Atoms and Molecules

Case Study Based Questions

Case Study 1

Lavoisier, along with other scientists, noted that many compounds were composed of two or more elements and each such compound had the same elements in the same proportions, irrespective of where the compound came from or who prepared it. In a compound such as water, the ratio of the mass of hydrogen to the mass of oxygen is always 1: 8, whatever be the source of water. Thus, if 9 g of water is decomposed, 1 g of hydrogen and g of oxygen are always obtained. Similarly in ammonia, nitrogen and hydrogen are always present in the ratio 14 : 3 by mass, whatever the method or the source from which it is obtained. This led to the law of constant proportions which is also known as the law of definite proportions.

Read the given passage carefully and give the answer of the following questions:

Q1. According to the law of definite proportions:

a. total mass of reactants is equal to the total mass of products

b. mass can neither be created nor destroyed

c. in a chemical substance, elements are always present in definite proportions by mass

d. Both a. and b.

Q2. Law of constant proportion was proposed by:

a. Lavoisier

b. Proust

c. Dalton

d. Berzelius

Q3. In ammonia, nitrogen and hydrogen are present in the ratio ..... by mass.

a. 14 : 3 b. 14 : 5

c. 1 : 8 d. 14 : 8

Q4. A sample of pure water, irrespective of its source contains 11.1% hydrogen and 88.9% oxygen. The data supports:

a. law of conservation of mass

b. law of constant proportions

c. law of multiple proportions

d. Avogadro's law

Q5. A sample of $CaCO_3$ has Ca = 40%, C = 12% and 0 = 48% by mass. If the law of constant proportion is true then the weight of O in 20 g $CaCO_3$ made from different processes will be:

a. 8 g

b. 10.4 g

c. 12 g

d. 9.6 g

Solutions

1. (c) in a chemical substance, elements are always present in definite proportions by mass

2. (b) Proust

3. (a) 14:3

4. (b) law of constant proportions

5. (d) 9.6 g

If law of constant proportion is true, weight of O in 20 g of $CaCO_3$

$$= \frac{48}{100} \times 20$$
$$= 9.6 \text{ g}$$

Case Study 2

The molecules of an element are constituted by the same type of atoms. Molecules of many elements, such as Argon (Ar), Helium (He) etc. are made up of only one atom of that element. But this is not the case with most of the non-metals. For example, a molecule of oxygen consists of two atoms of oxygen and hence it is known as a diatomic molecule, (O_2). If 3 atoms of oxygen unite into a molecule, instead of the

usual 2, we get ozone, (O_3). The number of atoms constituting a molecule is known as its atomicity.

Let us look at the atomicity of some non-metals.

Atomicity of Some Elements		
Type of elements	**Name**	**Atomicity**
Non-Metal	Argon	Monoatomic
	Helium	Monoatomic
	Oxygen	Diatomic
	Hydrogen	Diatomic
	Nitrogen	Diatomic
	Chlorine	Diatomic
	Phosphorus	Tetra-atomic
	Sulphur	Poly-atomic

Read the given passage carefully and give the answer of the following questions:

Q1. Atomicity of sulphur is:

a. 8 b. 4

c. 2 d. 1

Q2. Which of the following represents a polyatomic ion?

a. Hydrogen b. Oxygen

c. Argon d. Ammonium

Q3. Which of the following is a triatomic molecule?

a. Carbon dioxide b. Ammonia

c. Hydrogen chloride d. Carbon tetrachloride

Q4. All noble gas molecules are:

a. monoatomic b. diatomic

c. Both a. and b. d. triatomic

Q5. Valency of noble gases is:

a. 1 b. 0

c. 2 d. None of these

Solutions

1. (a) 8

2. (d) Ammonium

3. (a) Carbon dioxide

Carbon dioxide contains one atom of carbon and two atoms of oxygen.

4. (a) monoatomic

5. (b) O

Case Study 3

In the beginning, the names of elements were derived from the name of the place where they were found for the first time. For example, the name copper was taken from Cyprus. Some names were taken from specific colours. For example, gold was taken from the English word meaning yellow. Now-a-days, IUPAC (International Union of Pure and Applied Chemistry) is an international scientific organisation which approves names of elements, symbols and units. Many of the symbols are the first one or two letters of the element's name in English. The first letter of a symbol is always written as a capital letter (uppercase) and the second letter as a small letter (lowercase).

Symbols of some elements are formed from the first letter of the name and a letter, appearing later in the name.

Other symbols have been taken from the names of elements in Latin, German or Greek.

Read the given passage carefully and give the answer of the following questions:

Q1. Give two symbols which have been derived from the 'English names' of the elements.

Q2. Give two symbols which have been derived from the 'Latin names' of the elements.

Q3. What is the chemical symbol for nitrogen gas?

Q4. What is the chemical symbol for sodium?

Q5. Which of the following symbols of elements are incorrect? Give their correct symbols.

(i) Cobalt (CO)

(ii) Carbon (c)

(iii) Aluminium (AL)

(v) Tin (Ti)

(iv) Helium (He)

Solutions

1. Ca and Mg are derived from the 'English names' calcium and magnesium.

2. Cu (Copper), Au (Gold), Fe (Iron), K (Potassium) etc. are derived from their 'Latin names'

3. Nitrogen gas exists as a diatomic molecule hence, its symbol is N_2.

4. Chemical symbol for sodium is Na.

5.

Elements	**Correct symbols**
(i) Cobalt	Co
(ii) Carbon	C
(iii) Aluminium	AL
(v) Tin	Sn

Case Study 4

We define the atomic mass unit (earlier abbreviated as 'amu', but according to the latest IUPAC recommendations, it is now written as 'u' - unified mass) as equal to one-twelfth the mass of one carbon-12 atom. While searching for various atomic mass units, scientists initially took 1/16 of the mass of an atom of naturally occurring oxygen as the unit.

However, in 1961 for a universally accepted atomic mass unit, carbon-12 isotope was chosen as the standard reference for measuring atomic masses.

Read the given passage carefully and give the answer of the following questions:

Q1. What is the accepted unit of atomic mass and molecular mass?

Q2. What is the reference standard used for defining atomic mass unit?

Q3. Name the element whose gram-atomic mass and gram-molecular mass are the same.

Q4. What do you understand from the statement 'relative atomic mass of sulphur is 32'?

Q5. The relative atomic mass of beryllium is 9. How many times is an atom of beryllium heavier than atom of carbon-12?

Solutions

1. Atomic mass unit (amu) or unified mass (u).
2. C-12 atom.
3. Argon.
4. This means that an atom of sulphur is 32 times heavier as compared to 1/12 of the mass of 1 atom of C-12.
5. $$\frac{\text{Mass of one atom of beryllium}}{\text{Mass of one atom of carbon-12}} = \frac{9}{12} = 0.75$$

   $\therefore$ An atom of beryllium is 0.75 times heavier than an atom of carbon-12.

Case Study 5

Pankaj sir was explaining the 'crossing-over of valencies' method of working out the formula of molecular compounds as follows:

(i) We first write the symbols of the elements (ions) which from the compound.

(ii) Below the symbol of each element, we write down its valency (charge).

(iii) Finally, we cross-over the valencies (charges) of the combining elements (ions). This will give us the required formula.

Read the given passage carefully and give the answer of the following questions:

Q1. The formula of chloride of a metal MCl_3. What is the formula of the phosphate of metal M?

Q2. An element 'X' has a valency of 2. Write the simplest formula for:

(i) bromide of the element,

(ii) oxide of the element.

Q3. Out of the following, the valency of each of the constituent elements is equal to the total number of atoms in one molecule of the compound?

NaCl, CaO, H_2S, $ALBr_3$

Q4. Which of the following represents a correct chemical formula? Name it.

(i) CaCl **(ii) $BiPO_4$**

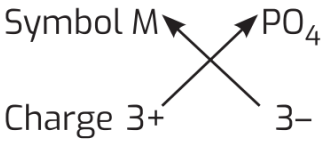
(iii) $NaSO_4$ **(iv) NaS**

Q5. Write is the molecular formula of zinc phosphate.

Solutions

1. The Metal 'M' is trivalent.

∴ The formula of phosphate of metal M will be $\underline{MPO_4}$.



2. (i) Valency of X = 2
Valency of Br = 1
∴ Formula for bromide of X is XBr_2.

(ii) Valency of X = 2
Valency of O = 2
∴ Formula for oxide of O is XO.

3. In CaO, valency of each constituent element is 2 and is equal to the total number of atoms (2) in one molecules of compound.

4. (ii) $\underline{BiPO_4}$ is correct chemical formula.
Bismuth phosphate is the name of the compound.

5. The molecular formula is $\underline{Zn_3(PO_4)_2}$.