

Mole Concept-2 (Solution)

Some Basic Concepts of Chemistry-2

30. Which has maximum number of atoms? (2003)

(a) 24 g of C (12) (b) 56 g of Fe (56) (c) 27 g of Al (27) (d) 108 g of Ag (108)

Explanation (simple words): Same mass me **lighter molar mass** \Rightarrow **more moles** \Rightarrow more atoms.

Approach: Atoms = $\frac{m}{M}N_A$; compare $\frac{m}{M}$ for each.

Steps:

$$\text{C: } n = \frac{24}{12} = 2 \text{ mol [largest]}$$

$$\text{Fe: } n = \frac{56}{56} = 1 \text{ mol} \quad \text{Al: } n = \frac{27}{27}$$

Why this formula? Number of atoms is proportional to moles $n = \frac{m}{M}$.

Answer: 24g of carbon (Option a).

Similar practice: Whose atoms are more: 12 g C, 27 g Al, or 23 g Na?

31. How many moles of electrons weigh 1 kg? (2002)

Explanation: Ek mole electrons ka mass $m_e N_A$ hota hai.

Approach: $n = \frac{m}{M_{(1 \text{ mol } e^-)}}$ where $M_{(1 \text{ mol } e^-)} = m_e N_A$.

Steps:

$$\begin{aligned} m_e &= 9.109 \times 10^{-31} \text{ kg}, \quad N_A = 6.022 \times 10^{23} \text{ mol}^{-1} \\ M_{(1 \text{ mol } e^-)} &= m_e N_A = (9.109 \times 10^{-31})(6.022 \times 10^{23}) \\ &= 5.485 \times 10^{-7} \text{ kg mol}^{-1} \\ n &= \frac{1.000 \text{ kg}}{5.485 \times 10^{-7}} = \boxed{1.82 \times 10^6 \text{ mol}} \end{aligned}$$

Why this formula? Moles = $\frac{\text{mass}}{\text{molar mass}}$; here molar mass of electrons = $m_e N_A$.

Similar practice: 10 g electrons correspond to how many coulombs? (Use $F = 96485 \text{ C mol}^{-1}$.)

32. The largest number of molecules is in (1979)

(a) 36 g water (b) 28 g CO (c) 46 g ethyl alcohol (d) 54 g N_2O_5

Explanation: More moles \Rightarrow more molecules.

Approach: $n = \frac{m}{M}$ for each.

Steps:

$$\begin{aligned} 36 \text{ g H}_2\text{O} : n &= \frac{36}{18} = 2 \text{ mol (largest)} \\ 28 \text{ g CO} : n &= \frac{28}{28} = 1 \text{ mol} \\ 46 \text{ g ethanol} : n &= \frac{46}{46} = 1 \text{ mol} \\ 54 \text{ g N}_2\text{O}_5 : n &= \frac{54}{108} = 0.5 \text{ mol} \end{aligned}$$

Answer: 36g of water (Option a).

Similar practice: 18 g H_2O vs 32 g O_2 — kis me molecules zyada?

33. Total number of electrons in one molecule of CO_2 is (1979)

Explanation: $Z(\text{C}) = 6$, $Z(\text{O}) = 8$.

Approach: Electrons per molecule = $6 + 2 \times 8$.

Steps:

$$N_{e^-} = 6 + 2 \times 8 = \boxed{22}$$

Why? Neutral atom me electrons = atomic number.

Similar practice: H_2SO_4 me total electrons?

34. A gaseous mixture contains O_2 and N_2 in the ratio 1:4 by weight. Ratio of their number of molecules is (1979)

Explanation: Same mass nahi, different molar masses — isliye pehle moles nikalo.

Approach: Take 1 g O_2 and 4 g N_2 . Use $n = \frac{m}{M}$ ($M_{\text{O}_2} = 32$, $M_{\text{N}_2} = 28$).

Steps:

$$n(\text{O}_2) = \frac{1}{32} = 0.03125$$

$$n(\text{N}_2) = \frac{4}{28} = 0.142857$$

$$\text{Ratio } n(\text{O}_2) : n(\text{N}_2) = 0.03125 : 0.142857 = \boxed{7 : 32}$$

Answer: Option (c).

Similar practice: By weight 3:14 of O_2 , molecules ka ratio?

35. A gaseous mixture has mass ratio O:N = 1:4. Ratio of number of molecules is (2014 Main)

Same working as Q34 $\Rightarrow \boxed{7 : 32}$ (Option b).

36. 5 moles of AB_2 weigh 125×10^{-3} kg and 10 moles of A_2B_2 weigh 300×10^{-3} kg. Find M_A and M_B in kg mol^{-1} (2019, 12 Apr I)

Explanation: Do compounds ke molar mass se linear equations banenge.

Approach: $M(\text{AB}_2) = M_A + 2M_B$, $M(\text{A}_2\text{B}_2) = 2M_A + 2M_B$.

Steps:

$$M(\text{AB}_2) = \frac{0.125}{5} = 0.025 \Rightarrow M_A + 2M_B = 0.025$$

$$M(\text{A}_2\text{B}_2) = \frac{0.300}{10} = 0.030 \Rightarrow 2M_A + 2M_B = 0.030$$

Subtract:

$$M_B = 0.025 - 0.015 = 0.010$$

$$\therefore M_A = 0.015 - 0.010 = 0.005$$

Answer: $\boxed{M_A = 5 \times 10^{-3}, M_B = 10 \times 10^{-3} \text{ kg mol}^{-1}}$ (Option d).

Similar practice: If $M(\text{AB}) = 0.035$ and $M(\text{A}_2\text{B}) = 0.060$, find M_A, M_B .

37. The weight of 1×10^{22} molecules of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is (1991)

Explanation: Pehle molar mass, phir per-molecule mass = $\frac{M}{N_A}$.

Approach: $M = 63.5 + 32 + 4 \times 16 + 5 \times 18 = 249.5 \text{ g mol}^{-1}$.

Steps:

$$\begin{aligned} m(10^{22} \text{ molecules}) &= \frac{10^{22}}{N_A} M = \frac{10^{22}}{6.022 \times 10^{23}} \times 249.5 \\ &= 4.14 \text{ g (approx)} \end{aligned}$$

Answer: $\boxed{\approx 4.14 \text{ g}}$.

Similar practice: 5×10^{21} molecules of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ ka weight?

38. Total number of electrons present in 18 mL of water is (1980)

Explanation: 18 mL water \Rightarrow 18 g \Rightarrow 1 mol H_2O .

Approach: 1 molecule H₂O me 10 electrons; isliye total = 10N_A.

Steps:

$$N_{e^-} = 10 \times N_A = \boxed{6.02 \times 10^{24}} \text{ electrons (approx)}$$

Similar practice: 9 g water me electrons kitne?

39. The modern atomic mass unit is based on the mass of (1980)

Answer with note: ^{12}C — 1 amu = $\frac{1}{12}$ of the mass of a ^{12}C atom.

40. 20% surface sites have adsorbed N₂. On heating, the desorbed N₂ at 0.001 atm and 298 K filled a 2.46 cm³ bulb. Site density = 6.023 × 10¹⁴ cm⁻² and surface area = 1000 cm². Find number of surface sites occupied per molecule of N₂. (2005)

Explanation: Pehle desorbed molecules = $\frac{PV}{RT}N_A$. Phir occupied sites = 0.2 × (site density) × (area).
Dono ka ratio de do.

Approach Steps:

$$n(\text{N}_2) = \frac{PV}{RT} = \frac{(0.001 \text{ atm})(2.46 \times 10^{-3} \text{ L})}{(0.082 \text{ L atm mol}^{-1}\text{K}^{-1})(298 \text{ K})} = 1.01 \times 10^{-7} \text{ mol}$$

$$N_{\text{N}_2} = nN_A \approx 1.01 \times 10^{-7} \times 6.022 \times 10^{23} = 6.07 \times 10^{16} \text{ molecules}$$

$$N_{\text{sites (occ)}} = 0.20 \times (6.023 \times 10^{14} \text{ cm}^{-2}) \times (1000 \text{ cm}^2) = 1.2046 \times 10^{17}$$

$$\text{Sites per molecule} = \frac{N_{\text{sites (occ)}}}{N_{\text{N}_2}} = \boxed{\approx 2}$$

Why ideal gas here? Desorbed gas at very low P behaves ideally; $PV = nRT$ gives n directly.

Similar practice: If 10% sites covered and $P = 0.002$ atm, $V = 1.00$ cm³ at 300 K, sites per N₂?

41. A plant virus is a uniform cylinder: diameter = 150 Å, length = 5000 Å. Specific volume = 0.75 cm³ g⁻¹. Treating virus as a single particle, find its molar mass. (1999)

Explanation: Per particle volume (cylinder) → per particle mass using specific volume; then $M = mN_A$.

Approach Steps:

$$r = \frac{150 \text{ Å}}{2} = 75 \text{ Å} = 7.5 \times 10^{-7} \text{ cm}, \quad h = 5000 \text{ Å} = 5.0 \times 10^{-5} \text{ cm}$$

$$V_{1 \text{ particle}} = \pi r^2 h = \pi (7.5 \times 10^{-7})^2 (5.0 \times 10^{-5}) = 8.83 \times 10^{-17} \text{ cm}^3$$

$$m_{1 \text{ particle}} = \frac{V}{\text{specific vol.}} = \frac{8.83 \times 10^{-17}}{0.75} = 1.18 \times 10^{-16} \text{ g}$$

$$M = mN_A = (1.18 \times 10^{-16})(6.022 \times 10^{23}) = \boxed{7.1 \times 10^7 \text{ g mol}^{-1}} \text{ (approx)}$$

Similar practice: If the cylinder length were 1.0×10^{-4} cm (same d), what would M be?

42. (JEE 2021) The number of atoms in 8 g of sodium is $x \times 10^{23}$. Find x (nearest integer). Given $N_A = 6.02 \times 10^{23}$, $M_{\text{Na}} = 23$.

Approach Steps:

$$n = \frac{8}{23} = 0.3478 \text{ mol}, \quad N = nN_A = 0.3478 \times 6.02 \times 10^{23} = 2.09 \times 10^{23}$$

$$x \approx \boxed{2}$$

Similar practice: 4.6 g Na me atoms = ? × 10²³.

43. (JEE 2022) Haemoglobin contains 0.34% Fe by mass. In 3.3 g Hb, Fe atoms =? (A.W. Fe=56; $N_A = 6.022 \times 10^{23}$).

Approach Steps:

$$m_{\text{Fe}} = 0.0034 \times 3.3 = 0.01122 \text{ g}$$

$$n_{\text{Fe}} = \frac{0.01122}{56} = 2.00 \times 10^{-4} \text{ mol}$$

$$N_{\text{Fe}} = nN_A = 2.00 \times 10^{-4} \times 6.022 \times 10^{23} = \boxed{1.21 \times 10^{20}} \text{ atoms}$$

Why percent-by-mass? Given composition directly converts sample mass \rightarrow solute mass.

44. (JEE 2022) In 681 g of $\text{C}_6\text{H}_9\text{N}_3\text{O}_6$, number of N atoms is $x \times 10^{21}$. Find integer x ($N_A = 6.02 \times 10^{23}$).

Approach Steps:

$$M = 6 \times 12 + 9 \times 1 + 3 \times 14 + 6 \times 16 = 219 \text{ g mol}^{-1}$$

$$n = \frac{681}{219} = 3.00 \text{ mol} \quad [\text{exact}]$$

$$\text{N atoms/molecule} = 3 \Rightarrow N_{\text{total}} = 9N_A = 5.418 \times 10^{24} = x \times 10^{21}$$

$$x = \boxed{5418}$$

Similar practice: 73 g of $\text{C}_2\text{H}_5\text{NO}_2$ me N atoms ko $y \times 10^{22}$ form me likhiye.

45. (JEE 2023) Match List-I with List-II and choose the correct option.

List-I	List-II
A. 16 g of $\text{CH}_4(\text{g})$	II. 60.2×10^{23} electrons
B. 1 g of $\text{H}_2(\text{g})$	IV. Occupies 11.2 L at STP
C. 1 mole of $\text{N}_2(\text{g})$	I. Weighs 28 g
D. 0.5 mol of $\text{SO}_2(\text{g})$	III. Weighs 32 g

Explanation: 16 g CH_4 is 1 mol $\Rightarrow 10N_A$ electrons; 1 g H_2 is 0.5 mol $\Rightarrow 11.2$ L at STP; 1 mol N_2 weighs 28 g; 0.5 mol SO_2 weighs 32 g.

Answer mapping: $\boxed{A \rightarrow \text{II}, B \rightarrow \text{IV}, C \rightarrow \text{I}, D \rightarrow \text{III}}$.

46. (JEE 2023) The number of molecules and moles in 2.8375 L of O_2 at STP are respectively:

Note: JEE STP uses 22.7 L mol^{-1} .

Steps:

$$n = \frac{2.8375}{22.7} = \boxed{0.125 \text{ mol}}$$

$$N = nN_A = 0.125 \times 6.022 \times 10^{23} = \boxed{7.527 \times 10^{22} \text{ molecules}}$$

Correct pair: 7.527×10^{22} and 0.125 mol.

46*. 2.8×10^{-3} mol of CO_2 is left after removing 10^{21} molecules from its x mg sample. Find the initial mass of CO_2 . ($N_A = 6.02 \times 10^{23}$)

Approach: $n_{\text{initial}} = n_{\text{left}} + \frac{10^{21}}{N_A}$; mass = nM with $M(\text{CO}_2) = 44 \text{ g mol}^{-1}$.

Steps:

$$n_{\text{rem}} = \frac{10^{21}}{6.02 \times 10^{23}} = 1.661 \times 10^{-3} \text{ mol}$$

$$n_{\text{initial}} = 2.8 \times 10^{-3} + 1.661 \times 10^{-3} = 4.461 \times 10^{-3} \text{ mol}$$

$$m_{\text{initial}} = 4.461 \times 10^{-3} \times 44 = 0.1963 \text{ g} = \boxed{196.2 \text{ mg}}$$

Answer: Option (3).

47. (JEE 2024) A silver coating of thickness 0.05 cm is deposited on a plate of area 0.05 m². Number of Ag atoms deposited = ? × 10²³. (At. mass Ag=108, density $d = 7.9 \text{ g cm}^{-3}$)

Explanation: Mass = ρV ; $V = \text{area} \times \text{thickness}$. Convert units to cm³.

Steps:

$$A = 0.05 \text{ m}^2 = 0.05 \times 10^4 = 500 \text{ cm}^2, \quad t = 0.05 \text{ cm}$$

$$V = At = 500 \times 0.05 = 25 \text{ cm}^3$$

$$m = \rho V = 7.9 \times 25 = 197.5 \text{ g}$$

$$n = \frac{197.5}{108} = 1.8287 \text{ mol}$$

$$N = nN_A = 1.8287 \times 6.022 \times 10^{23} = \boxed{1.10 \times 10^{24}}$$

$$\Rightarrow \text{Required number} = \boxed{11.0 \text{ (in units of } \times 10^{23}\text{)}}$$

Similar practice: If thickness were 0.025 cm on same plate, atoms deposited = ? × 10²³.
