1

GENERAL CHEMISTRY

Introduction

Chemistry is defined as that branch of science which deals with the composition and properties of matter and the changes in that matter undergoes by various interactions.

Matter

Anything that occupies space, has mass and offer resistance is called matter.

The food that we eat, the water that we drink, the air that we breathe and the clothes that we wear are all made up of matter.

- The space anything occupies is called its volume.
- The amount of matter anything contains is called its mass.

(a) Charge Particle in Matter

The electrical nature of matter was known in 600 BC. It was produced by rubbing two articles together such as glass rod or ebonite rod with silk or fur. As a result of rubbing, they got electrically charged.

KEY POINTS

To Show the nature of charge particles present in matter.

Materials required: Two pieces of glass and two pieces of resin.

Procedure:

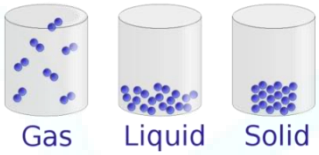
– Take two pieces of glass or two pieces of resin
– Rub glass pieces with each other, bring in contact
– Rub resin pieces with each other, bring in contact
– Bring glass and resin pieces in contact with each other.

Observations:

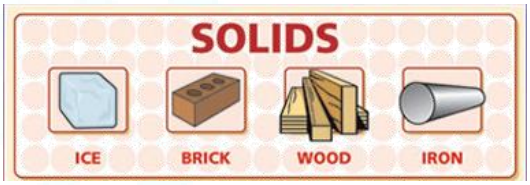
– Both glass pieces repel each other.
– Both resin pieces repel each other.
– Glass and resin pieces attract each other.

Conclusion: This experiment shows that nature of charged particles present in matter may be different. The electrical nature of two pieces of glass are similar to each other but opposite to those of the two pieces of resin.

(b) State of Matter

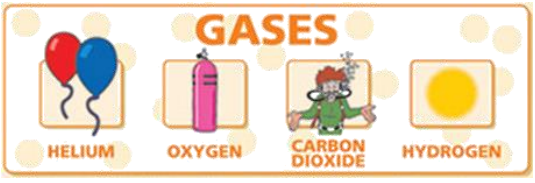


i. Solid: A solid has a fixed volume and a definite shape & definite mass.



ii. Liquid: A liquid has a fixed volume but not a definite shape. It takes the shape of the container.

iii. Gas: A gas has neither a fixed volume nor a definite shape. It assumes the volume and shape of the container.



Interesting Fact: Due to high compressibility of gases, Gases are used to fill the gas in cylinder.

FUNDAMENTAL UNLOCKED- (FU#1)

Q.1 Write down the physical state of following :

(a) Oil (b) Oxygen
(c) Diesel (d) Gold
(e) Mercury (f) Nitrogen dioxide

Q.2 Write down the definite property of matter.

Q.3 Give the name of the process in which solid changes into liquid.

Q.4 What is matter?

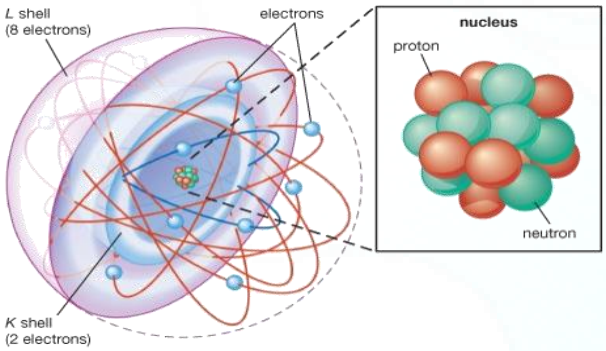
Q.5 Name the state of matter which is having fixed volume and mass but not shape.

Atom and Atomic Theories

An atom is the smallest particle of an element that can take part in a chemical reaction. The size of an atom is indicated by its radius which is called "atomic radius" (radius of an atom).

Atomic radius is measured in "nanometre" (nm).

1 metre = 10^9 nanometre or 1nm = 10^{-9} m. Hydrogen atom is the smallest atom of all having an atomic radius 0.037nm or 0.37 Å (1 Å = 10^{-10} metre)



Structure of Atom

(a) Discovery of Atom:

Ancient Indian and Greek philosophers have been thinking about what matter is ultimately made up of. It was around 500 BC that an Indian philosopher, Maharishi Kanad had postulated that matter is divisible i.e., if we go on breaking matter, we will get smaller and smaller particles and ultimately, the particles obtained may be so small that they cannot be further divided.

These indivisible particles were named as "paramanu". Almost during the same period, ancient Greek philosophers, Democritus and Leucippus, also put forward the same idea. However, they called the smallest indivisible particles as "atoms" (Greek : means un-cutable)

(b) How big are the atoms ? Can we see them ?

Atoms are extremely small particles, so small in size that they cannot be seen even under a microscope. To imagine about their size, it is interesting to mention here that if millions of atoms are stacked one above the other, the thickness produced may not be equal to the thickness of the sheet of a paper.

(c) Symbol

"A symbol is a brief representation of the name of the element". Berzelius, a Swedish chemist, was the first to introduce the system of using letters as symbols for the elements.

Symbol and Name of some elements

Atomic No.	Element	Symbol	Atomic No.	Element	Symbol
1	Hydrogen	H	11	Sodium	Na
2	Helium	He	12	Magnesium	Mg
3	Lithium	Li	13	Aluminium	Al
4	Beryllium	Be	14	Silicon	Si
5	Boron	B	15	Phosphorous	P
6	Carbon	C	16	Sulphur	S
7	Nitrogen	N	17	Chlorin	Cl
8	Oxygen	O	18	Argon	Ar
9	Fluorine	F	19	Potassium	K
10	Neon	Ne	20	Calcium	Ca

- Symbols may be derived from the first letter of the English name of the element.
- Symbols may be derived from the first letter and another significant letter of the name of element.
- Symbols may be derived from their Latin names of the elements.

Name of element	Chemical Symbol	Name of element (Language)
Potassium	K	Kalium (Latin)
Iron	Fe	Ferrum (Latin)
Copper	Cu	Cuprum (Latin)
Silver	Ag	Argentum (Latin)
Tin	Sn	Stannum (Latin)
Gold	Au	Aurum (Latin)
Mercury	Hg	Hydrargyrum (Latinized Greek)
Lead	Pb	Plumbum (Latin)
Tungsten	W	Wolfram (Latin)

Note : Dalton was the first to use symbols to represent elements.

(d) Dalton atomic theory

Dalton put forward his atomic theory of matter in 1808. The various postulates (or assumptions) of Dalton's atomic theory of matter are as follows:

- Matter consists of small indivisible particles called atoms.
- All atoms of an element are identical in nature.
- The atoms of an element are different from the atoms of any other element.
- A compound is formed by combination of atoms of two or more elements in simple ratio.

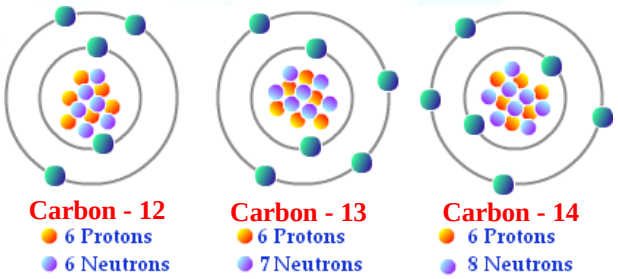
  e.g. Ratio between H and O in water is 2 : 1 by volume.
- Atoms take part in chemical reactions.
- Atoms can neither be created nor be destroyed.

i. Merit

- Dalton's atomic theory explains the law of conservation of mass and law of constant proportion.
- Atoms of elements take part in chemical reaction this is true till today.

ii. Demerit

- The atom is no longer supposed to be indivisible.
- He could not explain that why do atoms of same element combined with each other.
- Atoms of the same element may not necessarily be identical in all aspects. e.g. isotopes.



- Atoms of different elements may not necessarily be different in all aspects. e.g. isobars.

(e) Modern atomic theory

i. Structure of An Atom : An atom consists of two parts –

(A) Nucleus: Nucleus is situated in the centre of an atom.

All the protons & neutrons are situated in the nucleus, therefore, the entire mass of an atom is almost concentrated in the nucleus.

The overall charge of nucleus is positive due to the presence of positively charged protons.

The protons & neutrons are collectively called nucleons.

The radius of the nucleus of an atom is of the order of 10^{-13} cm and its density is of the order of 10^{17} kg/m^3.

(B) Extra nuclear region: In extra nuclear part electrons are present which revolve around the nucleus in orbits of fixed energies.

ii. Composition of an Atom: The atom is not the ultimate particle. There are still smaller particles which the atom itself is made of. These are electrons, protons and neutrons called the fundamental or subatomic particles.

S. No.	Property	Electron	Proton	Neutron
1	Discovery	J. J. Thomson	E. Goldstein	James chadwick
2	Symbol	E	P	N
3	Nature	Negatively charged	Positively charged	Neutral
4	Relative charge	–1	1	0
5	Absolute charge	1.602×10^{-19} C	1.602×10^{-19} C	0
6	Relative mass	1/1837	1	1
7	Absolute mass	9.109×10^{-28} g	1.6725×10^{-24} g	1.6748×10^{-24} g

(f) Atomic number (Z)

In 1913, Moseley introduced an atomic parameter called atomic number.

Atomic number of an element is equal to the number of proton present in the nucleus of an atom of that element.

For example,

Number of protons in hydrogen atom and carbon atom are 1 and 6 respectively. So, their atomic numbers are 1 and 6 respectively.

The number of protons in an atom is equal to the number of electrons since atom as a whole is electrically neutral.

Thus,

Atomic number of an element = Number of protons in the nucleus

= Number of electrons in the extra nuclear part (in neutral atom)

Atomic number of an element is generally denoted by the symbol 'Z'.

e.g. $_{13}Al$ Z = 13

p = 13

e = 13

Each element has a unique atomic number.

(g) Mass number (A)

Mass number is the sum of number of protons and neutrons present in the atom of an element.

It is denoted by "A". The mass number is represented either on the left hand side (LHS) or on the right hand side (RHS) of the symbol of the element as superscript

A = no. of protons + no. of neutrons (total no. of nucleons)

A = p + n

A = Z + n

How to Determine the Number of Electrons, Protons and Neutrons is an atom:

From the knowledge of atomic number and mass number of an element, the number of electrons, protons and neutrons can be easily predicted.

For an atom

Atomic number (Z) = No. of protons (p) = No. of electrons (e)

Mass number (A) = No. of protons (p) + No. of neutron (n)

But, No. of protons = Atomic number (Z)

$\therefore$ A = Z + n

n = A –Z

Number of neutrons = Mass number – Atomic Number

For example, lithium has atomic number (Z) = 3 and mass number (A) = 7, Therefore, Number of electrons = Atomic number = 3, Number or protons = Atomic number = 3

Number of neutrons = Mass number – Atomic number = A –Z = 7 – 3 = 4.

Nucleus consist of protons and neutrons and these are collectively known as nucleons. Since the electrons are of negligible mass, the entire mass of the atom is due to the nucleus i.e. nucleons.

e.g. Z = 13

A = 27

p = 13

e = 13

n = A – Z = 27 – 13 = 14

Atomic number (Z)
= number of protons = number of electrons
Represented as subscript $_{Z}X$

Mass number [A]
= number of protons + number of neutrons
Represented as superscript ^{A}X

Mass Number:
1 proton AND 1 neutron

Atomic number:
1 proton OR 1 electron

$$^{2}_{1}H$$

Isotopes: The atoms of same element, having same atomic number but different mass numbers, Properties of isotopes

- The atomic number and electronic configuration is same for all isotopes.
- Physical properties like mass, density, melting point, boiling point are different.

Isotope	Formula	Mass Number A	Atomic Number Z	Number of Neutrons
Potium or ordinary Hydrogen	$^{1}_{1}H$ (H)	1	1	0
Deuterium	$^{2}_{1}H$ (D)	2	1	1
Tritium	$^{3}_{1}H$ (T)	3	1	2

FUNDAMENTAL UNLOCKED- (FU#2)

Q.1 Write down the merit and demerit of Dalton's atomic theory.

Q.2 Define the term "Nucleus".

Q.3 Write down the name of fundamental particles of atom.

Q.4 Define atomic number and mass number.

Q.5 Define the term shell.

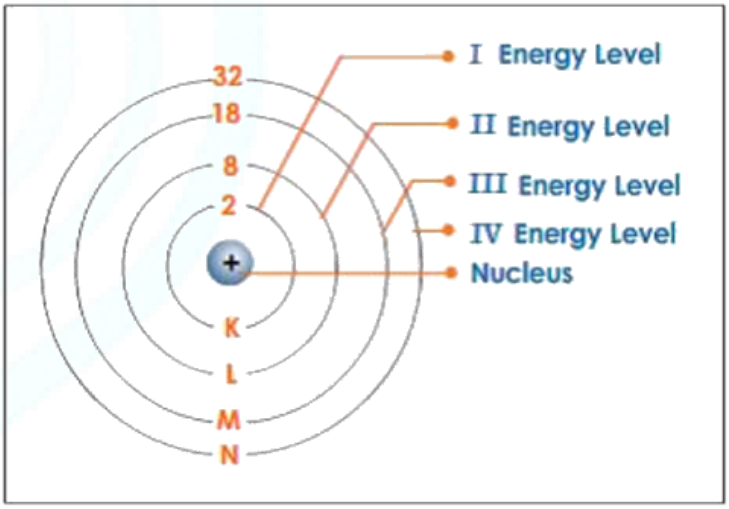
Electronic Configuration and Significance

We have studied that atoms of different elements differ in their atomic numbers as well as mass numbers. Therefore, they have also different number of electrons. These are distributed in the various energy shells (or energy levels) Which are given by Bohr i.e. K, L, M, N, ... etc.

This distribution of the electron in the energy shells is known as electronic configuration. It is based on certain guide-lines or rules given by Bohr and Bury. This is known as Bohr-Bury scheme.

(a) Bohr-Bury Scheme for Distribution of Electrons in Various Shells :

- The maximum number of electrons which can be present in a particular energy shell of an atom is given by $2n^2$. Here 'n' is the number of the energy shells or energy levels.



Name of shells	K	L	M	N
Number of shells	1	2	3	4
Maximum Number of electrons ($2n^2$)	2	8	18	32

- The outermost energy shell in an atom cannot have more than eight electrons even if it has a capacity to take up more electrons according to first rule.
- It is not necessary for a given shell to complete itself before another shell starts forming.

As a rule, the new shell is formed as soon as the outermost shell acquires eight electrons.

For example, the atomic number (Z) of the element potassium is 19. Its electronic configuration is expected to be 2, 8, 9. But actually it is not so the third shell (M-shell) which is the outermost shell in this case is shown to have nineteen electrons. However, it cannot have more than eight electrons. Therefore, the N-shell builds up as soon as the M-shell acquires eight electrons.

The actual electronic configuration of potassium is 2, 8, 8, 1.

K	L	M
2	8	9

(Expected electronic distribution in K)

K	L	M	N
2	8	8	1

(Actual electronic distribution in K)

Similarly for the next element calcium (Z = 20), N shell can have two electrons.

K	L	M
2	8	10

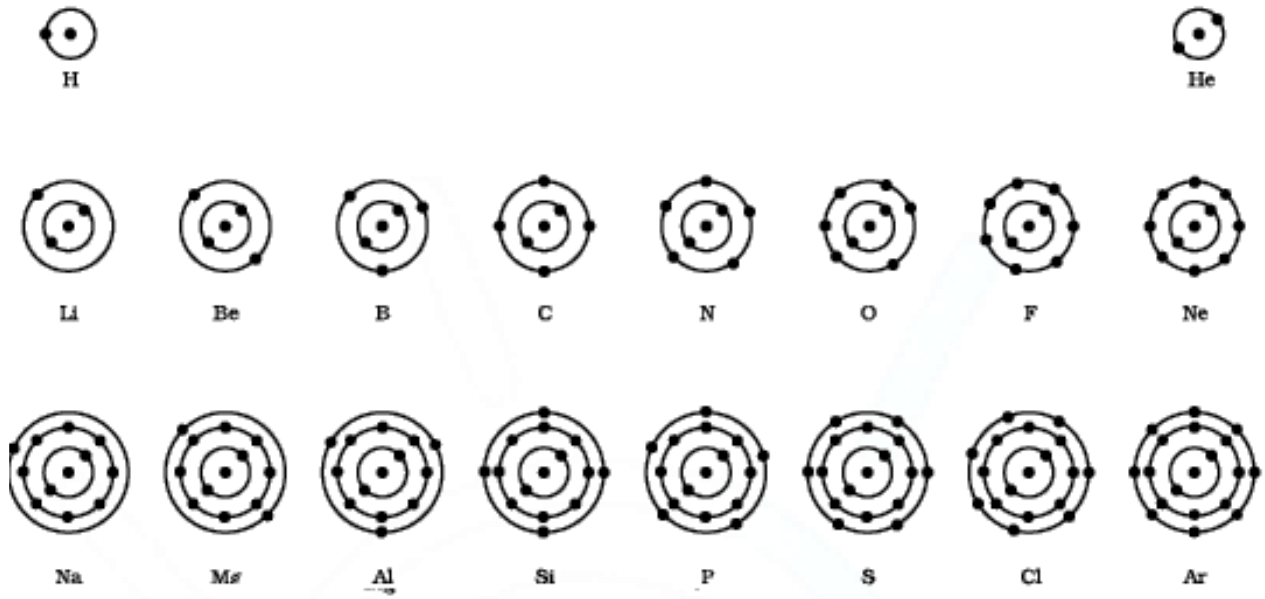
(Expected electronic distribution in Ca)

K	L	M	N
2	8	8	2

(Actual electronic distribution in Ca)

(b) Electronic Configuration of Some Elements :

Name of Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Number of Electrons	Distribution of Electrons				Vale-ncy
						K	L	M	N	
Hydrogen	H	1	1	-	1	1	-	-	-	1
Helium	He	2	2	2	2	2	-	-	-	0
Lithium	Li	3	3	4	3	2	1	-	-	1
Beryllium	Be	4	4	5	4	2	2	-	-	2
Boron	B	5	5	6	5	2	3	-	-	3
Carbon	C	6	6	6	6	2	4	-	-	4
Nitrogen	N	7	7	7	7	2	5	-	-	3
Oxygen	O	8	8	8	8	2	6	-	-	2
Fluorine	F	9	9	10	9	2	7	-	-	1
Neon	Ne	10	10	10	10	2	8	-	-	0
Sodium	Na	11	11	12	11	2	8	1	-	1
Magnesium	Mg	12	12	12	12	2	8	2	-	2
Aluminium	Al	13	13	14	13	2	8	3	-	3
Silicon	Si	14	14	14	14	2	8	4	-	4
Phosphorus	P	15	15	16	15	2	8	5	-	3,5
Sulphur	S	16	16	16	16	2	8	6	-	2
Chlorine	Cl	17	17	18	17	2	8	7	-	1
Argon	Ar	18	18	22	18	2	8	8		0



Pictorial diagram for electronic configuration

(c) Significance of Electronic Configuration:

- Electronic configuration of an atom helps us to understand the chemical reactivity of the element.
- When the outermost shell of an atom is completely filled as per Bohr-Bury scheme then the element is unreactive.
- When the outermost shell of an atom is not completely filled according to Bohr-Bury rule, the element is reactive.

  An atom can get the noble gas electronic configuration in three ways -
- By losing one or more electrons.
- By gaining one or more electrons.
- By sharing one or more electrons with other atom or atoms.

(d) Valence shell and valence electrons

The outermost shell of an atom is known as the valence shell. The electrons present in the valence shell of an atom are known as valence electrons.

The remainder of the atom i.e. the nucleus and other electrons is called the core of the atom.

Electrons present in the core of an atom are known as core electrons.

i. Significance of valence electrons

- The valence electrons of an atom are responsible for chemical reaction and take part in chemical changes.
- The valence electron determines the combining capacity or the valency of the atom.
- Elements having the same number of valence electrons in their atoms possess similar chemical properties. For example, all alkali metals have one valence electron in their atoms.

  Hence, their chemical properties are similar.

  e.g.

  The electronic configuration of the sodium (Na) atom is :-

  Na (11) K L M

  2 8 1

  Thus, valence electrons in Na atom = 1 and core electrons in Na atom = 2 + 8 = 10

ii. Valency: Element, other than noble gas elements, contain less than 8 electron in their outermost shells. These elements are chemically reactive and unstable. They tend to acquire the stable outermost electronic configuration of the noble gases. It is the tendency on the part of elements that leads to chemical reactions. The noble gas configuration is achieved by elements by losing, gaining or sharing electrons.

The number of electrons gained, lost or shared by the atom of an element so as to complete its octet (or duplet in case of elements having only K shell) is called the valency of the element.

The valency of an element = number of valence electrons

(when number of valence electrons are from 1 to 4)

The valency of an element = 8 – number of valence electrons. (when number of valence electrons are more than 4)

iii. Variable Valency: Certain elements (metals and non - metals) exhibit more than one valency.

(A) Among the metals iron, copper, silver etc. show variable valency. For lower valency a suffix-ous and for higher valency a suffix-ic is attached at the end of the name of the metals and non-metals.

e.g.

Ferrous = Fe^{+2} Ferric = Fe^{+3}

(B) Among the non - metals nitrogen, phosphorus, sulphur etc. show variable valency.

iv. How Do Atoms Exist ?

The atoms of only a few elements called noble gases (such as helium, neon, argon and krypton etc.) are chemically unreactive and exist in the free state (as single atoms). Atoms of most of the elements are chemically very reactive and do not exist in the free state (as single atoms).

Atoms usually exist in two ways:

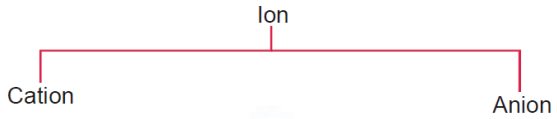
(A) In the form of ions and

(B) In the form of molecules

When atoms form molecules or ions, they become stable (because in doing so they acquire the stable electron arrangement of noble gases).

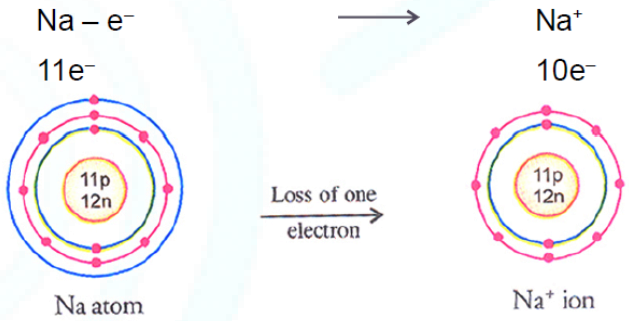
(A) Ions

The charged particles formed by an atom on the gain or loss of one or more electron(s) is called ions.



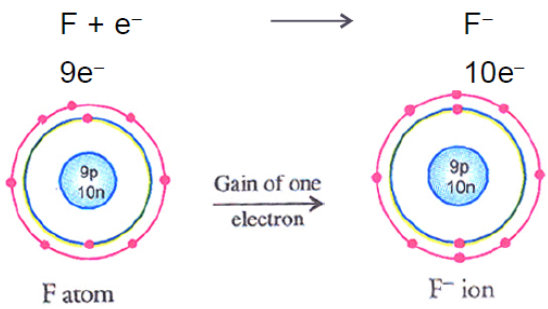
(1) Cation: A positive ion gets formed in case atom of an element loses one or more electrons. For example, the electronic distribution in sodium i.e. Na is 2, 8, 1. It loses one electron to form a positive ion with electronic distribution 2, 8. Since in the ion, the number of electrons (2 + 8 = 10) is one less than the number of protons (11), it has one unit positive charge. It may be represented as follows :

e.g.



(2) Anion: A negative ion gets formed in case atom of an element gains one or more electrons. For example, electronic distribution in fluorine i.e. F is 2, 7. It gains one electron to form a negative ion with electronic distribution 2, 8. Since in the ion, the number of electrons (2 + 8 = 10) is one more than the number of protons (9), it has one unit negative charge. It may be represented as follows.

e.g.



LIST OF COMMON ELECTROVALENT POSITIVE RADICALS

Monovalent Electropositive	Bivalent Electropositive	Trivalent Electropositive	Tetravalent Electropositive
1. Hydrogen H^+	1. Magnesium Mg^{2+}	1. Aluminium Al^{3+}	1. Stannic [Tin (IV)] Sn^{4+}
2. Ammonium NH_4^+	2. Calcium Ca^{2+}	2. Ferric [Iron (III)] Fe^{3+}	2. Plumbic [Lead (IV)] Pb^{4+}
3. Sodium Na^+	3. Zinc Zn^{2+}	3. Chromium Cr^{3+}	
4. Potassium K^+	4. Plumbous [Lead (II)] Pb^{2+}		
5. Cuprous [(Copper (I)] Cu^+	5. Cupric [(Copper) (II)] Cu^{2+}		
6. Argentous [Silver (I)] Ag^+	6. Argentic [Silver(II)] Ag^{2+}		
7. Mercurous [Mercury(I)] Hg^+	7. Stannous [Tin (II)] Sn^{2+}		
	8. Ferrous [Iron (II)] Fe^{2+}		
	9. Mercuric [Mercury (II)] Hg^{2+}		
	10. Barium Ba^{2+}		

LIST OF COMMON ELECTROVALENT NEGATIVE RADICALS

Monovalent Electronegative	Bivalent Electronegative	Trivalent Electronegative	Tetravalent Electronegative
1. Fluoride F^-	1. Sulphate SO_4^{2-}	1. Nitride N^{3-}	1. Carbide C^{4-}
2. Chloride Cl^-	2. Sulphite SO_3^{2-}	2. Phosphide P^{3-}	
3. Bromide Br^-	3. Sulphide S^{2-}	3. Phosphite PO_3^{3-}	
4. Iodide I^-	4. Thiosulphate $S_2O_3^{2-}$	4. Phosphate PO_4^{3-}	
5. Hydride H^-	5. Zincate ZnO_2^{2-}		
6. Hydroxide OH^-	6. Oxide O^{2-}		
7. Nitrite NO_2^-	7. Peroxide O_2^{2-}		
8.Nitrate NO_3^-	8. Dichromate $Cr_2O_7^{2-}$		
9. Bicarbonate or Hydrogen carbonate HCO_3^-	9. Carbonate CO_3^{2-}		
10. Bisulphite or Hydrogen sulphite HSO_3^-	10. Silicate SiO_3^{2-}		
11. Bisulphide or Hydrogen sulphide HS^-			
12. Bisulphate or Hydrogen sulphate HSO_4^-			
13. Acetate CH_3COO^-			

Interesting Facts: Generally, metals form Cations and non-metals form Anions.

(B) Molecule: A molecule is an electrically neutral group of two (or more) atoms chemically bonded together by means of attractive forces.

Or

A molecule is the smallest particle of a substance (element or compound) which has the properties of that substance and can exist in the free state. Molecules can be formed either by the combination of atoms of the "same element" or of "different elements".

There are two types of molecules: molecules of elements and molecules of compounds.

(1) Molecules of Elements: The molecule of an element contains two (or more) similar atoms chemically bonded together. For example, a molecule of hydrogen contains 2 hydrogen atoms combined together and it is written as H_2 representing Hydrogen gas. Similarly, Ozone gas has 3 oxygen atoms combined together, so ozone exists in the form of O_3. The noble gases like helium, neon, argon and krypton etc., exist as single atoms He, Ne, Ar and Kr respectively. So, their atoms and molecules are just the same.

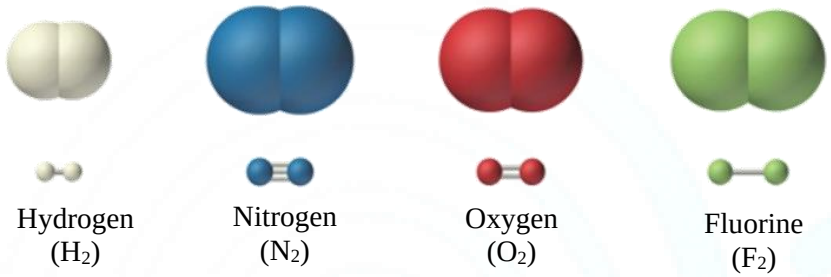
(2) Molecules of Compounds: The molecule of a compound contains two (or more) different types of atoms chemically bonded together. For example, molecule of hydrogen chloride (HCl) contains one atom of hydrogen (H) chemically bonded with one atom of chlorine (Cl). Some more examples of the molecules of compounds are : sulphur dioxide (SO_2), methane (CH_4) and ammonia (NH_3).

(3) Atomicity: The number of atoms present in one molecule of an element is called its atomicity.

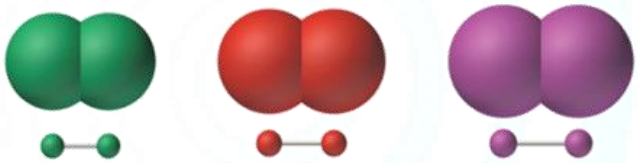
The atomicity of an element is indicated by writing the number as a subscript on the right hand side bottom of the symbol.

For example, H_2 shows that the atomicity of hydrogen is 2. P_4 shows that the atomicity of phosphorus is 4, He shows that the atomicity of helium is 1.

On the basis of their atomicities, the elements may be classified as monoatomic, diatomic, triatomic, tetra atomic, etc.



Hydrogen (H_2) Nitrogen (N_2) Oxygen (O_2) Fluorine (F_2)



Chlorine (Cl_2) Bromine (Br_2) Iodine (I_2)

a. Elements that exist as diatomic molecules

b. Elements that exist as polyatomic molecules

Phosphorus (P_4) Sulfur (S_8)

Name of the element	Symbol of the element	Atomicity	Representation of molecule
Argon	Ar	Monoatomic	Ar
Helium	He	Monoatomic	He
Hydrogen	H	Diatomic	H_2
Oxygen	O	Diatomic	O_2
Chlorine	Cl	Diatomic	Cl_2
Ozone	O	Triatomic	O_3
Phosphorus	P	Tetraatomic	P_4
Sulphur	S	Octaatomic	S_8

(e) Chemical formula

Molecule of an element or a compound may be represented by symbols of the elements present in one molecule of the compound. It is known as a chemical formula.

E.g. HCl is the formula of hydrogen chloride and NaCl is that of sodium chloride.

i. Significance of a Chemical Formula :

Name of the substance.

- Name of various elements present in that substance.
- Chemical formula of a substance represents one molecule of that substance.
- Relative number of atoms of various elements present in one molecule of that element or compound.
- Relative masses of various elements in the compound.
- We can calculate the gram molecular mass of that substance.

ii. Writing a Chemical Formula :

Step-I: Write the symbol of the positive ion or the radical to the left and that of the negative ion or radical to the right.

Step-II: Put the valency of each radical or the ion on its top right. Divide the valency by the highest common factor, if any, to get a simple ratio. Now ignore the (+) and (–) signs. Interchange the valency of radicals or ions.

Step-III: Shift the valency to the lower right side of the radical or ion. If the compound radical receives number more than 1, enclose it within brackets. Do not enclose simple radicals within brackets.

Names of compounds	Symbols with valence numbers (I and II steps)	Shifting valence numbers (III step)	Formula
Calcium chloride	$Ca^{+2}Cl^{-1}$	Ca_2Cl_1	$CaCl_2$
Magnesium sulphate	$Mg^{+2}SO_4^{-2}$ or $Mg^{+1}SO_4^{-1}$	Mg_1SO_4	$MgSO_4$
Aluminium sulphate	$Al^{+3}SO_4^{-2}$	Al_2SO_4	$Al_2(SO_4)_3$
Ammonium phosphate	$NH_4^{+1}PO_4^{-3}$	NH_4PO_4	$(NH_4)_3PO_4$
Potassium dichromate	$K^{+1}Cr_2O_7^{-2}$	KCr_2O_7	$K_2Cr_2O_7$

S.No.	Compounds	Common Names	Chemical Names
1	CaO	Lime	Calcium oxide
2	$NaHCO_3$	Baking soda	Sodium hydrogen carbonate
3	$Na_2CO_3.10H_2O$	Washing soda	Sodium carbonate decahydrate
4	$CaCO_3$	Limestone	Calcium carbonate
5	$Ca(OH)_2$	Slaked lime	Calcium hydroxide
6	$CuSO_4.5H_2O$	Blue vitriol	Copper sulphate pentahydrate
7	NaCl	Common salt	Sodium chloride
8	Na_2CO_3	Soda ash	Sodium carbonate
9	NaOH	Caustic soda	Sodium hydroxide
10	KOH	Caustic potash	Potassium hydroxide
11	$CaOCl_2$	Bleaching powder	Calcium oxychloride
12	$CaSO_4.1/2\ H_2O$	Plaster of paris	Calcium sulphate hemihydrate
13	$CaSO_4.2H_2O$	Gypsum	Calcium sulphate dihydrate
14	$FeSO_4.7H_2O$	Green vitriol	Ferrous sulphate heptahydrate
15	H_2SO_4	Oil of vitriol	Sulphuric acid

FUNDAMENTAL UNLOCKED- (FU#3)

Q.1 What is molecule? Explain with example.

Q.2 Write down the atomicity for following :

(A) S_8 (B) CO_2

(C) P_4 (D) H_2O

Q.3 Write down the common name of following

(A) CaO (B) $CuSO_4.5H_2O$

(C) NaOH (D) H_2SO_4

Q.4 Write down the chemical formula of following

(a) Calcium nitrate

(b) Calcium phosphate

Q.5 What is ion ? Define cation and anion.

Atomic Mass and Molecular Mass

(a) Atomic Mass

Actual masses of the atoms of the elements are very, very small. For example, one atom of hydrogen (H) has a mass of 1.673×10^{-24} gram. To avoid the inconvenience in using such small and complicated figures in our calculations, it was necessary to define atomic mass in such a way that we get simple figures for them. Carbon-12 atom is that atom of carbon which has 6 protons and 6 neutrons in its nucleus, so that its mass number is 12.

Carbon-12 atom has been assigned an atomic mass of exactly 12 atomic mass units, written as 12 u.

Definition of atomic mass : Atomic mass express as to how many time mass of an atom of an element is heavier than $\frac{1}{12}$ the mass of carbon - 12 atom.

Atomic Mass Unit (u) = One-twelfth the mass of a Carbon-12 atom.

$1u = 1.6605 \times 10^{-24}$ g.

One atomic mass unit (1u) is defined as exactly one-twelfth the mass of an atom of Carbon-12.The atomic mass of an element is the relative mass of its atom as compared with the mass of a Carbon-12 atom taken as 12 units.

(b) Molecular Mass

The molecular mass of a substance may be defined as the relative mass of its molecule as compared to the mass of an atom of carbon (carbon-12) taken as 12 units.

OR

Molecular mass expresses as to how many times a molecule of a substance is heavier than 1/12th of the mass of an atom of carbon (carbon-12).

Eg. A molecule of water is 18 times heavier than 1/12th of the mass of carbon atom. Therefore, the molecular mass of water is 18u. Similarly, the molecular mass of CO_2 is 44u.

Calculation : The molecular mass is equal to sum of the atomic masses of all the atoms present in one molecule of the substance.

Eg. The molecular mass of Sulphuric Acid (H_2SO_4) can be calculated as follows:

Molecular mass of H_2SO_4 = Mass of 2 H atoms + Mass of 1 S atom + Mass of 4 O atoms

$= (2 \times 1) + (1 \times 32) + (4 \times 16) = 2 + 32 + 64 = 98u$.

Thus, the molecular mass of Sulphuric acid is 98u.

FUNDAMENTAL UNLOCKED- (FU#4)

Q.1 Define atomic mass. Give three example.

Q.2 Define molecular mass. Give three example.

Q.3 Write down the molecular mass of the following :

(a) $CaCO_3$ (b) H_3PO_4 (c) $C_6H_{12}O_6$

Q.4 What is the molecular mass of sulphur ?

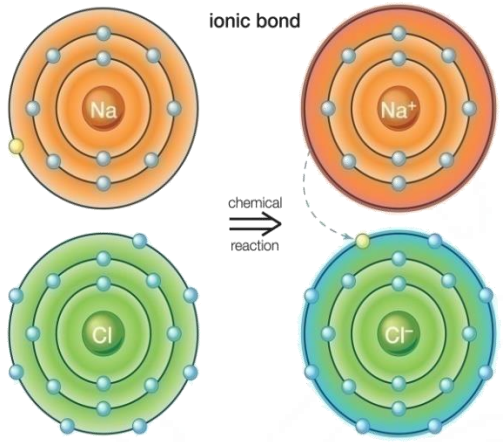
Q.5 What is molecular mass of phosphorous ?

List of atomic masses of some common elements :

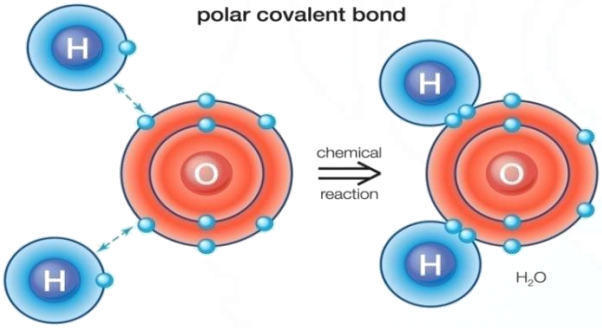
Atomic Number	Element	Symbol	Atomic mass
1	Hydrogen	H	1
2	Helium	He	4
3	Lithium	Li	7
4	Beryllium	Be	9
5	Boron	B	11
6	Carbon	C	12
7	Nitrogen	N	14
8	Oxygen	O	16
9	Fluorine	F	19
10	Neon	Ne	20
11	Sodium	Na	23
12	Magnesium	Mg	24
13	Aluminium	Al	27
14	Silicon	Si	28
15	Phosphorus	P	31
16	Sulphur	S	32
17	Chlorine	Cl	35.5
18	Argon	Ar	40
19	Potassium	K	39
20	Calcium	Ca	40

Add to your knowledge

- **Ionic bond:** The chemical bond which is formed by transfer of electron from one atom to another atom is called ionic bond. It is formed between metal and nonmetal.



- **Covalent bond:** The Chemical bond which is formed by sharing of electron between two or more atoms is called Covalent bond. It is formed between nonmetal and nonmetal.



- All atoms except hydrogen contain neutrons, thus the atomic mass of hydrogen is same as that of a proton.
- In the elements having atomic number more than 18, electron may go into a new shell even before the inner shell is completely filled.
- The atoms of noble gas elements are quite stable and can exist independently. These are therefore, monoatomic in nature. For example, helium (He), neon (Ne), argon (Ar), krypton (Kr) and xenon (Xe)

Atoms

- The smallest particle of an element that retains the properties of the element is called an atom.
- An element is made up of atoms of one kind.
- Below are atoms of Hydrogen, Oxygen and nitrogen.

Molecules

- A group of atoms formed by the combination of atoms is called a molecule.
- A molecule can exist by itself and retains all the Element of compound
- Below is a molecule of hydrogen made up of 2 Hydrogen atoms

Consitituent	Charge	Mass
Electron	Yes (negative charge)	Negligibel
Proton	Yes (positive charge)	Yes
Neutron	No	Yes

In 1911, Ernest Rutherford conducted an experiment and found the following model for atom:

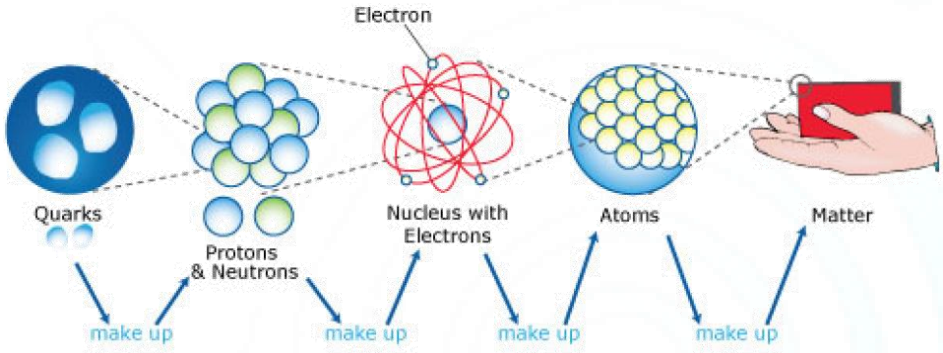
- The centre of an atom is a positively charged dense mass called the nucleus.
- The electron revolve around the nucleus in certain definite paths called the orbits or shells.
- The number of electrons in an atom is equal to the number of protons.

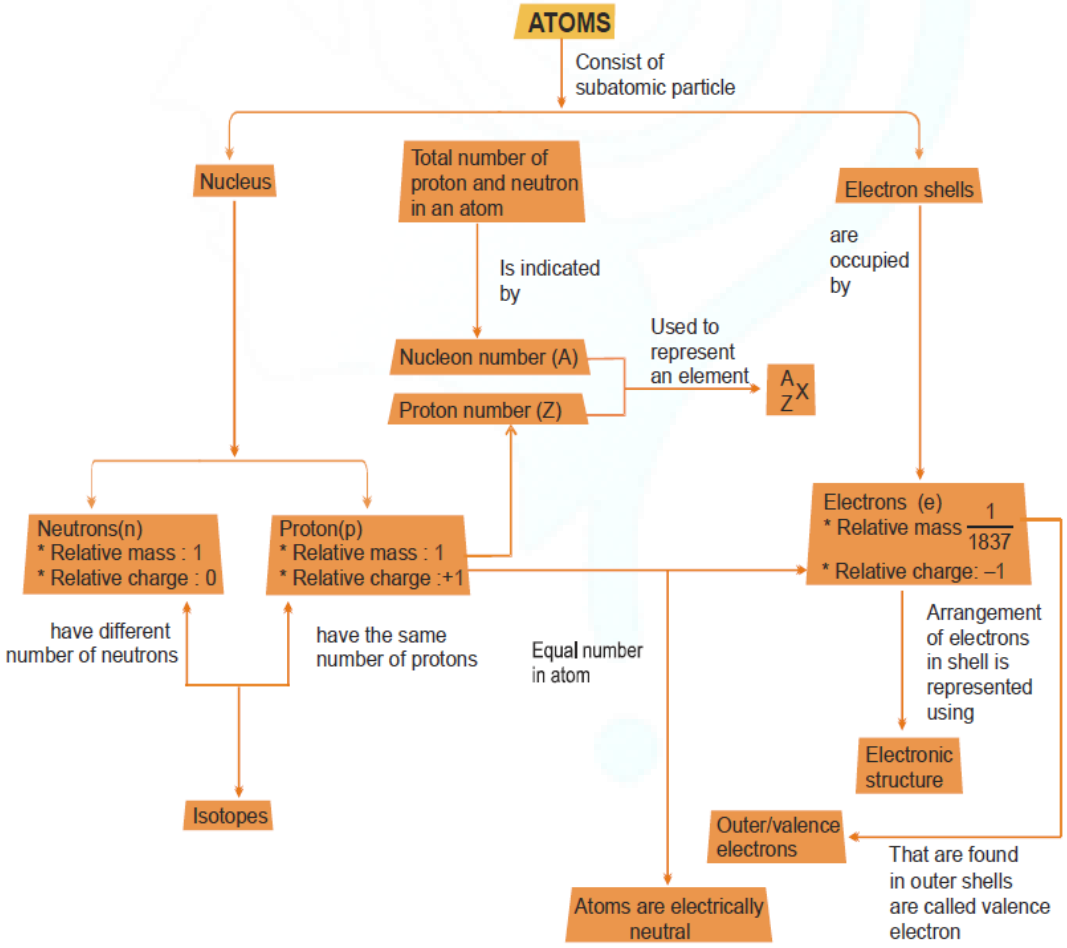
Summary

- An electron has –1 unit (1.6×10^{-19} C) charge and negligible (9.1×10^{-31} kg) mass.
- An electron is regarded as a universal particle i.e. its charge and mass remain the same.
- A proton has + 1 unit (1.6×10^{-19} C) charge and 1 u (1.67×10^{-27} kg) mass.
- Protons and neutrons present in the nucleus of an atom are also called nucleons.
- The mass of an atom is due to protons and neutrons present in the nucleus. Electrons do not contribute towards the mass of an atom.
- According to Bohr's theory, the different energy shells for the electrons are designated as: K, L, M, N, O, ... etc.
- The order of the energy of the energy shells is : K < L < M < N < O ..... etc.
- Atomic number (Z) of an element is equal to number of protons.
- When an atom changes to an ion, the protons present in the nucleus remain the same. Only the electrons change.
- Element He, Ne and Ar are known as inert elements and have zero valency.
- The formula of a compound should be written in such a way that the positive and negative charges are neutralized.

- Atoms of the same elements, having the same atomic number but different mass numbers are called isotopes of the elements.
- Atoms of the different elements, having the same mass number but different atomic numbers are called isobars of the elements.
- Atoms of the different elements with same number of neutron but different atomic number and mass number are called isotone of the element.
- Atoms of the different elements with same number of electrons but different atomic numbers and mass number are called isoelectron.
- The protons and neutrons are concentrated in a small region at the centre of an atom. This central part is known as nucleus.
- The protons and neutrons present inside the nucleus are called nucleons.
- The outermost shell is called valence shell.
- A group of atoms possessing either positive or negative charge by losing or gaining one or more electrons is called a radicals.

Chapter Map





EXERCISE - I

SINGLE CORRECT TYPE QUESTIONS

1. The compressibility of which state of matter is high -
(A) liquid (B) solid
(C) gas (D) all of these

2. A state of matter which has neither definite shape not definite volume :
(A) liquid (B) solid
(C) gas (D) all of these

3. Which of the following substance is not a liquid -
(A) Oil (B) Syrup (C) Petrol (D) CNG

4. Which of the following occur as a gas –
(A) Sand (B) Ozone (C) Soil (D) Milk

5. Liquids have :
(A) fixed volume and fixed shape
(B) fixed shape and no fixed volume
(C) fixed volume and no fixed shape
(D) neither fixed volume nor fixed shape

6. Atomic size of the order of –
(A) 10^{-8} cm (B) 10^{-10} cm
(C) 10^{-13} cm (D) 10^{-6} cm

7. Atomic number of an element represents –
(A) number of neutrons in the nucleus.
(B) atomic mass of an element.
(C) valency of an element
(D) number of protons in the nucleus.

8. The protons and neutrons are collectively called -
(A) deutrons (B) positrons
(C) mesons (D) nucleons

9. $_{11}Na^{23}$ has :
(A) 11 protons and 23 neutrons
(B) 11 neutrons and 11protons
(C) 11 electrons and 11protons
(D) None of these

10. An element with atomic number 9 is :
(A) a rare gas (B) a halogen gas
(C) an alkali metal (D) None of these

11. The electronic configuration of the sodium [Na] atom is -
(A) 2, 8, 2 (B) 2, 8, 1
(C) 2, 8 (D) 2, 8, 8, 1

12. Which of the following element will become stable after losing an electron ?
(A) Helium (B) Iodine
(C) Sodium (D) Oxygen

13. An element (A) is tetravalent electropositive and another element (B) is divalent electronegative.
The formula of the compound formed from these elements will be -
(A) A_2B (B) AB (C) AB_2 (D) A_2B_3

14. The difference between ions and atoms is of –
(A) relative size
(B) electronic configuration
(C) presence of charge
(D) all of these

15. How many types of atoms are present in a molecule of sugar ?
(A) 49 (B) 3 (C) 22 (D) 11

16. The correct chemical formula of aluminium sulphate is -
(A) $Al_2(SO_4)_3$ (B) $Al_2(SO_3)_4$
(C) $Al_3(SO_4)_4$ (D) $AlSO_4$

17. Relative atomic mass of O_3 is -
(A) 48 (B) 140 (C) 180 (D) 320

18. Chorine's relative atomic mass is 35.5. Reason for fractional atomic mass.
(A) isotopes (B) a half proton
(C) a half neutron (D) a half electron

19. Molecular weight of propane (C_3H_8) is -
(A) 44 amu (B) 40 amu
(C) 41 amu (D) 46 amu

20. Which of the following is molecular mass of $CaCO_3$:
(A) 100 u (B) 99 u
(C) 98 u (D) 97 u

21. Which of the following is molecular mass of $(NH_4)_2SO_4$:
(A) 138 u (B) 131 u (C) 132 u (D) 97 u

22. What is the atomic mass of iron :
(A) 56 u (B) 26 u (C) 25 u (D) 58 u

23. Which is not true about neutron ?
(A) It is a neutral particle
(B) It is present in the nucleus of atom
(C) It is highly unstable in nature
(D) It contributes to the mass of the atom

24. The number of valence electrons in Cl^- ion are:
(A) 16 (B) 8 (C) 17 (D) 18

25. Which is the correct electronic configuration of the element Mg ?
(A) 2, 8 (B) 2, 8, 1 (C) 2, 8, 2 (D) 8, 2, 2

26. Positive ion is formed from the neutral atom by the loss of :
(A) protons (B) neutrons
(C) alpha particles (D) electron

27. Maximum number of electrons which can be filled in the third shell of an atom is :
(A) 8 (B) 18 (C) 10 (D) 32

28. The mass number A, atomic number Z and number of neutrons n are related as :
(A) n = A – Z (B) n = A + Z
(C) n = A × Z
(D) none of these is correct

29. Which of the following elements has same number of protons, electrons and neutrons ?
(A) Al (B) Mg (C) P (D) Cl

30. Protons, neutrons and electrons are present in chlorine atom in the sequence :
(A) 17, 17, 18 (B) 17, 18, 17
(C) 18, 17, 17 (D) 17, 17, 17

31. Which of the following has/have 18 electrons?
(A) K^+ (B) Ca^{2+}
(C) Cl^- (D) all have 18 electrons

32. No. of valence electrons in an element $^{14}_{7}X$ is :
(A) 5 (B) 1 (C) 7 (D) 3

FILL IN THE BLANKS

1. There is no particle of matter smaller than an _____. According to Dalton's atomic theory.

2. Zincate ion is _____.

3. The chemical formula of nitric acid is _____.

4. Nucleons is collectively called the sum of _____ and _____.

5. Nucleus is situated in the _____ of an atom.

TRUE / FALSE

1. Discovery of electron is done by Rutherford.

2. One atomic mass unit is defined as exactly one twelfth the mass of an atom of carbon-12.

3. The overall charge of nucleus is positive.

4. J.J. Thomson was the first to introduce the system of using letters as symbols for the elements.

5. The negatively charged radical is called acidic radical.

EXERCISE – II

VERY SHORT ANSWER TYPE QUESTIONS

1. What are the fundamental particles of an atom ?

2. What is an electron? State its relative mass and charge.

3. Define the following terms:
(a) Nucleons (b) Atomic number (c) Mass number (d) Nucleus

4. How many elements are present in calcium carbonate ?

5. Calculate number of electrons, protons and neutrons.
a. $_{18}Ar^{40}$ b. $_{7}N^{14}$ c. $_{19}K^{39}$

SHORT ANSWER TYPE QUESTIONS

1. Write the electronic configuration of potassium (Z = 19). What is the number of valence electrons in it?

2. What is the difference between valency and valence electrons ?

3. What do you mean by an ion. Define cation and anion.

4. Write the formulae of following compound with the help of the valency of their constituent particle.
(i) Ferric sulphate (ii) Mercuric chloride
(iii) Calcium bicarbonate

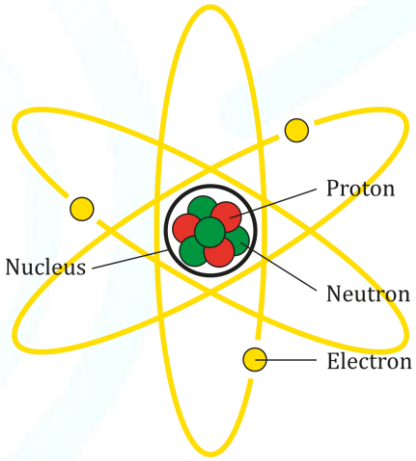
LONG ANSWER TYPE QUESTIONS

1. Write the postulates of Dalton's atomic theory.

2. Differentiate between electron, proton & neutron with respect to their charge and mass.

3. What is the significance of electronic configuration ?

4. Write molecular mass of the following.
(Zn = 65, Ag = 108, Hg = 200, Cl = 35.5, O = 16, S = 32, H = 1, N = 14, Cr = 63.5)
a. $ZnSO_4$ b. $(NH_4)_2Cr_2O_7$
c. AgBr d. Hg_2Cl_2



EXERCISE – III

PREVIOUS YEAR QUESTIONS

1. An element X of valency 3 combines with another element Y of valency 2. The formula of the compound formed is :
(A) XY_3 (B) X_2Y_3 (C) X_2Y_2 (D) XY_2

2. Read the given statements and mark the correct option :
Statement-1 : Relative atomic mass of chlorine is 35.5.
Statement-2 : Chlorine gas is diatomic element.
(A) Both statements 1 and 2 are true and statement-2 is the correct explanation statement-1.
(B) Both statements 1 and 2 are true but statement-2 is not the correct explanation statement-1.
(C) Statement-1 is true and statement-2 is false.
(D) Both Statement-1 is true and statement-2 is false.

3. The number of atoms present in a molecule of a substance is called its :
(A) Molecularity (B) Atomicity
(C) Valency (D) Reactivity

4. The atomic mass of oxygen is 16 and the molecular mass of ozone is 48. What is the atomicity of ozone if it is an allotrope of oxygen ?
(A) 1 (B) 2 (C) 3 (D) 4

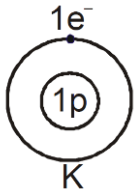
5. The nucleus of the atom consist of :
(A) Proton and neutron
(B) Proton and electron
(C) Neutron and electron
(D) Proton, neutron and electron

6. Which one of the following atoms has a mass number of 40 ?

Atom	Number of protons	Number of neutrons
i	13	14
ii	18	22
iii.	20	22
iv.	20	51

(A) i (B) ii (C) iii (D) iv

7. The given atomic diagram represents :



(A) Hydrogen atom (B) Nitrogen
(C) Helium atom (D) Neon atom

8. Which of the following is the formula of nitrate ion ?
(A) N^{3-} (B) NO_3^-
(C) NO^+ (D) NO_2^+

9. Which of the following species has more number of protons than the number of electrons?
(A) F^- (B) Na^+
(C) O^{2-} (D) Ne

10. Symbol of ferric ion is -
(A) Fe^{++} (B) Fe^{+++}
(C) Fe (D) F^-

11. The number of electrons present in L shell of sodium ion is
(A) 7 (B) 8
(C) 1 (D) 2

12. The molecular mass of $ZnSO_4$ (Zn = 61u)
(A) 157u (B) 150u
(C) 156u (D) 158u

13. The formula mass of NaCl is -
(A) 56.5 u (B) 36.5 u
(C) 58.5 u (D) 55.5 u

14. Molecular weight of $CaOCl_2$ is –
(A) 127 amu (B) 124 amu
(C) 126 amu (D) 125 amu

15. The electronic configuration of calcium atom is –
(A) 2, 8, 10 (B) 2, 8, 8, 2
(C) 2, 7, 11 (D) 2, 8, 8

ANSWER KEY

EXERCISE– I

SINGLE CORRECT TYPE QUESTIONS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	D	B	C	A	D	D	C	B	B	C	C	D	B
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	A	A	A	A	A	C	A	C	B	C	D	B	A	B	B
Que.	31	32													
Ans.	D	A													

FILL IN THE BLANKS

1. Atom **2.** ZnO_2^{-2} **3.** HNO_3

4. protons & neutrons **5.** Centre

TRUE / FALSE

1. False **2.** True **3.** True

4. False **5.** True

EXERCISE– III

PREVIOUS YEAR QUESTIONS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	B	B	A	B	A	B	B	B	B	A	C	A	B