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CHEMISTRY

TARGET : JEE Advanced – 2023

CAPS-1

MOLE CONCEPT

EQUIVALENT CONCEPT

1. A sample of $Fe_2(SO_4)_3$ and FeC_2O_4 was dissolved in dilute H_2SO_4. The complete oxidation of reaction mixture required 40 mL of N/16 $KMnO_4$ solution. After the oxidation, the reaction mixture was reduced by Zn and dilute H_2SO_4. On again oxidation by same $KMnO_4$, 60 mL were required. Calculate the ratio of milli moles of $Fe_2(SO_4)_3$ & FeC_2O_4.

(A) 7 : 4 (B) 4 : 7 (C) 3 : 7 (D) 7 : 3

2. 0.7 g of $(NH_4)_2\ SO_4$ sample was boiled with 100 mL of 0.2 N NaOH solution till all the NH_3 gas is evolved. The resulting solution was diluted to 250 mL. 25 mL of this solution was neutralized using 10 mL of a 0.1 N H_2SO_4 solution. The percentage purity of the $(NH_4)_2\,SO_4$ sample is :

(A) 94.3 (B) 50.8 (C) 47.4 (D) 79.8

3. Which of the following statements is incorrect :

(A) 0.2 moles of $KMnO_4$ will oxidise one mole of ferrous ions to ferric ions in acidic medium.

(B) 1.5 moles of $KMnO_4$ will oxidise 1 mole of ferrous oxalate to one mole of ferric ion and carbon dioxide in acidic medium in acidic medium.

(C) 0.6 moles of $KMnO_4$ will oxidise 1 mole of ferrous oxalate to one mole of ferric ion and carbon dioxide in acidic medium.

(D) 1 mole of $K_2Cr_2O_7$ will oxidise 2 moles of ferrous oxalate to ferric ions and carbon dioxide in acidic medium.

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

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

5. Consider the following statements :

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

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

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

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

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

7. A 5.0 cm^3 solution of H_2O_2 liberates 0.508 g of I_2 from an acidified KI solution.

The strength of H_2O_2 solution in terms of volume strength at STP is

(A) 2.24 vol (B) 8.96 vol (C) 1.12 vol (D) 4.48 vol

8. A 0.6 g sample of only CaC_2O_4 and MgC_2O_4 is heated at 500oC converting them to $CaCO_3$ and $MgCO_3$ weighing 0.465 g. If the sample was heated to 900oC where the products are CaO and MgO, what will be the weight of mixture of oxides

(A) 0.12 g (B) 0.21 g (C) 0.25 g (D) 0.3 g

9. $K_2Cr_2O_7$ can supply "oxygen" to oxidise pollutants in a water sample. If one kilogram of such water sample requires 20 ml of 0.1 M $K_2Cr_2O_7/H^+$, what is the oxygen requirement of that water in ppm units?

(A) 96 ppm (B) 48 ppm (C) 24 ppm (D) 32 ppm

10. Cl_2 disproportionate into Cl^- ions and ClO_3^- ions in hot alkali. Which statement is wrong about this reaction?

(A) Equivalent weight of Cl_2 is 60 % that of molecular weight.

(B) Equivalent weight of oxidised chlorine is 7.1.

(C) $\frac{5}{6}$ th fraction of total chlorine is reduced.

(D) $\frac{5}{6}$ th fraction of total chlorine is oxidized.

11. A mixture of H_2SO_4 and $H_2C_2O_4$ (oxalic acid) and some inert impurity weighing 3.185 g was dissolved in water and the solution made up to 1 litre, 10 mL of this solution required 3 mL of 0.1 N NaOH for complete neutralization. In another experiment 100 mL of the same solution in hot condition required 4 mL of 0.02M $KMnO_4$ solution for complete reaction. The wt. % of H_2SO_4 in the mixture was:

(A) 40 (B) 50 (C) 60 (D) 80

12. Oxalic acid ($H_2C_2O_4$) is a dibasic acid as well as a good reducing agent while KHC_2O_4 is an amphoteric salt in addition to being a good reducing agent. A 3.0 g sample containing KHC_2O_4, oxalic acid dihydrate ($H_2C_2O_4.2H_2O$) and some inert impurity was dissolved in water and diluted to 100 mL and finally analyzed. 0.228 g CaC_2O_4 is precipitated by 10 mL of the solution with $CaCl_2$ in NH_4OH. Answer the following question based on the information provided (Molar mass K = 39, C = 12 and O = 16) – A 10 mL portion of the above solution required 7.8 mL of a 0.05 M H_2SO_4 solution to reach the end point. What is the mass percentage of KHC_2O_4 in the original sample?

(A) 28% (B) 33% (C) 48% (D) 60%

13. Match the column

Column-I

(A) $\underset{3.5\text{mole}}{Sn^{+2}} + \underset{1.2\text{mole}}{MnO_4^-}(\text{acidic})$ (p) Amount of oxidant available decides the number of electrons transfer

(B) $\underset{8.4\text{mole}}{H_2C_2O_4} + \underset{3.6\text{mole}}{MnO_4^-}(\text{acidic})$ (q) Amount of reductant available decides the number of electrons transfer

(C) $\underset{7.2\text{mole}}{S_2O_3^{-2}} + \underset{3.6\text{mole}}{I_2}$ (r) Number of electrons involved per mole of oxidant > Number of electrons involved per mole of reductant

(D) $\underset{9.2\text{mole}}{Fe^{+2}} + \underset{1.6\text{mole}}{Cr_2O_7^{-2}}(\text{acidic})$ (s) Number of electrons involved per mole of oxidant < Number of electrons involved per mole of reductant.

14. Given two mixtures:

I) NaOH + Na_2CO_3

II) $NaHCO_3$ + Na_2CO_3

100 ml of mixture I required 'W' and 'X' ml of 1 M HCl in separate titrations using phenolphthalein and Methyl orange indicators. While 100 ml of mixture II required 'Y' and 'Z' ml of same HCl solution in separate titration using same indicators.

	Column I (Substance)	**Column II (Molarity in solution)**
(A)	Na_2CO_3 in mixture I	(P) $(2w - x) \times 10^{-2}$
(B)	Na_2CO_3 in mixture II	(Q) $(z - 2y) \times 10^{-2}$
(C)	NaOH in mixture I	(R) $y \times 10^{-2}$
(D)	$NaHCO_3$ in mixture II	(S) $(x - w) \times 10^{-2}$

15. Match the following

	Column I	**Column II**
(A)	$\underline{P_2H_4} \rightarrow PH_3 + P_4H_2$	(P) $E = \frac{3M}{4}$
(B)	$\underline{I_2} \rightarrow I^- + IO_3^-$	(Q) $E = \frac{3M}{5}$
(C)	$MnO_4^- + Mn^{2+} + H_2O \rightarrow Mn_3O_4 + H^+$	(R) $E = \frac{15M}{26}$
(D)	$\underline{H_3PO_2} \rightarrow PH_3 + H_3PO_3$	(S) $E = \frac{5M}{6}$

MULTIPLE CHOICE QUESTIONS

16. To a 25 ml H_2O_2 solution excess acidified solution of KI was added. The iodine liberated 20 ml of 0.3 N sodium thiosulphate solution. Use these data to choose the correct statements from the following :

(A) The weight of H_2O_2 present in 25 ml solution is 0.102 g

(B) The molarity of H_2O_2 solution is 0.12 M

(C) The weight of H_2O_2 present in 1 L of the solution is 0.816 g

(D) The volume strength of H_2O_2 is 1.344 L

17. Given following series of reactions:

(I) $NH_3 + O_2 \rightarrow NO + H_2O$ (II) $NO + O_2 \rightarrow NO_2$

(III) $NO_2 + H_2O \rightarrow HNO_3 + HNO_2$ (IV) $HNO_2 \rightarrow HNO_3 + NO + H_2O$

Select the correct option(s):

(A) Moles of HNO_3 obtained is half of moles of Ammonia used if HNO_2 is not used to produce HNO_3 by reaction (IV)

(B) $\frac{100}{6}$% more HNO_3 will be produced if HNO_2 is used to produce HNO_3 by reaction (IV) than if HNO_2 is not used to produce HNO_3 by reaction (IV)

(C) If HNO_2 is used to produce HNO_3 then $\frac{1}{4}$th of total HNO_3 is produced by reaction (IV)

(D) Moles of NO produced in reaction (IV) is 50% of moles of total HNO_3 produced.

18. One gram of carbonate of Alkaline Earth metal was dissolved in 25 ml of Normal HCl. The resulting liquid required 50 ml of $\frac{N}{10}$ caustic soda solution to neutralize it completely. Then which of the following are correct?

(A) Eq. wt of Metallic carbonate = 50 (B) Eq. wt of Metal = 20

(C) Eq. wt of Metal = 3 (D) Eq. wt of Metallic carbonate = 40

19. Identify intramolecular redox reactions but not disproportionation reactions

(A) $(NH_4)_2 Cr_2 O \rightarrow N_2 + Cr_2 O_3 + H_2O$ (B) $NH_4NO_3 \rightarrow N_2O + 2H_2O$

(C) $2KClO_3 \rightarrow 2KCl + 3O_2$ (D) $PCl_5 \xrightarrow{\Delta} PCl_3 + Cl_2$

20. A 150 ml mixture of CO and CO_2 is passed through a tube containing excess of red-hot charcoal. The volume become 200 ml due to reaction CO_2 (g) + C (s) $\rightarrow$ 2CO(g)

(a) Mole percent of CO_2 in the original mixture is 50.

(b) Mole fraction of CO in the original mixture is 0.66.

(c) The original mixture contains 50 ml of CO_2.

(d) The original mixture contains 50 ml of CO.

NUMERIC ANSWER TYPE

21. To 100 ml of 5 M NaOH solution (density 1.2 g/ml) were added 200 ml of another NaOH solution which has a density of 1.5 g/ml and contains 20 mass percent of NaOH. What will be the volume of the gas (at STP) in litres liberated when aluminium reacts with this (final) solution. The reaction is $Al + NaOH + H_2O \rightarrow NaAlO_2 + H_2$ (At. wt. Na = 23, 0 = 16, H = 1)

22. 10 g sample of bleaching powder was dissolved in water to make one litre solution. To this solution, 35 mL of 1.0 M Mohr salt solution was added containing enough H_2SO_4. After the reaction was complete, the excess Mohr salt required 30 mL of 0.1 M $KMnO_4$ for oxidation. Find the approximate % of available Cl_2.

23. 1 gm of a metal ion M^{x+} (atomic mass = 100) was treated with 3.00 gm of $N_2H_4.H_2O$ and CO_2(g) was passed through the mixture when entire metal got precipitated as a complex of formula $(N_2H_5)_m[M(N_2H_3COO)_n]$. One tenth of the volume of the filtrate after filtering off the precipitate required 20 ml of 0.1M KIO_3 solution in 6 M HCl.

$IO_3^- + N_2H_4 + 2H^+ + Cl^- \longrightarrow ICl + 3H_2O + N_2$

Find the value of (m + n).

24. $pCu_2O + qMnO_4^- + rH_2O \rightarrow sMnO_2 + t\ Cu(OH)_2\ u\ OH^-$. The value of $(p + q + r) - (s + t + u)$ is

SUBJECTIVE ANSWER TYPE

25. The density of a pure liquid (X_2) having molecular mass 70 is 3.5 gm/ml. If 2 ml of liquid contain 35 drops, then the number of mole atoms in 2 litre of liquid will be

26. What volume of liquid **'A'** has same number of moles of **'A'** as there are number of moles of **'B'** in $80cm^3$ of liquid **'B'**.

Given :[Density of A = 1.0×10^{-3} gm/mL ; Density of B = 1.0×10^{-3} gm/mL
Molecular mass of A and B liquids are 40 & 20 respectively]

27. At room temperature, the density of water is 1.0 g/ml and the density of ethanol is 0.789 g/ml. What volume of ethanol contains the same number of molecules as are present in 175 ml of water ?

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

$$F_2 + 2NaOH \longrightarrow O_2 + 2NaF + H_2O$$

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

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 ? [At mass F = 19], [Lime : CaO]

29. Two beakers A and B contain distilled water each. In beaker A, 100 g of $NaNO_3$ is dissolved and in B, 100 g of $NH_2CO\ NH_2$ is dissolved, so that the total volume in each of the beakers now becomes 500 ml respectively. What will be the molarity with respect to $NaNO_3$ and NH_2CONH_2 each when the two solutions are mixed. (Given At. mass Na = 23) (Assume no reaction between $NaNO_3$ and NH_2CONH_2).

30. $A_2 + 2B_2 \rightarrow A_2B_4; \frac{3}{2}A_2 + 2B_2 \rightarrow A_3B_4.$

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

(a) 4 moles A_2 & 4 moles B_2 (b) 1/2 moles A_2 & 2 moles B_2

(c) 1.25 moles A_2 & 2 moles B_2

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

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