

EXERCISE

MULTIPLE CHOICE QUESTIONS

1. Select the most suitable answer in the following MCQs.

i. How many molecules are there in one mole of H_2O ?

- (a) 6.02×10^{19} (b) 6.023×10^{23}
(c) 1.084×10^{18} (d) none of these

ii. A flask contains 500 cm^3 of SO_2 at STP. The flask contains

- (a) 40 g (b) 100 g
(c) 50 g (d) none of these

iii. A necklace has 6g of diamond in it. What are the numbers of atoms in it?

- (a) 6.02×10^{23} (b) 12.04×10^{23}
(b) 1.003×10^{23} (d) 3.01×10^{23}
(c)

iv. What is the mass of aluminium in 204 g of the aluminium oxide, Al_2O_3

- (a) 26g (b) 27 g (c) 54 g (d) 108 g

v. The reactant which is consumed earlier and gives least quantity of product is called.

- (a) Reactant (b) Stoichiometry
(c) Limiting reactant (d) Stoichiometric amount

vi. Which one of the following compounds contains the highest percentage by mass of nitrogen

- (a) NH_3 (b) N_2H_4 (c) NO (d) NH_4OH

vii. Vitamin-A has a molecular formula $C_{20}H_{30}O$. The number of vitamin - A molecules in 500 mg of its capsule will be

- (a) 6.02×10^{23} (b) 1.05×10^{23}
 (c) 3.01×10^{22} (d) 3.01×10^{23}
 (e) none of these

viii. When one mole of each of the following is completely burnt in oxygen, which will give the largest mass of CO_2 ?

- (a) Carbon Monoxide (b) Diamond
 (c) Ethane (d) Methane

ix. One mole of ethanol and one mole of ethane have an equal

- (a) Mass (b) Number of Atoms
 (c) Number of electron (d) Number of molecules

x. Methane reacts with steam to form H_2 and CO as shown below,



What volume of H_2 can be obtained from 100 cm^3 of methane at the standard temperature and pressure?

- (a) 300 cm^3 (b) 200 cm^3 (c) 150 cm^3 (d) 100 cm^3

xi. The Avogadro's constant is the number of

- a) Atoms in 1g of Helium
 b) Molecules in 35.5g of Chloride
 c) Electrons needed to deposit 24g of Mg
 d) Atoms in 24g of Mg

xii. How many moles of oxygen are needed for the complete combustion of two moles of butane?

Answers

i. b	ii. d	iii. d	iv. d	v. c	vi. b	vii. e
viii. c	ix. d	x. a	xi. d	xii. d	xiii. d	xiv. a
xv. d	xvi. a, d	xvii. a	xviii. e			

2. Answer the following questions briefly:**i. 58.5 amu are termed as formula mass and not molecular mass of NaCl. Why?**

Ans: Because NaCl is an ionic substance and molecules of ionic substances are termed as formula units but not as Molecular mass. That is why 58.5 amu is the formula mass of NaCl and not molecular mass.

ii. Concept of limiting reactant is not applicable to the reversible reactions. Explain.

Ans: "A reactant which consumes earlier due to its smaller amount and produces least amount of product is called limiting reactant "

During a reversible reaction, reactants are converted into products and products convert back into reactants. So reactants are not completely consumed. As a result, a limiting reactant cannot be identified in a reversible reaction,

OR (Second Answer)

Limiting reactant is the reactant which is completely consumed in a chemical reaction whereas in a reversible reaction, there is no reactant which is 100% consumed but is regenerated due to reversible reaction.

Therefore, concept a limiting reactant is not applicable to a reversible reaction.

iii. How many covalent bonds are present in 9g of H₂O?

$$\begin{aligned} \text{Ans: Mass of H}_2\text{O} &= 9\text{g} \\ \text{Molecular mass of H}_2\text{O} &= 16 + 2 = 18 \text{ g/ mole} \\ \text{Number of water molecules} &= \frac{\text{Mass of water}}{\text{Molar mass of water}} \times N_A \end{aligned}$$

$$\text{Number of molecules of H}_2\text{O} = \frac{9}{18} \times 6.02 \times 10^{23} = 3.01 \times 10^{23} \text{ molecules}$$

$$\begin{aligned} 1 \text{ molecule of H}_2\text{O} &= 2 \text{ Covalent Bonds} \\ 3.01 \times 10^{23} \text{ molecules of H}_2\text{O} &= 2 \times 3.01 \times 10^{23} \\ &= 6.02 \times 10^{23} \text{ Covalent Bonds} \end{aligned}$$

iv. Differentiate between limiting and non-limiting reactants.

Ans: Difference between limiting reactant and reactant in excess:

Limiting reactant	Reactant in excess
i. The reactant which controls the quantity of product or which is lesser quantity is called limiting reactant.	i. the reactant which remain unreacted after the completion of a reaction is called reactant in excess.
ii. It is taken in lesser quantity	ii. it is in excess.
iii It is usually expensive	iii. It is usually cheaper.
iv. It is consumed completely in a chemical reaction.	iv. It is not consumed completely in a chemical reaction.

v. How many molecules of water are there in 12 g of ice?

$$\begin{aligned} \text{Ans: Mass of ice} &= 12 \text{ g} \\ \text{Molar mass of water} &= 16 + 2 = 18 \text{ g/mole} \end{aligned}$$

$$\text{Number of molecules of water} = \frac{\text{Mass of water}}{\text{Molar mass of water}} \times N_A$$

$$\begin{aligned} \text{Number of molecules of water} &= \frac{12 \times 6.023 \times 10^{23}}{18} \\ &= 4.01 \times 10^{23} \text{ molecules} \end{aligned}$$

vi. One mole of H_2SO_4 should completely react with two moles of NaOH . How does Avogadro's number help to explain it?



In above reaction According to Avogadro's number 1 mole of or 6.02×10^{23} molecules of H_2SO_4 react with 2 moles or $2 \times 6.02 \times 10^{23}$ molecules of NaOH to produce 1 mole of Na_2SO_4 or 6.02×10^{23} molecules of Na_2SO_4 and 2 moles or $2 \times 6.02 \times 10^{23}$ molecules of H_2O .

vii. Give reason that 1 mole of different compounds have different masses but have the same number of molecules.

Ans: According to Avogadro's number 1 mole of different compounds have 6.02×10^{23} molecules but have different masses. As different molecules have different atoms having different atomic masses, so their molecular masses may be different but number of molecules in 1 mole must be same i.e. 6.02×10^{23} molecules.

Example: 18g of water = 1 mole = 6.023×10^{23} molecules.

342g of source = 1 mole = 6.023×10^{23} molecules.

viii. 23g of sodium and 238g of uranium have equal number of atoms in them,

Ans: Atomic mass of number is 23 and that of uranium is 238. It means 23g of Na is equal to 1 mole of Na and 238 g of uranium is equal to 1 mole of uranium and

according to Avogadro's Law 1 mole of any element has 6.02×10^{23} atoms. It means 1 mole of Na and 1 mole of uranium have equal number of atoms in them that is 6.02×10^{23} atoms.

ix. What is percentage composition? Calculate percentage composition of Glucose.

Ans: Percentage Composition:

A compound may contain certain elements. The percentage of each element in a compound is called percentage composition of that compound.

It is calculated as follow:

$$\% \text{ of an element} = \frac{\text{mass of element in compound} \times 100}{\text{Molar mass of compound}}$$

Percentage Composition of Glucose:

$$\text{Molar mass of glucose (C}_6\text{H}_{12}\text{O}_6) = 12 \times 6 + 1 \times 12 + 16 \times 6 = 180 \text{g mole}^{-1}$$

$$\% \text{ of an element} = \frac{\text{mass of element in compound} \times 100}{\text{Molar mass of compound}}$$

Molar mass of compound

$$\% \text{ of C} = \frac{72 \times 100}{180} = 40 \%$$

$$\% \text{ of H} = \frac{12 \times 100}{180} = 6.67 \%$$

$$\% \text{ of O} = \frac{96 \times 100}{180} = 53.33 \%$$

x. Calculate the weight of oxygen gas evolved when 5.0 g of KClO₃ are completely decomposed thermally.

Ans: Given Mass of KClO₃ = 5g

$$\text{Formula Mass of KClO}_3 = 39 + 35.5 + 16 \times 3 = 122.5 \text{ g/mole}$$

Number of Moles of $\text{KClO}_3 = \frac{\text{Mass in gram}}{122} = \frac{5}{122} = 0.04$ moles

Molar mass

122



According to the above equation

2 moles of $\text{KClO}_3 = 3$ moles of O_2

1 moles of $\text{KClO}_3 = \frac{3}{2}$ moles of O_2

2

0.04 moles of $\text{KClO}_3 = \frac{3}{2} \times 0.04 = 0.06$ moles of O_2

2

1 mole of $\text{O}_2 = 32$ g of O_2

0.06 mole of $\text{O}_2 = 0.06 \times 32 = 1.92$ g

xi. What is limiting reactant? How will you determine it?

Ans: Excess and Limiting Reactants:

The reactant that is consumed completely in a chemical reaction is called limiting reactant. Also, it can be defined as the reactant which produces the least number of moles of products in a chemical reaction.

Determination of Limiting Reactant:

The following three steps should be followed to find out the limiting reactant

- I. Calculate the number of moles from the given amount of reactant,
- II. Find out the number of moles of product with the help of a balanced chemical equation.
- III. Identify the reactant which produces the least amount of product as limiting reactant.

xii. Define Theoretical yield and actual yield.

Ans: Theoretical Yield:

"The amount of the products calculated from a balanced chemical equation is called theoretical Yield"

- I. It is also known as calculated yield or expected yield .
- II. Theoretical yield of a reaction is always greater than the actual yield of the same reaction .

Actual yield:

"The amount of the products obtained with a given amount of the reactant in an actual experiment is called actual yield."

- I. It is also known as experimental yield.
- II. The actual yield of a chemical reaction is always lesser than the theoretical yield .

xiii. What is conversion factor?**Ans: Conversion factor or Mole ratio:**

Conversion factor means the ratios of number of moles of reactants taking part and the number of moles of products formed.

Example Combustion of propane:

For example, combustion of propane



The mole ratios between the reactants and products can be shown as, one mole of C_3H_8 reacts with five moles of oxygen to give three moles of CO_2 and four moles of water the amount of propane used will not affect these ratios.

OR

The simplest stoichiometry problems are mole-to-mole conversions, and for those you need only a balanced chemical equation. The coefficients in the balance

equation is used to construct a conversion factor between moles of one substance and moles of a different substance in the same reaction.

Mole ratios of reactants and products as given by a balanced chemical equation is called conversion factor e.g. in reaction.



1 mole of C_3H_8 (propane) reacts with 5 moles of O_2 to produce 3 moles of CO_2 and 4 moles of H_2O . Conversion factor is not affected by number of reactants or products.

xiv. What is the relationship between mass and volume of a gas at S.T.P.?

Ans: Molar Volume:

A mole and volume relationship exists between reactants and products provided the gases are at S.T.P This volume of 22.414 dm^3 is called Molar Volume.

In stoichiometric calculations the problem can be solved easily if reactants and products are used correctly.

22.414 dm^3 of H_2 gas at STP = $2\text{g} = 6.02 \times 10^{23}$ molecules

22.414 dm^3 of NH_3 gas at STP = $17\text{g} = 6.02 \times 10^{23}$ molecules.

xv. The actual yield is lesser than the theoretical yield. Give reasons.

Ans: Actual yield of a reaction is less than the theoretical yield because of following reasons

- I. The reaction may not go to completion and may reduce the yield of product .
- II. Material may be lost in handling
- III. Side reactions may produce by-products
- IV. Reactions are reversible

- V. Mechanical loss takes place due to filtration, distillation, and separation by separating funnel, washing and crystallization etc
- VI. Inexperience worker or method may be faulty

xvi. What are the representative particles in one mole of a gas at

Ans: One mole of any gas at STP occupies 22.414 dm³ and contains 6.02 x 10²³ particles.

Examples:

(i) 2g of H₂ = 1 mole of H₂ = 22.414 dm³

(ii) 16g of CH₄ = 1 mole of = 22.414 dm³

According to Avogadro's Law

There are 6.02 x 10²³ Number of particles present in 22.414dm³ (1 mole) of a gas.

xvii. What is Stoichiometry and Stoichiometric amounts.

Ans: Stoichiometry:

The study of relative amounts of substances involved in a chemical reaction is called Stoichiometry. Such phenomenon is studied through the knowledge of Stoichiometry (Greek word *Stoicheion* means element and *metry* means measurement).

Stoichiometric Amounts:

The amounts of the reactants or the products as given by the balanced chemical equation are called stoichiometric amounts.



3. (a) What is Avogadro's number? Give examples. How will be explain moles with the help of Avogadro's Number.

(b) The liquid CHBr_3 has a density of 2.89 g dm^{-3} . What volume of this liquid should be measured to contain a total of

2.4×10^{24} molecules of CHBr_3 .

(Ans: 348.4 cm^3)

Ans: (a) What is Avogadro's number? Give examples. How will be explain moles with the help of Avogadro's Number.

The number of atoms, ions, molecules or formula units present in 1 mole of a substance is called Avogadro's number and its numerical value is 6.02×10^{23}

e.g. 1 mole of Na(23g) = 6.02×10^{23} atoms of Na

1 mole of NaCl

1 mole of NaCl

1 mole of NaCl

= 6.02×10^{23} formula
units of NaCl

= 6.02×10^{23} Na^+ ions

= 6.02×10^{23} Cl^- ions

Definition of Mole in terms of Avogadro's number:

6.02×10^{23} atoms of an element, 6.02×10^{23} molecules of a compound or 6.02×10^{23} formula units of an ionic substance is called a mole.

e.g. 6.02×10^{23} atoms of Na = 1 mole of Na

6.02×10^{23} molecules of H_2O = 1 mole of H_2O

6.02×10^{23} formula units of NaCl = 1 mole of NaCl

(b) The liquid $CHBr_3$ has a density of 2.89 g dm^{-3} . What volume of this liquid should be measured to contain a total of 4.8×10^{24} molecules of $CHBr_3$.

Solution:

(Ans: 696.8 dm^3)

Density of $CHBr_3 = 2.98 \text{ g dm}^{-3}$ Volume = ?

Molecules of $CHBr_3 = 4.8 \times 10^{24}$

Molar mass of $CHBr_3 = 12 + 1.008 + 239.7 = 252.7$

As we know that

Number of molecules = moles $\times N_A$

Number of molecules = Mass in gram $\times N_A$

Molar mass

Mass in gram = $\frac{252.7 \times 4.8 \times 10^{24}}{6.022 \times 10^{23}}$

6.022×10^{23}

Mass in gram = 2014.2 gram

Volume = Mass in gram

Density

Volume = $\frac{2014.2}{2.89}$ = 696.8 dm^3

2.89

4. (a) Differentiate between actual yield and theoretical yield. How will you explain the percentage yield of the substance with the help of;

(b) The following reaction never goes to completion. Therefore, less amount of NH_3 is obtained than expected theoretically,



42.0 g of H_2 produces 120.2 g of NH_3 . Calculate the percentage yield of NH_3 .

(Ans: 50.5%)

Ans: (a) Differentiate between actual yield and theoretical yield.

Actual Yield:

The quantity of product that is actually produced in a chemical reaction is called the actual yield.

Theoretical Yield:

"The quantity of product calculated to be obtained from given quantities of initial reactants is called theoretical yield of a reaction".

The theoretical yield is not an estimate, but the calculated amount of the yield based on the best of conditions for the reaction being carried to completion.

The actual yield is the measured amount from the actual experiment. This is often less than the ideal theoretical yield because of other factors that affect the reaction, mainly that the reagent used in the reaction is consumed so that you have less material to progress the reaction to its full theoretical yield.

(b) The following reaction never goes to completion. Therefore, less amount of NH_3 is obtained than expected theoretically, $\text{N}_2 + 3\text{H}_2 \longrightarrow 2\text{NH}_3$ 42.0 g of H_2 produces 120.2 g of NH_3 .

Calculate the percentage yield of NH_3 ,

(Ans: 50.5 %)

Ans. Expected theoretical yield can be calculated as.

Mass of $H_2 = 42\text{g}$

Number of moles of $H_2 = \frac{\text{Mass in gram}}{\text{Molar mass}} = \frac{42}{2} = 21$ moles

According to reaction equation



3 moles of $H_2 = 2$ moles of NH_3

1 mole of $H_2 = \frac{2}{3}$ moles of NH_3

21 moles of $H_2 = \frac{2}{3} \times 21 = 14$ moles of NH_3

Mass of NH_3 in grams = $14 \times 17 = 238\text{ g}$

But actual yield = 120.2 g

Percentage yield = $\frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$

% yield = $\frac{120.2}{238} \times 100 = 50.5\%$

5. (a) What do you know about percentage composition? How will you determine the percentage of each element in the substance?

(b) Glucose ($C_6H_{12}O_6$) is the most important nutrient in the cell for generating chemical potential energy. Calculate the mass percentage of each element in glucose.

(Ans: C = 40 %, H = 6.66 %, O = 53.33 %)

Ans: (a) What do you know about percentage composition? How will you determine the percentage of each element in the substance?

Method to determine the percentage composition of a known compound:

- (i) calculate the molar mass of compound
- (ii) calculate the percentage of each element in one mole of the compound. This is done by dividing the mass of each element in one mole of the compound by the molar mass multiplied by 100.

$$\% \text{ of an element} = \frac{\text{mass of element in compound}}{\text{Molar mass of compound}} \times 100$$

(b) Glucose (C₆H₁₂O₆) is the most important nutrient in the cell for generating chemical energy. Calculate the mass percentage of each element in

(Ans. C = 40 %, H = 6.66 %, O = 53.33 %)

Solution: Molar Mass of Glucose (C₆H₁₂O₆) = 72 + 12 + 96 = 180 g/mole

$$\% \text{ of an element} = \frac{\text{mass of element in compound}}{\text{Molar mass of compound}} \times 100$$

Molar mass of compound

$$\% \text{ of C} = \frac{72}{180} \times 100 = 40 \%$$

$$\% \text{ of H} = \frac{12}{180} \times 100 = 6.66\%$$

$$\% \text{ of O} = \frac{96}{180} \times 100 = 53.33\%$$

6. (a) How will you calculate the theoretical yield and percentage . yield in a balanced chemical equation?

(b) A small piece of pure Al Metal having a volume of 2.50 cm^3 is reacted with excess of HCl. What is the weight of H_2 liberated? The density of Al is 2.70 g cm^{-3} . (Ans: 0.7529)

Ans: (a) How will you calculate the theoretical yield and percentage yield in a balanced chemical equation?

Theoretical Yield:

"The quantity of product calculated to be obtained from given quantities of initial reactants is called theoretical yield of a reaction".

Method of finding theoretical yield:

- i. Find the number of moles of reactant which is not an excess
- ii. Find the number of moles of required product from the balanced chemical equation .
- iii. Find the mass of product by using formula: Number of moles = $\frac{\text{Mass in gram}}{\text{Molar mass}}$
- iv. The mass of the product is the theoretical yield.

$$\text{Theoretical yield} = \frac{\text{Actual yield}}{\% \text{ yield}} \times 100$$

Percent Yield: Percent yield is a measure of the efficiency of a chemical reaction.

Percent yield can be calculated from the balanced chemical equation it is done by divided the theoretical yield with actual yield multiplying it by 100.

$$\% \text{ yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

(b) A small piece of pure Al Metal having a volume of 2.50 cm^3 is reacted with excess of HCl. What is the weight of H_2 liberated? The density of Al is 2.70 g cm^{-3} . (Ans: 0.7529)

Volume of Al = 2.50 cm^3

Density of Al = 2.70 g cm^{-3}

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$\begin{aligned}\text{Mass of Al} &= \text{Density} \times \text{Volume} \\ &= 2.70 \times 2.50 = 6.75 \text{ g}\end{aligned}$$

$$\begin{aligned}\text{Moles of Al} &= \frac{\text{Mass in gram}}{\text{Molar Mass}} = \frac{6.25}{27} = 0.25 \text{ moles}\end{aligned}$$

According to Reaction:



$$2 \text{ moles of Al} = 3 \text{ moles of H}_2$$

$$1 \text{ mole of Al} = \frac{3}{2}$$

$$0.125 \text{ moles of Al} = \frac{3}{2} \times 0.25 = 0.375 \text{ moles}$$

$$\text{molecular mass of H}_2 = 2$$

$$\text{Mass of H}_2 \text{ in grams} = 0.375 \times 2 = 0.752 \text{ g}$$

7. How much Silver Chloride will be formed by mixing 120.0 g of Silver Nitrate with a solution of 52.0 g of NaCl.



Solution: Given mass of $\text{AgNO}_3 = 120 \text{ g}$

$$\begin{aligned}\text{Molar mass of AgNO}_3 &= 107.87 \times 1 + 14 \times 1 + 16 \times 3 \\ &= 169.87 \text{ g/mole}\end{aligned}$$

$$\text{Number of moles AgNO}_3 = \frac{\text{Mass in gram}}{\text{Molar mass}} = \frac{120}{169.868} = 0.71 \text{ moles}$$

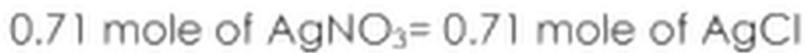
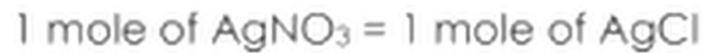
$$\text{Molar mass} \quad 169.868$$

$$\text{Mass of NaCl} = 52 \text{ g}$$

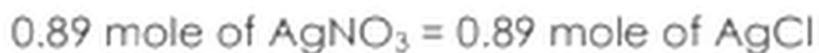
$$\text{Molar mass of NaCl} = 23 + 35.5 = 58.5 \text{ g/mole}$$

$$\text{Number of moles NaCl} = \frac{\text{mass in gram}}{\text{Molar mass}} = \frac{52}{58.5} = 0.89 \text{ moles}$$

According to the balanced chemical equation.



Also



Since, AgNO₃ produces least amount of product therefore, it is the limiting reactant.

Number of moles AgCl produces = 0.71 moles of AgCl

Molar mass of AgCl = 107.87 + 35.5 = 143.37 g/mole

Mass of AgCl produced = 0.71 × 143.37 = 101.7 g

8. Which contains more atoms, 1 mole of Fe or 1 mole of H₂? Justify your stand,

(Ans: H₂)

Solution: 1 mole of Fe atoms = 6.02 × 10²⁴ Fe atoms

1 mole of H₂ atoms = 2 × 6.02 × 10²⁴ H atoms = 12.04 × 10²⁴ H atoms

Therefore 1 mole of H₂ contains more atoms than 1 mole of Fe.

