

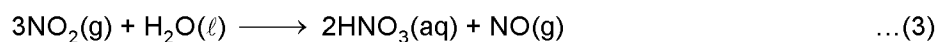
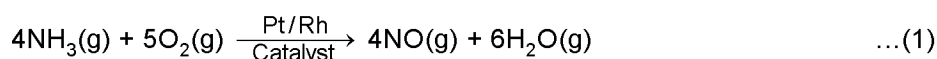
Topic : Mole Concept
Type of Questions

Type of Questions	M.M., Min.
Subjective Questions ('-1' negative marking) Q.1 to 3, 7 to 11, 13 (4 marks, 5 min.)	[32, 40]
Short Subjective Questions ('-1' negative marking) Q.12 (3 marks, 3 min.)	[3, 3]
Comprehension ('-1' negative marking) Q.4 to 6 (3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4) Q.14 (8 marks, 10 min.)	[8, 10]

- An alloy has Fe, Co and Mo equal to 60%, 29.5% and 10.5% by mass respectively. How many cobalt atoms are there in a cylinder made from same alloy, having radius 2.1 cm and a length of 10 cm? The density of alloy is $\frac{100}{21}$ g/mL. Atomic weight of cobalt = 59 u.
- What weight of CO is required to form $\text{Re}_2(\text{CO})_{10}$ from 2.42 g of Re_2O_7 according to the given unbalanced reaction? $\text{Re}_2\text{O}_7 + \text{CO} \longrightarrow \text{Re}_2(\text{CO})_{10} + \text{CO}_2$
(Atomic mass of Re = 186 u)
- Haemoglobin contains 0.25% iron by weight. The molecular weight of Haemoglobin is 89600 u. Calculate the weight of $\text{K}_4[\text{Fe}(\text{CN})_6]$ that can be produced, if all the iron atoms from 4.48 kg haemoglobin are converted into $\text{K}_4[\text{Fe}(\text{CN})_6]$ through a series of reactions.

Comprehension # (Q. 4 to Q. 6).

Nitric acid is the most important oxyacid formed by nitrogen. It is one of the major industrial chemicals and is widely used. Nitric acid is manufactured by the catalytic oxidation of ammonia, that is known as Ostwald process, which can be represented by the sequence of reactions shown below :



The aqueous nitric acid obtained by this method can be concentrated by distillation to $\approx 68.5\%$ by weight. Further concentration to 98% acid can be achieved by dehydration with concentrated sulfuric acid.

- 85 kg of NH_3 (g) was heated with 320 kg oxygen in the first step and HNO_3 is prepared according to the above reactions. If the final solution has volume 500 L, then molarity of HNO_3 solution is :
(A) 2M (B) 8M (C) 3.33 M (D) 6.66 M
- If 180 L of water completely reacts with NO_2 produced to form nitric acid according to the above reactions, then the volume of air required at STP containing 20% of NH_3 by volume is : ($\rho_{\text{H}_2\text{O}} = 1 \text{ g/mL}$)
(A) 1.56×10^6 L (B) 6.72×10^4 L (C) 3.36×10^6 L (D) None of these



6. If 170 kg of NH_3 is heated in excess of oxygen, then the volume of H_2O (ℓ) produced in 1st reaction at STP is : ($\rho_{\text{H}_2\text{O}} = 1 \text{ g/mL}$)
 (A) $336 \times 10^3 \text{ L}$ (B) 270 L (C) $224 \times 10^3 \text{ L}$ (D) 170 L
7. How many grams of Sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7$) should be added to a 50 mL volumetric flask to prepare 0.025 M $\text{Na}_2\text{Cr}_2\text{O}_7$ solution, when the flask is filled upto the mark with water ?
8. What volume of 0.25 M HNO_3 (nitric acid) solution reacts with 50 mL of 0.15 M Na_2CO_3 (sodium carbonate) solution in the following reaction :

$$2\text{HNO}_3(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \longrightarrow 2\text{NaNO}_3(\text{aq}) + \text{H}_2\text{O}(\ell) + \text{CO}_2(\text{g})$$
9. How would you prepare exactly 3 litre of 1 M NaOH solution by mixing proportions of stock solutions of 2.5 M NaOH and 0.4 M NaOH, if no water is to be used. Find the ratio of the volume (v_1/v_2).
10. A sample of H_2SO_4 (density 1.4 g mL^{-1}) solution is labelled as 84% by weight. What is molarity of acid solution? What volume of this acid solution has to be used to make 1 litre of 0.2 M H_2SO_4 solution ?
11. 10 mL of sulphuric acid solution (sp. gr. = 1.84) contains 98% by weight of pure acid. Calculate the volume of 2.5 M NaOH solution required to just neutralize the above acid solution.
12. When 10 g NaOH is added with 90 g of H_2O , a solution having density 1.2 g/mL is obtained. Then, calculate the following for this solution :
 (i) % w/w (ii) % w/v (iii) mole fraction of NaOH (iv) molarity (M) (v) molality (m)
13. Out of 5.85% w/v aq. NaCl solution and 5.55% w/v aq. CaCl_2 solution, which solution has more number of Cl^- ions per mL of solution ?
14. Match the following :
- | Column-I | Column-II |
|---|--------------------------------------|
| (A) 1 M glucose solution | (p) 1 mole solute per litre solution |
| (B) 3 M urea solution | (q) 180 g solute per litre solution |
| (C) 3 M CH_3COOH solution | (r) % w/v = 18% (solution) |
| (D) 1 M H_2SO_4 solution | (s) % w/v = 9.8% (solution) |

Answer Key

DPP No. # 10

- | | | | | | | | | | |
|-----|---|-----------------------------|--|----|--------|----|-------|----|-----|
| 1. | 3.3 N_A . | 2. | 2.38 g | 3. | 73.6 g | 4. | (D) | 5. | (C) |
| 6. | (B) | 7. | 0.3375 g. | 8. | 60 mL | 9. | 2 : 5 | | |
| 10. | 12 M, 16.66 mL | 11. | 147.2 mL | | | | | | |
| 12. | (i) % w/w = 10% | (ii) % w/v = 12% | (iii) mole fraction of NaOH = 1/21 | | | | | | |
| | (iv) molarity (M) = (3M) | (v) molality (m) = (2.78 m) | | | | | | | |
| 13. | Both have equal no. of Cl^- ions per ml. | 14. | (A - p, q, r) ; (B - q, r) ; (C - q, r) ; (D - p, s) | | | | | | |



Hints & Solutions

DPP No. # 10

1. Volume of cylinder = $\pi r^2 h$

$$= \frac{22}{7} \times (2.1)^2 \times 10$$

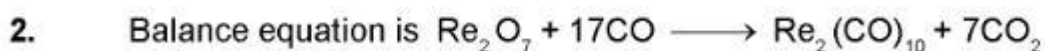
$$= 138.6 \text{ cm}^3$$

$$\text{Mass of cylinder} = V \times d = 138.6 \times \frac{100}{21} = 660 \text{ g}$$

$$\text{Mass of cobalt} = \frac{29.5}{100} \times 600 = 194.7 \text{ g.}$$

$$\text{Moles of cobalt} = \frac{194.7}{59} = 3.3$$

$$\therefore \text{Number of atoms of cobalt} = 3.3 N_A$$



3. 100 g haemoglobin has = 0.25 g Fe

$$89600 \text{ g} \text{ ----- } " \text{ ----- } " \text{ ----- } = \frac{0.25 \times 89600}{100} = 224 \text{ g Fe}$$

$$\therefore 1 \text{ mol of Haemoglobin has} = \frac{224}{56} \text{ mol Fe atoms} = 4 \text{ mol Fe.}$$

$$\text{Now mole of haemoglobin given} = \frac{4480 \text{ g}}{89600 \text{ g/mol}} = 0.05 \text{ mol}$$

$$\text{mol. wt of } \text{K}_4[\text{Fe}(\text{CN})_6] = 368 \text{ g/mol}$$

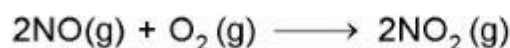
$$\text{Applying POAC for Fe atoms} - \text{mole of Haemoglobin} \times 4 = \text{mole of } \text{K}_4[\text{Fe}(\text{CN})_6] \times 1$$

$$0.05 \times 4 = \frac{\text{weight of } \text{K}_4[\text{Fe}(\text{CN})_6]}{368 \text{ g/mol}} \times 1$$

$$\text{weight of } \text{K}_4[\text{Fe}(\text{CN})_6] = 0.05 \times 4 \times 368 \text{ g} = 73.6 \text{ g}$$



$$\text{mole (मोल)} \quad 5 \times 10^3 \quad 10^4 \text{ mole (मोल)} \quad 5 \times 10^3$$



$$5 \times 10^3 \quad 5 \times 10^3$$



$$5 \times 10^3 \quad \frac{2}{3} \times 5 \times 10^3$$



$$\text{molarity (मोलरता)} = \frac{2}{3} \times \frac{5 \times 10^3}{500} = 6.66 \text{ M.}$$

5. Moles of water reacted = $\frac{180 \times 10^3}{18} = 10^4$

∴ moles of NO_2 required = $30 \times 10^3 =$ mole of NH_3 required

∴ volume of air at STP = $\frac{30 \times 10^3 \times 22.4}{0.2} = 3.36 \times 10^6 \text{ L.}$

6. Moles of $\text{NH}_3 = \frac{170}{17} = 10 \times 10^3$

∴ moles of H_2O formed = $\frac{6}{4} \times 10 \times 10^3$

∴ mass of H_2O formed = $\frac{6}{4} \times 10 \times 10^3 \times 18$

∴ volume of H_2O formed = $15 \times 18 \text{ L} = 270 \text{ L.}$

7. Molarity (मोलरता) = $0.025 = \frac{\text{Mole}}{50} \times 1000$

$$\text{Mole(मोल)} = \frac{50 \times 0.025}{1000}$$

$$\text{wt. of } \text{Na}_2\text{Cr}_2\text{O}_7 \text{ (का भार)} = \frac{50 \times 0.025}{1000} \times 270 = 0.3375 \text{ gm.}$$



$$\frac{\text{Millmole of } \text{HNO}_3}{2} = \frac{\text{Millmole of } \text{Na}_2\text{CO}_3}{1}$$

$$0.25 \times V_{\text{ml}} = 2 \times 50 \times 0.15$$

$$V_{\text{ml}} = \frac{2 \times 50 \times 0.15}{0.25} = 60 \text{ mL.}$$



9. $N_1V_1 + N_2V_2 = N_TV_T$
 $2.5V_1 + 0.4V_2 = 3 \times 1$
 $2.5V_1 + 0.4(3 - V_1) = 3$
 $2.5V_1 + 1.2 - 0.4V_1 = 3$
 $2.1V_1 = 1.8$
 $V_1 = \frac{1.8}{2.1} = \frac{6}{7}$
 $V_2 = 3 - \frac{6}{7} = \frac{15}{7}$
 $\frac{V_1}{V_2} = \frac{6}{7} \times \frac{7}{15} = 2 : 5$

10. $M = \frac{86 \times 1.787}{98} \times 10 = 15.68 \text{ M}$
 $M_1V_1 = M_2V_2$
 $15.68 \times V_1 = 0.2 \times 1000$
 $V_1 = 12.75 \text{ ml.}$

11. For neutralisation
m moles of $\text{H}_2\text{SO}_4 = 2 \times \text{m moles of NaOH}$
 $\frac{98}{98} \times 1.84 \times 10 \times 10 = 2 \times 2.5 \times V$
 $V = 147.2 \text{ ml}$

12. (i) % (w/w) = $\frac{10}{90 + 10} \times 100 = 10\%$
(ii) % (w/v) = $\frac{10}{\frac{(90 + 10)}{1.2}} \times 100 = 12\%$
(iii) Mole fraction of NaOH = $\frac{10}{40} = \frac{1}{21}$
 $\frac{10}{40} + \frac{90}{18}$

(iv) Molarity = $\frac{10}{\frac{(90 + 10)}{1.2}} \times 1000 = 3 \text{ M}$

(v) Molality = $\frac{10}{90} \times 1000 = 2.78 \text{ M.}$

13. 5.85% (w/v) \rightarrow 5.85 g NaCl / 100 ml NaCl
So, Mole/ ml = $\frac{5.85}{58.5} = 0.1/100 \text{ ml}$



$$\text{Cl}^- / \text{ml} = \frac{0.1 \times 1}{100}$$

5.55 % (w/v) \rightarrow 5.55 g CaCl_2 / 100 ml
 CaCl_2

$$\text{So, Mole/ ml} = \frac{5.55}{111} = 0.05 \text{ ml}$$

$$\text{Cl}^- / \text{ml} = \frac{0.05 \times 2}{100} = \frac{0.1}{100}$$

14. (A) 1 M glucose solution \equiv 1 mole of solute/L
 \equiv 180 g solute/L
 $\equiv (180 \text{ g}/1000) \times 100 = 18\% \text{ (w/v)}$
- (B) 3 M urea solution ($\text{NH}_2\text{CO}\text{NH}_2$) \equiv 3 mole of solute/L
 $\equiv (60 \times 3) \text{ g of solute/L}$
 $\equiv (180 \text{ g}/1000) \times 100 = 18\% \text{ (w/v)}$
- (C) 3 M CH_3COOH solution \equiv 3 mole of solute/L
 $\equiv (3 \times 60) \text{ g of solute/L}$
 $\equiv (180 \text{ g}/1000) \times 100 = 18\% \text{ (w/v)}$
- (D) 1 M H_2SO_4 solution \equiv 1 mole of solute/L
 $\equiv 98 \text{ g of solute/L}$
 $\equiv \frac{98}{1000} \times 100 = 9.8\% \text{ (w/v)}$

