Some Basic Concepts of Chemistry

CHAPTER 1

TRY YOURSELF ANSWERS

1. C is a compound because heat is absorbed in this process and properties of C are different than its constituents A and B.

2. Homogeneous mixtures : Kerosene oil, diesel oil, bronze and brass.

Heterogeneous mixtures : Paint, smoke, gun powder and butter.

3. (i) Gas
(ii) Gas
(iii) Solid

4. Suppose the temperature be x.

$$°F = \frac{9}{5}(°C) + 32$$

or, $x = \frac{9}{5} \times x + 32$

or, $x - \frac{9x}{5} = 32$ or, $\frac{5x - 9x}{5} = 32$

or, $-4x = 160$ or, $x = -40°$

5. (i) Ω^{-1} (ohm^{-1})
(ii) Hz (Hertz)
(iii) V (volt)
(iv) J (Joule)

6. (a) $2.00 \times 10^{-2} \times 10^{3}$ m + $4.2 \times 10^{2} \times 10^{-2}$ m
= (20.0 m) + (4.2 m) = 24.2 m
(b) $(1.5 \times 10^{1}$ cm$)(8.0 \times 10^{2}$ cm$)(0.0100 \times 10^{2}$ cm$)$
= 1.2×10^{4} cm^{3}

7. Mass of solid = 10.024 g – 0.03 g = 9.994 g

The 4 must be dropped from the difference since the mass of the weighing paper is known only to the second decimal place.

$\therefore$ Mass of solid = 9.99 g

$$\text{Density of solid} = \frac{\text{mass of solid}}{\text{volume of solid}} = \frac{9.99 \text{ g}}{1.23 \text{ cm}^3} = 8.12 \text{ g/cm}^3$$

8. (i) The answer calculated is 29.42, but the correctly reported answer will be 29.4 (to the same number of decimal places as that of the term with least number of decimal places).

(ii) The answer calculated is 130.8, but the last 8 is number is over 5, so the answer is rounded up to the next higher integer, *i.e.*, 131

9. $2KClO_3 \rightarrow 2KCl + 3O_2$ (Mass of $KClO_3$ = 4.85 g)

Total mass of products = (2.5 + 2.35)g = 4.85g

$\therefore$ Total mass of reactants = Total mass of products

Thus, it illustrates the law of conservation of mass.

10. $CaCO_3 \rightarrow CaO + CO_2$

Mass of reactant = Mass of product.

or $14 = 8.68 + x$ or, $x = 5.32$

$\therefore$ 5.32 g carbon dioxide was given out.

11. Method (i) : 1.43 g copper oxide contains 1.14 g copper

$\therefore$ 100 g copper oxide contains $= \frac{1.14}{1.43} \times 100 \simeq 80$ *g copper*

Method (ii) : 2.31 g copper oxide contains 1.85 g copper

$\therefore$ 100 g copper oxide contains $= \frac{1.85}{2.31} \times 100 = 80$ g copper

Method (iii) : 2.65 g copper oxide contains 2.12 g copper

$\therefore$ 100 g copper oxide contains $= \frac{2.12}{2.65} \times 100 = 80$ g copper

As the percentage of copper in copper oxide derived from all the three methods is same, hence, the above data illustrate the law of definite proportions.

12. In second case, 0.144 g weight is lost from CuO. This is due to reduction of CuO into Cu.

32 g oxygen = 22400 mL at STP

$$0.144 \text{ g oxygen} = \frac{22400 \times 0.144}{32} = 100.8 \text{ mL } O_2$$

It means ratio of H_2 and O_2 in water = 200 : 100.8 = 2 : 1

In first case,

Ratio is $H_2 : O_2$ = 10 : 5 = 2 : 1

Thus, law of constant composition is proved.

13. The percentage of oxygen and metal in both the oxides are given respectively.

First oxide	**Second oxide**
Oxygen = 27.6%	Oxygen = 30%
Metal = 72.4%	Metal = 70%

Formula of first oxide = M_3O_4

Let the atomic weight of metal = x

Percentage of metal in the compound M_3O_4 $\frac{3x}{3x + 64} \times 100$

$$\frac{3x}{3x + 64} \times 100 = 72.4$$

or $300x = 217.2x + 4633.6$

or $82.8x = 4633.6$ or $x = 55.96 \approx 56$

Now in the second oxide, metal and oxygen are 70% and 30%. Therefore, their atomic ratio will be

$$M : O$$
$$\frac{70}{56} : \frac{30}{16}$$
$$1.25 : 1.875$$

or $1 : 1.5$

or $2 : 3$

Therefore, formula of the second compound = M_2O_3.

14.

Compound *A*	Compound *B*	Compound *C*
59.68 g Cl	68.95 g Cl	74.75 g Cl
40.32 g *X*	31.05 g *X*	25.25 g *X*

For 1 g *X*, Cl needed in $A = \frac{40.32}{59.68} = 0.6756$ g *X*

For 1 g *X*, Cl needed in $B = \frac{31.05}{68.95} = 0.4503$ g *X*

For 1 g *X*, Cl needed in $C = \frac{25.25}{74.75} = 0.3378$ g *X*

The relative amounts of *X* in three cases are not affected if all three amount are divided by the smallest of them.

$$0.6756 : 0.4503 : 0.3378 = \frac{0.6756}{0.3378} : \frac{0.4503}{0.3378} : \frac{0.3378}{0.3378}$$
$$= 2 : 1.33 : 1$$

In whole number = 6 : 4 : 3

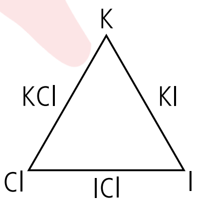
This illustrates law of multiple proportion.

15. In KCl : % of Potassium given = 52.0%

% of chlorine = (100 – 52) = 48%

In KI : % of Potassium given = 23.6%;

% of iodine = (100 – 23.6) = 76.4%



$\because$ In KI, 23.6 parts of potassium combine with 76.4 parts of iodine.

$\therefore$ 1 part of potassium combines with $= \frac{76.4}{23.6}$ parts of iodine = 3.237 parts of iodine

Now in KCl, 52.0 parts of potassium combine with 48 parts of chlorine.

$\therefore$ 1 part of potassium combines with $= \frac{48}{52}$ parts of chlorine = 0.92 part of chlorine

The proportion of masses of chlorine and iodine which combine with same mass of potassium = 0.92 : 3.237 = 1 : 3.5

In ICl : % of iodine = 78.2% and

% of chlorine = (100 – 78.2) = 21.8%

The ratio of chlorine and iodine in ICl = 21.8 : 78.2 = 1 : 3.5 Hence, the data illustrate the law of reciprocal proportions.

16. Gay Lussac's law of combining volume applies only to gases measured under the same temperature and pressure.

17. If any reactant or product is a liquid or solid, the volume occupied by them is extremely small as compared to the gas and hence, the law of Gay Lussac's is not obeyed.

18. According to Dalton's theory, atom is the fundamental particle of an element. Dalton considered atom to be indivisible and indestructible.

19. The postulate is "Matter is made up of atoms which can neither be created, nor destroyed *i.e.* atoms are indestructible".

20. This is because the atomic mass of an element is the average of relative masses of its various isotopes. While taking an average the result appears as a fraction.

21. Molecular mass of H_2SO_4

= 2 × Atomic mass of H + Atomics mass of S + 4 × Atomic mass of O

= 2 × 1 + 32 + 4 × 16 = 98 u

$\therefore$ Gram molecular mass of H_2SO_4 = 98 g

Mass of 1 gram molecule of H_2SO_4 = 98 g

$\therefore$ Mass of 5 gram molecule of H_2SO_4 = 5 × 98 g = 490 g

22. Average atomic mass of Fe

$$= \frac{5}{100} \times 54 + \frac{90}{100} \times 56 + \frac{5}{100} \times 57$$

= 2.7 + 50.4 + 2.85 = 55.95 u

23. For minimum molecular mass, insulin must have atleast one S atom in one molecule.

Atomic mass of S = 32 u

For 3.4 g S, molecular mass of insulin = 100

$\therefore$ For 32 g of S, molecular mass of insulin $= \frac{100 \times 32}{3.4}$ = 941.176

$\therefore$ Minimum molecular mass of insulin is 941.176 u

24. Molecular mass of $CaCO_3$ = 40 + 12 + 3 × 16 = 100 u

No. of moles of $CaCO_3 = \frac{150}{100} = 1.5$

1 mole of $CaCO_3$ contains 3 moles of oxygen

$\therefore$ 1.5 moles of $CaCO_3$ contain 3 × 1.5 = 4.5 moles of oxygen

No. of oxygen atoms = $4.5 \times 6.022 \times 10^{23} = 2.71 \times 10^{24}$

Mass of oxygen atoms = 4.5 × 16 = 72 g

25. Atomic mass of the element
= mass of 1 atom × Avogadro's constant
$= 6.644 \times 10^{-23} \times 6.022 \times 10^{23} = 40$ g
No. of g - atoms in 80 kg of x

$$= \frac{\text{Mass of } x}{\text{Atomic mass}} = \frac{80 \times 1000}{40} = 2000$$

26. Mass of 1 mole metal atoms = 54.94 g
∴ Mass of 1 metal atom

$$= \frac{54.94}{6.022 \times 10^{23}} \text{g} = 9.12 \times 10^{-23} \text{g}$$

∴ Volume occupied by one metal atom

$$= \frac{\text{Mass of one metal atom}}{\text{Denisty}} = \frac{9.12 \times 10^{-23}}{7.42} = 1.23 \times 10^{-23} \text{ cc}$$

27. Molar mass of copper pyrites, $CuFeS_2$
$= 63.5 + 56 + 2 \times 32 = 183.5$

$$\% \text{ of Cu} = \frac{63.5}{183.5} \times 100 = 34.60\%$$

$$\% \text{ of Fe} = \frac{56}{183.5} \times 100 = 30.52\%$$

$$\% \text{ of S} = \frac{2 \times 32}{183.5} \times 100 = 34.88\%$$

28. 17 parts of H_2O_2 contains oxygen = 16 parts.
∴ 100 parts of H_2O_2 contains oxygen

$$= \frac{16 \times 100}{17} = 94.12 \text{ parts}$$

∴ % of Hydrogen = (100 – 94.12) = 5.88

29. Mohr's salt is $FeSO_4.(NH_4)_2SO_4.6H_2O$
Molar mass = 56 + 32 + 64 + 28 + 8 + 32 + 64 + 6 × 18 = 392

$$\text{Percentage of water of crystallisation} = \frac{6 \times 18}{392} \times 100 = 27.55\%$$

$$\text{Percentage of } SO_4^{2-} \text{ ions} = \frac{2(32+64)}{392} \times 100 = 48.98\%$$

30.

Element	Percentage	Atomic ratio	Simplest ratio	Simplest whole, no. ratio
C	50	$\frac{50}{12} = 4.167$	$\frac{4.167}{3.125} = 1.33$	4
O	50	$\frac{50}{16} = 3.125$	$\frac{3.125}{3.125} = 1$	3

∴ Empirical formula is C_4O_3.
Empirical formula mass = 4 × 12 + 3 × 16 = 96
Given, molecular mass = 290 u

∴ $n = \frac{290}{96} \approx 3$

∴ Molecular formula is $(C_4O_3)_3 = C_{12}O_9$.

31.

Element	Percentage	Atomic ratio	Simplest ratio	Simplest whole no. ratio
C	57.82	$\frac{57.82}{12} = 4.82$	$\frac{4.82}{2.41} = 2$	4
H	3.6	$\frac{3.6}{1} = 3.6$	$\frac{3.6}{2.41} = 1.5$	3
O	100 – (57.82 + 3.6) = 38.58	$\frac{38.58}{16} = 2.41$	$\frac{2.41}{2.41} = 1$	2

∴ Empirical formula is $C_4H_3O_2$
Empirical formula mass = 4 × 12 + 3 × 1 + 2 × 16 = 83 u
Molecular Mass = 2 × vapour density = 2 × 83 = 166 u

$$n = \frac{166}{83} = 2$$

∴ Molecular formula = $(C_4H_3O_2)_2 = C_8H_6O_4$.

32. (i) NO_2 (ii) CH (iii) Fe_2O_3 (iv) CH_2O (v) CH_2

33. The involved balanced reaction is
$Zn + 2AgNO_3 \longrightarrow Zn(NO_3)_2 + 2Ag$
For 2 moles of $AgNO_3$, 1 mole of Zn is required.
Moles of $AgNO_3$ in the solution = 0.01

$$\text{Moles of Zn to be added in solution} = \frac{0.01}{2} = 0.005$$

Hence, mass of Zn to be added to solution = 0.005 × 65.4 = 0.327 g

34. The balanced chemical reaction is
$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$
Avogadro's law states that volume of one mole of an ideal gas at STP is 22.4 L.

∴ 44.8 lit. of butane or 2 moles of butane produces 8 moles of CO_2.

∴ Mass of CO_2 = 8 × 44 = 352 g

35. From the reactions,

2 moles of NH_3 require = 3 moles of H_2 and 1 mole of H_2 is produced from 1 mole of Zn.

∵ 3 moles of H_2 are produced from 3 moles of Zn.

∴ 2 moles of NH_3 requires 3 moles of Zn.

or, 5 moles of NH_3 requires = $\frac{3\times5}{2}$ moles of Zn

Mass of Zinc = $\frac{3}{2}$ × 5 × 65.4 g = 490.5 g

36. The given reaction is

$3BaCl_2 + 2Na_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6NaCl$

(a) Reaction shows that, 3 moles $BaCl_2 \equiv$ 1 mole $Ba_3(PO_4)_2$

∴ 0.5 mole $BaCl_2 \equiv$ 1/3 × 0.5 = 0.16 mole of $Ba_3(PO_4)_2$

Again, 2 moles $Na_3PO_4 \equiv$ 1 mole $Ba_3(PO_4)_2$

0.2 mole $Na_3PO_4 \equiv \frac{1\times0.2}{2} = 0.1$ mole mol of $Ba_3(PO_4)_2$

Now, since Na_3PO_4 gives lesser number of moles *i.e.*, 0.1 mole of $Ba_3(PO_4)_2$ than $BaCl_2$ which gives 0.16 mole of $Ba_3(PO_4)_2$, hence, Na_3PO_4 is the limiting reagent.

(b) Since, the number of moles of a product that can be obtained from limiting reagent are the maximum possible moles of the product, hence maximum number of moles of $Ba_3(PO_4)_2$ that can be formed = 0.1 mole.

(c) 0.2 mole $Na_3PO_4 \equiv \frac{3\times0.2}{2} = 0.3$ mole of $BaCl_2$

Hence, moles of $BaCl_2$ left after the reaction

= 0.5 – 0.3 = 0.2 mole

37. The reaction is $Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

In the reaction 1 mol of zinc reacts with 2 moles of HCl.

Thus, 0.30 mol of zinc will react with = 2 × 0.30

= 0.60 mol of HCl

But there are only 0.52 mol of HCl, therefore zinc cannot react completely and hence it is not a limiting reagent.

Again, 2 mol of HCl react with 1 mol of zinc

∴ 0.52 mol of HCl will react with $= \frac{1}{2}\times0.52$

= 0.26 mol of zinc

As there are 0.30 mol of zinc, therefore, HCl will react completely consumed in the reaction. *i.e.*, HCl is the limiting reactant.

∵ 2 moles of HCl produce = 1 mol of H_2

∴ 0.52 mol of HCl will produce

$= \frac{1}{2}\times0.52\text{ mol} = 0.26\text{ mol}$ of H_2

38. $2H_2 + O_2 \rightarrow 2H_2O$

100 g H_2 = $\frac{100}{2} = 50$ moles

100 g O_2 = $\frac{100}{32} = 3.125$ moles

1 mole of O_2 requires 2 moles of H_2

∴ 3.125 moles of O_2 requires = 2 × 3.125 moles

= 6.25 moles H_2

More H_2 is present than required. Hence, O_2 is the limiting reagent.

Amount of H_2O formed = 2 × 3.125 moles

= 2 × 3.125 × 18 g = 112.5 g

Volume of H_2O produced = $\frac{22.4\times112.5}{18}$ L = 140 L

Number of moles of H_2 left unreacted = 50 – 6.25 = 43.75

Volume occupied by 43.75 moles of H_2 = 43.75 × 22.4 = 980 L

39. Molality = $\frac{\text{Moles of solute}}{\text{kg of solvent}}$

10.2 g glucose = $\frac{10.2}{180} = 0.0567$ moles

405 g water = 0.405 kg

∴ Molality = $\frac{0.0567}{0.405} = 0.14$ m

40. (a) Molarity =

$$\frac{\text{Moles of solute}}{\text{Vol. of solution L}} = \frac{0.825/142}{0.45}\text{M} = 0.013\text{M}$$

(b) Molality = $\frac{\text{Moles of solute}}{\text{kg of solvent}} = \frac{0.825/142}{0.45} = 0.013\text{ m}$

(c) Moles of Na_2HPO_4 = 0.825/142 = 0.0058

Moles of water = $\frac{450}{18} = 25$

Mole fraction of Na_2HPO_4 = $\frac{0.0058}{25+0.0058} = 2.32\times10^{-4}$

(d) Mass percent of Na_2HPO_4 = $\frac{0.825}{0.825+450} = 1.83\times10^{-3}$

(e) ppm = $\frac{0.825}{450.825}\times10^6 = 1830$ ppm