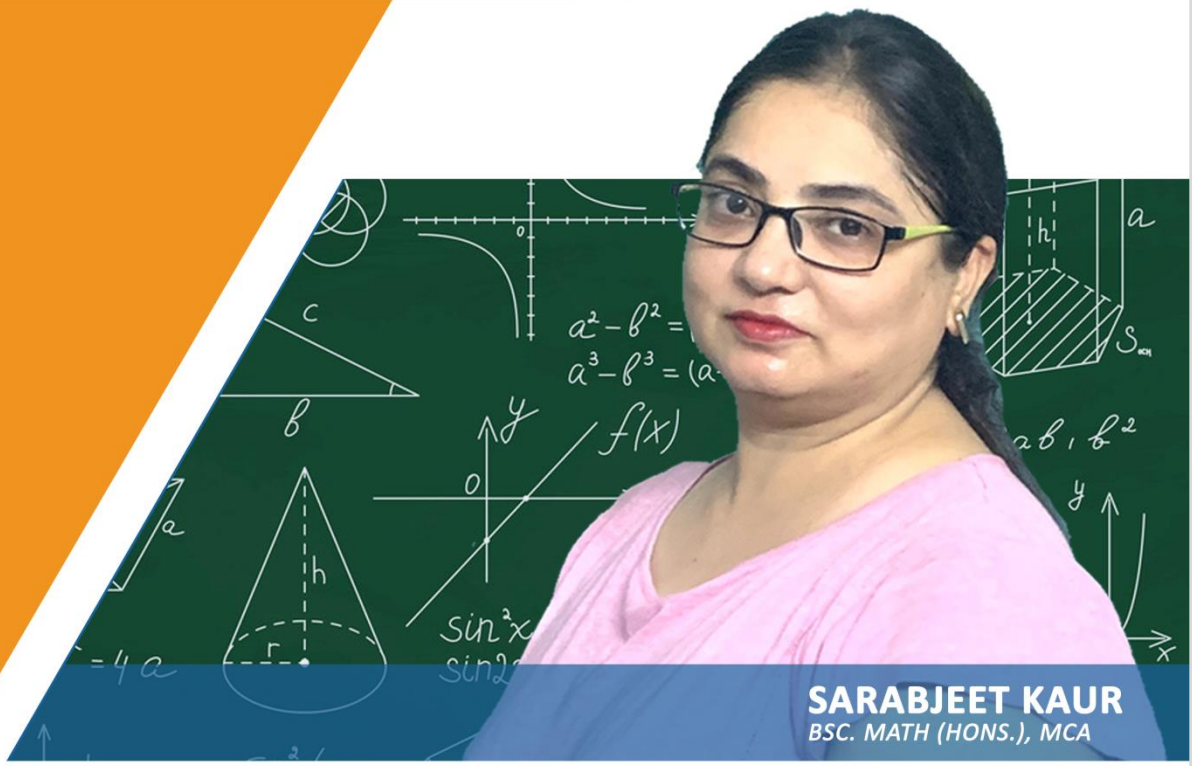
CAREER+ ACADEMY



SARABJEET KAUR
BSC. MATH (HONS.), MCA

GRADE 9TH Science

CHAPTER 4

www.careerplusacademy.com careerplusacademy@gmail.com

/careerplusacademy /in/sarabkaur /careerplusacademy +91-987-111-5373

CHAPTER – 4

STRUCTURE OF THE ATOM

STRUCTURE OF THE ATOM

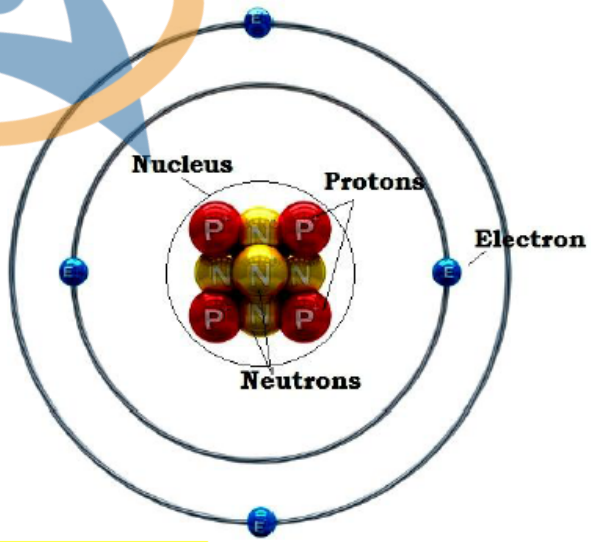
Atoms are the basic units of matter and the defining structure of elements. Matters are made of tiny particles called atom. Atom is made of three particles; electron, proton and neutron. These particles are called fundamental particles of an atom or sub atomic particles.

Electron (e^-) - Electron is denoted by 'e' and is a negatively charged particle. The absolute charge over an electron is equal to $1.6x10^{-19}$ of negative charge and is considered equal to – 1. The relative mass of electron is 1/1836. Since the mass of an electron is very small, thus it is considered equal to 0. Electrons revolve round the nucleus of atoms.

Proton (p^+) - Proton is denoted by 'p' and is positively charged particle. The absolute charge over proton is $1.6x10^{-19}$ coulomb of positive charge and it is considered as unit positive charge. Thus absolute charge over a proton is equal to +1.
The absolute mass of a proton is equal to $1.6x10^{-24}$ g and considered equal to 1 as it is equal to the mass of 1 hydrogen atom. Proton is present in the nucleus of atom.

Neutron (n) – Neutron is denoted by 'n' and is a neutral particle.

The absolute mass of neutron is 1.6×10^{-24} g. The relative mass of neutron is equal to 1. Neutron is presents in the nucleus of atom.
Nucleus – The centre of atom is called nucleus. Nucleus comprises of neutron and proton. Nucleus of an atom contains the whole mass of an atom.



INTEXT QUESTIONS PAGE NO. 47

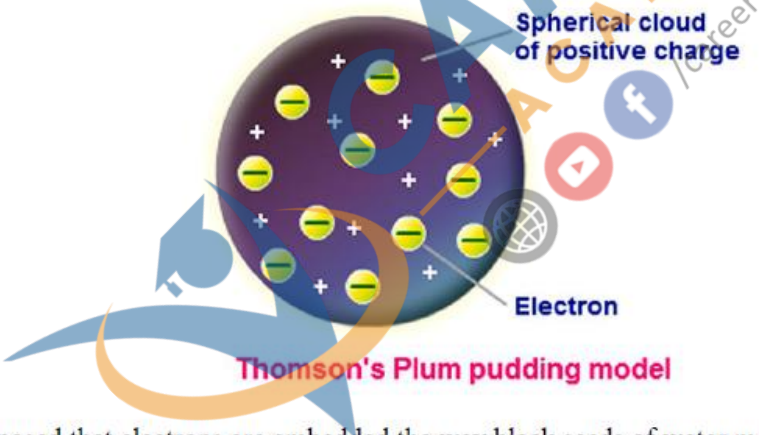
Q1. What are canal rays?
Answer:
Canal rays are positively charged radiations that can pass through perforated cathode plate. These rays consist of positively charged particles known as protons.

Q2. If an atom contains one electron and one proton, will it carry any charge or not?
Answer:
An electron is a negatively charged particle, whereas a proton is a positively charged particle. The magnitude of their charges is equal. Therefore, an atom containing one electron and one proton will not carry any charge. Thus, it will be a neutral atom.

Discovery of Electron
In 1897; J. J. Thomson, a British physicist, proposed that atom contains at least one negatively charged particle. Later this particle was named as electron. Thomson called those particles 'corpuscles'.
Discovery of Proton:
Ernest Goldstein in 1886 discovered the presence of new radiation in gas discharge tube even before the identification of electron. He called these rays as Canal Rays. His experiment led to the discovery of proton.
Discovery of Neutron:
In 1932 J. Chadwick discovered another subatomic particle called neutron. Neutron is present in the nucleus of all atoms.

THOMSON'S MODEL OF ATOM

J. J. Thomson proposed the model of atom similar to a Christmas Pudding or similar to a water melon. His model of atom is generally called plum and pudding model of atom.

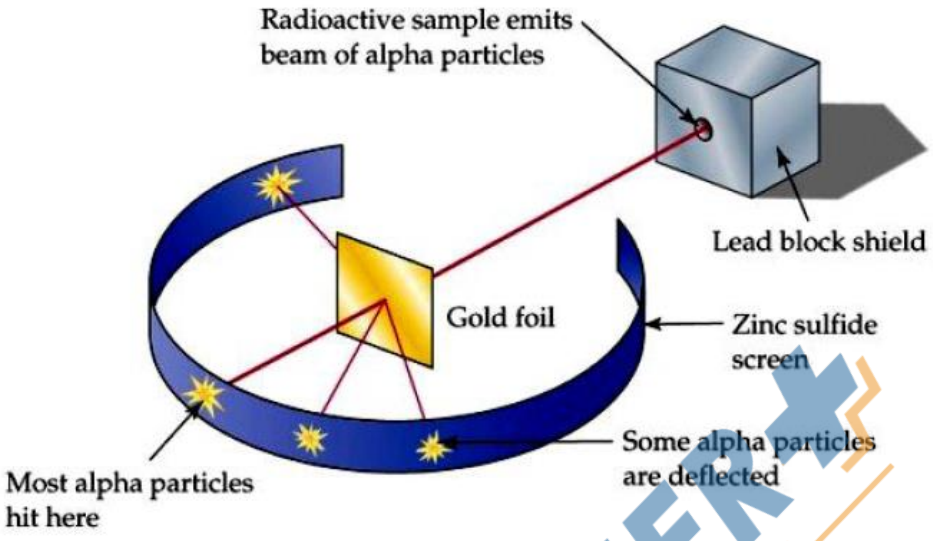


He proposed that electrons are embedded the way black seeds of water melon are embedded; in the sphere of positive charge. According to Thomson
(a) An atom consists of positively charged sphere in which electrons are embedded.
(b) The quanta of negative and positive charges are equal. The equal number of negative charge and positive charge makes an atom electrically neutral.

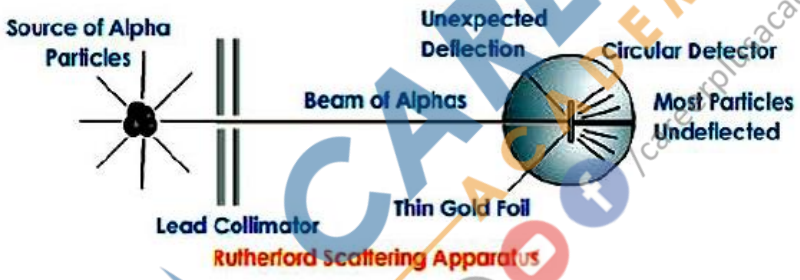
RUTHERFORD'S MODEL OF ATOM

Ernest Rutherford in 1909 with his team bombarded very thin gold foil with α – particles. He found that
(a) Most of the α – particles passed without any hindrance.
(b) Some of the α – particles deflected from their original path at noticeable angle.
(c) Very few of the α – particles bounced back at their original path.
On the basis of his observation, he proposed the model of atom. The Rutherford's Model of Atom is as follows:
(a) Most of the part in an atom is empty.
(b) There is a positively charged center in atom, which contains nearly the whole mass of atom. The centre is called nucleus.
(c) The size of nucleus is very small compared to an atom.

(d) Electrons revolve round the nucleus.



The Rutherford's Experiment is also known as Geiger-Marsden Experiment.



DRAWBACKS OF RUTHERFORD MODEL

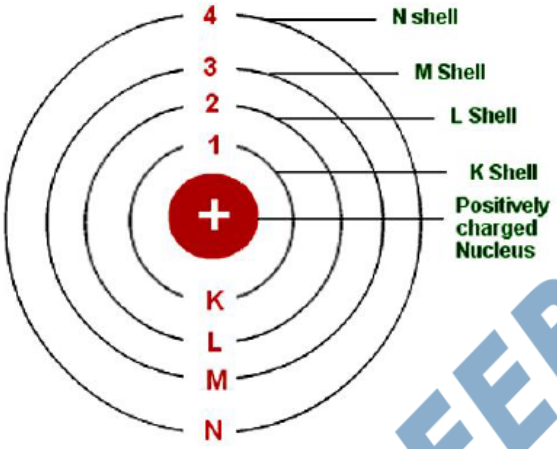
(a) According to Rutherford's Model, electron revolves round the positively charged nucleus which is not expected to be stable. But a charged particle in an accelerated motion along a circular path would lose energy because of radiation and finally would fall into nucleus. This makes an atom unstable while atoms are quite stable.
If atoms were not stable no matter would exist in nature.
(b) Rutherford model could not solve the problem of atomic mass of atom as it proposed only the existence of protons in the nucleus.
However, the problem of atomic mass could be solved after the discovery of neutron.

BOHR'S MODEL OF ATOM

Neils Bohr, a Danish physicist, in 1913 proposed model of atom which rectified the problems left by Rutherford's Model. He proposed that
(a) Electrons revolve round the nucleus in a fixed orbit.
(b) He called these orbits as 'stationary orbit'.
(c) Each stationary orbit is associated with fixed amount of energy, thus electrons do not radiate energy as long as they keep on revolving around the nucleus in fixed orbit.
The circular path around the nucleus is called orbit, energy level or shell. Energy level are represented by letter – K, L, M, N, …. and so on.
Therefore,

- 1st orbit is denoted by – K
- 2nd orbit is denoted by – L
- 3rd orbit is denoted by – M, and so on.

The orbits are denoted by 1, 2, 3, …. and so on.

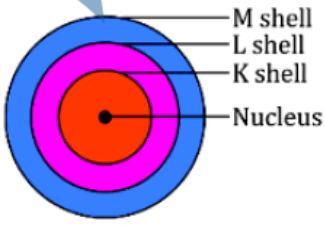


INTEXT QUESTIONS PAGE NO. 49

Q1. On the basis of Thomson's model of an atom, explain how the atom is neutral as a whole.
Answer:
As per Thomson's model of the atom, an atom consists both negative and positive charges which are equal in number and magnitude. So, they balance each other as a result of which atom as a whole is electrically neutral.

Q2. On the basis of Rutherford's model of an atom, which subatomic particle is present in the nucleus of an atom?
Answer:
On the basis of Rutherford's model of an atom, protons are present in the nucleus of an atom.

Q3. Draw a sketch of Bohr's model of an atom with three shells.
Answer:



Q4. What do you think would be the observation if the α-particle scattering experiment is carried out using a foil of a metal other than gold?
Answer:
If α-particle scattering experiment is carried out using a foil of any metal as thin as gold foil used by Rutherford, there would be no change in observations. But since other metals are not so malleable so, such a thin foil is difficult to obtain. If we use a thick foil, then more α-

particles would bounce back and no idea about the location of positive mass in the atom would be available with such a certainty.

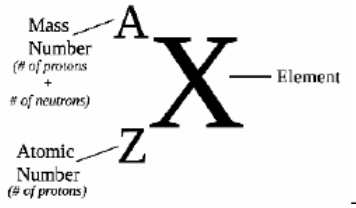
INTEXT QUESTIONS PAGE NO. 49

Q1. Name the three sub-atomic particles of an atom.
Answer:
The three sub-atomic particles of an atom are:
(i) Protons
(ii) Electrons, and
(iii) Neutrons

Q2. Helium atom has an atomic mass of 4 u and two protons in its nucleus. How many neutrons does it have?
Answer:
Number of neutrons = Atomic mass - Number of protons
Therefore, the number of neutrons in the atom = 4 - 2 = 2

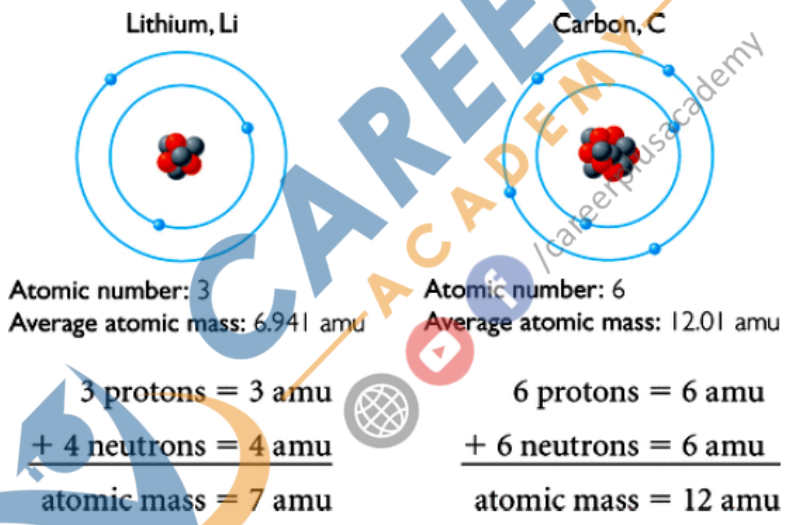
DISTRIBUTION OF ELECTRONS IN ORBIT OR SHELL:
The distribution of electrons in an orbit is obtained by $2n^2$, where 'n' is number of orbit.
Therefore,
Number of electrons in K-shell i.e. in 1st orbit.
Here n = 1
Therefore,
$2n^2 = 2 \times 1^2 = 2$
Thus, maximum number of electrons in K-shell i.e. 1st shell = 2
Number of electrons in L-shell, i.e. in 2nd orbit
Here n = 2, therefore,
$2n^2 = 2 \times 2^2 = 8$
Thus, maximum number of electrons in L-shell = 8
Number of electrons in M-shell, i.e. in 3rd orbit
Here n = 3, therefore,
$2n^2 = 2 \times 3^2 = 18$
Thus, maximum number of electrons in M-shell = 18
Number of electrons in N-shell, i.e. in 4th shell
Here n = 4, therefore,
$2n^2 = 2 \times 4^2 = 32$
Thus, maximum number of electrons in N-shell = 32
In similar way maximum number of electrons in any shell can be calculated.

ATOMIC NUMBER
Atomic number is the fundamental properties of an atom. Every atom is identified by its unique atomic number. Atomic number is denoted by 'z'.
Atomic number is equal to the number of protons present in an atom.
Since an atom is electrically neutral, thus number of protons and number of electrons are equal to make an atom electrically neutral.



Atomic number = Number of protons = Number of electrons
Example :–
The atomic number of Hydrogen is 1, helium is 2, lithium is 3, beryllium is 4, boron is 5, carbon is 6, nitrogen is 7, oxygen is 8, etc.
Sample exercise:
(1) Atomic number of calcium is 20. Calculate the number of electrons and protons in calcium.
Solution:
Since, Atomic number = Number of protons = Number of electrons
Therefore,
Number of electrons in calcium = 20
Number of protons in calcium = 20

(2) Number of protons in sodium atom is 11, find the atomic number and number of electrons in a sodium atom.
Solution,
Since, Atomic number = Number of protons = Number of electrons
Therefore,
Atomic number of sodium = 11
Number of electrons in sodium = 11



MASS NUMBER OR ATOMIC MASS

Mass number of an atom is defined as the sum of the number of protons and number of neutrons. Mass number is nearly equal to the atomic mass of an atom. Since, protons and neutrons reside in the nucleus, thus they are also known as nucleons.
This means
Mass number of an atom = Number of protons + Number of neutrons
Example
(1) Atomic mass of aluminium is 27 u and atomic number is 13, find the number of protons and number of neutrons in aluminium.
Solution:
Since,
Atomic number = 13
Therefore, number of proton = 13
We know that; Atomic mass (Mass number) = Number of protons + Number of neutrons

Therefore,
27 u = 13 + n
Or, n = 27 – 13 = 14
Therefore, number of proton = 13 and number of neutron = 14
(2) The atomic number of carbon is 6 and number of neutron is equal to 6. Find the atomic mass or mass number of carbon.
Solution:
Since atomic number of carbon = 6
Therefore, number of proton = 6
Now, Atomic mass = number of proton + number of neutron
Or, Atomic mass or mass number = 6 + 6 = 12 u
Thus, mass number or atomic mass of carbon = 12u

ARRANGEMENT OF ELECTRONS IN AN ATOM – ELECTRONIC CONFIGURATION

The maximum number of electrons can be obtained by $2n^2$; where 'n'is the orbit number. Thus after knowing the maximum number of electrons for a particular shell, the arrangement of electrons in an atom can be identified. It is called Bohr Bury Schemes.

Rules to write the electronic configuration of an atom

(a) Maximum number of electrons in an orbit is calculated by $2n^2$, where 'n' is number of orbit and may be equal to 1, 2, 3 , ...
(b) Electrons occupy the next orbit only after filling the inner orbit completely.
(c) The maximum number of electrons in outermost orbit will not be more than 8.

Electronic configuration of Hydrogen

Atomic number of hydrogen = 1
Therefore number of electrons = 1
Maximum number of electrons in 1st orbit = 2
Since, hydrogen has only one electron, therefore, it will reside in 1st orbit.
Thus electronic configuration of hydrogen

Number of orbit present in hydrogen = 1

Electronic configuration of Helium

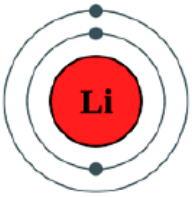
Atomic number of helium = 2
Therefore number of electrons = 2
Therefore, electronic configuration of helium is

Number of orbit in helium atom = 1

Electronic configuration of Lithium

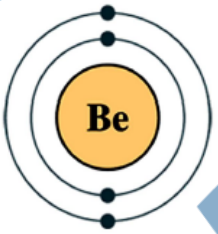
Atomic number of Lithium = 3

Therefore number of electrons = 3
Since the maximum number of electrons in 1st orbit is equal to 2, therefore, after accommodating 2 electrons in 1st orbit, the third electron will go in 2nd orbit.
Thus, electronic configuration of lithium is



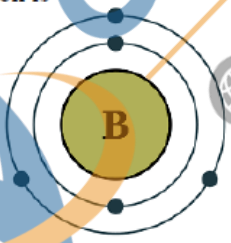
Number of orbit in Lithium atom = 3.

Electronic configuration of Beryllium
Atomic number of beryllium = 4.
Therefore number of electrons = 4.
Thus, electronic configuration of Beryllium is



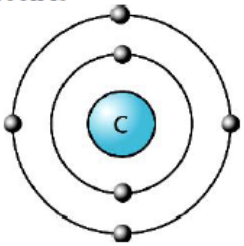
Number of orbit in beryllium = 2

Electronic configuration of Boron
Atomic number of boron = 5
Therefore number of electrons = 5
Thus, electronic configuration of boron is



Number of orbit in boron = 2

Electronic configuration of Carbon
Atomic number of carbon = 6
Therefore number of electrons = 6
Thus, electronic configuration of carbon is

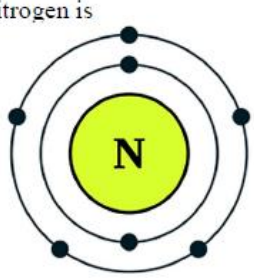


Number of orbit in carbon = 2

ELECTRONIC CONFIGURATION OF ELEMENTS – FROM NITROGEN (N) TO SODIUM (NA)

Electronic configuration of Nitrogen

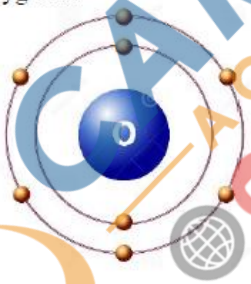
Atomic number of nitrogen = 7.
Therefore number of electrons = 7
Thus, electronic configuration of nitrogen is



Number of orbit in nitrogen = 2

Electronic configuration of Oxygen

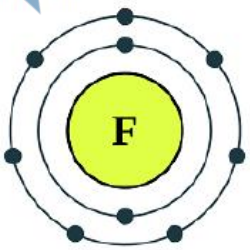
Atomic number of oxygen = 8.
Therefore number of electrons = 8.
Thus, electronic configuration of oxygen is



Number of orbit in oxgyen = 2

Electronic configuration of Fluorine

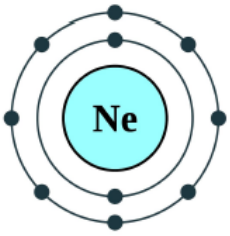
Atomic number of fluorine = 9
Therefore number of electrons = 9
Thus, electronic configuration of fluorine is



Number of orbit in fluorine = 2

Electronic configuration of Neon

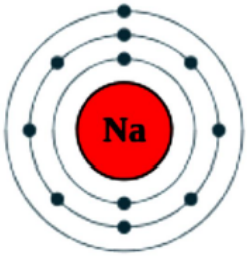
Atomic number of neon = 10
Therefore number of electrons = 10
Thus, electronic configuration of neon is



Number of orbit in Neon = 2

Electronic configuration of Sodium

Atomic number of sodium = 11
Therefore number of electrons = 11
Since, in ^{2nd} orbit the maximum number of electrons is equal to 8 and there are 11 electrons in sodium atom, thus the eleventh electron will go in third orbit.
Thus, electronic configuration of sodium is

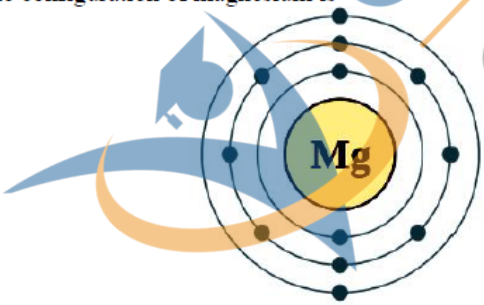


Number of orbit in sodium = 3

ELECTRONIC CONFIGURATION OF ELEMENTS – FROM MAGNESIUM TO CALCIUM

Electronic configuration of Magnesium

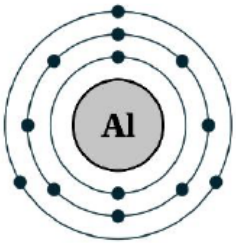
Atomic number of magnesium = 12
Therefore number of electrons = 12
Thus, electronic configuration of magnesium is



Number of orbit in magnesium = 3.

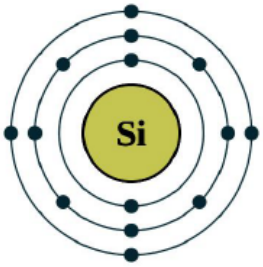
Electronic configuration of Aluminium

Atomic number of aluminium = 13.
Therefore number of electrons = 13.
Thus, electronic configuration of aluminium is



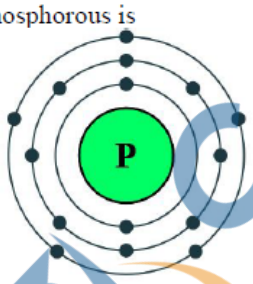
Number of orbit in aluminium = 3

Electronic configuration of Silicon
Atomic number of silicon = 14
Therefore number of electrons = 14
Thus, electronic configuration of silicon is



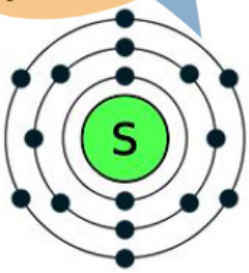
Number of orbit in silicon = 3

Electronic configuration of Phosphorous (P)
Atomic number of phosphorous = 15
Therefore number of electrons = 15
Thus, electronic configuration of phosphorous is



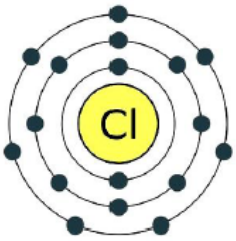
Number of orbit in phosphorous = 3

Electronic configuration of Sulphur (S)
Atomic number of sulphur = 16
Therefore number of electrons = 15
Thus, electronic configuration of sulphur is



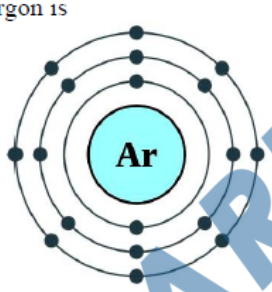
Number of orbit in sulphur = 3

Electronic configuration of Chlorine (Cl)
Atomic number of chlorine = 17
Therefore number of electrons = 17
Thus, electronic configuration of chlorine is



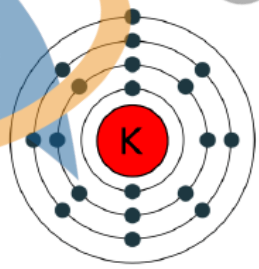
Number of orbit in chlorine = 3

Electronic configuration of Argon (Ar)
Atomic number of argon = 18
Therefore number of electrons = 18
Thus, electronic configuration of argon is



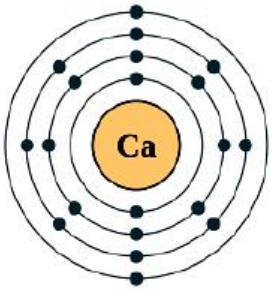
Number of orbit in argon = 3

Electronic configuration of Potassium (K)
Atomic number of potassium = 19
Therefore number of electrons = 19
Since, maximum number of electrons in outermost orbit will not be more than 8, thus the 19^{th} electron of potassium atom will reside in 4^{th} orbit.
Thus, electronic configuration of potassium is

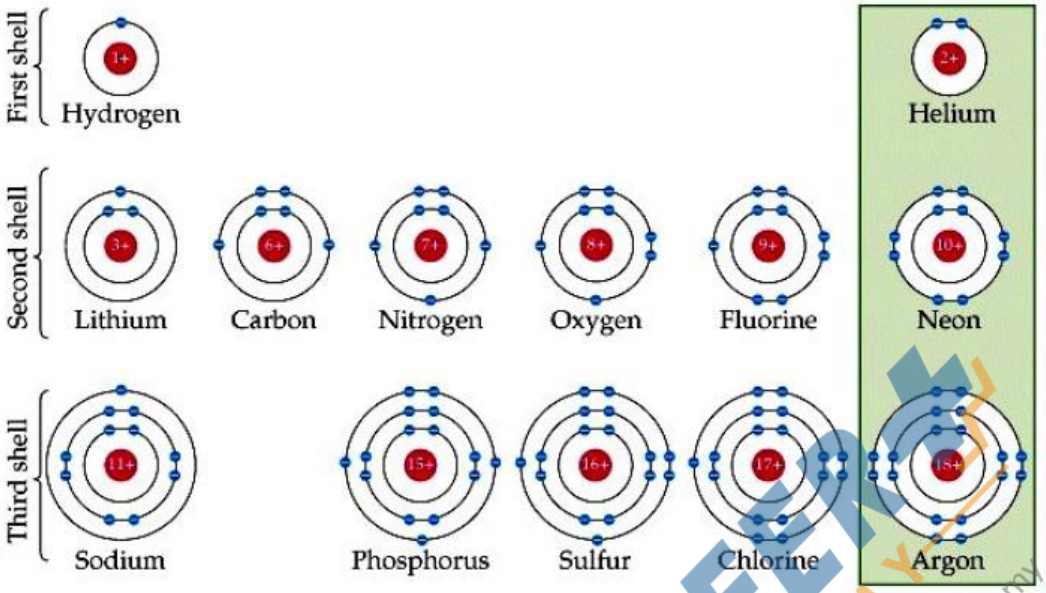


Number of orbit in potassium = 4

Electronic configuration of Calcium (Ca)
Atomic number of calcium = 20
Therefore number of electrons = 20
Thus, electronic configuration of calcium is



Number of orbit in calcium = 4



INTEXT QUESTIONS PAGE NO. 50

Q1. Write the distribution of electrons in carbon and sodium atoms.

Answer:

Carbon: The total number of electrons in a carbon atom is 6. The distribution of electrons in carbon atom is given by:
First orbit or K-shell = 2 electrons
Second orbit or L-shell = 4 electrons
Or, we can write the distribution of electrons in a carbon atom as 2, 4.

Sodium: The total number of electrons in a sodium atom is 11. The distribution of electrons in sodium atom is given by:
First orbit or K-shell = 2 electrons
Second orbit or L-shell = 8 electrons
Third orbit or M-shell = 1 electron
Or, we can write distribution of electrons in a sodium atom as 2, 8, 1.

Q2. If K and L shells of an atom are full, then what would be the total number of electrons in the atom?

Answer:

The maximum capacity of K shell is 2 electrons and L shell can accommodate maximum 8 electrons in it. Therefore, there will be ten electrons in the atom.

VALENCY

Noble gases have fully filled outermost shell. Due to this, they are stable and they do not react with other elements. Other elements also tend to attain stable configuration by completing the octet in their outermost orbit. This is important to note that, the number of electrons in the outermost orbit of an element is closer to octet. An element can lose or gain electron in order to complete the octet. This tendency of losing or gaining electrons imparts valency to an element. Let us take example of hydrogen. Hydrogen can readily lose or gain an electron. So, its valency is one. Now, let us take example of Hydrochloric Acid (HCl). One atom of chlorine combines with one atom of hydrogen to form hydrochloric acid. In this case, hydrogen loses one electron and thus gets +1 charge. On the other hand, chlorine gains an electron and thus gets – 1 charge. So, valency of hydrogen and chlorine are one.

Valency can be defined as combining capacity of an atom.

Example :

Hydrogen molecule - Hydrogen has only one electron in its outermost orbit, thus it requires one more electrons to complete its outermost orbit. Therefore, in order to complete outermost orbit, hydrogen shares one electron with another hydrogen atom and form H_2 (hydrogen molecule).

In the case of LiCl (Lithium chloride) - Lithium has three electrons in its outermost orbit and chlorine has seven electrons in its outermost orbit. Thus in order to make outermost orbit completely filled lithium loses one electrons and chlorine gains one electron. After losing one electron, lithium has two electrons in its outermost orbit and after gaining one electron, chlorine has eight electrons in its outermost orbit. And they form LiCl (Lithium chloride)

Name, Symbol, Atomic number, Number of electrons, Distribution of electrons in shells (electronic configuration) and Valency of some elements (From Hydrogen to Calcium)

Elements	Symbol	Atomic Number	No. of electron	Distribution of electron				Valency
				K	L	M	N	
Hydrogen	H	1	1	1				1
Helium	He	2	2	2				0
Lithium	Li	3	3	2	1			1
Beryllium	Be	4	4	2	2			2
Boron	B	5	5	2	3			3
Carbon	C	6	6	2	4			4
Nitrogen	N	7	7	2	5			3
Oxygen	O	8	8	2	6			2
Fluorine	F	9	9	2	7			1
Neon	Ne	10	10	2	8			0
Sodium	Na	11	11	2	8	1		1
Magnesium	Mg	12	12	2	8	2		2
Aluminium	Al	13	13	2	8	3		3
Silicon	Si	14	14	2	8	4		4
Phosphorous	P	15	15	2	8	5		3
Sulphur	S	16	16	2	8	6		2
Chlorine	Cl	17	17	2	8	7		1
Argon	Ar	18	18	2	8	8		0
Potassium	K	19	19	2	8	8	1	1
Calcium	Ca	20	20	2	8	8	2	2

INTEXT QUESTIONS PAGE NO. 52

Q1. How will you find the valency of chlorine, sulphur and magnesium?
Answer:
If the number of electrons in the outermost shell of the atom of an element is less than or equal to 4, then the valency of the element is equal to the number of electrons in the outermost shell. On the other hand, if the number of electrons in the outermost shell of the atom of an element is greater than 4, then the valency of that element is determined by subtracting the number of electrons in the outermost shell from 8.

The distribution of electrons in chlorine, sulphur, and magnesium atoms are 2, 8, 7; 2, 8, 6 and 2, 8, 2 respectively.

Therefore, the number of electrons in the outer most shell of chlorine, sulphur, and magnesium atoms are 7, 6, and 2 respectively.
Thus, the valency of chlorine = 8 −7 = 1
The valency of sulphur = 8 − 6 = 2
The valency of magnesium = 2

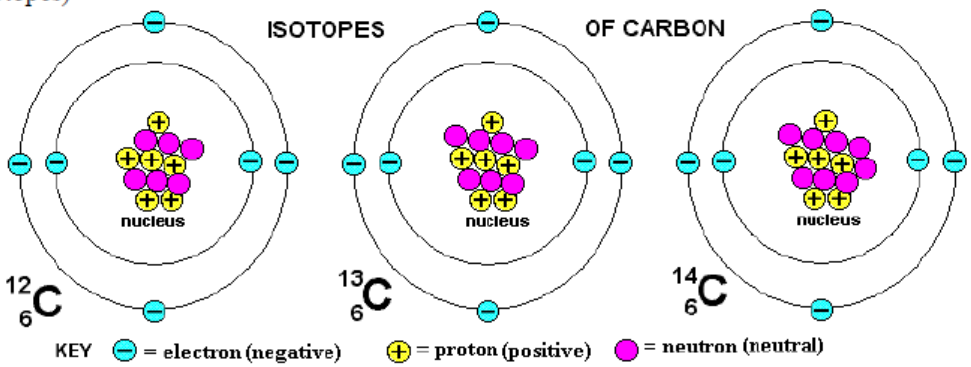
INTEXT QUESTIONS PAGE NO. 52

Q1. If number of electrons in an atom is 8 and number of protons is also 8, then (i) what is the atomic number of the atom? and (ii) what is the charge on the atom?
Answer:
(i) The atomic number is equal to the number of protons. Therefore, the atomic number of the atom is 8.
(ii) Since the number of both electrons and protons is equal, therefore, the charge on the atom is 0.

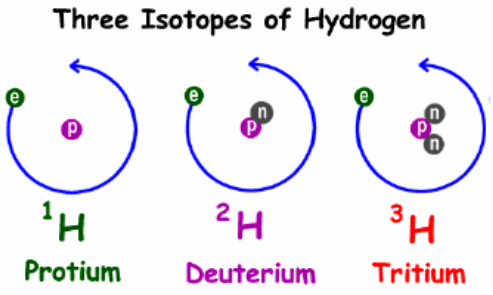
Q2. With the help of Table 4.1, find out the mass number of oxygen and sulphur atom.
Answer:
Mass number of oxygen = Number of protons + Number of neutrons = 8 + 8 = 16
Mass number of sulphur = Number of protons + Number of neutrons = 16 +16 = 32

ISOTOPES

Elements having same atomic number but different atomic masses are known as Isotopes.
Example –
Carbon-12, Carbon-13, Carbon-14 are thee isotopes of carbon atom. Here 12, 13 and 14 are the atomic masses of isotopes of carbon respectively. Since, atomic number is the unique property of an atom, thus the atomic number of carbon is 6 even in the case of three types of carbon (isotopes)



Hydrogen -1 , Deuterium – 2, Tritium -3 are three isotopes of hydrogen.
The isotopes of hydrogen are written as:



Use of Isotopes:
Carbon – 14 is used in carbon dating.
An isotope of uranium is used as fuel in nuclear reactor.
An isotope of cobalt is used in treatment of cancer.
An isotope of iodine is used in treatment of goitre.

ISOBARS

Atoms having same atomic mass and different atomic numbers are known as Isobars.

Example – ${}^{40}_{18}Ar$ (argon) and ${}^{40}_{20}Ca$ (calcium)

Both the elements have same atomic mass equal to 40 but different atomic numbers, i.e. argon has atomic number equal to 18 and calcium has atomic number equal to 20.

INTEXT QUESTIONS PAGE NO. 53

Q1. For the symbol H,D and T tabulate three sub-atomic particles found in each of them.
Answer:

Symbol	Proton	Neutron	Electron
H	1	0	1
D	1	1	1
T	1	2	1

Q2. Write the electronic configuration of any one pair of isotopes and isobars.
Answer:
$^{12}C_6$ and $^{14}C_6$ are isotopes, have the same electronic configuration as (2, 4).
$^{22}Ne_{10}$ and $^{22}Ne_{11}$ are isobars. They have different electronic configuration as given below:
$^{22}Ne_{10}$ – 2, 8
$^{22}Ne_{11}$ – 2, 8, 1

EXERCISE QUESTIONS PAGE NO. 55, 56

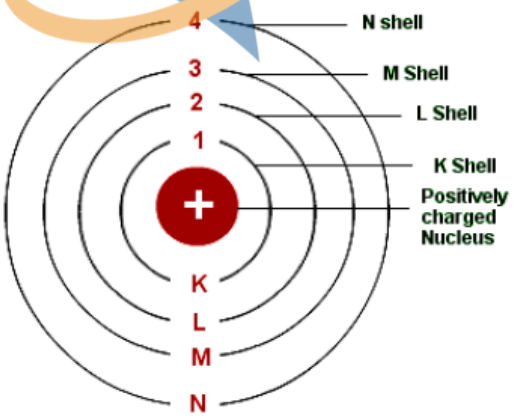
Q1. Compare the properties of electrons, protons and neutrons.
Answer:

Particle	Nature of Charge	Mass	Location
Electron	Electrons are negatively charged.	9×10^{-31} kg	Extra nuclear part distributed in different shell or orbits.
Proton	Protons are positively charged.	1.672×10^{-27} kg (1 μ) (approx. 2000 times that of the electron)	Nucleus
Neutron	Neutrons are neutral.	Equal to mass of proton	Nucleus

Q2. What are the limitations of J.J. Thomson's model of the atom?
Answer:
The limitations of J.J. Thomson's model of the atom are:
→ It could not explain the result of scattering experiment performed by rutherford.
→ It did not have any experiment support.

Q3. What are the limitations of Rutherford's model of the atom?
Answer:
The limitations of Rutherford's model of the atom are
→ It failed to explain the stability of an atom.
→ It doesn't explain the spectrum of hydrogen and other atoms.

Q4. Describe Bohr's model of the atom.
Answer:
→ The atom consists of a small positively charged nucleus at its center.
→ The whole mass of the atom is concentrated at the nucleus and the volume of the nucleus is much smaller than the volume of the atom.
→ All the protons and neutrons of the atom are contained in the nucleus.
→ Only certain orbits known as discrete orbits of electrons are allowed inside the atom.
→ While revolving in these discrete orbits electrons do not radiate energy. These orbits or cells are represented by the letters K, L, M, N etc. or the numbers, n = 1, 2, 3, 4, . . as shown in below figure.



Q5. Compare all the proposed models of an atom given in this chapter.
Answer:

Thomson's model	Rutherford's model	Bohr's model
→ An atom consists of a positively charged sphere and the electrons are embedded in it. → The negative and positive charges are equal in magnitude. As a result the atom is electrically neutral.	→ An atom consists of a positively charged center in the atom called the nucleus. The mass of the atom is contributed mainly by the nucleus. → The size of the nucleus is very small as compared to the size of the atom. → The electrons revolve around the nucleus in well-defined orbits.	→ Bohr agreed with almost all points as said by Rutherford except regarding the revolution of electrons for which he added that there are only certain orbits known as discrete orbits inside the atom in which electrons revolve around the nucleus. → While revolving in its discrete orbits the electrons do not radiate energy.

Q6. Summarise the rules for writing of distribution of electrons in various shells for the first eighteen elements.
Answer:
The rules for writing of the distribution of electrons in various shells for the first eighteen elements are given below.
→ If n gives the number of orbit or energy level, then $2n^2$ gives the maximum number of electrons possible in a given orbit or energy level. Thus,
First orbit or K-shell will have 2 electrons,
Second orbit or L-shell will have 8 electrons,
Third orbit or M-shell will have 18 electrons.
→ If it is the outermost orbit, then it should have not more than 8 electrons.
→ There should be step-wise filling of electrons in different orbits, i.e., electrons are not accompanied in a given orbit if the earlier orbits or shells are incompletely filled.

Q7. Define valency by taking examples of silicon and oxygen.
Answer:
The valency of an element is the combining capacity of that element. The valency of an element is determined by the number of valence electrons present in the atom of that element.
→ Valency of Silicon: It has electronic configuration: 2,8,4
Thus, the valency of silicon is 4 as these electrons can be shared with others to complete octet.
→ Valency of Oxygen: It has electronic configuration: 2,6
Thus, the valency of oxygen is 2 as it will gain 2 electrons to complete its octet.

Q8. Explain with examples (i) Atomic number, (ii) Mass number, (iii) Isotopes and iv) Isobars. Give any two uses of isotopes.
Answer:
(i) Atomic number
The atomic number of an element is the total number of protons present in the atom of that element. For example, nitrogen has 7 protons in its atom. Thus, the atomic number of nitrogen is 7.
(ii) Mass number
The mass number of an element is the sum of the number of protons and neutrons present in the atom of that element. For example, the atom of boron has 5 protons and 6 neutrons. So, the mass number of boron is 5 + 6 = 11.

(iii) Isotopes

Isotopes are atoms of the same element having the same atomic number, but different mass numbers. For example, hydrogen has three isotopes. They are protium ($_1^1H$), deuterium ($_1^2H$) and tritium ($_1^3H$).

(iv) Isobars

Isobars are atoms having the same mass number, but different atomic numbers i.e., isobars are atoms of different elements having the same mass number. For example, $_{20}^{40}Ca$ and $_{18}^{40}Ar$ are isobars.

Two uses of isotopes are:

(i) One isotope of uranium is used as a fuel in nuclear reactors.

(ii) One isotope of cobalt is used in the treatment of cancer.

Q9. Na^+ has completely filled K and L shells. Explain.

Answer:

An atom of Na has a total of 11 electrons. Its electronic configuration is 2, 8, 1. But, Na+ ion has one electron less than Na atom i.e., it has 10 electrons. Therefore, 2 electrons go to K-shell and 8 electrons go to L-shell, thereby completely filling K and L shells.

Q10. If bromine atom is available in the form of, say, two isotopes $_{35}^{79}Br$ (49.7%) and $_{35}^{81}Br$ (50.3%), calculate the average atomic mass of bromine atom.

Answer:

It is given that two isotopes of bromine are $_{35}^{79}Br$ (49.7%) and $_{35}^{81}Br$ (50.3%). Then, the average atomic mass of bromine atom is given by:

$$79\times\frac{49.7}{100}+81\times\frac{50.3}{100}=\frac{3926.3}{100}+\frac{4074.3}{100}$$

$$=\frac{8000.6}{100}=80.006u=80u(approx)$$

Q11. The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $_8^{16}X$ and $_8^{18}X$ in the sample?

Answer:

It is given that the average atomic mass of the sample of element X is 16.2 u.

Let the percentage of isotope $_8^{18}X$ be y%. Thus, the percentage of isotope $_8^{16}X$ will be (100 − y) %.

Therefore, $18\times\frac{y}{100}+16\times\frac{(100-y)}{100}=16.2$

$$\Rightarrow\frac{18y}{100}+\frac{16(100-y)}{100}=16.2$$

$$\Rightarrow\frac{18y+16(100-y)}{100}=16.2\Rightarrow\frac{18y+1600-16y}{100}=16.2$$

$$\Rightarrow 18y+1600-16y=1620$$

$$\Rightarrow 2y+1600=1620$$

$$\Rightarrow 2y=1620-1600=20$$

$$\Rightarrow y=10$$

Therefore, the percentage of isotope $_8^{18}X$ is 10%.

And, the percentage of isotope $_8^{16}X$ is (100 − 10) % = 90%.

Q12. If Z = 3, what would be the valency of the element? Also, name the element.
Answer:
By Z = 3, we mean that the atomic number of the element is 3. Its electronic configuration is 2, 1. Hence, the valency of the element is 1 (since the outermost shell has only one electron). Therefore, the element with Z = 3 is lithium.

Q13. Composition of the nuclei of two atomic species X and Y are given as under

	X	Y
Protons =	6	6
Neutrons =	6	8

Give the mass numbers of X and Y. What is the relation between the two species?
Answer:
Mass number of X = Number of protons + Number of neutrons = 6 + 6 = 12
Mass number of Y = Number of protons + Number of neutrons = 6 + 8 = 14
These two atomic species X and Y have the same atomic number, but different mass numbers. Hence, they are isotopes.

Q14. For the following statements, write T for True and F for False.
(a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons.
(b) A neutron is formed by an electron and a proton combining together. Therefore, it is neutral.
(c) The mass of an electron is about $\frac{1}{2000}$ times that of proton.
(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine.

Answer:
(a) False (b) False (c) True (d) False

Put tick (√) against correct choice and cross (X) against wrong choice in questions Q15, Q16 and Q17
Q15. Rutherford's alpha-particle scattering experiment was responsible for the discovery of
(a) Atomic Nucleus (b) Electron
(c) Proton (d) Neutron
Answer: (a) Atomic nucleus

Q16. Isotopes of an element have
(a) the same physical properties
(b) different chemical properties
(c) different number of neutrons
(d) different atomic numbers.
Answer: (c) different number of neutrons

Q17. Number of valence electrons in Cl^- ion are:
(a) 16 (b) 8 (c) 17 (d) 18
Answer: (b) 8

Q18. Which one of the following is a correct electronic configuration of sodium?
(a) 2,8 (b) 8,2,1 (c) 2,1,8 (d) 2,8,1.
Answer: (d) 2, 8, 1

Q19. Complete the following table.

Atomic number	Mass number	No. of neutrons	No. of Protons	No. of electrons	Name of the Atomic Species
9		10			
16	32				Sulphur
	24		12		
	2		1		
	1	0	1	0	

Answer:

Atomic number	Mass number	No. of neutrons	No. of Protons	No. of electrons	Name of the Atomic Species
9	**19**	10	**9**	**9**	**Fluorine**
16	32	**16**	**16**	**16**	Sulphur
12	24	**12**	12	**12**	**Magnesium**
1	2	**1**	1	**1**	**Deuterium**
1	1	0	1	0	**Hydrogen ion**

1. Which of the following correctly represent the electronic distribution in the Mg atom?
   (a) 3, 8, 1 (b) 2, 8, 2 (c) 1, 8, 3 (d) 8, 2, 2
2. Rutherford's 'alpha (α) particles scattering experiment' resulted in to discovery of
   (a) Electron (b) Proton (c) Nucleus in the atom (d) Atomic mass
3. The ion of an element has 3 positive charges. Mass number of the atom is 27 and the number of neutrons is 14. What is the number of electrons in the ion?
   (a) 13 (b) 10 (c) 14 (d) 16
4. Elements with valency 1 are
   (a) Always metals (b) always metalloids
   (c) either metals or non-metals (d) always non-metals
5. The first model of an atom was given by
   (a) N. Bohr (b) E. Goldstein
   (c) Rutherford (d) J.J. Thomson
6. Is it possible for the atom of an element to have one electron, one proton and no neutron? If so, name the element.
7. Why did Rutherford select a gold foil in his α–ray scattering experiment?
8. Will Cl-35 and Cl-37 have different valences?
9. Calculate the number of neutrons present in the nucleus of an element X which is represented as 31 X15 .
10. The atomic number of calcium and argon are 20 and 18 respectively, but the mass number of both these elements is 40. What is the name given to such a pair of elements?
11. Why do Helium, Neon and Argon have a zero valency?
12. In what way the Rutherford proposed atomic model?
13. In what way the Thomson proposed atomic model?
14. What were the drawbacks of Rutherford's model of an atom?
15. What are the limitations of J.J. Thomson's model of an atom?
16. In television picture tube which type of rays are used?
17. Which is heavier, neutron or proton?
18. If electrons move from K to L shell, will the energy be absorbed or evolved?
19. Helium atom has an atomic mass of 4u and two protons in its nucleus. How many neutrons does it have?
20. An ion X^{2+} contains 18 electrons and 20 neutrons. Calculate the atomic number and mass no. of element X. Name the element X.
21. Give one Achievement and one limitation of J.J Thomson's model of atom?

22. In a given electric field, β- particles are deflected more than α- particles inspite of the fact that α - particles have larger charge, why?

23. What are valence electrons? What is their significance?

24. What would be the observation if the α - particle scattering experiment is carried out using a foil of a metal other than gold?

25. Electronic configuration of Potassium is 2,8,8,1 and Calcium 2,8,8,2, when M shell can have maximum of 18 electrons then why next element Scandium has electronic configuration 2,8,9,2 and not 2,8,8,3 ?

26. What are isotopes and Isobars? What are two isotopes of chlorine? Calculate the average atomic mass of a chlorine atom?

27. What is present concept of an atom? Explain in detail? Why this model is considered to be the most appropriate model?

28. Explain the Rutherford's alpha particle scattering experiment. What were the main conclusions drawn from this experiment?

29. A naturally occurring sample of :-

(i) 69.2% of 53Cu& 30.8% of 65Cu. Find the average atomic mass of a naturally occuring sample of copper.

(ii)7.42% of 6Li & 92.58% of 7Li.Find the average atomic mass of a naturally occuring sample of Lithium.

30. Calculate the no. of atoms of each element persent in 9.8 g of sulphuric acid, H_2SO_4. (H=1, S=32, O=16)

31. How to calculate the atomicity and the atomic mass of an atom?

32. To weight $BaCl_2$ or Na_2SO_4

a) use a polythene bags and spring balance

b) use a watch glass and spring balance

c) use a polythene bags and physical balance

d) use a watch glass and physical balance

33. To weight sodium sulphate or barium chloride it should be in form of

a) saturated solution b) large crystals c) small crystals d) fine powder

34. What is the distribution of electrons in an atom of Phosphorus and how can it have two valencies

35. The maximum no. of electrons present in shell is given by the formula 2n2and the maximum no. of electrons filled in M shell is 18. But in the element calcium we only fill 8 electrons in the M shell and move on to the N shell. why ?

36. What are alpha particles?

37. Write ddifference between atomic mass and mass number?

38. An ion (M^{2+}) contain 10 electrons and 12 neutrons what is the atomic number and mass number of the element M.

---

39. An ion M^{3+} contains 10 electrons and 14 neutrons. What are the atomic mass and mass number of the element M ? Name the element.

40. 10 gm of silver nitrate solution is added to 10 gm of sodium chloride solution. What change in mass do you expect after the reaction and why?

1. Which of the following correctly represent the electronic distribution in the Mg atom?
   (a) 3, 8, 1
   (b) 2, 8, 2
   (c) 1, 8, 3
   (d) 8, 2, 2

2. Rutherford's 'alpha (α) particles scattering experiment' resulted in to discovery of
   (a) Electron
   (b) Proton
   (c) Nucleus in the atom
   (d) Atomic mass

3. The number of electrons in an element X is 15 and the number of neutrons is 16. Which of the following is the correct representation of the element?
   $(a)^{31}_{15}X \quad (b)^{31}_{16}X \quad (c)^{16}_{15}X \quad (d)^{15}_{16}X$

4. Dalton's atomic theory successfully explained
   (i) Law of conservation of mass
   (ii) Law of constant composition
   (iii) Law of radioactivity
   (iv) Law of multiple proportion
   (a) (i), (ii) and (iii)
   (b) (i), (iii) and (iv)
   (c) (ii), (iii) and (iv)
   (d) (i), (ii) and (iv)

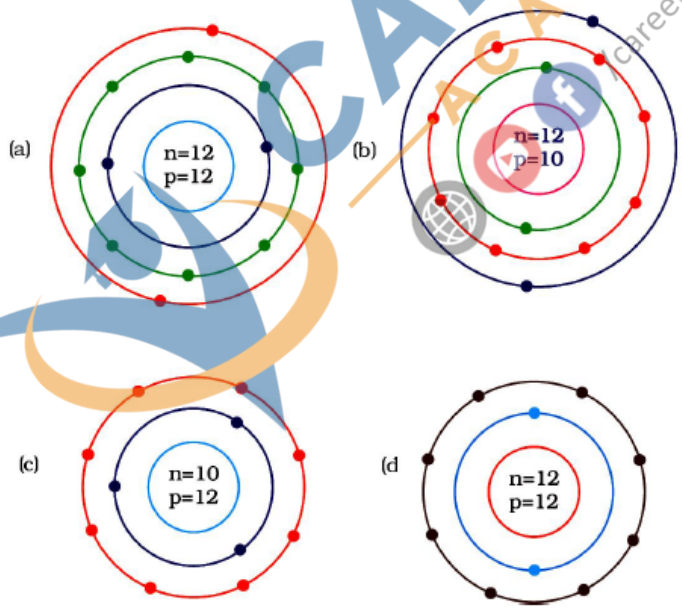
5. Which of the following statements about Rutherford's model of atom are correct?
   (i) considered the nucleus as positively charged
   (ii) established that the α-particles are four times as heavy as a hydrogen atom
   (iii) can be compared to solar system
   (iv) was in agreement with Thomson's model
   (a) (i) and (iii)
   (b) (ii) and (iii)
   (c) (i) and (iv)
   (d) only (i)

6. Which of the following are true for an element?
   (i) Atomic number = number of protons + number of electrons
   (ii) Mass number = number of protons + number of neutrons
   (iii) Atomic mass = number of protons = number of neutrons
   (iv) Atomic number = number of protons = number of electrons
   (a) (i) and (ii)
   (b) (i) and (iii)
   (c) (ii) and (iii)
   (d) (ii) and (iv)

7. In the Thomson's model of atom, which of the following statements are correct?
(i) the mass of the atom is assumed to be uniformly distributed over the atom
(ii) the positive charge is assumed to be uniformly distributed over the atom
(iii) the electrons are uniformly distributed in the positively charged sphere
(iv) the electrons attract each other to stabilise the atom
(a) (i), (ii) and (iii)
(b) (i) and (iii)
(c) (i) and (iv)
(d) (i), (iii) and (iv)

8. Rutherford's α –particle scattering experiment showed that
(i) electrons have negative charge
(ii) the mass and positive charge of the atom is concentrated in the nucleus
(iii) neutron exists in the nucleus
(iv) most of the space in atom is empty
Which of the above statements are correct?
(a) (i) and (iii)
(b) (ii) and (iv)
(c) (i) and (iv)
(d) (iii) and (iv)

9. Identify the Mg^{2+} ion from the Fig.4.1 where, n and p represent the number of neutrons and protons respectively



10. In a sample of ethyl ethanoate ($CH_3COOC_2H_5$) the two oxygen atoms have the same number of electrons but different number of neutrons. Which of the following is the correct reason for it?
(a) One of the oxygen atoms has gained electrons
(b) One of the oxygen atoms has gained two neutrons
(c) The two oxygen atoms are isotopes
(d) The two oxygen atoms are isobars.

11. The ion of an element has 3 positive charges. Mass number of the atom is 27 and the number of neutrons is 14. What is the number of electrons in the ion?
(a) 13
(b) 10
(c) 14
(d) 16

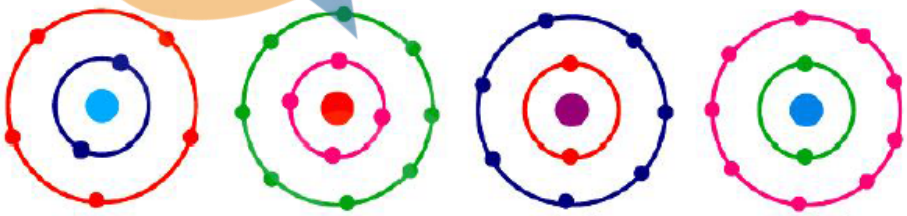
12. Elements with valency 1 are
(a) always metals
(b) always metalloids
(c) either metals or non-metals
(d) always non-metals

13. The first model of an atom was given by
(a) N. Bohr
(b) E. Goldstein
(c) Rutherford
(d) J.J. Thomson

14. An atom with 3 protons and 4 neutrons will have a valency of
(a) 3
(b) 7
(c) 1
(d) 4

15. The electron distribution in an aluminium atom is
(a) 2, 8, 3
(b) 2, 8, 2
(c) 8, 2, 3
(d) 2, 3, 8

16. Which of the following in Fig. 4.2 do not represent Bohr's model of an atom correctly?



(a) (i) and (ii)
(b) (ii) and (iii)
(c) (ii) and (iv)
(d) (i) and (iv)

17. Which of the following statement is always correct?
(a) An atom has equal number of electrons and protons.
(b) An atom has equal number of electrons and neutrons.
(c) An atom has equal number of protons and neutrons.
(d) An atom has equal number of electrons, protons and neutrons.

18. Atomic models have been improved over the years. Arrange the following atomic models in the order of their chronological order
(i) Rutherford's atomic model
(ii) Thomson's atomic model
(iii) Bohr's atomic model
(a) (i), (ii) and (iii)
(b) (ii), (iii) and (i)
(c) (ii), (i) and (iii)
(d) (iii), (ii) and (i)

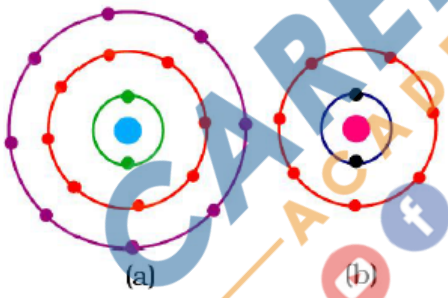
19. Is it possible for the atom of an element to have one electron, one proton and no neutron. If so, name the element.

20. Write any two observations which support the fact that atoms are divisible.

21. Will 35Cl and 37Cl have different valencies? Justify your answer.

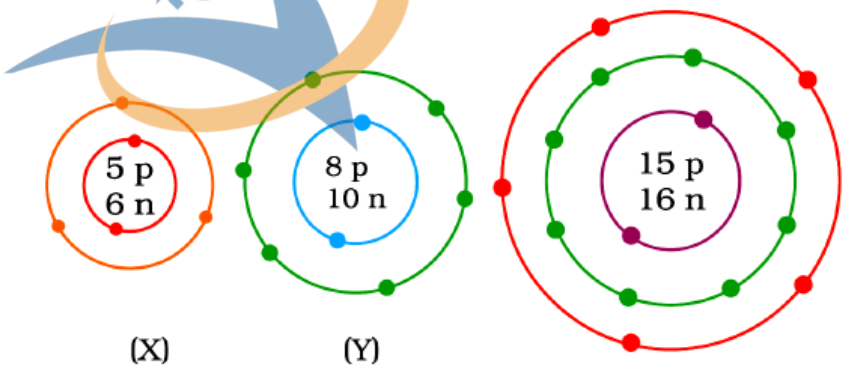
22. Why did Rutherford select a gold foil in his α –ray scattering experiment?

23. Find out the valency of the atoms represented by the Fig. 4.3 (a) and (b).



(a) (b)

24. What information do you get from the Fig. 4.4 about the atomic number, mass number and valency of atoms X, Y and Z? Give your answer in a tabular form.



(X) (Y) (Z)

25. In response to a question, a student stated that in an atom, the number of protons is greater than the number of neutrons, which in turn is greater than the number of electrons. Do you agree with the statement? Justify your answer.

26. Calculate the number of neutrons present in the nucleus of an element X which is represented as $^{31}_{15}X$

27. One electron is present in the outer most shell of the atom of an element X. What would be the nature and value of charge on the ion formed if this electron is removed from the outer most shell?

28. Write down the electron distribution of chlorine atom. How many electrons are there in the L shell? (Atomic number of chlorine is 17).

29. In the atom of an element X, 6 electrons are present in the outermost shell. If it acquires noble gas configuration by accepting requisite number of electrons, then what would be the charge on the ion so formed?

30. Match the names of the Scientists given in column A with their contributions towards the understanding of the atomic structure as given in column B

(A)	(B)
(a) Ernest Rutherford	(i) Indivisibility of atoms
(b) J.J.Thomson	(ii) Stationary orbits
(c) Dalton	(iii) Concept of nucleus
(d) Neils Bohr	(iv) Discovery of electrons
(e) James Chadwick	(v) Atomic number
(f) E. Goldstein	(vi) Neutron
(g) Mosley	(vii) Canal rays