

# CHEMISTRY

TARGET : JEE Advanced – 2023

## CAPS-1

### MOLE CONCEPT EQUIVALENT CONCEPT

- A sample of  $\text{Fe}_2(\text{SO}_4)_3$  and  $\text{FeC}_2\text{O}_4$  was dissolved in dilute  $\text{H}_2\text{SO}_4$ . The complete oxidation of reaction mixture required 40 mL of N/16  $\text{KMnO}_4$  solution. After the oxidation, the reaction mixture was reduced by Zn and dilute  $\text{H}_2\text{SO}_4$ . On again oxidation by same  $\text{KMnO}_4$ , 60 mL were required. Calculate the ratio of milli moles of  $\text{Fe}_2(\text{SO}_4)_3$  &  $\text{FeC}_2\text{O}_4$ .

(A) 7 : 4                      (B) 4 : 7                      (C) 3 : 7                      (D) 7 : 3
- 0.7 g of  $(\text{NH}_4)_2\text{SO}_4$  sample was boiled with 100 mL of 0.2 N NaOH solution till all the  $\text{NH}_3$  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  $\text{H}_2\text{SO}_4$  solution. The percentage purity of the  $(\text{NH}_4)_2\text{SO}_4$  sample is :

(A) 94.3                      (B) 50.8                      (C) 47.4                      (D) 79.8
- Which of the following statements is incorrect :

(A) 0.2 moles of  $\text{KMnO}_4$  will oxidise one mole of ferrous ions to ferric ions in acidic medium.  
 (B) 1.5 moles of  $\text{KMnO}_4$  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  $\text{KMnO}_4$  will oxidise 1 mole of ferrous oxalate to one mole of ferric ion and carbon dioxide in acidic medium.  
 (D) 1 mole of  $\text{K}_2\text{Cr}_2\text{O}_7$  will oxidise 2 moles of ferrous oxalate to ferric ions and carbon dioxide in acidic medium.
- A 10.0 g sample of a mixture of calcium chloride and sodium chloride is treated with  $\text{Na}_2\text{CO}_3$  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%
- Consider the following statements :

  - If all the reactants are not taken in their stoichiometric ratio, then at least one reactant will be left behind.
  - 2 moles of  $\text{H}_2(\text{g})$  and 3 moles of  $\text{O}_2(\text{g})$  produce 2 moles of water.
  - equal wt. of carbon and oxygen are taken to produce  $\text{CO}_2$  then  $\text{O}_2$  is limiting reagent.

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

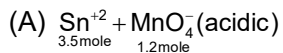
(A) T T T                      (B) F T F                      (C) F F F                      (D) T F T
- During the disproportionation of Iodine to iodide and iodate ions, the ratio of iodate and iodide ions formed in alkaline medium is :

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

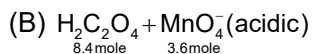
7. A  $5.0 \text{ cm}^3$  solution of  $\text{H}_2\text{O}_2$  liberates  $0.508 \text{ g}$  of  $\text{I}_2$  from an acidified KI solution.  
The strength of  $\text{H}_2\text{O}_2$  solution in terms of volume strength at STP is  
(A) 2.24 vol (B) 8.96 vol (C) 1.12 vol (D) 4.48 vol
8. A  $0.6 \text{ g}$  sample of only  $\text{CaC}_2\text{O}_4$  and  $\text{MgC}_2\text{O}_4$  is heated at  $500^\circ\text{C}$  converting them to  $\text{CaCO}_3$  and  $\text{MgCO}_3$  weighing  $0.465 \text{ g}$ . If the sample was heated to  $900^\circ\text{C}$  where the products are  $\text{CaO}$  and  $\text{MgO}$ , what will be the weight of mixture of oxides  
(A)  $0.12 \text{ g}$  (B)  $0.21 \text{ g}$  (C)  $0.25 \text{ g}$  (D)  $0.3 \text{ g}$
9.  $\text{K}_2\text{Cr}_2\text{O}_7$  can supply "oxygen" to oxidise pollutants in a water sample. If one kilogram of such water sample requires  $20 \text{ ml}$  of  $0.1 \text{ M}$   $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$ , what is the oxygen requirement of that water in ppm units?  
(A) 96 ppm (B) 48 ppm (C) 24 ppm (D) 32 ppm
10.  $\text{Cl}_2$  disproportionate into  $\text{Cl}^-$  ions and  $\text{ClO}_3^-$  ions in hot alkali. Which statement is wrong about this reaction?  
(A) Equivalent weight of  $\text{Cl}_2$  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  $\text{H}_2\text{SO}_4$  and  $\text{H}_2\text{C}_2\text{O}_4$  (oxalic acid) and some inert impurity weighing  $3.185 \text{ g}$  was dissolved in water and the solution made up to 1 litre,  $10 \text{ mL}$  of this solution required  $3 \text{ mL}$  of  $0.1 \text{ N}$   $\text{NaOH}$  for complete neutralization. In another experiment  $100 \text{ mL}$  of the same solution in hot condition required  $4 \text{ mL}$  of  $0.02 \text{ M}$   $\text{KMnO}_4$  solution for complete reaction. The wt. % of  $\text{H}_2\text{SO}_4$  in the mixture was:  
(A) 40 (B) 50 (C) 60 (D) 80
12. Oxalic acid ( $\text{H}_2\text{C}_2\text{O}_4$ ) is a dibasic acid as well as a good reducing agent while  $\text{KHC}_2\text{O}_4$  is an amphoteric salt in addition to being a good reducing agent. A  $3.0 \text{ g}$  sample containing  $\text{KHC}_2\text{O}_4$ , oxalic acid dihydrate ( $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ ) and some inert impurity was dissolved in water and diluted to  $100 \text{ mL}$  and finally analyzed.  $0.228 \text{ g}$   $\text{CaC}_2\text{O}_4$  is precipitated by  $10 \text{ mL}$  of the solution with  $\text{CaCl}_2$  in  $\text{NH}_4\text{OH}$ . Answer the following question based on the information provided (Molar mass  $\text{K} = 39$ ,  $\text{C} = 12$  and  $\text{O} = 16$ ) – A  $10 \text{ mL}$  portion of the above solution required  $7.8 \text{ mL}$  of a  $0.05 \text{ M}$   $\text{H}_2\text{SO}_4$  solution to reach the end point. What is the mass percentage of  $\text{KHC}_2\text{O}_4$  in the original sample?  
(A) 28% (B) 33% (C) 48% (D) 60%

13. Match the column

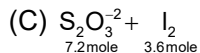
**Column-I**



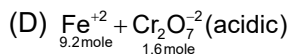
(p) Amount of oxidant available decides the number of electrons transfer



(q) Amount of reductant available decides the number of electrons transfer

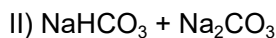
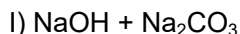


(r) Number of electrons involved per mole of oxidant > Number of electrons involved per mole of reductant



(s) Number of electrons involved per mole of oxidant < Number of electrons involved per mole of reductant.

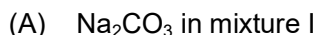
14. Given two mixtures:



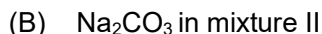
100 ml of mixture I required 'W' and 'X' ml of 1 M HCl in separate titrations using phenolphthalein and Methyl orange indicators. While 100 ml of mixture II required 'Y' and 'Z' ml of same HCl solution in separate titration using same indicators.

**Column I (Substance)**

**Column II (Molarity in solution)**



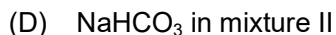
(P)  $(2w - x) \times 10^{-2}$



(Q)  $(z - 2y) \times 10^{-2}$



(R)  $y \times 10^{-2}$

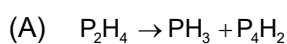


(S)  $(x - w) \times 10^{-2}$

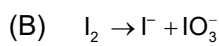
15. Match the following

**Column I**

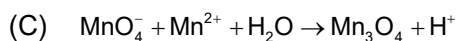
**Column II**



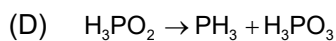
(P)  $E = \frac{3M}{4}$



(Q)  $E = \frac{3M}{5}$



(R)  $E = \frac{15M}{26}$



(S)  $E = \frac{5M}{6}$

**MULTIPLE CHOICE QUESTIONS**

16. To a 25 ml  $\text{H}_2\text{O}_2$  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 :

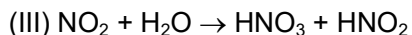
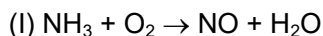
(A) The weight of  $\text{H}_2\text{O}_2$  present in 25 ml solution is 0.102 g

(B) The molarity of  $\text{H}_2\text{O}_2$  solution is 0.12 M

(C) The weight of  $\text{H}_2\text{O}_2$  present in 1 L of the solution is 0.816 g

(D) The volume strength of  $\text{H}_2\text{O}_2$  is 1.344 L

17. Given following series of reactions:



Select the correct option(s):

(A) Moles of  $\text{HNO}_3$  obtained is half of moles of Ammonia used if  $\text{HNO}_2$  is not used to produce  $\text{HNO}_3$  by reaction (IV)

(B)  $\frac{100}{6}\%$  more  $\text{HNO}_3$  will be produced if  $\text{HNO}_2$  is used to produce  $\text{HNO}_3$  by reaction (IV) than if  $\text{HNO}_2$  is not used to produce  $\text{HNO}_3$  by reaction (IV)

(C) If  $\text{HNO}_2$  is used to produce  $\text{HNO}_3$  then  $\frac{1}{4}$ th of total  $\text{HNO}_3$  is produced by reaction (IV)

(D) Moles of NO produced in reaction (IV) is 50% of moles of total  $\text{HNO}_3$  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?

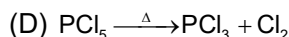
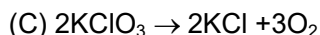
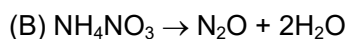
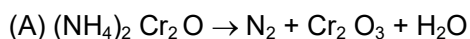
(A) Eq. wt of Metallic carbonate = 50

(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



20. A 150 ml mixture of CO and  $\text{CO}_2$  is passed through a tube containing excess of red-hot charcoal. The volume become 200 ml due to reaction  $\text{CO}_2(\text{g}) + \text{C}(\text{s}) \rightarrow 2\text{CO}(\text{g})$

(a) Mole percent of  $\text{CO}_2$  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  $\text{CO}_2$ .

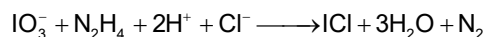
(d) The original mixture contains 50 ml of CO.

### 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  $\text{Al} + \text{NaOH} + \text{H}_2\text{O} \rightarrow \text{NaAlO}_2 + \text{H}_2$  (At. wt. Na = 23, O = 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  $\text{H}_2\text{SO}_4$ . After the reaction was complete, the excess Mohr salt required 30 mL of 0.1 M  $\text{KMnO}_4$  for oxidation. Find the approximate % of available  $\text{Cl}_2$ .

23. 1 gm of a metal ion  $\text{M}^{x+}$  (atomic mass = 100) was treated with 3.00 gm of  $\text{N}_2\text{H}_4 \cdot \text{H}_2\text{O}$  and  $\text{CO}_2(\text{g})$  was passed through the mixture when entire metal got precipitated as a complex of formula  $(\text{N}_2\text{H}_5)_m[\text{M}(\text{N}_2\text{H}_3\text{COO})_n]$ . One tenth of the volume of the filtrate after filtering off the precipitate required 20 ml of 0.1M  $\text{KIO}_3$  solution in 6 M HCl.



Find the value of (m + n).

24.  $p\text{Cu}_2\text{O} + q\text{MnO}_4^- + r\text{H}_2\text{O} \rightarrow s\text{MnO}_2 + t\text{Cu}(\text{OH})_2 + u\text{OH}^-$ . The value of  $(p + q + r) - (s + t + u)$  is

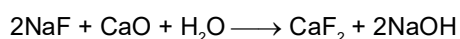
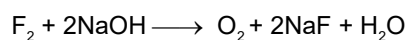
### SUBJECTIVE ANSWER TYPE

25. The density of a pure liquid ( $\text{X}_2$ ) 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  $80\text{cm}^3$  of liquid 'B'.

**Given :** [Density of A =  $1.0 \times 10^{-3}$  gm/mL ; Density of B =  $1.0 \times 10^{-3}$  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 :



As the plant operated, excess lime was added to bring about complete precipitation of the fluoride as  $\text{CaF}_2$ . 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 :  $\text{CaO}$ ]

29. Two beakers A and B contain distilled water each. In beaker A, 100 g of  $\text{NaNO}_3$  is dissolved and in B, 100 g of  $\text{NH}_2\text{CO NH}_2$  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  $\text{NaNO}_3$  and  $\text{NH}_2\text{CONH}_2$  each when the two solutions are mixed. (Given At. mass Na = 23) (Assume no reaction between  $\text{NaNO}_3$  and  $\text{NH}_2\text{CONH}_2$ ).

30.  $\text{A}_2 + 2\text{B}_2 \rightarrow \text{A}_2\text{B}_4$ ;  $\frac{3}{2}\text{A}_2 + 2\text{B}_2 \rightarrow \text{A}_3\text{B}_4$ .

Two substance  $\text{A}_2$  &  $\text{B}_2$  react in the above manner. When  $\text{A}_2$  is limited it gives  $\text{A}_2\text{B}_4$  in excess gives  $\text{A}_3\text{B}_4$ .  $\text{A}_2\text{B}_4$  can be converted to  $\text{A}_3\text{B}_4$  when reacted with  $\text{A}_2$ . Using this information calculate the composition of the final mixture when the mentioned amount of  $\text{A}_2$  &  $\text{B}_2$  are taken

- (a) 4 moles  $\text{A}_2$  & 4 moles  $\text{B}_2$  (b) 1/2 moles  $\text{A}_2$  & 2 moles  $\text{B}_2$   
(c) 1.25 moles  $\text{A}_2$  & 2 moles  $\text{B}_2$

31. Uranium is isolated from its ore by dissolving it as  $\text{UO}_2(\text{NO}_3)_2$  and separating it as solid  $\text{UO}_2(\text{C}_2\text{O}_4) \cdot x\text{H}_2\text{O}$ . A 1.0 g sample of ore on treatment with nitric acid yielded 1.48 g  $\text{UO}_2(\text{NO}_3)_2$  which on further treatment with 0.4 g  $\text{Na}_2\text{C}_2\text{O}_4$  yielded 1.23 g  $\text{UO}_2(\text{C}_2\text{O}_4) \cdot x\text{H}_2\text{O}$ . Determine weight percentage of uranium in the original sample and x.
32. A sample of fuming sulphuric acid containing  $\text{H}_2\text{SO}_4$ ,  $\text{SO}_3$  and  $\text{SO}_2$  weighing 1.00 g is found to require 23.47 mL of 1.00 M alkali ( $\text{NaOH}$ ) for neutralization. A separate sample shows the presence of 1.50%  $\text{SO}_2$ . Find the percentage of "free"  $\text{SO}_3$ ,  $\text{H}_2\text{SO}_4$  and "combined"  $\text{SO}_3$  in the sample.