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## Syllabus

Atoms and molecules, Law of constant proportions, atomic and molecular masses, mole concept. Relationship of mole to mass of the particles and numbers.

FND-NCERT EXEMPLARS

# TOPIC-1
## Law of Chemical Combination, Atoms and Molecules, Valency, Chemical Formula of Common Compounds.

### Revision Notes

- By the end of eighteenth century, scientists recognized the differences between elements and compounds and developed various laws which explained how atoms combine to form molecules.
- Symbols and formulae of atoms and molecules were discovered by the passage of time. Antoine L. Lavoisier laid the foundation of chemical sciences by establishing two important laws of chemical combination.
- **Laws of Chemical Combination :** The two laws of chemical combination were established after much experimentations by Lavoisier and Joseph L. Proust.
- **Law of Conservation of Mass :** This law states that mass can neither be created nor destroyed in a chemical reaction.

**Activity 2.1**

- Is there a change in mass when a chemical change (chemical reaction) takes place? Let us find out with this activity.
- Take one of the following sets of X and Y chemicals :

| | X | Y |
|---|---|---|
| (i) | copper sulphate 1.25 g | sodium carbonate 1.43 g |
| (ii) | barium chloride 1.22 g | sodium sulphate 1.53 g |
| (iii) | lead nitrate 2.07 g | sodium chloride 1.17 g |

- Prepare separately a 5% solution of any one pair of substances listed under X and Y each in 10 mL in water.
- Take a little amount of solution of Y in a conical flask and some solution of X in an ignition tube.
- Hang the ignition tube in the flask carefully, see that the solutions do not get mixed. Put a cork on the flask (See Fig. 2.1)

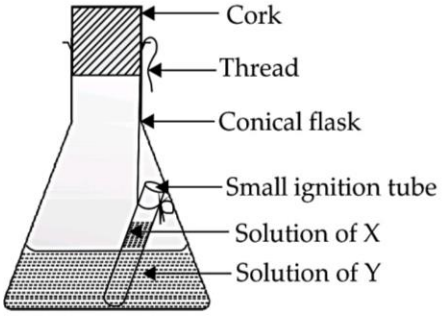



Fig. 2.1 Ignition tube containing solution of X, dipped in a conical flask, containing solution 'Y'.

- Weigh the flask with its contents carefully.
- Now tilt and swirl the flask, so that the solutions X and Y get mixed.
- Weigh again.
- What happens in the reaction flask?
- **Observation :** Mixing the solution result in chemical reactions but the mass of the flask remains the same.
- Here, when we heat the mixture separately, no reaction takes place. Since flask is closed by the cork, the vapours of water molecule do not escape and condense back to the bottom. As a result, we see no change in mass.
- When we swirl the conical flask, the mixture from the ignition tube comes out and mix with the solution in the flask. It results in the chemical reaction given below:
  - **(a)** Copper in copper sulphate displaces sodium from its carbonate and releases carbon dioxide. There is a change in the colour, the blue solution of copper sulphate change to green.
  - **(b)** Barium chloride reacts with sodium sulphate and forms a white precipitate of barium sulphate.
  - **(c)** Lead nitrate reacts with sodium chloride and forms a white precipitate of lead chloride and an aqueous solution of sodium nitrate.

➢ **Law of Constant Proportion or law of Definite Proportions :** This law states that in a chemical substance, the elements are always present in a definite proportions by mass. As in a compound such as water, the ratio of the mass of hydrogen to the mass of oxygen is always 1 : 8, whatever the source of water. Thus if 1 g of water is decomposed, 1 g of hydrogen and 8 g of oxygen are always obtained.

➢ **Postulates of Dalton's Atomic Theory :**

**(i)** Every matter is made up of very tiny particles called atoms.
**(ii)** Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction.
**(iii)** Atoms of a given element are identical in mass and chemical properties.
**(iv)** Atoms of different elements have different masses and chemical properties.
**(v)** Atoms combine in the ratio of small whole numbers to form compounds.
**(vi)** The relative number and kinds of atoms are constant in a given compound.

➢ **Atoms :** Atoms are the building blocks of all the matters.

➢ They are the smallest particles of an element which may or may not have an independent existence but participate in the chemical reaction.

➢ **How big are atoms?**

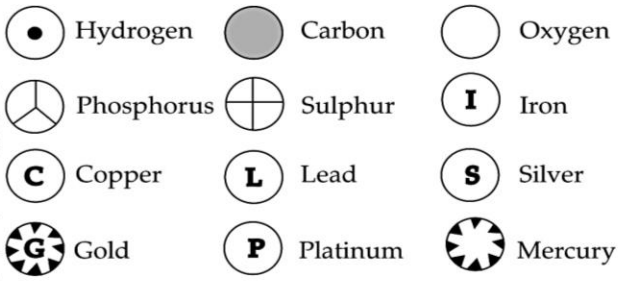
Atoms are very small. They are smaller than anything that we can imagine or compare with. Atomic radius is measured in nanometers.

$$1/10^9 \text{ m} = 1 \text{ nm}$$
$$1\text{m} = 10^9 \text{ nm}$$

➢ **Modern Day Symbols of Atoms of Different Elements :**

Dalton was the first scientist to use the symbols for elements in a very specific sense. Berzelius suggested that the symbols of elements be made from one or two letters of the name of the element.

Each element has a unique name and a unique symbol. Now-a-days IUPAC (International Union of Pure and Applied Chemistry) is an international scientific organisation which approves names of elements, symbols and units.



Symbols for some elements as proposed by Dalton

➢ **Rules for assigning symbols for atoms of various elements are as follows :**

**(i)** The abbreviation used to represent an element is generally the first letter of the elements name in English.

| | English name of element | Symbol |
|---|---|---|
| 1. | Hydrogen | H |
| 2. | Boron | B |
| 3. | Oxygen | O |
| 4. | Nitrogen | N |
| 5. | Fluorine | F |

**(ii)** When the names of two or more elements are beginning with the same initial letter, the initial letter is followed by the letter appearing latter in the name.

| | Name of element | Symbol |
|---|---|---|
| 1. | Barium | Ba |
| 2. | Bismuth | Bi |
| 3. | Bromine | Br |
| 4. | Silicon, Sulphur | Si, S |
| 5. | Cadmium Calcium | Cd, Ca |

**(iii)** Symbol of some elements are derived from their Latin, Greek or German names.

| | Name of element | Latin/Greek/German name | Symbol |
|---|---|---|---|
| 1. | Sodium | Natrium | Na |
| 2. | Potassium | Kalium | K |
| 3. | Copper | Cuprum | Cu |
| 4. | Iron | Ferrum | Fe |
| 5. | Gold | Aurum | Au |
| 6. | Silver | Argentum | Ag |

- **Atomic mass :**

  According to Dalton, each element has a characteristic atomic mass. But determining the mass of an individual atom was a relatively difficult task due to the small size of an atom so the relative atomic masses were determined using the laws of chemical combinations and the compound formed.

  However, in 1961 for a universally accepted atomic mass unit, C-12 isotope was chosen as a standard reference for measuring atomic masses. One atomic mass unit is a mass unit equal to exactly one twelfth the mass of one atom of carbon-12.

- The relative atomic masses of all elements have been found with respect to an atom of carbon-12.
- **Relative atomic mass** of the atom of an element is defined as the average mass of the atom as compared to $1/12^{th}$ the mass of one carbon -12 atom.
- **Atomic masses of few elements :**

| Element | Atomic Mass (u) |
|---|---|
| Hydrogen | 1 |
| Carbon | 12 |
| Nitrogen | 14 |
| Oxygen | 16 |
| Sodium | 23 |
| Magnesium | 24 |
| Sulphur | 32 |
| Chlorine | 35.5 |
| Calcium | 40 |

- **How do atoms exists?** Atoms of most elements are not able to exist independently. Atoms form molecules and ions.
- **Molecule :** It is atom or group of bonded atoms that exist independently. It is capable of independent existence and shows all the properties of that substance.
- It is a group of two or more atoms that are chemically bonded together. Atoms of the same element or of different elements can join together to form molecules.
- Molecules can be divided into two categories :

**1. Molecules of Elements :**

The molecules of an element are made up of the same type of atoms. Molecules of many elements such as argon (Ar), helium (He) are made up of only one atom of that element. A molecule of oxygen ($O_2$) contains two atoms of oxygen and is known as diatomic molecule and ozone ($O_3$) consists of three atoms of oxygen and is known as triatomic molecule.

**Atomicity :** The number of atoms constituting a molecule is known as its atomicity.

Metals and some other elements such as carbon do not have a simple structure but consists of a very large and indefinite number of atoms bonded together.

**Atomicity of some elements :**

| Type of Element | Name | Atomicity |
|---|---|---|
| Non-Metal | Argon | Monoatomic |
| | Helium | Monoatomic |
| | Oxygen | Diatomic |
| | Hydrogen | Diatomic |
| | Nitrogen | Diatomic |
| | Chlorine | Diatomic |
| | Phosphorus | Tetra-atomic |
| | Sulphur | Poly-atomic |

2. **Molecules of some Compounds :**

Atoms of different elements join together in definite proportions to form molecules of compounds.

**Examples :**

| Compound | Combining Elements | Ratio by Mass |
|---|---|---|
| Water ($H_2O$) | Hydrogen, Oxygen | 1 : 8 |
| Ammonia ($NH_3$) | Nitrogen, Hydrogen | 14 : 3 |
| Carbon dioxide ($CO_2$) | Carbon, Oxygen | 3 : 8 |

➢ **Calculation of Number of atoms from Mass Ratio :**

In order to calculate the number of atoms from mass ratio, divide the given mass of each element by the atomic mass of the element and calculate the simplest ratio from them.

**Activity 2.2**

- Refer to table for ratio by mass of atoms present in molecules and for atomic masses of elements.
- Find the ratio by number of the atoms of elements in the molecules of compounds given in Table.
- The ratio by number of atoms for a water molecule can be found as follows :

| Element | Ratio by mass | Atomic mass (u) | Mass ratio/ atomic mass | Simplest ratio |
|---|---|---|---|---|
| H | 1 | 1 | $\frac{1}{1} = 1$ | 2 |
| O | 8 | 16 | $\frac{8}{16} = \frac{1}{2}$ | 1 |

- Thus, the ratio by number of atoms for water is H:O = 2:1.

➢ **Ions :** Compounds composed of metals and non-metals contain charged species. The charged species are known as ions.

Symbol
[Charged species]

**CATIONS**
- Positively charged ions
- Formed when elements loses electrons
- Usually metals form cations
- eg : $K^+$, $Na^+$, $Ca^{2+}$, $Al^{3+}$

**ANIONS**
- Negatively charged ions
- Formed when elements gain electrons
- Usually non-metals form anions
- eg : $Br^-$, $Cl^-$, $O^{2-}$, $N^{3-}$

**POLYATOMIC IONS**
- Group of atoms that carry charge which act as a single entity
- Carries a fixed charge.
- eg : $SO_4^{2-}$ (Sulphate ion), $NO_3^{2-}$ (Nitrate ion), $CO_3^{2-}$ (Carbonate ion)

- **Some ionic compounds :**

| Ionic Compound | Constituting Elements | Ratio by Mass |
|---|---|---|
| Calcium oxide | Calcium and oxygen | 5:2 |
| Magnesium sulphide | Magnesium and sulphur | 3:4 |
| Sodium chloride | Sodium and chlorine | 23:35.5 |

- **Valency :** The combining capacity of an element is called its valency. It is used to know how the atoms of one element will combine with the atoms of the other element and form a chemical compound. The valency of an ion is equal to the charge on the ion.
- **Names and symbols of some ions :**

| Valency | Name of ion | Symbol | Non-metallic element | Symbol | Polyatomic ions | Symbol |
|---|---|---|---|---|---|---|
| 1. | Sodium<br>Potassium<br>Silver<br>Copper (I)* | $Na^+$<br>$K^+$<br>$Ag^+$<br>$Cu^+$ | Hydrogen<br>Hydride<br>Chloride<br>Bromide<br>Iodide | $H^+$<br>$H^-$<br>$Cl^-$<br>$Br^-$<br>$I^-$ | Ammonium<br>Hydroxide<br>Nitrate<br>Hydrogen carbonate | $NH_4^+$<br>$OH^-$<br>$NO_3^-$<br>$HCO_3$ |
| 2. | Magnesium<br>Calcium<br>Zinc<br>Iron (II)*<br>Copper (II)* | $Mg^{2+}$<br>$Ca^{2+}$<br>$Zn^{2+}$<br>$Fe^{2+}$<br>$Cu^{2+}$ | Oxide<br>Sulphide | $O^{2-}$<br>$S^{2-}$ | Carbonate<br>Sulphite<br>Sulphate | $CO_3^{2-}$<br>$SO_3^{2-}$<br>$SO_4^{2-}$ |
| 3. | Aluminium<br>Iron (III)* | $Al^{3+}$<br>$Fe^{3+}$ | Nitride | $N^{3-}$ | Phosphate | $PO_4^{3-}$ |

*Some elements show more than one valency. A Roman numeral shows their valency in a bracket.

- **Writing Chemical Formula :** The chemical formula of a compound is a symbolic representation of its composition.
- **There are some rules which are important while writing a chemical formula :**

**(1)** The valencies or charges on the ion must be balanced.

**(2)** When a compound consists of a metal and a non-metal, the name or symbol of the metal is written first. For example, Calcium oxide (CaO), sodium chloride (NaCl), iron sulphide (FeS), copper oxide (CuO) etc. Where oxygen, chlorine, sulphur are non-metals and are written on the right, where as calcium, sodium, iron and copper are metals and are written on the left.

**(3)** In compounds formed with polyatomic ions, the number of ions present in the compound is indicated by enclosing the formula of ion in a bracket and writing the number of ions outside the bracket.

For example, $Mg(OH)_2$. In case, the number of polyatomic ion is one, the bracket is not required. For example, NaOH.

- **Formula of simple compounds**

**The rules for writing the chemical formula for simple compounds are as follows :**

**(a)** Write the symbols of the elements with their valencies.

**(b)** Write the symbol of cation (positive ion) followed by the symbol of anion (negative ion).

**(c)** Cross over the valencies or charges of the combining atoms to get the formula.

**(d)** The positive and negative charges must balance each other and the overall compound (or formula) formed must be neutral.

➢ **Examples :**

1. **Formula of hydrogen chloride**

Symbol H Cl
Valency 1 1

**Formula :** HCl

2. **Formula of hydrogen sulphide**

Symbol H S
Valency 1 2

**Formula :** $H_2S$

3. **Formula of carbon tetrachloride**

Symbol C Cl
Valency 4 1

**Formula :** $CCl_4$

4. **Formula of magnesium chloride**

Symbol Mg Cl
Valency 2+ 1–

**Formula :** $MgCl_2$

Thus, in magnesium chloride, there are two chloride ions ($Cl^-$) for each magnesium ion ($Mg^{2+}$). The positive and negative charges must balance each other and the overall structure must be neutral. Note that in the formula, the charges on the ions are not indicated.

➢ **Some more examples**

(a) **Formula for aluminium oxide :**

Symbol Al O
Valency 3+ 2–

**Formula :** $Al_2O_3$

(b) **Formula for calcium oxide :**

Symbol Ca O
Valency 2+ 2–

**Formula :** CaO

Here, the valencies of the two elements are the same. You may arrive at the formula $Ca_2O_2$. But we simplify the formula as CaO.

## SELF ASSESSMENT – 1

### I. OBJECTIVE TYPE QUESTIONS [1 mark each]

#### A. Multiple Choice Questions

AI R **Q. 1. According to the Dalton's atomic theory, all matter is made of tiny particles called _____.**

(a) Molecules (b) Moles
(c) Atoms (d) Elements

AI R **Q. 2. What is the full form of IUPAC?**

(a) International Union of Pure and Applied Chemistry
(b) International Union Power of Applied Chemistry
(c) Internal Union of Pure Applied Chemistry
(d) International Universal Pure and Applied Chemistry

#### B. Passage Based Questions

**Q. 1. Read the given passage and answer the following questions.**

**Sanjana observed that when 3.0 gm of carbon is burnt in 8.0 gm of oxygen, 11.0 gm of carbon dioxide is produced. Based on the given information, answer the following questions.**

(a) Explain the above result.
(b) Name the law of chemical combination will govern your answer ?
(c) State the law.
(d) Which postulate of Dalton's atomic theory is the result of law of conservation of mass?

#### C. Assertion and Reason type questions. [2+2]

**Directions : In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:**

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

**Q. 1. Assertion :** Carbonates are polyatomic ions.

**Reason :** The carbonate ion consists of one carbon atom and three oxygen atoms and carries an overall charge of 2-

**Q. 2. Assertion :** Water molecules always contain hydrogen and oxygen in the ratio 1:8.

**Reason :** Water obeys law of constant proportions irrespective of source and method of preparation.

### D. Very short answer type questions.

AI **Q. 1.** Define atomicity. ®

AI **Q. 2.** What are the combining elements in water? ®

## II. SHORT ANSWER TYPE QUESTIONS-I [2 marks each]

**Q. 1.** Show the formation of chemical formulae of following compounds usings their ions :
(i) Ammonium sulphate
(ii) Magnesium nitrate

®+Ⓤ **(Board Term-II, 2016)**

**Q. 2.** Carbon and oxygen react in the ratio of 3 : 8 by mass to form carbon dioxide.
Calculate the amount of oxygen required to burn 6 gm of carbon. Which law of chemical combination governs your answer? State the law.

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## III. SHORT ANSWER TYPE QUESTIONS-II [3 marks each]

Ⓚ **Q. 1. (a)** What are anions ?

**(b)** Write the chemical formulae of the following compounds :
**(i)** Ammonium hydroxide
**(ii)** Calcium chloride

**(c)** Calculate the molecular mass of $H_2SO_4$.

Ⓤ **Q. 2. (a)** From the symbol $_{16}S^{32}$ state :
**(i)** Atomic number of sulphur
**(ii)** Mass number of sulphur
**(iii)** Electronic configuration of sulphur

**(b)** Which of the two elements given below would be chemically more reactive, 'X' of atomic number 18 or element 'Z' of atomic number 16 and why ?

## IV. LONG ANSWER TYPE QUESTIONS [5 marks each]

**Q. 1.** With the help of a labelled diagram describe an activity to demonstrate the law of conservation of mass.

# TOPIC-2
## Atomic and Molecular Masses, Mole concept, Relationship of Mole to Mass of the Particles and Numbers

## Revision Notes

➢ **Molecular Mass**

The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of a substance. It is, therefore, the relative mass of a molecule expressed in atomic mass unit (u).

**Example**

**(a) Calculate the relative molecular mass of water ($H_2O$).**

**(b) Calculate the molecular mass of $HNO_3$.**

**Solution :**

**(a)** Atomic mass of hydrogen = 1u,
Atomic mass of oxygen = 16 u

So, the molecular mass of water, which contains two atoms of hydrogen and one atom of oxygen is

$= 2 \times 1 + 1 \times 16$
$= 18$ u

**(b)** The molecular mass of $HNO_3$ = the atomic mass of H + the atomic mass of N + 3 x the atomic mass of O
$= 1 + 14 + 48 = 63$ u

- **Formula Unit Mass**

  The formula unit mass of a substance is the sum of the atomic masses of all the atoms in a formula unit of a compound.

  **Example : Sodium chloride has a formula unit NaCl.**

  Its formula unit mass can be calculated as :

  $1 \times 23 + 1 \times 35.5 = 58.5$ u

  **Example : Calculate the formula unit mass of $CaCl_2$.**

  **Solution :**

  Atomic mass of Ca + 2 (atomic mass of Cl)

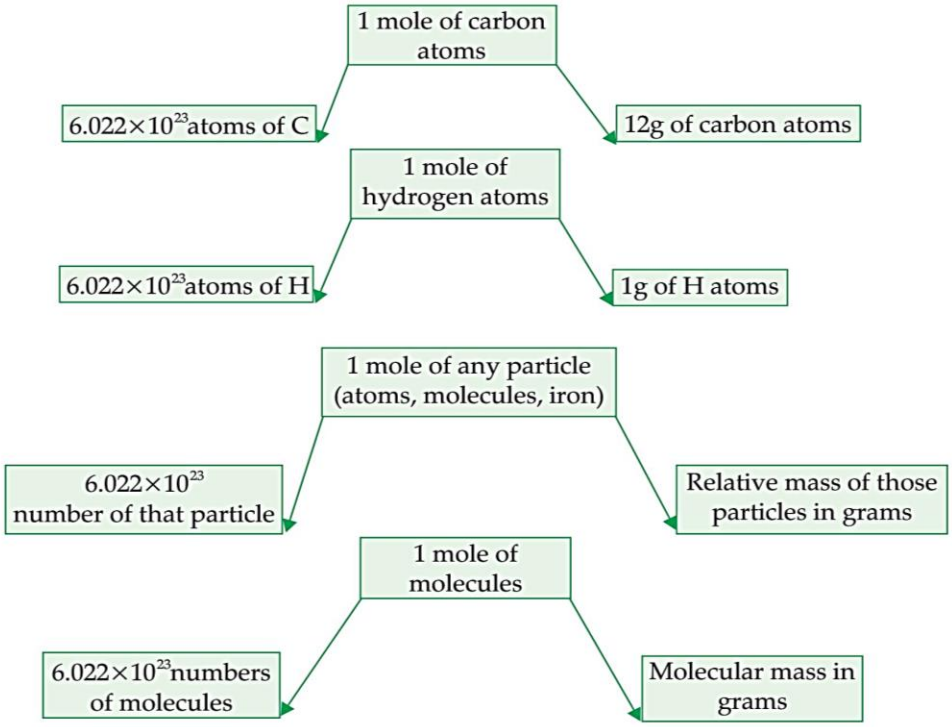
  $= 40 + 2 \times 35.5 = 40 + 71 = 111$ u

- **Mole Concept**

  One mole of any species (atoms, molecules, ions or particles) is that quantity in number having a mass equal to its atomic or molecular mass in grams.

  It can also be defined as the amount of substance that contains Avogadro's number ($6.022 \times 10^{23}$) of particles.

  It is the amount of substance that contains the same number of particles as there are atoms in exactly 12g of carbon-12.




Relationship between mole, Avogadro number and mass

- Mass of 1 mole of a substance is called its molar mass. It is expressed in g/mol.
- Mass of 1 mole of a particular substance is also fixed.
- Atoms of different elements are of different sizes and masses. A mole of one type will have a different mass from a mole of another type of atoms.
- **Molar mass** is the mass of one mole of a substance.
- **Gram atomic mass** is the atomic mass of an element expressed in terms of grams.

  **Example :**

  **1. Calculate the number of moles for the following :**

  **(i) 52 g of He (finding mole from mass)**

  **(ii) $12.044 \times 10^{23}$ number of He atoms (finding mole from number of particles)**

  **Solutions :**

  No. of moles = $n$

  Given mass = $m$

  Molar mass = M

  Given number of particles = N

  Avogadro number of particles = $N_a$

**(i)** Atomic mass of He = 4 u

Molar mass of He = 4g

Thus, the number of moles

$$= \frac{\text{given mass}}{\text{molar mass}}$$

$$n = \frac{m}{M} = \frac{52}{4} = 13$$

**(ii)** We know,

1 mole = $6.022 \times 10^{23}$

The number of moles

$$= \frac{\text{given number of particles}}{\text{Avogadro number}}$$

$$n = \frac{N}{N_a} = \frac{12.44 \times 10^{23}}{6.022 \times 10^{23}} = 2$$

**Example :**

**Calculate the mass of the following :**

**(i) 0.5 mole of $N_2$ gas (mass from mole of molecule)**

**(ii) 0.5 mole of N atoms (mass from mole of atom)**

**(iii) $3.011 \times 10^{23}$ number of N atoms (mass from number)**

**(iv) $6.022 \times 10^{23}$ number of $N_2$ molecules (mass from number)**

**Solutions :**

**(i)** mass = molar mass x number of moles

$m = M \times n = 28 \times 0.5 = 14$ g

**(ii)** mass = molar mass x number of moles

$m = M \times n = 14 \times 0.5 = 7$ g

**(iii)** The number of moles, $n$

$$= \frac{\text{given number of particles}}{\text{Avogadro number}} = \frac{N}{N_0}$$

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

$$m = M \times n = 14 \times \frac{3.011 \times 10^{23}}{6.022 \times 10^{23}}$$

$$= 14 \times 0.5 = 7g$$

**(iv)** $n = \frac{N}{N_0}$

$$m = M \times \frac{N}{N_0} = 28 \times \frac{6.022 \times 10^{23}}{6.022 \times 10^{23}}$$

$= 28 \times 1 = 28$ g

**Example :**

**Calculate the number of particles in each of the following :**

**(i)** 46 g of Na atoms (number from mass)

**(ii)** 8 g $O_2$ molecules (number of molecules from mass)

**(iii)** 0.1 mole of carbon atoms (number from given moles)

**Solutions :**

**(i)** The number of atoms

$$= \frac{\text{given mass}}{\text{molar mass}} \times \text{Avogadro number}$$

$$N = \frac{m}{M_0} \times N_0$$

$$N = \frac{46}{23} \times 6.022 \times 10^{23}$$

$$N = 12.044 \times 10^{23}$$

**(ii)** The number of molecules

$$= \frac{\text{given mass}}{\text{molar mass}} \times \text{Avogadro number}$$

$$N = \frac{m}{M} \times N_0$$

atomic mass of oxygen = 16u

molar mass of $O_2$ molecules

$16 \times 2 = 32$ g

$$N = \frac{8}{32} \times 6.022 \times 10^{23}$$

$$N = 1.5055 \times 10^{23}$$

$$= 1.51 \times 10^{23}$$

**(iii)** The number of particles (atoms) = number of moles of particles × Avogadro number

$$N = n \times N_0 = 0.1 \times 6.022 \times 10^{23}$$

$$= 6.022 \times 10^{22}$$

# SELF ASSESSMENT – 2

## I. OBJECTIVE TYPE QUESTIONS [1 mark each]

### A. Multiple Choice Questions

AI K **Q. 1. An atom contains 6 protons and 8 neutrons. What should be its atomic number?**

**(a)** 14 **(b)** 6
**(c)** 8 **(d)** 2

AI K **Q. 2. Which of the following has maximum number of atom ?**

**(a)** 18 g of $H_2O$
**(b)** 18 g of $O_2$
**(c)** 18 g of $CO_2$
**(d)** 18 g of $CH_4$

### B. Passage Based Questions

AI **Q. 1. Rahul took 5 moles of carbon atoms in a container and Sohan also took 5 moles of sodium atoms in another container of same weight.**

**(a)** Which container is heavier?
**(b)** Whose container has more number of atoms?
**(c)** What is Avogadro's constant ?
**(d)** How many atoms are there in 1 gm of hydrogen?

### C. Assertion and Reason type questions

**Directions : In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:**

**(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).**

**(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).**

**(c) Assertion (A) is true but reason (R) is false.**

**(d) Assertion (A) is false but reason (R) is true.**

**Q. 1. Assertion :** Magnesium and chloride ion combine to form a compound having chemical formula $MgCl_2$.

**Reason :** Magnesium and chloride ion contain + 1 and –2 charges respectively.

**Q. 2. Assertion :** Molecular weight of $SO_2$ is double to that of $O_2$.

**Reason :** One mole of $SO_2$ contains double the number of molecules present is one mole of $O_2$ .

### D. Very short answer type question

AI **Q. 1.** What is the chemical formula of ammonium phosphate? R

AI **Q. 2.** What is the valency of sodium ? R

AI **Q. 3.** Give an example of tetra-atomic molecule. U

## II. SHORT ANSWER TYPE QUESTIONS-I [2 marks each]

**Q. 1. (i)** Explain what do you understand by Avogadro constant?

**(ii)** Calculate the number of moles for 56 g of Ne. (Atomic mass Ne = 20 u)

R+A **(Board Term-II, 2016)**

**Q. 2.** Define formula unit mass. How is it calculated? Write the formula for unit mass of $(NH_4)_2SO_4$. (Given : Atomic mass : N = 14 u, H = 1 u, S = 32 u, O = 16 u) A **(Board Term-II, 2012)**

## III. SHORT ANSWER TYPE QUESTIONS-II [3 marks each]

AI K **Q. 1.** Define formula unit mass. How is it calculated? Write the formula for unit mass of $(NH_4)_2SO_4$. (Given : Atomic mass : N = 14 u, H = 1 u, S = 32 u, O = 16 u)

K **Q. 2.** Identify the polyatomic ions in the following compounds and compute the molar mass of the compounds.

**(i)** $MgCO_3$ **(ii)** $Na_2SO_4$

[Given that atomic mass of Mg = 24 u, C = 12 u, O = 16 u, S = 32 u, Na = 23 u]

## IV. LONG ANSWER TYPE QUESTIONS [5 marks each]

AI K+U **Q. 1. (i)** What do the following symbols / formulae stand for :

**(a)** 2O **(b)** $O_2$
**(c)** $O_3$ **(d)** $H_2O$ ?

**(ii)** Give the chemical formula of the following compounds :

**(a)** Potassium carbonate
**(b)** Calcium chloride

**(iii)** Calculate the formula unit mass of $Al_2(SO_4)_3$. (Given : Atomic mass of Al = 27 u, S = 32 u, O = 16 u)

# NCERT CORNER

## Intext Exercise

**Q. 1. In a reaction 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide, 0.9 g water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass.**

**Sodium carbonate + ethanoic acid → sodium ethanoate + carbon dioxide + water.**

**[NCERT Q. 1, Page 32]**

**Ans.** In a reaction, sodium carbonate reacts with ethanoic acid to produce sodium ethanoicate, carbon dioxide, and water.

Sodium carbonate + ethanoic acid → sodium ethanoate + Carbon dioxide + Water

Mass of sodium carbonate = 5.3 g (Given)

Mass of ethanoic acid = 6 g (Given)

Mass of sodium ethanoate = 8.2 g (Given)

Mass of carbon dioxide = 2.2 g (Given)

Mass of water = 0.9 g (Given)

Now, total mass before the reaction = (5.3 + 6) g = 11.3 g

and total mass after the reaction = (8.2 + 2.2 + 0.9) g = 11.3 g

Therefore, total mass before the reaction = Total mass after the reaction

Hence, the given observations are in agreement with the law of conservation of mass.

**Q. 2. Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas? [NCERT Q. 2, Page 33]**

**Ans.** The ratio of hydrogen and oxygen by mass to form water is 1 : 8. Then, the mass of oxygen gas required to react completely with 1 g of hydrogen gas is 8 g. Thus, the mass of oxygen gas required to react completely with 3 g of hydrogen gas is $8 \times 3 = 24$ g.

**Q. 3. Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?**

**[NCERT Q. 3, Page 33]**

**Ans.** The postulate of Dalton's atomic theory which is a result of the law of conservation of mass is "Atoms are indivisible particles, which can neither be created nor destroyed in a chemical reaction".

**Q. 4. Which postulate of Dalton's atomic theory can explain the law of definite proportions?**

**[NCERT Q. 4, Page 33]**

**Ans.** The postulate of Dalton's atomic theory which can explain the law of definite proportion is "The relative number and kind of atoms in a given compound remain constant".

**Q. 5. Define atomic mass unit. [NCERT Q. 1, Page 35]**

**Ans.** Mass unit equal to exactly one-twelfth the mass of one atom of carbon-12 is called one atomic mass unit. It is written as 'u'.

**Q. 6. Why is it not possible to see an atom with naked eyes? [NCERT Q. 2, Page 35]**

**Ans.** The size of an atom is so small that it is not possible to see it with naked eyes. Also, atom of an element does not exist independently.

**Q. 7. Write down the formula of**

**(i) Sodium oxide**

**(ii) Aluminium chloride**

**(iii) Sodium sulphide**

**(iv) Magnesium hydroxide [NCERT Q. 1, Page 39]**

**Ans.** **(i)** Sodium oxide → $Na_2O$

**(ii)** Aluminium chloride → $AlCl_3$

**(iii)** Sodium sulphide → $Na_2S$

**(iv)** Magnesium hydroxide → $Mg(OH)_2$

**Q. 8. Write down the name of compounds represented by the following formulae :**

**(i)** $Al_2(SO_4)_3$.

**(ii)** $CaCl_2$.

**(iii)** $K_2SO_4$.

**(iv)** $CaCO_3$. **[NCERT Q. 2, Page 39]**

**Ans.** **(i)** $Al_2(SO_4)_3$ → Aluminium sulphate

**(ii)** $CaCl_2$ → Calcium chloride

**(iii)** $K_2SO_4$ → Potassium sulphate

**(iv)** $CaCO_3$ → Calcium carbonate

**Q. 9. What is meant by the term chemical formula?**

**[NCERT Q. 3, Page 39]**

**Ans.** The chemical formula of a compound means the symbolic representation of the composition of a compound.

From the chemical formula of a compound, we can know the number and kinds of atoms of different elements that constitute the compound.

For example, from the chemical formula $CO_2$, carbon dioxide, we come to know that one carbon atom and two oxygen atoms are chemically bonded together to form one molecule of the compound, carbon dioxide.

**Q. 10. How many atoms are present in a**

**(i) $H_2S$ molecule, and**

**(ii) $PO_4$ ion? [NCERT Q. 4, Page 39]**

**Ans. (i)** In a $H_2S$ molecule, three atoms are present; two of hydrogen and one of sulphur.

**(ii)** In a $PO_4$ ion, five atoms are present; one of phosphorus and four of oxygen.

**Q. 11. Calculate the formula unit masses of ZnO, $Na_2O$, $K_2CO_3$, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.**

**[NCERT Q. 2, Page 40]**

**Ans.** Formula unit mass of ZnO = Atomic mass of Zn + Atomic mass of O
= 65 + 16 = 81 u

Formula unit mass of $Na_2O$ = 2 × Atomic mass of Na + Atomic mass of O
= 2 × 23 + 16 = 62 u

Formula unit mass of $K_2CO_3$ = 2 × Atomic mass of K+Atomic mass of C+ 3 × Atomic mass of O
= 2 × 39 + 12 + 3 × 16 = 138 u

**Q. 12. If one mole of carbon atoms weighs 12 g, what is the mass (in g) of 1 atom of carbon?**

**[NCERT Q. 1, Page 42]**

**Ans.** One mole of carbon atoms weighs 12 g (Given)

*i.e.*, mass of 1 mole of carbon atoms = 12 g

Then, mass of $6.022 \times 10^{23}$ number of carbon atoms = 12 g

Therefore, mass of 1 atom of carbon

$$= \frac{12}{6.022 \times 10^{23}}$$

$$= 6.022 \times 10^{23} \text{ g}$$

**Q. 13. Which has more number of atoms, 100 grams of sodium or 100 grams of iron (given, atomic mass of Na = 23 u, Fe = 56 u)?** **[NCERT Q. 2, Page 42]**

**Ans.** Atomic mass of Na = 23 u (Given)

Then, gram atomic mass of Na = 23 g

Now, 23 g of Na contains = $6.022 \times 10^{23}$ number of atoms

Thus,

$$100\text{g of Na contains} = \frac{6.022 \times 10^{23} \times 100}{23} \text{ number of atoms}$$

$$= 2.6182 \times 10^{24} \text{ number of atoms}$$

Again, atomic mass of Fe = 56 u (Given)

Then, gram atomic mass of Fe = 56 g

Now, 56 g of Fe contains = $6.022 \times 10^{23}$ number of atoms

Thus,

$$100 \text{ g of Fe} = \frac{6.022 \times 10^{23} \times 100}{56} \text{ number of atoms}$$

$$= 1.0753 \times 10^{24} \text{ number of atoms}$$

Therefore, 100 grams of sodium contain more number of atoms than 100 grams of iron.

**Commonly Made Error**

- Students do mistakes while writing chemical formulas.

**Answering Tip**

- Remember the valency of elements. Use Criss Cross method while writing chemical formula.

## NCERT Exercise

**Q. 1. A 0.24 g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen.**

**Calculate the percentage composition of the compound by weight.**

**Ans.** Mass of the given sample compound = 0.24g

Mass of boron in the given sample compound = 0.096g

Mass of oxygen in the given sample compound = 0.144g% composition of compound = % of boron and % of oxygen

Therefore % of boron = (mass of boron)/(mass of the sample compound) x 100 = 40%

Therefore % of oxygen = (mass of oxygen) / (mass of the sample compound) x 100 = 60%

**Q. 2. When 3.0 g of carbon is burnt in 8.00 g oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen? Which law of chemical combinations will govern your answer?**

**Ans.** Carbon + Oxygen → Carbon dioxide

3 g of carbon reacts with 8 g of oxygen to produce 11 g of carbon dioxide.

If 3 g of carbon is burnt in 50 g of oxygen, then 3 g of carbon will react with 8 g of oxygen.

The remaining 42 g of oxygen will be left unreactive.

In this case also, only 11 g of carbon dioxide will be formed.

The answer is governed by the law of constant proportions.

**Q. 3. What are polyatomic ions? Give examples.**

**Ans.** A polyatomic ion is a group of atoms carrying a charge (positive or negative).

For example, ammonium ion ($NH_4^{+}$), hydroxide ion ($OH^-$), carbonate ion ($CO_3^-$), sulphate ion ($SO_4^-$).

**Q. 4. Write the chemical formula of the following :**

**(a) Magnesium chloride.**

**(b) Calcium oxide.**

(c) **Copper nitrate.**
(d) **Aluminium chloride.**
(e) **Calcium carbonate.**
(f) **Hydrogen chloride.**

**Ans. (a)** Magnesium chloride → $MgCl_2$
(b) Calcium oxide → CaO
(c) Copper nitrate → $Cu(NO_3)_2$
(d) Aluminium chloride → $AlCl_3$
(e) Calcium carbonate → $CaCO_3$
(f) Hydrogen chloride → HCl

**Q. 5. Give the names of the elements present in the following compounds :**
**(a) Quick lime** **(b) Hydrogen bromide**
**(c) Baking powder** **(d) Potassium sulphate**

**Ans.**

| Compound | Chemical formula | Elements present |
|---|---|---|
| Quick lime | CaO | Calcium, Oxygen |
| Hydrogen bromide | HBr | Hydrogen, Bromine |
| Baking powder | $NaHCO_3$ | Sodium, Hydrogen, Carbon, Oxygen |
| Potassium sulphate | $K_2SO_4$ | Potassium, Sulphur, Oxygen |

**Q. 6. Calculate the molar mass of the following substances :**
**(a) Ethyne, $C_2H_2$.**
**(b) Sulphur molecule, $S_8$.**
**(c) Phosphorus molecule, $P_4$ (atomic mass of phosphorus = 31) .**
**(d) Hydrochloric acid, HCl.**
**(e) Nitric acid, $HNO_3$.**

**Ans. (a)** Molar mass of ethyne,
$C_2H_2 = 2 \times 12 + 2 \times 1 = 26g$
(b) Molar mass of sulphur molecule,
$S_8 = 8 \times 32 = 256$ g
(c) Molar mass of phosphorus molecule,
$P_4 = 4 \times 31 = 124$ g
(d) Molar mass of hydrochloric acid,
$HCl = 1 + 35.5 = 36.5$ g
(e) Molar mass of nitric acid,
$HNO_3 = 1 + 14 + 3 \times 16 = 63$ g

**Q. 7. What is the mass of**
**(a) 1 mole of nitrogen atoms?**
**(b) 4 moles of aluminium atoms (Atomic mass of aluminium = 27)?**
**(c) 10 moles of sodium sulphite ($Na_2SO_3$)?**

**Ans. (a)** 1 mole of nitrogen atoms = 1 × mass of N = 1 × 14 = 14g
**(b)** 4 moles of aluminium atoms = 4 × 27 = 108 g
**(c)** 10 moles of sodium sulphite ($Na_2SO_3$) = 10 × Mass of $Na_2SO_3$.
Mass of $Na_2SO_3$ = 2 × Mass of N a atom + 1 × Mass of S atom + 3 × Mass of O atom = 2 × 23 + 1 × 32 + 3 × 16 = 46 + 32 + 48 = 126g/mol
∴ 10 moles of $Na_2SO_3$ = 10 × 126 = 1260 g

**Q. 8. Convert into mole :**
**(a) 12 g of oxygen gas.** **(b) 20 g of water.**
**(c) 22 g of carbon dioxide.**

**Ans. (a)** 32 g of oxygen gas = 1 mole
Then, 12 g of oxygen gas = $\frac{12}{32}$ mole = 0.375 mole
**(b)** 18 g of water = 1 mole
Then, 20 g of water = $\frac{20}{18}$ mole = 1.11 mole (approx.)
**(c)** 44 g of carbon dioxide = 1 mole
Then, 22g of carbon dioxide = $\frac{22}{44}$ mole = 0.5 mole

**Q. 9. What is the mass of :**
**(a) 0.2 mole of oxygen atoms?**
**(b) 0.5 mole of water molecules?**

**Ans. (a)** Mass of one mole of oxygen atoms = 16 g
Then, mass of 0.2 mole of oxygen atoms = 0.2 × 16 g = 3.2 g
**(b)** Mass of one mole of water molecule = 18g
Then, mass of 0.5 mole of water molecules = 0.5 × 18 g = 9 g

**Q. 10. Calculate the number of molecules of sulphur ($S_8$) present in 16 g of solid sulphur.**

**Ans.** 1 mole of solid sulphur ($S_8$) = 8 × 32 g =256 g.
*i.e.*, 256g of solid sulphur contains = $6.022 \times 10^{23}$ molecules
Then, 16 g of solid sulphur contains = $\frac{6.022 \times 10^{23}}{256} \times$ 16 molecules
= $3.76 \times 10^{22}$ molecules (approx.)

**Q. 11. Calculate the number of aluminium ions present in 0.051 g of aluminium oxide.**
**(Hint : The mass of an ion is the same as that of an atom of the same element. Atomic mass of Al = 27 u)**

**Ans.** 1 mole of aluminium oxide ($Al_2O_3$) = 2 × 27 + 3 × 16 = 102 g
*i.e.*, 102 g of $Al_2O_3$ = $6.022 \times 10^{23}$ molecules of $Al_2O_3$
Then,
= $\frac{6.022 \times 10^{23}}{102} \times 0.051$ molecules

1g of $Al_2O_3$ contains

$= 3.011 \times 10^{20}$ molecules of $Al_2O_3$

The number of aluminium ions ($Al^{3+}$) present in one molecule of aluminium oxide is 2.

Therefore, The number of aluminium ions ($Al^{3+}$) present in $= 3.11 \times 10^{20}$ molecules (0.051 g) of aluminium oxide ($Al_2O_3$) $= 2 \times 3.11 \times 10^{20}$

$= 6.022 \times 10^{20}$

## NCERT Exemplar

### Multiple Choice Questions

**Q. 1. Which of the following correctly represents 360 g of water?**

**(i) 2 moles of $H_2O$**

**(ii) 20 moles of water**

**(iii) $6.022 \times 10^{23}$ molecules of water**

**(iv) $1.2044 \times 10^{25}$ molecules of water**

**(a)** (i)

**(b)** (i) and (iv)

**(c)** (ii) and (iii)

**(d)** (ii) and (iv)

**Ans. Correct option : (d)**

*Explanation :*

**(ii)** 20 moles of water $= 20 \times 18$ g $= 360$ g of water, because mass of 1 mole of water is the same as its molar mass, *i.e.*, 18 g.

**(iv)** $1.2044 \times 10^{25}$ molecules of water contains

$N_A = 6.022 \times 10^{23}$

Therefore, $\frac{1.2044 \times 10^{25}}{6.022 \times 10^{23}} = 20$ moles

20 moles of water $= 20 \times 18$ g

$= 360$ g of water.

**Q. 2. Which of the following statements is not true about an atom?**

**(a)** Atoms are not able to exist independently.

**(b)** Atoms are the basic units from which molecules and ions are formed.

**(c)** Atoms are always neutral in nature.

**(d)** Atoms aggregate in large numbers to form the matter that we can see, feel or touch.

**Ans. Correct option : (a)**

*Explanation :* Atoms are not able to exist independently; only inert gases exist in monoatomic form.

**Q. 3. The chemical symbol for nitrogen gas is**

**(a)** Ni **(b)** $N_2$

**(c)** $N^+$ **(d)** N

**Ans. Correct option : (b)**

*Explanation :* In the natural state, nitrogen pair off, sharing three electrons to fill their outer shells, so the nitrogen in the air consists of the $N_2$ molecule. The chemical symbol for nitrogen is N, but for nitrogen gas it is $N_2$.

**Q. 4. The chemical symbol for sodium is**

**(a)** So **(b)** Sd

**(c)** NA **(d)** Na

**Ans. Correct option : (d)**

*Explanation :* Sodium was discovered by Sir Humphrey Davy in 1807. The chemical symbol for sodium is Na because Na comes from the Latin word "Natrium" means sodium carbonate and Na is taken from the first two letters of Natrium.

**Q. 5. Which of the following would weigh the highest?**

**(a)** 0.2 mole of sucrose ($C_{12}H_{22}O_{11}$)

**(b)** 2 moles of $CO_2$

**(c)** 2 moles of $CaCO_3$

**(d)** 10 moles of $H_2O$

**Ans. Correct option : (c)**

*Explanation :*

Weight of a sample in gram = Number of moles × Molar mass

**(a)** 0.2 moles of $C_{12}H_{22}O_{11} = 0.2 \times 342 = 68.4$ g

**(b)** 2 moles of $CO_2 = 2 \times 44 = 88$ g

**(c)** 2 moles of $CaCO_3 = 2 \times 100 = 200$ g

**(d)** 10 moles of $H_2O = 10 \times 18 = 180$ g

Hence, option (c) is correct.

**Q. 6. Which of the following has maximum number of atoms?**

**(a)** 18 g of $H_2O$ **(b)** 18 g of $O_2$

**(c)** 18 g of $CO_2$ **(d)** 18 g of $CH_4$

**Ans. Correct option : (d)**

*Explanation :*

Number of atoms =

Mass of substance × Number of atoms in a molecule / Molar mass

Therefore,

**(a)** 18 g of $H_2O = \frac{18 \times 3}{18} \times N_A = 3N_A$

**(b)** 18 g of $O_2 = \frac{18 \times 2}{32} \times N_A = 1.12N_A$

(c) 18 g of $CO_2 = \frac{18 \times 3}{44} \times N_A = 1.23\ N_A$

(d) 18 g of $CH_4 = \frac{18 \times 5}{16} \times N_A = 5.63 N_A$

**Q. 7. Which of the following contains maximum number of molecules?**

**(a)** 1 g $CO_2$ **(b)** 1 g $N_2$

**(c)** 1 g $H_2$ **(d)** 1 g $CH_4$

**Ans. Correct option : (c)**

*Explanation :* $N_A = 6.022 \times 10^{23}$

No. of molecules 1 g $Co_2 = \frac{6.022 \times 10^{23}}{44} = 1.37 \times 10^{22}$
(molar mass of $Co_2 = 44$)
No. of molecules 1 g $N_2 = \frac{6.022 \times 10^{23}}{28} = 2.15 \times 10^{22}$
(molar mass of $N_2 = 28$)
No. of molecules 1 g $CH_4 = \frac{6.022 \times 10^{23}}{16} = 3.76 \times 10^{22}$
(molar mass of $CH_4 = 16$)
$= 0.5 \times 6.022 \times 10^{23}$
$= 3.011 \times 10^{23}$ molecule

**Q. 8. Mass of one atom of oxygen is :**

**(a)** $\frac{16}{6.022 \times 10^{23}}$ g **(b)** $\frac{32}{6.022 \times 10^{23}}$ g

**(c)** $\frac{1}{6.022 \times 10^{23}}$ g **(d)** 8 u

**Ans. Correct option : (a)**

*Explanation :*

Mass of one atom of oxygen $= \frac{\text{Atomic mass}}{N_A}$

$= \frac{16}{6.022 \times 10^{23}}$ g

**Q. 9. 3. 42 g of sucrose are dissolved in 18 g of water in a beaker. The number of oxygen atoms in the solution are**

**(a)** $6.68 \times 10^{23}$. **(b)** $6.09 \times 10^{22}$.

**(c)** $6.022 \times 10^{23}$. **(d)** $6.022 \times 10^{21}$.

**Ans. Correct option : (a)**

*Explanation :* Number of moles of sucrose

$= \frac{\text{Mass of substance}}{\text{molar mass}}$

$= \frac{3.42}{342} = 0.01$ mole

1 mole of sucrose ($C_{12}H_{22}O_{11}$) contains
$= 11 \times N_A$ atoms of oxygen
0.01 mole of sucrose ($C_{12}H_{22}O_{11}$) contains
$= 0.01 \times 11 \times N_A$ atoms of oxygen
$= 0.11 \times N_A$ atoms of oxygen

Number of moles of water $= \frac{18\,g}{18\,g/mole} = 1$ mole

1 mole of water ($H_2O$) contains $1 \times N_A$ atoms of oxygen

Total number of oxygen atoms = Number of oxygen atoms in sucrose + Number of oxygen atoms in water
$= 0.11\ N_A + 1.0\ N_A = 1.11\ N_A$
Number of oxygen atoms in solution
= 1.11 × Avogadro's number
$= 1.11 \times 6.022 \times 10^{23}$
$= 6.68 \times 10^{23}$

**Q. 10. A change in the physical state can be brought about**

**(a)** Only when energy is given to the system

**(b)** Only when energy is taken out from the system

**(c)** When energy is either given to or taken out from the system

**(d)** Without any energy change

**Ans. Correct option : (c)**

*Explanation :* When energy is either given to or taken out from the system, the physical state of a reactant can be changed. During this change there is no change in its chemical composition.

## Short Answer Questions

**Q. 11. Which of the following represents a correct chemical formula? Name it.**

**(a)** CaCl. **(b)** $BiPO_4$.

**(c)** $NaSO_4$. **(d)** NaS.

**Ans. Correct option : (b)**

*Explanation :* Bismuth phosphate ($BiPO_4$) is the correct chemical formula.

**Q.12. Write the molecular formulae for the following compounds**

**(a) Copper (II) bromide**

**(b) Aluminium (III) nitrate**

**(c) Calcium (II) phosphate**

**(d) Iron (III) sulphide**

**(e) Mercury (II) chloride**

**(f) Magnesium (II) acetate**

**Ans. (a)** $Cu^{2+} \times Br^{1-} = CuBr_2$

**(b)** $Al^{3+} \times NO^{1-} = Al(NO_3)_3$

**(c)** $Ca^{2+} \times PO^{3-} = Ca_3(PO_4)_2$

**(d)** $Fe^{3-} \times S^{2-} = Fe_2S_3$

**(e)** $Hg^{2+} \times Cl^{1+} = HgCl_2$

**(f)** $CH_3COO^{1-} \times Mg^{2+} = (CH_3COO)_2Mg$

**Q.13. Write the molecular formulae of all the compounds that can be formed by the combination of following ions:**

$Cu^{2+}, Na^+, Fe^{3+}, Cl^-, SO^{2-}, PO^{3-}$

**Ans. Compounds of $Cu^{2+}$**

**(i)** with $Cl^- \rightarrow Cu^{2+} \times Cl^{1-} = CuCl_2$

**(ii)** with $SO_4^{2-} \rightarrow Cu^{2+} \times SO_4^{2-} = CuSO_4$

**(iii)**with $PO_4^{3-} \rightarrow Cu^{2-} \times PO_4^{3-} = Cu_3(PO_4)_2$

**Compounds of $Na^+$**

**(i)** with $Cl^- \rightarrow Na^{1+} \times Cl^{1-} = NaCl$

**(ii)** with $SO_4^{2-} \rightarrow Na^{1+} \times SO_4^{2-} = Na_2SO_4$

**(iii)**with $PO_4^{3-} \rightarrow Na^{1+} \times PO_4^{3-} = Na_3PO_4$

**Compounds of $Fe^{3+}$**

**(i)** with $Cl^- \rightarrow Fe^{3+} \times Cl^{1-} = FeCl_3$

**(ii)** with $SO_4^{2-} \rightarrow Fe^{3+} \times SO_4^{2-} = Fe_2(SO_4)_3$

**(iii** with $PO_4^{3-} \rightarrow Fe^{3+} \times PO_4^{3-} = FePO_4$

**Q. 14. Write the cations and anions present (if any) in the following compounds**

**(a) $CH_3COONa$.**

**(b) NaCl.**

**(c) $H_2$.**

**(d) $NH_4NO_3$.**

**Ans.**

| S. No. | Anions | Cations |
|---|---|---|
| (a) | $CH_3COO^-$ | $Na^+$ |
| (b) | $Cl^-$ | $Na^+$ |
| (c) | It is a covalent compound | |
| (d) | $NO^{3-}$ | $NH_4^+$ |

**Q. 15. Give the formulae of the compounds formed from the following sets of elements.**

**(a) Calcium and fluorine.**

**(b) Hydrogen and sulphur.**

**(c) Nitrogen and hydrogen.**

**(d) Carbon and chlorine.**

**(e) Sodium and oxygen.**

**(f) Carbon and oxygen.**

**Ans. (a)** $CaF_2$

**(b)** $H_2S$

**(c)** $NH_3$

**(d)** $CCl_4$

**(e)** $Na_2O$

**(f)** $CO$, $CO_2$.

**Q.16. Which of the following symbols of elements are incorrect? Give their correct symbols.**

**(a) Cobalt CO**

**(b) Carbon c**

**(c) Aluminium AL**

**(d) Helium He**

**(e) Sodium So**

**Ans. (a)** Cobalt CO is incorrect symbol. Its correct symbol is Co.

**(b)** Carbon c is incorrect symbol. Its correct symbol is C.

**(c)** Aluminium AL is incorrect symbol, Its correct symbol is Al.

**(d)** Helium, He is the correct symbol.

**(e)** Sodium So is incorrect symbol. Its correct symbol is Na. (It is derived from Latin name 'Natrium').

**Q.17. Give the chemical formulae for the following compounds and compute the ratio by mass of the combining elements in each one of them.**

**(a) Ammonia**

**(b) Carbon monoxide**

**(c) Hydrogen chloride**

**(d) Aluminium fluoride**

**(e) Magnesium sulphide**

| S. No. | Compounds | Chemical formula | Ratio by mass of the combining eements |
|---|---|---|---|
| (a) | Ammonia | $NH_3$ | N : H = 14 : 3 |
| (c) | Carbon monoxide | CO | C : O = 12 : 16 = 3 : 4 |
| (c) | Hydrogen chloride | HCl | H : Cl = 1 : 35. 5 |
| (d) | Aluminium fluoride | $AlF_3$ | Al : F = 27 : 27 = 9 : 19 |
| (e) | Magnesium sulphide | MgS | Mg : S = 24 : 32 = 3 : 4 |

**Q. 18. State the number of atoms present in each of the following chemical species.**

**(a) $CO_3$** **(b) $PO_4$**

**(c) $P_2O_5$** **(d) CO**

**Ans. (a)** 4

**(b)** 5

**(c)** 7

**(d)** 2

**Q. 19. What is the fraction of the mass of water due to neutrons ?**

**Ans.** In water molecule ($H_2O$), number of neutrons = [(number of neutrons in H) x 2 + (number of neutrons in O)]

$= 0 \times 2 + 8 = 8$ (as number of neutrons in H =0)

Mass of 8 neutrons $= 8 \times 1.00893 = 8.07$ (Mass of one neutron = 1.008934)

Molar mass of water $= 1.008 \times 2 + 16.0 = 18.016$ u

$\therefore$ Fraction of mass due to neutrons

$$= \frac{\text{mass of total neutrons in water} \times 100}{\text{molar mass of water}}$$

$$= \frac{8.07}{18.016} \times 100 = 44.8\%$$

**Q. 20. Does the solubility of a substance change with temperature? Explain with the help of an example.**

**Ans.** Yes, the solubility of a substance changes with temperature.

The maximum amount of a solute which can be dissolved in 100 g of a solvent at a specified temperature is called its solubility.

**Effect of temperature on solubility :**

(i) The solubility of solids in liquids usually increases on increasing the temperature and decreases on decreasing the temperature.

(ii) The solubility of gases in liquids usually decreases on increasing the temperature and increases on decreasing the temperature.

Let us take an example of copper sulphate in water. When the temperature is increased from 0°C to 70°C, the solubility of copper sulphate in water increases from 14 g to 47g. This means that the solubility of a salt increases on increasing the temperature.

**Q. 21. Classify each of the following on the basis of their atomicity :**

**(a)** $F_2$ **(b)** $NO_2$
**(c)** $N_2O$ **(d)** $C_2H_6$
**(e)** $P_4$ **(f)** $H_2O_2$
**(g)** $P_4O_{10}$ **(h)** $O_3$
**(i)** HCl **(j)** $CH_4$
**(k)** He **(l)** Ag

**Ans.** **(a)** 2, **(b)** 3, **(c)** 3, **(d)** 8, **(e)** 4, **(f)** 4, **(g)** 14, **(h)** 3, **(i)** 2, **(j)** 5, **(k)** 1 (Noble gases do not combine and exist as monoatomic gases) **(l)** Polyatomic. It is difficult to talk about the atomicity of metals as any measurable quantity will contain millions of atoms bound by metallic bond.

**Q. 22. You are provided with a fine white coloured powder, which is either sugar or salt. How would you identify it without tasting?**

**Ans.** On heating the powder, it will char if it is a sugar. Alternatively, the powder may be dissolved in water and checked for conduction of electricity. If solution conducts electricity, the powder is a salt.

**Q. 23. Calculate the number of moles of Magnesium present in a Magnesium ribbon weighing 12 g. Molar atomic mass of Magnesium is 24 g $mol^{-1}$.**

**Ans.** $$\text{Number of moles} = \frac{12}{24}$$
$$= 0.5 \text{ mole}$$

**Long Answer Questions**

**Q. 24. Verify by calculating that**

**(a) 5 moles of $CO_2$ and 5 moles of $H_2O$ do not have the same mass.**

**(b) 240 g of calcium and 240 g magnesium elements have a mole ratio of 3 :5.**

**Ans.** **(a)** $CO_2$ has molar mass = 44 g $mol^{-1}$

5 moles of $CO_2$ have molar mass = $44 \times 5 = 220$ g

$H_2O$ has molar mass = 18 g $mol^{-1}$

5 moles of $H_2O$ have mass = $18 \times 5$ g = 90 g

**(b)** $$\text{Number of moles in 240 g Ca metal} = \frac{240}{40}$$
$$= 6$$

$$\text{Number of moles in 240 g of Mg metal} = \frac{240}{24}$$
$$= 10$$

Ratio 6 : 10 = 3 : 5

**Q. 25. Find the ratio by mass of the combining elements in the following compounds.**

**(a)** $CaCO_3$ **(b)** $MgCl_2$
**(c)** $H_2SO_4$ **(d)** $C_2H_5OH$
**(e)** $NH_3$ **(f)** $Ca(OH)_2$

**Ans.** **(a)** $CaCO_3 = Ca : C : O \times 3$
$40 : 12 : 16 \times 3$
$40 : 12 : 48$
$10 : 3 : 12$

**(b)** $MgCl_2 = Mg : Cl \times 2$
$24 : 35.5 \times 2$
$24 : 71$

**(c)** $H_2SO_4 = H \times 2 : S : O \times 4$
$1 \times 2 : 32 : 16 \times 4$
$2 : 32 : 64$
$1 : 16 : 32$

**(d)** $C_2H_5OH = C \times 2 : H \times 6 : O$
$12 \times 2 : 1 \times 6 : 16$
$24 : 6 : 16$
$12 : 3 : 8$

**(e)** $NH_3 = N \times 1 : H \times 3$
$14 \times 1 : 1 \times 3$
$14 : 3$

**(f)** $Ca(OH)_2 = Ca : O \times 2 : H \times 2$
$40 : 16 \times 2 : 1 \times 2$
$40 : 32 : 2$
$20 : 16 : 1$

**Commonly Made Error**

- Calculation error is commonly seen. Students often get confused and write incorrect mass of the elements.

**Answering Tip**

- Learn the mass of as many elements as possible.

**Q. 26. Calcium chloride when dissolved in water dissociates into its ions according to the following equation.**

$CaCl_2\ (aq) \rightarrow Ca^{2+}\ (aq) + 2Cl^-\ (aq)$

**Calculate the number of ions obtained from $CaCl_2$ when 222 g of it is dissolved in water.**

**Ans.** 1 mole of calcium chloride = 111 g

Therefore, 222 g of $CaCl_2$ is equal to 2 moles of $CaCl_2$.

Since 1 formula unit $CaCl_2$ gives 3 ions,

Therefore, 1 mole of $CaCl_2$ will give 3 moles of ions.

2 moles of $CaCl_2$ would give $3 \times 2 = 6$ moles of ions.

No. of ions = No. of moles of ions × Avogadro number

$= 6 \times 6.022 \times 10^{23}$

$= 36.132 \times 10^{23}$

$= 3.6132 \times 10^{24}$ ions

**Q. 27. The difference in the mass of 100 moles each of sodium atoms and sodium ions is 5.48002 g. Compute the mass of an electron.**

**Ans.** A sodium atom and ion differ by one electron. For 100 moles each of sodium atoms and ions there would be a difference of 100 moles of electrons.

Mass of 100 moles of electron = 5.48002 g

$$\text{Mass of 1 mole of electron} = \frac{5.48002}{100}\ \text{g}$$

$$\text{Mass of one electron} = \frac{5.48002}{100 \times 6.022 \times 10^{23}}$$

$= 9.1 \times 10^{-28}$ g

$= 9.1 \times 10^{-31}$ kg

**Q. 28. Cinnabar (HgS) is a prominent ore of mercury. How many grams of mercury are present in 225 g of pure HgS? Molar mass of Hg and S are 200.6 g $mol^{-1}$ and 32 g $mol^{-1}$ respectively.**

**Ans.** Molar mass of HgS = 200.6 + 32 = 232.6 g $mol^{-1}$

Mass of Hg in 232.6 g of HgS = 200.6 g

$$\text{Mass of Hg in 225 g of HgS} = \frac{200.6}{232.6} \times 225 = 194.04\ \text{g}$$

**Q. 29. The mass of one steel screw is 4.11 g. Find the mass of one mole of these steel screws. Compare this value with the mass of the Earth ($5.98 \times 10^{24}$ kg). Which one of the two is heavier and by how many times?**

**Ans.** One mole of screws weigh = $2.475 \times 10^{24}$ g

$(6.022 \times 10^{23} \times 4.11)$

$$\frac{\text{Mass of Earth}}{\text{Mass of 1 mole of screws}} = \frac{5.98 \times 10^{24}}{2.4 \times 10^{21}}\ \text{kg}$$

$= 2.49 \times 10^{3}$

Mass of earth is $2.49 \times 10^3$ times the mass of screws. The earth is 2400 times heavier than one mole of screws.

**Q. 30. A sample of vitamin C is known to contain $2.58 \times 10^{24}$ oxygen atoms. How many moles of oxygen atoms are present in the sample?**

**Ans.** 1 mole of oxygen atoms $6.022 \times 10^{23}$ atoms

Therefore, Number of moles of oxygen atoms in the sample

$$= \frac{2.58 \times 10^{24}}{6.022 \times 10^{23}}$$

= 4.28 mole

= 4.28 moles of oxygen atoms.

**Q. 31. Raunak took 5 moles of carbon atoms in a container and Krish also took 5 moles of sodium atoms in another container of same weight.**

**(a) Whose container is heavier?**

**(b) Whose container has more number of atoms?**

**Ans. (a)** Mass of sodium atoms carried by Krish = (5 × 23 g) = 115 g

While mass of carbon atom carried by Raunak = (5 × 12 g) = 60 g

Thus, Krish's container is heavy.

**(b)** Both the bags have same number of atoms as they have same number of moles of atoms.

**Q. 32. Fill in the missing data in the Table 3.1**

**Table 3.1 :**

| Species / Property | $H_2O$ | $CO_2$ | Na atom | $MgCl_2$ |
|---|---|---|---|---|
| No. of moles | 2 | — | — | 0.5 |
| No. of particles | — | $3.011 \times 10^{23}$ | | |
| Mass | 36g | — | 115g | — |

**Ans. For $H_2O$**

Given, number of moles = 2 and mass = 36g

∴ Number of particles = number of moles × $6.022 \times 10^{23}$

$= 2 \times 6.022 \times 10^{23} = 1.2044 \times 10^{24}$

**For $CO_2$**

Given, number of particles = $3.011 \times 10^{23}$

$$\therefore \text{Number of moles of } CO_2 = \frac{\text{number of particles}}{6.022 \times 10^{23}}$$

$$= \frac{3.011 \times 10^{23}}{6.022 \times 10^{23}} = 0.5 \text{ mol}$$

Mass of $CO_2$ = moles × molar mass

$= 0.5 \times 44 = 22$ g

(∴ molar mass of $CO_2 = 12 + 2 \times 16 = 44$)

**For Na-atom**

Given = 115 g

$$\text{Number of moles of } CO_2 = \frac{\text{mass}}{\text{molar mass}} = \frac{115}{23} = 5 \text{ mol}$$

∴ Number of particles = $5 + 6.022 \times 10^{23} = 3.011 \times 10^{24}$

**For $MgCl_2$**

Given, number of moles = 0.5

∴ Number of particles = $0.5 + 6.022 \times 10^{23} = 3.011 \times 10^{23}$

Mass = number of moles × molar mass

(molar mass of $MgCl_2 = 24 + 2 \times 35.5 = 24 + 71 = 95$)

$= 0.5 \times 95 = 47.5$ g

Thus, the completed table is as :

| Species property | $H_2O$ | $CO_2$ | Na-atom | $MgCl_2$ |
|---|---|---|---|---|
| Number of moles | 2 | 0.5 | 5.0 | 0.5 |
| number of particles | $1.2044 \times 10^{24}$ | $3.011 \times 10^{23}$ | $3.011 \times 10^{24}$ | $3.011 \times 10^{23}$ |
| Mass | 36 g | 22 g | 115 g | 47.5 g |

**Q. 33. The visible universe is estimated to contain $10^{22}$ stars. How many moles of stars are present in the visible universe?**

**Ans.** $$\text{Number of moles of stars} = \frac{10^{22}}{6.022 \times 10^{23}}$$

$= 0.0166$ moles

**Q. 34. What is the SI prefix for each of the following multiples and submultiples of a unit?**

(a) $10^3$ (b) $10^{-1}$
(c) $10^{-2}$ (d) $10^{-6}$
(e) $10^{-9}$ (f) $10^{-12}$

**Ans.** (a) kilo
(b) deci
(c) centi
(d) micro
(e) nano
(f) pico

**Q. 35. Express each of the following in kilograms.**

(a) $5.84 \times 10^{-3}$ mg (b) 58.34 g
(c) 0.584 g (d) $5.873 \times 10^{-21}$ g

**Ans.** (a) $5.84 \times 10^{-9}$ kg
(b) $5.834 \times 10^{-2}$ kg
(c) $5.84 \times 10^{-4}$ kg
(d) $5.873 \times 10^{-24}$ kg

**Q. 36. Compute the difference in masses of $10^3$ moles each of magnesium atoms and magnesium ions. (Mass of electron = $9.1 \times 10^{-31}$ g)**

**Ans.** Given, Mass of an electron $= 9.1 \times 10^{-31}$ kg

$10^3$ moles of Mg atoms $= 10^3 \times 6.022 \times 10^{23}$
$= 6.022 \times 10^{26}$ Mg atoms

$10^3$ moles of $Mg^{2+}$ ions $= 10^3 \times 6.022 \times 10^{23}$
$= 6.022 \times 10^{26}$ $Mg^{2+}$ ions

One $Mg^{2+}$ ion is formed from one Mg atom by loss of 2 electrons, As $Mg \rightarrow Mg^{2+} + 2e^-$

i.e., difference in the mass of 1 Mg atom and 1 $Mg^{2+}$ ion = mass of 2 electrons

$\therefore$ Difference in the mass of $6.022 \times 10^{26}$ Mg atoms and $Mg^{2+}$ ions
= mass of $2 \times 6.022 \times 10^{26}$ electrons
$= 2 \times 6.022 \times 10^{26} \times 9.1 \times 10^{-31}$ kg.
(as mass of an electron $= 9.1 \times 10^{-31}$ kg)
$= 109.6004 \times 10^{-5}$ kg $= 1.096 \times 10^{-3}$ kg $= 1.096$ g

**Q. 37. Which has more number of atoms? 100 g of $N_2$ or 100 g of $NH_3$**

**Ans.** (i) $100 \text{ g of } N_2 = \frac{100}{28} \text{ moles}$

$$\text{Number of molecules} = \frac{100}{28} \times 6.022 \times 10^{23}$$

$$\text{Number of atoms} = \frac{2 \times 100}{28} \times 6.022 \times 10^{23}$$
$$= 43.01 \times 10^{23}$$

(ii) $100 \text{ g of } NH_3 = \frac{100}{17} \text{ moles}$
$= \frac{100}{17} \times 6.022 \times 10^{23}$ molecules
$= \frac{100}{17} \times 6.022 \times 10^{23} \times 4$ atoms
$= 141.69 \times 10^{23}$

Therefore, $NH_3$ would have more atoms.

**Q. 38. Compute the number of ions present in 5.85 g of sodium chloride.**

**Ans.** $5.85 \text{ g of NaCl} = \frac{5.85}{58.5} = 0.1$ moles

or, 0.1 moles of NaCl particles

Each NaCl particle is equivalent to one $Na^+$ and one $Cl^- = 2$ ions

Total moles of ions $= 0.1 \times 2 = 0.2$ moles

No. of ions $= 0.2 \times 6.022 \times 10^{23}$
$= 1.2042 \times 10^{23}$ ions

**Q. 39. A gold sample contains 90% of gold and the rest copper. How many atoms of gold are present in one gram of this sample of gold?**

**Ans.** One gram of gold sample will contain $= \frac{90}{100} = 0.9$ g of gold

$$\text{Number of moles of gold} = \frac{\text{Mass of gold}}{\text{Atomic mass of gold}}$$

$$= \frac{0.9}{197} = 0.0046$$

One mole of gold contains $= 6.022 \times 10^{23}$ $N_A$ atoms

Therefore, 0.0046 mole of gold will contain
$= 0.0046 \times 6.022 \times 10^{23}$ $N_A$ atoms.
$= 2.77 \times 10^{21}$ $N_A$ atoms.

**Q. 40. What are ionic and molecular compounds? Give examples.**

**Ans. Ionic compounds :**

(i) Compounds which are produced by the combination of metals and non-metals containing charged species known as ions.
(ii) An ion is a charged particle and can be negatively or positively charged.
(iii) A negatively charged ion is called an anion.
(iv) A positively charged ion is known as a cation.
(v) **Examples :** Ionic compounds are sodium chloride, calcium oxide etc.

**Molecular compounds :**

(i) Atoms of different elements join together in definite proportions to form molecules of compounds.
(ii) In molecular compounds, the attraction of atoms is called a covalent bond (*i.e.* molecular compounds are made due to covalent bonding).
(iii) Molecular compounds are formed between two non-metals bonding. The bond between the two non-metals is a covalent bond.
(iv) Molecular compounds are actually the covalent compounds. Molecular compounds typically have little or no electrical conductivity properties.
(v) **Examples :** water, ammonia, carbon dioxide etc.

**Q. 41. Compute the difference in masses of one mole each of aluminium atoms and one mole of its ions. (Mass of an electron is $9.1 \times 10^{-28}$ g). Which one is heavier?**

**Ans.** Mass of 1 mole of aluminium atom
= Molar mass of aluminium
= 27 g $mol^{-1}$

An aluminium atom needs to lose three electrons to become an ion, $Al^{3+}$.

For one mole of $Al^{3+}$ ion, three moles of electrons are to be lost.

The mass of the three moles of electrons
$= 3 \times (9.1 \times 10^{-28}) \times 6.022 \times 10^{23}$ g
$= 27.3 \times 6.022 \times 10^{-5}$ g
$= 164.400 \times 10^{-5}$ g
$= 0.0016$ g

Molar mass of $Al^{3+} = (27 - 0.00164)$ g $mol^{-1}$
$= 26.9984$ g $mol^{-1}$

Difference $= 27 - 26.9984$
$= 0.0016$ g

**Q. 42. A silver ornament of mass '$m$' gram is polished with gold equivalent to 1% of the mass of silver. Compute the ratio of the number of atoms of gold and silver in the ornament.**

**Ans.** Mass of silver = $m$ g

$$\text{Mass of gold} = \frac{m}{100}\ g$$

$$\text{Number of atoms of silver} = \frac{\text{mass}}{\text{Atomic mass}} \times N_A$$
$$= \frac{m}{108} \times N_A$$

$$\text{Number of atoms of gold} = \frac{m}{100 \times 97} \times N_A$$

Ratio of number of atoms of gold to silver
= Au : Ag

$$\frac{m}{108} \times N_A : \frac{m}{100 \times 97} \times N_A$$
$$= 108 : 100 \times 197$$
$$= 108 : 19700$$
$$= 1 : 182.41$$

**Q. 43. A sample of ethane ($C_2H_6$) gas has the same mass as $1.5 \times 10^{20}$ molecules of methane ($CH_4$). How many $C_2H_6$ molecules do the sample of gas contain?**

**Ans.** $$\text{Mass of 1 molecule of } CH_4 = \frac{16\ g}{N_A}$$

Mass of $1.5 \times 10^{20}$ molecules of methane

$$= \frac{1.5 \times 10^{20} \times 16}{N_A}\ g$$

$$\text{Mass of 1 molecule of } C_2H_6 = \frac{30}{N_A}\ g$$

$$\text{Mass of molecules of } C_2H_6 = \frac{1.5 \times 10^{20} \times 16}{N_A}\ g$$

Therefore, Number of molecules of ethane

$$= \frac{1.5 \times 10^{20} \times 16}{N_A} \times \frac{N_A}{30}$$
$$= 0.8 \times 10^{20}$$

**Q. 44. Fill in the blanks**

**(a) In a chemical reaction, the sum of the masses of the reactants and products remains unchanged. This is called _____**

**(b) A group of atoms carrying a fixed charge on them is called _____**

**(c) The formula unit mass of $Ca_3(PO_4)_2$ is _____**

**(d) Formula of sodium carbonate is _____ and that of ammonium sulphate is _____**

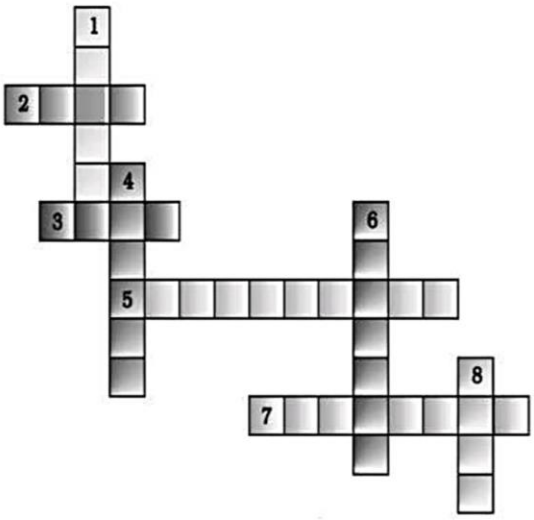
**Ans.** **(a)** Law of conservation of mass

**(b)** Polyatomic ion

**(c)** (3 × atomic mass of Ca) + (2 × atomic mass of phosphorus) + (8 × atomic mass of oxygen) = 310

**(d)** $Na_2CO_3$; $(NH_4)_2SO_4$

**Q. 45. Complete the following crossword puzzle by using the name of the chemical elements.**

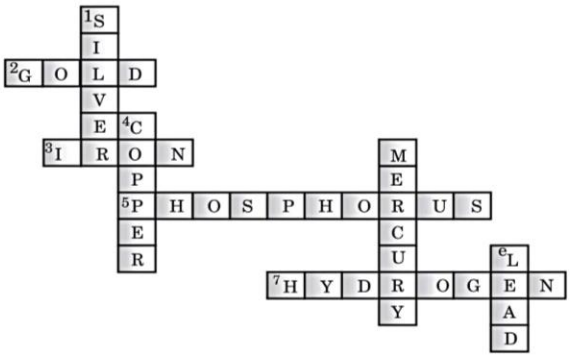



**Use the data given as follows :**

| Across | Down |
|---|---|
| **2.** The element used by Rutherford during his α–scattering experiment. | **1.** A white lustrous metal used for making ornaments and which tends to get tarnished black in the presence of moist air. |
| **3.** An element which forms rust on exposure to moist air. | **4.** Both brass and bronze are alloys of the element. |

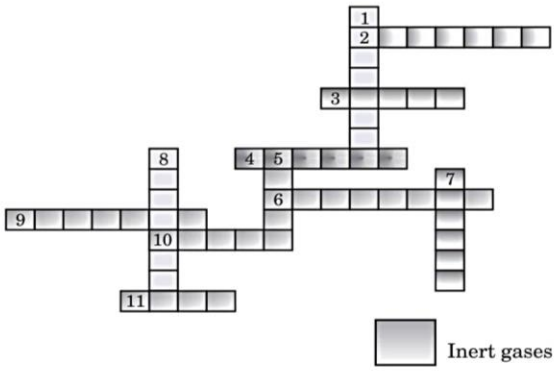
| | |
|---|---|
| **5.** A very reactive nonmetal stored under water. | **6.** The metal which exists in the liquid state at room temperature. |
| **7.** Zinc metal when treated with dilute hydrochloric acid produces a gas of this element which when tested with burning splinter produces a pop sound. | **8.** An element with symbol Pb. |

**Ans.**



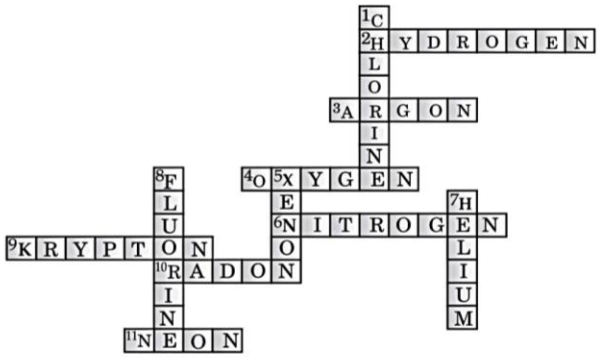
**Q. 46. (a) In the above crossword puzzle, names of 11 elements are hidden. Symbols of these are given below. Complete the puzzle.**

**1. Cl, 2. H, 3. Ar, 4. O, 5. Xe, 6. N, 7. He, 8. F 9., Kr 10., Rn, 11. Ne.**




**(b) Identify the total number of inert gases, their names and symbols from this crossword puzzle.**

**Ans. (a)**



**(b)** The total number of inert gases in this crossword puzzle are six : Helium (He); Neon (Ne); Argon (Ar); Krypton (Kr); Xenon (Xe); Radon (Rn).

**Q. 47. Write the formulae for the following and calculate the molecular mass for each one of them :**

**(a) Caustic potash.** **(b) Baking powder.**
**(c) Lime stone.** **(d) Caustic soda.**
**(e) Ethanol.** **(f) Common salt.**

**Ans. (a)** KOH

$(39 + 16 + 1) = 56 \text{ g mol}^{-1}$

**(b)** $NaHCO_3$

$23 + 1 + 12 + (3 \times 16) = 84 \text{ g mol}^{-1}$

**(c)** $CaCO_3$

$40 + 12 + (3 \times 16) = 100 \text{ g mol}^{-1}$

**(d)** NaOH

$23 + 16 + 1 = 40 \text{ g mol}^{-1}$

**(e)** $C_2H_5OH = C_2H_6O$

$2 \times 12 + (6 \times 1) + 16 = 46 \text{ g mol}^{-1}$

**(f)** NaCl

$23 + 35.5 = 58.5 \text{ g mol}^{-1}$

**Q. 48. In photosynthesis, 6 molecules of carbon dioxide combine with an equal number of water molecules through a complex series of reactions to give a molecule of glucose having a molecular formula $C_6H_{12}O_6$. How many grams of water would be required to produce 18 g of glucose? Compute the volume of water so consumed assuming the density of water to be 1 g $cm^{-3}$.**

**Ans.** $6CO_2 + 6H_2O \xrightarrow{\text{Chlorophyll and Sunlight}} C_6H_{12}O_6 + 6O_2$

1 mole of glucose needs = 6 moles of water

180 g of glucose needs = (6×18) g of water

1 g of glucose will need = $\frac{108}{180}$ g of water.

18 g of glucose would need = $\frac{108}{180} \times 18$ g of water = 10.8 g

$$\text{Volume of water used} = \frac{\text{Mass}}{\text{Density}} = \frac{10.8 \text{ g}}{1 \text{ g cm}^{-3}}$$

$$= 10.8 \text{ cm}^3$$

# BOARD CORNER

## Short Answer Questions

Ⓡ **Q. 1. (i) Write the full form of IUPAC.** **[3]**

**(ii) Hydrogen and oxygen combine in the ratio of 1:8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas?**

**Ans.** (i) International Union of Pure and Applied Chemistry. **[1]**

(ii) 1 g of hydrogen requires = 8 g of oxygen gas

So, 3 g of hydrogen requires = 8 x 3 g of oxygen gas

= 24 g of oxygen gas **[2]**

Ⓚ **Q. 2. Calculate the molecular mass of the following:-** **[3]**

**(a) Chlorine gas**

**(b) Ammonia gas**

**(c) Sulphur trioxide gas**

**(Given atomic mass of Cl = 35.5 u, N = 14 u, H = 1u, S = 32 u, O = 16 u**

**[SA-II, 2017]**

**Ans.** (a) $Cl_2 = 35.5 \times 2 = 71$ u.

(b) $NH_3 = 14 + (3\times1) = 14 + 3 = 17$u.

(c) $SO_3 = 32 + (16\times3) = 32 + 48 = 80$u. **[1+1+1]**

Ⓚ **Q. 3. Write the chemical formulae for the following compounds and find the ratio by mass of the combining elements in each one of them. (N = 14u, C = 12u, O = 16u, S = 32u).**

**(a) Methane** **(b) Carbon dioxide**

**(c) Hydrogen sulphide** **[3]**

**Ans.** (a) Methane $CH_4$, 12 : 4 = 3 : 1

(b) Carbon dioxide $CO_2$, 12 : (2 x 16) = 3 : 8

(c) Hydrogen Sulphide $H_2S$, 2 : 32 = 1 : 16

**[1+1+1]**

Ⓤ **Q. 4. Define valency. Classify the following cations on the basis of their valencies.**

**$Ca^{++}$, $Cu^{++}$, $NH^{+}_{4}$, $Al^{+++}$.** **[3]**

**[SA-II, 2017]**

**Ans.** The combining power (or capacity) of an element is known as its valency.

$Ca^{++}$ divalent, $Cu^{++}$ divalent, $NH_4^+$ monovalent, $Al^{+++}$ trivalent **[1+½+½+½+½]**

**Commonly made errors**

- Student often get confused with trivalent and tetravalent.

**Answering Tip**

- Remember that electrons in valence shell determine the valency.

**Q. 5. (a) What are polyatomic ions? Give one example.**

**(b) Write the formula of calcium hydroxide and aluminium chloride.** **[3]**

**(KVS Jammu Region, 2018)** Ⓡ

**Ans.** (a) (i) Polyatomic ions are a group of atoms carrying charge. They are also called as molecular ions.

**Example :** Carbonate or phosphate or nitrate ion.

(b) Formula of Calcium Hydroxide - $Ca(OH)_2$

Formula of Aluminium Chloride - $AlCl_3$

**[1+1+½+½]**

ⓇQ. 6. **Write the chemical formula of following compounds.** **[3]**

**(i) Quick lime**

**(ii) Magnesium chloride**

**(iii) Calcium carbonate**

**(KVS 2018-19 Agra Region)**

**Ans.** (i) Quick lime : CaO

(ii) Magnesium chloride : $MgCl_2$

(iii) Calcium carbonate : $CaCO_3$

## Long Answer Questions

Ⓤ **Q. 1. (a) Calculate the mass of**

**(i) 0.5 mole of $N_2$ gas**

**(ii) $3.011 \times 10^{23}$ number of N atoms.**

**(b) What is Atomicity? Give atomicity of sulphur and chlorine.** **(KVS Jammu Region 2018) [5]**

**Ans.** (a) (i) 0.5 mole of $N_2$ gas

1 mole of $N_2$ gas = 28g

0.5 mole of $N_2$ gas = $\frac{28 \times 0.5}{1} = 14.0$ g

(ii) $3.011 \times 10^{23}$ number of N atoms

$$\text{Number of moles} = \frac{\text{Given number of particles}}{\text{Avagadro's number}}$$

$$= \frac{3.011 \times 10^{23}}{6.022 \times 10^{23}} = \frac{1}{2} = 0.5 \text{ mole}$$

1 mole of N = 14 g

0.5 mole of N = $\frac{14 \times 0.5}{1} = 7.0$ g

(b) The number of atoms constituting a molecule is known as atomicity.

Atomicity of Sulphur $S_8$ = 8 (Polyatomic)

Atomicity of Chlorine $Cl_2$ = 2 (Diatomic) **[1+2+2]**

Ⓚ **Q. 2. (a) What are polyatomic ions? Give two examples.**

**(b) Write the chemical formula of sodium oxide.**

**(c) Calculate the formula unit mass of $CaCO_3$**

**(Given Ca = 40 u, O = 16 u).**

**(KVS - Agra Region - 2018)**

**Ans. (a)** Polyatomic ions are group of atoms carrying positive or negative charge.

**Example :** Ammonium ion $NH_4^+$

Carbonate ion $CO_3^{2-}$

**(b)** Chemical formula of sodium oxide is : $Na_2O$

**(c)** Mass of $CaCO_3$:

$(40 \times 1) + (12 \times 1) + (16 \times 3)$

$40 + 12 + 48$

$= 100$ amu. **[2+1+2]**

**Commonly Made Error**

- Students get confused with the valency of different ions and even the charge on them.

**Answering Tip**

- While writing chemical formula, use ion cross method to determine the formula according to the valency.

Ⓚ **Q. 3. (i) Calculate the molar mass of the following substances :** **[5]**

**(Given atomic masses of C = 12 u; H = 1 u; S =32 u; O = 16u)**

**(a) Ethyne, $C_2H_2$**

**(b) Sulphur molecule, $S_8$**

**(c) Sulphuric acid, $H_2SO_4$**

**Ans. (i) (a)** Ethyne $(C_2H_2) = 2 \times 12 + 2 \times 1$

$= 24 + 2 = 26$ u

**(b)** Sulphur molecule $(S_8) = 8 \times 32$

$= 256$ u

**(c)** Sulphuric acid $(H_2SO_4) = 2 \times 1 + 1 \times 32 + 4$

$= 16$

$= 2 + 32 + 64$

$= 98$ u **[2+1+2]**