SOLVED EXAMPLES

Ex. 1 Find the relative atomic mass, atomic mass of the following elements.
(i) Na **(i)**i F **(iii)** H **(iv)** Ca **(v)** Ag

Sol. **(i)** 23, 23 amu **(ii)** 19, 19 amu **(iii)** 1, 1.008 amu , **(iv)** 40, 40 amu, **(v)** 108, 108 amu.

Ex. 2 14 g of Nitrogen gas and 22 g of CO_2 gas are mixed together. Find the volume of gaseous mixture at STP.

Sol. Moles of $N_2 = \frac{14}{28} = 0.5$.

moles of $CO_2 = \frac{22}{44} = 0.5$.

So total moles = 0.5 + 0.5 = 1.
So vol. at STP = 1 × 22.4 = 22.4 lit.

Ex. 3 A sample of (C_2H_6) ethane has the same mass as 10^7 molecules of methane. How many C_2H_6 molecules does the sample contain ?

Sol. Moles of $CH_4 = \frac{10^7}{N_A}$

Mass of $CH_4 = \frac{10^7}{N_A} \times 16$ = mass of C_2H_6

So Moles of $C_2H_6 = \frac{10^7 \times 16}{N_A \times 30}$

So No. of molecules of $C_2H_6 = \frac{10^7 \times 16}{N_A \times 30} \times N_A = \mathbf{5.34 \times 106.}$

Ex. 4 From 160 g of SO_2 (g) sample, 1.2046 x 10^{24} molecules of SO_2 are removed then find out the volume of left over SO_2 (g) at STP.

Sol. Given moles = $\frac{160}{64} = 2.5$.

Removed moles = $\frac{1.2046 \times 10^{24}}{6.023 \times 10^{23}} = 2$.

so left moles = 0.5.
volume left at STP = 0.5 × 22.4 = 11.2 lit.

Ex. 5 Show that in the reaction N_2 (g) + $3H_2$(g) → $2NH_3$ (g), mass is conserved.

Sol.

	N_2 (g)	+ $3H_2$(g)	→ $2NH_3$ (g)
moles before reaction	1	3	0
moles after reaction	0	0	2

Mass before reaction = mass of 1 mole N_2(g) + mass of 3 mole H_2(g)
= 14 x 2 + 3 x 2 = 34 g
mass after reaction = mass of 2 mole NH_3
= 2 x 17 = 34 g.

Ex. 6 Find the density of $CO_2(g)$ with respect to $N_2O(g)$.

Sol. $\text{R.D.} = \dfrac{\text{M.wt. of } CO_2}{\text{M.wt. of } N_2O} = \dfrac{44}{44} = 1.$

Ex. 7 Find the vapour density of N_2O_5

Sol. $\text{V.D.} = \dfrac{\text{Mol. wt. of } N_2O_5}{2} = 54.$

Ex. 8 Write a balance chemical equation for following reaction :

When ammonia (NH_3) decompose into nitrogen (N_2) gas & hydrogen (H_2) gas.

Sol. $NH_3 \rightarrow \dfrac{1}{2}N_2 + \dfrac{3}{2}H_2$ or $2NH_3 \rightarrow N_2 + 3H_2$.

Ex. 9 When 170 g NH_3 (M =17) decomposes how many grams of N_2 & H_2 is produced.

Sol. $NH_3 \rightarrow \dfrac{1}{2}N_2 + \dfrac{3}{2}H_2$

$$\frac{\text{moles of } NH_3}{1} = \frac{\text{moles of } N_2}{1/2} = \frac{\text{moles of } H_2}{3/2}.$$

So $\text{moles of } N_2 = \dfrac{1}{2} \times \dfrac{170}{17} = 5.$ So $\text{wt. of } N_2 = 5 \times 28 = 140 \text{ g}.$

Similarly $\text{moles of } H_2 = \dfrac{3}{2} \times \dfrac{170}{17} = 15.$

So $\text{wt. of } H_2 = 15 \times 2 = 30 \text{ g}.$

Ex. 10 When x gram of a certain metal brunt in 1.5 g oxygen to give 3.0 g of its oxide. 1.20 g of the same metal heated in a steam gave 2.40 g of its oxide. shows the these result illustrate the law of constant or definite proportion

Sol. Wt. of metal = 3.0 – 1.5 = 1.5 g

so wt. of metal : wt of oxygen = 1.5 : 1.5 = 1 : 1

similarly in second case ,

wt. of oxygen = 2.4 – 1.2 = 1.2 g

so wt. of metal : wt of oxygen = 1.2 : 1.2 = 1 : 1

so these results illustrate the law of constant proportion.

Ex. 11 Find out % of O & H in H_2O compound.

Sol. $\%\text{ of O} = \dfrac{16}{18} \times 100 = 88.89\%$

$\%\text{ of H} = \dfrac{2}{18} \times 100 = 11.11\%$

Ex. 12 Acetylene & butene have empirical formula CH & CH_2 respectively. The molecular mass of acetylene and butene are 26 & 56 respectively deduce their molecular formula.

Ans. C_2H_2 & C_4H_8

Sol. $n = \dfrac{\text{Molecular mass}}{\text{Empirical formula mass}}$

For Acetylene :

$$n = \frac{26}{13} = 2$$

$\therefore$ Molecular formula = C_2H_2

For Butene :

$$n = \frac{56}{14} = 4$$

$\therefore$ Molecular formula = C_4H_8.

Ex. 13 An oxide of nitrogen gave the following percentage composition :

N = 25.94

and O = 74.06

Calculate the empirical formula of the compound.

Ans. N_2O_5

Sol.

Element	% / Atomic mass	Simple ratio	Simple intiger ratio
N	$\frac{25.94}{14} = 1.85$	1	2
O	$\frac{74.06}{16} = 4.63$	2.5	5

So empirical formula is N_2O_5.

Ex. 14 340 g NH_3 (M = 17) when decompose how many litres of nitrogen gas is produced at STP.

Sol. $NH_3 \rightarrow \frac{1}{2}N_2 + \frac{3}{2}H_2$

$$\text{moles of } NH_3 = \frac{340}{17} = 20.$$

So $\text{moles of } N_2 = \frac{1}{2} \times 20 = 10.$

$\therefore$ vol. of N_2 at STP = $10 \times 22.4 = 224$ lit.

Ex. 15 4 mole of $MgCO_3$ is reacted with 6 moles of HCl solution. Find the volume of CO_2 gas produced at STP, the reaction is

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O.$$

Sol. Here HCl is limiting reagent. So moles of CO_2 formed = 3.
So vol. at STP = $3 \times 22.4 = 67.2$ lit.

Ex. 16 117 gm NaCl is dissolved in 500 ml aqueous solution. Find the molarity of the solution.

Sol. $\text{Molarity} = \dfrac{117/58.5}{500/1000} = \mathbf{4M.}$

Ex. 17 0.32 mole of $LiAlH_4$ in ether solution was placed in a flask and 74 g (1 moles) of t-butyl alcohol was added. The product is $LiAlHC_{12}H_{27}O_3$. Find the weight of the product if lithium atoms are conserved.

[Li = 7, Al = 27, H = 1, C = 12, O = 16]

Sol. Applying POAC on Li

$1 \times$ moles of $LiAlH_4 = 1 \times$ moles of $LiAlH\ C_{12}H_{27}O_3$

$254 \times 0.32 = 1 \times$ wt. of $LiAlH\ C_{12}H_{27}O_3$.

wt. of $LiAlH\ C_{12}H_{27}O_3 = 81.28$ gm.

Ex. 18 Calculate the resultant molarity of following :

(a) 200 ml 1M HCl + 300 ml water **(b)** 1500 ml 1M HCl + 18.25 g HCl

(c) 200 ml 1M HCl + 100 ml 0.5 M H_2SO_4 **(d)** 200 ml 1M HCl + 100 ml 0.5 M HCl

Ans. **(a)** 0.4 M **(b)** 1.33 M **(c)** 1 M **(d)** 0.83 M.

Sol. **(a)** Final molarity $= \dfrac{200\times1+0}{200+300} = 0.4$ M.

(b) Final molarity $= \dfrac{1500\times1+\dfrac{18.25\times1000}{36.5}}{1500} = 1.33$ M

(c) Final molarity of $H^+ = \dfrac{200\times1+100\times0.5\times2}{200+100} = 1$ M.

(d) Final molarity $= \dfrac{200\times1+100\times0.5}{200+100} = 0.83$ M.

Ex. 19 Balance the following equations :

(a) $H_2O_2 + MnO_4^- \longrightarrow Mn^{+2} + O_2$ (acidic medium)

(b) $Zn + HNO_3(dil) \longrightarrow Zn(NO_3)_2 + H_2O + NH_4NO_3$

(c) $CrI_3 + KOH + Cl_2 \longrightarrow K_2CrO_4 + KIO_4 + KCl + H_2O.$

(d) $P_2H_4 \longrightarrow PH_3 + P_4$

(e) $Ca_3(PO_4)_2 + SiO_2 + C \longrightarrow CaSiO_3 + P_4 + CO$

Ans. **(a)** $6H^+ + 5H_2O_2 + 2MnO_4^- \longrightarrow 2Mn^{+2} + 5O_2 + 8H_2O$

(b) $4Zn + 10HNO_3(dil) \longrightarrow 4Zn(NO_3)_2 + 3H_2O + NH_4NO_3$

(c) $2CrI_3 + 64KOH + 27Cl_2 \longrightarrow 2K_2CrO_4 + 6KIO_4 + 54KCl + 32H_2O.$

(d) $6P_2H_4 \longrightarrow 8PH_3 + P_4$

(e) $2Ca_3(PO_4)_2 + 6SiO_2 + 10C \longrightarrow 6CaSiO_3 + P_4 + 10CO$

Ex. 20 Find the average and individual oxidation number of Fe & Pb in Fe_3O_4 & Pb_3O_4, which are mixed oxides.

Sol. **(i)** Fe_3O_4 is mixture of FeO & Fe_2O_3 in 1 : 1 ratio

so, individual oxidation number of Fe = +2 & +3

& average oxidation number = $\frac{1(+2)+2(+3)}{3} = 8/3$

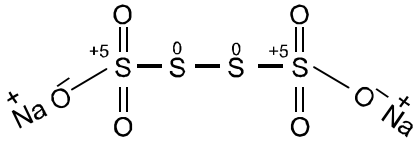
(ii) Pb_3O_4 is a mixture of PbO & PbO_2 in 2 : 1 molar ratio

so, individual oxidation number of Pb are +2 & +4

& average oxidation number of Pb = $\frac{2(+2)+1(+4)}{3} = 8/3$

Ex. 21 Calculate individual oxidation number of each S-atom in $Na_2S_4O_6$ (sodium tetrathionate) with the help of its structure

Sol.



Ex. 22 518 gm of an aqueous solution contains 18 gm of glucose (mol.wt. = 180). What is the molality of the solution.

Sol. wt. of solvent = 518 – 18 = 500 gm. $\Rightarrow$ So molarity = $\frac{18/180}{500/1000} = 0.2$.

Ex. 23 0.25 of a substance is dissolved in 6.25 g of a solvent. Calculate the percentage amount of the substance in the solution.

Sol. wt. of solution = 0.25 + 6.25 = 6.50.

so % (w/w) = $\frac{0.25}{6.50} \times 100 = 3.8\%$.

Ex. 24 A fresh H_2O_2 solution is labelled 11.2 V. This solution has the same concentration as a solution which is :

(A) 3.4% (w / w) **(B)** 3.4% (v / v) **(C)** 3.4% (w / v) **(D)** None of these

Sol. Molarity of H_2O_2 = $\frac{\text{vol.strength}}{11.2} = \frac{11.2}{11.2} = 1$

Now, %(w/v) = $\frac{\text{wt. of solute in g}}{\text{wt. of solution in mL}} \times 100$

= Molarity × Mol. wt. of solute × $\frac{1}{10}$

= $1 \times 34 \times \frac{1}{10} = 3.4\%$ **Ans. (C)**

Ex. 25 A fresh H_2O_2 solution is labelled 11.2 V. This solution has the same concentration as a solution which is :

(A) 3.4% (w / w) **(B)** 3.4% (v / v) **(C)** 3.4% (w / v) **(D)** None of these

Sol. Molarity of $H_2O_2 = \frac{\text{vol.strength}}{11.2} = \frac{11.2}{11.2} = 1$

Now, $\%(w/v) = \frac{\text{wt. of solute in g}}{\text{wt. of solution in mL}} \times 100$

$= \text{Molarity} \times \text{Mol. wt. of solute} \times \frac{1}{10}$

$= 1 \times 34 \times \frac{1}{10} = 3.4\%$ **Ans. (C)**

Ex. 26 0.25 of a substance is dissolved in 6.25 g of a solvent. Calculate the percentage amount of the substance in the solution.

Sol. wt. of solution = 0.25 + 6.25 = 6.50.

so % (w/w) = $\frac{0.25}{6.50} \times 100 = 3.8\%$.

Ex. 27 518 gm of an aqueous solution contains 18 gm of glucose (mol.wt. = 180). What is the molality of the solution.

Sol. wt. of solvent = 518 – 18 = 500 gm. $\Rightarrow$ so molarity = $\frac{18/180}{500/1000} = 0.2$.

Ex. 28 Calculate the resultant molarity of following :

(a) 200 ml 1M HCl + 300 ml water **(b)** 1500 ml 1M HCl + 18.25 g HCl

(c) 200 ml 1M HCl + 100 ml 0.5 M H_2SO_4 **(d)** 200 ml 1M HCl + 100 ml 0.5 M HCl

Ans. **(a)** 0.4 M **(b)** 1.33 M **(c)** 1 M **(d)** 0.83 M.

Sol. **(a)** Final molarity = $\frac{200 \times 1 + 0}{200 + 300} = 0.4$ M.

(b) Final molarity = $\frac{1500 \times 1 + \frac{18.25 \times 1000}{36.5}}{1500} = 1.33$ M

(c) Final molarity of $H^+ = \frac{200 \times 1 + 100 \times 0.5 \times 2}{200 + 100} = 1$ M.

(d) Final molarity = $\frac{200 \times 1 + 100 \times 0.5}{200 + 100} = 0.83$ M.

Exercise # 1 [Single Correct Choice Type Questions]

1. The charge on 1 gram ions of Al^{3+} is : (N_A = Avogadro number, e = charge on one electron)

(A) $\frac{1}{27} N_A e$ coulomb **(B)** $\frac{1}{3} \times N_A e$ coulomb **(C)** $\frac{1}{9} \times N_A e$ coulomb **(D)** $3 \times N_A e$ coulomb

2. Which of the following expressions is correct (n = no. of moles of the gas, N_A = Avogadro constant, m = mass of 1 molecule of the gas, N = no. of molecules of the gas)?

(A) $n = mN_A$ **(B)** $m = N_A$ **(C)** $N = nN_A$ **(D)** $m = mn/N_A$

3. The modern atomic weight scale is based on :

(A) C^{12} **(B)** O^{16} **(C)** H^{1} **(D)** N^{14}

4. The weight of a molecule of the compound $C_{60}H_{22}$ is :

(A) 1.09×10^{-21} g **(B)** 1.24×10^{-21} g **(C)** 5.025×10^{-23} g **(D)** 16.023×10^{-23} g

5. Which of the following contains the greatest number of atoms ?

(A) 1.0 g of butane (C_4H_{10}) **(B)** 1.0 g of nitrogen (N_2)
(C) 1.0 g of silver (Ag) **(D)** 1.0 g of water (H_2O)

6. A gaseous mixture contains CO_2(g) and N_2O(g) in 2 : 5 ratio by mass. The ratio of the number of molecules of CO_2(g) and N_2O(g) is :

(A) 5 :2 **(B)** 2 : 5 **(C)** 1 : 2 **(D)** 5 : 4

7. Four 1-1 litre flasks are separately filled with the gases H_2, He, O_2 and O_3 at the same temperature and pressure. The ratio of total number of atoms of these gases present in different flask would be :

(A) 1 : 1 : 1 : 1 **(B)** 1 : 2 : 2 : 3 **(C)** 2 : 1 : 2 : 3 **(D)** 3 : 2 : 2 : 1

8. Under the same conditions, two gases have the same number of molecules. They must

(A) be noble gases **(B)** have equal volumes
(C) have a volume of 22.4 dm^3 each **(D)** have an equal number of atoms

9. 16 g of an ideal gas SO_x occupies 5.6 L. at STP. The value of x is

(A) x = 3 **(B)** x = 2 **(C)** x = 4 **(D)** none

10 Boron has two stable isotopes, ^{10}B (relative abundance = 19%) and ^{11}B (relative abundance = 81%). The atomic mass (in amu) that should appear for boron in the periodic table is :

(A) 10.8 **(B)** 10.2 **(C)** 11.2 **(D)** 10.6

11 3g of a hydrocarbon on combustion in excess of oxygen produces 8.8 g of CO_2 and 5.4 g of H_2O. The data illustrates the law of :

(A) conservation of mass **(B)** multiple proportions
(C) constant proportions **(D)** none of these

12 Which is/are correct statements about 1.7 gm of NH_3

(A) It contain 3 mol H – atom **(B)** it contain 6.408×10^{23} atoms
(C) Mass % of hydrogen is 17.65% **(D)** It contains 0.3 mol N-atom

13. Calculate the molecular formula of compound which contains 20% Ca and 80% Br (by wt.) if molecular weight of compound is 200. (Atomic wt. Ca = 40, Br = 80)

(A) $Ca_{1/2}Br$ **(B)** $CaBr_2$ **(C)** CaBr **(D)** Ca_2Br

14. The empirical formula of a compound of molecular mass 120 is CH_2O. The molecular formula of the compound is :
(A) $C_2H_4O_2$ **(B)** $C_4H_8O_4$ **(C)** $C_3H_6O_3$ **(D)** all of these

15 A compound possess 8% sulphur by mass. The least molecular mass is :
(A) 200 **(B)** 400 **(C)** 155 **(D)** 355

16. Cortisone is a molecular substance containing 21 atoms of carbon per molecule. The mass percentage of carbon in cortisone is 69.98%. Its molar mass is :
(A) 176.5 **(B)** 252.2 **(C)** 287.6 **(D)** 360.1

17 12 g of alkaline earth metal gives 14.8 g of its nitride. Atomic weight of metal is -
(A) 12 **(B)** 20 **(C)** 40 **(D)** 14.8

18 For the reaction $2P + Q \rightarrow R$, 8 mol of P and excess of Q will produce :
(A) 8 mol of R **(B)** 5 mol of R **(C)** 4 mol of R **(D)** 13 mol of R

19 If 1.5 moles of oxygen combine with Al to form Al_2O_3, the weight of Al used in the reaction is :
(A) 27 g **(B)** 40.5 g **(C)** 54g **(D)** 81 g

20 How many liters of CO_2 at STP will be formed when 0.01 mol of H_2SO_4 reacts with excess of Na_2CO_3 .

$Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + CO_2 + H_2O$
(A) 22.4 L **(B)** 2.24 L **(C)** 0.224 L **(D)** 1.12 L

21. When 100g of ethylene polymerises entirely to polyethene, the weight of polyethene formed as per the equation $n(C_2H_4) \rightarrow (-CH_2-CH_2-)_n$ is :
(A) (n/2)g **(B)** 100g **(C)** (100/n)g **(D)** 100ng

22. How many moles of potassium chlorate need to be heated to produce 11.2 litre oxygen at N.T.P.

(A) $\frac{1}{2}$ mol **(B)** $\frac{1}{3}$ mol **(C)** $\frac{1}{4}$ mol **(D)** $\frac{2}{3}$ mol

23. For the reaction $2P + Q \rightarrow R$, 8 mol of P and 5 mol of Q will produce
(A) 8 mol of R **(B)** 5 mol of R **(C)** 4 mol of R **(D)** 13 mol of R

24. How many mole of $Zn(FeS_2)$ can be made from 2 mole zinc, 3 mole iron and 5 mole sulphur.
(A) 2 mole **(B)** 3 mole **(C)** 4 mole **(D)** 5 mole

25. Calculate the amount of Ni needed in the Mond's process given below

$Ni + 4CO \longrightarrow Ni(CO)_4$

If CO used in this process is obtained through a process, in which 6 g of carbon is mixed with 44 g CO_2 .
(A) 14.675 g **(B)** 29 g **(C)** 58 g **(D)** 28 g

26. The mass of 70% H_2SO_4 required for neutralisation of 1 mol of NaOH.
(A) 49 gm **(B)** 98 gm **(C)** 70 gm **(D)** 34.3 gm

27. In a certain operation 358 g of $TiCl_4$ is reacted with 96 g of Mg. Calculate % yield of Ti if 32 g of Ti is actually obtained

[At. wt. Ti = 48, Mg = 24] [Hint : $\frac{358}{190} = 1.88$]
(A) 35.38 % **(B)** 66.6 % **(C)** 100 % **(D)** 60 %

28. 0.5 mole of H_2SO_4 is mixed with 0.2 mole of $Ca(OH)_2$. The maximum number of moles of $CaSO_4$ formed is
(A) 0.2 **(B)** 0.5 **(C)** 0.4 **(D)** 1.5

29. Equal weight of 'X' (At. wt. = 36) and 'Y' (At. wt. = 24) are reacted to form the compound X_2Y_3. Then :
(A) X is the limiting reagent
(B) Y is the limiting reagent
(C) No reactant is left over and mass of X_2Y_3 formed is double the mass of 'X' taken
(D) none of these

30. 25.4 g of iodine and 14.2g of chlorine are made to react completely to yield a mixture of ICl and ICl_3. Calculate the number of moles of ICl and ICl_3 formed.
(A) 0.1 mole, 0.1 mole **(B)** 0.1 mole, 0.2 mole
(C) 0.5 mole, 0.5 mole **(D)** 0.2 mole, 0.2 mole

31. What weights of P_4O_6 and P_4O_{10} will be produced by the combustion of 31g of P_4 in 32g of oxygen leaving no P_4 and O_2.
(A) 2.75g, 219.5g **(B)** 27.5g, 35.5g **(C)** 55g, 71g **(D)** 17.5g, 190.5g

32 What weight of $CaCO_3$ must be decomposed to produce the sufficient quantity of carbon dioxide to convert 21.2 kg of Na_2CO_3 completely in to $NaHCO_3$. [Atomic mass Na = 23, Ca = 40]

$$CaCO_3 \longrightarrow CaO + CO_2$$

$$Na_2CO_3 + CO_2 + H_2O \longrightarrow 2NaHCO_3$$

(A) 100 Kg **(B)** 20 Kg **(C)** 120 Kg **(D)** 30 Kg

33 NX is produced by the following step of reactions

$M + X_2 \longrightarrow MX_2$; $3MX_2 + X_2 \longrightarrow M_3X_8$; $M_3X_8 + N_2CO_3 \longrightarrow NX + CO_2 + M_3O_4$

How much M (metal) is consumed to produce 206 gm of NX. (Take at wt of M = 56, N=23, X = 80)

(A) 42 gm **(B)** 56 gm **(C)** $\frac{14}{3}$ gm **(D)** $\frac{7}{4}$ gm

34 0.05 mole of $LiAlH_4$ in ether solution was placed in a flask containing 74g (1 mole) of t-butyl alcohol. The product $LiAlHC_{12}H_{27}O_3$ weighed 12.7 g. If Li atoms are conserved, the percentage yield is : (Li = 7, Al = 27, H = 1, C = 12, O = 16).
(A) 25% **(B)** 75% **(C)** 100% **(D)** 15%

35 A sample of a mixture of $CaCl_2$ and NaCl weighing 4.44 gm was treated to precipitate all the Ca as $CaCO_3$, which was then heated and quantitatively converted to 1.12g of CaO. (At . wt. Ca = 40, Na = 23, Cl = 35.5)
(A) Mixture contains 25% NaCl **(B)** Mixture contains 60% $CaCl_2$
(C) Mass of $CaCl_2$ is 2.22 g **(D)** Mass of $CaCl_2$ 1.11 g

36 The oxidation states of Sulphur in the anions SO_3^{2-}, $S_2O_4^{2-}$ and $S_2O_6^{2-}$ follow the order :
(A) $S_2O_6^{2-} < S_2O_4^{2} < SO_3^{2-}$ **(B)** $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-}$
(C) $SO_3^{2-} < S_2O_4^{2-} < S_2O_6^{2-}$ **(D)** $S_2O_4^{2} < S_2O_6^{2-} < SO_3^{2-}$

37 The oxidation number of Phosphorus in $Mg_2P_2O_7$ is :
(A) + 3 **(B)** + 2 **(C)** + 5 **(D)** – 3

38 The oxidation number of Oxygen in Na_2O_2 is :
(A) + 1 **(B)** + 2 **(C)** – 2 **(D)** – 1

39 In $FeCr_2O_4$, the oxidation numbers of Fe and Cr are :
(A) + 2 and + 3 **(B)** 0 and + 2 **(C)** + 2 and + 6 **(D)** + 3 and + 6

40 The average oxidation state of Fe in Fe_3O_4 is :

(A) 2 and 3 **(B)** 8/3 **(C)** 2 **(D)** 3

41 Which of the following are examples of disproportionation reaction :

(A) $HgO \longrightarrow Hg + O_2$ **(B)** $KClO_3 \longrightarrow KCl + O_2$

(C) $KClO_3 \longrightarrow KClO_4 + KCl$ **(D)** None of these

42 Match List-I (Compounds) with List-II (Oxidation states of Nitrogen) and select answer using the codes given below the lists :

	List-I		List-II
(a)	NaN_3	(1)	+5
(b)	N_2H_2	(2)	+2
(c)	NO	(3)	–1/3
(d)	N_2O_5	(4)	–1

(Code) :

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

43 1 mole of N_2H_4 loses ten moles of electrons to form a new compound Y. Assuming that all the nitrogen appears in the new compound, what is the oxidation state of nitrogen in Y? (There is no change in the oxidation state of hydrogen).

(A) – 1 **(B)** – 3 **(C)** + 3 **(D)** + 5

44 In the reaction $xHI + yHNO_3 \longrightarrow NO + I_2 + H_2O$, upon balancing with whole number coefficients :

(A) x = 3, y = 2 **(B)** x = 2, y = 3 **(C)** x = 6, y = 2 **(D)** x = 6, y = 1

45 For the redox reaction $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$,
the correct whole number stoichiometric coefficients of MnO_4^-, $C_2O_4^{2-}$ and H^+ are respectively:

(A) 2, 5, 16 **(B)** 16, 5, 2 **(C)** 5, 16, 2 **(D)** 2, 16, 5

46 For the redox reaction $xP_4 + yHNO_3 \longrightarrow H_3PO_4 + NO_2 + H_2O$, upon balancing with whole number coefficients:

(A) x = 1, y = 5 **(B)** x = 2, y = 10 **(C)** x = 1, y = 20 **(D)** x = 1, y = 15

47 In the reaction $X^- + XO_3^- + H^+ \longrightarrow X_2 + H_2O$, the molar ratio in which X^- and XO_3^- react is :

(A) 1 : 5 **(B)** 5 : 1 **(C)** 2 : 3 **(D)** 3 : 2

48 CN^- is oxidised by NO_3^- in presence of acid :

$$a\,CN^- + b\,NO_3^- + c\,H^+ \longrightarrow (a+b)\,NO + a\,CO_2 + \frac{c}{2}H_2O$$

What are the whole number values of a, b, c in that order :

(A) 3, 7, 7 **(B)** 3, 10, 7 **(C)** 3, 10, 10 **(D)** 3, 7, 10

49 In the following reaction : $Cr(OH)_3 + OH^- + IO_3^- \rightarrow CrO_4^{2-} + H_2O + I^-$

(A) IO_3^- is oxidising agent **(B)** $Cr(OH)_3$ is reduced

(C) $4e^-$ are being taken per iodine atom **(D)** None of these

50 Equal moles of H_2O and NaCl are present in a solution. Hence, molality of NaCl solution is :

(A) 0.55 **(B)** 55.5 **(C)** 1.00 **(D)** 0.18

51 500 mL of a glucose solution contains 6.02×10^{22} molecules. The concentration of the solution is
(A) 0.1 M **(B)** 1.0 M **(C)** 0.2 M **(D)** 2.0 M

52 Mole fraction of A in H_2O is 0.2. The molality of A in H_2O is :
(A) 13.9 **(B)** 15.5 **(C)** 14.5 **(D)** 16.8

53 What is the molarity of H_2SO_4 solution that has a density of 1.84 g/cc and contains 98% by mass of H_2SO_4? (Given atomic mass of S = 32)
(A) 4.18 M **(B)** 8.14 M **(C)** 18.4 M **(D)** 18 M

54 Decreasing order of mass of pure NaOH in each of the aqueous solution.
(I) 50 g of 40% (W/W) NaOH
(II) 50 ml of 50% (W/V) NaOH (d_{sol} = 1.2 g/ml).
(III) 50 g of 15 M NaOH (d_{sol} = 1 g/ml).
(A) I, II, III **(B)** III, II, I **(C)** II, III, I **(D)** III = II = I.

55 A solution of $FeCl_3$ is $\frac{M}{30}$ its molarity for Cl^- ion will be :
(A) $\frac{M}{90}$ **(B)** $\frac{M}{30}$ **(C)** $\frac{M}{10}$ **(D)** $\frac{M}{5}$

56. The molarity of the solution containing 2.8%(mass / volume) solution of KOH is : (Given atomic mass of K = 39) is :
(A) 0.1 M **(B)** 0.5 M **(C)** 0.2 M **(D)** 1 M

57. The volume of water that must be added to a mixture of 250 ml of 0.6 M HCl and 750 ml of 0.2 M HCl to obtain 0.25 M solution of HCl is :
(A) 750 ml **(B)** 100 ml **(C)** 200 m● **(D)** 300 m●

58. If 500 ml of 1 M solution of glucose is mixed with 500 ml of 1 M solution of glucose final molarity of solution will be :
(A) 1 M **(B)** 0.5 M **(C)** 2 M **(D)** 1.5 M

59. What volume of a 0.8 M solution contains 100 milli moles of the solute?
(A) 100 mL **(B)** 125 mL **(C)** 500 mL **(D)** 62.5 mL

60. The molarity of Cl^- in an aqueous solution which was (w/V) 2% NaCl, 4% $CaCl_2$ and 6% NH_4Cl will be
(A) 0.342 **(B)** 0.721 **(C)** 1.12 **(D)** 2.18

61. 2M of 100 ml Na_2SO_4 is mixed with 3M of 100 ml NaCl solution and 1M of 200 ml $CaCl_2$ solution. Then the ratio of the concentration of cation and anion.
(A) 1/2 **(B)** 2 **(C)** 1.5 **(D)** 1

62. The molar mass of normal water is ..... as compared to heavy water.
(A) 10% less **(B)** 10% high **(C)** 2% less **(D)** zero% less

63. A sample of ammonium phosphate $(NH_4)_3PO_4$ contains 3.18 mol of H atoms. The number of mol of O atoms in the sample is :
(A) 0.265 **(B)** 0.795 **(C)** 1.06 **(D)** 3.18

64. Which of the following will contain same number of atoms as 20g of calcium?
(A) 24g magnesium **(B)** 12g carbon **(C)** 8g oxygen gas **(D)** 16 g oxygen atom

65. The ratio of the weight of one litre of a gas to the weight of 1.0 L oxygen gas both measured at S.T.P. is 2.22. The molecular weight of the gas would be :
(A) 14.002 **(B)** 35.52 **(C)** 71.04 **(D)** 55.56

66. A certain organic substance used as a solvent in many reactions contains carbon, hydrogen, oxygen and sulphur. Weight % of hydrogen in the compound is 7.7. The weight ratio C : O : S = 3 : 2 : 4. What is the least possible molar mass of the compound ?
(A) 86 **(B)** 63 **(C)** 94 **(D)** 78

67. The oxides of a certain (hypothetical) element contain 27.28%, 42.86% and 52.94% oxygen. What is the ratio of the valancies of the element in the 3 oxides ?
(A) 2 : 3 : 4 **(B)** 1 : 3 : 4 **(C)** 1 : 2 : 4 **(D)** 1 : 2 : 3

68. Formation of polyethene from calcium carbide takes place as follows :
$CaC_2 + H_2O \rightarrow Ca(OH)_2 + C_2H_2$; $C_2H_2 + H_2 \rightarrow C_2H_4$
$n(C_2H_4) \rightarrow (-CH_2-CH_2-)_n$.
The amount of polyethylene possibly obtainable from 64.0 kg CaC_2 can be
(A) 28Kg **(B)** 14kg **(C)**) 21kg **(D)** 42 kg

69. The hourly energy requirement of an astronaut can be satisfied by the energy released when 34 g of sucrose ($C_{12}H_{22}O_{11}$) are burnt in his body. How many g of oxygen would be needed to be carried in space capsule to meet his requirement for one day :
(A) 916.2 gm **(B)** 91.62 gm **(C)** 8.162 gm **(D)** 9.162 gm.

70. One mole of a mixture of N_2, NO_2 and N_2O_4 has a mean molar mass of 55.4. On heating to a temperature at which all the N_2O_4 may be presumed to have dissociated : $N_2O_4 \rightleftharpoons 2NO_2$, the mean molar mass tends to the lower value of 39.6. What is the mole ratio of $N_2 : NO_2 : N_2O_4$ in the original mixture ?
(A) 0.5 : 0.1 : 0.4 **(B)** 0.6 : 0.1 : 0.3 **(C)** 0.5 : 0.2 : 0.3 **(D)** 0.6 : 0.2 : 0.2

71. 112.0 mL of NO_2 at STP was liquefied, the density of the liquid being 1.15 g mL^{-1}. Calculate the volume and the number of molecules in the liquid NO_2 (At. wt. of N = 14)
(A) 0.10 mL and 3.01×10^{22} **(B)** 0.20 mL and 3.01×10^{21}
(C) 0.20 mL and 6.02×10^{23} **(D)** 0.40 mL and 6.02×10^{21}

72. If a piece of iron gains 10% of its weight due to partial rusting into Fe_2O_3 the percentage of total iron that has rusted is :
(A) 23 **(B)** 13 **(C)** 23.3 **(D)** 25.67

73. If 10 g of Ag reacts with 1 g of sulphur , the amount of Ag_2S formed will be [Atomic weight of Ag = 108, S = 32] ?
(A) 7.75 g **(B)** 0.775 g **(C)** 11 g **(D)** 10 g

74. 100 g impure $CaCO_3$ on heating gives 5.6 lt. CO_2 gas at STP. Find the percentage of calcium in the lime stone sample. [At. wt. : Ca = 40 ; C = 12 ; O = 16]
(A) 10 **(B)** 20 **(C)** 1 **(D)** 30

75. XeF_6 fluorinates I_2 to IF_7 and liberates Xenon(g). 210 mmol of XeF_6 can yield a maximum of_____ mmol of IF_7
(A) 420 **(B)** 180 **(C)** 210 **(D)** 245

76. 1 mol of iron (Fe) reacts completely with 0.65 mol O_2 to give a mixture of only FeO and Fe_2O_3. Mole ratio of ferrous oxide to ferric oxide is :
(A) 3 : 2 **(B)** 4 : 3 **(C)** 20 : 13 **(D)** none of these

77. When a 12 g mixture of carbon and sulphur is burnt in air, then a mixture of CO_2 and SO_2 is produced, in which the number of moles of SO_2 is half that of CO_2. The mass of the carbon in the mixture is :

(A) 4.08 g **(B)** 5.14 g **(C)** 8.74 g **(D)** 1.54 g

78. When x grams of carbon are heated with y grams of oxygen in a closed vessel, no solid residue is left behind. Which of the following statements is correct ?

(A) y/x must lie between 1.33 and 2.67

(B) y/x must be greater than or equal 2.67.

(C) y/x must be less than or equal 1.33

(D) y/x must be greater than or equal 1.33.

79. Composition of a sample is $Fe_{0.93}\ O_{1.00}$. If Fe is present in +2 & +3 oxidation state in this sample then % of Fe present in +3 oxidation state

(A) 85% **(B)** 30% **(C)** 15% **(D)** 60%

80. When ZnS is boiled with strong nitric acid, the products are zinc nitrate, sulphuric acid and nitrogen dioxide. What are the changes in the oxidation numbers of Zn, S and N :

(A) $+2, +4, -1$ **(B)** $+2, +6, -2$ **(C)** $0, +4, -2$ **(D)** $0, +8, -1$

Exercise # 2 Part # I [Multiple Correct Choice Type Questions]

1. In which of the following pairs do 1 g of each have an equal number of molecules?

(A) N_2O and CO **(B)** N_2 and C_3O_2 **(C)** N_2 and CO **(D)** N_2O and CO_2

2. Silver metal in ore is dissolved by potassium cyanide solution in the presence of air by the reaction

$$4\,Ag + 8\,KCN + O_2 + 2H_2O \longrightarrow 4\,K[Ag(CN)_2] + 4\,KOH$$

(A) The amount of KCN required to dissolve 100 g of pure Ag is 120 g.

(B) The amount of oxygen used in this process is 0.742 g (for 100 gm pure Ag)

(C) The amount of oxygen used in this process is 7.40 g (for 100 gm pure Ag)

(D) The volume of oxygen used at STP is 5.20 litres.

3. If 27 g of Carbon is mixed with 88 g of Oxygen and is allowed to burn to produce CO_2, then :

(A) Oxygen is the limiting reagent. **(B)** Volume of CO_2 gas produced at NTP is 50.4 L.

(C) C and O combine in mass ratio 3 : 8. **(D)** Volume of unreacted O_2 at STP is 11.2 L.

4. $A + B \rightarrow A_3B_2$ (unbalanced)

$A_3B_2 + C \rightarrow A_3B_2C_2$ (unbalanced)

Above two reactions are carried out by taking 3 moles each of A and B and one mole of C. Then which option is/are correct ?

(A) 1 mole of $A_3B_2C_2$ is formed **(B)** 1/2 mole of $A_3B_2C_2$ is formed

(C) 1/2 mole of A_3B_2 is formed **(D)** 1/2 mole of A_3B_2 is left finally

5. Consider the redox reaction $2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2\,I^-$:

(A) $S_2O_3^{2-}$ gets reduced to $S_4O_6^{2-}$ **(B)** $S_2O_3^{2-}$ gets oxidised to $S_4O_6^{2-}$

(C) I_2 gets reduced to I^- **(D)** I_2 gets oxidised to I^-

6. If 100 ml of 1M H_2SO_4 solution is mixed with 100 ml of 9.8%(w/w) H_2SO_4 solution (d = 1 g/ml) then :

(A) concentration of solution remains same **(B)** volume of solution become 200 ml

(C) mass of H_2SO_4 in the solution is 98 gm **(D)** mass of H_2SO_4 in the solution is 19.6 gm

7. Equal volume of 0.1M NaCl and 0.1M $FeCl_2$ are mixed with no change in volume due to mixing. Which of the following will be true for the final solution. (No precipitation occurs). Assume complete dissociation of salts and neglect any hydrolysis.

(A) $[Na^+] = 0.05$ M **(B)** $[Fe^{2+}] = 0.05$M **(C)** $[Cl^-] = 0.3$M **(D)** $[Cl^-] = 0.15$M

8. Which of the following has same mass

(A) 1.0 mole of O_2 **(B)** 3.01×10^{23} molecules of SO_2

(C) 0.5 moles of CO_2 **(D)** 1 g atom of sulphur

9. A 5L vessel contains 2.8 g of N_2. When heated to 1800 K, 30% molecules are dissociated into atoms.

(A) Total no. of moles in the container will be 0.13

(B) Total no. of molecules in the container will be close to 0.421×10^{23}.

(C) Total no. of moles in the container will be 0.098.

(D) All of these are correct.

10. The density of air is 0.001293 g/cm^3 at STP. Identify which of the following statement is correct

(A) Vapour density is 14.48

(B) Molecular weight is 28.96

(C) Vapour density is 0.001293 g/cm^3

(D) Vapour density and molecular weight cannot be determined.

11. If H_2SO_4 is formed from it's elements by taking 6.023×10^{23} atom of 'O' 5.6 litre of H_2 gas at STP and 8 gm S then

(A) 0.125 moles of H_2SO_4 are formed

(B) 0.25 moles of H_2SO_4 are formed

(C) no moles of 'S' are left

(D) 1/4 mole of O_2 is left

12. The molality of a sulphuric acid solution is 0.2. Calculate the total weight of the solution having 1000 gm of solvent.

(A) 1000 g **(B)** 1098.6 g **(C)** 980.4 g **(D)** 1019.6g

13. Equal masses of SO_2 and O_2 are placed in a flask at STP choose the correct statement.

(A) The number of molecules of O_2 are more than SO_2

(B) Volume occupied at STP is more for O_2 than SO_2

(C) The ratio of number of atoms of SO_2 and O_2 is 3 : 4.

(D) Moles of SO_2 is greater than the moles of O_2 .

14. For the reaction $2P + Q \rightarrow R$, 12 mol of P and 8 mol of Q are taken then

(A) 3 mol of R is produced **(B)** 6 mol of R is produced

(C) 25% of Q is left behind **(D)** 25% of Q has reacted

15. When arsenic sulphide is boiled with NaOH, sodium arsenite and sodium thioarsenite are formed according to reaction :

$$x\,As_2S_3 + y\,NaOH \longrightarrow x\,Na_3AsO_3 + x\,Na_3AsS_3 + \frac{y}{2}\,H_2O$$

What are the values of x and y?

(A) 1, 6 **(B)** 2, 8 **(C)** 2, 6 **(D)** 1, 4

16. A mineral water sample was analysed and found to contain 1×10^{-3} % ammonia (w/w). The mole of dissolved ammonia gas in one litre water bottle is ($d_{water} \approx 1$ gm/ml)

(A) 5.8×10^{-4} mol **(B)** 1×10^{-2} mol **(C)** 0.58×10^{-2} mol **(D)** same as w/w

17. What is the quantity of water that should be added to 16 g. methanol to make the mole fraction of methanol as 0.25

(A) 27 g. **(B)** 12 g. **(C)** 18 g. **(D)** 36 g.

18. Calculate the mass percent (w/w) of sulphuric acid in a solution prepared by dissolving 4 g of sulphur trioxide in a 100 ml sulphuric acid solution containing 80 mass percent (w/w) of H_2SO_4 and having a density of 1.96 g/ml. (molecular weight of $H_2SO_4 = 98$). Take reaction $SO_3 + H_2O \rightarrow H_2SO_4$

(A) 80.8% **(B)** 84% **(C)** 41.65% **(D)** None of these

19. On mixing 15.0 ml of ethyl alcohol of density 0.792 g ml^{-1} with 15 ml of pure water at 4^{0}C, the resulting solution is found to have a density of 0.924 g ml^{-1}. The percentage contraction in volume is :

(A) 8 % **(B)** 2 % **(C)** 3 % **(D)** 4 %

20. The following equations are balanced atomwise and chargewise.

(i) $Cr_2O_7^{2-} + 8H^+ + 3H_2O_2 \longrightarrow 2Cr^{3+} + 7H_2O + 3O_2$

(ii) $Cr_2O_7^{2-} + 8H^+ + 5H_2O_2 \longrightarrow 2Cr^{3+} + 9H_2O + 4O_2$

(iii) $Cr_2O_7^{2-} + 8H^+ + 7H_2O_2 \longrightarrow 2Cr^{3+} + 11H_2O + 5O_2$

The precise equation/equations representing the oxidation of H_2O_2 is/are :

(A) (i) only **(B)** (ii) only **(C)** (iii) only **(D)** all the three

21. $xNO_3^- + yI^- + zH^+ \rightarrow 2NO + 3I_2 + 4H_2O$ x , y z respectively in the above equation are :

(A) 2, 6, 8 **(B)** 1, 6 , 4 **(C)** 0, 6 , 8 **(D)** 2 , 3 , 4

22. Molarity of H_2SO_4 is 18 M. Its density is 1.8 g/cm^3, hence molality is

(A) 18 **(B)** 100 **(C)** 36 **(D)** 500

23. A solution of glucose received from some research laboratory has been marked mole fraction x and molality (m) at 10ºC. When you will calculate its molality and mole fraction in your laboratory at 24ºC you will find

(A) mole fraction (x) and molality (m) **(B)** mole fraction (2x) and molality (2m)

(C) mole fraction (x/2) and molality (m/2) **(D)** mole fraction (x) and (m ± dm) molality

24. Mole fraction of ethyl alcohol in aqueous ethyl alcohol (C_2H_5OH) solution is 0.25. Hence percentage of ethyl alcohol by weight is :

(A) 54% **(B)** 25% **(C)** 75% **(D)** 46%

25. A sample of aluminium has a mass of 54.0 g. What is the mass of the same number of magnesium atoms? (At. wt. Al = 27, Mg=24)

(A) 12 g **(B)** 24 g **(C)** 48 g **(D)** 96 g.

26. The atomic weights of two elements A and B are 40 and 80 respectively. If x g of A contains y atoms, how many atoms are present in 2x g of B?

(A) $\frac{y}{2}$ **(B)** $\frac{y}{4}$ **(C)** y **(D)** 2y

27. Which of the following statement is correct :

(A) 1 mole of electrons has 1.6×10^{-19} C of charge.

(B) 1 mole of electron weighs 0.54 mg

(C) 1 mole of electrons weighs 5.4 mg

(D) 1 mole of electrons weighs 0.54 kg

28. The sodium salt of methyl orange has 7% sodium. What is the minimum molecular weight of the compound?

(A) 420 **(B)** 375 **(C)** 328.57 **(D)** 294.46

29. 64 g of an organic compound has 24 g carbon and 8 g hydrogen and the rest is oxygen. The empirical formula of the compound is

(A) CH_4O **(B)** CH_2O **(C)** C_2H_4O **(D)** None

30. $2KI + I_2 + 22\,HNO_3 \rightarrow 2HIO_3 + 2KIO_3 + 22NO_2 + 10H_2O$

If 3 mole of KI & 2 moles I_2 are reacted with excess of HNO_3. Volume of NO_2 gas evolved at NTP is

$2KI + I_2 + 22\,HNO_3 \rightarrow 2HIO_3 + 2KIO_3 + 22NO_2 + 10H_2O$

(A) 739.2 Lt **(B)** 1075.2 Lt **(C)** 44.8 Lt **(D)** 67.2 Lt

31. If 240 g of carbon is taken in a container to convert it completely to CO_2 but in industry it has been found that 280 g of CO was also formed along with CO_2. Find the mole percentage yield of CO_2. The reactions occurring are

$C + O_2 \longrightarrow CO_2$; $C + \frac{1}{2} O_2 \longrightarrow CO$

(A) 25 % **(B)** 50 % **(C)** 75 % **(D)** 100%

32. Minimum amount of Ag_2CO_3 (s) required to produce sufficient oxygen for the complete combustion of C_2H_2 which produces 11.2 ltr of CO_2 at S.T.P after combustion is: [Ag = 108]

$Ag_2CO_3(s) \rightarrow 2Ag(s) + CO_2(g) + 1/2\, O_2(g)$

$C_2H_2 + 5/2\, O_2 \rightarrow 2CO_2 + H_2O$

(A) 276 g **(B)** 345 g **(C)** 690 g **(D)** 1380 g

33. Consider the following statements :

1. If all the reactants are not taken in their stoichiometric ratio, then at least one reactant will be left behind.
2. 2 moles of H_2(g) and 3 moles of O_2(g) produce 2 moles of water.
3. equal wt. of carbon and oxygen are taken to produce CO_2 then O_2 is limiting reagent.

The above statements 1, 2, 3 respectively are (T = True, F = False)

(A) T T T **(B)** F T F **(C)** F F F **(D)** T F T

34. In the reaction $4A + 2B + 3C \longrightarrow A_4B_2C_3$ what will be the number of moles of product formed. Starting from 2 moles of A, 1.2 moles of B & 1.44 moles of C :

(A) 0.5 **(B)** 0.6 **(C)** 0.48 **(D)** 4.64

35. How many gram ions of SO_4^{-2} are present in 1 gram molecule of $K_2SO_4 . Al_2(SO_4)_3 . 24H_2O$:

(A) 2 **(B)** 3 **(C)** 1 **(D)** 4

36. Common salt obtained from sea - water contains 96% NaCl by mass. The approximate number of molecules of NaCl present in 10.0 g of the common salt is : (At. wt. Na = 23)

(A) 10^{21} **(B)** 10^{22} **(C)** 10^{23} **(D)** 10^{24}

37. X and Y are two elements which form X_2Y_3 and X_3Y_4. If 0.20 mol of X_2Y_3 weighs 32.0 g and 0.4 mol of X_3Y_4 weighs 92.8 g, the atomic weights of X and Y are respectively

(A) 16.0 and 56.0 **(B)** 8.0 and 28.0 **(C)** 56.0 and 16.0 **(D)** 28.0 and 8.0

38. If 10 g of Ag reacts with 1 g of sulphur , the amount of Ag_2S formed will be [Atomic weight of Ag = 108, S = 32] ?

(A) 7.75 g **(B)** 0.775 g **(C)** 11 g **(D)** 10 g

39. A 10.0 g sample of a mixture of calcium chloride and sodium chloride is treated with Na_2CO_3 solution. This calcium carbonate is heated to convert all the calcium to calcium oxide and the final mass of calcium oxide is 1.62 gm. The percentage by mass of calcium chloride in the original mixture is :

(A) 15.2% **(B)** 32.1% **(C)** 21.8% **(D)** 11.07%

40. Which of the following equations is a balanced one :

(A) $5BiO_3^- + 22H^+ + Mn^{2+} \longrightarrow 5Bi^{3+} + 7H_2O + MnO_4^-$

(B) $5BiO_3^- + 14H^+ + 2Mn^{2+} \longrightarrow 5Bi^{3+} + 7H_2O + 2MnO_4^-$

(C) $2BiO_3^- + 4H^+ + Mn^{2+} \longrightarrow 2Bi^{3+} + 2H_2O + MnO_4^-$

(D) $6BiO_3^- + 12H^+ + 3Mn^{2+} \longrightarrow 6Bi^{3+} + 6H_2O + 3MnO_4^-$

41. How much $NaNO_3$ must be weighed out to make 50 ml of an aqueous solution containing 70 mg of Na^+ per mL ?

(A) 12.394 g **(B)** 1.29 g **(C)** 10.934 g **(D)** 12.934 g

42. During the disproportionation of Iodine to iodide and iodate ions, the ratio of iodate and iodide ions formed in alkaline medium is :

(A) 1 : 5 **(B)** 5 : 1 **(C)** 3 : 1 **(D)** 1 : 3

43. A solution containing 0.1 mol of a metal chloride MCl_x requires 500 ml of 0.8 M $AgNO_3$ solution for complete reaction $MCl_x + xAgNO_3 \rightarrow xAgCl + M(NO_3)_x$. Then the value of x is :

(A) 1 **(B)** 2 **(C)** 4 **(D)** 3

44. The strength of 10^{-2} M Na_2CO_3 solution in terms of molality will be (density of solution = 1.10 g mL^{-1}). (Molecular weight of Na_2CO_3 = 106 g mol^{-1})

(A) 9.00×10^{-3} **(B)** 1.5×10^{-2} **(C)** 5.1×10^{-3} **(D)** 11.2×10^{-3}

45. The temperature at which molarity of pure water is equal to its molality is :

(A) 273 K **(B)** 298 K **(C)** 277 K **(D)** None

46. What is the molarity of H_2SO_4 solution that has a density 1.84 gm/cc at 35ºC and contains 98% by weight-

(A) 4.18 M **(B)** 8.14 M **(C)** 18.4 M **(D)** 18 M

47. 5.85 g of NaCl is dissolved in 1 L of pure water. The number of ions in 1 mL of this solution is

(A) 6.02×10^{19} **(B)** 1.2×10^{22} **(C)** 1.2×10^{20} **(D)** 6.02×10^{20}

48. The correct expression relating molality (m), molarity (M), density of solution (d) and molar mass (M_2) of solute is :

(A) $m = \dfrac{M}{d + MM_2} \times 1000$ **(B)** $m = \dfrac{M}{1000\,d - MM_2} \times 1000$

(C) $m = \dfrac{d + MM_2}{M} \times 1000$ **(D)** $m = \dfrac{1000\,d - MM_2}{M} \times 1000$

49. H_3PO_4 (98 g mol^{-1}) is 98% by mass of solution. If the density is 1.8 gm/ml, the molarity is :

(A) 18 M **(B)** 36 M **(C)** 54 M **(D)** 0.18 M

50. Suppose you want an acidic solution to carry out a chemical reaction with 2 moles of NaOH. Which sample of acid is the best choice for you. (At. wt. : S = 32, Cl = 35.5)

(A) 1 M H_2SO_4 (50 Rs per lt.) **(B)** 1 M H_2SO_4 (56 Rs per lt.)

(C) 1 M HCl (30 Rs per lt.) **(D)** 1 M HCl (27 Rs per lt.)

Part # II [Assertion & Reason Type Questions]

Each question has 5 choices (A), (B), (C), (D) and (E) out of which only one is correct.

(A) Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation for Statement-1.

(B) Statement-1 is true, Statement-2 is true and Statement-2 is not correct explanation for Statement-1.

(C) Statement-1 is true, Statement-2 is false.

(D) Statement-1 is false, Statement-2 is true.

(E) Both Statements are false.

1. **Statement-1 :** The average mass of one Mg atom is 24.305 amu, which is not the actual mass of one Mg atom.

Statement-2 : Three isotopes, ^{24}Mg, ^{25}Mg and ^{26}Mg, of Mg are found in nature.

2. **Statement-1 :** A molecule of butane, C_4H_{10} has a mass of 58.12 amu.
Statement-2 : One mole of butane contains 6.022×10^{23} molecules and has a mass of 58.12 g.

3. **Statement-1 :** Both 12 g. of carbon and 27 g. of aluminium will have 6.02×10^{23} atoms.
Statement-2 : Gram atomic mass of an element contains Avogadro's number of atoms.

4. **Statement-1 :** The ratio of the mass of 100 billion atoms of magnesium to the mass of 100 billion atoms of lead can be expressed as $\frac{24}{207}$.
Statement-2 : Atomic weights are relative masses.

5. **Statement-1 :** The weight percentage of a compound A in a solution is given by

$$\% \text{ of A} = \frac{\text{Mass A}}{\text{Total mass of solution}} \times 100$$

Statement-2 : The mole fraction of a component A is given by,

$$\text{Mole fraction of A} = \frac{\text{No. of moles of A}}{\text{Total no. of moles of all components}}$$

6. **Statement-1 :** Laboratory reagents are usually made up to a specific molarity rather than a given molality.
Statement-2: The volume of a liquid is more easily measured than its mass.

7. **Statement-1 :** Molality and mole fraction concentration units do not change with temperature.
Statement-2 : These units are not defined in terms of any volume.

8. **Statement-1 :** A one molal solution prepared at 20°C will retain the same molality at 100°C, provided there is no loss of solute or solvent on heating.
Statement-2 : Molality is independent of temperature.

9. **Statement-1 :** The molality and molarity of very dilute aqueous solutions differ very little.
Statement-2 : The density of water is about 1.0 g cm^{-3} at room temperature.

10. **Statement-1 :** For calculating the molality or the mole fraction of solute, if the molarity is known, it is necessary to know the density of the solution.
Statement-2 : Molality, molarity and the mole fraction of solute can be calculated from the weight percentage and the density of the solution

11. **Statement-I :** 16 g each O_2 and O_3 contains $\frac{N_A}{2}$ and $\frac{N_A}{3}$ atoms respectively.
Statement-II : 16 g O_2 and O_3 contains same no. of atoms.

12. **Statement-I :** 44 g of CO_2, 28 g of CO have same volume at STP.
Statement-II : Both CO_2 and CO are formed by C and oxygen.

13. **Statement-I :** Law of conservation of mass hold good for nuclear reaction.
Statement-II : Law states that mass can be neither created nor destroyed in a chemical reaction.

14. **Statement-I :** A reactant that is entirely consumed when a reaction goes to completion is known as limiting reactant.
Statement-II : The amount of reactant limits the amount of product formed.

15. **Statement-I :** The balancing of chemical equations is based on law of conservation of mass.
Statement-II : Total mass of reactants is equal to total mass of products.

16. **Statement-I :** Pure water obtained from different sources such as, river, well, spring, sea etc. always contains hydrogen and oxygen combined in the ratio 1 : 8 by mass.
Statement-II : A chemical compound always contains elements combined together in same proportion by mass, it was discovered by French chemist, Joseph Proust (1799).

Exercise # 3 Part # I [Matrix Match Type Questions]

1.

	Column I		Column II
(A)	$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(s) + H_2(g)$ above reaction is carried out by taking 2 moles each of Zn and HCl	(p)	50% of excess reagent left
(B)	$AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(g)$ above reaction is carried out by taking 170 g $AgNO_3$ and 18.25 g HCl (Ag = 108)	(q)	22.4 L of gas at STP is liberated
(C)	$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ 100 g $CaCO_3$ is decomposed]	(r)	1 moles of solid (product) obtained.
(D)	$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$ 2/3 moles of $KClO_3$ decomposed	(s)	HCl is the limiting reagent

2.

	Column - I		Column - II
(A)	A gaseous organic compound containing C = 52.17%, H = 13.04% & O = 34.78% (by weight) having molar mass 46 g/mol.	(p)	One mole of compound contains $4N_A$ atoms of Hydrogen.
(B)	0.3 g of an organic compound containing C, H and O on combustion yields 0.44 g of CO_2 and 0.18 g of H_2O, with two O atoms per molecule.	(q)	The empirical formula of the compound is same as its molecule formula
(C)	A hydrocarbon containing C = 42.857% and H = 57.143% (by mole) containing 3C atoms per molecule.	(r)	Combustion products of one mole of compound contains larger number of moles of CO_2 than that of H_2O.
(D)	A hydrocarbon containing 10.5 g carbon per gram of hydrogen having vapour density 46.	(s)	CO_2 gas produced by the combustion of 0.25 mole of compound occupies a volume of 11.2 L at NTP.

3.

	Column-I		Column-II
(A)	100 ml of 0.2 M $AlCl_3$ solution + 400 ml of 0.1 M HCl solution	(p)	Total concentration of cation(s) = 0.12 M
(B)	50 ml of 0.4 M KCl + 50 ml H_2O	(q)	$[SO_4^{2-}] = 0.06$ M
(C)	30 ml of 0.2 M K_2SO_4 + 70 ml H_2O	(r)	$[SO_4^{2-}] = 2.5$ M
(D)	200 ml 24.5% (w/v) H_2SO_4	(s)	$[Cl^-] = 0.2$ M

4.

	Column-I		Column-II
(A)	Molarity	(p)	Dependent on temperature
(B)	Molality	(q)	$\frac{M_A \times n_A}{n_A M_A + n_B M_B}$ x 100
(C)	Mole fraction	(r)	Independent of temperature
(D)	Mass %	(s)	$\frac{X_A}{X_B M_B} \times 1000$

Where M_A, M_B are molar masses, n_A, n_B are no of moles & X_A, X_B are mole fractions of solute and solvent respectively.

5.

Column-I	Column-II
(A) Law of conservation of mass	**(p)** CH_4 has carbon and hydrogen in 3 : 1 mass ratio.
(B) Law of multiple proportion	**(q)** 10 mL N_2 combines with 30 mL of H_2 to form 20 mL of NH_3
(C) Law of definite proportion	**(r)** S and O_2 combine to form SO_2 and SO_3
(D) Law of reciprocal proportion	**(s)** In H_2S and SO_2 mass ratio of H and O w.r.t. sulphur is 1 : 16, hence in H_2O, mass ratio of H and O is 1 : 8.
(E) Gay Lussac's Law	**(t)** 4.2 g $MgCO_3$ gives 2.0 g residue on heating.

6.

Column-I	Column-II (mass of product)
(A) $2H_2 + O_2 \longrightarrow 2H_2O$ 1g 1g	**(p)** 1.028 g
(B) $3H_2 + N_2 \longrightarrow 2NH_3$ 1g 1g	**(q)** 1.333 g
(C) $H_2 + Cl_2 \longrightarrow 2HCl$ 1g 1g	**(r)** 1.125 g
(D) $2H_2 + C \longrightarrow CH_4$ 1g 1g	**(s)** 1.214 g

Part # II [Comprehension Type Questions]

Comprehension # 1

According to the Avogadro's law, equal number of moles of gases occupy the same volume at identical condition of temperature and pressure. Even if we have a mixture of non-reacting gases then Avogadro's law is still obeyed by assuming mixture as a new gas.
Now let us assume air to consist of 80% by volume of Nitrogen (N_2) and 20% by volume of oxygen (O_2). If air is taken at STP then its 1 mol would occupy 22.4 L. 1 mol of air would contain 0.8 mol of N_2 and 0.2 mol of O_2 hence the mole fractions of N_2 and O_2 are given by $X_{N_2} = 0.8$, $X_{O_2} = 0.2$

1. Volume occupied by air at NTP containing exactly 11.2 gm of Nitrogen :
(A) 22.4 L **(B)** 8.96 L **(C)** 11.2 L **(D)** 2.24 L

2. If air is treated as a solution of O_2 and N_2 then % W/W of oxygen is :
(A) $\frac{10}{9}$ **(B)** $\frac{200}{9}$ **(C)** $\frac{700}{9}$ **(D)** $\frac{350}{9}$

3. Density of air at NTP is :
(A) 1 g/L **(B)** $\frac{9}{7}$ g/L **(C)** $\frac{2}{7}$ g/L **(D)** can't be determined

Comprehension # 2

A chemist decided to determine the molecular formula of an unknown compound. He collects following informations
(I) Compounds contains 2 : 1 'H' to 'O' atoms(number of atoms).
(II) Compounds has 40% C by mass
(III) Approximate molecular mass of the compound is 178 g
(IV) Compound contains C, H and O only.

1. What is the % by mass of oxygen in the compound
(A) 53.33% **(B)** 88.88% **(C)** 33.33% **(D)** None of these

2. What is the empirical formula of the compound
(A) CH_3O **(B)** CH_2O **(C)** C_2H_2O **(D)** CH_3O_2

3. Which of the following could be molecular formula of compound
(A) $C_6H_6O_6$ **(B)** $C_6H_{12}O_6$ **(C)** $C_6H_{14}O_{12}$ **(D)** $C_6H_{14}O_6$

Comprehension # 3

In chemistry, oxidation and reduction are taken as two mutually exclusive events. For example, if life is oxidation then death is taken as reduction, taking off a flight is oxidation then standing would be reduction and so many other. In brief it is used as redox in chemical science.
There are so many conceptual facts regarding redox such as adding oxygen or oxygenation, removing hydrogen or dehydrogenation, removing electron or dielectronation are fixed for oxidation and their corresponding antonyms would be reduction processes. Simple way of judging whether a monatomic species has under gone oxidation or reduction is to note if the charge number of species has changed. It is possible to assign to an atom in polyatomic species an operative charge number called their oxidation number or state. (O. N. or O. S.). There is no standard symbol for this quantity so we say it is ϕ. An O. N. is assigned to an element in a compound by assuming that it is present as ion with a characteristic charge for instance oxygen is present as $O(-II)$ and fluorine as $F(-I)$ and some time it may be hypothetical also. For example

For ZnO 

For NH_3 

In continuation to our study, species promoting oxidation are named as oxidant and those promoting reduction are termed as reductant. At the same time their equivalent weights is the ratio of their molecular weight and change is O. N. $(\Delta\phi)$ involving one molecule/formula unit of the reactant i.e., molecular weight divided by number of electrons lost or gained by one molecule/formula during their respective action.
Based on the above discussion answer the following objective question having one best answer.

1. Which corresponds to oxidation action
(A) $\phi = 0$ **(B)** $\Delta\phi = 0$ **(C)** $\Delta\phi > 0$ **(D)** $\Delta\phi < 0$

2. A compound contain P(II), Q(V) R(-II). The possible formula of the compound is
(A) PQR_2 **(B)** $Q_2(PR_3)_2$ **(C)** $P_3[QR_4]_2$ **(D)** $P_3(Q_4R)_2$

3. A compound has θ number of carbon, ϕ number of hydrogen and ψ number of oxygen their equation of finding oxidation number (x) of carbon will be
(A) $\psi^3 + 4x\theta^2 + \phi = 0$ **(B)** $x\theta + \phi - 2\psi = 0$ **(C)** $\theta x + \frac{\phi}{x} - \frac{2\psi}{3} = 0$ **(D)** none of these

Comprehension # 4

The concentrations of solutions can be expressed in number of ways; viz : mass fraction of solute (or mass percent), Molar concentration (Molarity) and Molal concentration (molality). These terms are known as concentration terms and also they are related with each other i.e. knowing one concentration term for the solution, we can find other concentration terms also. The definition of different concentration terms are given below :

Molarity : It is number of moles of solute present in one litre of the solution.

Molality : It is the number of moles of solute present in one kg of the solvent

$$\text{Mole Fraction} = \frac{\text{moles of solute}}{\text{moles of solute} + \text{moles of solvent}}$$

If molality of the solution is given as 'a' then mole fraction of the solute can be calculated by

$$\text{Mole Fraction} = \frac{a}{a + \frac{1000}{M_{solvent}}} ; = \frac{a \times M_{solvent}}{(a \times M_{solvent} + 1000)}$$

where a = molality and $M_{solvent}$ = Molar mass of solvent

We can change : Mole fraction $\leftrightarrow$ Molality $\leftrightarrow$ Molarity

1. 60 gm of solution containing 40% by mass of NaCl are mixed with 100 gm of a solution containing 15% by mass NaCl. Determine the mass percent of sodium chloride in the final solution.

(A) 24.4% **(B)** 78% **(C)** 48.8% **(D)** 19.68%

2. What is the molality of the above solution.

(A) 4.4 m **(B)** 5.5 m **(C)** 24.4 m **(D)** none

3. What is the molarity of solution if density of solution is 1.6 gm/ml

(A) 5.5 M **(B)** 6.67 M **(C)** 2.59 M **(D)** none

Comprehension # 5

Calcium lactate is used in the food and beverage industries. It has also been used medicinally for treatment of various allergies, for treatment of muscular leg cramps, and as an antidote for a variety of poisons, including lead, arsenicals and carbon tetrachloride. A 0.8274 g sample of anhydrous calcium lactate is found by analysis to contain 0.2732 g of C, 0.0382 g H, 0.1520 g Ca and 0.3640 g O. Each mole of calcium lactate is found to contain one mole of calcium ions. Calcium lactate can be crystallised from water as pentahydrate salt.

1. Simplest formula of the calcium lactate is :

(A) $CaO_6C_6H_{10}$ **(B)** $CaO_3C_3H_5$ **(C)** $CaO_2C_3H_3$ **(D)** $CaO_2C_3H_5$

2. Formula weight of calcium lactate is :

(A) 129 g mol^{-1} **(B)** 111 g mol^{-1} **(C)** 218 g mol^{-1} **(D)** 113 g mol^{-1}

3. How many grams of calcium lactate pentahydrate would be recovered from 1 g of anhydrous salt :

(A) 1.41 g **(B)** 1.00 g **(C)** 1.27 g **(D)** 1.51 g

Comprehension # 6

Potash is any potassium mineral that is used for its potassium content. Most of the potash produced in the United States goes into fertilizer. The major sources of potash are potassium chloride (KCl) and potassium sulphate (K_2SO_4). Potash production is often reported as the potassium oxide (K_2O) equivalent or the amount of K_2O that could be made from a given mineral. KCl costs Rs. 50 per kg.

1. What is the cost of K per mole of the KCl sample?

(A) Rs. 13.42 mol^{-1} **(B)** Rs. 3.73 mol^{-1} **(C)** Rs. 1.00 mol^{-1} **(D)** Rs. 2.00 mol^{-1}

2. For what price must K_2SO_4 be sold in order to supply the same amount of potassium as in KCl ?

(A) Rs. 58.40 kg^{-1} **(B)** Rs. 50.00 kg^{-1} **(C)** Rs. 42.82 kg^{-1} **(D)** Rs. 25.00 kg^{-1}

3. What mass (in kg) of K_2O contains the same number of moles of K atoms as 1.00 kg KCl?

(A) 0.158 kg **(B)** 0.315 kg **(C)** 1.262 kg **(D)** 0.631 kg

Comprehension # 7

342 g of 20% by mass of $Ba(OH)_2$ solution (sp. gr. 0.57) is reacted with 200 mL of 2 M HNO_3 according to given balanced reaction :

$$Ba(OH)_2 + 2HNO_3 \longrightarrow Ba(NO_3)_2 + 2H_2O$$

1. The nature of the final solution is :

(A) acidic **(B)** neutral **(C)** basic **(D)** can't say

2. Find the molarity of the ion in resulting solution by which nature of the above solution is identified, is

(A) 0.5 M **(B)** 0.8 M **(C)** 0.4 M **(D)** 1 M

Comprehension # 8

NaBr, used to produce AgBr for use in photography can be self prepared as follows :

$Fe + Br_2 \longrightarrow FeBr_2$ .....(i)

$FeBr_2 + Br_2 \longrightarrow Fe_3Br_8$ .....(ii) (not balanced)

$Fe_3Br_8 + Na_2CO_3 \longrightarrow NaBr + CO_2 + Fe_3O_4$ .....(iii) (not balanced)

How much Fe in kg is consumed to produce 2.06×10^3 kg NaBr .....(iv)

1. Mass of iron required to produce 2.06×10^3 kg NaBr

(A) 420 g **(B)** 420 kg **(C)** 4.2×10^5 kg **(D)** 4.2×10^8 g

2. If the yield of (ii) is 60% & (iii) reaction is 70% then mass of iron required to produce 2.06×10^3 kg NaBr.

(A) 10^5 kg **(B)** 10^5 g **(C)** 10^3 kg **(D)** none

3. If yield of (iii) reaction is 90% then mole of CO_2 formed when 2.06×10^3 kg NaBr is formed.

(A) 20 **(B)** 10 **(C)** 40 **(D)** none

Comprehension # 9

A monobasic acid of weight 15.5 g is heated with excess of oxygen & evolved gases when passed through KOH solution increased its weight by 22 g and when passed through anhydrous $CaCl_2$, increased its weight by 13.5 g. When the same mass of this organic acid is reacted with excess of silver nitrate solution form 41.75 g silver salt of the acid which on ignition gave the residue of weight 27 g.

1. The molecular formula of the organic acid is.

(A) C_2H_6 **(B)** $C_2H_5O_2$ **(C)** $C_2H_6O_2$ **(D)** C_2H_4O

2. The molar masses of the acid & its silver salt respectively are:

(A) 60, 168 **(B)** 167, 60 **(C)** 60, 167 **(D)** 168, 60

Exercise # 4 [Subjective Type Questions]

1. 1.375 g of cupric oxide was reduced by heating in a current of hydrogen and the weight of copper obtained was 1.098 g. In another experiment, 1.179 g of copper was dissolved in nitric acid and the resulting solution was evaporated to dryness. The residue of copper nitrate when strongly heated was converted into 1.4476 g of cupric oxide. Show that the results are in agreement with the law of constant proportion.
2. Elements X and Y from two different compounds. In the first 0.324 g of X is combined with 0.471 g of Y. In second, 0.117 g of X is combined with 0.509 g of Y. Show that these data illustrate the law of multiple proportions.
3. How many g of element are present in 35.125 g atom of Si. (Given at. wt. of Si = 28.)
4. Calculate the no. of molecules in a drop of water weighing 0.07 g.
5. Calculate no. of each atom present in 106.5 g of $NaClO_3$.
6. Find the no. of mole of phosphorus in 92.9 g of phosphorus assuming that molecular formula of phosphorus in P_4. Also determine the no. of atoms and molecules of phosphorus in the sample.
7. Calculate the number of moles in 5.75 g of sodium. (Atomic mass of sodium = 23.)
8. How many grams of each of the following elements must be taken to get 1 mol of the element?

   (a) Sodium **(b)** Chlorine **(c)** Copper
9. The density of liquid mercury is 13.6 / cm^3. How many moles of mercury are there in 1 litre of the metal ? (Atomic mass of Hg = 200)
10. 50 g of $CaCO_3$ is allowed to react with 70 g of H_3PO_4. Calculate :

    (i) amount of $Ca_3(PO_4)_2$ formed **(ii)** amount of unreacted reagent
11. N_2H_4, Hydrazine a rocket fuel can be produced according to the following reaction :

    $$ClNH_2 + 2NH_3 \longrightarrow N_2H_4 + NH_4Cl$$

    When 1000 g $ClNH_2$ is reacted with excess of NH_3, 473 g N_2H_4 is produced. What is the % yield of the reaction.
12. Carbon disulphide 'CS_2', can be made from by product SO_2. The overall reaction is

    $$5C + 2SO_2 \longrightarrow CS_2 + 4CO$$

    How much CS_2 can be produced from 450 kg of waste SO_2 with excess of coke if the SO_2 conversion is 82%.
13. Calculate the percent of BaO in 29.0 g of a mixture of BaO and CaO which just reacts with 100.8 mL of 6.00 M HCl.

    $$BaO + 2HCl \rightarrow BaCl_2 + H_2O$$

    $$CaO + 2HCl \rightarrow CaCl_2 + H_2O$$
14. Calculate the amount of 95% pure Na_2CO_3 required to prepare 5 litre of 0.5 M solution.
15. Calculate the molality of a sulphuric acid solution of specific gravity 1.2 containing 27% H_2SO_4 by weight.
16. A gaseous alkane is exploded with oxygen. The moles of O_2 for complete combustion and CO_2 formed is in the ratio 7 : 4. Deduce molecular formula of alkane.
17. When 2.86 g of a mixture of 1-butene, C_4H_8 and butane C_4H_{10} was burned in excess of oxygen, 8.80 g of CO_2 and 4.14 g of H_2O were obtained. What is percentage by mass of butane in the mixture.

18. If v mL of a gaseous hydrocarbon, after explosion with excess of oxygen, showed a contraction of 2.5 v mL and a further contraction of 2v mL with caustic potash, Find the formula of hydrocarbon.

19. The average mass of one gold atom in a sample of naturally occuring gold is 3.2707×10^{-22} g. Use this to calculate the molar mass of gold.

20. A plant virus is found to consist of uniform symmetrical particles of 150 Å in diameter and 5000 Å long. The specific volume of the virus is 0.75 cm^3/g. If the virus is considered to be a single particle, find its molecular weight.

21. Density of a gas relative to air is 1.17. Find the mol. mass of the gas [M_{air} = 29 g/mol]

22. One type of artificial diamond (commonly called YAG for yttrium aluminium garnet) can be represented by the formula $Y_3Al_5O_{12}$.

(a) Calculate the weight percentage composition of this compound.

(b) What is the weight of yttrium present in a 200 – carat YAG if 1 carat - 200 mg ? (Y = 89, Al = 27)

23. A chemical commonly called "dioxin" has been very much in the news in the past few years. (It is the by product of herbicide manufacture and is thought to be quite toxic.) Its formula is $C_{12}H_4Cl_4O_2$. If you have a sample of dirt (28.3 g) that contains 1.0×10^{-4} % dioxin, how many moles of dioxin are in the dirt sample?

24. A chemist wants to prepare diborane by the reaction

$$6\ LiH + 8\ BF_3 \longrightarrow 6\ Li\ BF_4 + B_2H_6$$

If the starts with 2.0 moles each of LiH & BF_3. How many moles B_2H_6 can be prepared.

25. One gram of an alloy of aluminium and magnesium when heated with excess of dil. HCl forms magnesium chloride, aluminium chloride and hydrogen. The evolved hydrogen collected over mercury at 0°C has a volume of 1.2 litres at 0.92 atm pressure. Calculate the composition of the alloy.

26. A 10 g sample of a mixture of calcium chloride and sodium chloride is treated with Na_2CO_3 to precipitate calcium as calcium carbonate. This $CaCO_3$ is heated to convert all the calcium to CaO and the final mass of CaO is 1.62 g. Calculate % by mass of NaCl in the original mixture.

27. By the reaction of carbon and oxygen, a mixture of CO and CO_2 is obtained. What is the composition of the mixture by mass obtained when 20 grams of O_2 reacts with 12 grams of carbon ?

28. The action of bacteria on meat and fish produces a poisonous compound called cadaverine. As its name and origin imply, it stinks ! It is 58.77% C, 13.81 % H, and 27.42 % N. Its molar mass is 102 g/mol. Determine the molecular formula of cadaverine.

29. Given the following empirical formulae and molecular weight, compute the true molecular formulae :

	Empirical formula	Molecular weight
(a)	CH_2	84
(b)	CH_2O	150
(c)	HO	34
(d)	HgCl	472
(e)	HF	80

30. What is the percentage of nitrogen in an organic compound 0.14 g of which gave by Dumas method 82.1 c.c. of nitrogen collected over water at 27°C and at a barometric pressure of 774.5 mm? (aqueous tension of water at 27°C is 14.5 mm)

31. Calculate the molarity of the following solutions :

(a) 4g of caustic soda is dissolved in 200 mL of the solution.

(b) 5.3 g of anhydrous sodium carbonate is dissolved in 100 mL of solution.

(c) 0.365 g of pure HCl gas is dissolved in 50 mL of solution.

32. A mixture of ethanol and water contains 54 % water by mass. Calculate the mole fraction of alcohol in this solution.

33. 10 mL of a mixture of CO, CH_4, and N_2 exploded with excess of oxygen gave a contraction of 6.5 mL. There was a further contraction of 7 mL, when the residual gas treated with KOH. What is the composition of the original mixture?

34. When 100 mL of a $O_2 - O_3$ mixture was passed through turpentine, there was reduction of volume by 20 mL. If 100 mL of such a mixture is heated, what will be the increase in volume?

35. A crystalline hydrated salt on being rendered anhydrous, loses 45.6% of its weight. The percentage composition of anhydrous salt is : Al = 10.5%, K = 15.1%, S = 24.8% and I = 49.6%. Find the empirical formula of the anhydrous and crystalline salt :

36. How much quantity of zinc will have to be reacted with excess of dilute HCl solution to produce sufficient hydrogen gas for completely reacting with the oxygen obtained by decomposing 5.104 g of potassium chlorate?

37. A 1.85 g sample of mixture of $CuCl_2$ and $CuBr_2$ was dissolved in water and mixed thoroughly with 1.8 g portion of AgCl. After reaction, the solid which now contain AgCl and AgBr was filtered, dried and weighed to be 2.052 g. What was the % by weight of $CuBr_2$ in the mixture?

38. 1.0 g of a sample containing NaCl, KCl and some inert impurity is dissolved in excess of water and treated with excess of $AgNO_3$ solution. A 2.0 g precipitate to AgCl separate out. also sample is 23% by mass in sodium. Determine mass percentage of KCl in the sample :

39. A mixture of $CuSO_4 . 5H_2O$ and $MgSO_4 . 7H_2O$ was heated until all the water was driven-off. If 5.0 g of mixture gave 3 g of anhydrous salts, what was the percentage by mass of $CuSO_4 . 5H_2O$ in the original mixture :

40. A compound containing Ca, C, N and S was subjected to quantitative analysis and formula mass determination. A 0.25 g of this compound was mixed with Na_2CO_3 to convert all Ca into 0.16 g $CaCO_3$. A 0.115 g sample of compound was carried through a series of reactions until all its S was changed into SO_4^{-2} and precipitated as 0.344 g of $BaSO_4$. A 0.712 g sample was processed to liberate all of its N as NH_3 and 0.155 g NH_3 was obtained. The formula mass was found to be 156. Determine the empirical and molecular formula of the compound

41. A 0.2 g sample, which is mixture of NaCl, NaBr and NaI was dissolved in water and excess of $AgNO_3$ was added. The precipitate containing AgCl, AgBr and AgI was filtered, dried and weighed to be 0.412 g. The solid was placed in water and treated with excess of NaBr, which converted all AgCl into AgBr. The precipitate was then weighed to be 0.4881 g. It was then placed into water and treated with excess of NaI, which converted all AgBr into AgI. The precipitate was then weighed to be 0.5868 g. What was the percentage of NaCl, NaBr and NaI in the original mixture :

42. 2.5 g of a sample containing Na_2CO_3 ; $NaHCO_3$ and some non-volatile impurity on gentle heating loses 12% of its weight. Residue is dissolved in 100 mL water and its 10 mL portion required 15 mL 0.1 M aqueous solution of $BaCl_2$ for complete precipitation of carbonates. Determine mass percentage of Na_2CO_3 in the original sample ?

43. Based on the following information, determine value x and y :

$$\underset{0.643\ g}{(CH_3)_x AlCl_y} \longrightarrow \underset{0.222\ g}{xCH_4(g)} + yCl^- + Al^{3+} \xrightarrow{AgNO_3} \underset{0.996\ g}{AgCl(s)}$$

44. A 5.0 g sample of felspar containing Na_2O, K_2O and some inert impurity is dissolved in dilute HCl solution and NaCl and KCl formed are separated by fractional crystallization. During crystallization some less soluble impurities also comes out. Mass of NaCl, KCl and impurity accompanying these salts was found to be 6.47 g. Solid crystal was then re-dissolved and required 300 mL of 0.3 M $AgNO_3$ for complete precipitation of chlorides. The precipitate this, obtained was found to contain 4.23 % insoluble impurity. Determine mass percentage of Na_2O and K_2O in the original sample :

45. $Pb(NO_3)_2$ and KI reacts in aqueous solution to form an yellow precipitate of PbI_2. In one series of experiments, the masses of two reactants varied, but the total mass of the two was held constant at 5.0 g. What maximum mass of PbI_2 can be produced in the above experiment :

46. Uranium is isolated from its ore by dissolving it as $UO_2(NO_3)_2$ and separating it as solid $UO_2(C_2O_4)$. xH_2O. A 1.0 g sample of ore on treatment with nitric acid yielded 1.48 g $UO_2(NO_3)_2$ which on further treatment with 0.4 g $Na_2C_2O_4$ yielded 1.23 g $UO_2(C_2O_4).xH_2O$. Determine weight percentage of uranium in the original sample and x :

47. A mother cell disintegrate into sixty identical cells and each daughter cell further disintegrate into 24 smaller cells. The smallest cells are uniform cylindrical in shape with diameter of 120 Å and each cell is 6000 Å long. Determine molar mass of the mother cell if density of the smallest cell is 1.12 g/cm^3 :

48. A sample is a mixture of Mohr's salts and $(NH_4)_2SO_4$. A 0.5 g sample on treatment with excess of $BaCl_2$ solution gave 0.75 g $BaSO_4$. Determine percentage composition of the salt mixture . What weight of Fe_2O_3 would be obtained if 0.2 g of the sample were ignited in air ?

49. A chloride mixture is prepared by grinding together pure $BaCl_2.2H_2O$, KCl and NaCl. What is the smallest and largest volume of 0.15 M $AgNO_3$ solution that may be used for complete precipitation of chloride from a 0.3 g sample of the mixture which may contain any one or all of the constituents ?

50. One mole of a mixture of N_2, NO_2 and N_2O_4 has a mean molar mass of 55.4. On heating to a temperature at which N_2O_4 may be dissociated : $N_2O_4 \longrightarrow 2NO_2$, the mean molar mass tends to the lower value of 39.6. What is the mole ratio of $N_2 : NO_2 : N_2O_4$ in the original mixture?

51. 10 mL of gaseous organic compound contain C, H and O only was mixed with 100 mL of O_2 and exploded under identical conditions and then cooled. The volume left after cooling was 90 mL. On treatment with KOH a contraction of 20 mL was observed, if vapour density of compound is 23 derive molecular formula of the compound.

52. Fluorocarbon polymers can be made by fluorinating polyethylene according to the reaction $(CH_2)_n + 4nCoF_3 \longrightarrow (CF_2)_n + 2nHF + 4nCoF_2$, where n is a large integer. The CoF_3 can be regenerated by the reaction $2\,CoF_2 + F_2 \longrightarrow 2CoF_3$. If the HF formed in the first reaction cannot be reused, how many kg of fluorine are consumed per kg of fluorocarbon produced, $(CF_2)_n$? If HF can be recovered and electrolyzed to hydrogen and flurine, and if this fluorine is used for regenerating CoF_3, what is the net consumption of fluorine per kg of fluorocarbon?

53. $A_2 + 2B_2 \longrightarrow A_2B_4$

$\frac{3}{2}A_2 + 2B_2 \longrightarrow A_3B_4$

Two substance A_2 & B_2 react in the above manner when A_2 is limited it gives A_2B_4 in excess gives A_3B_4. A_2B_4 can be converted to A_3B_4 when reacted with A_2. Using this information calculate the composition of the final mixture when the mentioned amount of A & B are taken :c

(a) 4 moles A_2 & 4 moles B_2

(b) $\frac{1}{2}$ moles A_2 & 2 moles B_2

(c) 1.25 moles A_2 & 2 moles B_2

54. In a water treatment plant, Cl_2 used for the treatment of water is produced from the following reaction $2KMnO_4 + 16HCl \longrightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$. If during each feed 1 L $KMnO_4$ having 79% (w/v) $KMnO_4$ & 9 L HCl with d = 1.825 g/mL & 10% (w/w) HCl are entered & if that percent yield is 80% then calculate :

(a) amount of Cl_2 produced.

(b) amount of water that can be treated by Cl_2 if 1 litre consumes 28.4 g of Cl_2 for treatment.

(c) calculate efficiency η of the process if $\eta = \dfrac{\text{vol. of water treated}}{\text{vol. of total feed}}$

55. A sea water sample has a density of 1.03 g/cm^3 and 2.8% NaCl by mass. A saturated solution of NaCl in water is 5.45 M NaCl. How much water would have to be evaporated from 1.00×10^6 L of the sea water before NaCl would precipitate ?

56. A sample of oleum is such that ratio of "free SO_3" by "combined SO_3" is equal to unity. Calculate its labelling in terms of percentage oleum.

57. One litre of milk weighs 1.035 kg. The butter fat is 4% (v/v) of milk has density of 875 kg/m^3. Find the density of fat free skimed milk.

58. A sample of fuming sulphuric acid containing H_2SO_4, SO_3 and SO_2 weighing 1.00 g is found to require 23.47 mL of 1.00 M alkali (NaOH) for neutralisation. A separate sample shows the presence of 1.50% SO_2. Find the percentage of "free" SO_3, H_2SO_4 and "combined" SO_3 in the sample.

59. In one process for waterproofing, a fabric is exposed to $(CH_3)_2SiCl_2$ vapour. The vapour reacts with hydroxyl groups on the surface of the fabric or with traces of water to form the waterproofing film $[(CH_3)_2SiO]_n$, by the reaction

$$n(CH_3)_2SiCl_2 + 2nOH \longrightarrow 2nCl^- + nH_2O + [(CH_3)_2SiO]_n$$

where n stands for a large integer. The waterproofing film is deposited on the fabric layer upon layer. Each layer is 6.0 Å thick [the thickness of the $(CH_3)_2SiO$ group]. How much $(CH_3)_2SiCl_2$ in needed to waterproof one side of a piece of fabric, 1.00 m by 3.00 m, with a film 300 layers thick ? The density of the film is 1.0 g/cm^3.

60. 20 mL of a mixture of methane and a gaseous compound of Acetylene series were mixed with 100 mL of oxygen and exploded. The volume of the products after cooling to original room temperature and pressure, was 80 mL and on treatment with potash solution a further contracting of 40 mL was observed. Calculate **(a)** the molecular formula of the hydrocarbon, **(b)** the percentage composition of the mixture.

61. In a solution the concentration of $CaCl_2$ is 5 M & that of $MgCl_2$ is 5 m. The specific gravity of solution is 1.05, calculate the concentration of Cl^- in the solution in terms of Molarity.

Exercise # 5 Part # I [Previous Year Questions] [AIEEE/JEE-MAIN]

1. 6.02×10^{20} molecules of urea are present in 100 ml of its solution. The concentration of urea solution is - **[AIEEE 2004]**

(1) 0.001 M **(2)** 0.01 M **(3)** 0.02 M **(4)** 0.1 M

2. If we consider that 1/6, in place of 1/12, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will **[AIEEE 2005]**

(1) decrease twice **(2)** increase two fold
(3) remain unchanged **(4)** be a function of the molecular mass of the substance

3. The oxidation state of Cr in $[Cr(NH_3)_4Cl_2]^+$ is : **[AIEEE 2005]**

(1) + 3 **(2)** + 2 **(3)** + 1 **(4)** 0

4. The oxidation state of chromium in the final product formed by the reaction between KI and acidified potassium dichromate solution is : **[AIEEE 2005]**

(1) + 4 **(2)** + 6 **(3)** + 2 **(4)** + 3

5. Two solution of a substance (non electrolyte) are mixed in the following manner. 480 ml of 1.5M first solution + 250 ml of 1.2M second solution.
What is the molarity of the final mixture ? **[AIEEE 2005]**

(1) 2.70M **(2)** 1.344M **(3)** 1.50M **(4)** 1.20M

6. Which of the following chemical reactions depicts the oxidizing behaviour of H_2SO_4? **[AIEEE 2006]**

(1) $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$ **(2)** $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$
(3) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$ **(4)** $2PCl_5 + H_2SO_4 \rightarrow 2POCl_3 + 2HCl + SO_2Cl_2$

7. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms ? **[AIEEE-2006]**

(1) 0.02 **(2)** 3.125×10^{-2} **(3)** 1.25×10^{-2} **(4)** 2.5×10^{-2}

8. Density of a 2.05M solution of acetic acid in water is 1.02 g/ml. The molality of the solution is : **[AIEEE-2006]**

(1) 1.14 mol kg^{-1} **(2)** 3.28 mol kg^{-1} **(3)** 2.28 mol kg^{-1} **(4)** 0.44 mol kg^{-1}

9. In the reaction **[AIEEE-2007]**

$$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 6Cl^-_{(aq)} + 3H_2(g)$$

(1) 6L $HCl_{(aq)}$ is consumed for every 3L H_2 produced.
(2) 33.6 L $H_{2(g)}$ is produced regardless temperature and pressure for every moles that reacts.
(3) 67.2 L $H_{2(g)}$ at STP is produced for every mole of Al that reacts .
(4) 11.2 L $H_{2(g)}$ at STP is produced for every mole of $HCl_{(aq)}$ consumed.

10. The density (in g mL^{-1}) of a 3.60 M sulphuric acid solution that is 29% (H_2SO_4 molar mass = 98 g mol^{-1}) by mass will be : **[AIEEE-2007]**

(1) 1.22 **(2)** 1.45 **(3)** 1.64 **(4)** 1.88

11. A 5.2 molal aqueous solution of methyl alcohol, CH_3OH, is supplied. What is the mole fraction of methyl alcohol in the solution? **[AIEEE-2011]**

(1) 0.100 **(2)** 0.190 **(3)** 0.086 **(4)** 0.050

12. The molality of a urea solution in which 0.0100 g of urea, $[(NH_2)_2CO]$ is added to 0.3000 dm^3 of water at STP is: **[Re. Paper AIEEE-2011]**

(1) 5.55×10^{-4} **(2)** 33.3 m **(3)** 3.33×10^{-2} m **(4)** 0.555 m

13. 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 : **[AIEEE-2012]**

(1) 0.50 M **(2)** 1.78 M **(3)** 1.02 M **(4)** 2.05 M

14. For the estimation of nitrogen, 1.4 g of organic compound was digested by Kjeldahl method and the evolved ammonia was absorbed in 60 mL of $\frac{M}{10}$ sulphuric acid. The unreacted acid required 20 ml of $\frac{M}{10}$ sodium hydroxide for complete neutralization. The percentage of nitrogen in the compound is : **[JEE MAIN-2014]**

(1) 3% **(2)** 5% **(3)** 6% **(4)** 10%

15. The moleclar formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$ (Mol. wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin ? **[JEE MAIN-2015]**

(1) $\frac{2}{309}$ **(2)** $\frac{1}{412}$ **(3)** $\frac{1}{103}$ **(4)** $\frac{1}{206}$

16. In Carius method of estimation of halogens, 250 mg of an organic compound gave 141 mg of AgBr. The percentage of bromine in the compound is : (at. mass Ag = 108, Br = 80) **[JEE MAIN-2015]**

(1) 48 **(2)** 60 **(3)** 24 **(4)** 36

17. 3 g 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 0.042N. The amount of acetic acid adsorbed (per gram of charcoal) is : **[JEE MAIN-2015]**

(1) 42 mg **(2)** 54 mg **(3)** 18 mg **(4)** 36 mg

18. At 300 K and 1 atm, 15 mL of a gaseous hydrocarbon requires 375 mL air containing 20% O_2 by volume for complete combustion. After combustion the gases occupy 300 mL. Assuming that the water formed is in liquid form and the volumes were measured at the same temperature and pressure, the formula of the hydrocarbon is: **[JEE MAIN-2016]**

(1) C_3H_8 **(2)** C_4H_8 **(3)** C_4H_{10} **(4)** C_3H_6

19. The most abundant elements by mass in the body of a healthy human adult are : Oxygen (61.4%), Carbon (22.9%), Hydrogen (10.0%), and Nitrogen (2.6%). The weight which a 75 kg person would gain if all ^1H atoms are replaced by ^2H atoms is : **[JEE MAIN-2017]**

(1) 15 kg **(2)** 37.5 kg **(3)** 7.5 kg **(4)** 10 kg

20. 1 gram of a carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. The molar mass of M_2CO_3 in g mol^{-1} is. **[JEE MAIN-2017]**

(1) 1186 **(2)** 84.3 **(3)** 118.6 **(4)** 11.86

21. The ratio of mass percent of C and H of an organic compound ($C_XH_YO_Z$) is 6 : 1. If one moleucle 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 : **[JEE MAIN-2018]**

(1) C_2H_4O **(2)** $C_3H_4O_2$ **(3)** $C_2H_4O_3$ **(4)** $C_3H_6O_3$

Part # II [Previous Year Questions][IIT-JEE ADVANCED]

1. Amongst the following, the pair having both the metals in their highest oxidation state is : **[JEE 2004]**

(A) $[Fe(CN)_6]^{3-}$ and $[Co(CN)_6]^{3-}$ **(B)** CrO_2Cl_2 and MnO_4^-

(C) TiO_2 and MnO_2 **(D)** $[MnCl_4]^{2-}$ and $[NiF_6]^{2-}$

2. **Paragraph for Question Nos. (i) to (iii)**

Chemical reactions involve interaction of atoms and molecules. A large number of atoms/molecules (approximately 6.023×10^{23}) are present in a few grams of any chemical compound varying with their atomic/molecular masses. To handle such large numbers conveniently, the mole concept was introduced. This concept has implications in diverse areas such as analytical chemistry, biochemistry, electrochemistry and radiochemistry. The following example illustrates a typical case, involving chemical / electrochemical reaction, which requires a clear understanding of the mole concept.

A 4.0 molar aqueous solution of NaCl is prepared and 500 mL of this solution is electrolysed. This leads to the evolution of chlorine gas at one of the electrodes (atomic mass : Na = 23, Hg = 200 ; 1 Faraday = 96500 coulombs).

[At the anode : $2Cl^- \rightarrow Cl_2 + 2e^-$

At the cathode : $Na^+ + e^- \rightarrow Na$

$Na + Hg \rightarrow NaHg$ (sodium amalgam)]

(These reactions were not present in IIT-JEE paper)

(i) The total number of moles of chlorine gas evolved is : **[JEE-2007]**

(A) 0.5 **(B)** 1.0 **(C)** 2.0 **(D)** 3.0

(ii) If the cathode is a Hg electrode, the maximum weight (g) of amalgam formed from this solution is : **[JEE-2007]**

(A) 200 **(B)** 225 **(C)** 400 **(D)** 446

(iii) The total charge (coulombs) required for complete electrolysis is : **[JEE-2007]**

(A) 24125 **(B)** 48250 **(C)** 96500 **(D)** 193000

3. Given that the abundances of isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe are 5%, 90% and 5%, respectively, the atomic mass of Fe is : **[JEE-2009]**

(A) 55.85 **(B)** 55.95 **(C)** 55.75 **(D)** 56.05

4. A student performs a titration with different burettes and finds titre values of 25.2 mL, 25.25 mL, and 25.0 mL. The number of significant figures in the average titre value is : **[JEE-2010]**

5. Among the following, the number of elements showing only one non-zero oxidation state is : **[JEE-2010]**

O, Cl, F, N, P, Sn, Tl, Na, Ti

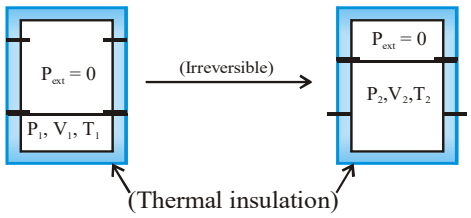
6. Reaction of Br_2 with Na_2CO_3 in aqueous solution gives sodium bromide and sodium bromate with evolution of CO_2 gas. The number of sodium bromide molecules involved in the balanced chemical equation is **[JEE-2011]**

7. Dissolving 120 g of urea (mol. wt. 60) in 1000 g of water gave a solution of density 1.15 g/mL. The molarity of the solution is : **[JEE-2011]**

(A) 1.78 M **(B)** 2.00 M **(C)** 2.05 M **(D)** 2.22 M

8. 29.2% (w/w) HCl stock solution has a density of 1.25 g mL^{-1}. The molecular weight of HCl is 36.5 g mol^{-1}. The volume (mL) of stock solution required to prepare a 200 mL solution of 0.4 M HCl is : **[JEE-2012]**

9. An ideal gas in a thermally insulated vessel at internal pressure = P_1, volume = V_1 and absolute temperature = T_1 expands irreversibly against zero external pressure, as shown in the diagram. The final internal pressure, volume and absolute temperature of the gas are P_2, V_2 and T_2, respectively. For this expansion, **[JEE-2014]**



(A) $q = 0$ (B) $T_2 = T_1$ (C) $P_2V_2 = P_1V_1$ (D) $P_2V_2^{\gamma} = P_1V_1^{\gamma}$

10. If the value of Avogadro number is 6.023×10^{23} mol^{-1} and the value of Boltzmann constant is 1.380×10^{-23} $J\,k^{-1}$. then the number of significant digits in the calculated value of the universal gas constant is **[JEE-2014]**

11. A compound H_2X with molar weight of 80 g is dissolved in a solvent having density of 0.4 ml^{-1}. Assuming no change in volume upon dissolution, the molality of a 3.2 molar solution is **[JEE-2015]**

12. The mole fraction of a solute in a solution is 0.1. At 298K, molarity of this solutions is the same as its molarity. Density of this solutions at 298 K is 2.0 g cm^{-3}. The ratio of the molecular weights of the solute and solvent, $\left(\frac{MW_{solute}}{MW_{solvent}}\right)$, is **[JEE-2016]**

13. The ammonia prepared by treating ammonium sulphate with calcium hydroxide is completely used by $NiCl_2.6H_2O$ to form a stable coordination compound. Assume that both the reactions are 100% complete. If 1584 g of ammonium sulphate and 952 g of $NiCl_2.6H_2O$ are used in the preparation, the combined weight (in grams) of gypsum and the nickel-ammonia coordination compound thus produced is___. **[JEE(ADVANCED) 2018]**

(Atomic weights in g mol^{-1} : H = 1, N = 14, O = 16, S = 32, Cl = 35.5, Ca = 40, Ni = 59)

14. Galena (an ore) is partially oxidized by passing air through it at high temperature. After some time, the passage of air is stopped, but the heating is continued in a closed furnace such that the contents undergo self-reduction. The weight (in kg) of Pb produced per kg of O_2 consumed is _____. (Atomic weights in g mol^{-1} : O = 16, S = 32, pb = 207 **[JEE(ADVANCED) 2018]**

15. To measure the quantity of $MnCl_2$ dissolved in an aqueous solution, it was completely converted to $KMnO_4$ using the reaction.

$MnCl_2 + K_2S_2O_8 + H_2O \rightarrow KMnO_4 + H_2SO_4 + HCl$ (equation not balanced).

Few drops of concentrated HCl were added to this solution and gently warmed. Further, oxalic acid (225 mg) was added in portions till the colour of the permanganate ion disappeared. The quantity of $MnCl_2$ (in mg) present in the initial solution is _____. (Atomic weights in g mol^{-1} : Mn : 55, Cl = 35.5) **[JEE(ADVANCED) 2018]**

MOCK TEST

SECTION - I : STRAIGHT OBJECTIVE TYPE

1. The charge on 1 gram ions of Al^{3+} is : (N_A = Avogadro number, e = charge on one electron)

(A) $\frac{1}{27} N_A e$ coulomb **(B)** $\frac{1}{3} \times N_A e$ coulomb **(C)** $\frac{1}{9} \times N_A e$ coulomb **(D)** $3 \times N_A e$ coulomb

2. The weight of a molecule of the compound $C_{60}H_{22}$ is :

(A) 1.09×10^{-21} g **(B)** 1.24×10^{-21} g **(C)** 5.025×10^{-23} g **(D)** 16.023×10^{-23} g

3. 16 g of an ideal gas SO_x occupies 5.6 L. at STP. The value of x is

(A) x = 3 **(B)** x = 2 **(C)** x = 4 **(D)** none

4. Calculate the molecular formula of compound which contains 20% Ca and 80% Br (by wt.) if molecular weight of compound is 200. (Atomic wt. Ca = 40, Br = 80)

(A) $Ca_{1/2}Br$ **(B)** $CaBr_2$ **(C)** CaBr **(D)** Ca_2Br

5. A compound possess 8% sulphur by mass. The least molecular mass is :

(A) 200 **(B)** 400 **(C)** 155 **(D)** 355

6. Equal weight of 'X' (At. wt. = 36) and 'Y' (At. wt. = 24) are reacted to form the compound X_2Y_3. Then :

(A) X is the limiting reagent

(B) Y is the limiting reagent

(C) No reactant is left over and mass of X_2Y_3 formed is double the mass of 'X' taken

(D) none of these

7. The mass of 70% H_2SO_4 required for neutralisation of 1 mol of NaOH.

(A) 49 gm **(B)** 98 gm **(C)** 70 gm **(D)** 34.3 gm

8. What weights of P_4O_6 and P_4O_{10} will be produced by the combustion of 31g of P_4 in 32g of oxygen leaving no P_4 and O_2.

(A) 2.75g, 219.5g **(B)** 27.5g, 35.5g **(C)** 55g, 71g **(D)** 17.5g, 190.5g

9. NX is produced by the following step of reactions

$M + X_2 \longrightarrow MX_2$; $3MX_2 + X_2 \longrightarrow M_3X_8$; $M_3X_8 + N_2CO_3 \longrightarrow NX + CO_2 + M_3O_4$

How much M (metal) is consumed to produce 206 gm of NX. (Take at wt of M = 56, N=23, X = 80)

(A) 42 gm **(B)** 56 gm **(C)** $\frac{14}{3}$ gm **(D)** $\frac{7}{4}$ gm

10. In $FeCr_2O_4$, the oxidation numbers of Fe and Cr are :

(A) + 2 and + 3 **(B)** 0 and + 2 **(C)** + 2 and + 6 **(D)** + 3 and + 6

11. The average oxidation state of Fe in Fe_3O_4 is :

(A) 2 and 3 **(B)** 8/3 **(C)** 2 **(D)** 3

12. A solution of $FeCl_3$ is $\frac{M}{30}$ its molarity for Cl^- ion will be :

(A) $\frac{M}{90}$ **(B)** $\frac{M}{30}$ **(C)** $\frac{M}{10}$ **(D)** $\frac{M}{5}$

13. The molarity of Cl^- in an aqueous solution which was (w/V) 2% NaCl, 4% $CaCl_2$ and 6% NH_4Cl will be

(A) 0.342 **(B)** 0.721 **(C)** 1.12 **(D)** 2.18

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

14. Which is/are correct statements about 1.7 gm of NH_3

(A) It contain 0.3 mol H – atom **(B)** it contain 2.408×10^{23} atoms

(C) Mass % of hydrogen is 17.65% **(D)** It contains 0.3 mol N-atom

15. Which of the following are examples of disproportionation reaction :

(A) $HgO \longrightarrow Hg + O_2$ **(B)** $KClO_3 \longrightarrow KCl + O_2$

(C) $KClO_3 \longrightarrow KClO_4 + KCl$ **(D)** $Cl_2 + OH^- \longrightarrow ClO^- + Cl^- + H_2O$

SECTION - III : ASSERTION AND REASON TYPE

Each question has 5 choices (A), (B), (C), (D) and (E) out of which only one is correct.

(A) Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation for Statement-1.

(B) Statement-1 is true, Statement-2 is true and Statement-2 is not correct explanation for Statement-1.

(C) Statement-1 is true, Statement-2 is false.

(D) Statement-1 is false, Statement-2 is true.

(E) Both Statements are false.

16. **Statement-1 :** The average mass of one Mg atom is 24.305 amu, which is not the actual mass of one Mg atom.
Statement-2 : Three isotopes, ^{24}Mg, ^{25}Mg and ^{26}Mg, of Mg are found in nature.

17. **Statement-1 :** A molecule of butane, C_4H_{10} has a mass of 58.12 amu.
Statement-2 : One mole of butane contains 6.022×10^{23} molecules and has a mass of 58.12 g.

18. **Statement-1 :** Both 12 g. of carbon and 27 g. of aluminium will have 6.02×10^{23} atoms.
Statement-2 : Gram atomic mass of an element contains Avogadro's number of atoms.

19. **Statement-1 :** For calculating the molality or the mole fraction of solute, if the molarity is known, it is necessary to know the density of the solution.
Statement-2 : Molality, molarity and the mole fraction of solute can be calculated from the weight percentage and the density of the solution

20. **Statement-1 :** A one molal solution prepared at 20°C will retain the same molality at 100°C, provided there is no loss of solute or solvent on heating.
Statement-2 : Molality is independent of temperature.

SECTION - IV : COMPREHENSION TYPE

Read the following comprehensions carefully and answer the questions.

Comprehension # 1

A chemist decided to determine the molecular formula of an unknown compound. He collects following informations

(I) Compounds contains 2 : 1 'H' to 'O' atoms(number of atoms).

(II) Compounds has 40% C by mass

(III) Approximate molecular mass of the compound is 178 g

(IV) Compound contains C, H and O only.

21. What is the % by mass of oxygen in the compound

(A) 53.33% **(B)** 88.88% **(C)** 33.33% **(D)** None of these

22. What is the empirical formula of the compound

(A) CH_3O **(B)** CH_2O **(C)** C_2H_2O **(D)** CH_3O_2

23. Which of the following could be molecular formula of compound

(A) $C_6H_6O_6$ **(B)** $C_6H_{12}O_6$ **(C)** $C_6H_{14}O_{12}$ **(D)** $C_6H_{14}O_6$

Comprehension # 2

According to the Avogadro's law, equal number of moles of gases occupy the same volume at identical condition of temperature and pressure. Even if we have a mixture of non-reacting gases then Avogadro's law is still obeyed by assuming mixture as a new gas.

Now let us assume air to consist of 80% by volume of Nitrogen (N_2) and 20% by volume of oxygen (O_2). If air is taken at STP then its 1 mol would occupy 22.4 L. 1 mol of air would contain 0.8 mol of N_2 and 0.2 mol of O_2 hence the mole fractions of N_2 and O_2 are given by $X_{N_2} = 0.8$, $X_{O_2} = 0.2$

24. Volume occupied by air at NTP containing exactly 11.2 gm of Nitrogen :

(A) 22.4 L **(B)** 8.96 L **(C)** 11.2 L **(D)** 2.24 L

25. If air is treated as a solution of O_2 and N_2 then % W/W of oxygen is :

(A) $\frac{10}{9}$ **(B)** $\frac{200}{9}$ **(C)** $\frac{700}{9}$ **(D)** $\frac{350}{9}$

26. Density of air at NTP is :

(A) 1 g/L **(B)** $\frac{9}{7}$ g/L **(C)** $\frac{2}{7}$ g/L **(D)** can't be determined

SECTION - V : MATRIX - MATCH TYPE

27.

Column - I	Column - II
(A) A gaseous organic compound containing C = 52.17%, H = 13.04% & O = 34.78% (by weight) having molar mass 46 g/mol.	**(p)** One mole of compound contains $4N_A$ atoms of Hydrogen.
(B) 0.3 g of an organic compound containing C, H and O on combustion yields 0.44 g of CO_2 and 0.18 g of H_2O, with two O atoms per molecule.	**(q)** The empirical formula of the compound is same as its molecule formula.
(C) A hydrocarbon containing C = 42.857% and H = 57.143% (by mole) containing 3C atoms per molecule.	**(r)** Combustion products of one mole of compound contains larger number of moles of CO_2 than that of H_2O.
(D) A hydrocarbon containing 10.5 g carbon per gram of hydrogen having vapour density 46.	**(s)** CO_2 gas produced by the combustion of 0.25 mole of compound occupies a volume of 11.2 L at NTP.

28.

Column I	Column II
(A) $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(s) + H_2(g)$ above reaction is carried out by taking 2 moles each of Zn and HCl	**(p)** 50% of excess reagent left
(B) $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(g)$ above reaction is carried out by taking 170 g $AgNO_3$ and 18.25 g HCl (Ag = 108)	**(q)** 22.4 L of gas at STP is liberated
(C) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ 100 g $CaCO_3$ is decomposed	**(r)** 1 moles of solid (product) obtained.
(D) $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$ 2/3 moles of $KClO_3$ decomposed	**(s)** HCl is the limiting reagent

SECTION - VI : SUBJECTIVE TYPE

29. (i) $K_4Fe(CN)_6 + 3H_2SO_4 \longrightarrow 2K_2SO_4 + FeSO_4 + 6HCN$

(ii) $6HCN + 12H_2O \longrightarrow 6HCOOH + 6NH_3$

(iii) (a) $6NH_3 + 3H_2SO_4 \longrightarrow 3(NH_4)_2SO_4$ (b) $6HCOOH \xrightarrow{H_2SO_4} 6CO + 6H_2O$

Above steps of reactions occur in a container starting with one mole of $K_4[Fe(CN)_6]$, 5 mole of H_2SO_4 and enough water. Find out the limiting reagent in step (i) and calculate maximum moles of CO gas and $(NH_4)_2SO_4$ that can be produced.

30. When 1 mol of A reacts with $\frac{1}{2}$ mol of B_2 ($A + \frac{1}{2}B_2 \longrightarrow AB$), 100 Kcal heat is liberated and when 1 mol of A reacted with 2 mol of B_2 ($A + 2B_2 \longrightarrow AB_4$), 200 Kcal heat is liberated. When 1 mol of A is completely reacted with excess of B_2 to form AB as well as AB_4, 140 Kcal heat is liberated Calculate the mol of B_2 used.
[Write your answer as (No. of moles of B_2 used × 1000)]

31. 1 g of dry green algae absorbs 4.7×10^{-3} mole of CO_2 per hour by photosynthesis. If the fixed carbon atoms were all stored after photosynthesis as starch $(C_6H_{10}O_5)_n$ how long would it take for the algae to double their own weight assuming photosynthesis takes place at a constant rate ?

ANSWER KEY

EXERCISE - 1

1. D	**2.** C	**3.** A	**4.** B	**5.** A	**6.** B	**7.** C	**8.** B	**9.** B	**10** A	**11** A	**12** C	**13.** B
14. B	**15** B	**16.** D	**17** C	**18** C	**19** C	**20** C	**21.** B	**22.** B	**23.** C	**24.** A	**25.** A	**26.** C
27. A	**28.** A	**29.** C	**30.** A	**31.** B	**32** B	**33** A	**34** C	**35** C	**36** B	**37** C	**38** D	**39** D
40 B	**41** C	**42** A	**43** C	**44** C	**45** A	**46** C	**47** B	**48** D	**49** A	**50** B	**51** C	**52** A
53 C	**54** B	**55** C	**56.** B	**57.** C	**58.** A	**59.** B	**60.** D	**61.** D	**62.** A	**63.** C	**64.** C	**65.** C
66. D	**67.** D	**68.** A	**69.** A	**70.** A	**71.** B	**72.** C	**73.** A	**74.** A	**75.** B	**76.** B	**77.** B	**78.** D
79. C	**80.** D											

EXERCISE - 2 : PART # I

1. C, D	**2.** A, C, D	**3.** B, C, D	**4.** B, D	**5.** B, C	**6.** A, B, D	**7.** A, B, D	**8.** A, B, D
9. A, B	**10.** A, B	**11.** C	**12.** D	**13.** A, B, C	**14.** B, C	**15.** A	**16.** A	**17.** A	**18.** A	**19.** C	**20.** A
21. A	**22.** D	**23.** A	**24.** D	**25.** C	**26.** C	**27.** B	**28.** C	**29.** A	**30.** A	**31.** B	**32.** B	**33.** A
34. C	**35.** D	**36.** C	**37.** C	**38.** A	**39.** B	**40.** B	**41.** D	**42.** A	**43.** C	**44.** A	**45.** C	**46.** C
47. C	**48.** B	**49.** A	**50.** A									

PART # II

1. A	**2.** A	**3.** A	**4.** A	**5.** B	**6.** A	**7.** A	**8.** A	**9.** A	**10.** B	**11.** D	**12.** B	**13.** D
14. A	**15.** A	**16.** A										

EXERCISE - 3 : PART # I

1. A → (p, q, r, s), B → (p, s), C → (q, r), D → (q)

2. A → (q, s), B → (p, s), C → (p, q, r), D → (q, r)

3. A → (p, s), B → (s), C → (p, q), D → (r)

4. A → (p), B → (r, s), C → (r), D → (r, q)

5. A → (t), B → (r), C → (p), D → (s), (E) → (q)

6. A → (r), B → s), C → (p), D → (q)

PART # II

Comprehension # 1 : **1.** C **2.** B **3.** B

Comprehension # 2 : **1.** A **2.** B **3.** B

Comprehension # 3 : **1.** C **2.** C **3.** B

Comprehension # 4 : **1.** A **2.** B **3.** B

Comprehension # 5 : **1.** A **2.** C **3.** A

Comprehension # 6 : **1.** B **2.** C **3.** D

Comprehension # 7 : **1.** C **2.** A

Comprehension # 8 : **1.** B **2.** C **3.** B

Comprehension # 9 : **1.** C **2.** A

EXERCISE - 5 : PART # I

1. 2 **2.** 3 **3.** 1 **4.** 4 **5.** 2 **6.** 1 **7.** 2 **8.** 3 **9.** 4 **10.** 1 **11.** 3 **12.** 1 **13.** 4
14. 4 **15.** 2 **16.** 3 **17.** 3 **18.** (Bonus) **19.** 3 **20.** 2 **21.** 3

PART # II

1. B **2.** (i) B (ii) D (iii) D **3.** B **4.** 3 **5.** 2 **6.** 5 **7.** C
8. 8 mL. **9.** A, B, C **10.** 4 **11.** 8 **12.** 9 **13.** 2992 **14.** 6.47 kg **15.** 126 mg

MOCK TEST

1.	D	**2.**	B	**3.**	B	**4.**	B	**5.**	B	**6.**	C	**7.**	C
8.	B	**9.**	A	**10.**	A	**11.**	B	**I2.**	C	**13.**	D		
14.	A, B, C	**15.**	C, D	**16.**	A	**17.**	A	**18.**	A	**19.**	B	**20.**	A
21.	A	**22.**	B	**23.**	B	**24.**	C	**25.**	B	**26.**	B		

27. A → (q, s), B → (p, s), C → (p, q, r), D → (q, r)

28. A → (p, q, r, s), B → (p, s), C → (q, r), D → (q)