NCERT Textbook Exercises

Q. 1. Calculate the molecular mass of the following:
(*i*) H_2O (*ii*) CO_2 (*iii*) CH_4

Ans. (*i*) Molecular mass of H_2O
$= 2\,(1.008\text{ u}) + (16.00\text{ u}) = 18.016\text{ u}$

(*ii*) Molecular mass of CO_2
$= 1\,(12.01\text{ u}) + 2(16.00\text{ u}) = 44.01\text{ u}$

(*iii*) Molecular mass of CH_4
$= 1\,(12.01\text{ u}) + 4(1.008\text{ u}) = 16.042\text{u}$

Q. 2. Calculate the mass percent of different elements present in sodium sulphate (Na_2SO_4).

Ans. Molar mass of Na_2SO_4
$= 2 \times$ At. mass of Na + At. mass of S + $4 \times$ At. mass of O
$= 2 \times 23.0 + 32 + 4 \times 16 = 142$

$$\text{Mass \% of sodium} = \frac{2\times23}{142} \times 100 = 32.39\%$$

$$\text{Mass \% of sulphur} = \frac{32}{142} \times 100 = 22.53\%$$

$$\text{Mass \% of oxygen} = \frac{4\times16}{142} \times 100 = \mathbf{45.07\%}$$

Q. 3. Determine the empirical formula of an oxide of iron which has 69.9% iron and 30.1% dioxygen by mass. (Atomic masses : Fe = 55.85 amu, O = 16.00 amu).

Ans. *Refer Solved Example 63 (Page 53).*

Q. 4. Calculate the amount of carbon dioxide that would be produced when
(*i*) 1 mole of carbon is burnt in air
(*ii*) 1 mole of carbon is burnt in 16 g of dioxygen
(*iii*) 2 moles of carbon are burnt in 16 g of dioxygen

Ans. The balanced chemical equation of combustion of carbon in dioxygen (or air) is

$C(s)$	+	$O_2(g)$	$\longrightarrow$	$CO_2(g)$
1 mol		1 mol		1 mol

(*i*) In air, carbon will be completely burnt. 1 mol of carbon will give 1 mol of CO_2 or = 44g

(*ii*) Since only 16 g of dioxygen is available (0.5 mol), it will combine with only 0.5 mol of carbon. Dioxygen is the limiting reagent. Thus, 0.5 mol of carbon will be burnt to give 0.5 mol of CO_2 or = 22 g

(*iii*) In this case also, dioxygen is limiting reagent and only 0.5 mol of carbon will be burnt. It will produce 22 g of CO_2.

Q. 5. Calculate the mass of sodium acetate (CH_3COONa) required to make 500 mL of 0.375 molar aqueous solution. Molar mass of sodium acetate is 82.0245 g mol^{-1}.

Ans. 0.375 M aqueous solution means that 0.375 mol of sodium acetate are present in 1000 mL of solution. 500 mL of the solution should contain sodium acetate

$$= \frac{0.375}{2}\text{ mol}$$

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

$$\text{Mass of sodium acetate required} = \frac{0.375}{2} \times 82.0245$$
$$= \mathbf{15.38\text{ g}}$$

Alternatively, it may be solved as :

$$\text{Molarity} = \frac{\dfrac{\text{Mass of sodium acetate}}{\text{Molar mass}}}{\text{Volume}} \times 1000$$

$$0.375 = \frac{\dfrac{\text{Mass of sodium acetate}}{82.0245}}{500} \times 1000$$

$$\therefore \text{Mass of sodium acetate} = \frac{0.375\times82.0245\times500}{1000}$$
$$= \mathbf{15.38\text{ g}}$$

Q. 6. Calculate the concentration of nitric acid in moles per litre in a sample which has a density, 1.41 g mL^{-1} and the mass per cent of nitric acid in it being 69%.

Ans. *Refer Solved Example 101 (Page 69).*

Q. 7. How much copper can be obtained from 100 g of copper sulphate ($CuSO_4$) ? (Atomic mass of Cu = 63.5 amu).

Ans. 1 mol of $CuSO_4$ contains 1 mol (1 gram atom) of Cu

Molar mass of $CuSO_4 = 63.5 + 32 + 4 \times 16$

$= 159.5\ g$

$\therefore$ 159.5 g of $CuSO_4$ will give Cu = 63.5 g

$$100 \text{ g of } CuSO_4 \text{ will give Cu} = \frac{63.5}{159.5} \times 100$$

$$= \mathbf{39.81\ g}$$

Q. 8. Determine the molecular formula of an oxide of iron in which the mass per cent of iron and oxygen are 69.9 and 30.1 respectively. Given that the molecular mass of iron oxide is 159.8 and atomic masses : Fe = 55.85 amu and O = 16.00 amu.

Ans. Calculation of empirical formula = Fe_2O_3 (See Solved Example 65)

Empirical formula mass of Fe_2O_3

$= 2 \times 55.85 + 3 \times 16.00$

$= 111.7 + 48.00 = 159.7\ g\ mol^{-1}$

Molecular formula mass = 159.8 g mol^{-1}

$$n = \frac{\text{Molecular formula mass}}{\text{Empirical formula mass}}$$

$$= \frac{159.8}{159.7} = 1$$

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

Q. 9. Calculate the atomic mass (average) of chlorine using the following data :

	% Natural abundance	Molar mass
^{35}Cl	75.77	34.9689
^{37}Cl	24.23	36.9659

Ans. Average atomic mass of Cl

$$= \frac{75.77 \times 34.9689 + 24.23 \times 36.9659}{100}$$

$$= \mathbf{35.453}$$

Q. 10. In three moles of ethane (C_2H_6), calculate the following :

(*i*) Number of moles of carbon atoms

(*ii*) Number of moles of hydrogen atoms

(*iii*) Number of molecules of ethane

Ans. (*i*) 1 mole of C_2H_6 contains 2 moles of carbon

$\therefore$ Number of moles of carbon in 3 moles of $C_2H_6 = 6$

(*ii*) 1 mole of C_2H_6 contain 6 mole atoms of hydrogen

$\therefore$ Number of moles of hydrogen atoms in 3 moles of $C_2H_6 = 3 \times 6 = 18$

(*iii*) 1 mole of $C_2H_6 = 6.022 \times 10^{23}$ molecules

$\therefore$ Number of molecules in 3 moles of $C_2H_6 = 3 \times 6.022 \times 10^{23}$

$$= \mathbf{1.807 \times 10^{24}\ molecules}$$

Q. 11. What is the concentration of sugar ($C_{12}H_{22}O_{11}$) in mol L^{-1} if its 20g are dissolved in enough water to make a final volume upto 2 L ?

Ans. *Refer Solved Example 103 (Page 70).*

Q. 12. If the density of methanol is 0.793 kg L^{-1}, what is its volume needed for making 2.5 L of its 0.25 M solution ?

Ans. *Refer Solved Example 104 (Page 70).*

Q. 13. Pressure is defined as force per unit area of the surface. The SI unit of pressure, pascal is shown below :

$$\mathbf{1\ Pa = 1Nm^{-2}}$$

If mass of air at sea level is 1034 g cm^{-2}, calculate the pressure in pascal.

Ans. Pressure is force (i.e., weight) acting per unit area

But weight = mg

$\therefore$ Pressure = Weight per unit area

$$= \frac{1034\text{g}}{\text{cm}^2} \times 9.8\ \text{ms}^{-2}$$

$$= \frac{1034\,\text{g}}{\text{cm}^2} \times 9.8\ \text{ms}^{-2} \times \frac{1\,\text{kg}}{1000\,\text{g}}$$

$$\times \frac{100\,\text{cm} \times 100\,\text{cm}}{1\,\text{m} \times 1\,\text{m}} \times \frac{1\,\text{N}}{\text{kg m s}^{-2}} \times \frac{1\text{Pa}}{1\text{Nm}^{-2}}$$

$$= \mathbf{1.01332 \times 10^5\ Pa}$$

Q. 14. What is the SI unit of mass ? How is it defined?

Ans. The SI unit of mass is kilogram (kg). Kilogram is defined as the mass of platinum-iridium (Pt-Ir) block, stored at the International Bureau of Weights and Measures in France. Thus it is the mass of the international prototype of the kilogram.

Q. 15. Match the following prefixes with their multiples :

	Prefixes	Multiples
(*i*)	micro	10^6
(*ii*)	deca	10^9
(*iii*)	mega	10^{-6}
(*iv*)	giga	10^{-15}
(*v*)	femto	10

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

Q. 16. What do you mean by significant figures ?

Ans. The significant figures in a number are all the certain digits plus one doubtful digit. It depends upon the precision of the scale or instrument used for the measurement. For example, if volume of a liquid is reported to be 18.25 mL, the digits 1, 8 and 2 are certain while 5 is doubtful. So, it has four significant figures (three certain plus one doubtful).

Q. 17. A sample of drinking water was found to be severely contaminated with chloroform, $CHCl_3$, supposed to be carcinogenic in nature. The level of contamination was 15 ppm (by mass).

(*i*) Express this in per cent by mass.

(*ii*) Determine the molality of chloroform in the water sample.

Ans. (*i*) 15 ppm means that 15 parts of chloroform is present in 10^6 parts.

$$\therefore \quad \%\text{ by mass of } CHCl_3 = \frac{15}{10^6} \times 100 = 1.5 \times 10^{-3}\%$$

(*ii*) Molar mass of $CHCl_3 = 12 + 1 + 3 \times 35.5 = 119.5$

$$\text{Moles of } CHCl_3 = \frac{1.5\times10^{-3}\,g}{119.5\,g\ mol^{-1}}$$
$$= 1.255 \times 10^{-5}$$
$$\text{Mass of water} = 100\ g$$
$$\therefore \quad \text{Molality} = \frac{1.225\times10^{-5}}{100}\times1000$$
$$= \mathbf{1.255 \times 10^{-4}\ m}$$

Q. 18. Express the following in the scientific notation.
(*i*) 0.0048 (*ii*) 234,000 (*iii*) 8008
(*iv*) 500.0 (*v*) 6.0012

Ans. *Refer Solved Example 2 (Page 15).*

Q.19. How many significant figures are present in the following ?
(*i*) 0.0025 (*ii*) 208 (*iii*) 5005
(*iv*) 126,000 (*v*) 500.0 (*vi*) 2.0034

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

Q. 20. Round up the following upto three significant figures :
(*i*) 34.216 (*ii*) 10.4107 (*iii*) 0.04597 (*iv*) 2808

Ans. (*i*) 34.2 (*ii*) 10.4 (*iii*) 0.0460 (*iv*) 2810

Q. 21. The following data were obtained when dinitrogen and dioxygen react together to form different compounds :

	Mass of dinitrogen	Mass of dioxygen
(*i*)	14 g	16 g
(*ii*)	14 g	32 g
(*iii*)	28 g	32 g
(*iv*)	28 g	80 g

(*a*) Which law of chemical combination is obeyed by the above experimental data ? Give its statement.

(*b*) Fill in the blanks in the following conversions :
(*i*) 1 km = ... mm = ... pm
(*ii*) 1 mg = ... kg = ... ng
(*iii*) 1 mL = ... L = ... dm^3

Ans. **(*a*)** Fixing the mass of dinitrogen as 14 g, the masses of dioxygen combined will be

16 : 32 : 16 : 40
or 2 : 4 : 2 : 5

This is a simple whole number ratio and hence, the data illustrate the **law of multiple proportions**. The law of multiple proportions states that when two elements combine to form two or more than two compounds, then the mass of one of the elements which combine with a fixed mass of the other bear a simple whole number ratio.

(*b*) (*i*)

$$1\ km = 1\ km \times \frac{1000\,m}{1\,km}\times\frac{100\,cm}{1\,m}\times\frac{10\,mm}{1\,cm} = 10^6 mm$$

$$1\ km = 1\ km \times \frac{1000\,m}{1\,km}\times\frac{1\,pm}{10^{-12}\,m} = 10^{15}\ pm$$

Correct answer : 10^6, 10^{15}

(*ii*) $1\ mg = 1\ mg \times \frac{1\,g}{1000\,mg}\times\frac{1\,kg}{1000\,g} = 10^{-6}\ kg$

$$1\ mg = 1\ mg \times \frac{1\,g}{1000\,mg}\times\frac{1\,ng}{10^{-9}\,g} = 10^6\ ng$$

Correct answer : 10^{-6}, 10^6

(*iii*) $1\ mL = 1mL \times \frac{1L}{1000\,mL} = 10^{-3}\ L$

$$1\ mL = 1\ cm^3 \times \left(\frac{1\,dm}{10\,cm}\right)^3 = 10^{-3}\ dm^3$$

Correct answer : 10^{-3}, 10^{-3}

Q. 22. If the speed of light is $3.0 \times 10^8\ ms^{-1}$, calculate the distance covered by light in 2.00 ns.

Ans. Distance covered by light = Speed × Time

$$= 3.0 \times 10^8\ ms^{-1} \times 2.00\ ns \times \left(\frac{10^{-9}}{1ns}\right)$$
$$= 6.00 \times 10^{-1}\ m = \mathbf{0.600\ m}$$

Q. 23. In a reaction

$$\mathbf{A + B_2 \longrightarrow AB_2}$$

identify the limiting reagent if any in the following reaction mixtures :
(*i*) 300 atoms of A + 200 molecules of B
(*ii*) 2 mol of A + 3 mol of B
(*iii*) 100 atoms of A + 100 molecules of B
(*iv*) 5 mol of A + 2.5 mol of B
(*v*) 2.5 mol of A + 5 mol of B

Ans. *Refer Solved Example 88 (Page 65).*

Q. 24. Dinitrogen and dihydrogen react with each other to produce ammonia according to the following chemical equation :

$$\mathbf{N_2\,(g) + 3H_2\,(g) \longrightarrow 2NH_3\,(g)}$$

(*i*) Calculate the mass of ammonia produced if 2.00×10^3 g of dinitrogen reacts with 1.00×10^3g of dihydrogen.
(*ii*) Will any of the two reactants remain unreacted ?
(*iii*) If yes, which one and what would be its mass ?

Ans. *Refer Solved Example 92 (Page 66).*

Q. 25. How are 0.50 m Na_2CO_3 and 0.50 M Na_2CO_3 different ?

Ans. Molar mass of $Na_2CO_3 = 2 \times 23 + 12 + 3 \times 16$
$= 106\ g\ mol^{-1}$
Mass of 0.5 mol of $Na_2CO_3 = 106 \times 0.5 = 53$ g
0.50 m Na_2CO_3 solution means that 0.5 mol or 53 g of Na_2CO_3 are present in 1000 g of solvent.
0.50 M Na_2CO_3 solution means that 0.5 mol or 53 g of Na_2CO_3 are present in 1 L of the solution.

Q. 26. If ten volumes of dihydrogen gas react with five volumes of dioxygen gas, how many volumes of water would be produced ?

Ans. Dihydrogen (H_2) reacts with dioxygen (O_2) as

$$2\,H_2\,(g) + O_2\,(g) \longrightarrow 2H_2O\,(g)$$

2 volumes of dihydrogen react with 1 volume of O_2 to produce 2 volumes of water vapour. Thus,

10 volumes of dihydrogen will react completely with 5 volumes of dioxygen to produce 10 volumes of water.

10 volumes of water would be produced.

Q. 27. Convert the following into basic units :

(*i*) 28.7 pm (*ii*) 15.15 μs (*iii*) 25365 mg

Ans. (*i*) $28.7\text{ pm} = 28.7\text{ pm} \times \dfrac{10^{-12}\text{m}}{1\text{pm}} = 2.87 \times 10^{-11}\text{ m}$

(*ii*) $15.15\ \mu\text{s} = 15.15\ \mu\text{s} \times \dfrac{10^{-6}\text{s}}{1\mu\text{s}} = 1.515 \times 10^{-5}\text{ s}$

(*iii*) $25365\text{ mg} = 25365\text{ mg} \times \dfrac{1\text{g}}{1000\text{ mg}} \times \dfrac{1\text{kg}}{1000\text{ g}}$

$= 2.5365 \times 10^{-2}\text{ kg}$

Q. 28. Which one of the following will have largest number of atoms ?

(*i*) 1 g Au (*s*) (*ii*) 1g Na(*s*) (*iii*) 1g Li (*s*)

(*iv*) 1g of Cl_2 (*g*)

Ans. No. of atoms can be calculated as :

(*i*) $1\text{g Au} = \dfrac{1}{197} \times 6.022 \times 10^{23} = \dfrac{6.022}{197} \times 10^{23}$

(*ii*) $1\text{g Na} = \dfrac{6.022}{23} \times 10^{23}$

(*iii*) $1\text{g Li} = \dfrac{6.022 \times 10^{23}}{7}$

(*iv*) $1\text{g } Cl_2 = \dfrac{2 \times 6.022 \times 10^{23}}{71} = \dfrac{6.022 \times 10^{23}}{35.5}$

It is clear that 1 g Li contains largest number of atoms.

Q. 29. Calculate the molarity of a solution of ethanol in water in which the mole fraction of ethanol is 0.040.

Ans. Mole fraction of ethanol

$$x(C_2H_5OH) = \frac{n(C_2H_5OH)}{n(C_2H_5OH) + n(H_2O)}$$

To calculate molarity, we need to calculate moles of ethanol in 1 L of solution or nearly 1L of water because the solution is dilute.

$$\text{No. of moles of water in 1 L of water} = \frac{1000}{18}$$

$$= 55.55 \text{ mole}$$

$$\therefore \quad \frac{n(C_2H_5OH)}{n(C_2H_5OH) + 55.55} = 0.040$$

$$n\,(C_2H_5OH) = 0.04\,[n\,(C_2H_5OH)] + 2.222$$

or $$0.96\,n\,(C_2H_5OH) = 2.222$$

$$\therefore \quad n = \frac{2.222}{0.96} = 2.31$$

$\therefore$ 2.31 moles of ethanol are present in 1 L of solution and hence, molarity of the solution is **2.31 M**

Q. 30. What will be the mass of one ^{12}C atom in g ?

Ans. 1 mole of ^{12}C atoms $= 6.022 \times 10^{23}$ atoms $= 12$g

$\therefore\ 6.022 \times 10^{23}$ atoms of ^{12}C have mass $= 12$g

$$1 \text{ atom of } {}^{12}C \text{ will have mass} = \frac{12}{6.022 \times 10^{23}}$$

$$= 1.9927 \times 10^{-23}\text{ g}$$

Q. 31. How many significant figures should be present in the answer of the following calculations ?

(*i*) $\dfrac{0.02856 \times 298.15 \times 0.112}{0.5785}$

(*ii*) 5×5.364

(*iii*) 0.0125 + 0.7864 + 0.0215

Ans. *Refer Solved Example 8 (Page 17).*

Q. 32. Use the data given in the following table to calculate the molar mass of naturally occurring argon isotopes :

Isotope	Isotopic molar mass	Abundance
^{36}Ar	35.96755 g mol^{-1}	0.337%
^{38}Ar	37.96272 g mol^{-1}	0.063 %
^{40}Ar	39.9624 g mol^{-1}	99.600 %

Ans. *Refer Solved Example 26 (Page 36).*

Q. 33. Calculate the number of atoms in each of the following :

(*i*) 52 mol of Ar (*ii*) 52 u of He (*iii*) 52 g of He

Ans. *Refer Solved Example 41 (Page 42).*

Q. 34. A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g of carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 L (mesured at S.T.P.) of this welding gas is found to weigh 11.6 g. Calculate (*i*) empirical formula (*ii*) molar mass of the gas and (*iii*) molecular formula.

Ans. *Refer Solved Example 66 (Page 55).*

Q. 35. Calcium carbonate reacts with aqueous HCl to give $CaCl_2$ and CO_2 according to the reaction :

$$CaCO_3 + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

What mass of $CaCO_3$ is required to react completely with 25 mL of 0.75 M HCl?

Ans. Let us calculate mass of HCl in 25 mL of 0.75 M HCl

1000 mL of 0.75 M HCl contain HCl $= 0.75 \times 36.5$ g

$\therefore$ 25 mL of 0.75 M HCl will contain HCl

$$= \frac{0.75 \times 36.5}{1000} \times 25 = 0.684\text{ g}$$

$$\underset{100\text{g}}{CaCO_3} + \underset{2 \times 36.5\text{ g}}{2HCl} \longrightarrow CaCl_2 + CO_2 + H_2O$$

2×36.5 g of HCl react completely with $CaCO_3 = 100$ g

0.684 g of HCl will react completely with $CaCO_3$

$$= \frac{100}{2 \times 36.5} \times 0.684 = \mathbf{0.937\text{ g}}$$