1 Some Basic Concepts of Chemistry

I. Multiple Choice Questions (Type-I)

1. Two students performed the same experiment separately and each one of them recorded two readings of mass which are given below. Correct reading of mass is 3.0 g. On the basis of given data, mark the correct option out of the following statements.

Student	Readings	
A	3.01	2.99
B	3.05	2.95

(*i*) Results of both the students are neither accurate nor precise.
(*ii*) Results of student A are both precise and accurate.
(*iii*) Results of student B are neither precise nor accurate.
(*iv*) Results of student B are both precise and accurate.

Ans. (*ii*)

Explanation: Precision refers to the closeness of various measurements for the same quantity and accuracy is the agreement of a particular value to the true value of the result. Results of student A are very close to 3g.

2. A measured temperature on Fahrenheit scale is 200 °F. What will this reading be on Celsius scale?

(*i*) 40° C (*ii*) 94° C
(*iii*) 93.3° C (*iv*) 30° C

Ans. (*iii*)

Explanation: $°F = \frac{9}{5}(°C) + 32$

$°C = \frac{5}{9}(°F - 32) = \frac{5}{9}(200 - 32) = 93.3$

3. What will be the molarity of a solution, which contains 5.85 g of NaCl(s) per 500 mL?

(*i*) 4 mol L^{-1} (*ii*) 20 mol L^{-1}
(*iii*) 0.2 mol L^{-1} (*iv*) 2 mol L^{-1}

Ans. (*iii*)

Explanation: No. of moles of NaCl = $\frac{5.85}{58.5} = 0.1 \text{mol/L}$

$$500 \text{ ml} = \frac{500}{1000} = 0.5 \text{ L}$$

$$\text{Molarity(M)} = \frac{\text{No. of moles of solute}}{\text{Vol. of solution in litres}}$$

$$\text{Molarity} = \frac{0.1}{0.5} = 0.2\text{M}$$

4. If 500 mL of a 5M solution is diluted to 1500 mL, what will be the molarity of the solution obtained?

(*i*) 1.5 M (*ii*) 1.66 M
(*iii*) 0.017 M (*iv*) 1.59 M

Ans. (*ii*)

Explanation: $M_1V_1 = M_2V_2$

$$M_2 = \frac{M_1V_1}{V_2} = \frac{500 \times 5}{1500} = 1.66 \text{ M}$$

5. The number of atoms present in one mole of an element is equal to Avogadro number. Which of the following element contains the greatest number of atoms?

(*i*) 4g He (*ii*) 46g Na
(*iii*) 0.40g Ca (*iv*) 12g He

Ans. (*iv*)

Explanation: 12g He = 3 moles of He
No. of atoms of He = $3 \times N_A = 3 \times 6.022 \times 10^{23}$

6. If the concentration of glucose ($C_6H_{12}O_6$) in blood is 0.9 g L^{-1}, what will be the molarity of glucose in blood?

(*i*) 5 M (*ii*) 50 M
(*iii*) 0.005 M (*iv*) 0.5 M

Ans. (*iii*)

Explanation: Concentration of glucose in blood = 0.9g/L
Molar mass of glucose = 180 g mol^{-1}.
0.9g = 0.9/180 = 1/200 moles
Molarity of glucose in blood = 0.005 M

7. What will be the molality of the solution containing 18.25 g of HCl gas in 500 g of water?

(*i*) 0.1 m (*ii*) 1 M
(*iii*) 0.5 m (*iv*) 1 m

Ans. (*iv*)

Explanation: No. of moles of HCl = 18.25/36.5 = 0.5

$$\text{Molality } (m) = \frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg.}}$$

$$\text{Molality} = \frac{0.5 \times 1000}{500} = 1 \text{ m}$$

8. One mole of any substance contains 6.022×10^{23} atoms/molecules. Number of molecules of H_2SO_4 present in 100 mL of 0.02M H_2SO_4 solution is _____.

(*i*) 12.044×10^{20} molecules (*ii*) 6.022×10^{23} molecules
(*iii*) 1×10^{23} molecules (*iv*) 12.044×10^{23} molecules

Ans. (*i*)

Explanation: Molarity = 0.02 M, Volume of sol. = 100 mL = 0.1 L
No. of moles of H_2SO_4 = molarity × volume in litres
$= 0.02 \times 0.1 = 2 \times 10^{-3}$
No. of molecules of H_2SO_4 $= 2 \times 10^{-3} \times 6.022 \times 10^{23}$
$= 12.044 \times 10^{20}$ molecules

9. What is the mass percent of carbon in carbon dioxide?

(*i*) 0.034% (*ii*) 27.27%

(*iii*) 3.4% (*iv*) 28.7%

Ans. (*ii*)

Explanation: Mass percent of C in $CO_2 = \frac{\text{Molar mass of carbon} \times 100}{\text{Molar mass of } CO_2}$

$\therefore$ % of C in $CO_2 = \frac{12}{44} \times 100 = 27.27$ %.

10. The empirical formula and molecular mass of a compound are CH_2O and 180 g respectively. What will be the molecular formula of the compound?

(*i*) $C_9H_{18}O_9$ (*ii*) CH_2O

(*iii*) $C_6H_{12}O_6$ (*iv*) $C_2H_4O_2$

Ans. (*iii*)

Explanation: Empirical formula = CH_2O

Empirical formula mass = 12 + 1 + 1 + 16 = 30 g

Molecular mass = 180 g

$n = \frac{\text{Molar mass}}{\text{Empirical formula mass}} = \frac{180}{30} = 6$

$\therefore n = 6$

So, molecular formula = $n \times CH_2O = 6 \times CH_2O = C_6H_{12}O_6$

11. If the density of a solution is 3.12 g mL^{-1}, the mass of 1.5 mL solution in significant figures is _____.

(*i*) 4.7g (*ii*) 4680×10^{-3}g

(*iii*) 4.680g (*iv*) 46.80g

Ans. (*i*)

Explanation: Mass = Density × Volume

= 3.12 g mL^{-1} × 1.5 mL = 4.68 g = 4.7g

12. Which of the following statements about a compound is incorrect?

(*i*) A molecule of a compound has atoms of different elements.

(*ii*) A compound cannot be separated into its constituent elements by physical methods of separation.

(*iii*) A compound retains the physical properties of its constituent elements.

(*iv*) The ratio of atoms of different elements in a compound is fixed.

Ans. (*iii*)

Explanation: The compound does not retain the physical properties of its constituent elements.

13. Which of the following statements is correct about the reaction given below:

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(g)$$

(*i*) Total mass of iron and oxygen in reactants = total mass of iron and oxygen in product therefore it follows law of conservation of mass.

(*ii*) Total mass of reactants = total mass of product; therefore, law of multiple proportions is followed.

(*iii*) Amount of Fe_2O_3 can be increased by taking any one of the reactants (iron or oxygen) in excess.

(*iv*) Amount of Fe_2O_3 produced will decrease if the amount of any one of the reactants (iron or oxygen) is taken in excess.

Ans. (*i*)

Explanation: According to the law of conservation, the mass of the reactants in a chemical reaction is equal to the mass of the product.

14. Which of the following reactions is not correct according to the law of conservation of mass.

(*i*) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

(*ii*) $C_3H_8(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

(*iii*) $P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$

(*iv*) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

Ans. (*ii*)

Explanation: No. of atoms in the reactant side is not equal to the no. of atoms in the product side.

15. Which of the following statements indicates that law of multiple proportion is being followed.

(*i*) Sample of carbon dioxide taken from any source will always have carbon and oxygen in the ratio 1 : 2.

(*ii*) Carbon forms two oxides namely CO_2 and CO, where masses of oxygen which combine with fixed mass of carbon are in the simple ratio 2 : 1.

(*iii*) When magnesium burns in oxygen, the amount of magnesium taken for the reaction is equal to the amount of magnesium in magnesium oxide formed.

(*iv*) At constant temperature and pressure 200 mL of hydrogen will combine with 100 mL oxygen to produce 200 mL of water vapour.

Ans. (*ii*)

Explanation: According to this law, 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.

II. Multiple Choice Questions (Type-II)

In the following questions two or more options may be correct.

16. One mole of oxygen gas at STP is equal to _____.

(*i*) 6.022×10^{23} molecules of oxygen

(*ii*) 6.022×10^{23} atoms of oxygen

(*iii*) 16 g of oxygen

(*iv*) 32 g of oxygen

Ans. (*i*) and (*iv*)

Explanation: 1 mol of oxygen gas at STP = 6.022×10^{23} molecules of oxygen.

1 mole O_2 = 32g/mol of O_2

17. Sulphuric acid reacts with sodium hydroxide as follows:

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

When 1L of 0.1M sulphuric acid solution is allowed to react with 1L of 0.1M sodium hydroxide solution, the amount of sodium sulphate formed and its molarity in the solution obtained is

(*i*) 0.1 mol L^{-1} (*ii*) 7.10 g

(*iii*) 0.025 mol L^{-1} (*iv*) 3.55 g

Ans. (*ii*) and (*iii*)

Explanation: $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

0.1 M H_2SO_4 = 0.1 mole of H_2SO_4

0.1 mole H_2SO_4 reacts with 2 moles of NaOH.

0.1 mole of NaOH will react with = $\frac{0.1}{2}$ moles of H_2SO_4

= 0.05 moles of H_2SO_4.

Here NaOH is the limiting reactant

2 moles of NaOH produce 1 mole of Na_2SO_4.

0.1 mole of NaOH = $\frac{0.1}{2}$ = 0.05 mole

Mass of Na_2SO_4 = 0.05 × (Molar mass of Na_2SO_4)

= 0.05 × (46 + 32 + 64) = 0.05 × 142 = 7.10 g

Volume of solution after mixing = 2 L

Molarity of Na_2SO_4 = $\frac{0.05}{2}$ = 0.025 mol L^{-1}

18. Which of the following pairs have the same number of atoms?

(*i*) 16 g of O_2(g) and 4 g of H_2(g)

(*ii*) 16 g of O_2 and 44 g of CO_2

(*iii*) 28 g of N_2 and 32 g of O_2

(*iv*) 12 g of C(s) and 23 g of Na(s)

Ans. (*iii*) and (*iv*)

Explanation: One mole is the amount of a substance that contains as many particles or entities as there are atoms in exactly 12 g (or 0.012 kg) of the 12C isotope.

12g C = 1 mole of C and, 23g Na = 1 mole of Na

28g N_2 = 1 mole of nitrogen = 2 × 6.022 × 10^{23} atoms of nitrogen

32g O_2 = 1 mole of oxygen = 2 × 6.022 × 10^{23} atoms of oxygen

19. Which of the following solutions have the same concentration?

(*i*) 20 g of NaOH in 200 mL of solution

(*ii*) 0.5 mol of KCl in 200 mL of solution

(*iii*) 40 g of NaOH in 100 mL of solution

(*iv*) 20 g of KOH in 200 mL of solution

Ans. (*i*) and (*ii*)

Explanation: (*i*) 20 g NaOH = 20/40 = 0.5 mol NaOH in 200 ml solution.

(*ii*) Molar concentration of NaOH = $\frac{20}{40} = \frac{0.500 \text{ mol}}{0.200 \text{ L}}$ = 2.5 M

Molar concentration of KCl = $\frac{0.5 \text{ mol}}{0.200 \text{ L}}$ = 2.5 M

20. 16 g of oxygen has same number of molecules as in

(*i*) 16 g of CO (*ii*) 28 g of N_2

(*iii*) 14 g of N_2 (*iv*) 1.0 g of H_2

Ans. (*iii*) and (*iv*)

Explanation: 16g oxygen = ½ mol of oxygen which is same as 14g of nitrogen, means ½ mole of nitrogen, 1.0 g H_2 = ½ mole of hydrogen.

21. Which of the following terms are unitless?

(*i*) Molality (*ii*) Molarity

(*iii*) Mole fraction (*iv*) Mass percent

Ans. (*iii*) and (*iv*)

Explanation: Mass percent $= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$

Mole Fraction: It is the ratio of number of moles of a particular component to the total number of moles of the solution.

22. One of the statements of Dalton's atomic theory is given below:

"Compounds are formed when atoms of different elements combine in a fixed ratio".

Which of the following laws is **not** related to this statement?

(*i*) Law of conservation of mass (*ii*) Law of definite proportions

(*iii*) Law of multiple proportions (*iv*) Avogadro law

Ans. (*i*) and (*iv*)

Explanation: Law of conservation of mass states that matter can neither be created nor destroyed. Avogadro proposed that equal volumes of gases at the same temperature and pressure should contain equal number of molecules.

III. Short Answer Type

23. What will be the mass of one atom of C-12 in grams?

Ans. Mass of 6.022×10^{23} atoms of C in gm = 12g

Mass of one atom of C = $12/6.022 \times 10^{23} = 1.992648 \times 10^{-23}$g

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

$$\frac{2.5 \times 1.25 \times 3.5}{2.01}$$

Ans. $\frac{2.5 \times 1.25 \times 3.5}{2.01} = 5.4415422885$

Significant figures = 2

25. What is the symbol for SI unit of mole? How is the mole defined?

Ans. Symbol for SI unit of mole is mol.

One mole is defined as the amount of a substance that contains as many particles or entities as there are atoms in exactly 12 g (0.012 kg) of the 12 C isotope.

26. What is the difference between molality and molarity?

Ans. **Molarity:** It is the most widely used unit and is denoted by M. It is defined as the number of moles of the solute in 1 litre of the solution.

Thus,

$$\text{Molarity (M)} = \frac{\text{No. of moles of solute}}{\text{Volume of solution in litres}}$$

Molality: It is defined as the number of moles of solute present in 1 kg of solvent. It is denoted by *m*.

Thus, $$\text{Molality } (m) = \frac{\text{No. of moles of solute}}{\text{Mass of solvent in kg}}$$

27. Calculate the mass percent of calcium, phosphorus and oxygen in calcium phosphate $Ca_3(PO_4)_2$.

Ans. $$\text{Mass percent of calcium} = \frac{3 \times (\text{atomic mass of calcium})}{\text{molecular mass of } Ca_3(PO_4)_2} \times 100$$

$$= \frac{120\,u}{310\,u} \times 100 = 38.71\%$$

$$\text{Mass percent of phosphorus} = \frac{2 \times (\text{atomic mass of phosphorus})}{\text{molecular mass of } Ca_3(PO_4)_2} \times 100$$

$$= \frac{2 \times 31u}{310\,u} \times 100 = 20\%$$

$$\text{Mass percent of oxygen} = \frac{8 \times (\text{Atomic mass of oxygen})}{\text{Molecular mass of } Ca_3(PO_4)_2} \times 100$$

$$= \frac{8 \times 16\,u}{310\,u} \times 100 = 41.29\,\%$$

28. 45.4 L of dinitrogen reacted with 22.7 L of dioxygen and 45.4 L of nitrous oxide was formed. The reaction is given below:

$$2N_2(g) + O_2(g) \rightarrow 2N_2O(g)$$

Which law is being obeyed in this experiment? Write the statement of the law.

Ans. **Gay Lussac's Law of Gaseous Volumes** (Given by Gay Lussac in 1808) is being obeyed in this experiment. According to this law, when gases combine or are produced in a chemical reaction they do so in a simple ratio by volume provided all gases are at same temperature and pressure.

$$\underset{1V}{H_2(g)} + \underset{1V}{Cl_2(g)} \rightarrow \underset{2V}{2HCl(g)}$$

(All reactants and products have simple ratio 1 : 1 : 2.)

29. 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 whole number ratio.

(*a*) Is this statement true?

(*b*) If yes, according to which law?

(*c*) Give one example related to this law.

Ans. (*a*) Yes, the given statement is true.

(*b*) Law of Multiple Proportions

(c) For example; carbon combines with oxygen to form two compounds CO and CO_2.

Masses of oxygen which combine with a fixed mass of carbon (12g) bear a simple ratio of 16 : 32 or 1 : 2.

30. Calculate the average atomic mass of hydrogen using the following data:

Isotope	% Natural abundance	Molar mass
^1H	99.985	1
^2H	0.015	2

Ans. Average Atomic Mass $= \frac{\{(\text{Natural abundance of } ^1H \times \text{molar mass}) + (\text{Natural abundance of } ^2H \times \text{molar mass of } ^2H)\}}{100}$

$$= \frac{99.985 \times 1 + 0.015 \times 2}{100} = \frac{99.985 + 0.030}{100} = \frac{100.015}{100} = 1.00015\ u$$

31. Hydrogen gas is prepared in the laboratory by reacting dilute HCl with granulated zinc. Following reaction takes place.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Calculate the volume of hydrogen gas liberated at STP when 32.65 g of zinc reacts with HCl. 1 mol of a gas occupies 22.7 L volume at STP; atomic mass of Zn = 65.3 u.

Ans. 65.3 g of Zn reacts with HCl to form 22.7 L of $H_2(g)$

$\therefore$ 32.65 g of Zn at STP reacts with HCl to form $= \frac{22.7 \times 32.65}{65.3} = 11.35$ L

32. The density of 3 molal solution of NaOH is 1.110 g mL^{-1}. Calculate the molarity of the solution.

Ans. 3 molal solution of NaOH means that 3 mols of NaOH are dissolved in 1000 g of solvent.

$\therefore$ Mass of solution = Mass of Solvent + Mass of Solute

$= 1000\ g + (3 \times 40\ g) = 1120\ g$

$$\text{Volume of solution} = \frac{\text{Mass}}{\text{Density}} = \frac{1120}{1.110}\ mL = 1009.00\ mL$$

(Since density of solution = 1.110 g mL^{-1})

Since 1009 mL solution contains 3 mols of NaOH.

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

$$= \frac{3\ mol}{1009.00} \times 1000 = 2.97\ M$$

33. Volume of a solution changes with change in temperature, then, will the molality of the solution be affected by temperature? Give reason for your answer.

Ans. Molality of the solution is not affected by temperature as molality is expressed in mass.

34. If 4 g of NaOH dissolves in 36 g of H_2O, calculate the mole fraction of each component in the solution. Also, determine the molarity of solution (specific gravity of solution is 1g mL^{-1}).

Ans. Mass of NaOH = 4g

$$\text{Number of moles of NaOH} = \frac{4\text{g}}{40\text{g}} = 0.1 \text{ mol}$$

$$\text{Mass of } H_2O = 36\text{g}$$

$$\text{Number of moles of } H_2O = \frac{36\text{g}}{18\text{g}} = 2 \text{ mol}$$

$$\text{Mole fraction of water} = \frac{\text{Number of moles of } H_2O}{\text{No. of moles of water} + \text{No. of moles of NaOH}}$$

$$= \frac{2}{2+0.1} = \frac{2}{2.1} = 0.95$$

$$\text{Mole fraction of NaOH} = \frac{\text{Number of moles of NaOH}}{\text{No. of moles of NaOH} + \text{No. of moles of water}}$$

$$= \frac{0.1}{2+0.1} = \frac{0.1}{2.1} = 0.047$$

Mass of solution = mass of water + mass of NaOH = 36g + 4g = 40g

Volume of solution = 40 × 1 = 40 mL

(Since specific gravity of solution is = 1g mL^{-1})

$$\text{Molarity of solution} = \frac{\text{Number of moles of solute}}{\text{Volume of solution in litre}}$$

$$= \frac{0.1 \text{ mol NaOH}}{0.04 \text{ L}} = 2.5 \text{ M}$$

35. The reactant which is entirely consumed in reaction is known as limiting reagent. In the reaction 2A + 4B → 3C + 4D, when 5 moles of A react with 6 moles of B, then

(*i*) which is the limiting reagent?

(*ii*) calculate the amount of C formed?

Ans. 2A + 4B → 3C + 4D

According to the above equation, 2 mols of 'A' require 4 mols of 'B' for the reaction.

(*i*) Hence, for 5 mols of 'A', the moles of 'B' required =

$$5 \text{ mol of A} \times \frac{4 \text{ mol of B}}{2 \text{ mol of A}} = 10 \text{ mol of B}$$

(*ii*) But we have only 6 mols of 'B', hence, 'B' is the limiting reagent. So, amount of 'C' formed is determined by amount of 'B'. Since, 4 mols of 'B' give 3 mols of 'C'. Hence, 6 mols of 'B' will give

$$6 \text{ mol of B} \times \frac{3 \text{ mol of C}}{4 \text{ mol of B}} = 4.5 \text{ mol of C.}$$

IV. Matching Type

36. Match the following:

Column I	Column II
(*i*) 88 g of CO_2	(*a*) 0.25 mol
(*ii*) 6.022×10^{23} molecules of H_2O	(*b*) 2 mol
(*iii*) 5.6 litres of O_2 at STP	(*c*) 1 mol
(*iv*) 96 g of O_2	(*d*) 6.022×10^{23} molecules
(*v*) 1 mol of any gas	(*e*) 3 mol

Ans. (*i*) → (*b*); (*ii*) → (*c*); (*iii*) → (*a*); (*iv*) → (*e*); (*v*) → (*d*)

Explanation:

Column I	Column II
(*i*) 88 g of CO_2	44g of CO_2 = 1 mol. So, 88 g of CO_2 = 2 mol.
(*ii*) 6.022×10^{23} molecules of H_2O	1 mol = 6.022×10^{23} molecules
(*iii*) 5.6 litres of O_2 at STP	0.25 mol (5.6/22.4 = 1/4 mol)
(*iv*) 96 g of O_2	32g O_2 = 1 mol, 96 g of O_2 = 3 mol
(*v*) 1 mol of any gas	1 mol = 6.022×10^{23} molecules

37. Match the following physical quantities with units.

Physical quantity	Unit
(*i*) Molarity	(*a*) gmL^{-1}
(*ii*) Mole fraction	(*b*) mol
(*iii*) Mole	(*c*) Pascal
(*iv*) Molality	(*d*) Unitless
(*v*) Pressure	(*e*) mol L^{-1}
(*vi*) Luminous intensity	(*f*) Candela
(*vii*) Density	(*g*) mol kg^{-1}
(*viii*) Mass	(*h*) Nm^{-1}
	(*i*) kg

Ans. (*i*) → (*e*); (*ii*) → (*d*); (*iii*) → (*b*); (*iv*) → (*g*); (*v*) → (*c*); (*vi*) → (*f*) ; (*vii*) → (*a*); (*viii*) → (*i*)

V. Assertion and Reason Type

Note: In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

38. Assertion (A) : The empirical mass of ethene is half of its molecular mass.
Reason (R) : The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

(*i*) Both A and R are true and R is the correct explanation of A.
(*ii*) A is true but R is false.
(*iii*) A is false but R is true.
(*iv*) Both A and R are false.

Ans. (*i*)

Explanation: Molecular formula = $n \times$ (empirical formula)

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

39. Assertion (A) : One atomic mass unit is defined as one twelfth of the mass of one carbon-12 atom.

Reason (R) : Carbon-12 isotope is the most abundant isotope of carbon and has been chosen as standard.

(*i*) Both A and R are true and R is the correct explanation of A.
(*ii*) Both A and R are true but R is not the correct explanation of A.
(*iii*) A is true but R is false.
(*iv*) Both A and R are false.

Ans. (*ii*)

Explanation: Carbon-12 is one of the *isotopes* of carbon and can be represented as 12C. In this system, 12C is assigned a mass of exactly 12 atomic mass unit **(amu)** and masses of all other atoms are given relative to this standard. One **atomic mass unit** is defined as a mass exactly equal to one twelfth the mass of one carbon-12 atom.

40. Assertion (A) : Significant figures for 0.200 is 3 whereas for 200 it is 1.

Reason (R) : Zero at the end or right of a number are significant provided they are not on the right side of the decimal point.

(*i*) Both A and R are true and R is correct explanation of A.
(*ii*) Both A and R are true but R is not a correct explanation of A.
(*iii*) A is true but R is false.
(*iv*) Both A and R are false.

Ans. (*iii*)

Explanation: Zeros at the end or right of a number are significant provided they are on the right side of the decimal point. For example, 0.200 g has three significant figures.

41. Assertion (A) : Combustion of 16 g of methane gives 18 g of water.

Reason (R) : In the combustion of methane, water is one of the products.

(*i*) Both A and R are true but R is not the correct explanation of A.
(*ii*) A is true but R is false.
(*iii*) A is false but R is true.
(*iv*) Both A and R are false.

Ans. (*iii*)

Explanation: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

VI. Long Answer Type

42. A vessel contains 1.6 g of dioxygen at STP (273.15K, 1 atm pressure). The gas is now transferred to another vessel at constant temperature, where pressure becomes half of the original pressure. Calculate

(*i*) volume of the new vessel.

(*ii*) number of molecules of dioxygen.

Ans. (*i*) $p_1 = 1$ atm, $T_1 = 273$ K, $V_1 = ?$

32g of oxygen occupies 22.4 L of volume at STP*.

Hence, 1.6 g of O_2 will occupy,

$$1.6\text{g } O_2 \times \frac{22.4\text{ L}}{32\text{g } O_2} = 1.12\text{ L}$$

$$V_1 = 1.12\text{ L}$$

$$p_2 = \frac{p_1}{2} = \frac{1}{2} = 0.5\ atm$$

$$V_2 = ?$$

According to Boyle's law:

$$p_1V_1 = p_2V_2$$

$$V_2 = \frac{p_1 \times V_1}{p_2} = \frac{1\ atm \times 1.12\ L}{0.5\ atm} = 2.24\ L$$

(*ii*) Number of molecules of O_2 in the vessel

$$= \frac{6.022 \times 10^{23} \times 1.6}{32} = 3.011 \times 10^{22}$$

43. Calcium carbonate reacts with aqueous HCl to give $CaCl_2$ and CO_2 according to the reaction given below:

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

What mass of $CaCl_2$ will be formed when 250 mL of 0.76 M HCl reacts with 1000 g of $CaCO_3$? Name the limiting reagent. Calculate the number of moles of $CaCl_2$ formed in the reaction.

Ans. Number of moles of HCl = $250\text{ mL} \times \frac{0.76\text{ M}}{1000} = 0.19$ mol

Mass of $CaCO_3$ = 1000 g

Number of moles of $CaCO_3 = \frac{1000\text{ g}}{100\text{ g}} = 10$ mol

According to given equation, 1 mol of $CaCO_3(s)$ requires 2 mol of $HCl(aq)$. Hence, for the reaction of 10 mol of $CaCO_3(s)$ number of moles of HCl required would be:

$$10\text{ mol of } CaCO_3 \times \frac{2\text{ mol } HCl(aq)}{1\text{ mol } CaCO_3(s)} = 20\text{ mol } HCl(aq)$$

But, we have only 0.19 mol $HCl(aq)$. Hence, $HCl(aq)$ is limiting reagent. So, amount of $CaCl_2$ formed will depend on the amount of HCl available. Since, 2 mol $HCl(aq)$ forms 1 mol of $CaCl_2$, therefore, 0.19 mol of $HCl(aq)$ would give:

$$0.19 \text{ mol HCl}(aq) \times \frac{1 \text{ mol } CaCl_2(aq)}{2 \text{ mol HCl}(aq)} = 0.095 \text{ mol of } CaCl_2$$

or $0.095 \times$ molar mass of $CaCl_2 = 0.095 \times 111 = 10.54$ g

44. Define the law of multiple proportions. Explain it with two examples. How does this law point to the existence of atoms?

Ans. The law of multiple proportions states that, "If two elements can combine to form more than one compound, the mass of one element that combine with a fixed mass of the other element, are in the ratio of small whole numbers."

For example, hydrogen combines with oxygen to form two compounds, namely, water and hydrogen peroxide.

Hydrogen	+	Oxygen	→	Water
2g		16g		18g
Hydrogen	+	Oxygen	→	Hydrogen Peroxide
2g		32g		34g

Here, the masses of oxygen (*i.e.* 16 g and 32 g) which combine with a fixed mass of hydrogen (2g) bear a simple ratio, *i.e.*, 16 : 32 or 1 : 2.

45. A box contains some identical red coloured balls, labelled as A, each weighing 2 grams. Another box contains identical blue coloured balls, labelled as B, each weighing 5 grams. Consider the combinations AB, AB_2, A_2B and A_2B_3 and show that law of multiple proportions is applicable.

Ans. According to the law of multiple proportions, when two elements combine to form two or more compounds, then the different masses of one element, which combine with a fixed mass of the other, bear a simple ratio to one another.

For the combination AB

1g of A combines with $\frac{5}{2}$g of B = 2.5 g B

For AB_2

1g of A combines with $\frac{10}{2}$g of B = 5 g of B

For A_2B

1g of A combines with $\frac{5}{4}$g of B = 1.25 g of B

For A_2B_3

1g of A combines with $\frac{15}{4}$g of B = 3.75 g of B

Thus, it is proved that law of multiple proportions is applicable.

❑❑❑