

I N D E X

CHAPTER NO.	CHAPTER NAME	PAGE NO.
1	MOLE CONCEPT	1
2	REDOX REACTIONS	12
3	SOLID STATE	18
4	LIQUID STATE	29
5	THERMODYNAMICS	45
6	THERMOCHEMISTRY	60
7	CHEMICAL KINETICS	73
8	PHASE EQUILIBRIA	91
9	SURFACE CHEMISTRY	94
10	ELECTROCHEMISTRY	104
11	QUANTUM CHEMISTRY	120
12	MOLECULAR SPECTROSCOPY	137
13	PHOTOCHEMISTRY	156

Multiple Choice Questions (MCQ)

- The ratio of mass percent of C and H of an organic compound ($C_xH_yO_z$) is 6 : 1. If one molecule of the above compound ($C_xH_yO_z$) contains half as much oxygen as required to burn one molecule of compound C_xH_y completely to CO_2 and H_2O . The empirical formula of compound $C_xH_yO_z$ is :
 (a) C_2H_4O (b) $C_3H_4O_2$
 (c) $C_2H_4O_3$ (d) $C_3H_6O_3$
- The concentrated sulphuric acid that is peddled commercially is 95% H_2SO_4 by weight. If the density of this commercial acid is 1.834 g cm^{-3} , the molarity of this solution is :-
 (a) 17.8 M (b) 15.7 M
 (c) 10.5 M (d) 12.0 M
- The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is :
 (a) 1 : 8 (b) 3 : 16
 (c) 1 : 4 (d) 7 : 32
- 3g of activated charcoal was added to 50 mL of acetic acid solution (0.06N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is :
 (a) 42 mg (b) 54 mg
 (c) 18 mg (d) 36 mg
- The density of a solution prepared by dissolving 120 g of urea (mol. mass = 60 u) in 1000 g of water is 1.15 g/mL. The molarity of this solution is
 (a) 2.05 M (b) 0.50 M
 (c) 1.78 M (d) 1.02 M
- The ratio of number of oxygen atoms (O) in 16.0g oxygen (O), 28.0 g carbon monoxide (CO) and 32.0g oxygen (O_2) is:
 (Atomic mass : C = 12, O = 16 and Avogadro's constant $N_A = 6.0 \times 10^{23} \text{ mol}^{-1}$)
 (a) 3 : 1 : 1 (b) 1 : 1 : 2
 (c) 3 : 1 : 2 (d) 1 : 1 : 1
- When CO_2 (g) is passed over red hot coke it partially gets reduced to CO(g). Upon passing 0.5 litre of CO_2 (g) over red hot coke, the total volume of the gases increased to 700 mL. The composition of the gaseous mixture at STP is:
 (a) $CO_2 = 200 \text{ mL}$; CO = 500mL
 (b) $CO_2 = 350 \text{ mL}$; CO = 350mL
 (c) $CO_2 = 0.0 \text{ mL}$; CO = 700mL
 (d) $CO_2 = 300 \text{ mL}$; CO = 400mL
- An open vessel at 300 K is heated till $\frac{3}{5}$ th of the air in it is expelled. Assuming that the volume of the vessel remains constant, the temperature to which the vessel is heated is:
 (a) 750 K (b) 400 K
 (c) 500 K (d) 1500K
- The density of 3M solution of sodium chloride is 1.252 g mL^{-1} . The molality of the solution will be (molar mass, NaCl = 58.5 g mol^{-1})
 (a) 2.18 m (b) 3.00 m
 (c) 2.60 m (d) 2.79 m
- 0.6 g of urea on strong heating with NaOH evolves NH_3 . Liberated NH_3 will combine with which of the following HCl solution?
 (a) 100 mL of 0.2 N HCl
 (b) 400 mL of 0.2 N HCl
 (c) 100 mL of 0.1 N HCl
 (d) 200 mL of 0.2 N HCl
- Calculate the mass of $FeSO_4 \cdot 7H_2O$ which must be added in 100 kg of wheat to get 10 PPM of Fe.
- Given a solution of HNO_3 of density 1.4 g/mL and 63% w/w. Determine the molarity of HNO_3 solution.
- A transition metal M forms a volatile chloride which has a vapour density of 94.8. If it contains 74.75% of chlorine the formula of the metal chloride will be
 (a) MCl_2 (b) MCl_4
 (c) MCl_5 (d) MCl_3
- 10 mL of 2(M) NaOH solution is added to 200 mL of 0.5 (M) of NaOH solution. What is the final concentration?
 (a) 0.57 M (b) 5.7 M
 (c) 11.4 M (d) 1.14 M
- A 5.2 molal aqueous solution of methyl alcohol, CH_3OH , is supplied. What is the mole fraction of methyl alcohol in the solution?
 (a) 0.086 (b) 0.050
 (c) 0.100 (d) 0.190

Numerical Answer Type Questions (NAT)

- How many molecules of water are there in 54 g of H_2O ?
- Calculate the mass of 6.022×10^{23} molecule of NH_4Cl ?
- Calculate the mass of 12.044×10^{23} Oxygen atoms.
- How many atoms of hydrogen are there in 36 g of NH_4 ?
- Calculate the number of hydrogen atoms in 1 mole of H_2 .
- Calculate the number of Cu atoms in 0.3175 g of Cu.
- Calculate the number of molecules in 22.4 litres of CH_4 gas at NTP.
- Find the volume of 1 g of H_2 gas in litres at N.T.P
 - Find the volume of 20g H_2 at NTP.
 - What is the volume occupied by 6.022×10^{23} molecules of any gas at NTP?
- An atom of some element Y weighs 6.644×10^{-23} g. Calculate the number of gram-atoms in 40 kg of it.
- Find the number of moles and number of atoms of H and S in 10 mole of H_2S .
- Calculate the number of atoms of each element in 245 g of KClO_3 .
- If 4 g of NaOH dissolves in 36 g of H_2O , calculate the mole fraction of each component in the solution. Also, determine the molarity of solution (specific gravity of solution is 1 gm/L).
- Calculate the number of atoms in 12.2 litres of the below gas at NTP
 - mono-atomic
 - diatomic gas
- If a mole were to contain 1×10^{24} particles, what would be the mass of
 - one mole of oxygen
 - a single oxygen molecule?
- How many moles of oxygen are necessary to make 179.2 L of water vapour at STP (assuming ideal gas behaviour of water vapor at STP)?
- Calculate the mass of 6.022×10^{23} molecule of Calcium carbonate (CaCO_3).
- Calculate the mass of 12.044×10^{23} carbon atoms.
- Calculate the number of oxygen atoms in 1 mole of O_2 .
- Calculate the number of Cu atoms in 0.635g of Cu.
- Calculate the number of molecules in 11.2 liters of SO_2 gas at NTP.
- An atom of some element X weighs 6.644×10^{-23} g. Calculate the number of gram-atoms in 40 kg of it.
- An atom of some element X weighs 6.644×10^{-23} g. Calculate the number of gram-atoms in 40 kg of it.
- Calculate the volume occupied by 1 mole atom of (i) monoatomic gas, and (ii) diatomic gas at NTP.
- Calculate the volume of 20g H_2 at NTP.
- What is the volume occupied by 6.022×10^{23} molecules of any gas at NTP?
- Calculate the number of atoms in 5.6 liters of a (i) monoatomic, and (ii) diatomic gas at NTP.
- Calculate the number of sulphate (SO_4^{2-}) ions in 100 mL of 0.001 M H_2SO_4 solution.
- Calculate the number of atoms in 100 u of He.
- If a mole were to contain 1×10^{24} particles, what would be the mass of (i) one mole of oxygen, and (ii) a single oxygen molecule?
- Calculate the standard molar volume of oxygen gas. The density of O_2 gas at NTP is 1.429g/L.
- Calculate the mass of 1 mole He gas. The density of He gas at NTP is 0.1784g/L.
- A metal M of atomic mass 54.94 has a density of 7.42g/cc. Calculate the apparent volume occupied by one atom of the metal.
- Calculate the number of moles, and number if atoms of H, S, and O in 5 mole of H_2SO_4 .
- Calculate the number of oxygen atoms and its mass in 50 g of CaCO_3 .
- Calculate the number of atoms of each element in 122.5 g of KClO_3 .
- Calculate the total number of electrons present in 1.6 g of CH_4 .
- Find the charge of 1 g-ion of N^{3-} in *Coulombs*.
- Find the charge of 27 g of Al^{3+} ions in *coulombs*.
- Equal masses of oxygen, hydrogen and methane are taken in a container in identical conditions. Find the ratio of the volumes of the gases.
- If the components of the air are N_2 , 78%; O_2 , 21%; Ar, 0.9% and CO_2 , 0.1% by volume, what would be the molecular mass of air?
- The atomic masses of two elements (A and B) are 20 and 40 respectively. x g of A contains y atoms, how many atoms are present in 2x g of B?
- Oxygen is present in a 1-liter flask at a pressure of 7.6×10^{-10} mm of Hg at 0°C . Calculate the number of oxygen molecules in the flask.

43. Calculate approximately the diameter of an atom of mercury, assuming that each atom is occupying a cube of edge length equal to the diameter of the mercury atom. The density of mercury is 13.6 g/cc.
44. The density of a particular crystal of LiF is 2.65 g/cc. X-ray analysis shows that Li^+ and F^- ions are arranged in a cubic array at a spacing of 2.01 Å. From these data calculate the apparent Avogadro constant. [$\text{Li} = 6.639\text{u}$, $\text{F} = 18.998\text{u}$ ($1 \text{ Å} = 10^{-8} \text{ cm}$)]
45. To 50 mL of 0.5 M H_2SO_4 , 75 mL of 0.25 M H_2SO_4 is added. What is the concentration of the final solution if its volume is 125 mL?
46. It is found that in 11.2 liters of any gaseous compound of phosphorus at NTP, there is never less than 15.5 g of P. Also, this volume of the vapour of phosphorus itself at NTP weighs 62 g. What should be the atomic mass and molecular mass of the phosphorus?
47. A polystyrene, having the formula $\text{Br}_3\text{C}_6\text{H}_3(\text{C}_3\text{H}_5)_n$, was prepared by heating styrene with tribromobenzoyl peroxide in the absence of air. If it was found to contain 10.46% bromine by weight, find the value of n.
48. It has been estimated that 93% of all atoms in the entire universe are hydrogen and that the vast majority of those remaining are helium. Based on only these two elements, estimate the mass percentage composition of the universe.
49. The molecular weight of haemoglobin is about 65,000 g/mol. Haemoglobin contains 0.35% Fe by mass. How many iron atoms are there in a haemoglobin molecule?
50. At room temperature, the density of water is 1.0 g/mL and the density of ethanol is 0.789 g/mL. What volume of ethanol contains the same number of molecules as are present in 175 mL of water?
51. A sample of ethane has the same mass as 10.0 million molecules of methane. How many C_2H_6 molecules does the sample contain?
52. How many grams of CaWO_4 would contain the same mass of tungsten that is present in 569 g of FeWO_4 ? ($W=184$)
53. 0.75 mole of solid 'A' and 2 moles of gaseous O_2 are heated in a sealed vessel, completely using up the reactants and producing only one compound. It is found that when the temperature is reduced to the initial temperature, the contents of the vessel exhibit a pressure equal to half the original pressure. What conclusions can be drawn from these data the product of the reaction?
54. Find the number of atoms in 48 g of ozone at NTP.
55. What is the ratio of the volumes occupied by 1 mole of O_2 and 1 mole of O_3 in identical conditions?
56. Calculate the mass of 5 moles of CaCO_3 in g.
57. Calculate the volume occupied by 11.2 g of the gas at NTP. Given that the vapour density of a gas is 11.2.
58. Calculate the number of oxygen atoms in 0.2 mole of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.
59. Calculate the number of moles of CuSO_4 contained in 100 mL of 1 M CuSO_4 solution. Also, find the number of SO_4^{2-} ions in it.
60. Find the total number of nucleons present in 12g of ^{12}C atoms.

ANSWER KEY

Multiple Choice Question (MCQ)									
1	2	3	4	5	6	7	8	9	10
c	a	d	c	a	d	d	c	d	a
11	12	13	14	15					
4.96g	14M	b	a	a					

Numerical Answer Type Question (NAT)				
1	2	3	4	5
18.066×10^{23}	53.5g	32g	96.352×10^{23}	12.044×10^{23}
6	7	8	9	10
30.11×10^{20}	6.022×10^{23}	a) 11.2 litre b) 224 L c) 22.4 L	1000	12.044×10^{24} H atoms, 6.022×10^{24} S atoms
11	12	13	14	15
12.044×10^{23} K atoms, 12.044×10^{23} Cl atoms, 1.806×10^{24} O atoms.	0.047, 2.5 M	(1) 3.011×10^{23} , (2) 6.022×10^{23}	(1) 32 g, (2) 3.2×10^{-23} g	4
16	17	18	19	20
100g	24g	12.044×10^{23} oxygen atoms.	6.022×10^{23} Cu atoms.	3.011×10^{23} SO ₂ molecules.
21	22	23	24	25
1000	0.00288	22.4L, 11.4 L	224 L	22.4 L
26	27	28	29	30
1.5×10^{23} , 3.0×10^{23} .	6.022×10^{19} .	25He atoms.	3.2×10^{-23} g.	22.39 Liters.
31	32	33	34	35
4g	1.23×10^{23} cc.	6.022×10^{24} H atoms, 3.011×10^{24} S atoms, 1.204×10^{25} O atoms.	9.033×10^{23} atoms, 24 g.	6.022×10^{23} K atoms, 6.022×10^{23} Cl atoms, 1.806×10^{24} O atoms.
36	37	38	39	40
6.022×10^{23} electrons.	2.894×10^5 Coulombs.	2.894×10^5 Coulombs.	O ₂ : H ₂ : CH ₄ = 1: 16: 2.	28.964
41	42	43	44	45
y	2.65×10^{10}	2.9×10^{-8} cm.	6.01×10^{23}	0.35 M
46	47	48	49	50
124g, 124	45	76.86%, 23.14%	4	566.82 mL
51	52	53	54	55
5.34×10^6	539.05 g	A ₃ O ₄	1.8066×10^{24}	1;1
56	57	58	59	60
500g	11.2 liters	1.565×10^{24}	0.1, 6.022×10^{22}	7.226×10^{24}

: SOLUTIONS :

Multiple Choice Question (MCQ)

1. Solution

Given the ratio of mass percent of C and H of an organic compound ($C_xH_yO_z$) is 6 : 1.

Atomic mass of carbon = 12

Atomic mass of Hydrogen = 1

If we have x atoms of Carbon and y atoms of Hydrogen,

$$12 \cdot x = 6(1 \cdot y)$$

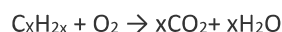
$$12x = 6y$$

$$\text{So } y = 2x$$

Given one molecule of compound ($C_xH_yO_z$) contains half as much oxygen as required to burn one molecule of compound C_xH_y completely to CO_2 and H_2O



Put $y = 2x$ in above equation



$$\text{Oxygen needed} = 2x + x = 3x$$

z is half of oxygen required to burn.

$$\text{So } z = 3x/2 = 1.5x$$

Check the given options which satisfies $z = 1.5x$.

So the empirical formula is $C_2H_4O_3$.

Hence option (3) is the answer.

2. Solution

Given Density = 1.834

1 ml solution contains 1.834 g

1000 ml solution will contain 1834 g

95% H_2SO_4 means 100 gm contain 95 gm H_2SO_4

$$\text{Mass of solute} = (95/100) \times 1834$$

$$\text{Molecular weight of } H_2SO_4 = 98$$

$$\text{Molarity} = \text{No. of moles} / \text{volume} = \text{mass of solute} / 98$$

$$= (95/100) \times (1834/98)$$

$$= 17.8 \text{ M}$$

Hence option (1) is the answer.

3. Solution

Given ratio of masses of oxygen and nitrogen = 1:4

Let mass of $O_2 = w$

Mass of $N_2 = 4w$

$$\text{Molecules of } O_2 = w / (32 \times N_A)$$

$$\text{Molecules of } N_2 = 4w / (28 \times N_A)$$

$$\text{Ratio of number of molecules} = w / (32 \times N_A) \div 4w / (28 \times N_A)$$

$$= w / (32 \times N_A) \times (28 \times N_A) / 4w$$

$$= 7/32$$

So the ratio is 7:32.

Hence option (4) is the answer.

4. Solution

Molarity of CH_3COOH solution = mass of acetic acid / molar mass / volume of solution in litre

$$0.042 = W / (60 \times 0.05)$$

$$W = 0.042 \times 60 \times 0.05 = 0.126 \text{ g}$$

$$\text{Amount of acetic acid actually adsorbed} = 0.180 - 0.126 = 54 \text{ mg}$$

Amount of charcoal available = 3 g

$$\text{So amount of acetic acid adsorbed per gram of charcoal} = 54 \text{ mg} \times 1 \text{ g} / 3.0 \text{ g} = 18 \text{ mg}$$

Hence option (3) is the answer.

5. Solution

Given density of solution = 1.15 g/mL

$$\text{mass of solution} = 1000 + 120 = 1120 \text{ gm}$$

$$\text{Molar mass} = 60$$

$$\text{Volume} = \text{mass} / \text{density of solution}$$

$$= 1120 / 1.15$$

$$\text{No. of moles} = 120 / 60 = 2$$

$$\text{Molarity} = \text{No. of moles} / \text{volume}$$

$$= 2 \div (1120 \times 10^{-3} / 1.15)$$

$$= 2 \times 1.15 \times 1000 / 1120$$

$$= 2.05 \text{ M}$$

Hence option (1) is the answer.

6. Solution

Molar mass of $O_3 = 48$

Given 16 g O_3 . So no. of moles of $O_3 = 16/48 = 1/3$

1 mole = $3 \times N_A$ oxygen atoms

So $1/3$ mole = $N_A \times 3 \times 1/3$ no of atoms

$$= N_A \text{ oxygen atoms}$$

Molar mass of CO = 28

Given 28 g CO. So no of moles = $28/28 = 1$

$$\text{No. of atoms} = 1 \times N_A = N_A$$

Molar mass of $O_2 = 32$

Given 32g O_2

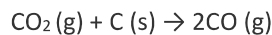
$$\text{No. of moles} = 32/32 = 1$$

$$\text{No. of atoms} = 1 \times N_A = N_A$$

So the ratio is 1:1:1

Hence option (4) is the answer.

7. Solution



$$\text{Total volume} = 700 \text{ ml} = 0.7 \text{ L}$$

$$0.5 + x = 0.7$$

$$x = .2 \text{ L} = 200 \text{ mL}$$

$$CO_2(g) = 0.5 - 0.2 = 300 \text{ ml}$$

$$CO(g) = 2x = 400 \text{ mL}$$

Hence option (4) is the answer.

8. Solution

At constant V and P, $n_1 T_1 = n_2 T_2$

$$n_1 = n$$

$$n_2 = n - 2n/5 = 3n/5$$

$$T_1 = 300 \text{ K}$$

$$300 n = (3n/5) T_2$$

$$T_2 = 300 \times 5/3 = 500 \text{ K}$$

Hence option (3) is the answer.

9. Solution

Given Molar mass of NaCl = 58.5 g

$$M = 3 \text{ mol L}^{-1}$$

Mass of weight W_2 of NaCl in 1L solution $W_2 = 3 \times 58.5 = 175.5 \text{ g}$

$$\text{Mass of L solution} = V \times d$$

$$= 1000 \times 1.25 = 1250 \text{ g}$$

$$\text{Mass of H}_2\text{O in solution (} W_1 \text{)} = 1250 - 175.5 = 1074.5$$

$$m = W_2 \times 1000 / M_{w2} \times W_1 = (175.5 \times 1000) / 58.5 \times 1074.5 = 2.79 \text{ m}$$

Hence option (4) is the answer.

10. Solution

2 mole of urea $\equiv$ one mole of NH_3

one mole of $\text{NH}_3 =$ one mole of HCl

So one mole of HCl = 2 mole of urea = $2 \times 0.6/60 = 0.02 \text{ mol}$.

Hence option (1) is the answer.

11. Solution

$$\text{Ppm} = (\text{Mass of Fe} / \text{total mass}) \times 10^6$$

$$\text{Total mass} = 100 \text{ kg} = 100 \times 1000 \text{ g}$$

$$\text{Mass of Fe} = (\text{ppm} \times \text{total mass}) / 10^6$$

$$= 10 \times 100 \times 1000 / 10^6 = 1 \text{ g}$$

$$\text{Molecular mass of FeSO}_4 \cdot 7\text{H}_2\text{O} = 278$$

$$\text{Mass of one Fe} = 56 \text{ g}$$

$$56 \text{ g of Fe} \rightarrow 278 \text{ g of FeSO}_4 \cdot 7\text{H}_2\text{O}$$

$$\text{So } 1 \text{ g of Fe} \rightarrow 278/56 = 4.96 \text{ g}$$

Hence 4.96 g is the answer.

12. Solution

Density = mass/volume of solution

$$\text{Volume} = \text{mass} / \text{density} = 100 \text{ g} / 1.4 \text{ g/ml} = (100/1.4) \text{ ml}$$

Molarity = no. of moles of solute / Volume of solution (l) =

$$1.4 \times 1000 / 100 = 14 \text{ M}$$

Hence 14 M is the answer.

13. Solution

Given vapour density = 94.8

Vapour density = molecular mass/2

$$\text{Molecular mass} = 94.8 \times 2 = 189.6$$

Given 74.75% chlorine.

$$\text{So } 74.75/100 \times 189.6 = 141.72 \text{ g of chloride is there.}$$

Then the number of atoms of chloride will be $141.72/35.5 = 3.97$ which is approximately 4.

So the formula of metal chloride will be MCl_4 .

Hence option (2) is the answer.

14. Solution

No. of moles of NaOH in 10 mL of 2 M solution = $(10/1000) \times 2 = 0.02 \text{ mol}$

Number of moles of NaOH in 200 mL of 0.5M solution = $(200/1000) \times 0.5 = 0.1 \text{ mol}$

Total number of moles of NaOH = $0.02 + 0.1 = 0.12 \text{ mol}$

Total volume = $10 + 200 = 210 \text{ mL} = 0.210 \text{ L}$

Final concentration = $0.12/0.210 = 0.57 \text{ M}$

Hence option (1) is the answer.

15. Solution

We know mole fraction = moles of solute / (moles of solute + moles of solvent)

Let mass of water is 1 kg. Moles of CH_3OH is 5.2

$$X_{\text{solute}} = 5.2 / (5.2 + 1000/18) = 5.2 / (5.2 + 55.556) = 5.2/60.756 = 0.086$$

Hence option (1) is the answer.

Numerical Answer Type Question (NAT)**1. Solution**

Molar Mass of $\text{H}_2\text{O} = 2 + 16 = 18 \text{ g/mol}$

So, number of moles of $\text{H}_2\text{O} = \text{Mass} / \text{Molar Mass} = 54/18 = 3 \text{ moles}$

Now 1 moles = 6.022×10^{23} molecule

So 3 moles will have 18.066×10^{23} molecules

2. Solution

Molar mass (Molecular mass in gram) of $\text{NH}_4\text{Cl} = 14 + 4 + 35.5 = 53.5 \text{ g}$

No. of moles of $\text{NH}_4\text{Cl} = 6.022 \times 10^{23} / 6.022 \times 10^{23} = 1 \text{ mole}$

Mass of $\text{NH}_4\text{Cl} = \text{No. of moles} \times \text{molar mass} = 1 \times 53.5 \text{ g} = 53.5 \text{ g}$.

3. Solution

No. of moles of Oxygen atoms = $12.044 \times 10^{23} / 6.022 \times 10^{23} = 2 \text{ mole}$

Mass of Oxygen atoms = No. of moles $\times$ atomic mass = $2 \times 16 = 32 \text{ g}$

4. Solution

Molar mass (Molecular mass in gram) of $\text{NH}_4 = 14 + 4 = 18 \text{ g}$

No. of moles of $\text{NH}_4 = 36/18 = 2 \text{ moles}$

Now Total Moles of Hydrogen Atoms = $16 \text{ moles} = 16 \times 6.022 \times 10^{23} = 96.352 \times 10^{23}$

5. Solution

1 molecule of H_2 = 2 hydrogen atoms

So, 1 mole of H_2 = 2 mole hydrogen atoms = $2 \times 6.022 \times 10^{23} = 12.044 \times 10^{23}$ hydrogen atoms.

6. Solution

No. of moles of Cu = Mass of Cu / Atomic mass = $0.3175/63.5 = 0.005$ mole

No. of Cu atoms = No. of moles $\times$ Avogadro constant = $0.005 \times 6.022 \times 10^{23} = 30.11 \times 10^{20}$ Cu atoms.

7. Solution

1 mole of CH_4 = 22.4 L (at NTP)

Therefore

22.4 L of CH_4 gas = 1 mole CH_4 gas = 6.022×10^{23} CH_4 gas molecules.

8. Solution

a. Molar Mass of H_2 gas = 2 gm

Number of moles = Mass/Molar Mass = $1/2 = 0.5$

1 mole of H_2 = 22.4 L (at NTP)

Therefore 0.5 mole of H_2 = $0.5 \times 22.4 = 11.2$ litre

b. No. of moles of H_2 = $20/2 = 10$

1 mole of H_2 = 22.4 L (at NTP)

Therefore 10 moles = $10 \times 22.4 = 224$ L

c. 6.022×10^{23} molecules = 1 mole molecules, and 1 mole molecules of any ideal gas occupies 22.4 L at NTP.

9. Solution

Mass of 1 mole Y atoms = mass of 1 atom $\times$ Avogadro constant

= $6.644 \times 10^{-23} \times 6.022 \times 10^{23} = 40$ g

So, the atomic mass of Y = 40

No. of gram-atoms (or moles) of X = mass of Y / atomic mass = $(40 \times 1000)/40 = 1000$

10. Solution

1 mole of H_2S contains 2 mole of H, 1 mole of S

Therefore, 10 mole of H_2S contains 20 mole of H = $20 \times 6.022 \times 10^{23} = 12.044 \times 10^{24}$ H atoms

10 mole of S = $10 \times 6.022 \times 10^{23} = 6.022 \times 10^{24}$ S atoms

11. Solution

Molecular mass of $KClO_3$ = $39 + 35.5 + 3 \times 16 = 122.5$

No. of mole of $KClO_3$ = $245 \text{ g} / 122.5 \text{ g} = 2$ mole

2 mole of $KClO_3$ contains 2 mole of K = $2 \times 6.022 \times 10^{23} = 12.044 \times 10^{23}$ K atoms

2 mole of Cl = $2 \times 6.022 \times 10^{23} = 12.044 \times 10^{23}$ Cl atoms

6 mole of O = $6 \times 6.022 \times 10^{23} = 1.806 \times 10^{24}$ O atoms.

12. Solution

Mass of NaOH = 4 g

Number of moles of NaOH = $4 \text{ g} / 40 \text{ g/mol} = 0.1$ mol

Mass of H_2O = 36 g

Number of moles of = $36 \text{ g} / 18 = 2$ mol

Mole fraction of water = Number of moles of water / (No. of moles of water + No. of moles of NaOH) = $22/22+0.1 = 0.95$

Mole fraction of NaOH = Number of moles of NaOH / (No. of moles of NaOH + No. of moles of water) = $0.12/0.12+0.1 = 0.047$

Mass of solution = mass of water + mass of NaOH = $36 \text{ g} + 4 \text{ g} = 40 \text{ g}$

Volume of solution = $40 \times 1 = 40$ mL (Since specific gravity of solution is = 1 g mL⁻¹)

Molarity of solution = Number of moles of solute / Volume of solution in litre = $0.1/0.04 = 2.5$ M

13. Solution

No. of moles in 12.2 L gas at NTP = $12.2/22.4 = 0.50$

No. of molecules in 12.2 L gas = $0.50 \times 6.022 \times 10^{23} = 3.011 \times 10^{23}$ molecules

In mono-atomic gases, No. of atoms = No. of molecules = 3.011×10^{23} .

In diatomic gases, No. of atoms = $2 \times$ No. of molecules = $2 \times 3.011 \times 10^{23} = 6.022 \times 10^{23}$.

14. Solution

Mass of one mole of oxygen molecule (O_2) = molecular mass of oxygen molecule (O_2) in gram = 32 g.

Mass of a single oxygen molecule = $32/1 \times 10^{24} = 3.2 \times 10^{-23}$ g

15. Solution

1 mole represents 6.023×10^{23} particles.

1 mole of iodine atom = 6.023×10^{23}

Given 127.0g of iodine.

no. of iodine atom = 1 mole of iodine

1 mole of magnesium = 24g of Mg = 6.023×10^{23} no. of Mg

Given 48g of Mg = $2 \times 6.023 \times 10^{23}$

no. of Mg = 2 moles of Mg

1 mole of chlorine atom = 6.023×10^{23}

no. of chlorine atom = 35.5g of chlorine atom

Given 71g of chlorine atom = $2 \times 6.023 \times 10^{23}$

no. of chlorine atom = 6.023×10^{23}

2 moles of chlorine atom.

Given that 4g of hydrogen atom.

will be equal to $4 \times 6.023 \times 10^{23}$

no. of atoms of hydrogen = 4 moles of hydrogen atom.

Hence option(4) is the answer.

16. Solution

Molar mass (Molecular mass in gram) of $CaCO_3$ = $40 + 12 + 3 \times 16 = 100$ g

No. of moles of $CaCO_3$ = No. of molecules/Avogadro constant

= $6.022 \times 10^{23} / 6.022 \times 10^{23}$

= 1 mole

Mass of CaCO_3

= No. of moles $\times$ molar mass

= $1 \times 100 \text{ g} = 100 \text{ g}$.

17. Solution

No. of moles of Carbon atoms

= No. of atoms/Avogadro constant

= $12.044 \times 10^{23} / 6.022 \times 10^{23}$

= 2 mole

Mass of carbon atoms

= No. of moles $\times$ atomic mass

= 2×12

= 24 g.

18. Solution

1 molecule of $\text{O}_2 = 2$ oxygen atoms

So, 1 mole of $\text{O}_2 = 2$ mole oxygen atoms

= $2 \times 6.022 \times 10^{23} = 12.044 \times 10^{23}$ oxygen atoms.

19. Solution

No. of moles of Cu

= Mass of Cu/Atomic mass

= $0.635/63.5$

= 0.01 mole

No. of Cu atoms

= No. of moles $\times$ Avogadro constant

= $0.01 \times 6.022 \times 10^{23}$

= 6.022×10^{23} Cu atoms.

20. Solution

1 mole of $\text{SO}_2 = 22.4 \text{ L}$ (at NTP)

=> 11.4 L of $\text{SO}_2 = 0.5$ mole $\text{SO}_2 = 0.5 \times 6.022 \times 10^{23} = 3.011 \times 10^{23}$ SO_2 molecules.

21. Solution

Mass of 1 mole X atoms

= mass of 1 atom $\times$ Avogadro constant

= $6.644 \times 10^{-23} \times 6.022 \times 10^{23}$

= 40 g

So, the atomic mass of X = 40

No. of gram-atoms (or moles) of X

= mass of X / atomic mass

= $40 \times 1000/40 = 1000$.

22. Solution

Molecular mass of $\text{CO}_2 = 12 + 2 \times 16 = 44$

Total no. of moles in 200mg CO_2

= Mass of CO_2 /Molecular mass

= $200 \times 10^{-3} \text{ g}/44$

= 0.00454

No. of moles removed

= $10^{21}/6.022 \times 10^{23}$

= 0.00166

No. of moles of CO_2 left

= $0.00454 - 0.00166$

= 0.00288.

23. Solution

1 mole atom of monoatomic gas occupies 22.4 L at NTP, and

1 mole of diatomic gas (1 molecule contains 2 atoms) occupies 11.4 L at NTP.

24. Solution

No. of moles of $\text{H}_2 = 20/2 = 10$

Volume of any ideal gas at NTP

= No. of moles $\times$ 22.4 L

= 10×22.4

= 224 L.

25. Solution

6.022×10^{23} molecules = 1 mole molecules, and

1 mole molecules of any ideal gas occupies 22.4 L at NTP.

26. Solution

No. of moles in 5.6 L gas at NTP = $5.6/22.4 = 0.25$

No. of molecules in 5.6 L gas

= $0.25 \times 6.022 \times 10^{23}$

= 1.5×10^{23} molecules

In monoatomic gases, No. of atoms = No. of molecules

= 1.5×10^{23} .

In diatomic gases, No. of atoms = $2 \times$ No. of molecules = $2 \times 1.5 \times 10^{23} = 3.0 \times 10^{23}$.

27. Solution

Molarity = No. of moles of solute/ Volume of solution in Liters

=> No. of moles of solute (H_2SO_4) = Molarity $\times$ volume of solution in Liters

= $0.001 \times 0.1 = 0.0001$

1 molecule of H_2SO_4 contains 1 SO_4^{2-} ion

=> 0.0001 mole of H_2SO_4 contains 0.0001 mole SO_4^{2-}

$\therefore$ No. of sulphate (SO_4^{2-}) ions = $0.0001 \times 6.022 \times 10^{23} = 6.022 \times 10^{19}$.

28. Solution

Atomic mass of He = 4 u

So, mass of one He atom = 4 u

$\therefore$ No. of atoms in 100 u of He = $100/4 = 25$ He atoms.

29. Solution

Mass of one mole of oxygen molecule (O_2)

= molecular mass of oxygen molecule (O_2) in gram

= 32 g.

Mass of a single oxygen molecule

= $32/1 \times 10^{24}$

= $3.2 \times 10^{-23} \text{ g}$.

30. Solution

Standard molar volume

= volume occupied by 1 mole (i.e., 32g) of the O_2 gas at NTP

= Mass/density [$\because$ density = mass/volume $\Rightarrow$ volume = mass/density]

= 32/1.429

= 22.39 Liters.

31. Solution

Mass of 1 mole He = Density at NTP $\times$ Standard molar volume = $0.1784 \times 22.4 \approx 4g$.

32. Solution

Mass of 1 mole metal atoms = 54.94g

$\Rightarrow$ Mass of 1 metal atom

= $54.94/6.022 \times 10^{23} g = 9.12 \times 10^{23} g$

Volume occupied by one metal atom

= Mass of one metal atom/density

= $9.12 \times 10^{23} / 7.42$

= $1.23 \times 10^{23} cc$.

33. Solution

1 mole of H_2SO_4 contains 2 mole of H, 1 mole of S, and 4 mole of O

$\Rightarrow$ 5 mole of H_2SO_4 contains

10 mole of H = $10 \times 6.022 \times 10^{23} = 6.022 \times 10^{24}$ H atoms

5 mole of S = $5 \times 6.022 \times 10^{23} = 3.011 \times 10^{24}$ S atoms

20 mole of O = $20 \times 6.022 \times 10^{23} = 1.204 \times 10^{25}$ O atoms.

34. Solution

Molecular mass of $CaCO_3$ = $40 + 12 + 3 \times 16 = 100$

No. mole of $CaCO_3$ = $50g/100g = 0.5$

0.5 mole of $CaCO_3$ contains 1.5 moles of oxygen atoms

No. of oxygen atoms = $1.5 \times 6.022 \times 10^{23} = 9.033 \times 10^{23}$ atoms

Mass of Oxygen atoms = $1.5 \times 16 = 24 g$.

35. Solution

Molecular mass of $KClO_3$ = $39 + 35.5 + 3 \times 16 = 122.5$

No. of mole of $KClO_3$ = $122.5g/122.5g = 1$ mole

1 mole of $KClO_3$ contains

1 mole of K = 6.022×10^{23} K atoms

1 mole of Cl = 6.022×10^{23} Cl atoms

3 mole of O = $3 \times 6.022 \times 10^{23} = 1.806 \times 10^{24}$ O atoms.

36. Solution

Molecular mass of CH_4 = $12 + 4 \times 1 = 16$

Moles of CH_4 = $1.6/16 = 0.1$

No. of electron in 1 molecule of CH_4 = $6 + 4 = 10$ electrons

Total no. of electrons = $0.1 \times 6.022 \times 10^{23} \times 10 = 6.022 \times 10^{23}$ electrons.

37. Solution

Charge on 1 N^{3-} ion = $3 e^- = 3 \times 1.602 \times 10^{-19} \text{ Coulombs}$

Charge on 1 g-ion of N^{3-}

= $3 \times 1.602 \times 10^{-19} \times 6.022 \times 10^{23} \text{ Coulombs}$

= $2.894 \times 10^5 \text{ Coulombs}$.

38. Solution

Atomic mass of Al = 27

No. of moles Al = $27/27 = 1$ mole

Charge on 1 Al^{3+} ion = $3 e^- = 3 \times 1.602 \times 10^{-19} \text{ Coulombs}$

Charge on 1 mole Al^{3+} ions

= $3 \times 1.602 \times 10^{-19} \times 6.022 \times 10^{23} \text{ Coulombs}$

= $2.894 \times 10^5 \text{ Coulombs}$.

39. Solution

Let X g of each gas is taken. Then,

Mole ratio

= $O_2 : H_2 : CH_4 = X/32 : X/2 : X/16$

= 1:16:2.

= Volume ratio [$\because$ Avogadro's Principle – the molar ratios are also volume ratios for gases]

$\therefore O_2 : H_2 : CH_4 = 1 : 16 : 2$.

40. Solution

The molar ratios are also volume ratios for gases (Avogadro's principle)

Molecular mass of air

= $(78 \times 28 + 21 \times 32 + 0.9 \times 40 + 0.1 \times 44) / (78 + 21 + 0.9 + 0.1)$

= 28.964.

41. Solution

No. of mole of A = $x/20$

No. of atoms of A = $(x/20) \times N$ [N is Avogadro constant]

$\therefore y = x \times N/20 \Rightarrow x = 20y/N$

Now, No. of mole of B = $2x/40$

No. of atoms of B

= $(2x/40) \times N$

= $2N/40 \times 20y/N$

= y.

42. Solution

Pressure = $7.6 \times 10^{-10} \text{ mm Hg}$

= $7.6 \times 10^{-10} / 760$ [1 atm = 760 mm Hg]

= 10^{-12} atm

Volume = 1 liter

Temperature = $0^\circ C = 273 \text{ K}$

We know $pV = nRT \Rightarrow n = pV/RT$

$n = (10^{-12} \times 1) / (0.0821 \times 273) = 0.44 \times 10^{-13}$

No. of molecules = no. of moles $\times$ Avogadro constant

= $0.44 \times 10^{-13} \times 6.022 \times 10^{23}$

= 2.65×10^{10} .