Science

(Chapter – 3) (Atoms and Molecules)

(Class – IX)

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Question 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, 0.9g 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

Answer 1:

In a reaction, sodium carbonate reacts with ethanoic acid to produce sodium ethanoate, carbondioxide, and water.

Sodium Carbonate	+	Ethanoic acid	⟶	Sodium ethanoate	+	Carbon dioxide + Water

Mass of sodium carbonate = 5.3g (Given)

Mass of ethanoic acid = 6g (Given)

Mass of sodium ethanoate = 8.2g (Given)

Mass of carbon dioxide = 2.2 (Given)

Mass of water = 0.9g (Given)

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

= 11. 3g

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

= 11.3g

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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Question 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 3g of hydrogen gas?

Answer 2:

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 1g of hydrogen gas is 8g. Therefore, the mass of oxygen gas required to react completely with 3g of hydrogen gas is $8 \times 3g = 24$ g.

Question 3:

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

Answer 3:

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".

Question 4:

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

Answer 4:

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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Question 1:

Define atomic mass unit.

Answer 1:

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'.

Question 2:

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

Answer 2:

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.

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Question 1:

Write down the formula of

(i) sodium oxide

(ii) aluminium chloride

(iii) sodium suphide

(iv) magnesium hydroxide

Answer 1:

(i) Sodium oxide → Na_2O

(ii) Aluminium chloride → $AlCl_3$

(iii) Sodium suphide → Na_2S

(iv) Magnesium hydroxide → $Mg(OH)_2$

Question 2:

Write down the names of compounds represented by the following formula:

(i) $Al_2(SO_4)_3$

(ii) $CaCl_2$

(iii) K_2SO_4

(iv) KNO_3

(v) $CaCO_3$

Answer 2:

(i) $Al(SO_4)_3$ → Aluminium sulphate

(ii) $CaCl_2$ → Calcium chloride

(iii) K_2SO_4 → Potassium sulphate

(iv) $CaCO_3$ → Calcium carbonate

Question 3:

What is meant by the term chemical formula?

Answer 3:

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.

Question 4:

How many atoms are present in a

(i) H_2S molecule and

(ii) PO_4^{3-} ion?

Answer 4:

(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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Question 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 1:

Molecular mass of H_2 = 2 × Atomic mass of H

= 2 × 1 = 2u

Molecular mass of O_2 = 2 × Atomic mass of O

= 2 × 16 = 32u

Molecular mass of Cl_2 = 2 × Atomic mass of Cl

= 2 × 35.5 = 71 u

Molecular mass of CO_2 = Atomic mass of C + 2 × Atomic mass of O

= 12 + 2 × 16 = 44 u

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

= 12 + 4 × 1 = 16 u

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

= 2 × 12 + 6 × 1 = 30u

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

= 2 × 12 + 4 × 1 = 28u

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

= 14 + 3 × 1 =17 u

Molecular mass of CH_3OH Atomic mass of C+4 ×Atomic mass of H+Atomic mass of O

= 12 + 4 × 1 + 16 = 32 u

Question 2:

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

Answer 2:

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 = 62u

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 = 138u

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Question 1:

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

Answer 1:

One mole of carbon atoms weighs 12g (Given)

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

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

Therefore, mass of 1 atom of carbon = $\frac{12}{6.022\times10^{23}}$ g

= 1.9926×10^{-23} g

Question 2:

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

Answer 2:

Atomic mass of Na = 23u (Given)

Then, gram atomic mass of Na = 23g

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

Thus, 100g of Na contains = $\frac{6.022\times10^{23}\times100}{23}$ number of atoms

= 2.6182×10^{24} number of atoms

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

Then, gram atomic mass of Fe = 56g

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

Thus, 100 g of Fe $\frac{6.022\times10^{23}\times100}{56}$ 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.

Exercises

Question 1:

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

Answer 1:

Mass of boron = 0.096g (Given)

Mass of oxygen = 0.144g (Given)

Mass of sample = 0.24g (Given)

Thus, percentage of boron by weight in the compound = $\frac{0.096\times100}{0.24}$ %

= 40%

Thus, percentage of oxygen by weight in the compound = $\frac{0.144\times100}{0.24}$ %

= 60 %

Question 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 2:

Carbon + Oxygen → Carbon dioxide

3g of carbon reacts with 8 g of oxygen to produce 11g of carbon dioxide. If 3g of carbon is burnt in 50g of oxygen, then 3g 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 11g of carbon dioxide will be formed. The above answer is governed by the law of constant proportions.

Question 3:

What are polyatomic ions? Give examples?

Answer 3:

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^{2-}), sulphateion (SO_4^{2-}).

Question 4:

Write the chemical formula of the following:

(a) Magnesium chloride

(b) Calcium oxide

(c) Copper nitrate

(d) Aluminium chloride

(e) Calcium carbonate

Answer 4:

(a) Magnesium chloride $\rightarrow MgCl_2$

(b) Calcium oxide $\rightarrow CaO$

(c) Copper nitrate $\rightarrow Cu(NO_3)_2$

(d) Aluminium chloride $\rightarrow AlCl_3$

(e) Calcium carbonate $\rightarrow CaCO_3$

Question 5:

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

(a) Quick lime

(b) Hydrogen bromide

(c) Baking powder

(d) Potassium sulphate.

Answer 5:

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

Question 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

Answer 6:

(a) Molar mass of ethyne, C_2H_2 = $2 \times 12 + 2 \times 1 = 28g$

(b) Molar mass of sulphur molecule, S_8 = $8 \times 32 = 256g$

(c) Molar mass of phosphorus molecule, P_4 = $4 \times 31 = 124g$

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

(e) Molar mass of nitric acid, HNO_3 = $1 + 14 + 3 \times 16 = 63g$

Question 7:

What is the mass of

(a) 1 mole of nitrogen atoms?

(b) 4 mole of aluminium atoms (Atomic mass of aluminium = 27)?

(c) 10 moles of sodium sulphite (Na_2SO_3)?

Answer 7:

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

(b) The mass of 4 moles of aluminium atoms is $(4 \times 27)g = 108g$

(c) The mass of 10 moles of sodium sulphite (Na_2SO_3) is $10 \times [2 \times 23 + 32 + 3 \times 16]g$

$= 10 \times 126g = 1260g$

Question 8:

Convert into mole.

(a) 12g of oxygen gas

(b) 12g of water

(c) 22g of carbon dioxide

Answer 8:

(a) 32 g of oxygen gas = 1 mole

Then, 12g of oxygen gas = 12/32 mole = 0.375 mole

(b) 18g of water = 1 mole

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

(c) 44g of carbon dioxide = 1 mole

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

Question 9:

What is the mass of:

(a) 0.2 mole of oxygen atoms?

(b) 0.5 mole of water molecules?

Answer 9:

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

Then, mass of 0.2 mole of oxygen atoms = 0.2 × 16g = 3.2g

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

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

Question 10:

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

Answer 10:

1 mole of solid sulphur (S_8) = 8 × 32g = 256g

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

Then, 16g of solid sulpur contains $\frac{6.022 \times 10^{23}}{256} \times 16$ molecules

= 3.76×10^{22} molecules (approx)

Question 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)

Answer 11:

1 mole of aluminium oxide (Al_2O_3) = 2 × 27 + 3 × 16 = 102g

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

Then, 0.051 g 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 of aluminium ions (Al^{3+}) present in one molecules of aluminium oxide is 2.

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

3.11×10^{20} molecules (0.051g) of aluminium oxide (Al_2O_3) = $2 \times 3.011 \times 10^{20}$

= 6.022×10^{20}