

NCERT SOLUTIONS

CLASS - 9th



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Class : 9th
Subject : Science
Chapter : 3

Chapter Name : ATOMS AND MOLECULES

Q1 In a reaction, 5.3 g of sodium carbonate reacted with 6 g of acetic acid. The products were 2.2 g of carbon dioxide, 0.9 g water and 8.2 g 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

Answer. In the given reaction, sodium carbonate reacts with ethanoic acid to produce sodium ethanoate, carbon dioxide, and water.

Sodium + Ethanoic \longrightarrow Sodium + Carbon + Water
carbonate acid ethanoate dioxide

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.

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Q2 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?

Answer. It is given that 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. Therefore, the mass of oxygen gas required to react completely with 3 g of hydrogen gas is $8 \times 3 \text{ g} = 24 \text{ g}$.

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Q3 Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

Answer. 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.

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Q4 Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Answer. 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 remains constant.

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Q1 . Define the atomic mass unit?

Answer. 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'.

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Q2 Why is it not possible to see an atom with naked eyes?

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

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Q1 Write down the formulae of

- (i) sodium oxide
- (ii) aluminium chloride
- (iii) sodium sulphide
- (iv) magnesium hydroxide

Answer. (i) sodium oxide- Na_2O
(ii) aluminium chloride- AlCl_3
(iii) sodium sulphide- Na_2S
(iv) magnesium hydroxide- $\text{Mg}(\text{OH})_2$

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Q2 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) $CaCO_3$

Answer. (i) $Al_2(SO_4)_3$ -> Aluminium sulphate

(ii) $CaCl_2$ -> Calcium chloride

(iii) K_2SO_4 -> Potassium sulphate

(iv) KNO_3 -> Potassium nitrate

(v) $CaCO_3$ -> Calcium carbonate

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Q3 What is meant by the term chemical formula?

Answer. 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 of 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.

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Q4 How many atoms are present in a

(i) H_2S molecule and

(ii) PO_4^{3-} ion?

Answer. (i) In an H_2S molecule, three atoms are present; two of hydrogen and one of sulphur.

(ii) In a PO_4^{3-} ion, five atoms are present; one of phosphorus and four of oxygen.

Q1 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 .

Answer.

$$\text{Molecular mass of H}_2 = 2 \times \text{Atomic mass of H}$$

$$= 2 \times 1$$

$$= 2 \text{ u}$$

$$\text{Molecular mass of O}_2 = 2 \times \text{Atomic mass of O}$$

$$= 2 \times 16$$

$$= 32 \text{ u}$$

$$\text{Molecular mass of Cl}_2 = 2 \times \text{Atomic mass of Cl}$$

$$= 2 \times 35.5$$

$$= 71 \text{ u}$$

$$\text{Molecular mass of CO}_2 = \text{Atomic mass of C} + 2 \times \text{Atomic mass of O}$$

$$= 12 + 2 \times 16$$

$$= 44 \text{ u}$$

$$\text{Molecular mass of CH}_4 = \text{Atomic mass of C} + 4 \times \text{Atomic mass of H}$$

$$= 12 + 4 \times 1$$

$$= 16 \text{ u}$$

$$\text{Molecular mass of C}_2\text{H}_6 = 2 \times \text{Atomic mass of C} + 6 \times \text{Atomic mass of H}$$

$$= 2 \times 12 + 6 \times 1$$

$$= 30 \text{ u}$$

$$\text{Molecular mass of C}_2\text{H}_4 = 2 \times \text{Atomic mass of C} + 4 \times \text{Atomic mass of H}$$

$$= 2 \times 12 + 4 \times 1$$

$$= 28 \text{ u}$$

$$\text{Molecular mass of NH}_3 = \text{Atomic mass of N} + 3 \times \text{Atomic mass of H}$$

$$= 14 + 3 \times 1$$

$$= 17 \text{ u}$$

$$\text{Molecular mass of CH}_3\text{OH} = \text{Atomic mass of C} + 4 \times \text{Atomic mass of H} + \text{Atomic mass of O}$$

$$= 12 + 4 \times 1 + 16$$

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Q2 Calculate the formula unit masses of ZnO, Na₂O, K₂CO₃, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.

Answer.

$$\text{Formula unit mass of ZnO} = \text{Atomic mass of Zn} + \text{Atomic mass of O}$$

$$= 65 + 16$$

$$= 81 \text{ u}$$

$$\text{Formula unit mass of Na}_2\text{O} = 2 \times \text{Atomic mass of Na} + \text{Atomic mass of O}$$

$$= 2 \times 23 + 16$$

$$= 62 \text{ u}$$

$$\text{Formula unit mass of K}_2\text{CO}_3 = 2 \times \text{Atomic mass of K} + \text{Atomic mass of C} + 3 \times \text{Atomic mass of O}$$

$$= 2 \times 39 + 12 + 3 \times 16$$

$$= 138 \text{ u}$$

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Q1 If one mole of carbon atoms weighs 12 grams, what is the mass (in grams) of 1 atom of carbon?

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

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

Then, mass of 6.022×10^{23} number of carbon atoms = 12

Therefore, mass of 1 atom of carbon $\frac{12}{6.022 \times 10^{23}}$ g

= 1.9926×10^{-21} g

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Q2 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)?

Answer. Atomic mass of Na = 23 u (Given)

Then, gram atomic mass of Na = 23 g

Now, 23 g of Na contains = 6.022×10^{23} number of atoms

Thus, 100 g of Na contains = $\frac{6.022 \times 10^{23}}{23} \times 100$

number of atoms = 2.6182×10^{24} 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 = $\frac{6.022 \times 10^{23}}{56} \times 100$ number of atoms

Thus, 100 g of Fe contains = 1.0753×10^{24} number of atoms

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

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Q1 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.

Answer. Mass of boron = 0.096 g (Given)

Mass of oxygen = 0.144 (Given)

Mass of sample = 0.24 g (Given)

Thus, percentage of boron by weight in the compound = $\frac{0.096}{0.24} \times 100$

= 40 %

And, percentage of oxygen by weight in the compound = $\frac{0.144}{0.24} \times 100$

= 60%

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Q2 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 combination will govern your answer?

Answer. Carbon + Carbon \rightarrow 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 un-reactive.

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

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

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Q3 What are polyatomic ions? Give examples.

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

Example ammonium ion (NH_4^+), hydroxide ion OH^- , carbonate ion CO_3^{2-} , sulphate ion SO_4^{2-}

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Q4 Write the chemical formulae of the following.

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

Answer.(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

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Q5 Give the names of the elements present in the following compounds.

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

Answer.

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 ₂ SO ₄	Potassium, sulphur, oxygen

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Q6 Calculate the molar mass of the following substances.

- Ethyne, C₂H₂
- Sulphur molecule, S₈
- Phosphorus molecule, P₄ (Atomic mass of phosphorus = 31)
- Hydrochloric acid, HCl
- Nitric acid, HNO₃

Answer. (a) Molar mass of ethyne, C₂H₂ = 2 x 12 + 2 x 1 = 26 g

(b) Molar mass of sulphur molecule, S₈ = 8 x 32 = 256 g

(c) Molar mass of phosphorus molecule, P₄ = 4 x 31 = 124 g

(d) Molar mass of hydrochloric acid, HCl = 1 + 35.5 = 36.5 g

(e) Molar mass of nitric acid, HNO₃ = 1 + 14 + 3 x 16 = 63 g

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Q7 What is the mass of—

- 1 mole of nitrogen atoms?
- 4 moles of aluminium atoms (Atomic mass of aluminium = 27)?
- 10 moles of sodium sulphite (Na₂SO₃)?

Answer. (a) The mass of 1 mole of nitrogen atoms is 14 g.

(b) The mass of 4 moles of aluminium atoms is (4 x 27) = 108g

(c) The mass of 10 moles of sodium sulphite is 10 x [23 + 32 + 3 x 16] g = 10 x 126 g = 1260g

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Q8 Convert into mole.

- 12 g of oxygen gas
- 20 g of water
- 22 g of carbon dioxide

Answer. (a) 32 g of oxygen gas = 1 mole

then, 12 g of oxygen gas = 12/32 mole = 0.375 moles

(b) 18 g of water = 1 mole

Then, 20 g of water = $20/18$ mole = 1.11 moles (approx)

(c) 44 g of carbon dioxide = 1 mole

Then, 22 g of carbon dioxide = $22/44$ mole = 0.5 mole

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Q9 What is the mass of:

(a) 0.2 mole of oxygen atoms?

(b) 0.5 mole of water molecules?

Answer, (a) Mass of one mole of oxygen atoms = 16 g

Then, mass of 0.2 mole of oxygen atoms = 0.2 \times 16g

(b) Mass of one mole of water molecule = 18 g

Then, mass of 0.5 mole of water molecules = 0.5 \times 18 g = 9 g

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Q10 Calculate the number of molecules of sulphur S_8 present in 16 g of solid sulphur.

Answer. 1 mole of solid sulphur S_8 = 8 \times 32 g = 256 g

i.e., 256 g of solid sulphur contains = 6.022×10^{23} molecules

Then, 16 g of solid sulphur contains = $\frac{6.022 \times 10^{23}}{256} \times 16$ molecules
 = 3.76×10^{22} molecules

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Q11 Calculate the number of aluminium ions present in 0.051 g of aluminium oxide.

Answer. 1 mole of aluminium oxide (Al_2O_3) = 2 \times 27 + 3 \times 16 = 102g

i.e., 102 gm of Al_2O_3 = 6.022×10^{23} molecules of Al_2O_3

Then, 0.051 gm of Al_2O_3 contains = $\frac{6.022 \times 10^{23}}{102} \times 0.051$ molecules
 = 3.011×10^{20} molecules of Al_2O_3

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

Therefore, the number of aluminium ions (Al^{3+}) present in

3.011×10^{20} molecules of aluminium oxide = 2 \times 3.011×10^{20}
 = 6.022×10^{20}

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