**Class IX**

**Chemistry**

**Structure of Atom**

**Objectives:**

* Students will learn the concept of subatomic particles and extra nuclear particles.
* Students will learn the Discovery of cathode rays, anode rays, Proton, Neutron, &electrons.
* Students will learn different Atomic models (Thomson’s atomic model, Rutherford’s model of Atom, Bohr’s Atomic Model etc.)
* Students will understand the basic difference between Isotopes and Isobars.
* Students will understand the distribution of electrons in various shells.

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|  **Topic** |  **Description** |
| **Discovery**  | * Electron - J.J.Thomson in 1897.
* Proton- E. Goldstein.
* Neutron- J. Chadwick in 1932.
 |
| **Electron** | * An electron is a subatomic or fundamental particle which carries one unit negative charge and has a mass nearly 1/18th of that of hydrogen.
* Electron is represented by the symbol -1e0.
* Charge--->-1 unit and mass is negligible.
 |
| **Cathode rays** | * Discovered by J.J. Thomson.
* **Properties**:
* Cathode rays travel in straight lines.
* Cathode rays are made up of material particles.
* They produce green fluorescence on the glass wall of the discharge tube as well as on certain substances like ZnS.
* They produce heating effect.
* Cathode ray carries negative charge.
* They produce X-rays when they strike against the surface of hard metals like tungsten, Molybdenum etc.
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| **Anode Rays** | * **Properties:**
* They travel in straight lines.
* They are made up of material particles.
* They carries positive charge.
* Mass of the positively charged particles constituting the anode rays also depends upon nature of the gas.
* Charge on the positively charged particles constituting the anode rays are also depends upon the nature of the gas and the voltage applied.
 |
| **Proton** | * A proton is defined as that sub-atomic or fundamental particle which carries one net positive charge and has mass nearly equal to that of hydrogen atom.
* Charge--> +1 and mass =1u, it is represented by the symbol 1P1
 |
| **Neutron** | * Neutron has no charge.
* The subatomic particle not present in hydrogen is neutron.
 |
| **Thomson’s model of Atom/Plum Pudding Model** | * An atom consists of a sphere of positive charge with negatively charged electrons embedded in it.
* The positive and negative charges in an atom are equal in magnitude, due to which an atom is electrically neutral.
* Thomson’s model of atom is similar to that of a Christmas Pudding
* **Limitations**: It could not explain the results of the scattering experiments carried by Rutherford.
 |
| **Rutherford’s Model of Atom** | * An atom consists of two parts :\*Nucleus

 \*Extranuclear part* The entire mass of an atom is concentrated in the nucleus .
* The nucleus is surrounded by negatively charged electrons. The electrons are revolving around the nucleus in circular path at very high speeds.
* The electrostatic attraction b/w the positively charged nucleus and negatively charged electrons holds the atoms together.
* An atom is electrically neutral.
* Most of the space inside the atom is empty.
* This model is also called Planetary model.
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| **Nucleus** | * The small heavy positively charged body present within the atom was called nucleus.
 |
| **Drawback of Rutherford’s model** | * It could not explain the stability of an atom.
 |
| **Bohr’s Model of Atom** | * An atom consists of a small heavy positively charged nucleus in the centre and the electrons revolve it in circular paths called ‘Orbits.’
* When an electron is revolving in a particular orbit or particular energy level around the nucleus, the electron does not radiate energy, even though it has accelerated motion around the nucleus.
* An atom is made up of three particles: Proton, neutron and electron.
* The protons and neutrons are located in a small nucleus at the centre of the atom.
* Each energy level is associated with a fixed amount of energy.
 |
| **Atomic Number** | * It is equal to the number of protons present in the nucleus of the atom of that element.
* **Atomic no. of an element=Number of protons in the nucleus.**

 **=Number of electrons in the extranuclear part.** |
| **Mass Number** | * Mass no. of the element is the sum of protons and neutrons present in the atom of the element, i.e.,

Mass no. of an element=Number of protons + number of neutrons.* **Proton + Neutron =Nucleons.**
 |
| **Basic difference b/w atomic mass and mass number** | * The mass no. of an element is nearly equal to the atomic mass of the element.
* Atomic no. is always a whole number whereas atomic mass is usually not a whole no.
 |
| **Representation of Atomic number and mass number**  | * **Mass no----->A**

 **X------>symbol of the element.****Atomic number---> Z** |
| * **Atomic number= Number of proton (P) = Number of electron (e) in a neutral atom.**
* **Number of neutron= Mass number – Atomic number**
 |
| **Electronic configuration of an element** | * The distribution or arrangement of the electrons in the different shells of the atom is called the electronic configuration.
* The maximum no. of electrons present in the nth shell is equal to 2n2.
* **K- Shell----> closest to the nucleus, it has minimum energy [2 e-]**
* **L- Shell----> 8 e-**
* **M-Shell---->18 e-**
* **N-Shell-----> 32 e-**
 |
| * Filling of e- starts into k-shell because of its lowest energy, can accommodate maximum 2e-.[H, He]
* Lithium has 3 e- , 3rd e- enters into the next shell i.e., L-Shell, can accommodate maximum 8 e-, filling of L-shell continues till it has a8 electrons, i.e., in Neon.
* After L-shell is filled up , next energy shell is M-shell.
 |
| **Valency** | * The no. of electrons gained, lost or shared by the atom of an element so as to complete its octet or duplet is called valency.
* Elements having valence electrons 1, 2, 3, valency is equal to the no.of valence electrons.
* Elements having valence electrons 4, 5, 6 or 7, valency is equal to the no. of electrons to be added so that the valence shell has 8 electrons.

Valency= 8 - no of valence electrons. |
| **Valence shell** | * The electrons present in the outermost shell of the atom of an element are called valence electrons and the outermost shell is called valence shell.
 |
| **Isotopes** | * The atoms of same element which have Same Atomic number but different Mass Numbers.
* Isotopes of an element differ only In the No. of Neutron Present In the Nucleus.
* Isotopes of hydrogen: Protium, deuterium and tritium.

Atomic no. is same i.e., 1 but mass no are 1,2,3 respectively.* Isotopes of Chlorine: two isotopes; mass no. 35 and 37.
* Isotopes of Oxygen:Three isotopes, mass no. 16, 17 &18 etc.
 |
| **Application of Isotopes** | * **As nuclear fuel**: U-235 is used as a nuclear fuel.
* **In medical field:**
* **Co-60**----->Treatment of cancer.
* **P-32**-------> Treatment of leukemia (blood cancer).
* **I-131**----->In diagnosis and treatment of thyroid disorders.
* **As-74**---->To detect tumor.
* **Na-24-**---->To detect blood clot.
 |
| **Isobars** | * Atoms of different elements which have different atomic numbers but same mass number.
* Argon and Calcium.[At. No of Ar=18 and Ca=20]
* Isobars have same mass number but different number of protons and neutrons.
 |
| **Important Points:*** **Isotones: Atoms of different elements have different atomic number and different mass numbers but they have same number of neutrons.e.g., 14C, 15N, 16O each of them has 8 neutrons.**
* **Isoelectronic: The species (atom or ions) containing the same number of electrons are called isoelectronic.**

**O2-, F-, Ne, Na+, Mg2+[ Each of them contains 10 electrons.]** |

**Class IX**

**Chemistry**

**Atoms and Molecules**

**Objectives:**

* Students will learn law of chemical combination.
* Students will able to understand the concept of Atom and molecules.
* Students will able to understand the concept of Atomic Formula and molecular formula.
* Students will learn the concept of Atomic mass and molecular mass.
* Students will learn the Postulates and limitations of Dalton’s Atomic theory.
* Students will learn the concept of Mole.

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| **Topic**  |  **Description** |
| **Atom** | * Kanad was the 1st person to propose that matter is made up of very small particles called “Parmanu”.
* John Dalton proposed the name atom for these Parmanu.
* The word atom means ‘indivisible’ i.e., which cannot be divided further.
 |
| **Law of chemical combination** | * Two important laws of chemical combination:
* Law of conservation of mass
* Law of constant proportion
 |
| **Law of conservation of mass** | * Proposed by Antoine Lavoisier.
* Mass can neither be created nor destroyed in a chemical reaction i.e., In a chemical reaction, the total mass of product is equal to total mass of reactant.
* There is no change in mass during a chemical reaction.
 |
| Calcium carbonate Calcium oxide + Carbon di oxideCaCO3 CaO CO2100 gm 56 gm 44gm 100gm* Since the total mass of products (100 gm) is equal to the total mass of reactant (100 gm)

There is no change of mass during chemical reaction.  |
| **Law of constant Proportion** | * Proposed by J. Proust
* A chemical compound always consists of the same elements combined together in the same proportion by mass.
 |
| * Water is a compound which always consists of same two elements, hydrogen and oxygen combined together in the same constant proportion of 1:8 by mass (1 part by mass of hydrogen and 8 parts by mass of oxygen).
 |
| **Dalton’s Atomic Theory** | * All the matter is made up of very small particles called ‘atoms’.
* Atoms cannot be divided.
* Atoms can neither be created nor destroyed.
* All the atoms of a given elements are identical i.e., having same mass, size and chemical properties.
* Atoms of different elements differ in mass, size and chemical properties.
* Chemical combination between two (or more) elements in the joining together of atoms of these elements to form molecules of compounds. The ‘number’ and ‘kind’ of atoms in a given compound is fixed.
* Atoms of the same elements can combine in more than one ratio to form more than one compound.
 |
| **Demerits of Dalton’s atomic theory** | * The major drawback of Dalton’s atomic theory is that atoms were thought to be indivisible but under special circumstances, atoms can be further divided into still smaller particles called electron, proton and neutrons.
* According to Dalton’s theory all the atoms of an element have exactly the same mass but isotopes have different masses.
* According to this theory atoms of different elements have different masses but some atoms of different elements can have same masses (isobars).
 |
| **Atom** | * The smallest particle of an element which may or may not be capable of free existence.
* It is the smallest particle that takes part in a chemical reaction.
 |
| **Modern symbols of elements** | * J.J Berzelius of Sweden proposed that the 1st letter of the name of an element be used as its symbol.
* The symbol of an element is the 1st letter or the’ first letter and another letter’ of the English name or latin name of the element**.**

**Elements and their symbols*** Hydrogen H Zinc Zn
* Helium He Magnesium Mg
* Lithium Li Aluminium Al
* Beryllium Be Silicon Si
* Boron B Phosphorus P
* Carbon C Sulphur S
* Nitrogen N Chlorine Cl
* Oxygen O Argon Ar
* Fluorine F Bromine Br
* Neon Ne Calcium Ca
* **Symbols derived from latin names of elements.**
* Sodium Na (Natrium)
* Potassium K (Kalium)
* Iron Fe (Ferrum)
* Copper Cu (Cuprum)
* Silver Ag (Argentum)
* Gold Au (Aurum)
* Mercury Hg (Hydragyrum)
* Lead Pb (Plumbum)
* TinSn (Stannum)
 |
| **Atomic mass** | * It is the relative mass of its atom as compared with the mass of a carbon-12 atom taken as 12 units.
* Carbon-12 atom has been assigned an atomic mass of exactly 12 atomic mass unit(amu).
* **One atomic mass unit (1 u)** is defined as exactly one-twelfth the mass of an atom of carbon -12.

Atomic masses of some elements* H 1u
* C 12u
* N 14u
* O 16u
* Na 23u
* Mg 24u
* Al 27u
* P 31u
* S 32u
* Cl 35.5u
* K 39u
* Ca 40u
* Iron 56u
* Cu 63.5u
 |
| **Molecules of atoms** | * An electrically neutral group of two(Or more) atoms chemically bonded together.
* A molecule is the smallest particle of a substance(element or a compound) which has the properties of that substance and can exist in the Free State.
* **Molecules of elements**: It contains two or more similar atoms chemically combined together.
* e.g., Hydrogen gas H2
* Oxygen gas O2
* S8( Sulphur), P4(Phosphorous), O3 (Ozone) etc
 |
| **Atomicity** | * The number of atoms present in one molecule of an element is called its atomicity.
* Noble gases( He, Ne, Ar, K etc) have one atom in their molecule hence atomicity is 1.
* Na, Mg, Al, Cu and Fe is also taken to be 1.Thus metals are considered to be monoatomic.
* H2, O2, Cl2, Br2and I2, all have 2 atoms each hence atomicity is 2.
* Ozone (O3) , atomicity- 3
* Phosphorus (P4), atomicity-4
* Sulphur (S8), atomicity-8
 |
| **Molecules of compounds** | * It contains two or more different types of atoms chemically combined together.
* HCl, H2O, CO2and CH4 etc.
 |
| **Chemical formulae** | * It represents the composition of a molecule of the substance in terms of the symbols of the elements present in the molecule.
* **Formulae of element**
* The chemical formula of an element is a statement of the composition of its molecule in which symbols tell us the element and the subscript tells us how many atoms are present in the molecules.
* **Formulae of compound**
* The chemical formula of a compound is a statement of its composition in which the chemical symbol tell us which elements are present and the subscript tell us how many atoms of each element are present in one molecule of the compound.

 Name * Water H2O
* Carbon dioxide CO2
* Ammonia NH3
* Methane CH4
* Hydrogen sulphide H2S
* Calcium carbonate CaCO3
* Magnesium oxide MgO
 |
| **Molecular mass** | * Molecular mass of a substance is the relative mass of its molecule as compared with the mass of a carbon-12 atom taken as 12 units.
* Molecular mass is equal to sum of the atomic masses of all the atoms present in one molecule of the substance.

e.g., Nitric acid( HNO3) Mass of H atom = 1u Mass of N atom = 14u Mass of 3O atom = 3x16  = 48uMolecular mass of HNO3 = 1 + 14+48 = 63u.Molecular mass of H2O = 18u |
| **Ions** | * An ion is a charged species.
* If an atom has less e- than normal, then it gets positive charge.e.g., Na+, Mg2+, Al3+.
* If an atom has more e- than normal, then it gets negative charge. e.g. Cl-, S2-, O2-.
* A positively charged species known as cation.
* Since a cation is formed by the loss of one or more e- by an atom, therefore, a cation contains less e- than proton.
* Due to more protons than e- , a cation has a positive charge on it.
* All the metal atoms can lose electron easily, so all the metal elements form cations or positive ions.
* A negatively charged species known as anion.
* An anion is formed by the gain of e-.
* Due to more e-, than protons, an anion has a negative charge on it.
* The ions of all the non-metal elements are anions.
 |
| **Ionic Compounds** | * The compounds which are made up of ions are known as ionic compounds e.g., CaCl2 which contains Ca2+ and Cl-
 |
| **Formula Unit mass** | * The formula unit mass of a substance is the sum of the atomic masses of all the atoms present in one formula unit of the compound.

e.g., Formula unit mass of Na2CO3.10H2O=2xAt.mass of Na+ At mass of C+3xAt.mass of O+10(2x At. mass of H+At.mass of O)=2x23u+12u+3x16u+10(2x1+16)u=46+12+48+180u=286u |
| **Electronegativity** | * The ability of an atom to attract the shared electron of a bond towards it, is known as electronegativity.
 |
| **Writing of Formulae of molecular compounds** | * 1st write the symbol of the elements which form the compound.
* Below the symbol of each element, we write down its valency.
* Finally, we cross –over the valencies of the combining atoms. That is , with 1st atom we write the valency of second atom(as a subscript); and with the second atom we write the valency of 1st atom(as subscript)
 |
| Hydrogen Sulphide Magnesium Chloride Symbol: H S Mg Cl (H2S) (MgCl2)Valencies: 1 2 2 1  Ca NO3 Al SO4  Al PO4 2+ 1- 3+ 2 - 3+ 3-  Ca(NO3)2  Al2(SO4)3 AlPO4  |
| **Valency** | * **Valency of an element is the combining capacity of the element.**
* The valency of an ion is equal to charge on the ion**.**
* **Monovalent cations** [H+(hydrogen ion), Li+(lithium ion), Na+(sodium ion, K+(Potassium ion), NH4+(Ammonium ion), Ag+(silver ion)]
* **Divalent cations** [Mg2+(Magnesium ion), Ca2+(Calcium ion), Cu2+ (Copper(II) ion), Ba2+(Barium ion), Zn2+(Zinc ion)**]**
* **Trivalent cations**[Al3+(Aluminium ion) , Fe3+ (Ferric ion]
* **Monovalent anions**.( H-(Hydride ion), F- (Fluoride ion), Cl-(Chloride ion), Br-(Bromide ion), I-(Iodide ion), NO2-(Nitrite ion)]
* **Divalent anions** (O2-(Oxide ion), S2-(Sulphide ion), SO32-Sulphite ion), CO32-(Carbonate ion), SO42-(Sulphate ion)])
* **Trivalent anions**(N3-(Nitride ion), P3-( Phosphide ion), PO43-(Phosphate ion)]
 |
| **Gram atomic mass** | * It represents the mass of 1 mole of atoms (6.022x1023 atoms) of that substance.
* The amount of substance, whose mass in grams is numerically equal to its atomic mass, is called gram atomic mass of that substance.

Atomic mass of oxygen O =16uGram atomic mass of oxygen, O= 16grams. |
| **Gram molecular mass** | * The amount of a substance, whose mass in grams is numerically equal to its molecular mass, is called gram molecular mass of that substance.
* The molar mass of a substance has 6.022x 1023 molecules of the substance in it.
 |
| **Mole concept** | * A mole of atom is defined as that amount of substance which has mass equal to gram atomic mass.
* A mole of molecule is defined as that amount of the substance which has mass equal to gram molecular mass.
 |
| **Mole in terms of number** | * A mole of particles (atoms, ions or molecules) is defined as that amount of the substance which contains the same number of particles as there are C-12 atoms in 12 gram.
* A mole of particles is that amount of the substance which contains Avogadro’s number of particles (i.e., 6.022x1023 particles).
 |
| **Mole in terms of volume** | * A mole of a gaseous substance is defined as that amount of the substance which has volume equal to 22400ml. at STP conditions.
 |
| **Molar mass** | * The mass of 1 mole of the substance (i.e., Avogadro’s number of particles) is called molar mass of that substance.
 |
| * The volume occupied by one mole of any gas at STP (Standard temperature and Pressure,i.e., O0C and 1 atmospheric pressure)is always same and equal to 22400 ml or 22.4 L or 22.4 dm3. This volume is called molar volume or gram molecular volume(G.M.V).
 |
| **Relationship b/w number of moles(n), mass(m), Molar mass(M), number of atoms or molecules(N) and Avogadro’s number(N0)** | * n = m/M
* n = N/N0
* m=nxM
* M=m/n = mxNo/N
 |