

Class: 11th

Subject: Chemistry

Unit 4: STOICHIOMETRY

❖ Important MCQs:

1. Stoichiometry is derived from which language?

- (a) Latin
- (b) Greek
- (c) English
- (d) Arabic

2. The word "stoicheion" means:

- (a) Measure
- (b) Element
- (c) Atom
- (d) Molecule



3. The word "metron" means:

- (a) Atom
- (b) Element
- (c) Measure
- (d) Reaction

4. Stoichiometry is the study of:

- (a) Atomic structure

(b) Relationship between amounts of reactants and products ✓

(c) Gas laws

(d) Chemical bonding

5. A balanced chemical equation has:

(a) Equal number of molecules

(b) Equal number of atoms of each element on both sides ✓

(c) Equal volumes

(d) Equal pressure

6. Stoichiometric calculations obey:

(a) Boyle's law

(b) Charles's law

(c) Law of conservation of mass ✓

(d) Avogadro's law

7. According to law of conservation of mass:

(a) Mass can be created

(b) Mass can be destroyed

(c) Mass can neither be created nor destroyed ✓

(d) Mass is variable

8. According to law of definite proportions:

- (a) Elements combine randomly
- (b) Elements combine in same ratio by mass ✓
- (c) Mass changes
- (d) Atoms are divisible

9. One mole is defined as the amount of substance containing:

- (a) 1.0×10^{23} particles
- (b) 6.02×10^{22} particles
- (c) 6.02×10^{23} particles ✓
- (d) 3.02×10^{23} particles



10. Avogadro's number is:

- (a) 6.02×10^{22}
- (b) 6.02×10^{23} ✓
- (c) 3.02×10^{23}
- (d) 1.66×10^{-23}

11. The mole is represented by:

- (a) M
- (b) n ✓

(c) N

(d) A

12. One mole of carbon-12 has mass:

(a) 6 g

(b) 10 g

(c) 12 g

(d) 14 g

13. One mole of H₂O contains:

(a) 6.02×10^{23} atoms

(b) 6.02×10^{23} molecules

(c) 18 atoms

(d) 1 atom



14. Molar mass is defined as:

(a) Mass of one atom

(b) Mass of one mole of a substance in grams

(c) Number of atoms

(d) Volume of gas

15. Number of moles is calculated by:

(a) mass \times molar mass

(b) mass \div molar mass

(c) molar mass \div mass

(d) volume \times mass

16. Which pair contains equal number of atoms?

(a) 12 g C and 2 g H₂

(b) 23 g Na and 1 g H

(c) 12 g C and 4 g He

(d) 16 g O₂ and 1 g H

17. Which sample contains maximum number of atoms?

(a) 1 g H

(b) 4 g He

(c) 23 g Na

(d) All have same number of atoms

18. Number of molecules in 36 g of H₂O is:

(a) 3.01×10^{23}

(b) 6.02×10^{23}

(c) 1.204×10^{24}

(d) 2.408×10^{23}

19. Number of moles in 3.01×10^{23} particles is:

(a) 0.25

(b) 0.5

(c) 1

(d) 2

20. Which statement is correct?

(a) Same mass \rightarrow same molecules

(b) Same moles \rightarrow same number of particles

(c) Same volume \rightarrow same mass

(d) Same atoms \rightarrow same compounds

21. Volume of 2 moles of gas at STP is:

(a) 11.2 dm^3

(b) 22.4 dm^3

(c) 44.8 dm^3

(d) 2 dm^3

22. Which gas occupies largest volume at STP?

(a) 1 mol CO_2

(b) 1 mol H₂

(c) 1 mol O₂

(d) All have same volume

23. If 11.2 dm³ of gas is present at STP, number of moles is:

(a) 0.25

(b) 0.5

(c) 1

(d) 2

24. Density of gas depends on:

(a) Volume

(b) Temperature

(c) Molar mass

(d) Pressure

25. Which gas has highest density at STP?

(a) H₂

(b) CO₂

(c) O₂

(d) SO₂

26. Number of molecules in 22.4 dm³ CO₂ at STP is:

(a) 3.01×10^{23}

(b) 6.02×10^{23} ✓

(c) 1.204×10^{24}

(d) 2.408×10^{23}

27. Which relation is correct?

(a) $n = V \times C$

(b) $n = C \times V$ ✓

(c) $C = n \times V$

(d) $V = C \div n$



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28. Molar concentration unit is:

(a) g/dm³

(b) mol

(c) mol/dm³ ✓

(d) dm³/mol

29. If density of a gas increases, its molar mass will:

(a) Decrease

(b) Increase ✓

(c) Remain same

(d) Become zero

30. Which contains Avogadro's number of particles?

(a) 22.4 dm³ gas at STP

(b) 1 mole substance

(c) Molar mass in grams

(d) All of these

31. In the equation $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$, mole ratio of $\text{N}_2 : \text{H}_2$ is:

(a) 1 : 2

(b) 1 : 3

(c) 2 : 3

(d) 3 : 1

32. In the same equation, mole ratio of $\text{H}_2 : \text{NH}_3$ is:

(a) 3 : 2

(b) 2 : 3

(c) 1 : 2

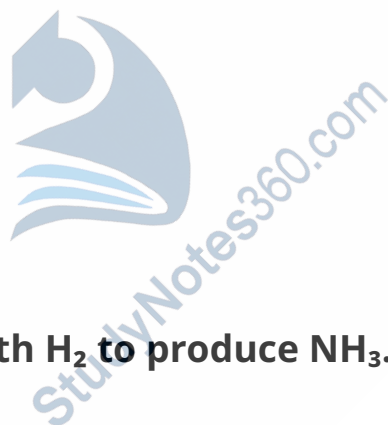
(d) 1 : 3

33. Which relationship is based on coefficients of balanced equation?

- (a) Mass-mass
- (b) Mole-mole
- (c) Volume-mass
- (d) Density-volume

34. Volume-volume relationship is valid for:

- (a) Solids
- (b) Liquids
- (c) Gases only
- (d) All states



35. 22.4 dm³ of N₂ reacts with H₂ to produce NH₃. Volume of H₂ required is:

- (a) 22.4 dm³
- (b) 44.8 dm³
- (c) 67.2 dm³
- (d) 11.2 dm³

36. Mass of NH₃ formed from 28 g of N₂ is:

-
- (a) 17 g
 - (b) 34 g
 - (c) 28 g
 - (d) 6 g

37. Limiting reactant is the one which:

- (a) Is in excess
- (b) Remains unreacted
- (c) Is completely consumed first
- (d) Has maximum mass

38. Excess reactant is the one which:

- (a) Is completely used
- (b) Remains after reaction
- (c) Limits reaction
- (d) Has less moles

39. Reaction stops when:

- (a) Excess reactant finishes
- (b) Limiting reactant finishes
- (c) Product forms

(d) Temperature changes

40. Amount of product formed depends on:

(a) Excess reactant

(b) Limiting reactant

(c) Volume

(d) Pressure

41. First step to find limiting reactant is:

(a) Calculate volume

(b) Calculate moles of reactants

(c) Find mass

(d) Balance equation

42. Which reactant produces least product is called:

(a) Excess reactant

(b) Limiting reactant

(c) Catalyst

(d) Product

43. In reaction $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, if H_2 is excess, limiting reactant is:

(a) H_2

(b) O₂ ✓

(c) H₂O

(d) None

44. Theoretical yield is:

(a) Actual product obtained

(b) Maximum calculated product ✓

(c) Minimum product

(d) Experimental error

45. Actual yield is:

(a) Calculated yield

(b) Ideal yield

(c) Obtained in experiment ✓

(d) Maximum yield

46. Actual yield is usually:

(a) Greater than theoretical

(b) Equal to theoretical

(c) Less than theoretical ✓

(d) Zero



47. Which factor decreases actual yield?

- (a) Proper reaction
- (b) No side reaction
- (c) Loss during filtration
- (d) Balanced equation

48. Percentage yield is calculated by:

- (a) Theoretical/Actual $\times 100$
- (b) Actual/Theoretical $\times 100$
- (c) Mass/Volume $\times 100$
- (d) Moles $\times 100$

49. If actual yield = theoretical yield, % yield is:

- (a) 50%
- (b) 75%
- (c) 100%
- (d) 25%

50. A reversible reaction results in:

- (a) Increased yield
- (b) Decreased yield

(c) Constant yield

(d) Zero yield

51. Stoichiometry in medicine is important for:

(a) Changing color of drugs

(b) Ensuring accurate drug dosage

(c) Increasing drug size

(d) Reducing reactions

52. Stoichiometry ensures in drug synthesis:

(a) Random reactions

(b) Efficiency and effectiveness

(c) No chemical reactions

(d) Only physical changes

53. Any deviation in stoichiometric calculation may cause:

(a) Pure product

(b) Incomplete reaction or contamination

(c) Faster reaction

(d) No change

54. Stoichiometry allows chemists to:

-
- (a) Avoid reactions
 - (b) Precisely control chemical reactions ✓
 - (c) Change drug color
 - (d) Stop synthesis

55. In antibiotics preparation, stoichiometry ensures:

- (a) Large dose
- (b) Correct dose with active ingredient ✓
- (c) Sweet taste
- (d) Longer shape

56. Stoichiometry is used to determine:

- (a) Oxygen level in air
- (b) Cholesterol level in blood ✓
- (c) Temperature of water
- (d) Density of solids

57. In diabetic patients, stoichiometry helps to control:

- (a) Body height
- (b) Blood sugar level using insulin ✓
- (c) Heart size

(d) Eye color

58. Stoichiometry is used to detect steroids in:

(a) Food

(b) Water

(c) Athletes' urine

(d) Soil

59. Stoichiometry is used in vaccine preparation to determine:

(a) Color of vaccine

(b) Viral antigen concentration

(c) Bottle size

(d) Label design

60. Incorrect drug dosage may result in:

(a) No effect

(b) Toxicity or severe damage

(c) Better health

(d) Faster recovery**

❖ Important Short Questions:

1. What is stoichiometry?

Ans: Stoichiometry is the branch of chemistry that studies the quantitative relationship between reactants and products in a balanced chemical equation.

Example: In $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, stoichiometry is used to calculate how much H_2 is required to produce water.

2. Define the term “mole”.

Ans: A mole is the amount of a substance that contains as many elementary entities as there are atoms in 12 g of carbon-12.

Example: 1 mole of H_2O contains 6.02×10^{23} molecules.

3. Who introduced the concept of Avogadro’s number?

Ans: The concept is named after the Italian scientist Amedeo Avogadro.

Example: Avogadro’s ideas helped relate gas volume to number of particles.

4. What is Avogadro’s number?

Ans: Avogadro’s number is the number of particles present in one mole of a substance.

Example: 1 mole of any substance contains 6.02×10^{23} particles.

5. What is the value of Avogadro’s number?

Ans: The value of Avogadro’s number is $6.02 \times 10^{23} \text{ mol}^{-1}$.

Example: 1 mole of NaCl contains 6.02×10^{23} formula units.

6. What is meant by elementary entities in chemistry?

Ans: Elementary entities are the basic particles of a substance such as atoms, molecules, ions, electrons, or formula units.

Example: In H_2O , the elementary entity is the molecule of water.

7. Give examples of elementary entities.

Ans: Examples include atoms, molecules, ions, and formula units.

Example: H_2 (molecule), Na^+ (ion), NaCl (formula unit).

8. What is molar mass?

Ans: Molar mass is the mass of one mole of a substance expressed in grams.

Example: Molar mass of CO_2 is 44 g/mol.

9. What is the unit of molar mass?

Ans: The unit of molar mass is grams per mole (g/mol).

Example: Molar mass of H_2O is 18 g/mol.

10. How is molar mass calculated?

Ans: Molar mass is calculated by adding the atomic masses of all atoms in a molecule or formula unit.

Example:

$$\text{CO}_2 = 12 + (16 \times 2) = 44 \text{ g/mol}$$

$$\text{H}_2\text{O} = (2 \times 1) + 16 = 18 \text{ g/mol}$$

11. What is the molar mass of CO₂?

Ans: 44 g/mol.

Example: 1 mole of CO₂ has a mass of 44 g.

12. What is the molar mass of H₂O?

Ans: 18 g/mol.

Example: 1 mole of H₂O has a mass of 18 g.

13. What is the molar mass of CaO?

Ans: 56 g/mol.

Example: 1 mole of CaO has a mass of 56 g.

14. Define balanced chemical equation.

Ans: A balanced chemical equation is one in which the number of atoms of each element is equal on both sides.

Example: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$

15. Why must a chemical equation be balanced?

Ans: To obey the law of conservation of mass, so that atoms are neither created nor destroyed.

Example: In a balanced equation, total atoms of each element remain equal on both sides.

16. State the law of conservation of mass.

Ans: Mass can neither be created nor destroyed; total mass of reactants equals total mass of products.

Example: In $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, mass before and after reaction remains the same.

17. How does the law of conservation of mass apply to chemical reactions?

Ans: Atoms are rearranged during a reaction, but their total mass remains constant.

Example: Reactants combine to form products without any loss or gain in mass.

18. State the law of definite proportions.

Ans: A pure compound always contains the same elements combined in a fixed ratio by mass.

Example: Water always contains hydrogen and oxygen in a fixed ratio of mass.

19. How do stoichiometric calculations depend on a balanced equation?

Ans: They depend on the mole ratios given by the coefficients of a balanced equation.

Example: In $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, 2 moles of H_2 react with 1 mole of O_2 .

20. How can the number of moles of a substance be calculated from its mass?

Ans: $n = \text{mass} / \text{molar mass}$.

Example: If mass = 36 g and molar mass of $\text{H}_2\text{O} = 18 \text{ g/mol}$, then

$n = 36 / 18 = 2$ moles.

21. Define optimum amount of active ingredient in medicine.

Ans: The optimum amount of an active ingredient is the exact quantity required in a medicine to produce the desired therapeutic effect in a patient without causing harmful side effects.

Example: In paracetamol tablets, a specific dose (e.g., 500 mg) is given so that it reduces fever and pain effectively without causing harm.

22. How does stoichiometry ensure accuracy in drug synthesis?

Ans: Stoichiometry ensures accuracy by allowing chemists to calculate precise amounts of reactants needed for a complete chemical reaction, reducing errors and impurities.

Example: While preparing a drug in a laboratory, exact moles of reactants are mixed so that the reaction goes to completion and no extra reactant remains.

23. What problems can occur if stoichiometric calculations are not accurate?

Ans: Incorrect calculations may lead to incomplete reactions, impurities, reduced effectiveness, or toxic effects due to excess substances.

Example: If excess reactants remain in a medicine, it may contaminate the final product and make it unsafe for patients.

24. Write one application of stoichiometry in antibiotics preparation.

Ans: Stoichiometry is used to ensure the correct proportion of active ingredients in antibiotics so that each dose can effectively kill or inhibit bacteria.

Example: The proper dose of an antibiotic is calculated so it can completely treat a bacterial infection without underdose or overdose.

25. How does stoichiometry help in determining the correct dosage of medicines?

Ans: Stoichiometry helps calculate the exact amount of medicine required for a patient, ensuring effectiveness and safety.

Example: Insulin dosage for diabetic patients is determined using stoichiometric calculations to maintain proper blood glucose levels.

❖ Important Long Questions:

☀ **Q1. Explain stoichiometry in detail. Also discuss its importance in chemical reactions and calculations.**

❖ **Answer:**

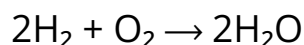
Stoichiometry is the branch of chemistry that deals with the quantitative relationship between reactants and products in a chemical reaction. It is based on a balanced chemical equation in which the number of atoms of each element is equal on both sides. The term stoichiometry comes from Greek words “stoicheion” (element) and “metron” (measure). It is used to calculate the amount of substances involved in chemical reactions.

In a balanced chemical equation, the coefficients represent the mole ratios of reactants and products. These mole ratios are used to determine how much of a reactant is required and how much product will be formed. Stoichiometric calculations follow the law of conservation of mass, according to which mass can neither be created nor destroyed. Therefore, the total mass of reactants is equal to the total mass of products.

Stoichiometry is important because it helps in predicting the amounts of substances involved in a reaction. It is used to calculate the required quantity of reactants and the expected amount of product. It also helps in identifying the limiting reactant and determining the maximum yield of a reaction. In industries, stoichiometry is used to control chemical

processes, reduce wastage, and improve efficiency. In laboratories, it ensures accurate measurements and proper experimental results.

Example:



This equation shows that 2 moles of hydrogen react with 1 mole of oxygen to produce 2 moles of water. Using this ratio, if 4 moles of hydrogen are available, then 2 moles of oxygen are required and 4 moles of water will be produced.

Thus, stoichiometry is essential for quantitative analysis of chemical reactions and plays a key role in both theoretical and practical chemistry.

🌟 **Q2. Define mole. Explain Avogadro's number and molar mass in detail with suitable examples.**

❖ **Answer:**

A mole is the amount of a substance that contains as many elementary entities (atoms, molecules, ions, or electrons) as there are atoms in 12 g of carbon-12. The mole is the SI unit used to count very large numbers of particles in chemistry and is represented by the symbol "n".

Avogadro's number is the number of elementary entities present in one mole of a substance. Its value is $6.02 \times 10^{23} \text{ mol}^{-1}$. It is named after the Italian scientist Amedeo Avogadro. This number represents how many particles are present in one mole of any substance.

Molar mass is the mass of one mole of a substance expressed in grams. It is equal to the atomic mass, molecular mass, or formula mass of a substance when expressed in grams per mole (g/mol). Molar mass is calculated by adding the atomic masses of all atoms present in a molecule or formula unit.

Examples:

1 mole of H_2O contains 6.02×10^{23} molecules of water and has a molar mass of 18 g/mol ($2 \times 1 + 16$).

1 mole of CO_2 contains 6.02×10^{23} molecules and has a molar mass of 44 g/mol ($12 + 2 \times 16$).

1 mole of NaCl contains 6.02×10^{23} formula units and has a molar mass of 58.5 g/mol ($23 + 35.5$).

Thus, the mole, Avogadro's number, and molar mass are fundamental concepts used to relate the mass of substances to the number of particles, making chemical calculations easier and more accurate.

☀ Q3. Describe molar mass. How is it calculated? Explain with examples of CO_2 , H_2O , and CaO .

❖ Answer:

Molar mass is defined as the mass of one mole of a substance expressed in grams. It is numerically equal to the atomic mass (for elements), molecular mass (for covalent compounds), or formula mass

(for ionic compounds) when expressed in grams per mole (g/mol).

Molar mass is an important concept used to relate the mass of a substance to the number of moles.

Molar mass is calculated by adding the atomic masses of all the atoms present in a molecule or formula unit. For a compound, each element's atomic mass is multiplied by the number of atoms of that element in the chemical formula, and then all are added together.

Examples:

CO₂:

Atomic mass of carbon = 12, oxygen = 16

Molar mass of CO₂ = 12 + (16 × 2) = 12 + 32 = 44 g/mol

H₂O:

Atomic mass of hydrogen = 1, oxygen = 16

Molar mass of H₂O = (1 × 2) + 16 = 2 + 16 = 18 g/mol

CaO:

Atomic mass of calcium = 40, oxygen = 16

Molar mass of CaO = 40 + 16 = 56 g/mol

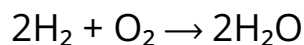
Thus, molar mass is calculated by summing the atomic masses of all atoms in a substance, and it is expressed in g/mol. It helps in converting between mass and moles in chemical calculations.

☀ **Q4. State and explain the law of conservation of mass and the law of definite proportions. How do these laws apply to chemical reactions?**

❖ **Answer:**

The law of conservation of mass states that matter can neither be created nor destroyed in a chemical reaction. It means that the total mass of reactants is equal to the total mass of products. During a chemical reaction, atoms are only rearranged to form new substances, but the total number and type of atoms remain unchanged.

Example: In the reaction



the total mass of hydrogen and oxygen before the reaction is equal to the total mass of water formed after the reaction.

The law of definite proportions states that a pure compound always contains the same elements combined in the same fixed ratio by mass, regardless of its source or method of preparation. This means the composition of a compound is constant.

Example: Water (H_2O) always contains hydrogen and oxygen in a fixed mass ratio of 1:8.

Application in chemical reactions:

These laws are fundamental in chemistry. The law of conservation of mass ensures that chemical equations must be balanced so that the number of atoms on both sides is equal. The law of definite proportions ensures that compounds have a fixed composition, which allows chemists to predict the exact ratios in which elements combine. Together, these laws form the basis of stoichiometric calculations and help in determining the amounts of reactants and products in a chemical reaction.

☀ Q5. Explain the role of a balanced chemical equation in stoichiometric calculations. How are mole ratios used to determine the amounts of reactants and products?

❖ Answer:

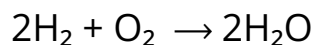
A balanced chemical equation plays a fundamental role in stoichiometric calculations because it provides the exact quantitative relationship between reactants and products. In a balanced equation, the number of atoms of each element is equal on both sides, which ensures that the law of conservation of mass is obeyed. The coefficients in a balanced chemical equation represent the mole ratios of the substances involved in the reaction.

These mole ratios are used to convert the amount of one substance into the amount of another substance in a chemical reaction. By using the coefficients of the balanced equation, chemists can determine how many moles of reactants are required to produce a certain amount of

product, or how much product will be formed from given reactants. This makes it possible to perform accurate stoichiometric calculations.

Example:

In the balanced equation:



The coefficients show that 2 moles of hydrogen react with 1 mole of oxygen to produce 2 moles of water. These ratios (2:1:2) are called mole ratios. If 4 moles of hydrogen are available, using the ratio, 2 moles of oxygen will be required and 4 moles of water will be produced.

Thus, a balanced chemical equation provides mole ratios that are essential for calculating the quantities of reactants and products, making stoichiometric calculations possible and accurate.

EXERCISE

Q.1 Four choices are given for each question. Select the correct choice.

I. Which one of the following statements is incorrect?

- a) One mole of nitrogen gas contains Avogadro's number of molecules
- b) One mole of ozone gas contains Avogadro's number of molecules
- c) One mole of ozone contains Avogadro's number of O atoms
- d) One mole of hydrogen gas contains Avogadro's number of molecules

II. Which one of the following has greatest mass?

- a) 0.5 mol of N_2
- b) 0.5 mol of NH_3
- c) 0.5 mol of He
- d) 0.5 mol of CO_2 ✓

III. Which one of the following gases will have greatest volume at STP?

- a) 22 g of CO_2
- b) 88 g of N_2O
- c) 28 g of CO
- d) 28 g of N_2 ✓

IV. Which of the following contains same number of particles as present in 12 g of carbon?

- a) 28 g of iron (Fe = 56)
- b) 48 g of magnesium (Mg = 24) ✓
- c) 32 g of S_8 (S = 32)
- d) 40 g of CO_2 (molar mass = 44)

V. Volume at STP of 22 g of CO_2 is same as that of:

a) 2 g of hydrogen

b) 8.5 g of NH_3

c) 64 g of SO_2 ✓

d) 7 g of CO

VI. 4.0 g of NaOH contains same number of sodium ions as are present in:

a) 10.6 g of Na_2CO_3

b) 58.5 g of NaCl ✓

c) 76 g of Na_2SO_4

d) 8.5 g of NaNO_3

VII. A container holds 0.5 moles of an ideal gas at STP. What is the volume?

a) 11.2 dm^3 ✓

b) 22.4 dm^3

c) 44.8 dm^3

d) 12.2 dm^3

VIII. A solution contains 4.0 g of NaOH in 250 cm^3 of solution. What is molar concentration?

a) 0.1 mol dm^{-3} ✓

b) 0.2 mol dm^{-3}

c) 0.4 mol dm^{-3}

d) 0.8 mol dm^{-3}

IX. A solution contains 10.0 g solute in 250 cm^3 , molarity = 0.20 mol dm^{-3} . Molar mass is:

a) 50 g mol^{-1}

b) 100 g mol^{-1}

c) 200 g mol^{-1}

d) 400 g mol^{-1}

X. A sample of nitrogen gas (14.0 g) contains how many nitrogen atoms?

a) 3.01×10^{23} atoms

b) 6.02×10^{23} atoms

c) 1.2×10^{24} atoms

d) 2.4×10^{24} atoms

XI. A gas has density 1.43 g dm^{-3} at STP. Molar mass is:

a) 14.3 g mol^{-1}

b) 22.4 g mol^{-1}

c) 32 g mol⁻¹ ✓

d) 64 g mol⁻¹

XII. A gas has density 1.96 g dm⁻³ at STP. Molecular mass is:

a) 11.2 g mol⁻¹

b) 22.4 g mol⁻¹

c) 44.0 g mol⁻¹ ✓

d) 88 g mol⁻¹

Q.2 Attempt the following short-answer questions:

a) How is the concept of mole derived from Avogadro's number?

Ans: The mole is defined using Avogadro's number. One mole of any substance contains 6.02×10^{23} particles (atoms, molecules, or ions). This fixed number is called Avogadro's number. Therefore, a mole represents a collection of particles equal to Avogadro's number.

b) Define the following terms with one example in each case:

Answer:

(a) Molar mass

Molar mass is the mass of one mole of a substance expressed in grams per mole.

Example: H₂O = 18 g mol⁻¹

(b) Molar volume

Molar volume is the volume occupied by one mole of a gas at STP.

Example: 1 mole of any gas = 22.4 dm^3 at STP

(c) Molar concentration

Molar concentration (molarity) is the number of moles of solute present in 1 dm^3 of solution.

Example: $1 \text{ mol dm}^{-3} \text{ NaCl}$ means 1 mole of NaCl in 1 dm^3 solution

c) What do you mean by molar volume of a gas? How Avogadro's number is related with molar volume?

Ans: Molar volume of a gas is the volume occupied by 1 mole of a gas at STP, which is 22.4 dm^3 .

According to Avogadro's law, equal volumes of gases at the same temperature and pressure contain equal numbers of molecules. Since 1 mole of any gas contains 6.02×10^{23} molecules, all gases have the same molar volume at STP (22.4 dm^3).

d) 39 g of potassium and 56 g of iron have equal number of atoms in them. Justify.

Answer:

Molar mass of potassium (K) = 39 g mol^{-1} $39 \text{ g} = 1 \text{ mole}$

Molar mass of iron (Fe) = $56 \text{ g mol}^{-1} \rightarrow 56 \text{ g} = 1 \text{ mole}$

Since both samples contain 1 mole, both have 6.02×10^{23} atoms. Therefore, they have equal number of atoms.

e) 4 g of He, 17 g of NH₃ and 64 g of SO₂ occupy separately the volumes of 22.414 dm³. Explain.

Answer:

At STP, 1 mole of any gas occupies 22.4 dm³.

Molar mass of He = 4 g mol⁻¹ → 4 g = 1 mole

Molar mass of NH₃ = 17 g mol⁻¹ → 17 g = 1 mole

Molar mass of SO₂ = 64 g mol⁻¹ → 64 g = 1 mole

Since each sample contains 1 mole, all gases occupy the same volume 22.414 dm³ at STP according to Avogadro's law.

f) Do you think that 1 mole of H₂ and 1 mole of NH₃ at 0°C and 1 atm will have Avogadro's number of particles?

Yes, 1 mole of any substance contains 6.02×10^{23} particles. Therefore, 1 mole of H₂ and 1 mole of NH₃ will each contain Avogadro's number of molecules at 0°C and 1 atm.

g) What is stoichiometry? Give the basic assumptions of stoichiometric calculations.

Answer:

Stoichiometry is the branch of chemistry that deals with the quantitative relationships between reactants and products in a chemical reaction.

Basic assumptions of stoichiometric calculations:

- Chemical equations are balanced.
- Reactants react completely (no side reactions).
- No loss of product during reaction.
- Reaction occurs under ideal conditions.
- All substances are pure.

g) What is a limiting reactant? How does it control the quantity of the product formed?

Ans: A limiting reactant is the reactant that is completely consumed first in a chemical reaction and limits the amount of product formed. The reaction stops when the limiting reactant is used up. The quantity of product depends on the limiting reactant because the other reactants may remain in excess, but no more product can form once the limiting reactant is finished.

h) Differentiate theoretical and actual yields. How is the percentage yield of a reaction calculated?

Ans: Theoretical yield is the maximum amount of product that can be obtained from a reaction as predicted by stoichiometric calculations.

Actual yield is the amount of product actually obtained from an experiment.

Percentage yield is calculated by the formula:

$$\text{Percentage yield} = (\text{Actual yield} / \text{Theoretical yield}) \times 100$$

i) What are the factors which are mostly responsible for the low yield of the products in chemical reactions?

Ans: The low yield of products may be due to incomplete reactions, side reactions forming unwanted products, loss of product during handling or purification, impure reactants, and errors in experimental conditions or measurements.

DESCRIPTIVE QUESTIONS

☀ **Q3. Differentiate limiting and non-limiting reactants. How a limiting reactant is determined from a balanced chemical equation and given data?**

❖ **Answer:**

A limiting reactant is the reactant that is completely consumed first during a chemical reaction and determines the amount of product formed. The reaction stops when this reactant is finished. A non-limiting (excess) reactant is the reactant that remains unreacted after the reaction is complete because it is present in excess amount.

A limiting reactant is determined by using the balanced chemical equation and given data. First, the given masses of reactants are converted into moles. Then, using the mole ratio from the balanced equation, the amount of product formed by each reactant is calculated. The reactant that produces the least amount of product is identified as the limiting reactant. This reactant controls the maximum yield of the reaction, while the other reactant remains in excess.

🌟 Q4. Difference Between Actual and Theoretical Yields & Reason for Higher Theoretical Yield

❖ Answer:

Actual yield is the amount of product actually obtained from a chemical reaction through experimental work. It is the real measured quantity in the laboratory.

Theoretical yield is the maximum amount of product predicted from stoichiometric calculations assuming complete reaction and no loss of material.

The theoretical yield is always greater than the actual yield because in real conditions reactions are not 100% efficient. Some product is lost during handling, purification, or separation. In addition, side reactions may occur, impurities may be present, and the reaction may not go to completion. Due to these factors, the actual yield is always less than the theoretical yield.

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