Chapter-03

Atoms and Molecules

Class-IX **Sub-Science**

Page-32(IN-TEXTS QUES-ANS)

1. In a reaction, 5.3g 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 → Sodium acetate + carbon dioxide + water

Solution:

Sodium carbonate + acetic acid → 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,

LHS = RHS

i.e., 5.3g + 6g = 2.2g + 0.9 g + 8.2 g = 11.3 g

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

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?

Solution:

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

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

Therefore, for 3g of hydrogen, the quantity of oxygen = 3 x 8 = 24g

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 postulate of Dalton's Atomic theory which is a result of the law of conservation of mass is,

"Atoms can neither be created nor destroyed".

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 – the

relative number and kinds of atoms are equal in given compounds.

Page-35(IN-TEXTS QUES-ANS)

1. Define the atomic mass unit?

Solution:

An atomic mass unit is a unit of mass used to express 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 naked eyes?

Solution:

It is not possible to see an atom with naked eyes because an atom is very, very small particle. The radius of an atom is of the order of 10^{-10}metre.

Page-39(IN-TEXTS QUES-ANS)

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 – $Mg(OH)_2$

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

(i) $Al_2(SO_4)_3$

(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) $Al_2(SO_4)_3$ – Aluminium sulphate

(ii) $CaCl_2$ – Calcium chloride

(iii) K_2SO_4 – Potassium sulphate

(iv) KNO_3 – Potassium nitrate

(v) $CaCO_3$ – Calcium carbonate

3. What is meant by the term chemical formula?

Solution:

Chemical formula is the symbolic representation of its compositions. 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 are as follows:

(i) H_2S molecule has 2 atoms of hydrogen and 1 atom of sulphur hence 3 atoms in totality.

(ii) PO_4^{3-} ion has 1 atom of phosphorus and 4 atoms of oxygen hence 5 atoms in totality.

Page-40 (IN-TEXTS QUES-ANS)

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 x 1u = 2u

The molecular mass of O_2 – 2 x atoms atomic mass of O = 2 x 16u = 32u

The molecular mass of Cl_2 – 2 x atoms atomic mass of Cl = 2 x 35.5u = 71u

The molecular mass of CO_2 – atomic mass of C + 2 x atomic mass of O = 12 + (2×16)u = 44u

The molecular mass of CH_4 – atomic mass of C + 4 x atomic mass of H = 12 + (4 x 1)u = 16u

The molecular mass of C_2H_6– 2 x atomic mass of C + 6 x atomic mass of H = (2 x 12) +

(6 x 1)u=24+6=30u

The molecular mass of C_2H_4– 2 x atomic mass of C + 4 x atomic mass of H = (2x 12) +

(4 x 1)u=24+4=28u

The molecular mass of NH_3– atomic mass of N + 3 x atomic mass of H = (14 +3 x 1)u= 17u

The molecular mass of CH_3OH – atomic mass of C + 3x atomic mass of H + atomic mass of O + atomic mass of H = (12 + 3×1+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 = 23 u, K=39u, C = 12u, and O=16u.

Solution:

Given:

Atomic mass of Zn = 65u

Atomic mass of Na = 23u

Atomic mass of K = 39u

Atomic mass of C = 12u

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 x 23)u +16u=46u+16u=62u

Page-42 (IN-TEXTS QUES-ANS)

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}

Molecular mass of carbon atoms = 12g = an atom of carbon mass

Hence, mass of 1 carbon atom = 12 / 6.022 X 10^{23} = 1.99 X 10^{-23}g

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)?

Solution:

Given: Atomic mass of Na=23u, Atomic mass of Fe= 56u

To calculate the number of atoms in 100g of sodium:

23g of Na contains = 6.022 X 10^{23} atoms

1g of Na contains = 6.022 X 10^{23} atoms / 23

100g of Na contains = 6.022 X 10^{23} atoms X 100 / 23

= 2.6182 X 10^{24} atoms

To calculate the number of atoms in 100g of sodium:

56g of Fe contains = 6.022 X 10^{23} atoms

1g of Fe contains = 6.022 X 10^{23} atoms / 56

100g of Fe contains = 6.022 X 10^{23} atoms X 100 / 56

= 1.075 X 10^{24} atoms

Hence, through comparison, it is evident that 100g of Na has more atoms.

(Exercise Questions)Page: 43

1. A 0.24g sample of 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 percentage composition of the compound:

Percentage of boron = mass of boron / mass of the compound x 100

= 0.096g / 0.24g x 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:

11.00g of carbon dioxide is formed when 3.00g carbon is burnt in 8.00g of oxygen.

Carbon and oxygen are combined in the ratio 3:8 to give carbon dioxide using up all the carbon and

oxygen

Hence, for 3g of carbon and 50g of oxygen, 8g of oxygen is used and 11g of carbon is formed, the

left oxygen is unused i.e., 50-3=47g of oxygen is unused.

This depicts the law of definite proportions – The combining elements in compounds are present in

definite proportions by mass.

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 – $Cu(NO_3)_2$

(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 x Mass of C+2 x Mass of H = (2×12)+(2×1)=24+2=26g

(b) Molar mass of Sulphur molecule S_8 = 8 x Mass of S = 8 x 32 = 256g

(c) Molar mass of Phosphorus molecule, P_4 = 4 x Mass of P = 4 x 31 = 124g

(d) Molar mass of Hydrochloric acid, HCl = Mass of H+ Mass of Cl = 1+35.5 = 36.5g

(e) Molar mass of Nitric acid, HNO_3 =Mass of H+ Mass of Nitrogen + 3 x Mass of O = 1 + 14+

3×16 = 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, 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 x 27 = 108g

(c) Mass of 1 mole of sodium sulphite Na_2SO_3 = Molecular mass of sodium sulphite = 2 x Mass of Na + Mass of S + 3 x Mass of O = (2 x 23) + 32 +(3x 16) = 46+32+48 = 126g

Therefore, mass of 10 moles of Na_2SO_3 = 10 x 126 = 1260g

8. Convert into 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=12g

Molar mass of oxygen gas = 2 Mass of Oxygen = 2 x 16 = 32g

Number of moles = Mass given / molar mass of oxygen gas = 12/32 = 0.375 moles

(b) Given: Mass of water = 20g

Molar mass of water = 2 x Mass of Hydrogen + Mass of Oxygen = 2 x 1 + 16 = 18g

Number of moles = Mass given / molar mass of water

= 20/18 = 1.11 moles

(c) Given: Mass of carbon dioxide = 22g

Molar mass of carbon dioxide = Mass of C + 2 x Mass of Oxygen = 12 + 2x 16 = 12+32=44g

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 x 16 = 3.2u

(b) Mass of 1 mole of water molecules = 18u, hence it weighs 18g

Mass of 0.5 moles of water molecules = 0.5 x 18 = 9u

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

Solution:

To calculate molecular mass of sulphur:

Molecular mass of Sulphur (S_8) = 8xMass of Sulphur = 8×32 = 256g

Mass given = 16g

Number of moles = mass given/ molar mass of sulphur

= 16/256 = 0.0625 moles

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

Number of molecules = Number of moles x Avogadro number

= 0.0625 x 6.022 x 10^{23} molecules

= 3.763 x 10^{22} 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 x 10^{23} molecules of aluminium oxide

1 mole of aluminium oxide (Al_2O_3) = 2 x Mass of aluminium + 3 x Mass of Oxygen

= (2x 27) + (3 x16) = 54 +48 = 102g

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

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

= 3.011×10^{20} 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

= 6.022×10^{20}