

Exercise-3.1

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

Sodium carbonate + acetic acid \rightarrow Sodium acetate + carbon dioxide + water

Solution:

Sodium carbonate + acetic acid \rightarrow Sodium acetate + carbon dioxide + water

5.3g 6g 8.2g 2.2g 0.9g

As per the law of conservation of mass, the total mass of reactants must be equal to the total mass of products.

As per the above reaction, L.H.S. = R.H.S. i.e., $5.3\text{g} + 6\text{g} = 2.2\text{g} + 0.9\text{g} + 8.2\text{g} = 11.3\text{g}$

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

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

Solution:

We know hydrogen and water mix in a ratio 1: 8.

For every 1g of hydrogen, it is 8g of oxygen.

Therefore, for 3g of hydrogen, the quantity of oxygen = $3 \times 8 = 24\text{g}$

Hence, 24g of oxygen would be required for the complete reaction with 3g of hydrogen gas.

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

Solution:

The relative number and types of atoms are constant in a given composition, says Dalton's atomic theory, which is based on the rule of conservation of mass.

"Atoms cannot be created nor be destroyed in a chemical reaction."

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

Solution:

The postulate of Dalton's atomic theory that can explain the law of definite proportions is that the relative number and kinds of atoms are equal in given compounds.

Exercise-3.2

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1. Define the atomic mass unit.

Solution:

An atomic mass unit is a unit of mass used to express the weights of atoms and molecules where one atomic mass is equal to 1/12th the mass of one carbon-12 atom.

2. Why is it not possible to see an atom with the naked eyes?

Solution:

Firstly, atoms are minuscule in nature, measured in nanometres. Secondly, except for atoms of noble gases, they do not exist independently. Hence, an atom cannot be visible to the naked eyes.

Exercise-3.3-3.4 Page: 39

1. Write down the formulae of

(i) sodium oxide

(ii) aluminium chloride

(iii) sodium sulphide

(iv) magnesium hydroxide

Solution:

The following are the formulae:

(i) sodium oxide – Na_2O

(ii) aluminium chloride – AlCl_3

(iii) sodium sulphide – Na_2S

(iv) magnesium hydroxide – $\text{Mg}(\text{OH})_2$

2. Write down the names of compounds represented by the following formulae:

(i) $\text{Al}_2(\text{SO}_4)_3$

(ii) CaCl_2

(iii) K_2SO_4

(iv) KNO_3

(v) CaCO_3

Solution:

Listed below are the names of the compounds for each of the following formulae:

(i) $\text{Al}_2(\text{SO}_4)_3$ – Aluminium sulphate

- (ii) CaCl_2 – Calcium chloride
- (iii) K_2SO_4 – Potassium sulphate
- (iv) KNO_3 – Potassium nitrate
- (v) CaCO_3 – Calcium carbonate

3. What is meant by the term chemical formula?

Solution:

Chemical formulas are used to describe the different types of atoms and their numbers in a compound or element. Each element's atoms are symbolised by one or two letters. A collection of chemical symbols that depicts the elements that make up a compound and their quantities.

For example, the chemical formula of hydrochloric acid is HCl .

4. How many atoms are present in a

(i) H_2S molecule and

(ii) PO_4^{3-} ion?

Solution:

The number of atoms present is as follows:

- (i) H_2S molecule has 2 atoms of hydrogen and 1 atom of sulphur hence 3 atoms in total.
- (ii) PO_4^{3-} ion has 1 atom of phosphorus and 4 atoms of oxygen hence 5 atoms in total.

Exercise-3.5.1-3.5.2**Page: 40****1. Calculate the molecular masses of H_2 , O_2 , Cl_2 , CO_2 , CH_4 , C_2H_6 , C_2H_4 , NH_3 , CH_3OH .**

Solution:

The following are the molecular masses:

The molecular mass of H_2 = 2 x atoms atomic mass of H = $2 \times 1u = 2u$ The molecular mass of O_2 = 2 x atoms atomic mass of O = $2 \times 16u = 32u$ The molecular mass of Cl_2 = 2 x atoms atomic mass of Cl = $2 \times 35.5u = 71u$ The molecular mass of CO_2 = atomic mass of C + 2 x atomic mass of O = $12 + (2 \times 16)u = 44u$ The molecular mass of CH_4 = atomic mass of C + 4 x atomic mass of H = $12 + (4 \times 1)u = 16u$ The molecular mass of C_2H_6 = 2 x atomic mass of C + 6 x atomic mass of H = $(2 \times 12) + (6 \times 1)u = 24 + 6 = 30u$ The molecular mass of C_2H_4 = 2 x atomic mass of C + 4 x atomic mass of H = $(2 \times 12) + (4 \times 1)u = 24 + 4 = 28u$ The molecular mass of NH_3 = atomic mass of N + 3 x atomic mass of H = $(14 + 3 \times 1)u = 17u$ The molecular mass of CH_3OH = atomic mass of C + 3 x atomic mass of H + atomic mass of O + atomic mass of H = $(12 + 3 \times 1 + 16 + 1)u = (12 + 3 + 17)u = 32u$ **2. Calculate the formula unit masses of ZnO , Na_2O , K_2CO_3 , given atomic masses of Zn = 65u, Na = 23u, K=39u, C = 12u, and O=16u.**

Solution:

Given:

The atomic mass of Zn = 65u

The atomic mass of Na = 23u

The atomic mass of K = 39u

The atomic mass of C = 12u

The atomic mass of O = 16u

The formula unit mass of ZnO = Atomic mass of Zn + Atomic mass of O = $65u + 16u = 81u$ The formula unit mass of Na_2O = 2 x Atomic mass of Na + Atomic mass of O = $(2 \times 23)u + 16u = 46u + 16u = 62u$ The formula unit mass of K_2CO_3 = 2 x Atomic mass of K + Atomic mass of C + 3 x Atomic mass of O = $(2 \times 39)u + 12u + (3 \times 16)u = 78u + 12u + 48u = 138u$

Exercise-3.5.3**Page: 42**

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

Solution:

Given: 1 mole of carbon weighs 12g

1 mole of carbon atoms = 6.022×10^{23}

The molecular mass of carbon atoms = 12g = an atom of carbon mass

Hence, mass of 1 carbon atom = $12 / 6.022 \times 10^{23} = 1.99 \times 10^{-23}\text{g}$

2. Which has more number of atoms, 100 grams of sodium or 100 grams of iron (given the atomic mass of Na = 23u, Fe = 56 u)?

Solution:

(a) In 100 grams of Na:

$m = 100\text{g}$, Molar mass of Na atom = 23g, $N_0 = 6.022 \times 10^{23}$, $N = ?$

$N = (\text{Given mass} \times N_0) / \text{Molar mass}$

$N = (100 \times 6.022 \times 10^{23}) / 23$

$N = 26.18 \times 10^{23}$ atoms

(b) In 100 grams of Fe:

$m = 100\text{ g}$, Molar mass of Fe atom = 56 g, $N_0 = 6.022 \times 10^{23}$, $N = ?$

$N = (\text{Given mass} \times N_0) / \text{Molar mass}$

$N = (100 \times 6.022 \times 10^{23}) / 56$

$N = 10.75 \times 10^{23}$ atoms

Therefore, the number of atoms is more in 100g of Na than in 100g of Fe.

Exercise

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1. A 0.24g sample of a compound of oxygen and boron was found by analysis to contain 0.096g of boron and 0.144g of oxygen. Calculate the percentage composition of the compound by weight.

Solution:

Given: Mass of the sample compound = 0.24g, mass of boron = 0.096g, mass of oxygen = 0.144g

To calculate the percentage composition of the compound,

Percentage of boron = mass of boron / mass of the compound \times 100

$$= 0.096\text{g} / 0.24\text{g} \times 100 = 40\%$$

Percentage of oxygen = 100 – percentage of boron

$$= 100 - 40 = 60\%$$

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

Solution:

When 3.0 g of carbon is burnt in 8.00 g of oxygen, 11.00 g of carbon dioxide is produced.

Given that

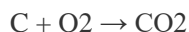
3.0 g of carbon combines with 8.0 g of oxygen to give 11.0 of carbon dioxide.

Find out

We need to find out the mass of carbon dioxide that will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen.

Solution

First, let us write the reaction taking place here.



As per the given condition, when 3.0 g of carbon is burnt in 8.00 g of oxygen, 11.00 g of carbon dioxide is produced.



The total mass of reactants = mass of carbon + mass of oxygen

$$= 3\text{g} + 8\text{g}$$

$$= 11\text{g}$$

The total mass of reactants = Total mass of products

Therefore, the law of conservation of mass is proved.

Then, it also depicts that carbon dioxide contains carbon and oxygen in a fixed ratio by mass, which is 3:8.

Thus, it further proves the law of constant proportions.

3 g of carbon must also combine with 8 g of oxygen only.

This means that $(50-8)=42\text{g}$ of oxygen will remain unreacted.

The remaining 42 g of oxygen will be left un-reactive. In this case, too, only 11 g of carbon dioxide will be formed

The above answer is governed by the law of constant proportions.

3. What are polyatomic ions? Give examples.

Solution:

Polyatomic ions are ions that contain more than one atom, but they behave as a single unit.

Example: CO_3^{2-} , H_2PO_4^-

4. Write the chemical formula of the following.

- (a) Magnesium chloride
- (b) Calcium oxide
- (c) Copper nitrate
- (d) Aluminium chloride
- (e) Calcium carbonate

Solution:

The following are the chemical formula of the above-mentioned list:

- (a) Magnesium chloride – MgCl_2
- (b) Calcium oxide – CaO
- (c) Copper nitrate – $\text{Cu}(\text{NO}_3)_2$
- (d) Aluminium chloride – AlCl_3
- (e) Calcium carbonate – CaCO_3

5. Give the names of the elements present in the following compounds.

- (a) Quick lime
- (b) Hydrogen bromide
- (c) Baking powder
- (d) Potassium sulphate

Solution:

The following are the names of the elements present in the following compounds:

- (a) Quick lime – Calcium and oxygen (CaO)
- (b) Hydrogen bromide – Hydrogen and bromine (HBr)
- (c) Baking powder – Sodium, Carbon, Hydrogen, Oxygen (NaHCO_3)

(d) Potassium sulphate – Sulphur, Oxygen, Potassium (K_2SO_4)

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

Solution:

Listed below is the molar mass of the following substances:

(a) Molar mass of Ethyne $C_2H_2 = 2 \times \text{Mass of C} + 2 \times \text{Mass of H} = (2 \times 12) + (2 \times 1) = 24 + 2 = 26g$

(b) Molar mass of Sulphur molecule $S_8 = 8 \times \text{Mass of S} = 8 \times 32 = 256g$

(c) Molar mass of Phosphorus molecule, $P_4 = 4 \times \text{Mass of P} = 4 \times 31 = 124g$

(d) Molar mass of Hydrochloric acid, $HCl = \text{Mass of H} + \text{Mass of Cl} = 1 + 35.5 = 36.5g$

(e) Molar mass of Nitric acid, $HNO_3 = \text{Mass of H} + \text{Mass of Nitrogen} + 3 \times \text{Mass of O} = 1 + 14 + 3 \times 16 = 63g$

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)?

Solution:

The mass of the above-mentioned list is as follows:

(a) Atomic mass of nitrogen atoms = 14u

Mass of 1 mole of nitrogen atoms = Atomic mass of nitrogen atoms

Therefore, the mass of 1 mole of nitrogen atom is 14g.

(b) Atomic mass of aluminium =27u

Mass of 1 mole of aluminium atoms = 27g

1 mole of aluminium atoms = 27g, 4 moles of aluminium atoms = $4 \times 27 = 108g$

(c) Mass of 1 mole of sodium sulphite $Na_2SO_3 = \text{Molecular mass of sodium sulphite} = 2 \times \text{Mass of Na} + \text{Mass of S} + 3 \times \text{Mass of O} = (2 \times 23) + 32 + (3 \times 16) = 46 + 32 + 48 = 126g$

Therefore, mass of 10 moles of $Na_2SO_3 = 10 \times 126 = 1260g$

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

Solution:

Conversion of the above-mentioned molecules into moles is as follows:

(a) Given: Mass of oxygen gas = 12gMolar mass of oxygen gas = 2 Mass of Oxygen = $2 \times 16 = 32\text{g}$ Number of moles = Mass given / molar mass of oxygen gas = $12/32 = 0.375$ moles**(b)** Given: Mass of water = 20gMolar mass of water = 2 x Mass of Hydrogen + Mass of Oxygen = $2 \times 1 + 16 = 18\text{g}$

Number of moles = Mass given / molar mass of water

 $= 20/18 = 1.11$ moles**(c)** Given: Mass of carbon dioxide = 22gMolar mass of carbon dioxide = Mass of C + 2 x Mass of Oxygen = $12 + 2 \times 16 = 12 + 32 = 44\text{g}$ Number of moles = Mass given / molar mass of carbon dioxide = $22/44 = 0.5$ moles**9. What is the mass of?****(a) 0.2 mole of oxygen atoms?****(b) 0.5 mole of water molecules?**

Solution:

The mass is as follows:

(a) Mass of 1 mole of oxygen atoms = 16u; hence, it weighs 16g.Mass of 0.2 moles of oxygen atoms = $0.2 \times 16 = 3.2\text{g}$ **(b)** Mass of 1 mole of water molecules = 18u; hence, it weighs 18g.Mass of 0.5 moles of water molecules = $0.5 \times 18 = 9\text{g}$ **10. Calculate the number of molecules of sulphur (S_8) present in 16g of solid sulphur.**

Solution:

To calculate the molecular mass of sulphur,

Molecular mass of Sulphur (S_8) = 8 x Mass of Sulphur = $8 \times 32 = 256\text{g}$

Mass given = 16g

Number of moles = mass given / molar mass of sulphur

$$= 16/256 = 0.0625 \text{ moles}$$

To calculate the number of molecules of sulphur in 16g of solid sulphur,

Number of molecules = Number of moles \times Avogadro number

$$= 0.0625 \times 6.022 \times 10^{23} \text{ molecules}$$

$$= 3.763 \times 10^{22} \text{ molecules}$$

11. Calculate the number of aluminium ions present in 0.051g 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 = 27u)

Solution:

To calculate the number of aluminium ions in 0.051g of aluminium oxide,

1 mole of aluminium oxide = 6.022×10^{23} molecules of aluminium oxide

1 mole of aluminium oxide (Al_2O_3) = 2 \times Mass of aluminium + 3 \times Mass of oxygen

$$= (2 \times 27) + (3 \times 16) = 54 + 48 = 102\text{g}$$

1 mole of aluminium oxide = 102g = 6.022×10^{23} molecules of aluminium oxide

Therefore, 0.051g of aluminium oxide has = $6.022 \times 10^{23} / 102 \times 0.051$

$$= 3.011 \times 10^{20} \text{ molecules of aluminium oxide}$$

One molecule of aluminium oxide has 2 aluminium ions; hence, the number of aluminium ions present in 0.051g of aluminium oxide = $2 \times 3.011 \times 10^{20}$ molecules of aluminium oxide.

$$= 6.022 \times 10^{20}$$

