



NCERT Solutions for 9th class Science : Chapter 3 Atoms and Molecules



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Class 9: Science Chapter 3 solutions. Complete Class 9 Science Chapter 3 Notes.

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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.

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Show that these observations are in agreement with the law of conservation of mass.

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

Answer

In the given reaction, sodium carbonate reacts with ethanoic acid to produce sodium ethanoate, 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

∴ 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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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?

Answer

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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 $8 \times 3 \text{ g} = 24 \text{ g}$.

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

Answer

The postulate of Dalton : "Atoms are indivisible particles, which can not be created or destroyed in a chemical reaction" is the result of the law of conservation of mass.

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

Answer

The postulate of Dalton, "The relative number and kinds of atoms are constant in a given compound", can explain the law of definite proportions.

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1. Define 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'.

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

Answer

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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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1. Write down the formulae of

(i) sodium oxide

▶ Na_2O

▶ AlCl_3

▶ Na_2S

▶ $\text{Mg}(\text{OH})_2$

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

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

▶ 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?

Answer

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The chemical formula of a compound is a symbolic representation of its composition.

4. 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.

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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 .

Answer

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

$$= 2 \times 1$$

$$= 2 \text{ u}$$

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

$$= 2 \times 16$$

$$= 32 \text{ u}$$

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

$$= 2 \times 35.5$$

$$= 71 \text{ u}$$

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

$$= 12 + 2 \times 16$$

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$$= 44 \text{ u}$$

► Molecular mass of CH_4 = Atomic mass of C + 4 × Atomic mass of H

$$= 12 + 4 \times 1$$

$$= 16 \text{ u}$$

► Molecular mass of C_2H_6 = 2 × Atomic mass of C + 6 × Atomic mass of H

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

$$= 30 \text{ u}$$

► Molecular mass of C_2H_4 = 2 × Atomic mass of C + 4 × Atomic mass of H

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

$$= 28 \text{ u}$$

► Molecular mass of NH_3 = Atomic mass of N + 3 × Atomic mass of H

$$= 14 + 3 \times 1$$

$$= 17 \text{ u}$$

► Molecular mass of CH_3OH = Atomic mass of C + 3 × Atomic mass of H + Atomic mass of O +

Atomic mass of H

$$= 12 + 3 \times 1 + 8 + 1$$

$$= 24 \text{ u}$$

2. 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.

Answer

► Formula unit mass of ZnO = Atomic mass of Zn + Atomic mass of O

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$$= 65 + 16$$

$$= 81 \text{ u}$$

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

$$= 2 \times 23 + 16$$

$$= 62 \text{ u}$$

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

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

$$= 78 + 12 + 48$$

$$= 122 \text{ u}$$

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1. If one mole of carbon atoms weighs 12 gram, what is the mass (in gram) 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 g

Therefore, mass of 1 atom of carbon = $12 \div (6.022 \times 10^{23})$

$$= 1.9926 \times 10^{-23} \text{ g}$$

2. 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

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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} g number of atoms

Thus, 100 g of Na contains = $6.022 \times 10^{23} / 23 \times 100$ 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 = 6.022×10^{23} g number of atoms

Thus, 100 g of Fe contains = $6.022 \times 10^{23} / 56 \times 100$ number of atoms

= 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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Exercises

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.

Answer

Total mass of Compound = 0.24 g (Given)

Mass of boron = 0.096 g (Given)

Mass of oxygen = 0.144 g (Given)

Thus, percentage of boron by weight in the compound = $0.096 / 0.24 \times 100\% = 40\%$

And, percentage of oxygen by weight in the compound = $0.144 / 0.24 \times 100\% = 60\%$

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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?

Answer

3.0 g of carbon combines with 8.0 g of oxygen to give 11.0 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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3. What are polyatomic ions? Give examples?

Answer

A polyatomic ion is a group of atoms carrying a charge (positive or negative). For example, Nitrate (NO_3^-), hydroxide ion (OH^-).

4. Write the chemical formulae of the following:

(a) Magnesium chloride

▶ MgCl_2

(b) Calcium oxide

▶ $\text{Cu}(\text{NO}_3)_2$

(d) Aluminium chloride

▶ AlCl_3

(e) Calcium carbonate

▶ CaCO_3

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

(a) Quick lime

▶ Calcium and oxygen

(b) Hydrogen bromide

▶ Hydrogen and bromine

(c) Baking powder

▶ Sodium, hydrogen, carbon, and oxygen

(d) Potassium sulphate

▶ Potassium, sulphur, and oxygen

6. Calculate the molar mass of the following substances:

(a) Ethyne, C_2H_2

▶ Molar mass of ethyne, $C_2H_2 = 2 \times 12 + 2 \times 1 = 26 \text{ g}$

(b) Sulphur molecule, S_8

▶ Molar mass of sulphur molecule, $S_8 = 8 \times 32 = 256 \text{ g}$

(c) Phosphorus molecule, P_4 (atomic mass of phosphorus = 31)

▶ Molar mass of phosphorus molecule, $P_4 = 4 \times 31 = 124 \text{ g}$

(d) Hydrochloric acid, HCl

▶ Molar mass of hydrochloric acid, $HCl = 1 + 35.5 = 36.5 \text{ g}$

(e) Nitric acid, HNO_3

▶ Molar mass of nitric acid, $HNO_3 = 1 + 14 + 3 \times 16 = 63 \text{ g}$

7. What is the mass of-

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- (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)?

Answer

- (a) The mass of 1 mole of nitrogen atoms is 14 g.
- (b) The mass of 4 moles of aluminium atoms is $(4 \times 27) \text{ g} = 108 \text{ g}$
- (c) The mass of 10 moles of sodium sulphite (Na_2SO_3) is
 $10 \times [2 \times 23 + 32 + 3 \times 16] \text{ g} = 10 \times 126 \text{ g} = 1260 \text{ g}$

8. Convert into mole.

- (a) 12 g of oxygen gas
- (b) 20 g of water
- (c) 22 g of carbon dioxide

Answer

- (a) 32 g of oxygen gas = 1 mole
Then, 12 g of oxygen gas = $12 / 32 \text{ mole} = 0.375 \text{ mole}$
- (b) 18 g of water = 1 mole
Then, 20 g of water = $20 / 18 \text{ mole} = 1.111 \text{ mole}$
- (c) 44 g of carbon dioxide = 1 mole
Then, 22 g of carbon dioxide = $22 / 44 \text{ mole} = 0.5 \text{ mole}$

9. What is the mass of:

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(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 = $0.2 \times 16\text{g} = 3.2\text{ g}$

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

Then, mass of 0.5 mole of water molecules = $0.5 \times 18\text{ g} = 9\text{ g}$

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

Answer

1 mole of solid sulphur (S_8) = $8 \times 32\text{ g} = 256\text{ g}$

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

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

= 3.76375×10^{22} molecules

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)

Answer

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 x Mass of aluminium + 3 x Mass of Oxygen

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

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

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

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

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

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

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