STRUCTURE OF ATOM

INTRODUCTION

(i) The idea of tiniest unit of matter (Anu and Parmanu) was propounded by **maharishi Kanad** in Vedic period in our country.

(ii) Democritus, a Greek philosopher also proposed that matter is made up of extremely small particles, the "atom". The name atom comes from Greek language.

(iii) John Dalton in **1808** published theory of atom assuming that atoms are the ultimate indivisible particles of matter.

(iv) Later the works f **William Crookes (1878) , J.J. Thomson** (1897) and **Goldstein** proved that atom of any element contains smaller particles which are either positively charged or negatively charged.

(v) Work of **Rutherford and Neils Bohr** confirmed that an atom consists of three subatomic particles, that are electrons, protons and neutrons.

(vi) It has been established that the central core of an atom consists of protons and neutrons and is commonly called **nucleus.** The electrons revolve around the nucleus.

(vii) The atom as a whole is **electrically neutral** as the number of protons in it, is equal to the number of electrons.

The smallest indivisible particle or unit of an element is called an atom, which can take part in a chemical reaction and may or may not exist independently.

An element is a pure substance which cannot be subdivided into two or more new substances by any means.

The word "ATOM" is given by "John Dalton".

FUNDAMENTAL PARTICLES OF AN ATOM

(a) Electron :

Electron has a **negative charge** on it, its mass is **1/1837** times the **mass of one atom of hydrogen.** It is denoted by the symbol $^{0}_{-1}\theta,$, where 0 denotes its mass and -1 denotes its charge. Electrons in the outer most shell are called **valence electrons.**

(b) Proton :

Proton has a **unit positive charge,** it is denoted by the symbol $^{1}_{+1}\mathrm{p},$ where 1 denotes it atomic mass and +1 denotes its charge.

(c) Neutron :

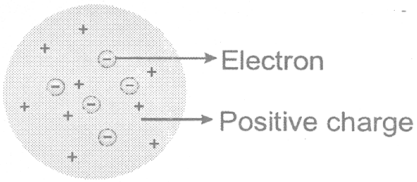
Neutron has **no electric charge** on it. Its mass is almost equal to the **mass of one atom of hydrogen.** it is denoted by the symbol $^{1}_{0}\mathrm{n},$, where 1 denotes its atomic mass and 0 denotes its charge.

In the neutral atom the total number of protons in the nucleus is equal to the number of electrons revolving round the nucleus.

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	$\frac{1}{1837}$	1	1
7. Absolute mass	9.109×10^{-28} g	1.6725×10^{-24} g	1.6748×10^{-24} g

THOMSONS MODEL OF AN ATOM

After the discovery of electrons and protons **J.J. Thomson (1898)** tried to explain the arrangement of electrons and protons within the tom. **He proposed that an atom consists of a sphere of positive electricity in which electrons are embedded like plum in pudding or seeds evenly distributed in red spongy mass in watermelon.** The radius of the sphere is of the other 10^{-8} cm which is equal to the size of the atom. Although Thmoson's model could explain the electrical neutrality of an atom but this model could not satisfy experimental facts proposed by Rutherford and hence was discarded.



"Proton is a sub - atomic particle having a unit positive charge (+1.602 × 10^{-19} kg) & mass (1.6725 × 10^{-27} kg) which is about 1837 times greater than the mass of an electron."

RUTHERFORD'S MODEL OF AN ATOM

(a) Rutherford's Alpha Scattering Experiment :

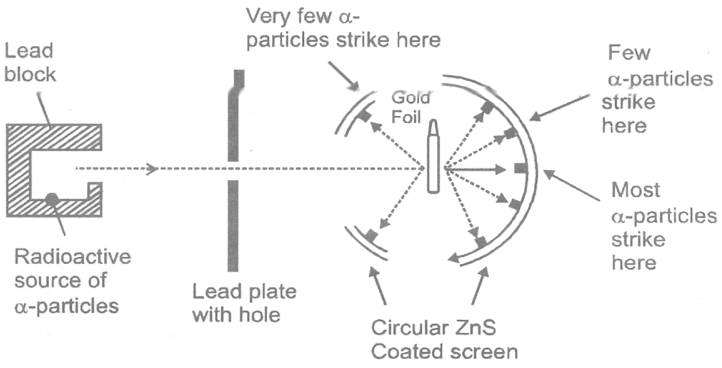
Ernest Rutherford and his coworkers performed numerous experiments in which $\alpha-$ **particles** emitted from a **radioactive element** such as polonium were allowed to strike thin sheets of metals such as **gold and platinum.**

(i) A beam of α-particles (He^{2+}) we obtained by placing polonium in a **lead box** and letting the alpha particles come out of a pinhole in the lead box. This beam of α-rays was directed against a thin **gold foil (0.00004 cm).** A circular screen coated with **zinc sulphide** was placed on the other side of the foil.

(ii) About **99% of the** $\alpha-$ **particles** passed **undeflected** through the gold foil and caused **illumination of zinc sulphide screen.**

(iii) Very few α-particles underwent small and large deflections after passing through the gold foil.

(iv) A very few (**about 1 in 20,000)** were deflected backward on their path at an angle of 180^0.



Rutherford was able to explain these observations as follows :

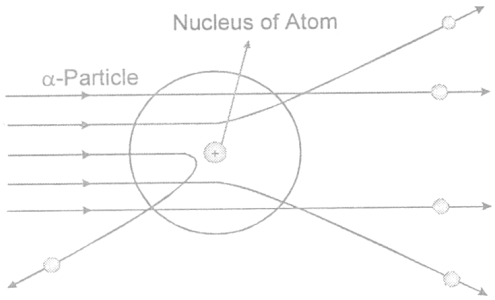
(i) Since a large number of α-particles pass through the atom **undeflected,** hence, there must be **large empty space within the atom.**

(ii) As some of the α- particles got **defleted,** therefore, there must be something **massive and positively charged present in the atom.**

(iii) The number of α-**particles** which got deflected is very small, therefore, **the whole positive charge in the atom is conventratted in a very small space.**

(iv) Some of the α-particles **retracted** their path i.e. **came almost straight back towards the sources as a result of their direct collisions with the heavy mass.**

α- particles are made up of two protons and two neutrons and are He nuclei.



The positively charged heavy mass which occupies only a small space as compared to the total space occupied by the atom is called nucleus.

(b) Rutherford's Nuclear Model of Atom :

Rutherford proposed a new picture of the structure of the atom. **Main feature of this model are as follows**

-

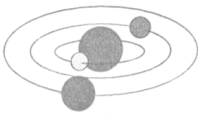
(i) The atom of an element consists of a small **positively charged "Nucleus"** which is situated at the **centre of the atom** and which carries almost the entire mss of the atom.

(ii) The **electrons** are distributed in the empty space of the atom **around the nucleus** in different **concentric circular paths (orbits).**

(iii) The number of electrons in the orbits is equal to the total number of protons in the nucleus.

(iv) Volume of nucleus is very small as compared to the volume of atom.

(v) Most of the space in the atom is **empty.**



The stability of such a system in which negatively charged electrons surround a positively charged nucleus was explained by proposing that **the electrons revolve around the nucleus at very high speed in circular orbits.** This arrangement is just like our **solar system.** The **high sped** of the moving electrons given them a **centrifugal force acting away from the nucleus.** The centrifugal force balance the electrostatic force of attraction acting between the nucleus and the electrons.

(c) Defects in Rutherford's Model :

(i) Rutherford did not specify the number of electrons in each orbit.

(ii) According to **electromagnetic theory,** if a **charged particle (electron)** is accelerated around another **charged particle (nucleus)** then there would be **continuous radiation of energy.** This **loss of energy** would slow down the **speed of electron** and eventually the **electron would fall into the nucleus.** But such a collapse does not occur. Rutherford's model could not explain this theory.

EXERCISE

OBJECTIVE DPP - 11.1

1. Where are protons located in an atom ?

(A) Around the nucleus (B) Inside the nucleus

(C) Both (A) & (B) (D) None of these

2. Which of the following statements is true ?

(A) A proton is 1837 times heavier than an electron.

(B) A proton is 1/1837 times heavier than an electron.

(C) A proton is 1/1837 times lighter than an electron.

(D) Proton has the same mass as an electron.

3. When alpha particles are sent through a thin metal foil, most of them go straight through the foil because -

(A) alpha particles are much heavier than electrons.

(B) alpha particles are positively charged.

(C) most part of the atom is empty.

(D) alpha particles move with high velocity.

4. Rutherford's scattering experiment is related to the size of -

(A) nucleus (B) atom (C) electron (D) neutron

5. The mass of a proton is -

(A) 1.00728 amu (B) 1.673×10^{-24} gm (C) 1.673×10^{-27} kg (D) all of these

6. Rutherford performed his alpha scattering experiment using -

(A) silver (B) gold (C) mercury (D) diamond

7. A proton is usually represented as -

(A) ${}_{1}^{1}p$ (B) ${}_{1}^{1}H$ (C) ${}_{2}^{4}He$ (D) both (A) & (B)

8. The protons and neutrons are collectively called -

(A) deuterons (B) positrons (C) mesons (D) nucleons

9. contains ${}_{11}^{23}Na$ -

(A) 22 protons (B) 22 neutrons (C) 12 neutrons (D) None of these

10. The credit of discovering neutron goes to -

(A) Rutherford (B) Thomson (C) Goldstein (D) Chadwick

SUBJECTIVE DPP - 11.2

1. Why were protons discovered ?

2. What is the difference between the charge & mass of a proton and an electron ?

3. Why was Thomson's atomic model discarded ?

4. Show the different observations of Rutherford's alpha scattering experiment by a diagram only.

STRUCUTRE OF ATOM

BOHR'S MODEL OF AN ATOM

Rutherford's model of the atom was unable to explain certain observations with regard to the atom i.e. stability of the atom and the occurrence of the atomic spectra. **Neils Bohr** accepted Rutherford's idea that the **positive charge** and most of the **mass** of the atom is concentrated in its **nucleus** with the **electrons** present at some distance away.

According to Bohr's theory -

(i) Electrons revolve around the nucleus in well defined **orbits or shells,** each shell having a **definite amount of energy** associated with the electrons in it. Therefore, these shells are also called **energy levels.**

(ii) The **energy** associated with the electrons in an orbit **increases** as the **radius of the orbit** increases. These shells are known as **K, L, M, N** etc. starting from the one closest to the nucleus.

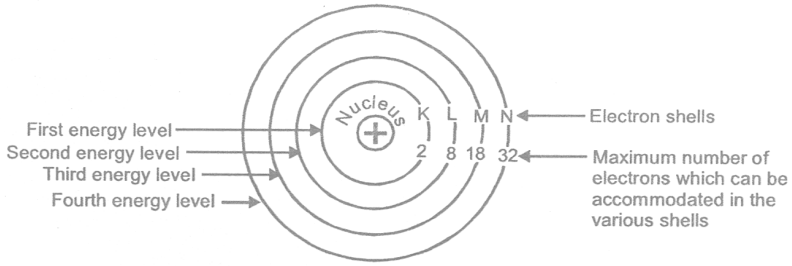
(iii) An electron in a shell can more to a higher or lower energy shell by absorbing or releasing a fixed amount of energy.

(iv) The amount of **energy absorbed** or **emitted** is given by the **difference of energies** associated with the two energy levels.

Energy absorbed, $\Delta E = E_2 - E_1 = h\nu$

Energy emitted, $\Delta E = E_2 - E_1 = h\nu$

Where h is Plank's constant (h = 6.62 × 10^{-34} Js) and ν is the frequency of the radiation.



ATOMIC STRUCTURE

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** (neutrons present have no charge). The **protons & neutrons** are collectively called **nucleons.** The **radius** of the nucleus of an atom is of the order of 10^{-15} m.

(b) Extra nuclear region :

In extra nuclear part or in the region outside the nucleus, **electrons** are present which revolve around the nucleus in orbits of fixed energies. These orbits are called **energy levels.** These energy levels are designated as **K, L, M, N and so on.**

The maximum number of electrons that can be accommodated in a shell is given by the formula $\underline{2n^2}$ (where n = number of shell i.e. 1, 2, 3--)

Shell	n	$2n^2$	max. no. of e^-
K	1	$2(1)^2$	2
L	2	$2(2)^2$	8
M	3	$2(3)^2$	18
N	4	$2(4)^2$	32

Each energy level is further divided into subshells designated as ***s.p.d.f.***

1st shell (K) contains 1 subshell (s)
2nd shell (L) contains 2 subshells (s,p)
3rd shell (M) contains 3 subshells (s,p,d)
4th shell (N) contains 4 subshells (s,p,d,f).

ORBITALS

Like shells are divided into subshells, subshells further contain orbitals.
An orbital may be defined as a

"Region in the three - dimensional space around the nucleus where the probability of finding an electron is maximum. The maximum capacity of each orbital is that of two electrons."

Subshell	Orbital (s)	Max. no. of electrons
s	1	2
p	3	6
d	5	10
f	7	14

The total number of nucleons is equal to the mass number (A) of the atom.

EXERCISE

OBJECTIVE DPP - 12.1

1. The formula that gives the maximum number of electrons in a particular shell is -

(A) n^2 (B) $2n^2$ (C) $2n$ (D) $\frac{n^2}{2}$

2. The radius of an atomic nucleus is of the order of -

(A) 10^{-10} cm (B) 10^{-13} cm (C) 10^{-15} cm (D) 10^{-8} cm

3. A p-orbital can accommodate upto -

(A) 4 electrons (B) 2 electrons (C) 6 electrons (D) 3 electrons

4. Energy levels are designated as -

(A) K, L, M, N and so on

(B) k, ℓ, m, n and so on

(C) I, II, III, IV and so on

(D) All of these

5. A neutron is represented as -

(A) ${}^{0}_{0}n$ (B) ${}^{1}_{1}n$ (C) ${}^{1}_{0}n$ (D) ${}^{1}_{-1}n$

6. The different subshells in an atom are represented as -

(A) s,p,d,f (B) S,P,D,F (C) 1,2,3,4 (D) All of these

7. The maximum number of electrons is N shell is -

(A) 2 (B) 8 (C) 18 (D) 32

8. The maximum number of electrons is f - subshell is -

(A) 5 (B) 6 (C) 14 (D) 10

9. The maximum number of electrons that can be accommodated in the valence shell of an atom is -

(A) 5 (B) 6 (C) 7 (D) 8

10. The maximum number of orbitals in f - subshell are -

(A) 1 (B) 3 (C) 5 (D) 7

SUBJECTIVE DPP - 12.2

1. How did Bohr's atomic model explain the stability of an atom ?

2. Form what observations do you derive the following inferences ?

(a) The most of the space inside the atom is empty.

(b) The volume of the nucleus is very small**.**

3. An atom has 2K and 8L electrons. Write down its electronic configuration and indicate in it -

(a) the number of subshells.

(b) the number of orbitals.

STRUCTURE OF ATOM

ELECTRONIC CONFIGUATION OF AN ATOM

(i) Each of the orbits can accommodate a **fixed number of electrons. Maximum number of electrons** in an orbit is equal to **$2n^2$**, where 'n' is the number of the orbit.

If **n = 1 then $2n^2 = 2$**

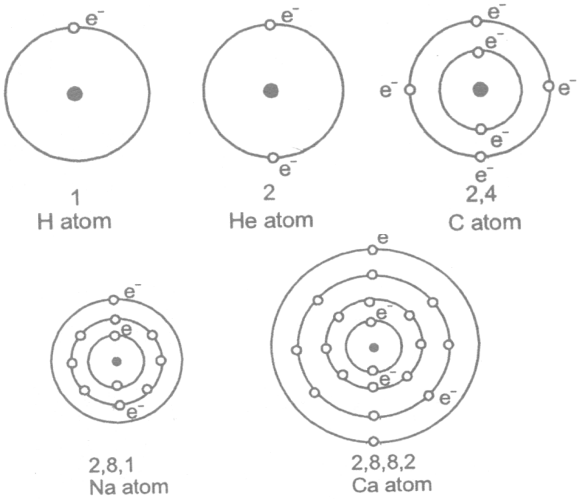
n = 2 then $2n^2 = 8$

n = 3 then $2n^2 = 18$

n = 4 then $2n^2 = 32$

(ii) In the outermost shell of any atom, the maximum possible number of electrons is 8, except in the first shell which can have at the most 2 electrons.

(iii) The arrangement of the electrons is different shells is known as the **electronic configuration** of the element. The pictorial representations of Bohr's model o hydrogen, helium, carbon, sodium and calcium atoms having 1, 2, 6, 11 and 20 electrons respectively are shown in the figure where the centre of the circle represents the nucleus.



If the outermost shell has 8 electrons it is said to be an octet. If the first shell has its full quota of 2 electrons, it is said to be duplet.

ELECTRONIC CONFIGURATION OF ELEMENTS UPTO ATOMIC NUMBER 30-

Atomic number	Symbols of the element	Name of the element	Electronic configuration
1	H	Hydrogen	1
2	He	Helium	2
3	Lo	Lithium	2,1
4	Be	Beryllium	2,2
5	B	Boron	2,3
6	C	Carbon	2,4
7	N	Nitrogen	2,5
8	O	Oxygen	2,6
9	F	Fluorine	2,7
10	Ne	Neon	2,8
11	Na	Sodium	2,8,1
12	Mg	Magnesium	2,8,2
13	Al	Aluminium	2, 8,3
14	Si	Silicon	2 ,8, 4
15	P	Phosphorus	2, 8,5
16	S	Sulphur	2,8,6
17	Cl	Chlorine	2,8,7
18	Ar	Argon	2,8,8
19	K	Potassium	2,8,8,1
20	Ca	Calcium	2,8,8,2
21	Sc	Scandium	2,8,9,2
22	Ti	Titanium	2,8,10,2
23	V	Vanadium	2, 8,11,2
24	Cr	Chromium	2,8,12,2
25	Mn	Manganese	2,8,13,2
26	Fe	Iron	2,8,14,2
27	Co	Cobalt	2,8,15,2
28	Ni	Nickel	2,8,16,2
29	Cu	Copper	2,8,17,2
30	Zn	Zinc	2,8,18,2

VALENCY

Valency of an element is the combining capacity of the atoms of the element with atoms of the same or different elements. The combining capacity of the atoms of other elements was explained in terms of their tendency to attain a fully - filled outermost shell (stable octet or duplet).

The number of electrons gained, lost or contributed for sharing by an atom of the element gives us directly the combining capacity or valency of the element.

Valency of an element is determined by the number of valence electrons in an atom 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)

eg. Na has 1 valence electron, thus, its valency is 1.
Cl has 7 valence electrons, thus, its valency is 8 - 7 = 1.

ATOMIC NUMBER (Z)

The number of protons is the nucleus of an atom of a given element is called the atomic number of that element.

or

Atomic number is the number of protons present in the atom of an element. It is **denoted. by "Z"**

Atomic number = Number of protons = Number of electrons

(in a neutral atom)

Atomic number = Number of protons

(in an ion)

e.g. $_{11}$**Na**

-Atomic number of sodium is 11

-Nucleus of sodium has 11 protons.

- Nucleus of sodium has 11 units of positive charge.

- There are 11 electrons, revolving round the nucleus of sodium.

The atomic number is represented on the LHS of the symbol of the element as subscript.

MASS NUBER (A)

Mass number is the 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.

Mass number = Number of protons + Number of neutrons.

e.g. $^{27}_{13}Al$

-Mass number of aluminum is 27.

-The total number of protons and neutrons is the nucleus of aluminum is 27.

-Number of protons is 13.

-Number of neutrons is = 27 - 13 = 14.

Each element has a unique atomic number which is its identity.

(a) Relation between Z, A and N

A = Z + N

Z = Number of Protons

N = Number of neutrons

A = Mass number

$\therefore$ N = A - Z

ISOTOPES

(a) Atoms of same element having the same chemical properties, but differing in mass are known as isotopes.

The isotopes of an element have the same atomic number but different atomic masses. Isotopes have the same electrical charges means same number of protons. The difference in their masses is due to the presence of different number of neutrons.

e.g. (a) Isotopes of hydrogen

Hydrogen Characteristics \ isotopes	Protium $^{1}_{1}H$	Deuterium $^{2}_{1}H$	Tritium $^{3}_{1}H$
1. Atomic number	**1**	**1**	**1**
2. No. of protons	**1**	**1**	**1**
3. No. of electrons	**1**	**1**	**1**
4. No. of neutrons	**0**	**1**	**2**
5. Mass number	**1**	**2**	**3**

(b) Isotopes of oxygen

Characteristics \ Oxygen isotopes	$^{16}_{8}O$	$^{17}_{8}O$	$^{18}_{8}O$
1. Atomic number	**8**	**8**	**8**
2. No. of protons	**8**	**8**	**8**
3. No. of electrons	**8**	**8**	**8**
4. No. of neutrons	**8**	**9**	**10**
5. Mass number	**16**	**17**	**18**

All the isotopes of an element have identical chemical properties.

(b) Characteristics of Isotopes :

(i) The **physical properties** of the isotopes of an element are **different number of neutrons** in their nuclei. Hence **mass, density and other physical properties of the isotopes of an element are different.**

(ii) All the **isotopes** of an element contains the **same number of electrons.** So, they have the same electronic configuration with the same number of valence electrons. Since the chemical properties of an element are determined by the number of valence electrons in its atom, all the isotopes of an element have **identical chemical properties.**

(c) Reason for the fractional atomic masses of elements :

The **atomic masses** of many elements are in **fraction** and not whole number. The fractional atomic masses of elements are due to the existence of their isotopes having different masses.

e.g. :

The **atomic mass of chlorine** is **35.5 u.** Chlorine has two isotopes $^{35}_{17}Cl$ and $^{37}_{17}Cl$ with abundance of 75% and 25% respectively. Thus the average mass of a chlorine atom will be 75% of Cl - 35 and 25% of Cl-37, which is 35.5 u.

i.e., average atomic mass of chlorine $= 35\times\frac{75}{100}+37\times\frac{25}{100}$

$= \frac{2625}{100}+\frac{925}{100}$

$= 26.25 + 9.25$

$=$ **35.5 u.**

Thus, the average atomic mass of chlorine is 35.5 u.

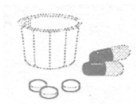
Similarly, average atomic mass of copper is 63.5 u.

(d) Applications of Radioactive isotopes :

(i) In agriculture : Certain elements such as **boron, cobalt, copper, manganese, zinc and molybdenum** are necessary is very minute quantities for **plant nutrition.**

By radioactive isotopes we van identify the presence and requirements of these element in the nutrition of plants.

(ii) In industry : Coating on the arm of clock to seen in dark. To identify the **cracks in metal casting.**



(iii) In medicine : Thyroid, bone diseases, brain tumours and **cancer** and diagnosed, controlled or destroyed with the help of radioactive isotopes like $^{60}_{27}Co$, $^{24}_{21}$**Na, iodine, phosphorus** etc.

(iv) Determination of the mechanism of chemical reaction : by replacing an atom or molecule by its isotope.

(v) In carbon dating : Will and Libby (1960) developed the technique of **radiocarbon dating** to **determine the age of plants, fossils and archeological samples.**

Isotopes (Like Uranium - 238) are used in nuclear reactor to produce energy and power.

ISOBARS

the atoms of different elements with different atomic numbers, but same mass number are called isobars.

e.g. $^{14}_{6}C$ and $^{14}_{7}N$ are isobars $^{40}_{20}Ca$ and $^{40}_{18}Ar$ are isobars

Characteristics \ Isobars	$^{40}_{18}Ar$	$^{40}_{20}Ca$
1. Atomic number	18	20
2. Mass number	40	40
3. No. of electrons	18	20
4. No. of protons	18	20
5. No. of neutrons	22	20
6. Electronic configuration	2.8.8	2,8,8,2

ISOTONES

The isotones may be defined as the atoms of different elements containing same number of neutrons.

e.g. $^{13}_{6}C$ and $^{14}_{7}N$

Number of neutrons (N) = A - Z

For $^{13}_{6}C$ N = 13 - 6 For $^{14}_{7}N$ N = 14 - 7

Other example $^{30}_{14}Si$, $^{31}_{15}P$ and $^{32}_{16}S$

ISOELECTRIC

Ion or atom or molecule which have the same number of electrons are called as isoelectronic species.

e.g.	**Cl^-**	**Ar**	**K^+**	**Ca^{+2}**
No. of electrons	**18**	**18**	**18**	**18**

Isobars contain different number of electrons, protons and neutrons.

SOLVED EXAMPLES

1. Calculate the number of electrons, protons and neutrons in the following species.
(i) Phosphorus atom (ii) Phosphide ion (P^{3-}) (iii) Magnesium ion (Mg^{2+})
Mass number : P = 31, Mg = 24
Atomic numbers : P = 15, Mg = 12

Sol. (i) **Phosphorus atom**
Number of electrons = Atomic number = 15
Number of protons = Atomic number = 15
Number of neutrons = Mass number - Atomic number = 31 - 15 = 13.
(ii) Phosphide ion (P^{3-}).
Phosphide ion (P^{3-}) = Phosphorus atom + 3 electrons
$P^{3-} \equiv P + 3e^-$
Thus, phosphide ion has same number of protons and neutrons as phosphorus atom but has three electrons more.
Number of electrons = 15 + 3 = 18
Number of protons = 15
Number of neutrons = 31 - 15 = 16
(iii) Magnesium ion (Mg^{2+})
Mg^{2+} ion is formed by the loss of two electrons by Mg atom. Therefore, it has two electrons less than the number of electrons is Mg atom.
Number of electrons = 12 - 2 = 10
Number of protons = 12
Number of neutrons = (24 - 12_ = 12

2. The number of protons in the nucleus of an atom of mass number 97 is 41. What will be the number of neutrons in its isotope of mass number 99 ?

Sol. The atomic number of isotopes is same. Therefore, the number of protons in both the atoms is same.
Mass number = Number of protons + Number of neutrons
$\therefore$ Number of neutrons = Mass number - Number of protons
= 99 - 41 = 58

3. Give number of protons and neutrons in $^{238}_{92}U$.

Sol. From the given symbol it is clear that the atomic number of uranium is 92 and its mass number is 238.
Now, number of protons = Atomic number = 92
Number of neutrons = Mass number - Atomic number
= 238 - 92 = 146

4. Calculate the atomic number of an element whose mass number is 31 and number of neutrons is 13. What is the symbol of the element ?

Sol. We know that, mass number = Number of protons + Number of neutrons
But number of protons is equal to the atomic number.
$\therefore$ **Mass number = Atomic number + number of neutron**
or Atomic number = Mass number - number of neutron = 31 - 16 = 15
The element with atomic number 15 is **phosphorus** which has symbol **P.**

5. If bromine atom is available in the form o f, say two isotopes $^{79}_{35}Br$ (49.7%) and $^{81}_{35}Br$ (50.3%), calculate the average atomic mass of bromine atom.

Sol. % of Br (79) = 49.7 ; % of Br (81) = 50.3

Atomic mass of Br = $\frac{79\times 49.7 + 81\times 50.3}{100}$

= 80.0

Thus, **atomic mass of bromine is 80.0**

6. An isotope has atomic number 17 and mass number 37. What is the arrangement of electrons in the shells of this isotope ? State nuclear composition of this isotope.

Sol. Number of electrons = Atomic number = 17

Number of protons = Atomic number = 17

Number of neutrons = Mass number - Atomic number = 37 - 17 = 20

Electronic configuration of the isotope is

K	L	M
2	8	7

Nucleus of the isotope contains **17 protons** and **20 neutrons.**

7. An element has 2 electrons is the M-shell. What is the electronic configuration of the element and what is its atomic number ?

Sol. The 2 electrons in M-shell indicates that the K and L - shell must be full. K - shell can accommodate a maximum of 2 electrons while L-shell can accommodate a maximum of 8 electrons. Thus, the electronic configuration of the element may be written as :

K	L	M
2	8	2

The total number of electrons is an atom of the element is 2 + 8 + 2 = 12

Therefore, **atomic number of element** is 12.

8. How will you find the valency of chlorine, sulphur and magnesium ?

Sol. (i) The atomic number of Cl is 17. Its electronic configuration is

K	L	M
2	8	7

Cl has 7 electrons in the valence shell. It needs one more electron to complete its octet. Hence, its **valency is 1.**

(ii) The atomic number of S is 16. Its electronic configuration is

K	L	M
2	8	6

S has 6 electrons is the valence shell. It requires two more electrons to complete its octet. Hence, its **valency is 2.**

(iii) The atomic number of Mg is 12. Its electronic configuration is

K	L	M
2	8	2

Mg has only 2 electrons in the valence shell. By losing these 2 electrons it can attain octet of electrons in its outer most shell. Hence, it **valency is 2.**

EXERCISE

OBJECTIVE DPP - 13.1

1. The number of valence electrons in Na is -

(A) 1 (B) 2 (C) 3 (D) 4

2. The valency of $_{10}Ne$ = 2, 8 is -

(A) 10 (B) 8 (C) 2 (D) 0

3. Which of the following has the same number of protons, electrons & neutrons ?

(A) $^{54}_{27}X$ (B) $^{55}_{27}X^{+1}$ (C) $^{54}_{26}X$ (D) $^{55}_{28}X^{+}$

4. In an atom there are four orbits, the maximum number of electrons in this atom will be -

(A) 30 (B) 36 (C) 32 (D) 62

5. Isotones of an element have -

(A) same number of electrons (B) same number of protons

(C) same number of neutrons (D) same number of neutrons & protons

6. An isotone of $^{76}_{32}Ge$ is -

(A) $^{77}_{32}Ge$ (B) $^{77}_{33}As$ (C) $^{77}_{34}Se$ (D) $^{79}_{34}Se$

7. Many element have non - integral masses because -

(A) they have isobars.

(B) their isotopes have non - integral masses.

(C) they have isotopes.

(D) the constituents neutrons, protons & electrons combine to give fractional masses.

8. A deuteron contains -

(A) a neutron & a positron. (B) a neutron & a proton.

(C) a neutron & 2 protons (D) 2 neutrons & a proton.

9. The triad of nuclei that is isotonic is -

(A) $^{14}_{6}C, ^{15}_{7}N, ^{17}_{19}F$ (B) $^{12}_{6}C, ^{14}_{7}N, ^{19}_{9}F$ (C) $^{14}_{6}C, ^{14}_{7}N, ^{17}_{9}F$ (D) $^{14}_{6}C, ^{14}_{7}N, ^{19}_{9}F$

10. Pick out the isoelectronic structures from the following -

(I) CH_3^+ (II) H_3O^+ (III) NH_3 (IV) CH_3^-

(A) I and II (B) III and IV (C) I and III (D) II, III, IV

11. Two atoms of the same element are found to have different number of neutrons in their nuclei. These two atoms are -

(A) isomers (B) isotopes (C) isobars (D) allotropes

12. Members of which of the following have similar chemical properties ?

(A) Isotopes (B) Isobars

(C) Allotropes (D) Both isotopes & allotropes

13. An atom which as a mass number of 14 & 8 neutrons is an -

(A) isotope of oxygen (B) isobar of oxygen

(C) isotope of carbon (D) isobar of carbon

14. The electronic configuration of Mn^{+2} is -

(A) 2, 8, 13 (B) 2, 8, 11, 2

(C) 2, 8, 13, 2 (D) None of these

15. The number of electrons in the L - shell of phosphorus is not equal to that in the -

(A) L - shell of neon (B) M - shell of potassium

(C) M - shell of chromium (D) M - shell of argon

SUBEJCTEIVE DPP - 13.2

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1. Why is the valency of inert gases zero ?

2. Find out the number of electrons, protons and neutrons in the following -

(a) oxygen atom (b) oxide ion (O^{-2}) (c) oxygen molecule

3. Which isotope of hydrogen is present in heavy water ?

4. Ar (40) & Ca (40) have the same mass number but their properties are entirely difference. Why ?

5. Mention three applications of radioactive isotopes.

ANSWER KEY

(OBJECTIVE DPP - 11.1)

Qus.	1	2	3	4	5	6	7	8	9	10
Ans.	B	A	C	A	D	B	D	D	C	D

2. Charge of a proton = 1.602×10^{-19} C

Charge of an electron = 1.602×10^{-19} C

Mass of a proton = 1.6725×10^{-24} g

Mass of a electron = 9.109×10^{-28} g

(OBJECTIVE DPP - 12.1)

Qus.	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	B	A	C	A	D	C	D	D

3. The electronic configuration of the given atom is 2, 8.s
(a) 3 (b) 5

(OBJECTIVE DPP - 13.1)

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

2. (a) 8,8,8 (b) 10,8,8 (c) 16,16,16 **3.** D_2O