

Unit 1: Fundamentals of Chemistry

Exercise Questions

Exercise Multiple Choice Question Answers

- Industrial chemistry deals with the manufacturing of compounds:**
(a) in the laboratory (b) on micro scale
(c) on commercial scale (d) on economic scale
- Which one of the following can be separated by physical means?**
(a) mixture (b) element (c) compound (d) radical
- The most abundant element occurring in the oceans is:**
(a) oxygen (b) hydrogen (c) nitrogen (d) silicon
- Which one of the following element is found in most abundance in the earth's crust?**
(a) oxygen (b) aluminum (c) silicon (d) iron
- The third abundant gas found in the atmosphere is:**
(a) carbon monoxide (b) oxygen. (c) nitrogen (d) argon
- One amu (atomic mass unit) is equivalent to:**
(a) 1.66×10^{-24} mg (b) 1.66×10^{-24} g (c) 1.66×10^{-21} g (d) 1.66×10^{-23} g
- All of the followings are tri-atomic molecule except:**
(a) H₂ (b) O₃ (c) H₂O (d) CO₂
- The mass of one molecule of water is:**
(a) 18 amu (b) 18 g (c) 18 mg (d) 18 kg
- The molar mass of H₂SO₄ is:**
(a) 98 g (b) 48 amu (c) 4.8 g (d) 98 amu
- Molar mass is usually expressed in grams. Which one of the following is molar mass of O₂ in amu?**
(a) 32 amu (b) 53.2×10^{-24} amu
(c) 1.92×10^{-25} amu (d) 192.64×10^{-25} amu
- How many numbers of moles are equivalent to 8 grams of CO₂?**
(a) 0.15 (b) 0.18 (c) 0.21 (d) 0.24
- Which one of the following pairs has the same number of ions?**
(a) 1 mole of NaCl and 1 mole of MgCl₂
(b) 1/2 mole of NaCl and 1/2 mole of MgCl₂
(c) 1/2 mole of NaCl and 1/3 mole of MgCl₂
(d) 1/3 mole of NaCl and 1/2 mole of MgCl₂
- Which one of the following pairs has the same mass?**
(a) 1 mole of CO and 1 mole of N₂ (b) 1 mole of CO and 1 mole of CO₂
(c) 1 mole of O₂ and 1 mole of N₂ (d) 1 mole of O₂ and 1 mole of CO₂

ANSWR KEY

1	c	3	a	5	d	7	a	9	a	11	b	13	a
2	a	4	a	6	b	8	a	10	a	12	c		

Exercise Short Questions Answers

Q.1 Define industrial chemistry and analytical chemistry.

Ans: Industrial Chemistry

“The branch of chemistry that deals with the manufacturing of chemical substances (elements and compounds) on commercial scale, is called industrial chemistry.”

Applications:

- It deals with the manufacturing of basic chemicals such as oxygen, chlorine, ammonia, caustic soda, nitric acid and sulphuric acid.
- Use of these chemicals to provide the raw materials for many other industries such as fertilizers, soap, textiles, agricultural products, paints and paper etc

Analytical Chemistry

“The branch of chemistry that deals with separation and analysis of a sample to identify its components is called analytical chemistry. The separation is carried out prior to qualitative and quantitative analysis.”

Qualitative Analysis

It provides the identity of a substance (composition of chemical species).

Quantitative Analysis

It determines the amount of each component present in the sample.

Scope

In this branch different techniques and instruments used for analysis are studied.

The scope of this branch covers food, water, environmental and clinical analyses.

Q.2 How can you differentiate between organic and inorganic chemistry?

Ans: Organic Chemistry

“The branch of chemistry that deals with the study of covalent compounds of carbon and hydrogen and their derivatives is called organic chemistry.”

Scope

Organic chemists determine the structure and properties of these naturally occurring as well as synthesized compounds.

Scope of this branch covers petroleum, petrochemicals and pharmaceutical industries.

Inorganic Chemistry

“The branch of chemistry that deals with the study of all elements and their compounds except those of compounds of carbon and hydrogen (hydrocarbons) and their derivatives is called inorganic chemistry.”

Applications

It has applications in every aspect of the chemical industry such as glass, cement, ceramics and metallurgy (extraction of metals from ores).

Q.3 Give the scope of biochemistry.

Ans: *“The branch of chemistry that deals with the study of structure, composition, and chemical reactions of substances found in living organism.”*

Scope

It covers all chemical processes taking place in living organisms such as synthesis and metabolism of bio-molecules like carbohydrates, proteins, fats etc.

Emergence of biochemistry as a separate discipline

Biochemistry emerged as a separate discipline when scientists began to study:

- i. How living things obtain energy from food?
- ii. How the fundamental biological changes occur during a disease?

Applications:

It is applied in the fields of medicine, food science and agriculture.

Q.4 How does homogeneous mixture differ from heterogeneous mixture?

Ans:

Homogeneous Mixture	Heterogeneous Mixture
<i>Mixtures that have uniform composition throughout are called homogeneous mixtures. It is called solution.</i>	<i>Those mixtures in which composition is not uniform throughout are called heterogeneous mixtures.</i>
For example: Air, gasoline and ice cream	For example: Soil, rock, wood, concrete and paint etc.

Q.5 What is the relative atomic mass? How it is related to gram?

Ans: **Relative atomic mass**

“The average mass of an atom of an element as compared to $1/12^{\text{th}}$ (one-twelfth) the mass of one atom of carbon-12 isotope is called relative atomic mass.”

Unit of relative atomic mass:

Its unit is atomic mass unit, with symbol amu.

Atomic mass unit:

“One atomic mass unit is $1/12^{\text{th}}$ the mass of one atom of carbon-12.”

When this atomic mass unit is expressed in grams it is.

$$1 \text{ amu} = 1.66 \times 10^{-24} \text{ g}$$

Q.6 Define empirical formula with example.

Ans: Empirical Formula:

"It is the simplest whole number ratio of atoms present in a compound."

The empirical formula of a compound is determined by knowing the percentage composition of a compound.

Example:

Glucose has simplest ratio 1: 2: 1 of carbon, hydrogen and oxygen respectively.

Hence its empirical formula is CH_2O .

Q.7 State three reason why do you think air is a mixture and water is a compound?

Ans: Reasons:

i. Water is a compound because it is formed by chemical combination of hydrogen and oxygen whereas air is formed by simple mixing of different gases.

ii. Water has fixed ratio between masses of hydrogen and oxygen, whereas in air ratio between masses of component gases is not fixed.

iii. Water has definite melting and boiling points whereas air does not have any fixed melting and boiling point.

Q.8 Explain why are hydrogen and oxygen considered elements whereas water as a compound.

Ans: Hydrogen and oxygen are elements because they have same type of atoms, having same atomic number and it cannot be decompose into simple substances by chemical means. Water is considered as compound because it is a substance made up of two or more elements chemically combined together in a fixed ratio by mass. As a result of this combination oxygen and hydrogen lose their own properties and produce new substance (H_2O).

Q.9 What is the significance of the symbol of an element?

Ans: Significance of the symbol of an element:

Symbols are used for elements instead of writing of their complete names. So, it takes less time/save time and element can be recognized by that symbol in all over the world.

i. Symbol represents the name of an element.

ii. It represents one atom of the element

iii. It represents one mole of atoms of the element.

iv. It represents atomic mass of an element.

v. It helps to write and understand chemical equation for different chemical reactions.

vi. Periodic table is based on symbols of different elements.

For example: Oxygen (O), Sulphur (S), Nitrogen (N)

Q.10 State the reasons: soft drink is a mixture and water is a compound.

Ans:

Mixture (Soft Drink)	Compound (Water)
• Soft drink is made up of simple mixing up of substances without any fixed ratio.	• Water is formed by chemical combination of atoms of elements hydrogen and oxygen in a fixed ratio of 1:8 by mass.
• Soft drink has heterogeneous composition.	• Water has homogeneous composition.
• Its components can be separated by physical means.	• Its components can't be separated by physical means

Q.11 Classify the following into element, compound and mixture:

- **He and H₂**
- **CO and CO₂**
- **Water and milk**
- **Gold and brass**
- **Iron and steel**

Ans:

- (i) **He and H₂:** He and H₂ are elements
- (ii) **CO and Co:** CO is a compound and Co is an element.
- (iii) **Water and milk:** Water is a compound and milk is a mixture
- (iv) **Gold and brass:** Gold is an element and brass is a mixture
- (v) **Iron and steel:** Iron is an element and steel is a mixture.

Q.12 Define atomic mass unit. Why is it needed?

Ans: **Atomic mass unit**

“The mass equal to one twelfth of the mass of a carbon -12 atom is called atomic mass unit.”

The atomic mass unit is abbreviated as amu.

1 amu = $\frac{1}{12} \times$ mass of C-12 atom

The mass of one atom of carbon -12 is 12 amu.

It is the unit used for the relative atomic mass. It is used to compare masses of atoms.

Q.13 State the nature and name of the substance formed by combining the following:

- i. Zinc + Copper ii. Water + Sugar iii. Aluminium + Sulphur**
iv. Iron + Chromium + Nickel

Ans:

(i) Zinc + Copper

It is a mixture or alloy. The name of alloy is brass.

(ii) Water + Sugar

It is a mixture. The name of mixture or solution is syrup.

(iii) Aluminium + Sulphur

It forms compound. The name of compound is aluminium -sulphide.

(iv) Iron + Chromium + Nickel

It is a mixture or alloy. The name of alloy is nichrome.

Q.14 Differentiate between molecular mass and formula mass, which of the following will be molecular formula?

- H_2O
- NaCl
- KI
- H_2SO_4

Ans:

Molecular Mass	Formula Mass
<i>i. The sum of atomic masses of all the atoms present in one molecule of a molecular substance called molecular mass.</i>	<i>i. The sum of atomic masses of all the atoms present in one formula unit of an ionic compound is called formula mass.</i>
ii. The term molecular mass is used for compounds that exist as molecules.	ii. The term formula mass is used for compounds that exists as formula units i.e. the compounds consists of ions.
For example: Molecular mass of water is 18 amu and that of carbon is 44 amu	For example: Formula mass of sodium chloride is 58.5 amu and that of CaCO_3 is 100 amu.

H_2O and H_2SO_4 are the molecular formula.

Q.15 Which has more then atoms: 10 g of Al/ or 10 g of Fe?

Ans: 10 g of Al has more atoms than 10 g of Fe.

For Al

i.

$$\begin{aligned}\text{Given mass of Al} &= 10\text{g} \\ \text{Molar mass of Al} &= 27 \text{ g mol}^{-1} \\ \text{No of atoms in 10g of Al} &= \text{No of moles} \times N_A \\ \text{Number of atom} &= \frac{\text{Mass}}{\text{Molar Mass}} \times N_A \\ &= \frac{10}{27} \times 6.02 \times 10^{23} \\ &= 2.23 \times 10^{23} \text{ atoms}\end{aligned}$$

ii.

$$\begin{aligned}\text{Given mass of Fe} &= 10\text{g} \\ \text{Molar mass of Fe} &= 56 \text{ g mol}^{-1} \\ \text{For Fe} \\ \text{Number of atom} &= \frac{\text{Mass}}{\text{Molar Mass}} \times N_A\end{aligned}$$

$$= \frac{10}{56} \times 6.02 \times 10^{23}$$

$$= 1.075 \times 10^{23}$$

Therefore: Aluminium has more number of atoms than iron.

Q.16 Which one has more molecules: 9 g of water or 9 g of sugar (C₁₂H₂₂O₁₁)?

Ans: 9 g of H₂O has more molecules than 9 g of C₁₂H₂₂O₁₁

i.

Given mass of water (H ₂ O)	= 9 g
Molar mass of water (H ₂ O)	= 18 g mol ⁻¹

Number of molecules in 9g of water	= $\frac{\text{Given Mass}}{\text{Molar Mass}} \times N_A$
	= $\frac{9}{18} \times 6.02 \times 10^{23}$ molecules
	= 3.01×10^{23} molecules

ii.

Given mass of sugar	= 9 g
Molar mass of sugar	= 342 g mol ⁻¹
Number of molecules in 9g of sugar	= $\frac{\text{Mass}}{\text{Molar Mass}} \times N_A$
	= $\frac{9}{342} \times 6.02 \times 10^{23}$
	= 1.584×10^{22} molecules

Therefore: 9 g of H₂O has more molecules than 9 g of C₁₂H₂₂O₁₁.

Q.17 Which one has more formula units: 1 g of NaCl or 1 g of KCl?

Ans:

i.

Given mass	= 1g
Formula mass of NaCl = 58.5 g mol ⁻¹	
Formula units in 1g of NaCl	= $\frac{\text{Given mass}}{\text{Formula mass}} \times N_A$
	= $\frac{1}{58.5} \times 6.02 \times 10^{23}$
	= 1.029×10^{22} formula units

ii.

Given mass of KCl	= 1g
Formula mass of KCl	= 74.5 g mol ⁻¹
Formula units	= $\frac{\text{Given mass}}{\text{Formula mass}} \times N_A$

$$= \frac{1}{74.5} \times 6.02 \times 10^{23}$$

$$= 8.080 \times 10^{21} \text{ formula units}$$

Therefore 1g of NaCl has more formula units than 1g of KCl.

Q.18 Differentiate between homoatomic and heteroatomic molecules with examples.

Ans:

Homoatomic molecules	Heteroatomic molecules
<i>A molecule containing same type of atoms is called homoatomic molecule.</i>	<i>A molecule consists of different kinds of atoms is called a heteroatomic molecule.</i>
Examples: Hydrogen (H ₂), Oxygen (O ₃) and sulphur (S ₈) These are molecules of elements	Examples: CO ₂ , H ₂ O and NH ₃ These are molecules of compounds

Q.19: In which one of the followings the number of hydrogen atoms in more? 2 moles of HCl or 1 mole of NH₃ (Hint: 1 mole of a substance contains as much number of moles of atoms as are in 1 molecule of a substance.)

Ans: No of moles of hydrogen in 1 mole of HCl = 1 mole

No of moles of hydrogen in 2 moles of HCl = 2 moles

Whereas No of moles of hydrogen in 1 mole of NH₃ = 3 moles

Hence 1 mole of NH₃ contains 3 moles of hydrogen will have more hydrogen atoms than 2 moles of hydrogen present in 2 moles of HCl.

Exercise Long Question Answers

Q.1 Define element and classify the elements with examples.

Ans: See Q. No. 4 (Subjective Part, Long Questions Answers)

Q.2 List five characteristics by which compounds can be distinguished from mixtures.

Ans: See Q. No. 9 (Subjective Part, Long Questions Answers)

Q.3 Differentiate between the following with examples:

(a) Molecule and gram molecule

(b) Atom and gram atom

(c) Molecular mass and molar mass

(d) Chemical formula and gram formula

Ans: See Q. No. 21 (Subjective Part, Long Questions Answers)

Q.4 Mole is SI unit for the amount of a substance. Define it with examples?

Ans: See Q. No. 23 (Subjective Part, Long Questions Answers)

Exercise Solved Numericals

Q.1 Sulphuric acid is the king of chemicals. If you need 5 moles of sulphuric acid for a reaction, how many grams of it will you weigh?

Given Data:

$$\begin{aligned}\text{Number of moles of H}_2\text{SO}_4 &= 5 \text{ moles} \\ \text{Molar mass of H}_2\text{SO}_4 &= 2(1) + 1(32) + 4(16) \\ &= 2 + 32 + 64 \\ &= 98 \text{ g/mol}\end{aligned}$$

To find:

$$\text{Mass of H}_2\text{SO}_4 = ?$$

Solution:

$$\begin{aligned}\text{Number of Moles} &= \frac{\text{Mass of H}_2\text{SO}_4}{\text{Molar mass of H}_2\text{SO}_4} \\ \text{Mass in grams} &= \text{No of moles} \times \text{molar mass} = 5 \times 98 = 490 \text{ g} \\ \text{Therefore, 5 moles of sulphuric acid will have mass 490 g.}\end{aligned}$$

Q.2 Calcium carbonate is insoluble in water. If you have 40 g of it; how many Ca^{2+} and CO_3^{2-} ions are present in it?

Given Data:

$$\begin{aligned}\text{Mass of calcium carbonate} &= 40\text{g} \\ \text{Molar mass of calcium carbonate} &= \text{CaCO}_3 \\ &= (40 \times 1) + (12 \times 1) + (16 \times 3) \\ &= 40 + 12 + 48 \\ &= 100 \text{ g/mol}\end{aligned}$$

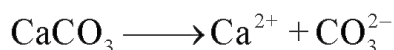
To find:

$$\begin{aligned}\text{Number of Ca}^{2+} \text{ ions} &= ? \\ \text{Number of CO}_3^{2-} \text{ ions} &= ?\end{aligned}$$

Solution:

$$\begin{aligned}\text{Number of Moles of CaCO}_3 &= \frac{\text{Mass}}{\text{Molar mass}} \\ &= \frac{40}{100} = 0.4 \text{ mol}\end{aligned}$$

Balanced equation:



$$\text{Number of moles of CaCO}_3 = 0.4 \text{ mole}$$

$$\text{Number of moles of Ca}^{2+} \text{ ions in one mole of CaCO}_3 = 6.02 \times 10^{23}$$

$$\begin{aligned}\text{Number of Ca}^{2+} \text{ ion in 0.4 moles of CaCO}_3 &= \text{No of moles} \times N_A \\ &= 0.4 \times 6.02 \times 10^{23} \\ &= 2.408 \times 10^{23} \text{ ions}\end{aligned}$$

We know that

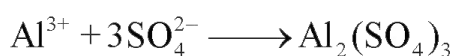
$$\begin{aligned}\text{No of Ca}^{2+} \text{ ions} &= \text{No of CO}_3^{2-} \text{ ions} \\ \text{No of CO}_3^{2-} &= 2.40 \times 10^{23} \text{ ions} \\ &= \mathbf{2.408 \times 10^{23} \text{ ions}}\end{aligned}$$

Q.3 If you have 6.02×10^{23} ions of aluminium; how many sulphate ions will be required to prepare $\text{Al}_2(\text{SO}_4)_3$?

Given Data:

$$\begin{aligned}\text{Number of ions of Al}^{3+} &= 6.02 \times 10^{23} \\ \text{Number of sulphate ions in Al}_2(\text{SO}_4)_3 &=?\end{aligned}$$

Solution:



According to balanced chemical equation:

$$\text{No of moles of SO}_4^{2-} \text{ ion required for 2 moles of Al}^{3+} \text{ ions} = 3$$

$$\text{No of moles of SO}_4^{2-} \text{ ions for 1 mole of Al}^{3+} = 3/2 = 1.5 \text{ moles}$$

$$\begin{aligned}\text{Thus, number of SO}_4^{2-} \text{ ions} &= \text{No of moles} \times N_A \\ &= 1.5 \times 6.02 \times 10^{23} \\ &= \mathbf{9.03 \times 10^{23} \text{ ions}}\end{aligned}$$

Q.4 Calculate the number of molecules of the following compounds:

a. 16 g of H_2CO_3

b. 20 g of HNO_3

c. 30 g of $\text{C}_6\text{H}_{12}\text{O}_6$

Given Data:

a. 16g of H_2CO_3

$$\begin{aligned}\text{Given mass of H}_2\text{CO}_3 &= 16\text{g} \\ \text{Molar mass of H}_2\text{CO}_3 &= 2(1)+1(12)+3(16) \\ &= 2 + 12 + 48 \\ &= 62\text{g / mol} \\ \text{Number of molecules of H}_2\text{CO}_3 &=? \\ \text{Number of molecules of H}_2\text{CO}_3 &= \frac{\text{Given mass of H}_2\text{CO}_3}{\text{Molar mass of H}_2\text{CO}_3} \times N_A \\ &= \frac{16}{62} \times 6.02 \times 10^{23} \\ &= \mathbf{1.505 \times 10^{23} \text{ molecules}}\end{aligned}$$

b. 20g of HNO_3

Given data:

$$\begin{aligned}\text{Given mass of HNO}_3 &= 20\text{g} \\ \text{Molar mass of HNO}_3 &= 1(1)+1(14)+3(16) \\ &= 1+14+48=63\text{g/mol} \\ \text{Number of molecules of HNO}_3 &=?\end{aligned}$$

Solution:

$$\begin{aligned}
 \text{Number of molecules of HNO}_3 &= \frac{\text{Given mass of HNO}_3}{\text{Molar mass of HNO}_3} \times N_A \\
 &= \frac{20}{63} \times 6.02 \times 10^{23} \\
 &= 1.91 \times 10^{23} \text{ molecules} \\
 &= \mathbf{1.908 \times 10^{23} \text{ molecules}}
 \end{aligned}$$

c. **30g of C₆ H₁₂ O₆**

Given data:

$$\text{Given mass of C}_6\text{H}_{12}\text{O}_6 = 30\text{g.}$$

$$\text{Molar mass of C}_6\text{H}_{12}\text{O}_6 = 72 + 12 + 96$$

$$= 180\text{g / mol}$$

$$\text{Number of moles of C}_6\text{H}_{12}\text{O}_6 = \frac{\text{Given mass of C}_6\text{H}_{12}\text{O}_6}{\text{Molar mass of C}_6\text{H}_{12}\text{O}_6} \times N_A$$

$$= \frac{30}{180} \times 6.02 \times 10^{23}$$

$$= \mathbf{1 \times 10^{23} \text{ molecules}}$$

Q.5 Calculate the number of ions in the following compounds:

a. 10g of AlCl₃

b. 30 g of BaCl₂

c. 58 g of H₂SO₄

Ans:

a. 10g of AlCl₃

Given Data:

$$\text{Given mass of AlCl}_3 = 10\text{g}$$

$$\text{Molar mass of AlCl}_3 = 1(27) + 3(35.5)$$

$$= 133.5 \text{ g / mol}$$

$$\text{No. of ions of AlCl}_3 = ?$$

$$\text{No of formula units of AlCl}_3 \text{ in } 10\text{g} = \frac{\text{Given mass of AlCl}_3}{\text{Molar mass of AlCl}_3}$$

$$= \frac{10}{133.5} \times 6.02 \times 10^{23}$$

$$= 0.451 \times 10^{23} \text{ formula units}$$

$$1 \text{ formula unit of AlCl}_3 \text{ contains total number of ions} = 4 \text{ ions}$$

$$0.451 \times 10^{23} \text{ formula units of AlCl}_3 \text{ contain total number of ions} = 4 \times 0.451 \times 10^{23}$$

$$= \mathbf{1.80 \times 10^{24} \text{ ions}}$$

$$\text{Therefore number of ions in } 10\text{g of AlCl}_3 = \mathbf{1.80 \times 10^{24} \text{ ions}}$$

b. 30g of BaCl₂

Given Data:

$$\text{Given mass of BaCl}_2 = 30\text{g}$$

$$\text{Molar mass of BaCl}_2 = 1(137) + 2(35.5)$$

$$= 137 + 71 = 208 \text{ g/mol}$$

$$\text{No of ions of } 30\text{g of BaCl}_2 = ?$$

$$\begin{aligned}\text{No. of formula units in 30g of BaCl}_2 &= \frac{\text{Given mass of BaCl}_2}{\text{Molar mass of BaCl}_2} \times N_A \\ &= \frac{30}{208} \times 6.02 \times 10^{23} = 0.86 \times 10^{23} \text{ formula units} \\ 1 \text{ formula unit of BaCl}_2 \text{ contains total number of ions} &= 3 \\ 0.86 \times 10^{23} \text{ formula units will contain total number of ions} &= 3 \times 0.86 \times 10^{23} \\ \text{ions} &= 2.58 \times 10^{23} \text{ ions}\end{aligned}$$

c. 58g of H₂SO₄

Given Data:

$$\begin{aligned}\text{Given mass of H}_2\text{SO}_4 &= 58\text{g} \\ \text{Molar mass of H}_2\text{SO}_4 &= 2(1)+1(32)+4(16) \\ &= 2+32+64 \\ &= 98 \text{ g/mol} \\ \text{Number of ion of H}_2\text{SO}_4 &= ? \\ \text{Number of formula units in 58g of H}_2\text{SO}_4 &= \frac{\text{Given mass of H}_2\text{SO}_4}{\text{Molar mass of H}_2\text{SO}_4} \times N_A \\ &= \frac{58}{98} \times 6.02 \times 10^{23} \\ &= 3.56 \times 10^{23} \text{ formula units} \\ 1 \text{ formula unit of H}_2\text{SO}_4 \text{ contains total number of ions} &= 3 \text{ ions} \\ 3.56 \times 10^{23} \text{ formula units of H}_2\text{SO}_4 \text{ contain total number of ions} &= 3 \times 3.56 \times 10^{23} \\ &= 10.682 \times 10^{23} \text{ ions}\end{aligned}$$

Q.6 What will be the mass of 2.05×10^{16} molecules of H₂SO₄

Ans:

Given Data:

$$\begin{aligned}\text{Number of molecules of H}_2\text{SO}_4 &= 2.05 \times 10^{16} \\ \text{Molar mass of H}_2\text{SO}_4 &= 2(1)+1(32)+4(16)=2+32+64=98\text{g/mol} \\ \text{Mass of H}_2\text{SO}_4 &= ?\end{aligned}$$

Solution:

$$\begin{aligned}\text{Number of molecules of H}_2\text{SO}_4 &= \frac{\text{Mass of H}_2\text{SO}_4}{\text{Molar mass of H}_2\text{SO}_4} \times N_A \\ 2.05 \times 10^{16} &= \frac{\text{Mass of H}_2\text{SO}_4}{98} \times 6.02 \times 10^{23} \\ \text{Mass of H}_2\text{SO}_4 &= \frac{2.05 \times 10^{16} \times 98}{6.02 \times 10^{23}} \\ &= 3.332 \times 10^{-6} \text{g}\end{aligned}$$

Q.7 How many total atoms are required to prepare 60 g of HNO_3 ?

Given Data:

$$\begin{aligned}\text{Given mass of } \text{HNO}_3 &= 60\text{g} \\ \text{Molar mass of } \text{HNO}_3 &= 1(1)+1(14)+3(16) \\ &= 1 + 14 + 48 \\ &= 63\text{g / mol} \\ \text{No of atoms of } \text{HNO}_3 &= ?\end{aligned}$$

Solution:

$$\begin{aligned}\text{Number of molecules of } \text{HNO}_3 &= \frac{\text{Given mass of } \text{HNO}_3}{\text{Molar mass of } \text{HNO}_3} \times N_A \\ &= \frac{60}{63} \times 6.02 \times 10^{23} \\ &= 0.95 \times 6.02 \times 10^{23} \text{ moles} \\ &= 5.73 \times 10^{23} \text{ molecules}\end{aligned}$$

As one molecule of HNO_3 contain atoms = 5 atoms

There fore,

$$\begin{aligned}5.73 \times 10^{23} \text{ molecules contain No of atoms} &= 5 \times 5.73 \times 10^{23} \\ &= 28.5 \times 10^{23} \\ &= \mathbf{2.87 \times 10^{24} \text{ atoms}}\end{aligned}$$

Q.8 How many ions of Na^+ and Cl^- will be present in 30 g of NaCl ?

Given Data:

$$\begin{aligned}\text{Given mass of } \text{NaCl} &= 30\text{g} \\ \text{Molar mass of } \text{NaCl} &= 1(23)+35.5 \\ &= 23 + 35.5 \\ &= 58.5\text{g / mol}\end{aligned}$$

To Find:

$$\begin{aligned}\text{No of } \text{Na}^+ \text{ ions} &= ? \\ \text{No of } \text{Cl}^- \text{ ions} &= ?\end{aligned}$$

Solution

$$\begin{aligned}\text{Number of formula units of } \text{NaCl} &= \frac{\text{Given mass of } \text{NaCl}}{\text{Molar mass of } \text{NaCl}} \times N_A \\ &= \frac{30}{58.5} \times 6.02 \times 10^{23} \\ &= 3.08 \times 10^{23} \text{ formula units}\end{aligned}$$

As,

$$\begin{aligned}1 \text{ formula unit of } \text{NaCl} \text{ contains number of } \text{Na}^+ \text{ ions} &= 1 \\ 3.08 \times 10^{23} \text{ formula units of } \text{NaCl} \text{ contain number of } \text{Na}^+ \text{ ions} &= 3.08 \times 10^{23} \text{ ions}\end{aligned}$$

We knew that in NaCl

$$\text{Number of } \text{Na}^+ \text{ ions} = \text{number of } \text{Cl}^- \text{ ion}$$

$$\text{Thus number of Cl ions} = 3.08 \times 10^{23}$$

$$\text{Total number of sodium ions } (\text{Na}^+) \text{ and chloride ions } (\text{Cl}) = 6.16 \times 10^{23} \text{ ions}$$

Q.9 How many molecules of HCl will be required to have 10 grams of it?

$$\text{Given mass of HCl} = 10\text{g}$$

$$\text{Molar mass of HCl} = 1(1)+1(35.5)=1+35.5 = 36.5\text{g / mol}$$

$$\text{Number of molecules of HCl} = ?$$

Solution:

$$\begin{aligned}\text{Number of molecules of HCl} &= \frac{\text{Given mass of HCl}}{\text{Molar mass of HCl}} \times N_A \\ &= \frac{10}{36.5} \times 6.02 \times 10^{23} \\ &= 1.64 \times 10^{23} \text{ molecules}\end{aligned}$$

Q.10 How many grams of Mg will have the same number of atoms as 6 grams of C have?

Given data

$$\text{Given mass of carbon} = 6\text{g}$$

$$\text{Atomic mass of carbon} = 12 \text{ g/ mole}$$

To find:

$$\text{Mass of Mg} = ?$$

Solution:

$$\begin{aligned}\text{No. of moles of carbon} &= \frac{\text{Given mass of Carbon}}{\text{Molar mass of Carbon}} \\ &= \frac{6}{12} \\ &= 0.5 \text{ mol}\end{aligned}$$

$$\text{Number of carbon atoms} = \text{Number of moles} \times N_A$$

$$\begin{aligned}\text{Number of carbon atoms in 0.5 moles of carbon} &= 0.5 \times 6.02 \times 10^{23} \text{ atoms} \\ &= 3.01 \times 10^{23} \text{ atoms}\end{aligned}$$

As

The number of atoms of mg and carbon are same, so their number of moles are also equal.

Thus,

$$\begin{aligned}\text{No. of atoms of Mg} &= \frac{\text{Given mass of Mg}}{\text{Molar mass of Mg}} \times N_A \\ 3.01 \times 10^{23} &= \frac{\text{mass of Mg}}{24} \times 6.02 \times 10^{23} \\ \text{Mass of Mg} &= \frac{3.01 \times 10^{23} \times 24}{6.02 \times 10^{23}} \\ &= 12\text{g}\end{aligned}$$

So

12g of Mg will have same number of atoms as 6g of carbon.