3. Atoms and Molecules

Check Point 01

1. Question

If 100 g of calcium carbonate on heating produces 44g of carbon dioxide, how much quicklime will be formed? Which law is followed for solving this problem?

Answer

Let the mass of quicklime formed is “x”

$$CaCO_3 \rightarrow CaO + CO_2$$
$$100g \quad x \quad 44g$$

According to the law of conservation of mass, the sum of the masses of reactants is equal to the sum of the masses of products formed.

Hence, 100g = x + 44g

⇒ x = 100 – 44g

⇒ x = 56 g

Law of conservation of mass was followed for solving this problem.

2. Question

Which law states, that in a chemical compound, elements always combine in a fixed proportion?

Answer

Law of constant proportion or law of definite proportion states that in a chemical compound, elements always combine in a fixed proportion.

3. Question

20g silver nitrate solution is added to 20g of sodium chloride solution. What change in mass do you expect after the reaction and why?

Answer

There will be no change in the mass after the reaction.

According to the law of conservation of mass which states that atoms are neither created nor destroyed in a chemical reaction. This means that the total mass of the products formed in chemical reaction must be equal to the mass of reactants consumed.

4. Question

In a given sample of ammonia, 9g hydrogen and 42g nitrogen are present. In another sample, 5g hydrogen is present along with nitrogen. Calculate the amount of nitrogen in the second sample.

Answer

In the first sample:

9g of hydrogen and 42g of nitrogen are present. According to the law of definite proportion, hydrogen and nitrogen are present in the ratio of 9:42 i.e., 3:14

In the second sample:

It is given that 5g of hydrogen is present along with nitrogen.

According to the law of constant proportion the second sample

must also contain hydrogen and nitrogen in 3:14 ratio.

$$\frac{\text{Amount of hydrogen}}{\text{Amount of nitrogen}} = \text{Ratio}$$

$$\Rightarrow \frac{5}{\text{Amount of nitrogen}} = \frac{3}{14}$$

⇒ 14 × 5 = 3 × amt. of nitrogen

⇒ Amount of nitrogen = 70/3

⇒ Amount of nitrogen = 23.3g

Thus, the amount of nitrogen in the second sample is 23.3g.

5. Question

Why definition of an atom given by Dalton is no longer valid?

Answer

Atoms contains protons, neutrons, and electrons. Dalton was not able to explain this concept. According to him, atoms are indivisible particles. Hence, the definition of an atom given by Dalton is no longer valid.

Check Point 02

1. Question

Why is it necessary to use the symbol for the elements?

Answer

It is necessary to use the symbol for the elements because by writing symbols of the elements, chemical equations become easier to write as well as to understand and saves time too.

For example:

Zinc – Zn

Hydrogen – H

Aluminium – Al

Calcium – Ca

Sodium – Na

Lithium – Li

2. Question

What is wrong with the following symbols? Give the correct symbol in each case.

(i) Sodium (So)

(ii) Hydrogen (Hg)

(iii) Copper (Co)

(iv) Sulphur (S)

(v) Calcium (CA)

Answer

(i) Correct symbol for sodium is Na. The symbol of sodium was derived from its latin name "natrium".

(ii) Correct name for hydrogen is "H". The symbol "Hg" is used for mercury.

(iii) Correct symbol for copper is Cu. The symbol "Co" is used for cobalt.

(iv) The given symbol of sulphur (S) is correct.

(v) Correct symbol for calcium is "Ca". According to IUPAC, the first letter of the symbol is always written as a capital letter (uppercase) and the second

letter is always written as a small letter (lowercase). Both letters cannot be written as capital letters.

3. Question

Name any two elements whose symbols do not start with the same letter as that of the name of the element.

Answer

Elements whose symbols do not start with the same letter as that of the name of the element are:

Sodium (Na)	Silver (Ag)	Iron (Fe)
Potassium (K)	Gold (Au)	Tin (Sn)
Tungsten (W)	Mercury (Hg)	Antimony (Sb)

4. Question

Why the symbols of few elements, like sodium, do not start with the initial letter of the name?

Answer

The symbols of a few elements like sodium do not start with the initial letter of the name because their symbol was derived from their names in Latin.

For example:

i. The symbol of sodium (Na) was derived from its latin name “natrium”

ii. The symbol of potassium (K) was derived from its latin name “kalium”

iii. The symbol of iron (Fe) was derived from its latin name “ferrum”

5. Question

What is the difference between 2 Cl and Cl_2? Which one of these two forms exist in nature? Also, give the atomic mass of this element.

Answer

The difference between 2Cl and Cl_2:

i. 2Cl indicates the two chloride ions.

ii. Cl_2 indicates one chlorine molecule which is formed by combining of two atoms of chlorine.

iii. Cl_2 is also known as chlorine gas.

iv. Cl_2 form exists in nature. The atomic mass of this element is

(Atomic mass of chlorines × 2) = 35.5 × 2 = 71u

6. Question

Write the atomicity of the following:

(i) I_2 (ii) H_2S

(iii) HNO_3 (iv) Na_2SO_4

(v) S_8

Answer

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

i. In I_2, there are two atoms of iodine constituting a molecule.

Hence, the atomicity is 2 (diatomic).

ii. In H_2S, there are two atoms of hydrogen and one atom of Sulphur constituting a molecule of H_2S. Hence, the atomicity is 3 (triatomic).

iii. In HNO_3, there are three atoms of oxygen, one atom of nitrogen and one atom of hydrogen sulphur constituting a molecule of HNO_3. Hence, the atomicity is five.

iv. In Na_2SO_4, there are two atoms of sodium, one atom of Sulphur and four atoms of oxygen constituting a molecule of Na_2SO_4 Hence, the atomicity is seven.

v. In S_8, there are eight atoms of sulphur constituting a molecule.

Hence, the atomicity is eight.

7. Question

An oxide of nitrogen is found to contain nitrogen and oxygen combined together in the ratio of 7: 16 by mass. Derive the formula of the oxide and name it.

Answer

It is given that nitrogen and oxygen are combined together in the ratio of 7:16 by mass.

Mass of nitrogen = 14u

Mass of oxygen = 16u and mass of O_2 = 16× 2 = 32u

Hence, we can write 14:32 which is equal to 7:16

Therefore, the formula of the oxide is NO_2 and its name is nitrous dioxide.

Check Point 03

1. Question

How is an ion different from an atom? How is cation different from anion?

Answer

Difference between ion and atom:

Atom	Ion
The building blocks of all matter are atoms.	Compounds composed of metals and non-metals have charged species. The charge species are known as ions.

Difference between cation and anion:

Cation	Anion
A positively charged ion is called a cation.	A negatively charged ion is called an anion.
For example: Na^+, Ca^{2+}, Mg^{2+}	For ex: Cl^-, SO_4^{2-}, CO_3^{2-}

2. Question

Predict the total number of atoms in each case.

(i) Calcium phosphate

(ii) Hydrogen sulphide

(iii) Magnesium bromide

(iv) Sodium oxide

(v) Aluminium hydroxide

Answer

i. Calcium phosphate $[Ca_3(PO_4)_2]$:

There are three calcium atoms, two phosphorus atoms and eight oxygen atoms.

Total number of atoms = 2Ca + 2P + 8O

Hence, there are total 12 atoms.

ii. Hydrogen sulphide (H_2S) :

There are two hydrogen atoms and one sulphur atom.

Total number of atoms = 2H + 1S

Hence, there are total 3 atoms.

iii. Magnesium bromide ($MgBr_2$) :

There are two bromine atoms and one magnesium atom.

Total number of atoms = 2Br + 1Mg

Hence, there are total 3 atoms.

iv. Sodium oxide (Na_2O):

There are two sodium atoms and one oxygen atom.

Total number of atoms = 2Na + 1O

Hence, there are total 3 atoms.

v. Aluminium hydroxide [$Al(OH)_3$]:

There are three hydrogen and oxygen atoms and one atom of aluminum.

Total number of atoms = 3H + 3O + 1Al

Hence, there are total 7 atoms.

3. Question

Give symbol and valency of the following ions.

Hydroxide ion, carbonate ion.

Answer

Hydroxide ion:

Symbol of hydroxide ion = OH^-

Valency = -1

Carbonate ion:

Symbol of carbonate ion = CO_3^{2-}

Valency = -2

4. Question

What is the role of valency in the combination of atoms?

Answer

Role of valency:

i. The combining power of an element is known as its valency.

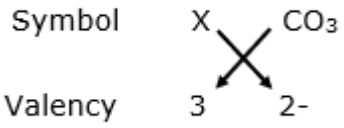
ii. Valency can be used to find out how the atoms of an element will combine with the atoms of another element to form a compound.

5. Question

An element X forms $X_2(CO_3)_3$ type compound. What is the formula of its phosphate and chloride?

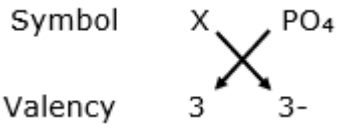
Answer

$X_2(CO_3)_3$



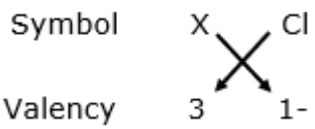
From this, we came to know that valency of X is 3+

<u>The formula</u> <u>for the phosphate of the element X:</u>



Formula: $X_3(PO_4)_3$ or XPO_4

<u>The formula</u> <u>for the chloride of the element X:</u>



Formula: XCl_3

6. Question

Write the formula of the following compounds.

(i) Magnesium sulphate

(ii) Sodium bromide

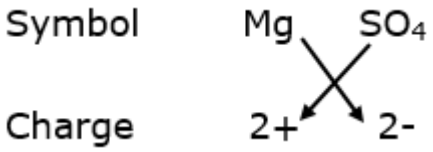
(iii) Calcium chloride

(iv) Potassium nitrate

(v) Sodium phosphate

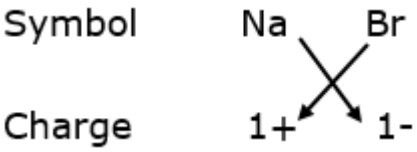
Answer

i. Formula of magnesium sulphate:



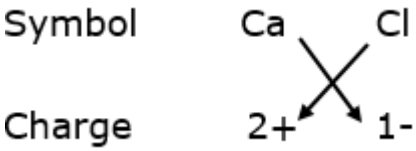
Formula: $MgSO_4$

ii. Formula of sodium bromide:



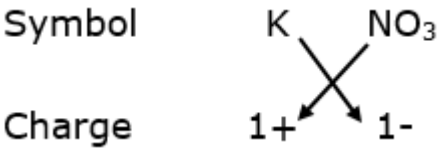
Formula: NaBr

iii. The formula of calcium chloride:



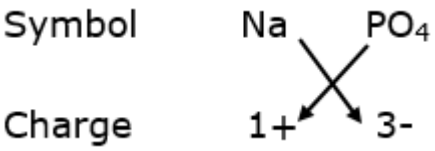
Formula: $CaCl_2$

iv. Formula of potassium nitrate:



Formula: KNO_3

v. Formula of sodium phosphate:



Formula: Na_3PO_4

Check Point 04

1. Question

How formula unit mass is different from molecular mass?

Answer

Formula unit mass	Molecular mass
Formula unit mass of a substance is the sum of the atomic masses of all atoms in a formula unit of a compound.	The molecular mass of a substance is the sum of atomic masses of all the atoms in a molecule of the substance.
It is used for those substances whose constituent particles are ions.	It is used for those substances whose constituent particles are molecules.
The formula mass is the sum of all the molecules in the compound.	The molecular mass remains the same even if millions of molecules are added.
Example: The formula mass for sodium chloride is: NaCl, 23 + 35.5 = 58.5 amu.	Example: The molecular mass of CO_2 = 1× Atomic Mass of Carbon + 2× Atomic Mass of oxygen = 12 + 2 × 16 = 12 + 32 = 44u.

2. Question

Which one is a larger quantity molar mass or molecular mass? Explain.

Answer

Molar mass is the mass of one mole of substance, while molecular mass is the mass of one molecule of the substance. Molecular mass is the larger quantity because it contains the mass of one molecule (made up of atoms).

3. Question

Calculate the molar mass of the following compounds:

(i) MgO (ii) Na_2CO_3

(iii) H_3PO_4 (iv) $Ca(OH)_2$

(v) $Al_2(SO_4)_3$

Answer

i. MgO:

Molar mass of Mg + 2 × Molar mass of oxygen

⇒ 24u + 2×16

⇒ 24 + 32

⇒ 56g/molThus, the molar mass of MgO is 56g/mol.

ii. Na_2CO_3:

2 × Molar mass of Na + Molar mass of carbon + 3×molar mass of oxygen

⇒ 2 × 23 + 12 + 3 × 16

⇒ 46 + 12 + 48

⇒ 106g/mol

Thus, the molar mass of Na_2CO_3 is 106g/mol.

iii. H_3PO_4:

3 × Molar mass of hydrogen + Molar mass of phosphorus + 4×molar mass of oxygen

⇒ 3 × 1 + 31 + 4 × 16

⇒ 3 + 31 + 64

⇒ 98g/mol

Thus, the molar mass of H_3PO_4 is 98g/mol.

iv. $Ca(OH)_2$

Molar mass of calcium + 2 × Molar mass of oxygen + 2×molar mass of hydrogen

⇒ 40 + 2 × 16 + 2 × 1

⇒ 40 + 32 + 2

⇒ 74g/mol

Thus, the molar mass of $Ca(OH)_2$ is 74g/mol.

v. $Al_2(SO_4)_3$

2 × Molar mass of aluminium + 3 × Molar mass of sulphur + 12×molar mass of oxygen

⇒ 2 × 27 + 3 × 32 + 12 × 16

⇒ 54 + 96 + 192

⇒ 342g/mol

Thus, the molar mass of $Al_2(SO_4)$ is 342g/mol.

4. Question

Predict the mass possessed by certain number of oxygen atoms which is equal to the number of molecules present 1g of hydrogen gas?

Answer

Mass of oxygen atoms = number of molecules present 1g of hydrogen gas

Number of molecules in 1g H_2 = 1/2 mole

⇒ $1/2 \times 6.022 \times 10^{23}$ atoms

⇒ 3.01×10^{23}

Thus, the mass possessed by certain number of oxygen atoms is 3.01×10^{23}

5. Question

Calculate the number of sodium ions that are present in 212g of sodium carbonate.

Answer

Given:

Mass of sodium carbonate = 212g

Sodium carbonate is Na_2CO_3

First, we need to calculate the number of moles of sodium

carbonate we have in a 212g sample. To calculate this, we will

find the molar mass of sodium carbonate (Na_2CO_3):

⇒ 2 × Molar mass of sodium + Molar mass of carbon + 3×molar mass of oxygen

⇒ 2 × 23 + 12 + 3 × 16

$\Rightarrow 46 + 12 + 48$

$\Rightarrow 106 g/mol$

Thus, the molar mass of Na_2CO_3 is 106g/mol.

Now we will calculate total number of moles by applying the

formula given:

$$\text{Number of moles} = \frac{\text{Mass of sodium carbonate}}{\text{Molar mass of sodum carbonate}}$$

$$\Rightarrow \text{Number of moles} = \frac{212g}{106g/mol}$$

$\Rightarrow 2$ mol

Now, we know that every mole of Na_2CO_3 have 2 moles of Na^+ ions. Hence, total moles of Na_2CO_3 is 4 moles

Number of ions present = $6.022 \times 10^{23} \times 4mol = 24.088 \times 10^{23}$ions

Chapter Exercise

1. Question

Why are Dalton's symbols not used in chemistry?

Answer

Dalton's symbols were not used in chemistry as he used the symbols for elements in a very specific sense. He also meant a definite quantity of that element by depicting symbol.

But a scientist Berzilius suggested that the symbols of elements be made from one or two letters of the element.

2. Question

Atoms of most elements are not able to exist independently. Name two atoms which exist as independent atoms.

Answer

Helium and neon exist as independent atoms. Mostly elements of noble gases exist as independent forms.

3. Question

In which form do atoms exist in aqueous solution? Give example.

Answer

Yes, atoms exist in aqueous solution.

For example: Common salt (NaCl) dissolves in water (aqueous

solution) and breaks into Na^+ and Cl^- ions.

4. Question

Give the symbols of the following elements.

(i) Aluminium (ii) Cobalt

(iii) Arsenic (iv) Radon

Answer

i. The symbol of aluminium is Al.

ii. The symbol of cobalt is Co.

iii. The symbol of arsenic is As.

iv. The symbol of radon is Rn.

5. Question

What do you understand from the statement "relative atomic mass of sulphur is 32"?

Answer

The relative atomic mass of an element is defined as the average mass of the atom, as compared to $1/12^{th}$the mass of one-carbon atom.

Relative atomic mass of sulphur is 32 means the average mass of the sulphur atom is found with respect to an atom of carbon-12.

6. Question

Write the ions present in

(i) $Al_2(CO_3)_3$ (ii) $AlBr_3$

Answer

i. $Al_2(CO_3)_3$: There are total two ions of Al^{3+} and three ions of CO_3^{2-} present. Hence total no. of ions = 5

ii. $AlBr_3$: There are total three ions of Br^- and one ion of Al^{3+} present. Hence total no. of ions = 4

7. Question

An element has a valency of 3. write the simplest formula for sulphide of the element.

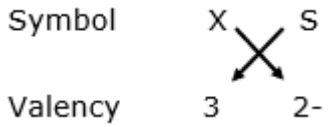
Answer

It is given that an element has a valency of 3.

Let the element is "X"

Valency of sulphide (S^{2-}) = -2

Formula for sulphide of element X:



Formula: X_2S_3

8. Question

Name the compound represented by formula K_2SO_4.

Answer

The name of the compound represented by formula K_2SO_4 is potassium sulphate.

9. Question

Give the formulae of the compounds formed from the sets of carbon and oxygen.

Answer

The formulae of the compounds formed from the sets of carbon and oxygen are:

i. Na_2CO_3 – Sodium carbonate

ii. H_2CO_3 – Carbonic acid

iii. $NaHCO_3$ – Sodium bicarbonate

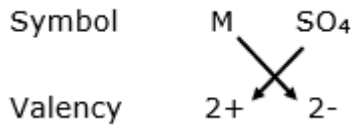
10. Question

The formula for the sulphate of a metal is MSO_4. What is the formula for the chloride of that metal?

Answer

It is given that sulphate of a metal is MSO_4.

By applying criss cross method, we can know the valency of "M":



Hence, the valency of "M" is +2

Now, formula for chloride of metal M:

Formula: MCl_2

Thus, the formula for the chloride of metal is MCl_2.

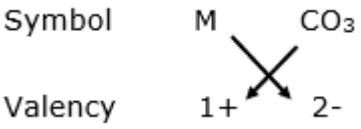
11. Question

The formula of carbonate of a metal M is M_2CO_3. What is the formula for phosphate of M?

Answer

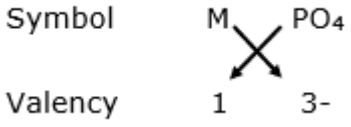
It is given that carbonate of a metal M is M_2CO_3.

By applying criss cross method, we can know the valency of "M":



Hence, the valency of "M" is +1

Now, formula for phosphate of metal M:



Formula: M_3PO_4

Thus, the formula for phophate of metal is M_3PO_4.

12. Question

(i) Which element is used as a standard for atomic mass scale?

(ii) What is the value of mass of this reference atom?

Answer

i. In 1961, for a universally accepted atomic mass unit, carbon-12 isotope was chosen as the standard reference for measuring atomic masses.

ii. One atomic mass unit is a mass unit equal to exactly $1/12^{th}$ the mass of one atom of carbon-12.

13. Question

While searching for various atomic mass units, scientists initially took 1/16 of the mass of a naturally occurring oxygen atom as one unit. State two reasons for this.

Answer

While searching for various atomic mass units, scientists initially took 1/16 of the mass of a naturally occurring oxygen atom as one unit. The two reasons are:

i. According to them, oxygen reacted with a large number of elements and formed compounds.

ii. The given atomic mass unit gave masses of most of the elements as whole numbers.

14. Question

What is the difference between 3O and O_3?

Answer

The difference between 3O and O_3:

i. 3O indicates the three oxide ions.

ii. O_3 indicates one ozone molecule which is formed by combining of three atoms of oxygen.

iii. O_3 is known as ozone gas which protects the earth from ultraviolet radiations.

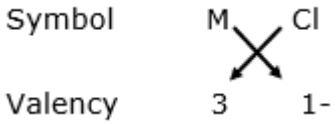
15. Question

If an element X has a valency of 3, then find out the formula of its chloride and sulphide.

Answer

It is given that element X has a valency of 3.

Formula for chloride of element X:



Formula: MCl_3

Thus, the formula for chloride of element X is MCl_3.

Formula for sulphide of element X:

Formula: M_2S_3

Thus, the formula for sulphide of element X is M_2S_3.

16. Question

(i) The valency of carbon is 4 and that of chlorine is 1. What will be the formula of carbon tetrachloride?

(ii) The valency of an element X is 1 and that of oxygen is 2. What will be the formula of the compound formed by the combination of element X with oxygen?

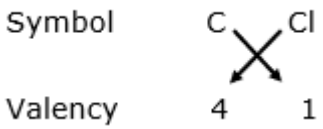
Answer

i. Given:

Valency of carbon is 4

Valency of chlorine is 1

By applying criss-cross method:



Formula: CCl_4

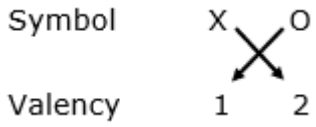
Thus, the formula for carbon tetrachloride is CCl_4.

ii. Given:

Valency of element X is 1

Valency of oxygen is 2

By applying criss-cross method:



Formula: X_2O

17. Question

In the chemical reaction given below, find the amount of barium sulphate formed. Also write the law involvedBarium chloride +Sodium sulphate→Barium sulpahte + Sodium chloride(20.8 g) (14.2 g) (?) (11.7 g)

Answer

Let the amount of barium sulphate is "x"g

The given reaction is:

Barium chloride + Sodium sulphate → Barium sulphate + sodium sulphate
20.8g 14.2g 11.7g

According to law of conservation of mass,

Amount of reactants = Amount of products formed

Hence, 20.8g + 14.2g = x + 11.7g

⇒ 35g = x + 11.7g

⇒ x = 23.5g

Thus, the amount of barium sulphate is 23.5g.

The law involved is Law of conservation of mass which states that

the sum of the masses of reactants and products remain unchanged.

18. Question

Name any two monovalent cations, divalent cations and trivalent cations. Also name any one compound each one of them make.

Answer

Two monovalent cations: Na^+ and K^+

Compounds they make: NaCl and KCl

Two divalent cations: Ca^{2+} and Ba^{2+}

Compounds they make: $CaCl_2$ and $BaCl_2$

Two trivalent cations: Al^{3+} and Fe^{3+}

Compounds they make: $AlCl_3$ and $FeCl_3$

Note: Monovalent cations: The cations (positively charged species) which have a valency of +1 are called monovalent cations.

Divalent cations: The cations which have a valency of +2 are called divalent cations.

Trivalent cations: The cations which have a valency of +3 are called trivalent cations.

19. Question

How are given mass, molar mass and number of moles related to each other?

Answer

$$\text{Number of moles} = \frac{\text{Given mass}}{\text{Molar mass}}$$

20. Question

The symbols of some of the ions are given below

Na^+, Mg^{2+}, H^+, CO_3^{2-}, Cl^-, S^{2-}

Using this information, find out the formulae of

(i) sodium carbonate

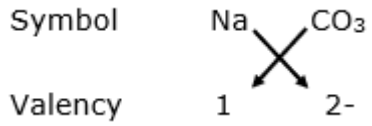
(ii) magnesium chloride

(iii) hydrogen sulphide

Answer

(i) Sodium carbonate

By applying criss-cross method:

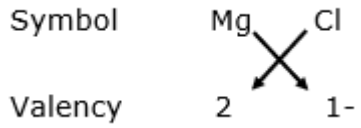


Formula: Na_2CO_3

Thus, the formula for sodium carbonate is Na_2CO_3.

(ii) Magnesium chloride

By applying criss-cross method:

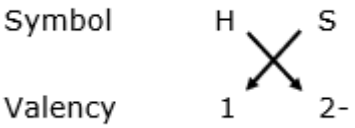


Formula: $MgCl_2$

Thus, the formula for magnesium chloride is $MgCl_2$.

(iii) Hydrogen sulphide

By applying criss-cross method:



Formula: H_2S

Thus, the formula for hydrogen sulphide is H_2S.

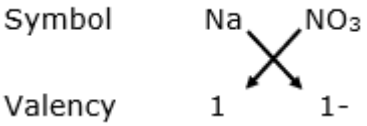
21. Question

Write the chemical formulae of Nitrates (NO_3^-) of Na^+, K^+, Al^{3+}, Mg^{2+}, Ca^{2+}, Zn^{2+}.

Answer

(i) For Na^+

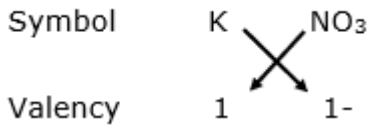
By applying criss-cross method:



Formula: $NaNO_3$

(ii) For K^{+}

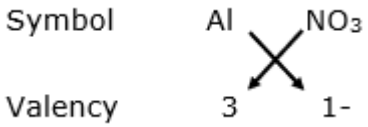
By applying criss-cross method:



Formula: KNO_3

(iii) For Al^{3+}

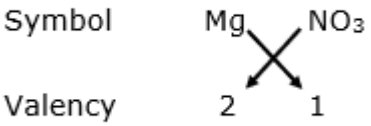
By applying criss-cross method:



Formula: $Al(NO_3)_3$

(iv) For Mg^{2+}

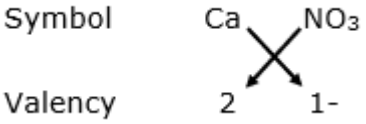
By applying criss-cross method:



Formula: $Mg(NO_3)_2$

(v) For Ca^{2+}

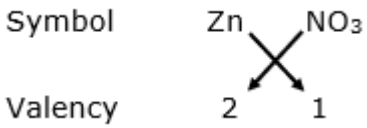
By applying criss-cross method:



Formula: $Ca(NO_3)_2$

(vi) For Zn^{2+}

By applying criss-cross method:



Formula: $Zn(NO_3)_2$

22. Question

Write the chemical formulae and names of the compounds formed by the following ions:

(i) Cr^{3+} and SO_4^{2-}

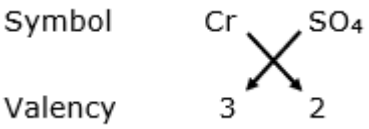
(ii) Pb2+ and NO_3^-

(iii) Mg^{2+} and CO_3^{2-}

Answer

(i) $\underline{Cr^{3+}}$ $\underline{\text{and } SO_4^{2-}}$

By applying criss-cross method:

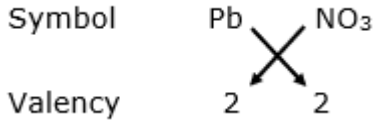


Chemical formula: $Cr_2(SO_4)_3$

Name of the compound: Chromium sulphate

(ii) $\underline{Pb^{2+}}$ $\underline{\text{and } NO_3^-}$

By applying criss-cross method:

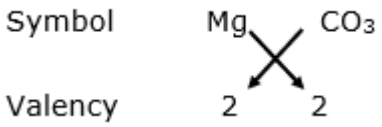


Chemical formula: $Pb(NO_3)$

Name of the compound: Lead nitrate

(iii) $\underline{Mg^{2+}}$ $\underline{\text{and } CO_3^{2-}}$

By applying criss-cross method:



Chemical formula: $MgCO_3$

Name of the compound: Magnesium carbonate

23. Question

In a chemical compound calcium sulphate:

(i) Identify the two ions.

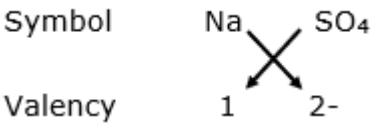
(ii) Write the chemical formula of compound formed when positive ion is replaced by sodium ion.

(iii) Name the resulting compound.

Answer

(i) The two ions are Ca^{2+} (cation) and SO_4^{2-}(anion)

(ii) When positive ion is replaced by sodium ion:



Chemical formula: Na_2SO_4

(iii) The name of the resulting compound (Na_2SO_4) is sodium sulphate.

24. Question

(i) Calculate the formula unit mass of Na_2CO_3.

[given atomic mass of Na = 23 u, C = 12 u and O = 16 u]

(ii) What is the mass of one mole of oxygen atoms?

(iii) Convert 12g of oxygen gas into mole, if atomic mass of oxygen is 16 u.

Answer

(i) Formula unit mass of Na_2CO_3:

2 × (Atomic mass of Na) + atomic mass of C + 3 × (Atomic

mass of oxygen)

⇒ 2 × 23 + 12 + 3×16

⇒ 46 + 12 + 48

⇒ 106u

(ii) <u>To calculate the mass of 1 mole of oxygen atoms:</u>

By applying the formula given:

$$\text{Number of moles} = \frac{\text{Mass of oxygen atoms}}{\text{Molar mass of oxygen}}$$

Mass of oxygen atoms = Number of moles × Molar mass

⇒ Mass of oxygen atoms = 1mole × 32g/mol

⇒ Mass of oxygen atoms = 32g

Thus, the mass of 1 mole of oxygen atoms is 32g.

(iii) Given: Mass of oxygen = 12g

Atomic mass = 16u

By applying the formula given:

$$\text{Number of moles} = \frac{\text{Mass of oxygen atoms}}{\text{Molar mass of oxygen}}$$

$$\Rightarrow \text{Number of moles} = \frac{12g}{16u}$$

⇒ Number of moles = 0.75mol

Thus, the number of moles = 0.75mol

25. Question

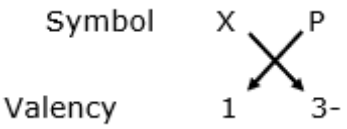
An element X has a valency 1.

(i) Write the chemical formula of its phosphide.

(ii) Write the chemical formula of its chloride.

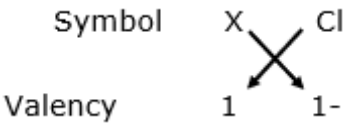
(iii) Is element X a metal or a non-metal?

Answer



Chemical formula: X_3P

(ii)



Chemical formula: XCl

(iii) The element X is metal.

26. Question

You are asked by your teacher to buy 10 moles of distilled water from a shop where small bottles each containing 20 g of such water are available. How many bottles will you buy?

Answer

Given:

No. of moles = 10mol

Mass of water in each bottle = 20g

As we know that molar mass of water (H_2O) is 18g/mol

Hence, we can say that 1mole of water = 18g

10 moles of water = 18 × 10 = 180g

Number of bottles = 180g /20g = 9

Thus, we will buy 9 bottles.

27. Question

State the two important laws of chemical combination. How Dalton's atomic theory explains the two Laws?

Answer

The two important laws of chemical combination are:

i) Law of constant proportion:

The law states that "in a chemical substance, the elements are always present in definite proportions by mass.

For example: In ammonia (NH_3), nitrogen and hydrogen are always present in the ratio of 14:3 by mass, whatever the method

or source from which it is obtained.

In water, hydrogen and oxygen are always present in the ratio of 1:8 by mass, whatever the method or source from which water is obtained.

ii) Law of conservation of mass:

According to the law of conservation of mass states, atoms are neither created nor destroyed in a chemical reaction. This means that the total mass of the products formed in a chemical reaction must be equal to the mass of reactants consumed.

For example:

$$\underset{100g}{CaCO_3} \rightarrow \underset{56g}{CaO} + \underset{44g}{CO_2}$$

Sum of mass of reactants = Sum of masses of prodcuts

28. Question

Give a brief description of the following:

(i) Relative atomic mass

(ii) Atomic mass unit

(iii) Ions

(iv) Ionic compound

(v) Atomicity

Answer

(i) Relative atomic mass: The relative atomic mass of an element is defined as the average mass of the atom, as compared to $1/12^{th}$the mass of one-carbon atom.

The relative atomic masses of all the elements have been found with respect to an atom of carbon-12.

(ii) Atomic mass unit: One atomic mass unit is a mass unit equal to the exactly $1/12^{th}$ the mass of one atom of carbon-12.

Carbon-112 was chosen as the standard reference for measuring atomic masses.

(iii) Ions: Compounds composed of metals and non-metals has charged species. The charge species are known as ions.

The negatively charged ions are called anions and positively charged ions are called cations.

(iv) Ionic compounds: Compounds formed by the exchange of ions (cations or anions) are called ionic compounds.

In ionic compounds, the charge on each ion is used to determine the chemical formula of the compound.

(v) Atomicity:

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

In P_4, there are four atoms of phosphorus constituting a molecule. Hence, the atomicity is 4 (tetra-atomic).

29. Question

Give the formulae of the compounds formed from the following set of elements.

(i) Carbon and hydrogen

(ii) Nitrogen and magnesium

(iii) Sodium and phosphorus

(iv) Potassium and oxygen

(v) Boron and oxygen

Answer

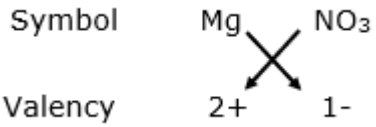
(i) Carbon and hydrogen:

CH_4 (methane)

C_2H_6 (ethane)

(ii) Nitrogen and magnesium:

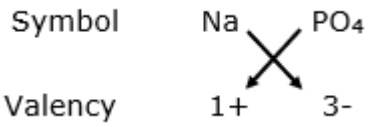
Magnesium nitrate



Formula: $Mg_3(NO_3)_2$

(iii) Sodium and phosphorus:

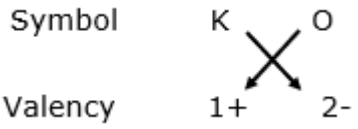
Sodium phosphate



Formula: Na_3PO_4

(iv) <u>Potassium and oxygen:</u>

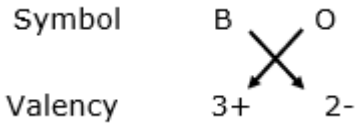
Potassium oxide



Formula: K_2O

(v) <u>Boron and oxygen:</u>

Boron oxide



Formula: B_2O_3

30. Question

In an experiment, 1.288 g of barium sulphate was obtained from 1.03 g of barium. In another experiment, 3.672 g of barium sulphate gave, on reduction, 2.938 g of barium. Show that these figures verify the law of constant proportions.

Answer

<u>In first experiment:</u>

Mass of barium sulphate = 1.288g

Mass of barium left = 1.03g

Mass of Sulphur present = 1.288 – 1.03 = 0.25g

Percentage of sulphur present in $BaSO_4 = \frac{0.25 \times 100}{1.288g}$

⇒ Percenatage of sulphur is 20%

<u>In second experiment:</u>

Mass of barium sulphate = 3.672g

Mass of barium left = 2.938g

Mass of Sulphur present = 3.672 – 2.938 = 0.73g

Percentage of sulphur present $\text{in } BaSO_4 = \frac{0.734 \times 100}{3.672g}$

⇒ Percenatage of sulphur is 20%

In both the experiments, the percentage of sulphur is same.

Hence, it is verified that these figures verify the law of constant proportions.

Note: Law of constant proportions states that "in a chemical substance, the elements are always present in definite proportions by mass.

31 A. Question

Calculate the mass of each of the following:

5 moles of aluminium borate

Answer

Given: Number of moles = 5

Atomic mass of $AlBO_3$ = 30+ 10.8 + 2 × 16 = 72.8g/mol

To find out the mass of aluminium borate, apply the formula given:

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

$$\Rightarrow 5 = \frac{\text{mass}}{72.8\ \text{g/mol}}$$

⇒ Mass = 5 mol × 72.8g/mol

⇒ Mass = 364g

Thus, the mass of aluminium borate is 364g.

31 B. Question

Calculate the mass of each of the following:

2 moles of potassium bromide

Answer

Given: Number of moles = 2

Atomic mass of KBr = 39 + 80 = 119g/mol

To find out the mass of potassium bromide, apply the formula given:

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

$$\Rightarrow 2 = \frac{\text{mass}}{119\ \text{g/mol}}$$

⇒ Mass = 2mol × 119g/mol

⇒ Mass = 238g

Thus, the mass of potassium bromide is 238g.

31 C. Question

Calculate the mass of each of the following:

10 moles of hydrogen cyanide

Answer

Given: Number of moles = 10

Atomic mass of HCN = 1+ 12 + 14 = 27g/mol

To find out the mass of hydrogen cyanide, apply the formula given:

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

$$\Rightarrow 10 = \frac{\text{mass}}{27\ \text{g/mol}}$$

⇒ Mass = 10 mol × 27g/mol

⇒ Mass = 270g

Thus, the mass of hydrogen cyanide is 270g.

31 D. Question

Calculate the mass of each of the following:

2 moles of methane

Answer

Given: Number of moles = 2

Atomic mass of CH_4 = 12+ 1 × 4 = 16g/mol

To find out the mass of methane, apply the formula given:

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

$$\Rightarrow 2 = \frac{\text{mass}}{16\ \text{g/mol}}$$

⇒ Mass = 2 mol × 16g/mol

⇒ Mass = 32g

Thus, the mass of methane is 32g.

31 E. Question

Calculate the mass of each of the following:

7 moles of sulphuric acid

Answer

Given: Number of moles = 7

Atomic mass of H_2SO_4 = 2 ×1 + 32 + 4 × 16 = 98g/mol

To find out the mass of sulphuric acid, apply the formula given:

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

$$\Rightarrow 7 = \frac{\text{mass}}{98\ \text{g/mol}}$$

⇒ Mass = 7 mol × 98g/mol

⇒ Mass = 686g

Thus, the mass of sulphuric acid is 686g.

32 A. Question

Name a greenhouse gas with molar mass 44 g mol^{-1} and is known to extinguish fire.

[Given, atomic masses of C = 12 u, O = 16 u, N_A = 6.022 × 10^{23} per mole]

Answer

Carbon dioxide

Carbon dioxide is a greenhouse gas and is used to

extinguish fire.

The molar mass of CO_2 is:

Atomic mass of C + 2 × (Atomic mass of oxygen)

⇒ 12 + 2×16

⇒ 44g/mol

32 B. Question

Name the elements present in this gas and wire their valency.

[Given, atomic masses of C = 12 u, O = 16 u, $N_A = 6.022 \times 10^{23}$ per mole]

Answer

The elements present in carbon dioxide gas are carbon and oxygen. The valency of carbon is 1 and the valency of oxygen is 2-

32 C. Question

Calculate the number of moles in 360 g of this gas sample.

[Given, atomic masses of C = 12 u, O = 16 u, $N_A = 6.022 \times 10^{23}$ per mole]

Answer

Given:

Mass of gas = 360g

Molar mass = 44g/mol

To calculate the number of moles, we apply the formula:

$$\text{Number of moles} = \frac{\text{Mass of } CO_2}{\text{Molar mass of } CO_2}$$

$$\Rightarrow \text{Number of moles} = \frac{360g}{44g/mol}$$

⇒ Number of moles = 8.1mol

Thus, the number of moles in 360g of the sample is 8.1

32 D. Question

Calculate the number of molecules in 88 g of this gas sample.

[Given, atomic masses of C = 12 u, O = 16 u, $N_A = 6.022 \times 10^{23}$ per mole]

Answer

Given: Mass of CO_2 = 88g

To calculate the number of molecules, first we apply the formula:

$$\text{Number of gram molecules} = \frac{\text{mass of } CO_2}{\text{Molar mass of } CO_2}$$

$$\Rightarrow \text{Number of gram molecules} = \frac{88g}{44g}$$

⇒ Number of gram molecules = 2

Now, number of molecules = 2 × Avogadro's number

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

$= 1.2 \times 10^{24}$

Thus, number of molecules of CO_2 is 1.2×10^{24}

33. Question

Jyoti buys a gold jewellery which has 90% gold and the rest copper. She is given a bill which charges amount equivalent to 100% of gold. She argues with seller about the discrepancy, who settles the bill accordingly.

(i) What is the ratio of gold and copper in the jewellery?

(ii) How many atoms of gold are present in 1g of it?

(iii) What are the values displayed by Jyoti?

Answer

(i) The ratio of gold and copper in the jewellery is 90:10

(ii) Mass of gold in 1g jewellery = 90% × 1g

= 0.9g

Atomic mass of gold = 197g/mol

197 g = 6.022×10^{23} atoms

$$\text{For } 0.9g = \frac{0.9g \times 6.022 \times 10^{23} \text{ atoms}}{197g/mol}$$

⇒ 2.72×10^{21} atoms

Thus, the number of atoms present in 1g of gold is 2.72×10^{21} atoms.

(iii) Jyoti is aware, concern and a knowledgeable person.

34. Question

Iron is present in haemoglobin (in blood) which acts as oxygen carrier in our body. Deficiency of iron leads to anaemia. It must be a part of our diet.

Read the above passage and answer the following questions.

(i) Name a fruit and a green vegetable which contain iron. Is iron metal or non metal?

(ii) Give the chemical formula of iron sulphate.

(iii) How will you make students of your school aware that they must take iron in the diet regularly?

Answer

(i) A fruit which contains iron is pomegranate. It is iron rich fruit.

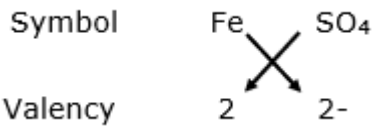
It also contains other important nutrients too.

A vegetable which contains iron is spinach. It is iron rich

vegetable. It contains 3.6mg of iron

Iron is a metal.

(ii) Iron sulphate:



Formula: $Fe_2(SO_4)_2$ or $FeSO_4$

(iii) Iron is present in haemoglobin (in blood) which acts as oxygen carrier in our body. It is an important nutrient for our body

Deficiency of iron leads to may problems. It can cause anaemia, shortness of breath, tiredness, headache or migraine. Hence, it must be a part of our diet.

35. Question

Mr. Seema taught mole concept to the students of class IX and asked the students to revise whatever had been taught. In the next period, she divided the class into several groups and asked each member of each group to explain what they have understood to the other members of their group.

Afreen a member of one of the group started to explain mole concept to the other members of her group as follow. Number of moles of molecules is equal to its mass and it is also equal to the Avogadro's number.

Read the above passage and answer the following questions.

(i) Comment on Afreen's understanding of mole concepts. What modification do her statement need?

(ii) What is the unit of Avogadro's number?

(iii) What are the value displayed by Mrs. Seema?

Answer

(i) Number of moles is equal to the mass of an element divided by its molar mass. The number of particles (atoms, molecules, ions) present in 1 mole of substance is fixed with a value of 6.022×10^{23} atoms (Avogadro's number)

(ii) The unit of Avogadro's number depends upon the nature the nature of the substance. The unit of Avogadro's number can be atoms. molecules or ions.

(iii) Mr. Seema is concern for students. She revises all the topics with students so that they can grab the topics easily. She is a very good teacher.

Challengers

1. Question

Antacid are prescribed during acidity. Commercially available antacids consist of magnesium hydroxide [$Mg(OH)_2$], sugar and flavouring agents. The magnesium hydroxide act as base and form salt and water on reaction with hydrochloric acid of the stomach. The mass of salt and water formed is equal to the combined mass of

A. Mg $(OH)_2$ and HCl

B. Mg $(OH)_2$ flavouring agent and HCl

C. Mg $(OH)_2$ sugar and HCl

D. Mg $(OH)_2$ sugar, flavouring agent and HCl

Answer

Acoording to the law of conservation of mass, the mass of products formed are equal to the mass of reactants consumed. Hence, the mass of salt and water formed is equal to the combined mass of magnesium hydroxide Mg $(OH)_2$ and HCl.

2. Question

In order to verify the law of conservation of mass, we carry out chemical reactions in a closed container, so that

A. gaseous products do not escape

B. heat transfer does not occur

C. reactants do not mix with the products

D. None of the above

Answer

In order to verify the law of conservation of mass, we carry out chemical reactions in a closed container, so that gaseous products do not escape. According to the law, mass of products must be equal to the mass of reactants.

3. Question

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

A. CaCl

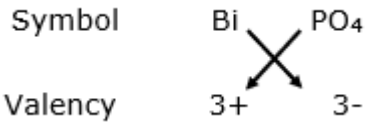
B. $BiPO_4$

C. $NaSO_4$

D. NaS

Answer

The correct chemical formula is $BiPO_4$



Formula: $BiPO_4$

The correct chemical formula of (i) is $CaCl_2$

The correct chemical formula of (iii) is Na_2SO_4

The correct chemical formula of (iv) is Na_2S

4. Question

Four students A, B, C and D verified the law of conservation of mass by performing chemical reaction between barium chloride and sodium sulphate. All of them took 107.2 g barium chloride solution and 116.1g of sodium sulphate solution and mixed them in the beaker of mass 150 g. They reported their results as follows:

Students	Colour of reaction mixture after mixing	Mass of reaction mixture in the beaker including mass of beaker
A	White precipitate	383.3g
B	Brown precipitate	393.3g
C	White precipitate	373.3g
D	Brown precipitate	363.3g

The correct observation is that of student.

A. A

B. B

C. C

D. D

Answer

Mass of barium sulphate =107.2 g

Mass of barium chloride = 116.1g

Mass of beaker = 150 g

Total mass of reaction mixture in the beaker including mass of

Beaker = 107.2g + 116.1g + 150g = 373.3g

5. Question

In a chemical reaction 10.6 g of sodium carbonate reacted with 12g of ethanoic acid. The products were 4.4 g carbon dioxide, 1.8 g of water and sodium ethanoate. The mass of sodium ethanoate formed is

A. 16.4 g

B. 0.16 g

C. 24 g

D. 8.2 g

Answer

Let the mass of sodium etanoate is “x”g

$$Na_2CO_3 + CH_3COOH \rightarrow CH_3COONa + CO_2 + H_2O$$
$$10.6g \quad 12g \quad xg \quad 4.4g \quad 1.8g$$

Acoording to law of conservation of mass,

Sum of masses of reactants = Sum of masses of products

Hence, 10.6g +12.g = x + 4.4g +1.8g

⇒ x = 16.4g

Thus, the mass of sodium ethanoate formed is 16.4g

6. Question

During an experiment hydrogen (H_2) and oxygen (O_2) gases reacted in an electric are to produce water as

follows: $2H + O_2 \xrightarrow{\text{Electricity}} 2H_2O$

The experiment is repeated three times and data tabulated as shown below:

Experiment number	Mass of H_2 reacted	Mass of O_2 reacted	Mass of H_2O produced
1	2g	16g	18g
2	4g	32g	36g
3	-	-	9g

During 3rd experiment the researcher forgot to list masses of H_2 and O_2 used. So, if the law of constant proportion is correct then find mass of O_2 used during 3rd experiment.

A. 4g

B. 8g

C. 16g

D. 32g

Answer

In experiment (i), the ratio is 2:16, i.e., 1:8

In experiment (ii), the ratio is 4:32, i.e., 1:8

According to the law of constant proportions, the ratio of third experiment should be the same (1:8)

Therefore, the mass of O_2 used during 3rd experiment is 8g.

7. Question

Nitrogen and hydrogen combine together to form ammonia.

$N_2 + 3H_2 \rightarrow 2NH_3$

[Relative atomic masses of N = 14 u, H = 1 u]

The mass of nitrogen and hydrogen which combine together to form 6.8 g ammonia is

A. N_2 = 2.8g, H_2 = 4.0g

B. N_2 = 5.6g, H_2 = 1.2g

C. N_2 = 4.0g, H_2 = 2.8g

D. N_2 = 12g, H_2 = 5.6g

Answer

If N_2 = 5.6g, H_2 = 1.2g

According to the law of conservation of mas,

5.6g + 1.2g = 6.8g of ammonia

Hence, the option (b) is correct

8. Question

Which of the following correctly represent 360 g of water?

I. 2 moles of H_2O

II. 20 moles of water

III. 6.022×10^{23} molecules of water

IV. 1.2044×10^{25} molecules of water

A. Only I

B. I and IV

C. II and III

D. II and IV

Answer

$$\text{Number of moles} = \frac{\text{Mass of water}}{\text{Molar mass of water}}$$

$$\Rightarrow \text{Number of moles} = \frac{360\text{g}}{18\text{g/mol}}$$

⇒ Number of moles = 20

Number of molecules = $20 \times 6.022 \times 10^{23}$

= 1.2044×10^{25} molecules of water

Thus, option (d) is correct.

9. Question

3.42 g of glucose are dissolved in 18 g of water in a beaker. The number of oxygen atoms in the solution is

A. 6.68×10^{23}

B. 6.09×10^{22}

C. 6.022×10^{23}

D. 6.022×10^{21}

Answer

Molar mass of sucrose = $C_{12}H_{22}O_{11}$

= 12× 12 + 1× 22 + 16 × 11 = 342g/mol

$$\text{Number of moles} = \frac{\text{Mass of glucose}}{\text{Molar mass of sucrose}}$$

$$\Rightarrow \text{Number of moles} = \frac{3.42\text{g}}{342\text{g/mol}}$$

⇒ Number of moles = 0.01

Sucrose ($C_{12}H_{22}O_{11}$) contains 11 oxygen atoms

⇒ $11 \times 6.022 \times 10^{23}$

For 0.01 moles of sucrose

⇒ $0.01 \times 11 \times 6.022 \times 10^{23} = 6.6 \times 10^{22}$

Now, Molar mass of water = H_2O = 2× 1 + 16 = 18g/mol

$$\text{Number of moles} = \frac{\text{Mass of water}}{\text{Molar mass of water}}$$

$$\Rightarrow \text{Number of moles} = \frac{18\text{g}}{18\text{g/mol}}$$

⇒ Number of moles = 1

Sucrose (H_2O) contains 1 oxygen atom = 6.022×10^{23}

For 1 mole of water = 6.022×10^{23}

Now, add the both values: $6.6 \times 10^{22} + 6.022 \times 10^{23}$

We get 6.68×10^{23} atoms. Hence, the option (a) is correct.

10. Question

Which of the following contains maximum number of molecules?

A. 1g CO_2

B. 1g N_2

C. 1g H_2

D. 1g CH_2

Answer

Less is the molar mass, more will be the number of

molecules. H_2 has lowest molar mass among the given options.

Hence, it contains he maximum number of molecules.