_3O_2$

Mol of M_3O_2 formed = $\frac{1}{3} \times 0.02 = 0.0066$

Mass of M_3O_2 = 1.373 g

2. 4.6 g Na is dissolved in 1 litre of water. Then how much H_2 gas will be evolved at S.T.P.?

   (1) 2.24 L (2) 1.12 L (3) 4.48 L (4) 11.2 L

Sol. Answer (1)

$2Na + 2H_2O \longrightarrow 2NaOH + H_2$

3. A metal carbonate (0.5 kg) gives 0.28 kg of its oxide on heating. Hence, the equivalent weight of metal is

   (1) 20 g eq^{-1} (2) 40 g eq^{-1} (3) 25 g eq^{-1} (4) 30 g eq^{-1}

Sol. Answer (1)

$MCO_3 \longrightarrow MO + CO_2$

$\frac{500}{E+30} = \frac{280}{E+8}$; $E = 20$ g eq^{-1}

4. One mole of $KClO_3$ is heated in presence of MnO_2. The produced oxygen is used in burning of Al. Then oxide of Al that will be formed

(1) 2 moles (2) 1 mole (3) 4 moles (4) 3 moles

Sol. Answer (2)

$$KClO_3 \xrightarrow{\Delta} KCl + \frac{3}{2}O_2$$

$$2Al + \frac{3}{2}O_2 \longrightarrow Al_2O_3$$

5. 24 g of carbon is burnt in presence of air, the gas produced form 1M dibasic acid when passed through 1L water, then correct statement is

(1) 12 g C react to form CO_2 (2) 8 g C react to form CO

(3) 16 g C react to form CO (4) 9 g C react to form CO_2

Sol. Answer (1)

$$C + O_2 \longrightarrow CO_2$$

$$2C + O_2 \longrightarrow 2CO$$

6. When a gaseous olefinic hydrocarbon is burnt completely in excess of O_2, a contraction in volume equal to double to the volume of hydrocarbon is noticed then hydrocarbon will be

(1) C_2H_2 (2) C_2H_4 (3) C_2H_6 (4) C_3H_8

Sol. Answer (2)

$$C_xH_{2x} + \frac{3x}{2}O_2 \longrightarrow xCO_2 + xH_2O$$

Contraction in volume $\left(V + \frac{3xV}{2}\right) - xV$

7. Choose the incorrect match regarding equivalent weight (M = Molar mass of acid)

Acid	Equivalent wt.
(1) H_3PO_2	$-M$
(2) H_3PO_4	$-\frac{M}{3}$
(3) H_3BO_3	$-\frac{M}{3}$
(4) H_2SO_4	$-\frac{M}{2}$

Sol. Answer (3)

H_3BO_3 is mono basic.

8. An element A reacts with compound BO_3 to produce A_3O_4 and B_2O_3. The no. of moles of A_3O_4 produced if one mole each of A and BO_3 is reacted, is

(1) 3 (2) $\frac{1}{3}$ (3) $\frac{2}{3}$ (4) 1

Sol. Answer (2)

$$6A + 4BO_3 \longrightarrow 2A_3O_4 + 2B_2O_3$$

9. Metal chloride contains 71% chlorine. Then calculate equivalent weight of that metal bromide (at. wt. Br = 80)

(1) 14.5 (2) 85 (3) 94.5 (4) 100

Sol. Answer (3)

Eq. wt. of metal = 14.5

Eq. wt. of metal Bromide = 80 + 14.5 = 94.5

10. Which of the following has highest number of neutrons?

(1) 44 g of CO_2 (2) 28 g $_{26}Fe^{56}$ (3) 80 g H_2 (4) 100 g He

Sol. Answer (4)

No. of neutron = 25 N_A × 2 = 50 N_A.

11. Which of the following has maximum weight?

(1) 1 mole of electron (2) 1 mole of neutron (3) 1 mole proton (4) 1 mole of α particle

Sol. Answer (4)

α -particle is helium nucleus.

12. A compound contains elements X and Y in 1 : 4 mass ratio. If the atomic masses of X and Y are in ratio 1 : 2, then empirical formula will be

(1) XY (2) XY_2 (3) X_2Y (4) X_4Y

Sol. Answer (2)

$$\begin{matrix} & X & Y \\ \text{Mass ratio} = & 1 & : 4 \end{matrix}$$

Atomic ratio: 1 : 2

Mole ratio = X : Y_2

13. In which of the following reactions, law of mass conservation is not valid?

(1) $_4Be^9 + {}_2He^4 \longrightarrow {}_6C^{12} + {}^1_0n$ (2) $C + O_2 \longrightarrow CO_2$

(3) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ (4) $NaOH + HCl \longrightarrow NaCl + H_2O$

Sol. Answer (1)

This reaction is an example of nuclear reaction.

14. Molarity of pure D_2O will be (assume density of D_2O is 1 g/ml)

(1) 55.56 (2) 1 (3) 50 (4) 10

Sol. Answer (3)

$$\text{Molarity} = \frac{1000}{20} = 50$$

15. 1 ml of gaseous aliphatic compound $C_nH_{3n}O_m$ is completely burnt in an excess of O_2 and cooled to room temperature. The contraction in volume is

(1) $\left(1+\frac{1}{2}n-\frac{3}{4}m\right)$ (2) $\left(1+\frac{1}{4}n-\frac{1}{4}m\right)$ (3) $\left(1+\frac{3}{4}n-\frac{1}{4}m\right)$ (4) $\left(1+\frac{3}{4}n-\frac{1}{2}m\right)$

Sol. Answer (4)

$$C_nH_{3n}O_m + \frac{\left(2n+\frac{3n}{2}-m\right)}{2}O_2 \longrightarrow nCO_2 + \frac{3n}{2}H_2O(l)$$

$$\text{Contraction} = 1 + \frac{\left(2n+\frac{3n}{2}-m\right)}{2} - n = 1+\frac{3n}{4}-\frac{m}{2}$$

16. 1 mole of aliphatic compound $C_nH_{3n}O_m$ is completed burnt in an excess of O_2. The number of moles of oxygen reacted are

(1) $n+\frac{3n}{4}-\frac{m}{2}$ (2) $n+\frac{3n}{2}-\frac{m}{2}$ (3) $n+\frac{3n}{4}+\frac{m}{2}$ (4) $n+\frac{3n}{4}-\frac{m}{4}$

Sol. Answer (1)

As solution 15

$$\text{Required } O_2 = n+\frac{3n}{4}-\frac{m}{2}$$

17. 1 mol of gaseous compound $C_nH_{3n}O_m$ is completely burnt in excess of O_2. The number of moles of CO_2 formed is

(1) n (2) n/2 (3) 2n (4) 3n

Sol. Answer (1)

As solution 15

Moles of CO_2 = n

18. 1 mole of gaseous aliphatic compound $C_xH_{3n}O_m$ is completely burnt in excess of O_2 . The no. of moles of H_2O is formed

(1) n (2) 3n/2 (3) 2n (4) 3n

Sol. Answer (2)

As solution 15

$$\text{Moles of } H_2O = \frac{3n}{2}$$

19. 1 litre of gaseous aliphatic compound $C_xH_yO_z$ is completely burnt in excess of O_2 and cooled to room temperature. The contraction in volume is

(1) $x+\frac{y}{4}-\frac{z}{2}$ (2) $1+\frac{y}{4}-\frac{z}{2}$ (3) $x+\frac{y}{2}-\frac{z}{2}$ (4) $1-\frac{y}{4}+\frac{z}{2}$

Sol. Answer (2)

$$C_xH_yO_z + \frac{\left[2x+\frac{y}{2}-z\right]}{2}O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$$

$$\text{Contraction} = 1+\frac{\left(2x+\frac{y}{2}-z\right)}{2}-x = 1+\frac{y}{4}-\frac{z}{2}$$

20. 1 litre of aliphatic compound $C_xH_yO_z$ is completely burnt in an excess of O_2 and cooled to room temperature. The reacted volume of oxygen will be

(1) $x+\frac{y}{4}-\frac{z}{2}$ (2) $x+\frac{y}{2}-\frac{z}{2}$ (3) $\frac{y}{4}-\frac{z}{2}$ (4) $\frac{y}{8}-\frac{z}{4}$

Sol. Answer (1)

SECTION - B

Objective Type Questions (More than one options are correct)

1. 1 mole of CO_2 contains

(1) 6.023×10^{23} atoms of O (2) 6.023×10^{23} atoms of C

(3) 6.023×10^{23} molecules of CO_2 (4) All of these

Sol. Answer (2, 3)

1 mole CO_2 contains N_A no. of molecules

$\because$ 1 molecule of CO_2 contain 1 C atom

$\therefore$ N_A molecule of CO_2 contain N_A C atom

$\because$ 1 molecule of CO_2 contains 2 O atom

$\therefore$ N_A molecule of CO_2 contains = $2 \times N_A$ O atom

N_A = Avogadro number

$= 6.023 \times 10^{23}$

2. Which of the following contains the same number of atoms?

(1) 1 g of O (2) 1 g of O_2 (3) 1 g O_3 (4) 1 g F_2

Sol. Answer (1, 2, 3)

$$\text{Number of atoms of O in 1 gm O} = \frac{1}{16}\times N_A \times 1 = \frac{N_A}{16}$$

$$\text{Number of atoms of O in 1 gm } O_2 = \frac{1}{32}\times N_A \times 2 = \frac{N_A}{16}$$

$$\text{Number of atoms of O in 1 gm } O_3 = \frac{1}{48}\times N_A \times 3 = \frac{N_A}{16}$$

$$\text{Number of atoms of F} = \frac{1}{38}\times N_A \times 2 = \frac{N_A}{19}$$

(1), (2), (3) have same number of atoms and greatest number of atoms also.

3. Atomic masses of many elements are non-integral because

(1) They have isotopes

(2) The isotopes have non-integral atomic masses

(3) Their isotopes have different masses

(4) The constituents neutrons, protons and electrons combine to give fractional masses

Sol. Answer (1, 3)

Facts

4. Which of the following pairs follow law of multiple proportion?

(1) CO_2, CO (2) Fe_2O_3, $Fe_{0\cdot90}O$ (3) $^{12}CO_2$, ^{14}CO (4) N_2O_4, N_2O_3

Sol. Answer (1, 4)

For isotope, law of multiple proportions is not valid.

5. Largest number of bond pair will be in

(1) 30 g C_2H_6 (2) 24 g C_2H_2 (3) 14 g H_2 (4) 44 g CO_2

Sol. Answer (1, 3)

Mole of H_2 = 7

No. of bond pair = 7 × 1 = 7

6. Choose the correct match/matches.

(1) 18 ml of H_2O at 4°C — N_A molecule of H_2O

(2) 11.2 L of CO_2 at 273°C and 1 atm — $\frac{N_A}{2}$ molecule of CO_2

(3) 56 g of Fe^{57} — N_A atom

(4) 5.6 L of CH_4 at 273 K and 1 atm — weigh 4 g

Sol. Answer (1, 4)

1 mole of Fe^{57} = 57 g

7. Out of following, which molecules has same weight under identical volume at STP?

(1) $^{14}CO_2$ (2) NO_2 (3) $^{13}CO_2$ (4) CO_2^{18}

Sol. Answer (1, 2)

If molecular weight for different gas is same then under identical volume, weight will be same.

8. 10 g carbon reacts with 100 g Cl_2 to form CCl_4. The correct statement is

(1) Carbon is the limiting reagent (2) Cl_2 is the limiting reagent

(3) 107.8 g CCl_4 is formed (4) 0.833 moles of CCl_4 are formed

Sol. Answer (2, 3)

$$C + 2Cl_2 \longrightarrow CCl_4$$

moles of C = $\frac{10}{12}$ = 0.833

moles of $Cl_2 = \frac{100}{71} = 1.40$

$$C\begin{bmatrix}1\,\text{mole C} \Rightarrow 1\,\text{mole } CCl_4\\ 0.833\,\text{mole} \Rightarrow 0.833\,\text{mole } CCl_4\end{bmatrix}$$

$$O\begin{bmatrix}2\,\text{mole } Cl_2 \Rightarrow 1\,\text{mole } CCl_4\\ 1.40\,\text{mole } Cl_2 \Rightarrow 0.70\,\text{mole } CCl_4\end{bmatrix}$$

Cl_2 is limiting reagent because it forms least number of moles of product.

$W_{CCl_4} = 0.70 \times 154$

$= 107.8$ g

9. For the reaction,

$A + 2B \rightarrow 2C$,

5 moles of A and 8 moles of B are reacted, then

(1) Whole A is consumed
(2) Whole B is consumed
(3) 8 moles of C are formed
(4) 8 equivalents of C are formed

Sol. Answer (2, 3)

$$A + 2B \longrightarrow 2C$$

$$A\begin{bmatrix}1\,\text{mole} \Rightarrow 2\,\text{mole C}\\ 5\,\text{mole} \Rightarrow 10\,\text{mole C}\end{bmatrix}$$

$$B\begin{bmatrix}2\,\text{mole} \Rightarrow 2\,\text{mole C}\\ 8\,\text{mole} \Rightarrow 8\,\text{mole C}\end{bmatrix}$$

B forms least number of moles of product hence B is limiting reagent.

Moles of C formed = 8

10. For the reaction,

$A + 2B \rightarrow C + 2D$.

The correct statement is

(1) Equivalents of A = 2 × equivalents of B
(2) Moles of A reacted = Moles of D formed
(3) Equivalents of B = Equivalents of C
(4) Moles of B reacted = 2 × Moles of C formed

Sol. Answer (3, 4)

$$A + 2B \longrightarrow C + 2D$$

Number of eq. of A = number of eq. of B = number of eq. of C = number of eq. of D

Moles of A reacted = 2 × moles of D formed

Moles of B reacted = 2 × moles of C formed

11. Which of the following pairs have same number of molecules?

(1) 2 g of O_2, 4 g of SO_2

(2) 2 g CO_2, 2 g of N_2O

(3) 224 ml O_2 at STP, 448 ml of He at 0.5 atm and 273 K

(4) 2 g oxygen and 2 g ozone

Sol. Answer (1, 2, 3)

(1) 2 g O_2 = $\left(\frac{2}{32}\right)\times N_A = \frac{N_A}{16}$ molecules

4 g SO_2 = $\left(\frac{4}{64}\right)\times N_A = \frac{N_A}{16}$ molecules

(2) 2 g CO_2 = $\left(\frac{2}{44}\right)\times N_A = \frac{N_A}{22}$ molecules

2 g N_2O = $\left(\frac{2}{44}\right)\times N_A = \frac{N_A}{22}$ molecules

(3) 224 ml O_2 at STP = $\left(\frac{224}{22400}\right)\times N_A = \frac{N_A}{100}$ molecules

$= 10^{-2}\ N_A$

448 ml of He at 0.5 atm and 273 K

PV = nRT

$n = \frac{PV}{RT} = \frac{0.5\times\frac{448}{1000}}{0.0821\times 273} = 10\times10^{-3} = 1\times10^{-2}$ moles

molecules = $1 \times 10^{-2}\ N_A$

(4) 2 g oxygen = $\left(\frac{2}{32}\right)\times N_A = \frac{N_A}{16}$

2 g ozone = $\left(\frac{2}{48}\right)\times N_A = \frac{N_A}{24}$

12. 12 g of Mg will react completely with an acid to give

(1) 1 mole of O_2 (2) $\frac{1}{2}$ mole of H_2 (3) 1 equivalent of H_2 (4) 2 equivalents of H_2

Sol. Answer (2, 3)

Number of eq. of Mg = Number of eq. of H_2

$\frac{12}{24}\times 2 = \frac{W_{H_2}}{E_{H_2}}$

$$1 = \frac{W_{H_2}}{1}$$

$$W_{H_2} = 1$$

$$n_{H_2} = \frac{W_{H_2}}{M_{H_2}} = \frac{1}{2} \text{ mole}$$

Number of eq. of Mg = 1

Hence number of eq. of H_2 = 1

Magnesium does not liberate O_2 on reaction with an acid.

13. 11.2 L of CH_4 and 22.4 L of C_2H_6 at STP are mixed. Then choose correct statement/statements

(1) Vapour density of the mixture is 12.67

(2) Average molecular wt. will be less than 16

(3) Average molecular wt. will be greater than 16 and less than 30

(4) Average molecular weight will be greater then 30

Sol. Answer (1, 3)

Average molecular wt. = $\frac{1}{3} \times 16 + \frac{2}{3} \times 30$

= 5.33 + 20 = 25.33

14. Which of the following is/are independent of temperature?

(1) Molarity (2) Molality (3) Mole fraction (4) Normality

Sol. Answer (2, 3)

Molarity and normality contain volume while molality and mole fraction contain weight hence molality and mole fraction is independent of temperature.

15. 4 g of NaOH can be neutralised by

(1) 100 ml of 1N HCl (2) 200 ml of $\frac{N}{2}$ H_2SO_4

(3) 1000 ml of $\frac{N}{10}$ KOH (4) 200 ml of $\frac{M}{20}$ H_3PO_4

Sol. Answer (1, 2)

Equivalent of NaOH $= \frac{4}{40} = \frac{1}{10}$

Eq. of HCl = $\frac{100}{1000} \times 1 = \frac{1}{10}$

Eq. of H_2SO_4 = $\frac{200}{1000} \times \frac{1}{2} = \frac{1}{10}$

Eq. of H_3PO_4 = $\frac{200}{1000} \times 3 \times \frac{1}{20} = \frac{3}{100}$

16. 100 ml of 0.02 N oxalic acid is equivalent to

(1) 100 ml of 0.01 M oxalic acid

(2) 6.023×10^{20} molecules of oxalic acid

(3) 50 ml of 0.02 M oxalic acid

(4) 100 ml of 0.02 M oxalic acid

Sol. Answer (1, 2, 3)

Number of eq. of oxalic acid

$$= 0.02 \times \frac{100}{1000} = 0.002$$

(1) Number of eq. of $H_2C_2O_4$

$$= \left(0.01 \times \frac{100}{1000}\right) \times 2 = 0.002$$

(2) Number of eq. of oxalic acid

$$= \left(\frac{6.023 \times 10^{20}}{6.023 \times 10^{23}}\right) \times 2 = 2 \times 10^{-3} = 0.002$$

(3) Number of eq. of oxalic acid

$$= \left(0.02 \times \frac{50}{1000}\right) \times 2 = 0.002$$

(4) Number of eq. of oxalic acid

$$= \left(0.02 \times \frac{100}{1000}\right) \times 2 = 0.004$$

(1), (2), (3) are correct.

17. 1 gram atom of Na is equivalent to

(1) 1 gram equivalent of Na

(2) 13 g

(3) 23 g

(4) 1 g

Sol. Answer (1, 3)

1 g atom of Na

= 1 mole Na

= 23 gm

for Na, n factor = 1

Number of eq. = Number of moles × nf

= 1 × 1

= 1

18. Choose the correct statement regarding equivalent weight.

(1) Equivalent weight of a substance always remain same

(2) Equivalent weight of substance depends on reaction

(3) Equivalent weight may be equal to atomic weight

(4) Equivalent weight may be less than atomic weight

Sol. Answer (2, 3, 4)

Fact.

19. A given solution of H_2SO_4 is labelled as 49% (w/w), then correct statement regarding the solution is (d = 1.3 g/ml)

(1) $m = \frac{500}{51}$ (2) $N = \frac{1000}{51}$ (3) % w/v = (49 × 1.3)% (4) M = 6.5

Sol. Answer (1, 3, 4)

$$m = \frac{49}{98} \times \frac{1000}{51} = \frac{500}{51}$$

$$N = \frac{49}{49} \times \frac{1000}{100} \times d = 10d \text{ (where d = density) = 13}$$

20. 0.5 g of fuming H_2SO_4 oleum is diluted with water. This solution is completely neutralised by 26.7 ml of 0.4 N NaOH. The correct statement is/are

(1) Mass of SO_3 is 0.104 g (2) % of free SO_3 = 20.7

(3) Normality of H_2SO_4 for neutralization is 0.2 N (4) Weight of H_2SO_4 is 0.104 g

Sol. Answer (1, 2)

Let 0.5 gm fuming H_2SO_4 contains x gm SO_3.

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

1 mole SO_3 gives 1 mole H_2SO_4

$\frac{x}{80}$ mole SO_3 give, $\frac{x}{80}$ mole H_2SO_4

Total number of moles of

$$H_2SO_4 = \frac{x}{80} + \frac{0.5 - x}{98}$$

Number of eq. of H_2SO_4 = Number of eq. of NaOH

$$\left(\frac{x}{80} + \frac{0.5 - x}{98}\right) \times 2 = 0.4 \times \frac{26.7}{1000}$$

On solving, x = 0.104 gm

Percentage of free SO_3 = 20.7%

SECTION - C

Linked Comprehension Type Questions

Comprehension-I

Atoms of same element having same atomic number and different atomic mass are known as isotopes. If atomic masses of two isotopes of an element are A_1 and A_2 and they exist in the ratio $P_1 : P_2$, then average atomic mass

$$A_{avg} = \frac{A_1P_1 + A_2P_2}{P_1 + P_2}$$

1. Which isotope can be used to decide the scale of atomic mass?

(1) $_6C^{12}$ (2) $_7N^{15}$ (3) $_{11}Na^{24}$ (4) $_6C^{14}$

Sol. Answer (1)

$_6C^{12}$ is not radioactive hence can be used to decide the scale of atomic mass.

2. If % abundance of two isotopes of carbon $_6C^{12}$ and $_6C^{14}$ are 90% and 10% respectively then number of C-12 atoms in 12 g of sample will be approximately

(1) 0.44 N_A (2) 0.88 N_A (3) 0.22 N_A (4) 0.11 N_A

Sol. Answer (2)

Average atomic mass

$$= \frac{A_1P_1 + A_2P_2}{100} = \frac{12\times 90 + 14\times 10}{100} = \frac{1220}{100} = 12.2$$

Moles of carbon present in 12 g sample = $\frac{12}{12.2} = 0.98$

Total number of C-atoms present in 12 g = 0.98 N_A

Since C-12 atoms are 90% of total atoms, hence number of C-12 atoms present in the sample

$$= 0.98N_A \times \frac{90}{100} = 0.88\ N_A$$

3. If average atomic mass of Cl is 35.5. Chlorine exist in nature in the form of two isotopes $_{17}Cl^{35}$ and $_{17}Cl^{37}$, then ratio in which they exist in nature will be

(1) 1 : 1 (2) 3 : 1 (3) 2 : 1 (4) 3 : 2

Sol. Answer (2)

Let % of $_{17}Cl^{35}$ = x and $_{17}Cl^{37}$ = 100 – x

$$\frac{A_1P_1 + A_2P_2}{100} = 35.5$$

$$\frac{35x + 37(100 - x)}{100} = 35.5$$

35x + 3700 – 37x = 3550

37x – 35x = 3700 – 3550

2x = 150

x = 75

100 – x = 25

Ratio of $_{17}Cl^{35}$: $_{17}Cl^{37}$ = 75 : 25 = 3 : 1

Comprehension-II

Avogadro's law states that under similar condition of T and P, equal volumes of gases contain equal number of particles. Experiments show that at one atmosphere pressure and at a temperature 273 K (*i.e.* at STP) one mole of any gas occupies a volume approximately 22.4 litres. Therefore number of moles of any sample of gas can be found by comparing its volume at STP with 22.4.

1 mole of any species contains 6.023×10^{23} particles which is denoted by symbol N_A. Number of atoms present in 1 gm-atom of an element or number of molecules present in 1 gm-molecule of any substance is equal to N_A. Hence it is number of particles present in one mole of the substance.

1. If N_{AV} is Avogadro's number, then 10 amu will be equal to _____ gram

(1) $10\ N_{AV}$ (2) $\frac{N_{AV}}{10}$ (3) $\frac{10}{N_{AV}}$ (4) N_{AV}

Sol. Answer (3)

$$1 \text{ amu} = \frac{1}{12} \times \text{mass of one C} - 12 \text{ atom}$$

$$= \frac{1}{12} \times \frac{12}{N_{AV}} = \frac{1}{N_{AV}}$$

$$\therefore \quad 10 \text{ amu} = \frac{10}{N_{AV}}$$

2. At STP 11.2 L of CO_2 contains

(1) 1 mol (2) 2 mol (3) 0.5 mol (4) 3 mol

Sol. Answer (3)

$$\text{Moles of } CO_2 = \frac{\text{Volume}}{\text{Molar volume}}$$

$$= \frac{11.2}{22.4} = 0.5 \text{ mole}$$

3. The number of g atoms of oxygen present in 0.2 mole of $H_2S_2O_8$ is

(1) 0.2 (2) 8 (3) 1.6 (4) 0.8

Sol. Answer (3)

$\because$ 1 mole $H_2S_2O_8$ contains 8 g atoms of O

$\therefore$ 0.2 mole $H_2S_2O_8$ will contain = 0.2×8

= 1.6 g atoms of O

Comprehension-III

All chemical reactions take place under certain laws out of which three laws are given here.

(i) Law of conservation of mass: According to this law, total mass of reactants is equal to total mass of products.

(ii) Law of constant composition: According to this law, a chemical compound is always found to be made up of same elements combined together in fixed proportion by weight.

(iii) Law of multiple proportion: According to this law, when two elements are combined to form two or more chemical compounds, the weight of one of the elements which combine with a fixed weight of another bear a simple whole number ratio to one another.

1. 3 g of a hydrocarbon on combustion with 11.2 g of oxygen produces 8.8 g CO_2 and 5.4 g H_2O. The data illustrates

(1) Law of conservation of mass (2) Law of multiple proportions

(3) Law of definite proportions (4) Law of reciprocal proportions

Sol. Answer (1)

$m_{LHS} = m_{RHS}$

2. The percentage of carbon and oxygen in samples of CO_2 obtained by different methods were found to be the same. This illustrates

(1) Law of conservation of mass (2) Law of constant proportions

(3) Law of multiple proportions (4) Law of reciprocal proportions

Sol. Answer (2)

Fact.

Comprehension-IV

On being heated in oxygen 5.72 g of red metallic oxide A was converted to 6.36 gram black metallic oxide B. When 4.77 g of B was heated in a stream of H_2 gas, 3.81 g of metal M was formed. (Given, atomic weight of metal is 63.50)

1. The formula of red metallic oxide A is

(1) MO (2) MO_2 (3) M_2O (4) M_2O_3

2. The formula of black metallic oxide is

(1) MO (2) M_2O_5 (3) M_2O_3 (4) M_2O

3. The equivalent weight of metal M in B is

(1) 118.9 (2) 65.4 (3) 63.5 (4) 31.8

Solution of Comprehension-IV

In B, wt. of oxygen = 4.77 – 3.81 = 0.96 g

Equivalent of oxygen = $\frac{0.96}{8} = 0.12$

So, equivalent of metal = 0.12

Eq. wt. of metal in B = $\frac{3.81}{0.12} = \frac{381}{12} = 31.8$

By considering eq. wt. of metal in B

$\frac{5.72}{x+8} = \frac{6.36}{39.8}$, where x is the equivalent weight of metal in A

x = 63.5

Valency of metal in black oxide = $\frac{63.8}{31.8}$ = 2

So, formula is MO.

1. Answer (3)
2. Answer (1)
3. Answer (4)

Comprehension-V

36 ml of a gaseous mixture consisting of a gaseous organic compound A and just sufficient amount of oxygen required for complete combustion gives 16 ml of CO_2, 24 ml water vapour and 8 ml of N_2. The volumes are measured at same temperature and pressure.

1. Volume of O_2 required for complete combustion

(1) 8 ml (2) 28 ml (3) 74 ml (4) 22 ml

Sol. Answer (2)

2. The molecular formula of compound will be

(1) CH_5N (2) C_2H_5N (3) $C_2H_6N_2$ (4) $C_4H_{10}N_2$

Sol. Answer (3)

SECTION - D

Matrix-Match Type Questions

1. Match the following.

Column I	Column II
(A) Number of carbon atoms in 1 g molecule of CO_2	(p) $0.5\ N_0$
(B) Number of molecules in 48 g O_2	(q) N_0
(C) No. of molecules in 11.2 L H_2 at STP	(r) $3\ N_0$
(D) No. of hydrogen atoms in 1 Mole of NH_3 (N_0 = Avogadro's Number)	(s) $1.5\ N_0$

Sol. Answer A(q), B(s), C(p), D(r)

(A) No. of C-atoms in 1 g molecule of $CO_2 = N_0$

(B) No. of molecules in 48 g of $O_2 = \frac{48}{32} \times N_0 = 1.5\ N_0$

(C) No. of molecules in 11.2 L H_2 at STP $= \frac{N_0}{2} = 0.5\ N_0$

(D) No. of H-atoms in 1 mole of $NH_3 = 3 \times N_0 = 3N_0$

2. Match the following.

Column I	Column II
(A) $\underset{3g}{2H_2} + \underset{22.66g}{O_2} \longrightarrow 2H_2O$	(p) 25.5 g product is formed
(B) $\underset{24.5\ g}{N_2} + \underset{5.5\ g}{3H_2} \longrightarrow 2NH_3$	(q) 0.25 g of a reactant is left
(C) $\underset{1.4\ g}{H_2} + \underset{40g}{Cl_2} \longrightarrow 2HCl$	(r) H_2 is the limiting reagent
(D) $\underset{20g}{C} + \underset{6.375g}{2H_2} \longrightarrow CH_4$	(s) 41.12 g product

Sol. Answer A(p), B(q), C(s), D(r)

3. Match the following.

Column I	Column II (% by mass of oxygen)
(A) $Na_2S_2O_3$	(p) ≈ 30%
(B) $KMnO_4$	(q) ≈ 39%
(C) Na_3PO_4	(r) ≈ 57%
(D) $MgCO_3$	(s) ≈ 40.5%

Sol. Answer A(p), B(s), C(q), D(r)

4. Match the following.

Column I	Column II
(A) 1 g molecule of chlorine gas	(p) 14 L at STP
(B) 1 g equivalent of Br_2 gas	(q) 22.4 L at STP
(C) 32 g of CH_4 (g)	(r) 80 g
(D) 40 g SO_2 (g)	(s) 44.8 L at STP

Sol. Answer A(q), B(r), C(s), D(p)

SECTION - E

Assertion-Reason Type Questions

1. STATEMENT-1 : One mole of an ideal gas have volume of 22.4 litre at 1 atm at 273.15 K.

and

STATEMENT-2 : Under identical condition, equal weight of gases have same volume.

Sol. Answer (3)

Fact

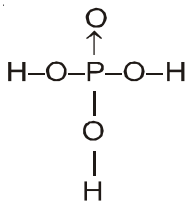
2. STATEMENT-1 : H_3PO_4 is a tribasic acid.

and

STATEMENT-2 : In H_3PO_4, only two H-atoms are replaceable.

Sol. Answer (3)

H_3PO_4



H_3PO_4 is a tribasic acid and its 3 H atoms are replaceable.

3. STATEMENT-1 : 18 g of water vapour and 18 g of ice will not contain the same number of molecules.

and

STATEMENT-2 : Number of molecules are independent of temperature and pressure.

Sol. Answer (4)

Since molecular mass of H_2O and ice are same, hence, 18 g H_2O and 18 g ice will contain same number of molecules.

4. STATEMENT-1 : Atomic mass of Mg is 24.

and

STATEMENT-2 : An atom of magnesium is 24 times heavier than $\frac{1}{12}^{th}$ of the mass of carbon atom (C^{12}).

Sol. Answer (1)

Atomic mass of Mg = 24

$_{12}Mg^{24}$

$$\text{Atomic mass} = \frac{\text{Mass of single atom of element}}{\frac{1}{12} \times \text{Mass of single atom of element}}$$

From above relation we can say that an atom of Mg is 24 times heavier than $\frac{1}{12}$ of the mass of C^{12}.

5. STATEMENT-1 : Atomic weight of an atom can never be in fraction.

and

STATEMENT-2 : Average atomic weight of chlorine is 35.5.

Sol. Answer (4)

Average atomic weight may be in fraction while atomic wt. of an atom never be in fraction.

6. STATEMENT-1 : Law of conservation of mass is generally applicable to all the chemical reactions.

and

STATEMENT-2 : Law of constant composition is not valid for non stoichiometric compound like $Fe_{0.93}O$.

Sol. Answer (2)

On chemical reaction, mass of reactants is equal to mass of products.

7. STATEMENT-1 : Solvent have always same physical state as that of solution.

and

STATEMENT-2 : Solution contains more than one solvent.

Sol. Answer (3)

In a solution, solvent is always one but solute may be more than one.

8. STATEMENT-1 : Molality is equal to molarity, if density of solution is one.

and

STATEMENT-2 : Molality does not depend on the temperature.

Sol. Answer (4)

If density is one then weight of solution is equal to volume of solution. To calculate molality, weight of solvent is required. Which is independent from temperature.

9. STATEMENT-1 : On dilution, molarity of solution changes.

and

STATEMENT-2 : Number of moles of solute in a solution does not change on dilution.

Sol. Answer (2)

On dilution, molarity decreases while number of moles of solute does not change.

10. STATEMENT-1 : Equivalent weight of an acid is always less than its molecular weight.

and

STATEMENT-2 : Equivalent weight of acid = $\frac{\text{Molecular weight}}{\text{n-factor}}$

Sol. Answer (4)

Equivalent weight of acid may be equal to molecular weight if basicity of acid is one.

11. STATEMENT-1 : In any chemical reaction, total no. of molecules are conserved.

and

STATEMENT-2 : Atom can neither be created nor be destroyed.

Sol. Answer (4)

Number of molecule may change in a reaction.

12. STATEMENT-1 : In a chemical reaction, total mass remains constant.

and

STATEMENT-2 : In chemical reaction total number moles always remain constant.

Sol. Answer (3)

Moles may vary in a reaction.

13. STATEMENT-1 : Compound having same general formula may have different empirical formula.

and

STATEMENT-2 : Compound having same empirical formula may have different general formula.

Sol. Answer (4)

Fact.

14. STATEMENT-1 : 18 ml of H_2O and 18 ml of CO_2 at 277 K have same no. of moles.

and

STATEMENT-2 : Density of H_2O is more than CO_2.

Sol. Answer (4)

H_2O is liquid.

15. STATEMENT-1 : In 32 g of O_2, two gram atom of oxygen atom are present.

and

STATEMENT-2 : Molecular weight of O_2 is 32 g.

Sol. Answer (3)

Molecular wt. of O_2 is 32 g mol^{-1}.

SECTION - F

Integer Answer Type Questions

1. Number of hydrogen atoms in 36 ml of H_2O at 277 K are x N_A. x is _____.

Sol. Answer (4)

36 ml H_2O = 36 g H_2O = 2 mole

$\therefore$ 1 mole H_2O contains 2 × N_A H atoms

$\therefore$ 2 mole H_2O contains 4 × N_A H atoms

2. 5.6 litre of the gas have weigh 1 g at STP. Then atomic weight of the gas is _____.

Sol. Answer (4)

No. of moles of gas $\frac{5.6}{22.4} = \frac{1}{4}$

No. of moles $= \frac{\text{Weight}}{\text{Molecular weight}}$

$\frac{1}{4} = \frac{1}{\text{Mol. wt.}} \Rightarrow$ Mol. wt. = 4

3. How much amount of $CaCO_3$ in gram having percentage purity 50 per cent produces 0.56 litre of CO_2 at STP on heating?

Sol. Answer (5)

$CaCO_3 \longrightarrow CaO + CO_2$

To produce 0.56 litre or $\frac{5.6}{22.4 \times 10} = \frac{1}{40}$ mole

Amount of $CaCO_3$ required = $\frac{1}{40} \times 100 = \frac{5}{2}$ g

Percentage purity is = 50%

So, amount required = 5 g

4. Number of lone pairs in 18 ml H_2O at 273 K is xN_A. Then value of x will be

Sol. Answer (2)

No. of moles = 1

No. of molecules = N_A

No. of lone pair = 2 N_A

5. Equivalent weight of Potash alum is $\frac{M_1}{x}$ and equivalent weight of gypsum is $\frac{M_2}{y}$. Then x – y will be

Sol. Answer (6)

Eq.wt of Potash alum = $\frac{M}{8}$

Eq.wt of Gypsum = $\frac{M}{2}$

6. An Oleum is labelled as 105%. Then 100 g of this Oleum will react with y gram of water. What will be value of y?

Sol. Answer (5)

$$\underset{100\text{ g}}{\text{Oleum}} + \underset{5\text{ g}}{\text{water}} \longrightarrow \underset{105\text{ g}}{H_2SO_4}$$

7. The given compounds follow law of multiple proportion : N_2O_4 and N_xO_5. The value of x may be

Sol. Answer (2)

N_2O_4 and N_XO_5 show law of multiple proportion therefore x can be only 2.

8. H_2O_2 is unstable in nature on heating it decomposes according to reaction

$2H_2O_2\ (l) \rightarrow 2H_2O\ (l) + O_2\ (g)$

If 90 ml of water is produced in above reaction at STP $(d_{H_2O(l)} = 1\text{ g/ml})$. The volume of oxygen produced at STP in litre is X. Find value of $\frac{X}{14}$.

Sol. Answer (4)

X = 56 litres

9. Gas analysis of sample shows that it has 20% H_2, 40% CH_4, 10% CO, 20% C_2H_6 and 10% noncombustible inert gases (Volume%). $2m^3$ volume of above sample is combusted (burnt) completely with oxygen. If X is the volume of air required (in m^3). Calculate the value of $\frac{10X}{33}$.(Air consist 20% oxygen by volume)

Sol. Answer (5)

$2m^3$ volume = 2000 L of sample

$$\underset{400\text{ lit}}{H_2} + \frac{1}{2}\underset{200\text{ lit}}{O_2} \longrightarrow H_2O$$

$$\underset{800\text{ lit}}{CH_4} + 2\underset{1600\text{ lit}}{O_2} \longrightarrow CO_2 + 2H_2O$$

$$\underset{200\text{ lit}}{CO} + \frac{1}{2}\underset{100\text{ lit}}{O_2} \longrightarrow CO_2$$

$$\underset{400\text{ lit}}{C_2H_6} + \frac{7}{2}\underset{1400\text{ lit}}{O_2} \longrightarrow 2CO_2 + 3H_2O$$

volume of oxygen required

= 200 +1600 +100 +1400

= 3300 L

(X) Volume of air $= \frac{3300}{0.2} = 16500\text{ L} = 16.5\text{ m}^3$

$$= \frac{10X}{33} = \frac{16.5 \times 10}{33} = 5$$

10. A gaseous alkane (C_nH_{2n+2}) is exploded with oxygen. The volume of O_2 used and CO_2 formed are in the ratio of 7 : 4. Deduce the value of n.

Sol. Answer (2)

$$C_nH_{2n+2} + \left[n + \frac{n+1}{2}\right]O_2 \longrightarrow nCO_2 + (n+1)H_2O$$

$$\Rightarrow \frac{n + \frac{(n+1)}{2}}{n} = \frac{7}{4} \text{ or } n = 2$$

11. A macromolecule of iron has molar mass 2800 amu, it contains 8% iron by mass. The number of iron atom in one formula unit of the macromolecule is

Sol. Answer (4)

Number of iron atoms in one formula unit of compound

$$= \frac{\%}{100} \times \frac{\text{Molecular mass}}{\text{Atomic mass}} = \frac{8}{100} \times \frac{2800}{56} = 4$$

12. 5 g H_2 is allowed to react with 14 g N_2 for the following reaction :

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

What mass of H_2 will be left unreacted at the end of reaction?

Sol. Answer (2)

N_2 is limiting reactant, thus 14 g N_2 will give 17 g NH_3 and x g H_2 remains unreacted.

Mass before reaction = Mass after reaction

(5 + 14) = (17 + *x*)

x = 2 g

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