Mole Concept-3

Some Basic Concepts of Chemistry-3

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48. The weight of 2.01×10^{23} molecules of CO is — [AIEEE 2002]

Explanation (simple words): Pehle molecules → moles, fir moles → mass using molar mass of CO.

Approach: $n = \dfrac{N}{N_A}$ and $m = nM$. Here $M(\text{CO}) = 12 + 16 = 28\,\text{g mol}^{-1}$.

Steps:

$$n = \frac{2.01 \times 10^{23}}{6.022 \times 10^{23}} = 0.3337\,\text{mol}$$

$$m = nM = 0.3337 \times 28 = 9.35\,\text{g} \approx \boxed{9.3\,\text{g}}$$

Why this formula? Avogadro's relation converts number of particles to moles; mass = nM.

Similar practice (with answer): 3.01×10^{23} molecules of CO_2 ka mass? → 0.5 mol $\times 44 = \boxed{22\,\text{g}}$.

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49. If $\frac{1}{6}$ (in place of $\frac{1}{12}$) of the mass of a ^{12}C atom is taken as the atomic mass unit, the mass of one mole of a substance will — [AIEEE 2005]

Explanation: Unit badalne se *numerical* atomic/molecular masses scale ho jaate hain, par 1 mole ka actual mass (grams me) us substance ke N_A particles ka real mass hai — woh nahi badalta.

Approach: New unit = 2 old u. Relative masses ↓ to half, but the defined mole keeps the same number of entities, so gram-molar mass remains same.

Answer: $\boxed{\text{Remain unchanged}}$.

Similar practice (with answer): Agar unit = $\frac{1}{24}$ of ^{12}C ho jaye, to one mole water ka mass? → $\boxed{18g(unchanged)}$.

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50. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$, will contain 0.25 mol of oxygen atoms? [AIEEE 2006]

Explanation: Har formula unit me O atoms gin lo, fir required compound ke moles nikaalo.

Approach: PO_4 me 4 O; $Mg_3(PO_4)_2$ me $2 \times 4 = 8$ O atoms per formula unit. $n_{\text{comp}} = \dfrac{n_{\text{O atoms}}}{8}$.

Steps:

$$n\big(Mg_3(PO_4)_2\big) = \frac{0.25}{8} = 0.03125 = \boxed{3.125 \times 10^{-2}\,\text{mol}}$$

Similar practice (with answer): 0.40 mol O atoms ko $Al_2(SO_4)_3$ se laane ke liye compound ke moles? (per FU = 12 O) → $0.40/12 = \boxed{3.33 \times 10^{-2}\,\text{mol}}$.

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51. The ratio of number of oxygen atoms in 16.0 g O_3, 28.0 g CO and 16.0 g O_2 is — [AIEEE 2012 (Online)]

Explanation: Each sample ka O-atom moles nikaal kar ratio lo.

Approach: $n(O_3) = 16/48 = 1/3$ mol molecules ⇒ O atoms $= 3 \times \frac{1}{3} = 1$ mol. CO : $28/28 = 1$ mol (1 O atom each) ⇒ 1 mol atoms. O_2 : $16/32 = 1/2$ mol molecules ⇒ $2 \times \frac{1}{2} = 1$ mol atoms.

Answer: $\boxed{1:1:1}$.

Similar practice (with answer): 32 g O_3, 44 g CO_2, 16 g O_2 me O atoms ka ratio? → O_3 : 2 mol O; CO_2 : 2 mol O; O_2 : 1 mol O ⇒ $\boxed{2:2:1}$.

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52. The percentage composition of carbon *by mole (of atoms)* in methane is — [JEE(Main) 2019 (Apr)]

Explanation: CH_4 me total atoms $= 1 + 4 = 5$. Carbon atoms = 1.

Approach: Mole (atom)
Steps:

$$\%\,(\text{mol})\,\text{C} = \frac{1}{5} \times 100 = \boxed{20\%}$$

Similar practice (with answer): C_2H_6 me C ka mole

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53. 8 g of oxygen at NTP contain — [IJSO Stage-I/2012]
Approach Steps:

$$n(O_2) = \frac{8}{32} = 0.25\,\text{mol}, \quad N = nN_A = 0.25 \times 6.022 \times 10^{23} = \boxed{1.51 \times 10^{23}\,\text{molecules}}$$

Similar practice (with answer): 16 g O_2 me molecules = $\boxed{3.01 \times 10^{23}}$.

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54. How many H atoms are in 3.4 g of $C_{12}H_{22}O_{11}$? [IJSO Stage-II/2013]
Explanation: Sucrose ka $M = 342$; har molecule me 22 H.
Approach: $n = \dfrac{m}{M}$, molecules $= nN_A$, H atoms $= 22\times$ molecules.
Steps:

$$n = \frac{3.4}{342} = 9.94 \times 10^{-3}\,\text{mol}$$
$$N_{\text{molecules}} = 9.94 \times 10^{-3} \times N_A = 5.99 \times 10^{21}$$
$$N_{\text{H atoms}} = 22 \times 5.99 \times 10^{21} = \boxed{1.32 \times 10^{23}}$$

Similar practice (with answer): 6.84 g $C_{12}H_{22}O_{11}$ me H atoms = $\boxed{2.66 \times 10^{23}}$.

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55. The mass of 0.2 mole of oxygen molecule is — [IJSO Stage-II/2013]
Approach Steps:

$$m = nM = 0.2 \times 32 = \boxed{6.4\,\text{g}}$$

Similar practice (with answer): 0.1 mol O_2 ka mass = $\boxed{3.2\,\text{g}}$.

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56. 8 grams of oxygen at NTP contain — [IJSO Stage-I/2012–13]
Same as Q53: $\boxed{1.51 \times 10^{23}\,\text{molecules}}$.
Similar practice (with answer): 5.6 L O_2 at STP me molecules = 0.25 mol $\Rightarrow$ $\boxed{1.51 \times 10^{23}}$.

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57. Which of the following contains the same number of atoms as 13.5 g of aluminium? [IJSO Stage-I/2014–15]
Explanation: 13.5 g Al $\Rightarrow$ 13.5/27 = 0.5 mol atoms. Jisme 0.5 mol atoms ho, wahi correct.
Check: 20 g Ca $\to$ 20/40 = 0.5 mol (match); 10 g Mg $\to$ 10/24 $\approx$ 0.417; 20 g K $\to$ 20/39 $\approx$ 0.513; 10 g Na $\to$ 10/23 $\approx$ 0.435.
Answer: $\boxed{20\,\text{g of Ca}}$.
Similar practice (with answer): 6.02 g C me jitne atoms, utne atoms kis me? $\to$ 6.02 g C = 0.5 mol atoms; answer: $\boxed{12.0\,\text{g of Mg}}$.

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58. How many molecules of water of crystallisation are present in 252 mg of oxalic acid ($H_2C_2O_4 \cdot {}_2H_2O$)? [IJSO Stage-II/2014]
Explanation: Pehle compound ke molecules, har molecule me 2 water molecules.

Approach Steps:

$$M\,(H_2C_2O_4\cdot{}_2H_2O) = 90+36 = 126\,\text{g mol}^{-1}$$
$$n = \frac{0.252}{126} = 2.00\times10^{-3}\,\text{mol}$$
$$N_{\text{FU}} = 2.00\times10^{-3}\,N_A = 1.204\times10^{21}$$
$$N_{\text{water}} = 2\times1.204\times10^{21} = \boxed{2.41\times10^{21}}\ \text{molecules}$$

Similar practice (with answer): 0.630 g $CuSO_4\cdot{}_5H_2O$ me water molecules $= 5\times\frac{0.630}{249.5}N_A = \boxed{7.60\times10^{21}}$.

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59. A batch has +0.5% weight error in each tablet: Aspirin ($C_9H_8O_4$) 250 mg; Paracetamol ($C_8H_9NO_2$) 500 mg. Extra molecules per tablet are x and y. Choose the best relation between x and y. [IJSO Stage-I/2015]

Explanation: Extra molecules $\propto$ (extra mass)/(molar mass). Dono me percentage error same hai.

Approach Steps:

$$\Delta m_{\text{asp}} = 0.005\times250\,\text{mg} = 1.25\,\text{mg} = 1.25\times10^{-3}\,\text{g}$$
$$M_{\text{asp}} = 9\times12+8\times1+4\times16 = 180\,\text{g mol}^{-1}$$
$$x = \frac{\Delta m_{\text{asp}}}{M_{\text{asp}}}N_A = \frac{1.25\times10^{-3}}{180}N_A = \boxed{4.18\times10^{18}}$$
$$\Delta m_{\text{para}} = 0.005\times500\,\text{mg} = 2.50\,\text{mg} = 2.50\times10^{-3}\,\text{g}$$
$$M_{\text{para}} = 8\times12+9\times1+14+2\times16 = 151\,\text{g mol}^{-1}$$
$$y = \frac{2.50\times10^{-3}}{151}N_A = \boxed{9.97\times10^{18}}$$
$$\Rightarrow\ y\approx2.4\,x\ \Rightarrow\ \boxed{y>x}$$

Similar practice (with answer): Same error with 200 mg drug (M=200): extra molecules $= 0.005\times\frac{200\times10^{-3}}{200}N_A = \boxed{3.01\times10^{18}}$.

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60. Four 1-L flasks at same T, P contain N_2, Ne, N_2O and SO_3. Ratio of total atoms in the flasks is —

Explanation: Equal $T, P, V \Rightarrow$ equal #molecules. Multiply by atoms per molecule.

Approach: Atoms per molecule: N_2 (2), Ne(1), N_2O (3), SO_3 (4). Ratio $= 2:1:3:4$.

Answer: $\boxed{2:1:3:4}$.

Similar practice (with answer): 1-L flasks of O_2, CO_2, NH_3 at same T, P: atom ratio $= 2:3:4 \Rightarrow \boxed{2:3:4}$.

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61. 4.4 g CO_2 and 2.24 L H_2 at STP are mixed. Total molecules present?

Approach Steps:

$$N_{CO_2} = \left(\frac{4.4}{44}\right)N_A = 0.1N_A = 6.022\times10^{22}$$
$$N_{H_2} = \left(\frac{2.24}{22.4}\right)N_A = 0.1N_A = 6.022\times10^{22}$$
$$N_{\text{total}} = 1.2044\times10^{23} = \boxed{1.204\times10^{23}\,\text{molecules}}$$

Similar practice (with answer): 22 g CO_2 + 11.2 L O_2 at STP $\Rightarrow 0.5N_A+0.5N_A = \boxed{6.022\times10^{23}}$ molecules.

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62. How many atoms are contained in 1 mole of $Ca(OH)_2$?

Explanation: Per formula unit atoms $= 1\,(\text{Ca})+2\,(\text{O})+2\,(\text{H}) = 5$.

Answer: $\boxed{5N_A = 5 \times 6.022 \times 10^{23}\,\text{atoms}}$.
Similar practice (with answer): 1 mol $Al_2(SO_4)_3$ me atoms $= 2 + 3 \times (1 + 4) = 2 + 15 = 17$ per FU $\Rightarrow \boxed{17N_A}$.

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63. Number of moles present in $1\,\text{m}^3$ of a gas at NTP are —
Approach Steps: $V_{\text{molar}}\,(\text{NTP}) = 22.4$ L. $1\,\text{m}^3 = 1000$ L.

$$n = \frac{1000}{22.4} = \boxed{44.6\,\text{mol}}$$

Similar practice (with answer): $2\,\text{m}^3$ gas at STP me moles $= \boxed{89.3}$.

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64. 5.6 L of oxygen at STP contains —
Approach Steps:

$$n(O_2) = \frac{5.6}{22.4} = 0.25\,\text{mol} \Rightarrow N_{\text{atoms}} = 2 \times 0.25N_A = \boxed{3.01 \times 10^{23}\,\text{atoms}}$$

Similar practice (with answer): 11.2 L O_2 at STP me O atoms $= \boxed{6.02 \times 10^{23}}$.

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65. The volume of a gas in discharge tube is 1.12×10^{-7} mL at STP. Number of molecules?
Approach Steps:

$$V = 1.12 \times 10^{-7}\,\text{mL} = 1.12 \times 10^{-10}\,\text{L}$$
$$n = \frac{V}{22.4} = 5.00 \times 10^{-12}\,\text{mol}$$
$$N = nN_A = 5.00 \times 10^{-12} \times 6.022 \times 10^{23} = \boxed{3.01 \times 10^{12}\,\text{molecules}}$$

Similar practice (with answer): 2.24×10^{-7} mL gas at STP $\Rightarrow N = \boxed{6.02 \times 10^{12}}$ molecules.

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66. The number of sodium atoms in 2 moles of sodium ferrocyanide $\left(Na_4[Fe(CN)_6]\right)$ is —
Explanation: Per formula unit: 4 Na atoms. 2 mol formula units $\Rightarrow$ 8 mol Na atoms.
Steps:

$$N_{\text{Na}} = 8\,N_A = 8 \times 6.022 \times 10^{23} = \boxed{4.82 \times 10^{24}\,\text{atoms}}$$
(also written as $\boxed{48 \times 10^{23}}$)

Similar practice (with answer): 0.5 mol $K_3[Fe(CN)_6]$ me K atoms $= 3 \times 0.5\,N_A = \boxed{1.5N_A}$.
