Atoms and molecules and chemical reactions

Types of law of chemical combination
The following two laws of the chemical combination were established after many experimentations by Lavoisier and Joseph Proust:
Law of conservation of mass
Law of constant proportions
Law of multiple proportions
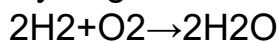Gay-lussac's law
Avogadro's law
Law
Law of conservation of mass
the law of conservation of mass states that mass in an isolated system is neither created nor destroyed by chemical reactions or physical transformations. According to the law of conservation of mass, the mass of the products in a chemical reaction must equal the mass of the reactants.
Law
Law of conservation of mass in experiments
Hydrogen combines with oxygen to form water.
$2H_2+O_2 \rightarrow 2H_2O$
Mass of reactants = 2×2+32=36g
Mass of products= 2× mass of water=2×18=36 g.
This show that mass is conserved in experiments.
Law
Law of constant proportions
The law of constant composition says that, in any particular chemical compound, all samples of that compound will be made up of the same elements in the same proportion or ratio. For example, any water molecule is always made up of two hydrogen atoms and one oxygen atom in a 2 : 1 ratio.
Definition
Numerical problem on law of constant proportions
According to this law a pure sample of copper carbonate contains 51.35% copper by weight 38.91% carbon by weight and 9.74% oxygen by weight.
Definition
Composition of water
Water is a molecule made of 2 hydrogen atoms and 1 oxygen atom. It's chemical formula is H_2O. Water has a surface tension, so a little water can make drops on a surface, rather than always spreading out to wet the surface.

Dalton's atomic theory

According to Daltons atomic theory, all matter, whether an element, a compound or a mixture is composed of small particles called atoms. The postulates of this theory may be stated as follows:
(i) All matter is made of very tiny particles called atoms.
(ii) Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction.
(iii) Atoms of a given element are identical in mass and chemical properties.
(iv) Atoms of different elements have different masses and chemical properties.
(v) Atoms combine in the ratio of small whole numbers to form compounds.
(vi) The relative number and kinds of atoms are constant in a given compound.

Limitations of Dalton's atomic theory :
 Atoms of the same or different types have a strong tendency to combine together to form a new group of atoms. For example, hydrogen, nitrogen, oxygen gases exist in nature as group of two atoms. This indicates that the smallest unit capable of independent existence is not an atom, but a group of atoms.
 With the discovery of sub-atomic particles, e.g.,electrons, neutrons and protons, the atom can no longer be considered indivisible.

Definition
Atoms and its examples
An atom is the basic unit of matter. It is the smallest particle of an element which may or may not exists on its own. An atom is found to be divisible now a later into protons, electrons, and neutrons. Examples includes hydrogen atom, oxygen atom.

Definition
Size of atoms
Atoms are very small particles that are smaller than anything that we can imagine. Atomic radius is measured in nanometers.

Definition
Existence of atoms
The strongest evidence for the reality of atoms comes from scanning tunneling microscopy, studies of Brownian motion, and by the remarkably good agreement for experimental estimates of Avogadro's Number.

Definition
Maharshi Kanad's view of Atom
Kanad was an ancient Indian scientist to give the idea of a particle that could not be divided any further. He called that indivisible particle Parmanu or Anu. He proposed that no human organ could sense this indivisible particle, and that a natural impulse made one Parmanu combine with another. When two Parmanu belonging to one class of substance combined, a dwinuka (binary molecule) was formed. This dwinuka had properties similar to two parent Parmanu. Kanad also suggested that it was the different combinations of Parmanu which produced different types of substances. He also gave the idea that atoms could be combined in various ways to produce chemical changes in presence of other factors such as heat. Back then, he used blackening of earthen pot and ripening of fruit as examples to explain this phenomenon.

History of atoms

The idea of divisibility of atoms goes back to around 500 B.C. An Indian philosopher 'Maharishi Kanad' was the first one who postulated that the atom is indivisible. He named these particles 'Parmanu'. Another greek philosophers "Democritus and Leucippus" suggested that if we go on dividing matter, a time will come that we cannot further divide. He named those particles as atoms. Antonie Lavoisier laid the foundation of chemical sciences by giving the two important laws of chemical combination.

1. Laws of conservation of mass
2. Law of definite proportion

Example

Molecules of Elements

A molecule is the fundamental building block of a substance which can normally exist on its own. When two or more atoms of same type combine, the molecule of an element is obtained. Examples of molecules of element are Hydrogen, Oxygen etc.

Definition

Molecules of Element

A molecule is the smallest part of a substance which can normally exist on its own. Atoms of the same element combine to form a molecule of an element. A molecule is known for retaining the physical and chemical properties of the substance.

Example

Molecules of Compounds

When two or more atoms of different elements combine, the molecule of a compound is obtained. Examples of molecules of compound are Water, Ammonia, Carbon Dioxide, Methane etc.

Definition

History of chemical symbols

Dalton's theory was presented in New System of Chemical Philosophy (1808-1827). Since the old chemical symbols were not fit to use in his theory, he proposed a new set of standard symbols for the chemical elements in the first volume of his New System.

Definition

Symbols

A symbol is the shortest form that stands for the atom of a specific element. Each element is denoted by a symbol, which is usually the first letter of its name in English or Latin. Eg. Sulphur has a symbol S.

Difference between element and compound

A compound is made of two or more elements and it has different chemical and physical properties than the constituent elements present in that compound.

Homoatomic molecules

The molecule contain same atoms is called as homoatomic molecules.

Example : Cl_2, Br_2, O_2

Heteroatomic molecules
The molecules contain different atom is called as hetroatomic molecule.
For example : HCl, HNO3 etc.

Ions
Compounds composed of metals and nonmetals contain charged species. These charged particles or species are known as ions. There are two types of ions: Cations and Anions. The positively charged ions are known as cations and the negatively charged ions are known as anions. For example, in NaCl, the cation is Na^+ and the anion is Cl^-.
Definition
Cations and Anions
An atom or a group of atoms bearing an overall positive charge is known as 'Cation'.
Atom as such is neutral with equal number of protons and electrons. So when atom loses one or more electrons, it now has more protons than electrons which imparts net positive charge to the cation. For ex. Na^+, Ca^{2+}, NH^+_4
An atom or a group of atoms bearing an overall negative charge is known as 'Anion'. When atom gains one or more electrons, it now has more electrons than protons which imparts net negative charge to the anion. For ex. Cl^-, SO^{2-}_4, NO^-_3

Definition
Chemical formula
The chemical formula of a compound is a symbolic representation of its composition. The chemical formulae of different compounds can be written easily. The chemical formula of the compound can be easily written using the valency. e.g the formula of aluminium sulphate is $Al_2(SO_4)_3$. The valency of aluminium is 3 and that of sulphate is 2. Chemical formula is found by cross-multiplying the valencies of both the ions.
Definition
Atomic mass unit
An atomic mass unit (a.m.u) is defined as precisely 112 the mass of carbon-12 atom. It is a unit of mass of elements e.g the atomic mass of Helium is 4 a.m.u.

Relative atomic mass w.r.t. hydrogen scale
Number of times one atom of an element is heavier than the mass of an atom of hydrogen.
Definition
Relative atomic mass w.r.t C-12 atom
Number of times an atom of an element is heavier than the 112the mass of an atom of carbon.
Definition
Molecular mass
Molecular mass or molecular weight is the mass of a molecule. It is calculated as the sum of the mass of each constituent atom multiplied by the number of atoms of that element in the molecular formula.
E.g., Molecular mass of H_2O = Mass of hydrogen atom × 2 + Mass of oxygen atom = 2×1+16=18 amu

Relative molecular mass w.r.t. carbon
Number of times one molecule of the substance is heavier than 112 the mass of an atom of carbo
Definition
Molecular mass numericals
Q. Calculate molecular mass of H2O.
No. of atoms of Hydrogen is 2, hence, atomic mass will be 1+1=2. Atomic mass of O is 16. As molecular mass is the addition of atomic masses, hence, 2+16=18 is the molecular mass of wate
Definition
Formula mass unit
The formula unit mass of a substance is the sum of the atomic masses of all the atoms in the formula unit of a compound. For example, calcium oxide has a formula unit CaO. Formula unit mass is calculated in the same way as molecular mass.
Definition
Numericals on formula mass unit
Formula mass unit of water is 18 amu. Add the total mass of the atoms.
Definition
Mole
A mole of a substance is defined as the mass of a substance containing the same number of fundamental units as there are atoms in exactly 12 g of C12.
Mole in terms of volume:
One mole of all gaseous substances at 273 K and 1 atm pressure occupies a volume equal to 22.4 liter or 22,400 ml. The unit of molar volume is liter per mole or milliliter per mole.
Avogadro Number :
The number of particles present in 1 mole of any substance is fixed with a value of 6.023×10^{23} This is known as Avogadro number or constant represented by No.
Formula
Formula for mole calculation
Mole=Given massMolecular/atomic mass
Definition
Avogadro number
The number of particles present in 1 mole of any substance is fixed with a value of 6.023×1023. This is known as Avogadro number or constant represented by No.
Definition
Mass of different compounds or atoms using mole concept
According to mole concept 1 mole of molecules = molecular mass in grams

Combination reaction
A reaction in which a single product is formed from two or more reactants is known as a combination reaction. For example,
$CaO(s) + H_2O(l) \square Ca(OH)_2(aq)$