Exercise-1

Marked questions are recommended for Revision.

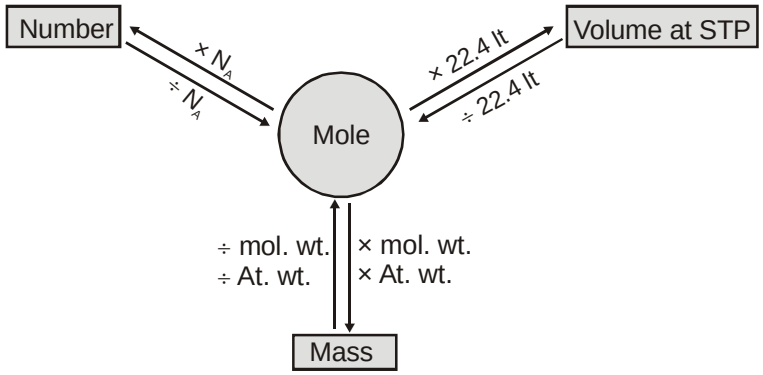
PART - I : SUBJECTIVE QUESTIONS

MOLE-I : Law of Chemical Combination

Section (A) : Molar volume of ideal gases at STP, Average molar mass

Commit to memory :

Y-map : Interconversion of mole - volume, mass and number of particles :



A-1. What is the volume of following at STP (i) 2 g of H_2 (ii) 16 g of O_3.

A-2. A gaseous mixture of H_2 and N_2O gas contains 66 mass % of N_2O. What is the average molecular mass of mixture :

Section (B) : Empirical Formula, % Composition of a given compound by mass, % By mole, Minimum molecular mass determination.

Commit to memory :

The molecular formula is an integral multiple of the empirical formula.

B-1. In a gaseous mixture 2mol of CO_2, 1 mol of H_2 and 2 mol of He are present than determine mole percentage of CO_2.

B-2. A compound has haemoglobin like structure. It has one Fe. It contain 4.6% of Fe. Determine its molecular mass.

B-3. A compound contains 25% hydrogen and 75% carbon by mass. Determine the empirical formula of the compound.

MOLE-II : Basic Stoichiometry

Section (C) : Stoichiometry, Equation based calculations (Elementary level single equation or 2)

Commit to memory :

Now for any general balance chemical equation like

$$aA + bB \longrightarrow cC + dD$$

You can write.

$$\frac{\text{Moles of A reacted}}{a} = \frac{\text{Moles of B reacted}}{b} = \frac{\text{Moles of C reacted}}{c} = \frac{\text{Moles of D reacted}}{d}$$

C-1. Calculate the residue obtained on strongly heating 2.76 g Ag_2CO_3.

$$Ag_2CO_3 \xrightarrow{\Delta} 2Ag + CO_2 + \frac{1}{2}O_2$$

C-2. Calculate the weight of iron which will be converted into its oxide by the action of 18g of steam.
Unbalanced reaction : $Fe + H_2O \xrightarrow{\Delta} Fe_3O_4 + H_2$.

C-3. A sample of $KClO_3$ on decomposition yielded 448 mL of oxygen gas at NTP.
Calculate (i) Weight of oxygen product, (ii) Weight of $KClO_3$ originally taken, and (iii) Weight of KCl produced.
(K = 39 , Cl = 35.5 and O = 16)

Section (D) : Limiting reagent, % Excess, % Yield / Efficiency

D-1.^ 50 g of $CaCO_3$ is allowed to react with 73.5 g of H_3PO_4.

$CaCO_3 + H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + H_2O + CO_2$
Calculate :
(i) Amount of $Ca_3(PO_4)_2$ formed (in moles)
(ii) Amount of unreacted reagent (in moles)

D-2.^ The percent yield for the following reaction carried out in carbon tetrachloride (CCl_4) solution is 80%

$$Br_2 + Cl_2 \longrightarrow 2BrCl$$

(a) How many moles of BrCl is formed from the reaction of 0.025 mol Br_2 and 0.025 mol Cl_2?
(b) How many moles of Br_2 is left unreacted?

Section (E) : Reactions in sequence & parallel, Principle of atom conservation (POAC), Mixture analysis, % Purity

E-1. $KClO_3$ decomposes by two parallel reaction

(i) $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$ (ii) $4KClO_3 \xrightarrow{\Delta} 3KClO_4 + KCl$

If 3 moles of O_2 and 1 mol of $KClO_4$ is produced along with other products then determine initial moles of $KClO_3$.

E-2.^ What mass of CaO will be produced by 1 g of Calcium ?

E-3. A 2 g sample containing Na_2CO_3 and $NaHCO_3$ loses 0.248 g when heated to 300^0 C, the temperature at which $NaHCO_3$ decomposes to Na_2CO_3, CO_2 and H_2O. What is the mass percentage of Na_2CO_3 in the given mixture ?

E-4. A sample of chalk contains clay as impurity. The clay impurity loses 11% of its weight as moisture on prolong heating. 5 gram sample of chalk on heating shows a loss in weight (due to evolution of CO_2 and water) by 1.1 g. Calculate % of chalk ($CaCO_3$) in the sample. [Hint : Chalk ($CaCO_3$) releases CO_2 on heating]

MOLE-III : Oxidation Reduction & Balancing Redox Equations

Section (F) : Basics of oxidation number

F-1. Calculate the oxidation number of underlined elements in the following compounds :

(a) $K[\underline{Co}(C_2O_4)_2(NH_3)_2]$ (b) $K_4\underline{P}_2O_7$ (c) $\underline{Cr}O_2Cl_2$
(d) $Na_2[\underline{Fe}(CN)_5(NO^+)]$ (e) $\underline{Mn}_3O_4$ (f) $Ca(\underline{Cl}O_2)_2$
(g) $[\underline{Fe}(NO^+)(H_2O)_5]SO_4$ (h) $\underline{Zn}O_2^{2-}$ (i) $\underline{Fe}_{0.93}O$

F-2. Identify the oxidant and the reductant in the following reactions :

(a) $KMnO_4 + KCl + H_2SO_4 \longrightarrow MnSO_4 + K_2SO_4 + H_2O + Cl_2$

(b) $FeCl_2 + H_2O_2 + HCl \longrightarrow FeCl_3 + H_2O$

(c) $Cu + HNO_3$ (dil) $\longrightarrow Cu(NO_3)_2 + H_2O + NO$

(d) $Na_2HAsO_3 + KBrO_3 + HCl \longrightarrow NaCl + KBr + H_3AsO_4$

(e) $I_2 + Na_2S_2O_3 \longrightarrow Na_2S_4O_6 + NaI$

Section (G) : Balancing redox reactions

G-1. Write balanced net ionic equations for the following reactions in acidic solution :

(a) IO_3^- (aq) + Re(s) $\longrightarrow$ ReO_4^- (aq) + I^- (aq)

(b) $S_4O_6^{2-}$(aq) + Al(s) $\longrightarrow$ H_2S(aq) + Al^{3+}(aq)

(c) $S_2O_3^{2-}$(aq) + $Cr_2O_7^{2-}$(aq) $\longrightarrow$ $S_4O_6^{2-}$(aq) + Cr^{3+}(aq)

(d) ClO_3^- (aq) + As_2S_3(s) $\longrightarrow$ Cl^- (aq) + $H_2AsO_4^-$ (aq) + HSO_4^- (aq)

(e) HSO_4^- (aq) + As_4(s) + Pb_3O_4(s) $\longrightarrow$ $PbSO_4$(s) + $H_2AsO_4^-$ (aq)

(f) HNO_2(aq) $\longrightarrow$ NO_3^- + NO(g)

G-2. Write balanced net ionic equations for the following reactions in basic solution :

(a) Tl_2O_3(s) + NH_2OH(aq) $\longrightarrow$ TlOH(s) + N_2(g)

(b) $C_4H_4O_6^{2-}$(aq) + ClO_3^- (aq) $\longrightarrow$ CO_3^{2-}(aq) + Cl^- (aq)

(c) H_2O_2(aq) + Cl_2O_7(aq) $\longrightarrow$ ClO_2^- (aq) + O_2(g)

(d) Al(s) + $BiONO_3$(s) $\longrightarrow$ Bi(s) + NH_3(aq) + $[Al(OH)_4]^-$ (aq)

(e) $[Cu(NH_3)_4]^{2+}$ (aq) + $S_2O_4^{2-}$(aq) $\longrightarrow$ SO_3^{2-}(aq) + Cu(s) + NH_3(aq)

(f) $Mn(OH)_2$(s) + MnO_4^- (aq) $\longrightarrow$ MnO_2(s)

MOLE-IV : Concentration Measurement

Section (H) : Units of concentration measurement, Interconversion of concentration units

Commit to memory :

$$\text{Molarity of solution} = \frac{\text{number of moles of solute}}{\text{volume of solution in litre}}$$

$$\text{molality} = \frac{\text{number of moles of solute}}{\text{mass of solvent in gram}} \times 1000$$

Let number of moles of solute in solution = n

Number of moles of solvent in solution = N

$$\therefore \quad \text{Mole fraction of solute } (x_1) = \frac{n}{n+N} \qquad \therefore \quad \text{Mole fraction of solvent } (x_2) = \frac{N}{n+N}$$

$$\%\ w/w = \frac{\text{mass of solute in g}}{\text{mass of solution in g}} \times 100$$

$$\%\ w/v = \frac{\text{mass of solute in g}}{\text{volume of solution in ml}} \times 100$$

$$\%\ v/v = \frac{\text{volume of solute in ml}}{\text{volume of solution in ml}} \times 100$$

$$ppm_A = \frac{\text{mass of A}}{\text{Total mass}} \times 10^6 = \text{mass fraction} \times 10^6$$

H-1. Find the mass of KOH needed to prepare 100 ml 1 M KOH solution. [At. mass K = 39]

H-2. Calculate the molality of KCl solution prepared by dissolving 7.45 g of KCl to make 500 mL of the solution. (d_{sol} = 1.2 g mL^{-1})

H-3.^

(i) If you are given a 2M NaOH solution having density 1 g/mL, then find the molality of solution.

(ii) Find the molarity of 5m (molal) NaOH solution having density 1.5 g/ml.

(iii) Find the mole fraction of solute in problem (i)

(iv) Find the mole fraction of solute in problem (ii)

(v) Find the % (w/w) of NaOH in solution in problem (i)

(vi) Find the % (w/w) of NaOH in solution in problem (ii)

(vii) Find the % (w/v) of NaOH in solution in problem (ii)

Section (I) : Dilution & Mixing of two liquids

I-1. Find the Cl^- concentration in solution which is obtained by mixing one mole each of $BaCl_2$, NaCl and HCl in 500 ml water.

I-2. What volume of water should be added to 50 ml of HNO_3 having density 1.5 g ml^{-1} and 63.0% by weight to have one molar solution.

I-3. What maximum volume of 3 M solution of KOH can be prepared from 1 L each of 1 M KOH and 6 M KOH solutions by using water ?

I-4.^

(i) A 300 g, 30% (w/w) NaOH solution is mixed with 500 g, 40% (w/w) NaOH solution. Find the mass percentage (w/w) of final solution.

(ii) What is % (w/v) NaOH in problem (i) if density of final solution is 2 g/ml ?

(iii) What is the molality of final solution obtained in problem (i) ?

PART - II : ONLY ONE OPTION CORRECT TYPE

MOLE-I : Law of Chemical Combination

Section (A) : Molar volume of ideal gases at STP, Average molar mass

A-1. 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

A-2. 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

Section (B) : Empirical Formula, % Composition of a given compound by mass, % By mole, Minimum molecular mass determination.

B-1. The empirical formula of a compound of molecular mass 120 u 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

B-2. Calculate the molecular formula of compound which contains 20% Ca and 80% Br (by wt.) if molecular weight of compound is 200 u. (Atomic wt. Ca = 40, Br = 80)
(A) $Ca_{1/2}Br$ (B) $CaBr_2$ (C) CaBr (D) Ca_2Br

B-3. A compound possess 8% sulphur by mass. The least molecular mass is :
(A) 200 u (B) 400 u (C) 155 u (D) 355 u

B-4. 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 g (B) 252.2 g (C) 287.6 g (D) 360.1 g

MOLE-II : Basic Stoichiometry

Section (C) : Stoichiometry, Equation based calculations (Elementary level single equation or 2)

C-1. How many moles of potassium chlorate need to be heated to produce 11.2 litre oxygen at N.T.P.

$$KClO_3 \longrightarrow KCl + \frac{3}{2}O_2$$

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

C-2. 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

C-3. 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) 54 g (D) 81 g

C-4. 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

C-5. When 100 g 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

C-6. 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

Section (D) : Limiting reagent, % Excess, % Yield / Efficiency

D-1. 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

D-2. 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

D-3. 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

D-4. 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. (Ni = 59 u)
(A) 14.675 g (B) 29 g (C) 58 g (D) 28 g

Section (E) : Reactions in sequence & parallel, Principle of atom conservation (POAC), Mixture analysis, % Purity

E-1. 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

E-2. 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 g of NX. (Take at wt of M = 56, N=23, X = 80)
(A) 42 g (B) 56 g (C) $\frac{14}{3}$ g (D) $\frac{7}{4}$ g

E-3. The following process has been used to obtain iodine from oil-field brines in California.
$NaI + AgNO_3 \longrightarrow AgI + NaNO_3$; $2AgI + Fe \longrightarrow FeI_2 + 2Ag$
$2FeI_2 + 3Cl_2 \longrightarrow 2FeCl_3 + 2I_2$
How many grams of $AgNO_3$ are required in the first step for every 254 kg I_2 produced in the third step.
(A) 340 kg (B) 85 kg (C) 68 kg (D) 380 kg

E-4. 25.4 g of iodine and 14.2 g 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

E-5. 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) 2.75 g, 219.5 g (B) 27.5 g, 35.5 g (C) 55 g, 71 g (D) 17.5 g, 190.5 g

E-6. 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%

E-7. In a gravimetric determination of P, an aqueous solution of dihydrogen phosphate ion $H_2PO_4^-$ is treated with a mixture of ammonium and magnesium ions to precipitate magnesium ammonium phosphate, $Mg(NH_4)PO_4.6H_2O$. This is heated and decomposed to magnesium pyrophosphate, $Mg_2P_2O_7$, which is weighed. A solution of $H_2PO_4^-$ yielded 1.054 g of $Mg_2P_2O_7$. What weight of NaH_2PO_4 was present originally ?
(A) 1.14 g (B) 1.62 g (C) 2.34 g (D) 1.33 g

E-8. 10 g of a sample of a mixture of $CaCl_2$ and NaCl is treated to precipitate all the calcium as $CaCO_3$. This Ca CO_3 is heated to convert all the Ca to CaO and the final mass of CaO is 1.62 g . The percent by mass of $CaCl_2$ in the original mixture is.
(A) 32.1 % (B) 16.2 % (C) 21.8 % (D) 11.0 %

E-9. The mass of 70% pure H_2SO_4 required for neutralisation of 1 mol of NaOH is
(A) 49 g (B) 98 g (C) 70 g (D) 34.3 g

MOLE-III : Oxidation Reduction & Balancing Redox Equations

Section (F) : Basics of oxidation number

F-1. The oxidation number of Oxygen in Na_2O_2 is :
(A) + 1 (B) + 2 (C) – 2 (D) – 1

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

F-3. 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) $S_2O_4^{2} < S_2O_6^{2-} < SO_3^{2-}$

F-4. 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

F-5. The average oxidation state of Fe in Fe_3O_4 is :
(A) – 8/3 (B) 8/3 (C) 2 (D) 3

F-6. 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

Section (G) : Balancing redox reactions

G-1. 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

G-2. 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

G-3. 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

G-4. 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

G-5. CN^- is oxidised by NO_3^- in presence of acid :

$$aCN^- + bNO_3^- + cH^+ \longrightarrow (a + b)\,NO + aCO_2 + \frac{c}{2}H_2O$$

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

MOLE-IV : Concentration Measurement

Section (H) : Units of concentration measurement, Interconversion of concentration units

H-1. 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

H-2. 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

H-3. 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) $\frac{M}{5}$

H-4. 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

H-5. 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

H-6. 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

H-7. 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

H-8. 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

Section (I) : Dilution & Mixing of two liquids

I-1. 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

I-2. 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 mℓ (D) 300 mℓ

I-3. 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

I-4. 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

I-5. What volume (in ml) of 0.2 M H_2SO_4 solution should be mixed with the 40 ml of 0.1 M NaOH solution such that the resulting solution has the concentration of H_2SO_4 as $\frac{6}{55}$ M ?
(A) 70 (B) 45 (C) 30 (D) 58

PART - III : MATCH THE COLUMN

1.

	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)	A hydrocarbon containing 10.5 g carbon per gram of hydrogen having vapour density 46.	(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)	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.	(s)	CO_2 gas produced by the combustion of 0.25 mole of compound occupies a volume of 11.2 L at NTP.

2.

	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

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

Exercise-2

Marked questions are recommended for Revision.

PART - I : ONLY ONE OPTION CORRECT TYPE

1. A sample of Calcium phosphate $Ca_3(PO_4)_2$ contains 8 mol of O atoms. The number of mol of Ca atoms in the sample is :
(A) 4 (B) 1.5 (C) 3 (D) 8

2. 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

3. 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 gram of oxygen would be needed to be carried in space capsule to meet his requirement for one day :
(A) 916.2 g (B) 91.62 g (C) 8.162 g (D) 9.162 g.

4. If 10 g of Ag reacts with 1 g of sulphur, the amount of Ag_2S formed will be :
(A) 7.75 g (B) 0.775 g (C) 11 g (D) 10 g

5.^ When a mixture of 10 mole of SO_2, 15 mole of O_2 was passed over catalyst, 8 mole of SO_3 was formed. How many mole of SO_2 and O_2 did not enter into combination ?
(A) 2 moles of SO_2, 11 moles of O_2 (B) 3 moles of SO_2, 11.5 moles of O_2
(C) 2 moles of SO_2, 4 moles of O_2 (D) 8 moles of SO_2, 4 moles of O_2

6. 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

7. 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) 28 kg (B) 14 kg (C) 21 kg (D) 42 kg

8. 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

9. 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.

10. 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

11. 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

12. $xNO_3^- + yI^- + zH^+ \rightarrow 2NO + 3I_2 + 4H_2O$ 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

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

$x\ As_2S_3 + y\ NaOH \longrightarrow xNa_3AsO_3 + xNa_3AsS_3 + \frac{y}{2} H_2O$. What are the values of x and y?

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

14. Balance the following equation and choose the quantity which is the sum of the coefficients of reactants and products :

..... $KMnO_4$ +..... H_2O_2 +..... H_2SO_4 ..... $\longrightarrow$ $MnSO_4$ +..... O_2 +..... H_2O +..... K_2SO_4

(A) 26 (B) 23 (C) 28 (D) 22

15.^ 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

16. 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

17. 36.5 % HCl has density equal to 1.20 g mL^{-1}. The molarity (M) and molality (m), respectively, are

(A) 15.7, 15.7 (B) 12, 12 (C) 15.7, 12 (D) 12, 15.7

18. An aqueous solution of ethanol has density 1.025 g/mL and it is 2M. What is the molality of this solution?

(A) 1.79 (B) 2.143 (C) 1.951 (D) None of these.

19. 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%

20. 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

21. 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 %

PART - II : NUMERICAL VALUE QUESTIONS

1. How many gram ions of SO_4^{-2} are present in 1.25 mole of $K_2SO_4.Al_2(SO_4)_3.24H_2O$:

2. 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 (in g) of the compound ?

3. Consider the following reaction involved in the preparation of teflon polymer $\left(CF_2–CF_2\right)_n$.

$XeF_6 + \left(CH_2–CH_2\right)_n \longrightarrow \left(CF_2–CF_2\right)_n + HF + XeF_4$.

Determine the moles of XeF_6 required for preparation of 100 g Teflon.

4. In the reaction : $2Al + Cr_2O_3 \longrightarrow Al_2O_3 + 2Cr$, 49.8 g of Al reacted with 200.0 g Cr_2O_3. How much grams of reactant remains at the completion of the reaction ?

5. A 3 : 2 molar ratio mixture of FeO and Fe_2O_3 react with oxygen to produce a 2 : 3 molar ratio mixture of FeO and Fe_2O_3. Find the mass (in g) of O_2 gas required per mole of the initial mixture.

6. A fluorine disposal plant was constructed to carryout the reactions :

$$F_2 + 2NaOH \longrightarrow \frac{1}{2}O_2 + 2NaF + H_2O$$

$$2NaF + CaO + H_2O \longrightarrow CaF_2 + 2NaOH$$

As the plant operated, excess lime was added to bring about complete precipitation of the fluoride as CaF_2. Over a period of operation, 1900 kg of fluorine was fed into a plant and 10,000 kg of lime was required. What was the percentage utilisation of lime ? [Lime : CaO]

7. $Cl_2 + KOH \xrightarrow{60\%} KCl + KClO + H_2O$

$KClO \xrightarrow{50\%} KCl + KClO_3$

$KClO_3 \xrightarrow{80\%} KClO_4 + KCl$

112 L Cl_2 gas at STP is passed in 10 L KOH solution, containing 1 mole of potassium hydroxide per liter.

Calculate the total moles of KCl produced, rounding it off to nearest whole number. (Yield of chemical reactions are written above the arrow ($\rightarrow$) of respective reaction)

8. 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 :

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

9. When 1 mole of A reacts with $\frac{1}{2}$ mole of B_2 ($A + \frac{1}{2}B_2 \rightarrow AB$), 100 Kcal heat is liberated and when 1 mole of A reacted with 2 mole of B_2 ($A + 2B_2 \rightarrow AB_4$), 200 Kcal heat is liberated. When 1 mole 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 mole of B_2 used. [Write your answer as number of mole of B_2 used × 10]

10. 92 g mixture of $CaCO_3$, and $MgCO_3$ heated strongly in an open vessel. After complete decomposition of the carbonates it was found that the weight of residue left behind is 48 g. Find the mass of $MgCO_3$ in grams in the mixture.

11. Among the following compounds given below, what is the sum of the oxidation states of all underlined elements ?

$\underline{C}O_2$, $K_2\underline{Mn}O_4$

12. Find the sum of average oxidation number of S in H_2SO_5 (peroxy monosulphuric acid) and $Na_2S_2O_3$ (sodium thiosulphate).

13. The reaction Cl_2 (g) + $S_2O_3^{2-} \longrightarrow SO_4^{2-} + Cl^-$ is to be carried out in basic medium. Starting with 1.5 mole of Cl_2, 0.1 mole $S_2O_3^{2-}$ and 3 mole of OH^-. How many moles of OH^- will be left in solution after the reaction is complete. Assume no other reaction occurs.

14. In the following reaction

$xZn + yHNO_3(dil) \longrightarrow aZn(NO_3)_2 + bH_2O + cNH_4NO_3$

What is the sum of the coefficients (a + b + c) ?

15. What is the quantity of water (in g) that should be added to 16 g methanol to make the mole fraction of methanol as 0.25 ?

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

17. What volume (in mL) of 90% alcohol by weight (d = 0.8 g mL^{-1}) must be used to prepare 80 mL of 10% alcohol by weight (d = 0.9 g mL^{-1}) ?

18. 3.0 litre of water are added to 2.0 litre of 5 M HCl. What is the molarity of HCl (in M) the resultant solution ?

19. 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 :

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Which is/are correct statements about 1.7 g 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

2. 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.

3. $\underset{\displaystyle C_2H_5}{\overset{|}{\underset{|}{(CH-COOH)_n}}}$ + $AgNO_3$ (Excess) $\longrightarrow$ Silver salt $\longrightarrow$ Ag (metal)

If 0.5 mole of silver salt is taken and weight of residue obtained is 216 g. (Ag = 108 g/mol).
Then which the following is correct :
(A) n = 4
(B) n = 2
(C) M.wt. of silver salt is 718 g/mol
(D) M.wt. of silver salt is 388 g/mol

4. 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.

5. For the following reaction : $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$
106.0 g of Na_2CO_3 reacts with 109.5 g of HCl.
Which of the following is/are correct.
(A) The HCl is in excess.
(B) 117.0 g of NaCl is formed.
(C) The volume of CO_2 produced at NTP is 22.4 L.
(D) None of these

6. (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 $(NH_4)_2 SO_4$ that can be produced.
(A) LR = H_2SO_4
(B) LR = $K_4Fe(CN)_6$,
(C) 6 moles of CO, 2 moles of $(NH_4)_2SO_4$
(D) 5 moles of CO, 2.5 moles of $(NH_4)_2SO_4$

7. $A + B \rightarrow A_3B_2$ (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

8. A sample of a mixture of $CaCl_2$ and NaCl weighing 4.44 g 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 50% NaCl
(B) Mixture contains 60% $CaCl_2$
(C) Mass of $CaCl_2$ is 2.22 g
(D) Mass of $CaCl_2$ 1.11 g

9. Which of the following statements is/are correct ? 1.0 g mixture of $CaCO_3$(s) and glass beads liberate 0.22 g of CO_2 upon treatment with excess of HCl. Glass does not react with HCl.

$CaCO_3 + 2HCl \longrightarrow CO_2 + H_2O + CaCl_2$

[M.wt. of $CaCO_3$ = 100, M.wt. of CO_2 = 44, [Atomic weight of Ca = 40]

(A) The weight of $CaCO_3$ in the original mixture is 0.5 g

(B) The weight of calcium in the original mixture is 0.2 g

(C) The weight percent of calcium in the original mixture is 40% Ca.

(D) The weight percent of Ca in the original mixture is 20% Ca.

10. 21.2 g sample of impure Na_2CO_3 is dissolved and reacted with a solution of $CaCl_2$, the weight of precipitate of $CaCO_3$ is 10.0 g. Which of the following statements is/are correct ?

(A) The % purity of Na_2CO_3 is 50%

(B) The percentage purity of Na_2CO_3 is 60%

(C) The number of moles of $Na_2CO_3 = CaCO_3$ = 0.1 mol.

(D) The number of moles of NaCl formed is 0.1 mol.

11. 100 g sample of clay (containing 19% H_2O, 40% silica, and inert impurities as rest) is partially dried so as to contain 10% H_2O

Which of the following is/are correct statement(s) ?

(A) The percentage of silica in paritially dried clay is 44.4%

(B) The mass of paritially dried clay is 90.0 g.

(C) The percentage of inert impurity in paritially dried clay is 45.6%

(D) The mass of water evaporated is 10.0 g

12. Which of the following reactions is not a redox reaction ?

(A) $H_2O_2 + KOH \longrightarrow KHO_2 + H_2O$ (B) $Cr_2O_7^{2-} + 2OH^- \longrightarrow 2CrO_4^{2-} + H_2O$

(C) $Ca(HCO_3)^2 \xrightarrow{\Delta} CaCO_3 + CO_2 + H_2O$ (D) $H_2O_2 \longrightarrow H_2O + \frac{1}{2} O_2$

13. 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^-

14. 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) $Cl_2 + OH^- \longrightarrow ClO^- + Cl^- + H_2O$

15. 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 oxidised

(C) $6e^-$ are being taken per iodine atom (D) None of these

16. Which of the following statements is/are correct ?

In the reaction $xCu_3P + yCr_2O_7^{2-} + zH^+ \longrightarrow Cu^{2+} + H_3PO_4 + Cr^{3+}$

(A) Cu in Cu_3P is oxidised to Cu^{2+} whereas P in Cu_3P is also oxidised to PO_4^{3-}

(B) Cu in Cu_3P is oxidised to Cu^{2+} whereas P in Cu_3P is reduced to H_3PO_4

(C) In the conversion of Cu_3P to Cu^{2+} and H_3PO_4, 11 electrons are involved

(D) The value of x is 6.

17. Select dimensionless quantity(ies) :

(A) vapour density (B) molality (C) specific gravity (D) mass fraction

18. Which of the following solutions contains same molar concentration ?

(A) 166 g. KI/L solution (B) 33.0 g $(NH_4)_2\ SO_4$ in 200 mL solution

(C) 25.0 g $CuSO_4.5H_2O$ in 100mL solution (D) 27.0 mg Al^{3+} per mL solution

19. Solutions containing 23 g HCOOH is/are :

(A) 46 g of 70% $\left(\frac{w}{v}\right)$ HCOOH ($d_{solution}$ = 1.40 g/mL)

(B) 50 g of 10 M HCOOH ($d_{solution}$ = 1 g/mL)

(C) 50 g of 25% $\left(\frac{w}{w}\right)$ HCOOH

(D) 46 g of 5 M HCOOH ($d_{solution}$ = 1 g/mL)

20. 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 g (D) mass of H_2SO_4 in the solution is 19.6 g

21. 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) $[Fe^{2+}]$ = 0.05M (C) $[Cl^-]$ = 0.3M (D) $[Cl^-]$ = 0.15M

PART - IV : COMPREHENSION

Read the following comprehension carefully and answer the questions.

Comprehension # 1

A chemist decided to determine the molecular formula of an unknown compound. He collects following information :
(I) Compounds contains 2 : 1 'H' to 'O' atoms(number of atoms).
(II) Compounds has 40% C by mass
(III) Molecular mass of the compound is 180 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 # 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 $X_{N_2} = 0.8$, $X_{O_2} = 0.2$.

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

5. 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) $\frac{350}{9}$

6. 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 # 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.

7. Which corresponds to oxidation action

(A) $\phi = 0$ (B) $\Delta\phi = 0$ (C) $\Delta\phi > 0$ (D) $\Delta\phi < 0$

8. 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) $P_3(Q_4R)_2$

9. 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 givenas '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

10. 60 g of solution containing 40% by mass of NaCl are mixed with 100 g 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%

11. What is the molality of the above solution.
(A) 4.4 m (B) 5.5 m (C) 24.4 m (D) none

12. What is the molarity of solution if density of solution is 1.6 g/ml
(A) 5.5 M (B) 6.67 M (C) 2.59 M (D) none

Comprehension # 5

Answer Q.13, Q.14 and Q.15 by appropriately matching the information given in the three columns of the following table.

Salt and water is formed by acid-base neutralisation reaction. If ratio of moles of acid & base taken is not similar to the ratio of their stoichiometric coefficient, then one of the component is limiting reagent. Assume no dissociation of water in following reactions. (Base is 80% pure only, take impurity present as inert & non electrolytic) (Molecular mass of Cs = 133, I = 127, Rb = 85.5, Sr = 88)

Column-1		Column-2		Column-3	
(I)	$CsOH + HI \longrightarrow CsI + H_2O$ 37.5 g in 500mL 500 mL of 0.8M	(i)	Acid is limiting reagent	(P)	Molarity of H^+ in resulting solution = 0.2M
(II)	$RbOH + HNO_3 \longrightarrow RbNO_3 + H_2O$ 51.25 g in 500 mL 500 mL of 0.2M	(ii)	Base is limiting reagent	(Q)	Molarity of cation in resulting solution = 0.4M
(III)	$Sr(OH)_2 + H_2SO_4 \longrightarrow SrSO_4 + 2H_2O$ 61 g in 500 mL 500 mL of 0.8M	(iii)	Molarity of cation in resulting solution = 0.8M	(R)	Molarity of cation in resulting solution = 1.6M
(IV)	$Ba(OH)_2 + 2HBr \longrightarrow BaBr_2 + 2H_2O$ 342 g in 500 mL 500 mL of 6.4M	(iv)	Molarity of anion in resulting solution = 3.2M	(S)	Molarity of anion in resulting solution = 0.4 M

13. Select correct combination for the resulting basic solution.
(A) (I) (iii) (S) (B) (I) (iv) (R) (C) (II) (i) (Q) (D) (III) (ii) (S)

14. Select correct combination for the resulting acidic solution.
(A) (I) (iii) (S) (B) (I) (iv) (S) (C) (I) (ii) (P) (D) (II) (i) (R)

15*. Select incorrect combination(s)
(A) (I) (ii) (P) (B) (II) (i) (R) (C) (IV) (iv) (R) (D) (III) (ii) (S)

Exercise-3

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

1. Amongst the following, the pair having both the metals in their highest oxidation state is : **[JEE 2004, 3/84]**

(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, 4/162]**

(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, 4/162]**

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

(iii) The total charge (coulombs) required for complete electrolysis is : **[JEE-2007, 4/162]**

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

3. 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, 3/163]**

4. The difference in the oxidation numbers of the two types of sulphur atoms in $Na_2S_4O_6$ is **[JEE 2011, 4/180]**

5. 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, 4/180]**

6. 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, 3/160]**

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

7. 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, 4/136]**

8.* For the reaction : $I^- + ClO_3^- + H_2SO_4 \longrightarrow Cl^- + HSO_4^- + I_2$

The correct statement(s) in the balanced equation is/are : **[JEE(Advanced) 2014, 3/120]**

(A) Stoichiometric coefficient of HSO_4^- is 6.

(B) Iodide is oxidized.

(C) Sulphur is reduced.

(D) H_2O is one of the products.

9. A compound **H_2X** with molar weight of 80 g is dissolved in a solvent having density of 0.4 g ml^{-1}. Assuming no change in volume upon dissolution, the **molality** of a 3.2 molar solution is **[JEE(Advanced) 2014, 3/120]**

10. The mole fraction of a solute in a solution is 0.1. At 298 K, molarity of this solution is the same as its molality. Density of this solution 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(Advanced) 2016, 3/124]**

11. The order of the oxidation state of the phosphorus atom in H_3PO_2, H_3PO_4, H_3PO_3, and $H_4P_2O_6$ is **[JEE(Advanced) 2017, 3/122]**

(A) $H_3PO_4 > H_3PO_2 > H_3PO_3 > H_4P_2O_6$ (B) $H_3PO_4 > H_4P_2O_6 > H_3PO_3 > H_3PO_2$

(C) $H_3PO_2 > H_3PO_3 > H_4P_2O_6 > H_3PO_4$ (D) $H_3PO_3 > H_3PO_2 > H_3PO_4 > H_4P_2O_6$

12. The Mole fraction of urea in an aqueous urea solution containing 900 g of water is 0.05. If the density of the solution is 1.2 g/cm^3, the molarity of urea solution is_____`. **[JEE(Advanced) 2019, 3/124]**

(**Given data :** Molar masses of urea and water are 60 g mol^{-1} and 18 g mol^{-1}, respectively)

PART - II : JEE (MAIN) ONLINE PROBLEMS (PREVIOUS YEARS)

1. Dissolving 120 g of a compound of (mol. wt. 60) in 1000 g of water gave a solution of density 1.12 g/mL. The molarity of the solution is : **[JEE(Main) 2014 Online (09-04-14), 4/120]**
(1) 1.00 M (2) 2.00 M (3) 2.50 M (4) 4.00 M

2. The amount of oxygen in 3.6 moles of water is : **[JEE(Main) 2014 Online (09-04-14), 4/120]**
(1) 115.2 g (2) 57.6 g (3) 28.8 g (4) 18.4 g

3. A gaseous compound of nitrogen and hydrogen contains 12.5% (by mass) of hydrogen. The density of the compound relative to hydrogen is 16. The molecular formula of the compound is : **[JEE(Main) 2014 Online (11-04-14), 4/120]**
(1) NH_2 (2) N_3H (3) NH_3 (4) N_2H_4

4. The amout of $BaSO_4$ formed upon mixing 100 mL of 20.8% $BaCl_2$ solution with 50 mL of 9.8% H_2SO_4 solution will be : (Ba = 137, Cl = 35.5, S = 32, H = 1 and O = 16) : **[JEE(Main) 2014 Online (12-04-14), 4/120]**
(1) 23.3 g (2) 11.65 g (3) 30.6 g (4) 33.2 g

5. Amongst the following, identify the species with an atom in +6 oxidation state : **[JEE(Main) 2014 Online (19-04-14), 4/120]**
(1) $[MnO_4]^-$ (2) $[Cr(CN)_6]^{3-}$ (3) Cr_2O_3 (4) CrO_2Cl_2

6. Consider the reaction :
$$H_2SO_{3(aq.)} + Sn^{4+}_{(aq)} + H_2O_{(l)} \rightarrow Sn^{2+}_{(aq)} + HsO^-_{4(aq)} + 3H^+_{(aq)}$$
Which of the following statements is correct ? **[JEE(Main) 2014 Online (19-04-14), 4/120]**
(1) Sn^{4+} is the oxidizing agent because it undergoes oxidation
(2) Sn^{4+} is the reducing agent because it undergoes oxidation
(3) H_2SO_3 is the reducing agent because it undergoes oxidation
(4) H_2SO_3 is the reducing agent because it undergoes reduction

7. How many electrons are involved in the following redox reaction ? **[JEE(Main) 2014 Online (19-04-14), 4/120]**
$$Cr_2O_7^{2-} + Fe^{2+} + C_2O_4^{2-} \rightarrow Cr^{3+} + Fe^{3+} + CO_2 \text{ (unbalanced)}$$
(1) 3 (2) 4 (3) 6 (4) 5

8. A sample of a hydrate of barium chloride weighing 61 g was heated until all the water of hydration is removed. The dried sample weighed 52 g. The formula of the hydrated salt is: (atomic mass, Ba = 137 amu, Cl = 35.5 amu) **[JEE(Main) 2015 Online (10-04-15), 4/120]**
(1) $BaCl_2 + H_2O$ (2) $BaCl_2 + 4H_2O$ (3) $BaCl_2 + 3H_2O$ (4) $BaCl_2 + 2H_2O$

9. $A + 2B + 3C \rightleftharpoons AB_2C_3$
Reaction of 6.0 g of A, 6.0×10^{23} atoms of B, and 0.036 mol of C yields 4.8 g of compound AB_2C_3. If the atomic mass of A and C are 60 and 80 amu, respectively, the atomic mass of B is (Avogadro no. = 6×10^{23}) : **[JEE(Main) 2015 Online (11-04-15), 4/120]**
(1) 50 amu (2) 60 amu (3) 70 amu (4) 40 amu

10. The non-metal that does not exhibit positive oxidation state is : **[JEE(Main) 2016 Online (09-04-16), 4/120]**
(1) Fluorine (2) Oxygen (3) Chlorine (4) Iodine

11. 5 L of an alkane requires 25 L of oxygen for its complete combustion. If all volumes are measured at constant temperature and pressure, the alkane is ; **[JEE(Main) 2016 Online (09-04-16), 4/120]**
(1) Butane (2) Isobutane (3) Ethane (4) Propane

12. An organic compound contains C, H and S. The minimum molecular weight of the compound containing 8% sulphur is: (atomic weight of S = 32 amu) **[JEE(Main) 2016 Online (09-04-16), 4/120]**
(1) 300 g mol^{-1} (2) 400 g mol^{-1} (3) 200 g mol^{-1} (4) 600 g mol^{-1}

13. The amount of arsenic pentasulphide that can be obtained when 35.5 g arsenic acid is treated with excess H_2S in the presence of conc. HCl (assuming 100% conversion) **[JEE(Main) 2016 Online (09-04-16), 4/120]**
(1) 0.25 mol (2) 0.125 mol (3) 0.333 mol (4) 0.50 mol

14. Excess of NaOH (aq) was added to 100 mL of $FeCl_3$(aq) resulting into 2.14 g of $Fe(OH)_3$. The molarity of $FeCl_3$(aq) is : **[JEE(Main) 2017 Online (08-04-17), 4/120]**

(Given molar mass of Fe = 56 g mol^{-1} and molar mass of Cl = 35.5 g mol^{-1})

(1) 1.8 M (2) 0.2 M (3) 0.6 M (4) 0.3 M

15. The pair of compounds having metals in their highest oxidation state is : **[JEE(Main) 2017 Online (08-04-17), 4/120]**

(1) MnO_2 and CrO_2Cl_2 (2) $[FeCl_4]^-$ and Co_2O_3

(3) $[Fe(CN)_6]^{3-}$ and $[Cu(CN)_4]^{2-}$ (4) $[NiCl_4]^{2-}$ and $[CoCl_4]^{2-}$

16. A sample of $NaClO_3$ is converted by heat to NaCl with a loss of 0.16 g of oxygen. The residue is dissolved in water and precipitated as AgCl. The mass of AgCl (in g) obtained will be : (Given: Molar mass of AgCl = 143.5 g mol^{-1}) **[JEE(Main) 2018 Online (15-04-18), 4/120]**

(1) 0.35 (2) 0.54 (3) 0.41 (4) 0.48

17. An unknown chlorohydrocarbon has 3.55 % of chlorine. If each molecule of the hydrocarbon has one chlorine atom only ; chlorine atoms present in 1 g of chlorohydrocarbon are :
(Atomic wt. of Cl = 35.5 u ; Avogadro constant = 6.023×10^{23} mol^{-1}) **[JEE(Main) 2018 Online (16-04-18), 4/120]**

(1) 6.023×10^9 (2) 6.023×10^{23} (3) 6.023×10^{21} (4) 6.023×10^{20}

18. A solution of sodium sulfate contains 92 g of Na^+ ions per kilogram of water. The molality of Na^+ ions in that solution in mol kg^{-1} is : **[JEE(Main) 2019 Online (09-01-19)S1, 4/120]**

(1) 16 (2) 12 (3) 8 (4) 4

19. For the following reaction, the mass of water produced from 445 g of $C_{57}H_{110}O_6$ is :

$$2C_{57}H_{110}O_6(s) + 163O_2(g) \longrightarrow 114CO_2(g) + 110H_2O(l)$$

[JEE(Main) 2019 Online (09-01-19), 4/120]

(1) 490 g (2) 445 g (3) 495 g (4) 890 g

20. The amount of sugar ($C_{12}H_{22}O_{11}$) required to prepare 2 L of its 0.1 M aqueous solutions is: **[JEE(Main) 2019 Online (10-01-19)S2, 4/120]**

(1) 68.4 g (2) 34.2 g (3) 17.1 g (4) 136.8 g

21. An organic compound is estimated through Dumas method and was found to evolve 6 moles of CO_2, 4 moles of H_2O and 1 mole of nitrogen gas. The formula of the compound is: **[JEE(Main) 2019 Online (11-01-19)S1, 4/120]**

(1) C_6H_8N (2) $C_6H_8N_2$ (3) $C_{12}H_8N_2$ (4) $C_{12}H_8N$

22. A 10 mg effervescent tablet containing sodium bicarbonate and oxalic acid releases 0.25 ml of CO_2 at T = 298.15 K and p = 1 bar. If molar volume of CO_2 is 25.0 L under such condition, what is the percentage of sodium bicarbonate in each tablet ? [Molar mass of $NaHCO_3$ = 84 g mol^{-1}] **[JEE(Main) 2019 Online (11-01-19)S1, 4/120]**

(1) 0.84 (2) 33.6 (3) 8.4 (4) 16.8

23. 50 mL of 0.5 M oxalic acid is needed to neutralize 25 mL of sodium hydroxide solution. The amount of NaOH in 50 mL of the given sodium hydroxide solution is: **[JEE(Main) 2019 Online (12-01-19)S1, 4/120]**

(1) 10 g (2) 40 g (3) 80 g (4) 20 g

24. 8 g of NaOH is dissolved in 18 g of H_2O. Mole fraction of NaOH in solution and molality (in mol kg^{-1}) of the solution respectively are : **[JEE(Main) 2019 Online (12-01-19)S2, 4/120]**

(1) 0.2, 11.11 (2) 0.167, 11.11 (3) 0.167, 22.20 (4) 0.2, 22.20

25. The percentage composition of carbon by mole in methane is : **[JEE(Main) 2019 Online (08-04-19)S2, 4/120]**

(1) 80% (2) 20% (3) 75% (4) 25%

26. For a reaction, $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$; identify dihydrogen (H_2) as a limiting reagent in the following reaction mixtures. **[JEE(Main) 2019 Online (09-04-19)S1, 4/120]**

(1) 14g of N_2 + 4g of H_2 (2) 35g of N_2 + 8g of H_2 (3) 28 g of N_2 + 6g of H_2 (4) 56g of N_2 + 10g of H_2

27. What would be the molality of 20% (mass/mass) aqueous solution of KI? (molar mass of KI = 166 g mol^{-1}) **[JEE(Main) 2019 Online (09-04-19)S2, 4/120]**
(1) 1.35 (2) 1.08 (3) 1.48 (4) 1.51

28. At 300 K and 1 atmospheric pressure, 10 mL of a hydrocarbon required 55 mL of O_2 for complete combustion, and 40 mL of CO_2 is formed. The formula of the hydrocarbon is : **[JEE(Main) 2019 Online (10-04-19)S1, 4/120]**
(1) C_4H_7Cl (2) C_4H_6 (3) C_4H_{10} (4) C_4H_8

29. The minimum amount of $O_2(g)$ consumed per gram of reactant is for the reaction :
(Given atomic mass : Fe = 56, O = 16, Mg = 24, P = 31, C= 12, H = 1) **[JEE(Main) 2019 Online (10-04-19)S2, 4/120]**
(1) $4\,Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$ (2) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
(3) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ (4) $P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$

30. An example of a disproportionation reaction is : **[JEE(Main) 2019 Online (12-04-19)S1, 4/120]**
(1) $2MnO_4^- + 10I^- + 16H^+ \rightarrow 2Mn^{2+} + 5I_2 + 8H_2O$ (2) $2CuBr \rightarrow CuBr_2 + Cu$
(3) $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$ (4) $2NaBr + Cl_2 \rightarrow 2NaCl + Br_2$

31. 5 moles of AB_2 weigh 125×10^{-3} kg and 10 moles of A_2B_2 weigh 300×10^{-3} kg. The molar mass of A(M_A) and molar mass of B(M_B) in kg mol^{-1} are **[JEE(Main) 2019 Online (12-04-19)S1, 4/120]**
(1) $M_A = 10 \times 10^{-3}$ and $M_B = 5 \times 10^{-3}$ (2) $M_A = 25 \times 10^{-3}$ and $M_B = 50 \times 10^{-3}$
(3) $M_A = 5 \times 10^{-3}$ and $M_B = 10 \times 10^{-3}$ (4) $M_A = 50 \times 10^{-3}$ and $M_B = 25 \times 10^{-3}$

32. The mole fraction of a solvent in aqueous solution of a solute is 0.8. The molality (in mol kg^{-1}) of the aqueous solution is **[JEE(Main) 2019 Online (12-04-19)S1, 4/120]**
(1) 13.88×10^{-3} (2) 13.88 (3) 13.88×10^{-2} (4) 13.88×10^{-1}

33. 25 g of an unknown hydrocarbon upon burning produces 88g of CO_2 and 9 g of H_2O. This unknown hydrocarbon contains : **[JEE(Main) 2019 Online (12-04-19)S2, 4/120]**
(1) 22 g of carbon and 3g of hydrogen (2) 24 g of carbon and 1g of hydrogen
(3) 20 g of carbon and 5g of hydrogen (4) 18 g of carbon and 7g of hydrogen

34. Oxidation number of potassium in K_2O, K_2O_2 and KO_2, respectively, is: **[JEE(Main) 2020 Online (07-01-20)S1, 4/120]**
(1) +1, +2 and +4 (2) +1, +4 and +2 (3) +1, +1 and +1 (4) +2, +1 and $+\frac{1}{2}$

35. The ammonia (NH_3) released on quantitative reaction of 0.6 g urea (NH_2CONH_2) with sodium hydroxide (NaOH) can be neutralized by : **[JEE(Main) 2020 Online (07-01-20)S2, 4/120]**
(1) 200 ml of 0.4 N HCl (2) 200 ml of 0.2 N HCl (3) 100 ml of 0.1 N HCl (4) 100 ml of 0.2 N HCl

36. The redox reaction among the following is : **[JEE(Main) 2020 Online (07-01-20)S2, 4/120]**
(1) reaction of $[Co(H_2O)_6]Cl_3$ with $AgNO_3$
(2) formation of ozone from atmospheric oxygen in the presence of sunlight
(3) combination of dinitrogen with dioxygen at 2000 K (4) reaction of H_2SO_4 with NaOH

37. Ferrous sulphate heptahydrate is used to fortify foods with iron. The amount (in grams) of the salt required to achieve 10 ppm of iron in 100 kg of wheat is _____. **[JEE(Main) 2020 Online (08-01-20)S1, 4/120]**
Atomic weight : Fe = 55.85 ; S = 32.00 ; O = 16.00

38. $NaClO_3$ is used, even in spacecrafts, to produces O_2.The daily consumption of pure O_2 by a person is 492L at 1 atm, 300 K. How much amount of $NaClO_3$, in grams, is required to produce O_2 for the daily consumption of a person at 1 atm, 300 K ? _____ **[JEE(Main) 2020 Online (08-01-20)S2, 4/120]**
$NaClO_3(s) + Fe(s) \rightarrow O_2(g) + NaCl(s) + FeO(s)$; R = 0.082 L atm $mol^{-1}K^{-1}$

39. The compound that cannot act both as oxidising and reducing agent is : **[JEE(Main) 2020 Online (09-01-20)S1, 4/120]**
(1) HNO_2 (2) H_3PO_4 (3) H_2SO_3 (4) H_2O_2

40. The molarity of HNO_3 in a sample which has density 1.4 g/mL and mass percentage of 63% is _____. (Molecular Weight of HNO_3 = 63) **[JEE(Main) 2020 Online (09-01-20)S1, 4/120]**

41. 10.30 mg of O_2 dissolved into a liter of sea water of density 1.03 g/mL. The concentration of O_2 in ppm is_____. **[JEE(Main) 2020 Online (09-01-20)S2, 4/120]**

Answers

EXERCISE – 1

PART – I

A-1. (i) 22.4 L (ii) 7.466 L **A-2.** 5.40 **B-1.** % CO_2 = 40%.

B-2. 1217 g mole^{-1} **B-3.** CH_4 **C-1.** 2.16 g **C-2.** 42 g

C-3. (i) 0.64 g, (ii) 1.64 g, (iii) 0.993 g. **D-1.** (i) 1/6 mole (ii) 5/12 mole

D-2. (a) 0.04 mole (b) 0.005 mole **E-1.** $\frac{10}{3}$ mole **E-2.** m = 1.4 g

E-3. 66.4 %. **E-4.** 33.33 %

F-1. (a) +3 (b) +5 (c) +6 (d) +2 (e) +8/3
(f) +3 (g) +1 (h) +2 (i) 200/93 = 2.15

F-2. (a) $\overset{(+7)}{K}\overset{}{Mn}\overset{}{O_4} + \overset{(-1)}{K}\overset{}{Cl} + H_2SO_4 \longrightarrow \overset{(+2)}{Mn}SO_4 + K_2SO_4 + H_2O + \overset{(0)}{Cl_2}$.

$\overset{(+7)}{K}\overset{}{Mn}\overset{}{O_4}$ (oxidant) $\longrightarrow$ $\overset{(+2)}{Mn}SO_4$ (reduction half).

$\overset{(-1)}{K}\overset{}{Cl}$ (reductant) $\longrightarrow$ $\overset{(0)}{Cl_2}$ (oxidation half).

(b) $\overset{(+2)}{Fe}Cl_2 + H_2\overset{(-1)}{O_2} + HCl \longrightarrow \overset{(+3)}{Fe}Cl_3 + \overset{(-2)}{H_2O}$ (oxidation half)

$\overset{(+2)}{Fe}Cl_2$ (reductant) $\longrightarrow$ $\overset{(+3)}{Fe}Cl_3$ (oxidation half).

$H_2\overset{(-1)}{O_2}$ (oxidant) $\longrightarrow$ H_2O^{2-} (reduction half).

(c) $\overset{(0)}{Cu} + H\overset{(+5)}{N}O_3$ (dil) $\longrightarrow \overset{2+}{Cu}(NO_3)_2 + H_2O + \overset{2+}{NO}$.

$\overset{(0)}{Cu}$ (reductant) $\longrightarrow$ $\overset{2+}{Cu}(NO_3)_2$ (oxidation half).

$H\overset{+5}{N}O_3$ (oxidant) $\longrightarrow$ $\overset{+2}{N}O$ (reduction half).

(d) $Na_2H\overset{+3}{As}O_3 + K\overset{+5}{Br}O_3 + HCl \longrightarrow NaCl + K\overset{-1}{Br} + H_3\overset{+5}{As}O_4$

$Na_2H\overset{+3}{As}O_3$ (reductant) $\longrightarrow$ $H_3\overset{+5}{As}O_4$ (oxidation half).

$K\overset{+5}{Br}O_3$ (oxidant) $\longrightarrow$ $K\overset{-1}{Br}$.

(e) $\overset{0}{I_2} + Na_2\overset{+2}{S_2}O_3 \longrightarrow Na_2\overset{+2.5}{S_4}O_6 + \overset{-1}{NaI}$.

$\overset{0}{I_2}$ (oxidant) $\longrightarrow$ $\overset{-1}{NaI}$ (reduction half).

$Na_2\overset{+2}{S_2}O_3$ (reductant) $\longrightarrow$ $Na_2\overset{+2.5}{S_4}O_6$ (oxidation half).

G-1. (a) $7IO_3^-(aq) + 6Re(s) + 3H_2O \longrightarrow 6ReO_4^-(aq) + 7I^-(aq) + 6H^+$
(b) $S_4O_6^{2-}(aq) + 6\,Al(s) + 20\,H^+ \longrightarrow 4H_2S(aq) + 6Al^{3+}(aq) + 6H_2O$
(c) $6S_2O_3^{2-}(aq) + Cr_2O_7^{2-}(aq) + 14\,H^+ \longrightarrow 3S_4O_6^{2-}(aq) + 2Cr^{3+}(aq) + 7H_2O$
(d) $14ClO_3^-(aq) + 3As_2S_3(s) + 18H_2O \longrightarrow 14Cl^-(aq) + 6H_2AsO_4^-(aq) + 9HSO_4^-(aq) + 15H^+$
(e) $26H^+ + 30HSO_4^-(aq) + As_4(s) + 10\,Pb_3O_4(s) \longrightarrow 30\,PbSO_4(s) + 4H_2AsO_4^-(aq) + 24H_2O$
(f) $3HNO_2(aq) \longrightarrow NO_3^- + 2NO(g) + H_2O + H^+$

G-2. (a) $Tl_2O_3(s) + 4NH_2OH(aq) \longrightarrow 2TlOH(s) + 2N_2(g) + 5H_2O$
(b) $3C_4H_4O_6^{2-}(aq) + 5ClO_3^-(aq) + 18OH^- \longrightarrow 12\ CO_3^{2-}(aq) + 5\ Cl^-(aq) + 15H_2O$
(c) $4H_2O_2(aq) + Cl_2O_7(aq) + 2OH^- \longrightarrow 2ClO_2^-(aq) + 4O_2(g) + 5H_2O$
(d) $11Al(s) + 3BiONO_3(s) + 21H_2O + 11OH^- \longrightarrow 3Bi(s) + 3NH_3(aq) + 11Al(OH)_4^-(aq)$
(e) $[Cu(NH_3)_4]^{2+}(aq) + S_2O_4^{2-}(aq) + 4OH^- \longrightarrow 2SO_3^{2-}(aq) + Cu(s) + 4NH_3(aq) + 2H_2O$
(f) $3Mn(OH)_2(s) + 2MnO_4^-(aq) \longrightarrow 5MnO_2(s) + 2H_2O + 2OH^-$

H-1. 5.6 g **H-2.** 0.168 m

H-3. (i) 2.17 m (ii) 6.25 M (iii) 0.0376 (iv) 0.0826 (v) 8% (vi) 16.67% (vii) 25%

I-1. 8 M **I-2.** 700 ml. **I-3.** 2.33 L

I-4. (i) 36.25%, (ii) 72.5%, (iii) 14.2 m.

PART - II

A-1.	(B)	**A-2.**	(B)	**B-1.**	(B)	**B-2.**	(B)	**B-3.**	(B)
B-4.	(D)	**C-1.**	(B)	**C-2.**	(C)	**C-3.**	(C)	**C-4.**	(C)
C-5.	(B)	**C-6.**	(C)	**D-1.**	(A)	**D-2.**	(A)	**D-3.**	(C)
D-4.	(A)	**E-1.**	(B)	**E-2.**	(A)	**E-3.**	(A)	**E-4.**	(A)
E-5.	(B)	**E-6.**	(C)	**E-7.**	(A)	**E-8.**	(A)	**E-9.**	(C)
F-1.	(D)	**F-2.**	(C)	**F-3.**	(B)	**F-4.**	(A)	**F-5.**	(B)
F-6.	(C)	**G-1.**	(C)	**G-2.**	(A)	**G-3.**	(C)	**G-4.**	(B)
G-5.	(D)	**H-1.**	(C)	**H-2.**	(B)	**H-3.**	(C)	**H-4.**	(B)
H-5.	(A)	**H-6.**	(C)	**H-7.**	(B)	**H-8.**	(B)	**I-1.**	(A)
I-2.	(C)	**I-3.**	(D)	**I-4.**	(D)	**I-5.**	(A)		

PART - III

1. (A - q,s); (B - q, r); (C - p, q, r); (D - p, s) **2.** (A - p,q,r,s; (B - p,s; (C - q,r) ; (D - q)

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

EXERCISE - 2

PART - I

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

PART - II

1.	5	**2.**	78	**3.**	4	**4.**	60	**5.**	2
6.	28	**7.**	4	**8.**	50	**9.**	11	**10.**	42
11.	10	**12.**	8	**13.**	2	**14.**	8	**15.**	27
16.	18	**17.**	10	**18.**	2	**19.**	4		

PART - III

1.	(ABC)	**2.**	(AB)	**3.**	(AC)	**4.**	(BCD)	**5.**	(ABC)
6.	(BC)	**7.**	(BD)	**8.**	(AC)	**9.**	(ABD)	**10.**	(AC)
11.	(ABCD)	**12.**	(ABC)	**13.**	(BC)	**14.**	(CD)	**15.**	(ABC)
16.	(ACD)	**17.**	(ACD)	**18.**	(ACD)	**19.**	(AB)	**20.**	(ABD)
21.	(ABD)								

PART - IV

1.	(A)	**2.**	(B)	**3.**	(B)	**4.**	(C)	**5.**	(B)
6.	(B)	**7.**	(C)	**8.**	(C)	**9.**	(B)	**10.**	(A)
11.	(B)	**12.**	(B)	**13.**	(C)	**14.**	(C)	**15.**	(BD)

EXERCISE - 3

PART - I

1.	(B)	**2.**	**(i)**	(B)	**(ii)**	(D)	**(iii)**	(D)		**3.**	3
4.	5	**5.**	5		**6.**	(C)		**7.**	8 mL.	**8.**	(ABD)
9.	8	**10.**	(9)		**11.**	(B)		**12.**	(2.98)		

PART - II

1.	(2)	**2.**	(2)	**3.**	(4)	**4.**	(2)	**5.**	(4)
6.	(3)	**7.**	(3)	**8.**	(4)	**9.**	(1)	**10.**	(1)
11.	(4)	**12.**	(2)	**13.**	(2)	**14.**	(2)	**15.**	(3)
16.	(4)	**17.**	(4)	**18.**	(4)	**19.**	(3)	**20.**	(1)
21.	(2)	**22.**	(3)	**23.**	BONUS	**24.**	(2)	**25.**	(2)
26.	(4)	**27.**	(3)	**28.**	(2)	**29.**	(1)	**30.**	(2)
31.	(3)	**32.**	(2)	**33.**	(2)	**34.**	(3)	**35.**	(4)
36.	(3)	**37.**	4.95 to 4.97	**38.**	2120.00 to 2140.00			**39.**	(2)
40.	14.00 to 14.00	**41.**	10.00 to 10.00						