Some Basic Concepts of Chemistry

CHAPTER 1

NCERT FOCUS

ANSWERS

TOPIC 1

1. Mass of air at sea level = 1034 g cm^{-2}
Acceleration due to gravity, g = 9.8 m s^{-2}
Pressure of air

$$= 1034\ g\ cm^{-2} \times 9.8\ m\ s^{-2} \times \frac{1\ kg}{1000\ g} \times \frac{(100)^2 cm^2}{1\ m^2} \times \frac{1\ N}{kg\ m/s^2} \times \frac{1\ Pa}{1\ N/m^2} = 1.01332 \times 10^5\ Pa$$

2. The S.I. unit of mass is kilogram. The amount of matter present in a substance is called mass. The unit of mass *i.e.*, kilogram is defined as being equal to the mass of international prototype of the kilogram.

3. (i) micro → 10^{-6}
(ii) deca → 10
(iii) mega → 10^6
(iv) giga → 10^9
(v) femto → 10^{-15}

4. The total number of digits in a number with the last digit that shows the uncertainty of the result is known as significant figure, *e.g.*, 2.005 has four significant figures.

5. (i) 4.8×10^{-3}
(ii) 2.34×10^5
(iii) 8.008×10^3
(iv) 5.00×10^2
(v) 6.0012×10^0 or 6.0012

6. (i) 2
(ii) 3
(iii) 4
(iv) 3
(v) 4
(vi) 5

7. (i) 34.2
(ii) 10.4
(iii) 0.0460
(iv) 2.81×10^3

8. (a) **Law of multiple proportions :** This law was proposed by Dalton in 1803. It states, "If two elements can combine to form more than one compound the masses of one element that combine with a fixed mass of the other element are in the ratio of small whole numbers".
Fixing the mass of dinitrogen as 28 g, masses of dioxygen combined will be 32, 64, 32 and 80 g in the given four oxides. These are in the ratio of 2 : 4 : 2 : 5 which is a simple whole number ratio. Hence, the given data obeys the law of multiple proportions.
(b) (i) 10^6 mm, 10^{15} pm
(ii) 10^{-6} kg, 10^6 ng
(iii) 10^{-3} L, 10^{-3} dm^3

9. Speed of light = 3.0×10^8 m s^{-1}
Distance covered by light in 2.00 ns
$= 3.0 \times 10^8 \times 2 \times 10^{-9} = 6.00 \times 10^{-1}$ m = 0.600 m

10. (i) 28.7×10^{-12} m or 2.87×10^{-11} m
(ii) 15.15×10^{-12} m or 1.515×10^{-11} m
(iii) 25365 mg = 25365×10^{-6} kg [$\because$ 1 mg = 10^{-6} kg]
$= 2.5365 \times 10^{-2}$ kg

11. (i) The least precise term has 3 significant figures

$$= \frac{0.02856 \times 298.15 \times 0.112}{0.5785}$$

$$= \frac{0.9536983}{0.5785} = 1.6485711$$

Correct answer = 1.64
(ii) The second term has 4 significant figures
$5 \times 5.364 = 26.82$
(iii) The least number of decimal places in the term has 4 significant figures so,
$0.0125 + 0.7864 + 0.0215 = 0.8204$

TOPIC 2

1. (i) The molecular mass of H_2O = 1 × 2 + 16 = 18 amu or 18 u
(ii) The molecular mass of CO_2 = 12 + 2 × 16 = 12 + 32 = 44 amu or 44 u
(iii) The molecular mass of CH_4 = 12 + 1 × 4 = 12 + 4 = 16 amu or 16 u

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2. The molar mass of $CuSO_4$

= 63.5 + 32 + 4 × 16 = 63.5 + 32 + 64 = 159.5 amu or u

159.5 g of $CuSO_4$ contains copper = 63.5 g

100 g of $CuSO_4$ contains copper $\frac{63.5}{159.5}\times100$ = 39.81 g

3. The atomic mass (average) of chlorine

$=\frac{75.77\times34.9689+24.23\times36.9659}{75.77+24.23}$

$=\frac{2649.59+895.68}{100}=\frac{3545.27}{100}=35.45$ u

4. (i) 1 mole of C_2H_6 contains 2 moles of carbon atoms.

Number of moles of carbon atoms in 3 moles of C_2H_6 = 3 × 2 = 6

(ii) 1 mole of C_2H_6 contains 6 moles of hydrogen atoms.

Number of moles of hydrogen atoms in 3 moles of C_2H_6 = 3 × 6 = 18

(iii) 1 mole of C_2H_6 = 6.022 × 10^{23} molecules

Number of molecules in 3 moles of C_2H_6

= 3 × 6.022 × 10^{23} = 1.807 × 10^{24} molecules

5. **(iii) :** (i) No. of atoms in 1 g of Au

$=\frac{1}{197}\times6.022\times10^{23}$ = 3.057 × 10^{21} atoms

(ii) No. of atoms in 1 g of Na

$=\frac{1}{23}\times6.022\times10^{23}$ = 2.618 × 10^{22} atoms

(iii) No. of atoms in 1 g of Li $=\frac{1}{7}\times6.022\times10^{23}$

= 8.604 × 10^{22} atoms

(iv) No. of atoms in 1 g of Cl_2

$=\frac{1}{71}\times2\times6.022\times10^{23}$ = 1.696 × 10^{22} atoms

Thus, 1 g of Li has largest number of atoms.

6. 1 mol of ^{12}C = 6.022 × 10^{23} atoms = 12 g

Thus, 6.022 × 10^{23} atoms of ^{12}C = 12 g

Mass of one atom of $^{12}C=\frac{12}{6.022\times10^{23}}$

= 1.992 × 10^{-23} g

7. Molar mass of naturally occurring argon isotope

$$=\frac{35.96755\times0.337+37.96272\times0.063+39.9624\times99.600}{0.337+0.063+99.600}$$

$=\frac{12.12+2.39+3980.255}{100}=\frac{3994.765}{100}$

= 39.94 g mol^{-1}

8. (i) 1 mole of Ar contains 6.022 × 10^{23} atoms

52 moles of Ar contains 52 × 6.022 × 10^{23}

= 3.13 × 10^{25} atoms

(ii) 4 u of He = 1 atom

52 u of He $=\frac{1}{4}\times52$ = 13 atoms

(iii) 4 g of He contains 6.022 × 10^{23} atoms

52 g of He contains $\frac{6.022\times10^{23}}{4}\times52$ = 7.83 × 10^{24} atoms

TOPIC 3

1. The molecular mass of sodium sulphate (Na_2SO_4)

= 2 × 23 + 32 + 4 × 16 = 46 + 32 + 64 = 142 amu or 142 u

Mass % of sodium = $\frac{2\times23}{142}\times100=\frac{46}{142}\times100$ = 32.39 %

Mass % of sulphur = $\frac{32}{142}\times100=22.53$ %

Mass % of oxygen = $\frac{4\times16}{142}\times100=45.07$ %

2. Molar mass of sodium acetate = 82.0245 g mol^{-1}

Mass of CH_3COONa required to make 500 mL of 0.375 M solution

$=\frac{0.375\times82.0245\times500}{1000}=15.38$ g

3.

Element	Atomic mass	%	Mole of atom	Mole ratio	Simplest whole no. ratio
Fe	56	69.9	$\frac{69.9}{56}$ = 1.25	$\frac{1.25}{1.25}=1$	2
O	16	30.1	$\frac{30.1}{16}$ = 1.88	$\frac{1.88}{1.25}=1.5$	3

Hence, the empirical formula is Fe_2O_3.

4. (i) $\underset{\substack{1\text{ mole}\\(12\text{ g})}}{C} + \underset{\substack{1\text{ mole}\\(32\text{ g})}}{O_2} \longrightarrow \underset{\substack{1\text{ mole}\\(44\text{ g})}}{CO_2}$

Hence, 1 mole of C produces 44 g of CO_2.

(ii) $\underset{12\text{ g}}{C} + \underset{32\text{ g}}{O_2} \longrightarrow \underset{44\text{ g}}{CO_2}$

Here, O_2 is the limiting reagent.

∵ 32 g of O_2 reacts with C to produce 44 g of CO_2.

∴ 16 g of O_2 reacts with C to produce

$\frac{44}{32}\times16$ = 22 g of CO_2

(iii) $\underset{24\text{ g}}{2C} + \underset{64\text{ g}}{2O_2} \longrightarrow \underset{88\text{ g}}{2CO_2}$

Here, O_2 is the limiting reagent.

$\because$ 64 g of O_2 reacts with C to produce 88 g of CO_2

$\because$ 16 g of O_2 reacts with C to produce $\frac{88}{64} \times 16 = 22$ g of CO_2.

5. 69 mass per cent of nitric acid means that 69 g of HNO_3 is present in 100 g of solution.

$\therefore$ Volume of solution = $\frac{\text{Mass}}{\text{Density}} = \frac{100\text{ g}}{1.41\text{g mL}^{-1}} = 70.92$ mL

Moles of $HNO_3 = \frac{69}{63} = 1.095$

Molarity $= \frac{\text{Moles of } HNO_3}{\text{Volume of soln. in mL}} \times 1000$

$= \frac{1.095}{70.92} \times 1000 = 15.44$ M

6. *For empirical formula, Refer Ans. 3*

Molecular mass of $Fe_2O_3 = 2 \times 56 + 3 \times 16$

$= 112 + 48 = 160$

Molecular formula = *n* (Empirical formula)

$\therefore \quad n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{160}{160} \Rightarrow n = 1$

$\therefore$ Molecular formula = $(Fe_2O_3) \times 1 = Fe_2O_3$

7. The molecular mass of sugar $(C_{12}H_{22}O_{11}) = 12 \times 12 + 1 \times 22 + 11 \times 16 = 144 + 22 + 176 = 342$

$\therefore$ Moles of sugar $= \frac{20}{342} = 0.058$

Volume of solution = 2 L

$\therefore$ Molarity $= \frac{\text{Moles of solute}}{\text{Volume of solution in litre}}$

$= \frac{0.058}{2} = 0.029$ mol L^{-1}

8. Moles of methanol present in 2.5 L of 0.25 M solution

$$\text{Molarity} = \frac{\text{Moles of } CH_3OH}{\text{Volume in litre}}$$

$$\Rightarrow \quad 0.25 = \frac{\text{Moles of } CH_3OH}{2.5}$$

$\therefore$ Moles of $CH_3OH = 2.5 \times 0.25 = 0.625$

$\therefore$ Mass of $CH_3OH = 0.625 \times 32 = 20$ g

[$\because$ Molecular mass of $CH_3OH = 12 + 1 \times 3 + 16 + 1 = 32$]

$\therefore$ 0.793×10^3 g of CH_3OH is present in 1000 mL

$\therefore$ 20 g of CH_3OH is present in

$= \frac{1000}{0.793 \times 10^3} \times 20 = 25.2$ mL

9. (i) 15 ppm means 15 parts in million (10^6) parts.

% by mass $= \frac{15}{10^6} \times 100 = 15 \times 10^{-4} = 1.5 \times 10^{-3}$ %

(ii) Molality of $CHCl_3 = \frac{1.5 \times 10^{-3}}{100} \times \frac{1000}{119.5}$

$= 0.125 \times 10^{-3} = 1.25 \times 10^{-4}$ m

[$\because$ Mass of $CHCl_3 = 12 + 1 + 35.5 \times 3 = 119.5$]

10. According to the equation, one mole of *A* reacts with one mole of *B* and one atom of *A* reacts with one molecule of *B*.

(i) *B* is limiting reagent because 200 molecules of *B* will react with 200 atoms of *A* and 100 atoms of *A* will be left in excess.

(ii) *A*

(iii) Both will react completely because it is stoichiometric mixture. No limiting reagent.

(iv) *B*

(v) *A*

11. The balanced chemical equation is $N_2 + 3H_2 \rightarrow 2NH_3$

Moles of $N_2 = \frac{2.00 \times 10^3}{28} = 71.43$

Moles of $H_2 = \frac{1.00 \times 10^3}{2} = 500$

1 mole of N_2 required 3 moles of H_2 from above equation.

$\therefore$ 71.43 mole of N_2 will require 3×71.43

$= 214.29$ mole of H_2

But moles of H_2 actually present = 500 moles

Thus, H_2 is in excess and will remain unreacted and N_2 is limiting reagent.

(i) 1 mole of N_2 reacts with H_2 to form NH_3 = 2 moles

71.43 moles of N_2 react with H_2 to form $NH_3 = \frac{2}{1} \times 71.43$

= 142.86 moles

Mass of NH_3 produced $= 142.86 \times 17 = 2428.6$ g

(ii) Yes.

(iii) Hydrogen will remain unreacted.

Moles of H_2 remaining unreacted

= 500 – 214.29 = 285.71 moles

Mass of H_2 left unreacted $= 285.71 \times 2 = 571.42$ g

12. 1 mol $Na_2CO_3 \equiv 2 \times 23 + 12 + 3 \times 16 = 106$ g mol^{-1}

0.50 mol $Na_2CO_3 \equiv 0.50 \times 106 = 53$ g

0.50 M Na_2CO_3 solution means that 0.50 moles or 53 g of Na_2CO_3 are dissolved in 1000 mL of solution.

13. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

2 volume + 1 volume $\rightarrow$ 2 volume

10 volume + 5 volume $\rightarrow$ 10 volume

Thus, 10 volumes of H_2O vapour will be produced.

14. $\chi_{C_2H_5OH} = \dfrac{n_{C_2H_5OH}}{n_{C_2H_5OH} + n_{H_2O}}$

= 0.040 (Given) .... (i)

The aim is to find number of moles of ethanol in 1 L of the solution which is nearly = 1 L of water (because solution is dilute)

Number of moles of water in 1 L of water

$= \dfrac{1000\text{ g}}{18\text{ g mol}^{-1}} = 55.55$ moles

Substituting $n_{H_2O} = 55.55$ in eqn (i), we get

$\dfrac{n_{C_2H_5OH}}{n_{C_2H_5OH} + 55.55} = 0.040$

or $0.96\, n_{C_2H_5OH} = 55.55 \times 0.040$

or $n_{C_2H_5OH} = 2.31$ mol

Hence, molarity of the solution = 2.31 M

15. Number of moles of $CO_2 = \dfrac{3.38}{44} = 0.0768$ mole

No. of moles of C = 0.0768 mole

No. of moles of $H_2O = \dfrac{0.690}{18} = 0.0383$ mole

No. of moles of H = 2 × 0.0383 = 0.0766 mole

(i) The ratio of moles of C to H is

0.0768 : 0.0766 or 1 : 1

Therefore, empirical formula = CH

(ii) 10.0 L of fuel gas at STP weighs 11.6 g

∴ 22.4 L of fuel gas at STP weighs $\dfrac{11.6 \times 22.4}{10} = 25.98$ g

Molar mass of gas = 25.98 ≈ 26 g mol^{-1}

(iii) $n = \dfrac{\text{Molar mass}}{\text{Empirical formula mass}} = \dfrac{26}{13} = 2$

Molecular formula = (Empirical formula)$_n$ = $(CH)_2 = C_2H_2$

16 $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

No. of moles of HCl given = $M_{HCl}V_{HCl}$

= 0.75 mole L^{-1} × 25 × 10^{-3} L

= 18.75 × 10^{-3} mole = 0.0188 mole

2 moles of HCl requires 1 mole of $CaCO_3$

0.0188 mole of HCl will require $= \dfrac{0.0188}{2}$

= 0.0094 mole of $CaCO_3$

Molar mass of $CaCO_3$ = 100 g/mole

Mass of $CaCO_3$ required = 100 × 0.0094 = 0.94 g

17. $\underset{\substack{4\text{ mole}\\ \text{or } 146\text{ g}}}{4HCl_{(aq)}} + \underset{\substack{1\text{ mole}\\ \text{or } 87\text{ g}}}{MnO_{2(s)}} \longrightarrow 2H_2O_{(l)} + MnCl_{2(aq)} + Cl_{2(g)}$

87 g of MnO_2 reacts with HCl = 146 g

5 g of MnO_2 reacts with HCl $= \dfrac{146 \times 5}{87} = 8.39 \approx 8.40$ g

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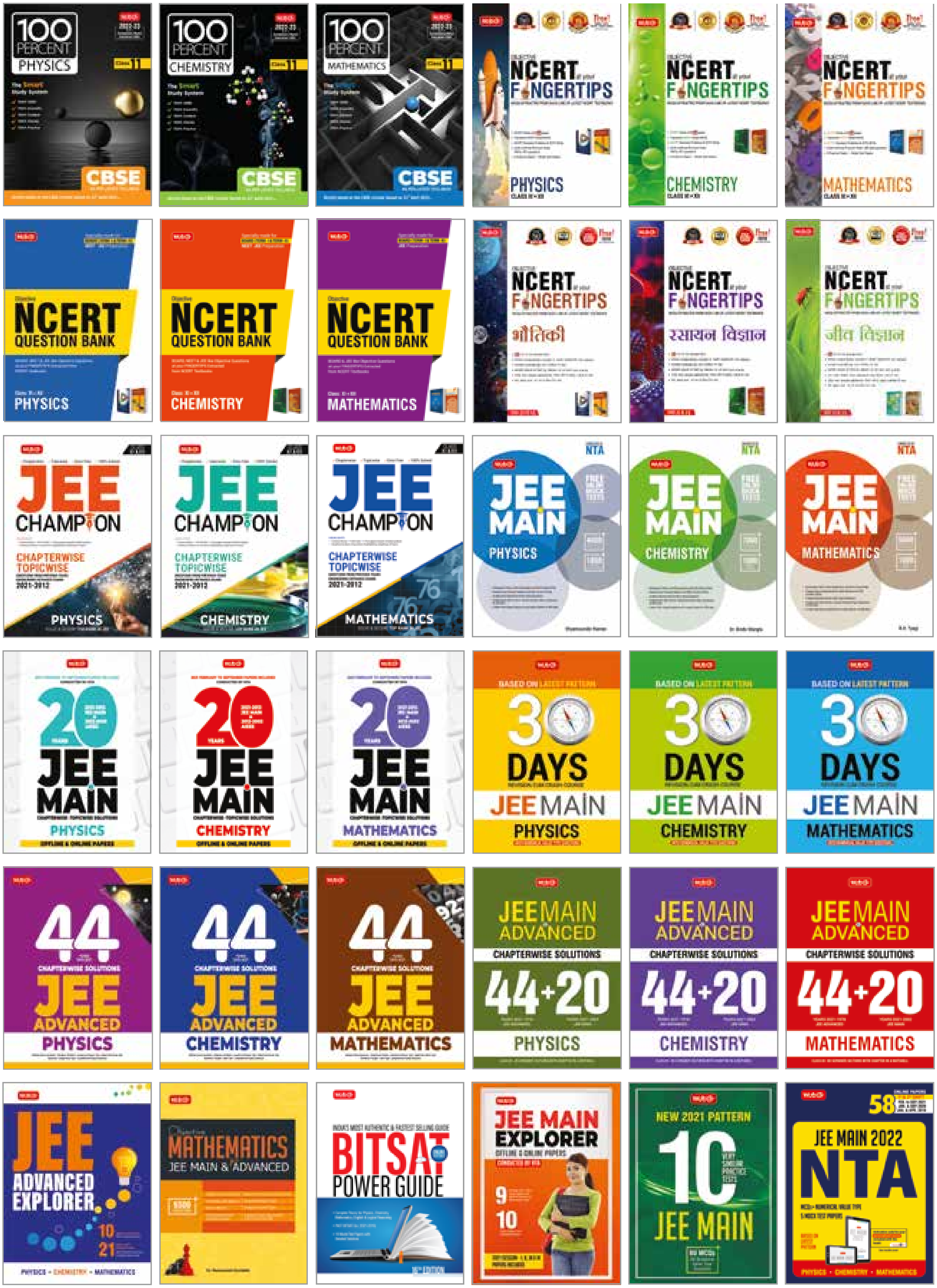

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