CHAPTER 3
ATOMS AND MOLECULES

SOLUTIONS

TEXTUAL QUESTIONS & ANSWERS

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Let us answer these:

1. **Name any two laws of chemical combination.**
   Ans.
   1. **Law of conservation of mass.**
   2. **Law of constant proportions.**

2. **What law of chemical combination was given by (a) Lavoisier (b) Proust?**
   Ans.
   (a) **Lavoisier** gave the law of conservation mass.
   (b) **Proust** gave the law of constant proportions.

3. **10.6 g of sodium carbonate reacted with 7.3 g of hydrochloric acid producing 11.7 g of sodium chloride, 1.8 g of water and 4.4 g of carbon dioxide gas. Show that this data verifies the law of conservation of mass.**
   Ans. Mass of the reactants = Mass of sodium carbonate + Mass of hydrochloric acid
   = 10.6 g + 7.3 g
   = 17.9 g

   Mass of the product= Mass of sodium chloride + Mass of water + Mass of carbon dioxide
   = 11.7 g + 1.8 g + 4.4 g
   = 17.9 g
   Here, the total mass of the reactants is the same of the total mass of the product.
   Hence, this data verified the law of conservation of mass.

4. **A pure sample of calcium oxide contains calcium and oxygen in the ratio 5:2 by mass. How many grams of calcium will be required to combine with 32 g of oxygen to form calcium oxide.**
   Ans. 2 g of oxygen combines with 5 g of calcium by mass.
   ∴ 1 g of oxygen combines with $\frac{5}{2}$ g of calcium by mass.
   Hence, 32 g of oxygen combines with $\frac{5}{2}$ x 32 g of calcium by mass.
   = 80 g of calcium by mass

5. **Which postulates of Dalton's atomic theory can explain:**
   (a) Law of conservation of mass and
   (b) Law of constant proportions?

   Ans.
   (a) Atoms are neither created nor destroyed explains Law of Conservation of mass.
   (b) The postulates
   1. **The relative number and kinds of atoms are constant in a given compound** can explain the law of constant proportions.
   2. **Atoms of one element are all identical. They have the same mass and the same properties.**
   3. **Atoms of different elements combine in fixed ratios to form compounds.**
   4. **When elements combine to form compounds, the atoms of these elements unite in simple whole number ratios to form compound atoms.**

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Let us answer these:

1. **Define an atom.**
   Ans: **An atom** can be defined as the smallest particle of an element which can take part in a chemical reaction.
2. **In what unit the radius of an atom is usually expressed?**
   Ans. The radius of an atom is usually expressed in **nanometre.**

3. **What is a molecule? Explain with an example.**
   Ans. **A molecule** is the smallest particle of an element **or** a compound which can exist independently and shows all the properties of that substance.
   Example: Au (Gold) molecule exists as monoatomic and it possesses all the properties of gold metal.

4. **What is the difference between the molecule of an element and the molecule of a compound? Illustrate with one example.**

   Ans. **Molecules of an element** is composed of atoms of the same kind. **e.g.** a molecule of Cl_2 consists of two Chlorine atoms.
   While **molecule of a compound** consists of two or more different atoms e.g. Carbon dioxide (CO_2) is a compound whose molecules are made up of one atom of carbon and two atoms of oxygen.

5. **What is meant by atomicity? Give example.**
   Ans. Atomicity is the number of atoms present in one molecule of the element e.g. a molecule of oxygen consists of two atoms of oxygen and hence its atomicity is 2 (diatomic).
6. **Define atomic mass. What is meant by saying that atomic mass of Calcium is 40.**
   Ans. The atomic mass is defined average relative mass of an atom of an element as compare to the mass of an atom of Carbon taken as 12 u or amu.

$$Atomic\ mass = \frac{Mass\ of\ 1\ atom\ of\ an\ element}{1/12 of\ the\ mass\ of\ an\ atom\ of\ C-12}$$

It means that calcium has 40 times 1/12th mass of carbon – 12 atom (1u or 1amu) in its one atom.

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EXERCISES

1. **What are the postulates of Dalton's atomic theory?**

   Ans: **The postulates of Dalton's atomic theory are as follows-**

   (a) Mater is made up of indivisible particles known as atoms.
   (b) Atoms are neither created nor destroyed.
   (c) Atoms of one element are all identical. They have the same mass and the same properties.
   (d) Atoms of different elements combine in fixed ratios to form compounds.
   (e) When elements combine to form compounds, the atoms of these elements unite in simple whole number ratios to form compound atoms.

2. **3 g of magnesium combines with 2 g of oxygen to produce 5 g of magnesium oxide compound. If 6 g of magnesium is allowed to react with 20 g of oxygen, what mass of magnesium oxide will be produced in the reaction? Name the law which governs your answer.**

   Ans. Magnesium combines with oxygen in the ration 3 : 2 by mass to produced 5 g of Magnesium oxide. Therefore 6 g of magnesium will only 4 g of oxygen to give 10 g of magnesium oxide (ratio 6 : 4). Here, the remaining (20-4) = 16 g of oxygen will remain unreacted.
   It governs the law of constant proportions.

   [Note: It does not obey law of conservation of mass because in the reaction of 20 g oxygen with 6 g of magnesium, only 4 g of oxygen is use during the reaction and left out only 16 g of oxygen unreacted, therefore, the total mass of reactant is not equal to the total mass of the product.]

N.B.

Mg : Oxygen
3 : 2
6 : 4 ⟶ 10 MgO

1. **Distinguish between atom and molecule of an element.**

   Ans. **An atom** is the smallest particle of an element which can take part in a chemical reaction whereas **a molecule** is the smallest particle of an element - or a compound which can exist independently and shows all the properties of that substance.

2. **Define atomic mass unit.**

   Ans. **Atomic mass unit** is the average mass of an atom of an element as compared to 1/12 of the mass of an atom of C-12.

3. **Why are atoms regarded as building blocks of all matter?**

   Ans. **All the matter are constituted by molecules and all molecules are constituted by atoms** hence atoms are regarded as building blocks of all matter.

EXTRA QUESTIONS & ANSWERS

Q1. Who converted the word *permanu* (indivisible) of Indian Philosopher Maharishi Kanad into the name atom?
Ans: Greek philosopher **Democritus**

Q2. Define an atom.
Ans: **An atom** can be defined as the smallest particle of an element which can take part in a chemical reaction.

Q3. How many types of Laws of Chemical Combination are there? Give their names.
Ans: There are two types of Laws of Chemical Combination. They are
(1) Law of conservation of mass
(2) Law of constant proportion

Q4. **What is the approximate diameter of our Galaxy?**
Ans: **About 2.3 x 10^{17} Km**

Q5. **What is the chemical name of vitamin C?**
Ans: **Ascorbic Acid**

Q6. **Name the devices used to measure the atomic radii?**
Ans: **Electron microscope, X-ray diffraction Camera and Spectroscopic studies.**

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