CLASS : CC -AD

Revision Worksheet Mole & Equivalent Concepts

Single correct

Q.1 A sample of urea, NH_2CONH_2, contains 42% nitrogen, by mass. Percentage purity of the sample is :
(A) 60% (B) 90% (C) 40% (D) 100%

Q.2 Which of following mixture when burnt to produce $CO_2(g)$ and $H_2O(l)$, will cause a 40% reduction in volume.
(A) 10 ml $C_3H_6O_2$ + 50 ml O_2 (B) 40 ml $C_2H_2O_4$ + 60 ml O_2
(C) 10 ml C_3H_8 + 110 ml O_2 (D) 20 ml C_2H_6O + 80 ml O_2

Q.3 In the redox reaction : $x\,MnO + y\,PbO_2 + z\,HNO_3 \longrightarrow a\,HMnO_4 + b\,Pb(NO_3)_2 + c\,H_2O$
(A) x = 2, y = 5, z = 10 (B) x = 2, y = 7, z = 8
(C) x = 2, y = 5, z = 8 (D) x = 2, y = 5, z = 5

Q.4 The relationship between mole fraction (X_A) of a solute A and its molality "m" in ammonia will be
(A) $58.8\,\dfrac{(1-X_A)}{X_A}$ (B) $\dfrac{58.8\,X_A}{(1-X_A)}$ (C) $\dfrac{55.56(X_A)}{(1-X_A)}$ (D) $\dfrac{55.56(1-X_A)}{X_A}$

Q.5 SO_2Cl_2, sulphuryl chloride reacts with water to give a mixture of H_2SO_4 & HCl. What volume of 0.2 M $Ba(OH)_2$ is needed to completely neutralize 50 ml of 0.2 M SO_2Cl_2 solution?
(A) 100 ml (B) 200 ml (C) 300 ml (D) 400 ml

Q.6 Two acids H_2SO_4 & H_3PO_4 are neutralised separately by the same amount of a base, producing sulphate & dihydrogen phosphates respectively. The ratio of mass of H_2SO_4 and H_3PO_4 reacted with base respectively is
(A) 1 : 1 (B) 2 : 1 (C) 1 : 2 (D) Data insufficient.

Q.7 A clay sample contains 50% silica and 15% water. Now, the sample is heated until it loses 10 gm water. If the partially dried clay now contains 52% silica, what should be the percentage of water in it? All the percentages are given by mass. Assume that only moisture is lost from clay, on heating.
(A) 5.56% (B) 11.6% (C) 5.0 % (D) 15.6 %

Q.8 Some amount of a diacidic organic Lewis base (molar mass = 175) reacts with chloroplatinic acid to form 9 gm of chloroplatinate salt. The mass of residue produced on heating is
(A) 1.5 gm (B) 2 gm (C) 3 gm (D) 4 gm

Q.9 Total number of moles of Fe^{2+} ions in 139.52 gm of $Fe_{0.96}O$ (Fe = 56)
(A) 1.76 (B) 1.92 (C) 2 (D) $\dfrac{2}{0.96}$

Q.10 The minimum mass of mixture of A_2 and B_4 required to produce at least 1 kg of each product is (Given At. mass of 'A' = 10 ; At. mass of 'B' = 120)

$$5A_2 + 2B_4 \longrightarrow 2AB_2 + 4A_2B$$

(A) 2120 gm (B) 1060 gm (C) 560 gm (D) 1660 gm

Comprehension

Paragraph for question nos. 11 to 13

90 ml of a gaseous mixture consisting of a gaseous organic compound 'A' and just sufficient amount of oxygen required for complete combustion, yielding on burning 40 ml of CO_2, 60 ml of water vapour and 20 ml of N_2. All volumes are measured at the same temperature and pressure. The compound 'A' contained only carbon, hydrogen and nitrogen.

Q.11 The volume of compound 'A' present initially was

(A) 90 ml (B) 70 ml (C) 20 ml (D) 4 ml

Q.12 The mole percent of oxygen in the initial gaseous mixture was

(A) 50% (B) $\frac{700}{9}$ % (C) $\frac{200}{9}$ % (D) 35 %

Q.13 What is the molecular formula of the compound 'A'?

(A) $C_2H_6N_2$ (B) $C_2H_8N_2$ (C) CH_5N (D) C_2H_6N

More than one correct :

Q.14 A solution contains Na_2CO_3 and $NaHCO_3$. 10 ml of this solution requires 2.5 ml of $\left(\frac{1}{5}\right)$ M – HCl solution for the end point using phenolphthalein, as indicator. In another experiment, 10 ml of the same original solution requires 7.5 ml of $\left(\frac{1}{5}\right)$ M–HCl solution for the end point using methyl orange, as indicator. Which of the following statement(s) is/are correct regarding the original solution.

(A) 10 ml of original solution contains 0.053 g Na_2CO_3.
(B) 10 ml of original solution contains 0.042 g $NaHCO_3$.
(C) Concentration of Na_2CO_3 in original solution is 0.05 M
(D) Concentration of $NaHCO_3$ in original solution is 0.05 M

Match the Column

Q.15

	Column-I *(Atomic masses)*				**Column-II** *(% composition of lighter isotope)*
	Isotope-I	*Isotope-II*	*Average*		
(A)	(a + 4)	(a – 1)	a	(P)	66.67% by moles
(B)	a	5a	2a	(Q)	50% by moles
(C)	(a + 3)	(a + 1)	(a + 2)	(R)	% by mass independent of **'a'**
(D)	(a + 2)	(a – 1)	a	(S)	80% by moles

Subjective :

Q.16 Calculate the mole ratio of C_2H_5OH and CH_3OH in aqueous solution if molality of C_2H_5OH is 40/9 and mole fraction of CH_3OH is 0.1 in solution.

Q.17 Acid samples are prepared for analysis by using H_2SO_4, H_3PO_4 and HNO_3 separately or as mixture. What minimum volume of 33.6 (w/v) % KOH solution (d = 1.6 gm/ml) must be added to a sample of 1.96 gm in order to ensure complete neutralisation of acid in every possible case.

Q.18 A mixture containing 1 mole of N_2 and 3 mole of H_2 is partially converted into NH_3. The NH_3 formed is completely neutralized by 200 ml of 2.5 M H_3PO_4. Calculate the vapour density of first mixture (containing N_2, H_2 and NH_3) if NH_3 is not consumed in II reaction.

Q.19 Molality of SO_3 in a mixture of H_2SO_4 and SO_3 taking H_2SO_4 as solvent is found to be 2m. Calculate
(a) mole fraction of H_2SO_4 (b) % labelling of oleum

Q.20 Calculate volume of 0.4 M NaOH required to react with following mixture.

KHC_2O_4 (1 mol) + $H_2C_2O_4$ (2 mol)

Q.21 Calculate volume of 0.2 M $KMnO_4$ required to react with following mixture in acidic medium.

KHC_2O_4 (128 gm) + $H_2C_2O_4$ (180 gm)

Q.22 20 ml of $KMnO_4$ solution completely reacts with 10 ml solution of 1M FeS_2 and 2M CuS to produce Cu^{+2}, Fe^{+3}, SO_2. Calculate Normality of $KMnO_4$ solution?
[Fill you answer by multiplying with 100]

Q.23 1 litre solution containing 0.1 M $Na_2S_2O_3$ & 0.2 M IO_4^- is titrated with I_2 according to following reaction.

$$Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + I^-$$

$$IO_4^- + I_2 \longrightarrow IO_3^-$$

Calculate millimoles of I_2 consumed ?

Q.24 100 ml of '11.2 Vol' H_2O_2 solution is mixed with 200 ml of 2.8m – H_2O_2 solution of density 1.0952 gm/ml. The molarity of the resulting solution, if 10 % expansion in volume occurs, is

Q.25 A certain reactant A^{n+} is getting converted to $A^{(n+4)+}$ in solution. The rate constant of this reaction is measured by titrating a volume of the solution with a reducing reagent which only reacts with A^{n+} and $A^{(n+4)+}$. In this process, it converts A^{n+} to $A^{(n-2)+}$ and $A^{(n+4)+}$ to $A^{(n-1)+}$.

Time	0	10 min
Volume of reagent consumed	30 ml	45 ml

Calculate the rate constant of the conversion of A^{n+} to $A^{(n+4)+}$ assuming it to be a first order reaction.

[n-factor of reagent remain same when it reacts with A^{n+} & $A^{(n+4)+}$]

[Given : $ln\ 3/2 = 0.4$]

Write your answer by multiplying it with 1000.

Q.26 Octane is a component of gasoline. Complete combustion of octane leads to CO_2 and H_2O while incomplete combustion produces CO and H_2O, which not only reduces the efficiency of the engine using the fuel but is also toxic. In a certain test run, 10 L of octane is burned in the engine. The total mass of CO, CO_2 and H_2O produced is 43.72 kg. The percentage of octane converted to CO_2 is
(Density of octane is 1.14 gm/ml)
(Round off your answer to nearest integer)

Q.27 It is found that in 11.2L at 0°C and 1 atm, of any gaseous compound of 'X', there is never less than 15.5 gm of 'X'. It is also found that 11.2 L of vapours of 'X' at 0°C and 1 atm, weighs 62 gm. The atomicity of 'X' is :

Q.28 $(COOH)_n + AgNO_3(\text{excess}) \rightarrow$ Silver salt $\rightarrow$ White residue
If 0.25 moles of silver salt is taken and weight of residue obtained is 54 gm then what will be the molecular mass of $(COONa)_n$ **in amu.**

Q.29 An aqueous solution containing 0.10g KIO_3 (formula wt. = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated I_2 consumed 45.0 ml of thiosulphate solution to decolourise the blue starch – iodine complex. Calculate the molarity of the sodium thiosulphate solution.

Q.30 A sample of hard water contains 96 ppm of SO_4^{2-} and 183 ppm of HCO_3^-, with Ca^{2+} as the only cation. How many moles of CaO will be required to remove HCO_3^- from 1000 kg of this water? If 1000 kg of this water is treated with the amount of CaO calculate above, what will be the conentration (in ppm) of residual Ca^{2+} ions (Assume $CaCO_3$ to be completely insoluble in water)? If the Ca^{2+} ions in one litre of the treated water are completely exchanged with hydrogen ions, what will be its pH (one ppm means one part of the substance in one million part of water, weight/ weights)?

REVISION FLOW CHART

Mole Concept

Application of mole concept

- Law of chemical combination (T)
- Basic definition (T)
- Calculation of mole (N)
- Average atomic / mol. mass (N)
  (Calculation of mole % & mass % by $M_{avg.}$)
- Empirical and Molecular formula (N)
- Concept of Limiting reagent (N)
- Parallel reactions, sequential reaction (N)
- Percentage yield, Percentage purity (N)
- Experimental method (N)
  - Estimation of Carbon and Hydrogen
  - Estimation of Nitrogen
  - Estimation of Halogens
  - Estimation of Sulphur
  - Estimation of Phosphorus
  - Estimation of Oxygen

  } using POAC

Concentration Term

- Solutions (N)
  - M, m, X(mole fraction)
  - % (w/w),% (w/v),% (v/v)
  - PPM
- Typical concentration (N)
  - Labelling of oleum
  - Volume strength of H_2O_2
- Relationship between concentration terms (N)

Oxidation & Reduction

- Assigning oxidation no. (N)
  - Through structure
  - Through formula
- Balancing of redox reaction (N)

Equivalent Concept

- Calculation of "n" factor (N)
  - non redox reaction
  - redox reaction (some typical cases)
- Equivalents (N)
- Normality (N)
- Chemical equivalence (N)
- titration (N)

(G) → represents topic of graphical importance

(T) → represents topic of theoretical importance

(N) → represents topic of numerical importance

LIST OF IMPORTANT FORMULAS

1. Application of mole concept :

(i) Atomic mass unit (amu)

The quantity [$\frac{1}{12}\times$ mass of an atom of C–12] is known as atomic mass unit.

(ii) Average molecular weight = $\frac{\sum n_i M_i}{\sum n_i}$

Where n_i = no. of moles of any compound and m_1 = molecular mass of any compound

(iii) **Mole :** One mole is a collection of that many entities as there are number of atoms exactly in 12 gm of C-12 isotope.

or 1 mole = collection of 6.02×10^{23} species

$6.02 \times 10^{23} = N_A$ = Avogadro's No.

(iv) No. of moles = $\frac{\text{Given no.}}{N_A}$

(v) No of moles = $\frac{\text{Given wt.}}{\text{Atomic wt.}}$ (for atoms), or $= \frac{\text{Given wt.}}{\text{Molecular wt.}}$ (for molecules)

(vi) No. of mole : $n = \frac{PV}{RT}$

(vii) Molecular formula = Empirical formula × n

$$n = \frac{\textit{Molecular mass}}{\textit{Empirical Formula mass}}$$

(viii) The percentage yield of product $= \frac{\textit{actual yield}}{\textit{the theoretical maximum yield}} \times 100$

(ix) Dulong's and Petit's Law :

Atomic weight × specific heat (cal/gm°C) $\propto \cong 6.4$

2 Concentration term :

(i) x% (w/w) means 100 g of solution containts x (gram) of solute

(ii) x% (w/v) means 100 ml of solution containts x (gram) of solute

(iii) x% (v/v) means 100 ml of solution containts x (ml) of solute

(iv) 109 % oleum means 100 g H_2SO_4 contains 9 g H_2O

(v) 20 V H_2O_2 means 1 volume of H_2O_2 gives 20 volume of O_2 at STP

(vi) Molality = $\frac{1-x_A}{x_A} \times \frac{1000}{M_A}$, X_A = mole fraction of solvent

M_A = M. W. of solvent

3. Equivalation concept :

(i) Calculation of n-factor.

Case-I : In case of non-redox reaction.

(a) for acid/base

n-factor = number of H^+ / OH^- given / taken by 1 moles of acid / base

(b) for ions

n-factor = charge on ion

(c) for compounds

n-factor = Total charge on cation/anion replaced

Case-II : In case of redox reaction.

n factor = number of electrons lost or gained by one mole of the concerned species.

(ii) *Equivalents = moles × "n" factor*

$$= \frac{\text{wt.}}{\text{Eq. wt}}$$

(iii) *Normality = molarity × "n" factor*

(iv) *Chemical equivalent*

$$aA + bB \longrightarrow mM + nN$$

eq. of A = eq. of B = eq. M = eq. of N

Some Typical Cases :

* Reaction in which more than one element in a compound undergoes oxidation or reduction.

$$\overset{3}{FeC_2O_4} + \overset{5}{KMnO_4} \longrightarrow Fe^{3+} + CO_2 + \overset{5}{Mn^{2+}}$$

($FeC_2O_4 + KMnO_4$) → solve by eq. concept

($Fe^{3+} + CO_2$) → avoid eq. concept, solve using POAC

* Disproportionation reaction

$$\overset{5/3}{Br_2} \longrightarrow \overset{1}{Br^-} + \overset{5}{BrO_3^-}$$

* Reaction in which element undergoes either oxidation or reduction is more than one oxidation state.

$$\overset{1}{3Mn^{+7}} \longrightarrow 2Mn^{+7} + \overset{3}{Mn^{+4}}$$

($2Mn^{+7}$) → avoid eq. concept, solve using POAC

* For compounds involved in redox reaction but not undergoing either oxidation of reduction.

$$BaCrO_4 + KI + \underline{HCl} \longrightarrow BaCl_2 + KCl + I_2 + CrCl_3$$

n-factor (of HCl) = 6 / 16

Note : In this is n_f can be determined only after balancing the reaction.

To predict the product of redox reaction remember :

(a) *In alkaline medium $KMnO_4$ is reduced to K_2MnO_4 but in strong alkaline or neutral medium it reduces to Mn^{+4}.*

(b) *In acid solution $KMnO_4$ is reduced to Mn^{2+}.*

(c) *H_2O_2 on reduction gives water and on oxidation gives oxygen.*

(d) *Dichromate ion in acid solution is reduced to Cr^{3+}.*

(e) *Case of HNO_3*

In general : conc. $HNO_3 \rightarrow NO_2$

dil $HNO_3 \rightarrow NO$

(f) *$C_2O_4^{2-}$ on oxidation gets converted to CO_2*

LAST MOMENT REVIEW

MOLE & EQUIVALENT CONCEPTS

Theory : ....

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Exercise - 1 : Question ....

Exercise - 2 : Question ....

Exercise - 3 : Question ....

Exercise - 4 : Question ....

DPPs : ....

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Other Sources : ....

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CLASS : CC -AD

Revision Worksheet Mole & Equivalent Concepts

Single correct

Q.1 A sample of urea, NH_2CONH_2, contains 42% nitrogen, by mass. Percentage purity of the sample is :
(A) 60% (B*) 90% (C) 40% (D) 100%

Q.2 Which of following mixture when burnt to produce $CO_2(g)$ and $H_2O(l)$, will cause a 40% reduction in volume.
(A) 10 ml $C_3H_6O_2$ + 50 ml O_2 (B) 40 ml $C_2H_2O_4$ + 60 ml O_2
(C) 10 ml C_3H_8 + 110 ml O_2 (D*) 20 ml C_2H_6O + 80 ml O_2

Q.3 In the redox reaction : $x\,MnO + y\,PbO_2 + z\,HNO_3 \longrightarrow a\,HMnO_4 + b\,Pb(NO_3)_2 + c\,H_2O$
(A*) x = 2, y = 5, z = 10 (B) x = 2, y = 7, z = 8
(C) x = 2, y = 5, z = 8 (D) x = 2, y = 5, z = 5

Q.4 The relationship between mole fraction (X_A) of a solute A and its molality "m" in ammonia will be
(A) $58.8\,\frac{(1-X_A)}{X_A}$ (B*) $\frac{58.8\,X_A}{(1-X_A)}$ (C) $\frac{55.56(X_A)}{(1-X_A)}$ (D) $\frac{55.56(1-X_A)}{X_A}$

Q.5 SO_2Cl_2, sulphuryl chloride reacts with water to give a mixture of H_2SO_4 & HCl. What volume of 0.2 M $Ba(OH)_2$ is needed to completely neutralize 50 ml of 0.2 M SO_2Cl_2 solution?
(A*) 100 ml (B) 200 ml (C) 300 ml (D) 400 ml

Q.6 Two acids H_2SO_4 & H_3PO_4 are neutralised separately by the same amount of a base, producing sulphate & dihydrogen phosphates respectively. The ratio of mass of H_2SO_4 and H_3PO_4 reacted with base respectively is
(A) 1 : 1 (B) 2 : 1 (C*) 1 : 2 (D) Data insufficient.

Q.7 A clay sample contains 50% silica and 15% water. Now, the sample is heated until it loses 10 gm water. If the partially dried clay now contains 52% silica, what should be the percentage of water in it? All the percentages are given by mass. Assume that only moisture is lost from clay, on heating.
(A) 5.56% (B*) 11.6% (C) 5.0 % (D) 15.6 %

Q.8 Some amount of a diacidic organic Lewis base (molar mass = 175) reacts with chloroplatinic acid to form 9 gm of chloroplatinate salt. The mass of residue produced on heating is
(A) 1.5 gm (B) 2 gm (C*) 3 gm (D) 4 gm

Q.9 Total number of moles of Fe^{2+} ions in 139.52 gm of $Fe_{0.96}O$ (Fe = 56)
(A*) 1.76 (B) 1.92 (C) 2 (D) $\frac{2}{0.96}$

Q.10 The minimum mass of mixture of A_2 and B_4 required to produce at least 1 kg of each product is (Given At. mass of 'A' = 10 ; At. mass of 'B' = 120)

$$5A_2 + 2B_4 \longrightarrow 2AB_2 + 4A_2B$$

(A*) 2120 gm (B) 1060 gm (C) 560 gm (D) 1660 gm

Comprehension

Paragraph for question nos. 11 to 13

90 ml of a gaseous mixture consisting of a gaseous organic compound 'A' and just sufficient amount of oxygen required for complete combustion, yielding on burning 40 ml of CO_2, 60 ml of water vapour and 20 ml of N_2. All volumes are measured at the same temperature and pressure. The compound 'A' contained only carbon, hydrogen and nitrogen.

Q.11 The volume of compound 'A' present initially was
(A) 90 ml (B) 70 ml (C*) 20 ml (D) 4 ml

Q.12 The mole percent of oxygen in the initial gaseous mixture was
(A) 50% (B*) $\frac{700}{9}$ % (C) $\frac{200}{9}$ % (D) 35 %

Q.13 What is the molecular formula of the compound 'A'?
(A*) $C_2H_6N_2$ (B) $C_2H_8N_2$ (C) CH_5N (D) C_2H_6N

More than one correct :

Q.14 A solution contains Na_2CO_3 and $NaHCO_3$. 10 ml of this solution requires 2.5 ml of $\left(\frac{1}{5}\right)$ M – HCl solution for the end point using phenolphthalein, as indicator. In another experiment, 10 ml of the same original solution requires 7.5 ml of $\left(\frac{1}{5}\right)$ M–HCl solution for the end point using methyl orange, as indicator. Which of the following statement(s) is/are correct regarding the original solution.
(A*)10 ml of original solution contains 0.053 g Na_2CO_3.
(B*) 10 ml of original solution contains 0.042 g $NaHCO_3$.
(C*) Concentration of Na_2CO_3 in original solution is 0.05 M
(D*) Concentration of $NaHCO_3$ in original solution is 0.05 M

Match the Column

Q.15

	Column-I *Atomic masses* Isotope-I	Isotope-II	Average		Column-II *% composition of lighter isotope*
(A)	(a + 4)	(a – 1)	a	(P)	66.67% by moles
(B)	a	5a	2a	(Q)	50% by moles
(C)	(a + 3)	(a + 1)	(a + 2)	(R)	% by mass independent of **'a'**
(D)	(a + 2)	(a – 1)	a	(S)	80% by moles

[Ans. (A) S, (B) R, (C) Q, (D) P]

Subjective :

Q.16 Calculate the mole ratio of C_2H_5OH and CH_3OH in aqueous solution if molality of C_2H_5OH is 40/9 and mole fraction of CH_3OH is 0.1 in solution. [Ans. 0.66]

Q.17 Acid samples are prepared for analysis by using H_2SO_4, H_3PO_4 and HNO_3 separately or as mixture. What minimum volume of 33.6 (w/v) % KOH solution (d = 1.6 gm/ml) must be added to a sample of 1.96 gm in order to ensure complete neutralisation of acid in every possible case. [Ans. 10 ml]

Q.18 A mixture containing 1 mole of N_2 and 3 mole of H_2 is partially converted into NH_3. The NH_3 formed is completely neutralized by 200 ml of 2.5 M H_3PO_4. Calculate the vapour density of first mixture (containing N_2, H_2 and NH_3) if NH_3 is not consumed in II reaction. [Ans. 6.8]

Q.19 Molality of SO_3 in a mixture of H_2SO_4 and SO_3 taking H_2SO_4 as solvent is found to be 2m. Calculate
(a) mole fraction of H_2SO_4 (b) % labelling of oleum
[Ans. (a) 0.836, (b) 103.103]

Q.20 Calculate volume of 0.4 M NaOH required to react with following mixture.
KHC_2O_4 (1 mol) + $H_2C_2O_4$ (2 mol)
Ans. 12.5 l

Q.21 Calculate volume of 0.2 M $KMnO_4$ required to react with following mixture in acidic medium.
KHC_2O_4 (128 gm) + $H_2C_2O_4$ (180 gm)
Ans. 6 l

Q.22 20 ml of $KMnO_4$ solution completely reacts with 10 ml solution of 1M FeS_2 and 2M CuS to produce Cu^{+2}, Fe^{+3}, SO_2. Calculate Normality of $KMnO_4$ solution?
[Fill you answer by multiplying with 100] [Ans. 1150]

Q.23 1 litre solution containing 0.1 M $Na_2S_2O_3$ & 0.2 M IO_4^- is titrated with I_2 according to following reaction.

$$Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + I^-$$

$$IO_4^- + I_2 \longrightarrow IO_3^-$$

Calculate millimoles of I_2 consumed ? [Ans. 90]

Q.24 100 ml of '11.2 Vol' H_2O_2 solution is mixed with 200 ml of 2.8m – H_2O_2 solution of density 1.0952 gm/ml. The molarity of the resulting solution, if 10 % expansion in volume occurs, is
[Ans. 0002]

Q.25 A certain reactant A^{n+} is getting converted to $A^{(n+4)+}$ in solution. The rate constant of this reaction is measured by titrating a volume of the solution with a reducing reagent which only reacts with A^{n+} and $A^{(n+4)+}$. In this process, it converts A^{n+} to $A^{(n-2)+}$ and $A^{(n+4)+}$ to $A^{(n-1)+}$.

Time	0	10 min
Volume of reagent consumed	30 ml	45 ml

Calculate the rate constant of the conversion of A^{n+} to $A^{(n+4)+}$ assuming it to be a first order reaction.
[n-factor of reagent remain same when it reacts with A^{n+} & $A^{(n+4)+}$]
[Given : ln 3/2 = 0.4]
Write your answer by multiplying it with 1000. [Ans.40]

Q.26 Octane is a component of gasoline. Complete combustion of octane leads to CO_2 and H_2O while incomplete combustion produces CO and H_2O, which not only reduces the efficiency of the engine using the fuel but is also toxic. In a certain test run, 10 L of octane is burned in the engine. The total mass of

CO, CO_2 and H_2O produced is 43.72 kg. The percentage of octane converted to CO_2 is (Density of octane is 1.14 gm/ml)
(Round off your answer to nearest integer) [Ans. 0040]

Q.27 It is found that in 11.2L at 0°C and 1 atm, of any gaseous compound of 'X', there is never less than 15.5 gm of 'X'. It is also found that 11.2 L of vapours of 'X' at 0°C and 1 atm, weighs 62 gm. The atomicity of 'X' is : [Ans. 0004]

Q.28 $(COOH)_n + AgNO_3(\text{excess}) \rightarrow$ Silver salt $\rightarrow$ White residue
If 0.25 moles of silver salt is taken and weight of residue obtained is 54 gm then what will be the molecular mass of $(COONa)_n$ **in amu.** [Ans. 0134]

Q.29 An aqueous solution containing 0.10g KIO_3 (formula wt. = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated I_2 consumed 45.0 ml of thiosulphate solution to decolourise the blue starch – iodine complex. Calculate the molarity of the sodium thiosulphate solution.

Ans. 0.0623M

Q.30 A sample of hard water contains 96 ppm of SO_4^{2-} and 183 ppm of HCO_3^-, with Ca^{2+} as the only cation. How many moles of CaO will be required to remove HCO_3^- from 1000 kg of this water? If 1000 kg of this water is treated with the amount of CaO calculate above, what will be the conentration (in ppm) of residual Ca^{2+} ions (Assume $CaCO_3$ to be completely insoluble in water)? If the Ca^{2+} ions in one litre of the treated water are completely exchanged with hydrogen ions, what will be its pH (one ppm means one part of the substance in one million part of water, weight/ weights)?

Ans. 1.5, 40 ppm, pH = 2.6989

REVISION FLOW CHART

Mole Concept

Application of mole concept
- → Law of chemical combination (T)
- → Basic definition (T)
- → Calculation of mole (N)
- → Average atomic / mol. mass (N)
  (Calculation of mole % & mass % by $M_{avg.}$)
- → Empirical and Molecular formula (N)
- → Concept of Limiting reagent (N)
- → Parallel reactions, sequential reaction (N)
- → Percentage yield, Percentage purity (N)
- → Experimental method (N)
  - → Estimation of Carbon and Hydrogen
  - → Estimation of Nitrogen
  - → Estimation of Halogens
  - → Estimation of Sulphur
  - → Estimation of Phosphorus
  - → Estimation of Oxygen

  } using POAC

Concentration Term
- → Solutions (N)
  - → M, m, X(mole fraction)
  - → % (w/w),% (w/v),% (v/v)
  - → PPM
- → Typical concentration (N)
  - → Labelling of oleum
  - → Volume strength of H_2O_2
- → Relationship between concentration terms (N)

Oxidation & Reduction
- → Assigning oxidation no. (N)
  - → Through structure
  - → Through formula
- → Balancing of redox reaction (N)

Equivalent Concept
- → Calculation of "n" factor (N)
  - → non redox reaction
  - → redox reaction (some typical cases)
- → Equivalents (N)
- → Normality (N)
- → Chemical equivalence (N)
- → titration (N)

(G) → represents topic of graphical importance

(T) → represents topic of theoretical importance

(N) → represents topic of numerical importance

LIST OF IMPORTANT FORMULAS

1. Application of mole concept :

(i) Atomic mass unit (amu)

The quantity [$\frac{1}{12} \times$ mass of an atom of C–12] is known as atomic mass unit.

(ii) Average molecular weight = $\frac{\sum n_i M_i}{\sum n_i}$

Where n_i = no. of moles of any compound and m_1 = molecular mass of any compound

(iii) **Mole :** One mole is a collection of that many entities as there are number of atoms exactly in 12 gm of C-12 isotope.

or 1 mole = collection of 6.02×10^{23} species

$6.02 \times 10^{23} = N_A$ = Avogadro's No.

(iv) No. of moles = $\frac{\text{Given no.}}{N_A}$

(v) No of moles = $\frac{\text{Given wt.}}{\text{Atomic wt.}}$ (for atoms), or $= \frac{\text{Given wt.}}{\text{Molecular wt.}}$ (for molecules)

(vi) No. of mole : $n = \frac{PV}{RT}$

(vii) Molecular formula = Empirical formula × n

$$n = \frac{\textit{Molecular mass}}{\textit{Empirical Formula mass}}$$

(viii) The percentage yield of product $= \frac{\textit{actual yield}}{\textit{the theoretical maximum yield}} \times 100$

(ix) Dulong's and Petit's Law :

Atomic weight × specific heat (cal/gm°C) $\propto\cong 6.4$

2 Concentration term :

(i) x% (w/w) means 100 g of solution containts x (gram) of solute

(ii) x% (w/v) means 100 ml of solution containts x (gram) of solute

(iii) x% (v/v) means 100 ml of solution containts x (ml) of solute

(iv) 109 % oleum means 100 g H_2SO_4 contains 9 g H_2O

(v) 20 V H_2O_2 means 1 volume of H_2O_2 gives 20 volume of O_2 at STP

(vi) Molality = $\frac{1 - x_A}{x_A} \times \frac{1000}{M_A}$, X_A = mole fraction of solvent

M_A = M. W. of solvent

3. Equivalation concept :

(i) Calculation of n-factor.

Case-I : In case of non-redox reaction.

(a) for acid/base

n-factor = number of H^+ / OH^- given / taken by 1 moles of acid / base

(b) for ions

n-factor = charge on ion

(c) for compounds

n-factor = Total charge on cation/anion replaced

Case-II : In case of redox reaction.

n factor = number of electrons lost or gained by one mole of the concerned species.

(ii) *Equivalents = moles × "n" factor*

$$= \frac{\text{wt.}}{\text{Eq. wt}}$$

(iii) *Normality = molarity × "n" factor*

(iv) *Chemical equivalent*

$$aA + bB \longrightarrow mM + nN$$

eq. of A = eq. of B = eq. M = eq. of N

<u>Some Typical Cases :</u>

* Reaction in which more than one element in a compound undergoes oxidation or reduction.

$$\overset{3}{FeC_2O_4} + \overset{5}{KMnO_4} \longrightarrow Fe^{3+} + CO_2 + \overset{5}{Mn^{2+}}$$

($FeC_2O_4 + KMnO_4$) solve by eq. concept

($Fe^{3+} + CO_2$) avoid eq. concept, solve using POAC

* Disproportionation reaction

$$\overset{5/3}{Br_2} \longrightarrow \overset{1}{Br^-} + \overset{5}{BrO_3^-}$$

* Reaction in which element undergoes either oxidation or reduction is more than one oxidation state.

$$\overset{1}{3Mn^{+7}} \longrightarrow 2Mn^{+7} + \overset{3}{Mn^{+4}}$$

($2Mn^{+7}$) avoid eq. concept, solve using POAC

* For compounds involved in redox reaction but not undergoing either oxidation of reduction.

$$BaCrO_4 + KI + \underline{HCl} \longrightarrow BaCl_2 + KCl + I_2 + CrCl_3$$

n-factor (HCl) = 6 / 16

Note : In this is n_f can be determined only after balancing the reaction.

To predict the product of redox reaction remember :

(a) *In alkaline medium $KMnO_4$ is reduced to K_2MnO_4 but in strong alkaline or neutral medium it reduces to Mn^{+4}.*

(b) *In acid solution $KMnO_4$ is reduced to Mn^{2+}.*

(c) *H_2O_2 on reduction gives water and on oxidation gives oxygen.*

(d) *Dichromate ion in acid solution is reduced to Cr^{3+}.*

(e) *Case of HNO_3*

In general : *conc. $HNO_3 \to NO_2$*

dil $HNO_3 \to NO$

(f) *$C_2O_4^{2-}$ on oxidation gets converted to CO_2*

LAST MOMENT REVIEW

MOLE & EQUIVALENT CONCEPTS

Theory : ....

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Exercise - 1 : Question ....

Exercise - 2 : Question ....

Exercise - 3 : Question ....

Exercise - 4 : Question ....

DPPs : ....

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Other Sources : ....

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