CBSE class IX science
NCERT Solutions
Chapter 3
Atoms and Molecules

(Page No. 32)

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

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

Ans. According to the law of conservation of mass:

Mass of reactants = Mass of products

Let's calculate and find out both results –

Mass of reactants = Mass of sodium carbonate +Mass of ethanoic acid
= 5.3g + 6g
= 11.3g

Mass of products = Mass of sodium ethanoate + Mass of carbon dioxide + Mass of water
= 8.2g +2.2g + 0.9g = 11.3g

Hence it is proved that these 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?

Ans. As per the given 1:8 ratio mass of oxygen gas required to react completely with 1g of hydrogen gas is 8g.

Therefore, mass of oxygen gas required to react completely with 3g of hydrogen gas will be = 3 x 8 = 24g

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

Ans. The following postulate of Dalton's atomic theory is a result of the law of conservation of mass:

"Atoms are indivisible particles which cannot be created or destroyed in a chemical reaction."

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

Ans. The following postulate of Dalton's atomic theory can explain the law of definite proportions :

"The relative number and kinds of atoms are constant in a given compound."

(Page No. 35)

1.Define the atomic mass unit.

Ans. Atomic mass unit is defined as the mass equal to exactly one-twelfth(1/12th) of the mass of an atom of carbon-12.

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

Ans. An atom is an extremely small particle whose radius is of the order 10^{-10}m. This size is so small that our eyes are not able to see it.

(Page No. 39)

1. Write down the formulae of

(i) sodium oxide

(ii) aluminium chloride

(iii) sodium sulphide

(iv) magnesium hydroxide

Ans.

Compound	Formula
Sodium oxide	Na_2O
Aluminum Chloride	$AlCl_3$
Sodium Sulphide	Na_2S
Magnesium Hydroxide	$Mg(OH)_2$

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

(i) $Al_2(SO_4)_3$

(ii) $CaCl_2$

(iii) K_2SO_4

(iv) KNO_3

(v) $CaCO_3$

Ans.

Formula	Compound
$Al_2(SO4)_3$	Aluminum sulphate
$CaCl_2$	Calcium chloride
K_2SO_4	Potassium sulphate
KNO_3	Potassium nitrate
$CaCO_3$	Calcium carbonate

3. What is meant by the term chemical formula?

Ans. A chemical formula is the representation of elements present in a compound with the help of symbols and also the number of atoms of each element with those numbers only. for eg: A molecule of water (compound) contains 2 atoms of hydrogen and one atom of oxygen hence its chemical formula is H_2O.

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4. How many atoms are present in a

(i) H_2S molecule and

(ii) PO_4^{3-} ion?

Ans. (i) 2 atoms of hydrogen + 1 atom of sulphur = 3 atoms

(ii)1 atom of phosphorus + 4 atoms of oxygen = 5 atoms

(Page No. 40)

1. Calculate the molecular masses of $H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH$

Ans. Molecular mass of H_2= atomic mass of H x 2 = 1 x 2 = 2u

Molecular mass of O_2= atomic mass of O x 2 = 16 x 2 = 32u

Molecular mass of Cl_2= atomic mass of Cl x 2 = 35.5 x 2 = 71u

Molecular mass of CO_2= atomic mass of C + (atomic mass of O x 2)

= 12 + (16 x 2)

= (12 + 32)

= 44 u

Molecular mass of CH_4= 12 + atomic mass of hydrogen x 4

= 12 (1 x 4)

= 12 + 4

= 16 u

Molecular mass of C_2H_6= 12 x 2 + 6 x 1= 24+6 = 30 u

Molecular mass of C_2H_4= 12 x 2 + 4 x 1=24 + 4 = 28 u

Molecular mass of NH_3= 14 + 3= 17 u

Molecular mass of CH_3OH= 12+1x3+16+1=12+3+16+1=32 u

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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.

Ans. Formula unit mass of:

i) ZnO = Atomic mass of Zn + atomic mass of O = (65 + 16) u = 81 u

ii) Na_2O= Atomic mass of Na + atomic mass of O= 23 x 2 + 16= 46 + 16 = 62 u

iii) K_2CO_3= Atomic mass of K + atomic mass of C + atomic mass of O= 39 x 2 + 12 + 3 x 16= 78 + 12 + 48 = 138 u

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(Page No. 42)

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

Ans. Weight of one mole of carbon = atomic mass of carbon (1 atom of carbon) = 12 u

Therefore, one mole of carbon contains = 12 g = 6.022 x 10^{23}atoms (Avogadro number)

So, 1 atom of Carbon = $\frac{12}{6.022\times10^{23}}$ g

= 1.993 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 = 23 u, Fe = 56 u)?

Ans. We can find out the element with more number of atoms by calculating number of moles of each of them:

Number of moles of sodium in 100 g = 100/23 = 4.34
Number of moles of iron in 100g= 100/56 = 1.78
Therefore, the number of atoms is more for sodium as compared to iron.

(Chapter – end)

1. A 0.24 g sample of a 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.

Ans. Mass of the given sample compound = 0.24g

Mass of boron in the given sample compound = 0.096g

Mass of oxygen in the given sample compound = 0.144g

% composition of compound = % of boron and % of oxygen

Therefore % of boron = mass of boron $\times$100/mass of the sample compound

$$= 0.096 \times \frac{100}{0.24}$$

= 40%

Therefore % of oxygen = mass of oxygen $\times$ 100/mass of the sample compound

$$= 0.144 \times \frac{100}{0.24}$$

= 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 combination will govern your answer?

Ans. According to the law of chemical combination of constant proportions “In a chemical compound the elementary constituents always combine in constant proportions by weight/mass”. Therefore, whether 3 g carbon is burnt in 8 g oxygen or 3g carbon is burnt in 50g oxygen ,in both the cases only 11g carbon dioxide will be formed. The remaining 42g

oxygen (50g-8g) will remain unreacted.

3. What are polyatomic ions? Give examples.

Ans. A group of atoms containing positive or negative charge on them are called polyatomic ions. For $eg : NH_4^+, NO_3^-$ etc.

4. Write the chemical formulae of the following.

(a) Magnesium chloride

(b) Calcium oxide

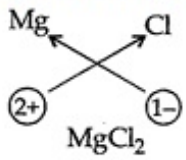
(c) Copper nitrate

(d) Aluminium chloride

(e) Calcium carbonate.

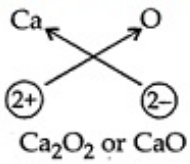
Ans.

(a) Magnesium chloride



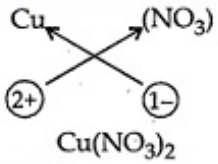
$MgCl_2$

(b) Calcium oxide



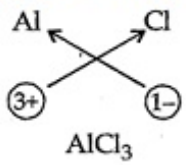
Ca_2O_2 or CaO

(c) Copper nitrate



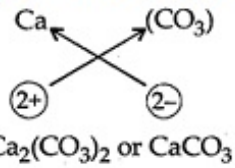
$Cu(NO_3)_2$

(d) Aluminium chloride



$AlCl_3$

(e) Calcium carbonate



$Ca_2(CO_3)_2$ or $CaCO_3$

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

(a) Quick lime

(b) Hydrogen bromide

(c) Baking powder

(d) Potassium sulphate.

Ans.

Compound	Formula	Elements present
Quick lime	CaO	Calcium and oxygen
Hydrogen bromide	HBr	Hydrogen and bromine
Baking powder	$NaHCO_3$	Sodium, hydrogen, carbon and oxygen
Potassium sulphate	K_2SO_4	Potassium, Sulphur and oxygen

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

Ans. (a) Ethyne,C_2H_2=12 x 2+ 2 x 1= 24 + 2= 26 u =26 g

(b) Sulphur molecule ,S_8= 8 x 32= 256 u= 256 g

(c) Phosphorus molecule,P_4 = 124 u= 124 g

(d) Hydrochloric acid,HCl = 1+ 35.5 = 36.5 u= 36.5 g

(e) Nitric acid,HNO_3= 1 + 14 + 16 x 3= 15 + 48 = 63 u =63 g

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?

Ans. (a) Atomic mass of nitrogen is 14 u.
therefore 1 mol of N = 14g

(b) Atomic mass of aluminium = 27u
therefore 1 mol of Al = 27g and so 4 mol of Al = 27 x 4 =108g

(c) molecular mass of Na_2SO_3 = 23 x 2+32+ 16 x3= 46 + 32 + 48 = 126 u

therefore 1 mol of Na_2SO_3 has weight/mass 126g.

hence, 10 mol of Na_2SO3 = 126 x 10 =1260g

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8. Convert into mole.

(a) 12 g of oxygen gas

(b) 20 g of water

(c) 22 g of carbon dioxide.

Ans. (a) molecular mass of O_2= 32 u= 32g(1 mole)

since 32 g of O_2=1mole then 12g of $O_2 = \frac{12}{32}$ =0.375 mol

(b) molecular mass of H_2O = 2 x1+16 = 18 u= 18g(1mole)

20g H_2O= $\frac{20}{18}$ = 1.11mol

(c) molecular mass of CO_2= 12 + 2 x 16 =12+32 = 44 u= 44g (1mole)

22g of CO_2 = $\frac{22}{44}$ =0.5mol

9.What is the mass of:

(a) 0.2 mole of oxygen atoms?

(b) 0.5 mole of water molecules?

Ans. (a) Since 1 mole of O = atomic mass of O = 16u=16g mol^{-1}

then 0.2mole of O_2 = 0.2 mol x 16g mol^{-1} = 3.2g

(b) Molar mass of H_2O = 2 x 1 + 16 g mol^{-1} = 18 g mol^{-1}

∴ Mass of 0.5 mole of water molecules = 0.5 mol x 18 g mol^{-1} =9.0g

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

Ans. 1mol of S_8= molecular mass of S_8= 8x 32= 256u= 256g

since 256g of S_8= 6.022 x 10^{23} molecules (Avogadro number)

16g of S_8 molecules = $\frac{16\times6.022\times10^{23}}{256}$ = 3.76 x 10^{22} molecules

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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)

Ans. 1mol of Al_2O_3= molecular mass of Al_2O_3 = 2 x 27 + 3 x 16 = 54+48= 02u=102g

aluminium ions present in Al_2O_3 = 2 Al^{3+}

102 g of Al_2O_3 contains aluminium ions 2 x 6.022 x 10^{23}

then 0.051 g Al_2O_3 contains aluminium ions $\frac{2\times6.022\times10^{23}\times0.051}{102}$ = 6.022 x 10^{20} aluminium ions