Unit 4 (Structure Of The Atoms)

Multiple Choice Questions (MCQs)

Question 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

Answer:

(b) Atomic number and the number of electrons in magnesium atom is 12. So, electronic configuration is 2, 8, 2 (because 12=2 + 8 + 2).

Question 2:

Rutherford's alpha(a) particles scattering experiment resulted into discovery of

(a) electron (b) proton

(c) nucleus in the atom (d) atomic mass

Answer:

(c) Rutherford discovered nucleus of the atom by his a-particle scattering experiment. So, this experiment resulted into discovery of nucleus in the atom.

Question 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) ${}^{31}_{15}X$ (b) ${}^{31}_{16}X$ (c) ${}^{16}_{15}X$ (d) ${}^{15}_{16}X$

Answer:

(a) Given that, number of electrons in element X = 15 and number of neutrons = 16 Atomic number = number of protons = number of electrons in neutral atom = 15 Mass number = number of protons + number of neutrons = 15+16=31

Thus, the atom is represented as ${}^{31}_{15}X$.

Question 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)

Answer:

(d) Dalton's atomic theory successfully explained the laws of chemical combination but no point about radioactivity was mentioned by Dalton in his theory.

Question 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 a-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)

Answer:

(a) According to Rutherford model, a central positively charged nucleus is present in the atom and electrons revolve around it. This model is similar to solar system so also called planetary model.

Question 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 number = 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)

Answer:

(d) Points (ii) and (iv) are correct.

Question 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 uniformaly distributed over the atom.

(ii) The positive charge is assumed to be uniformaly distributed over the atom.

(iii) The electrons are uniformaly 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)

Answer:

(a) Points (i), (ii) and (iii) are correct. According to Thomson' model of the atom, an atom consists of a sphere of positively charge with negatively charged electrons embedded in it. These negative and positive charges in an atom are equal in magnitude, due to which an atom is electrically neutral.

Question 8:

Rutherford's a-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)

Answer:

(b) Points (ii) and (iv) are correct. An atom consists of a positively charged, dense and very small nucleus which have all the protons and neutrons. Positive charge is due to protons, as neutrons have no charge. Most of the space is empty because most of the alpha particles pass straight through the gold foil without any deflection.

Electrons have negative charge, it was explained by Thomson. The existance of neutron was discovered by Chadwick.

Question 9:

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

Answer:

(b) Given that, charge = + 3, mass number = 27 and number of neutrons = 14 Number of protons = atomic number

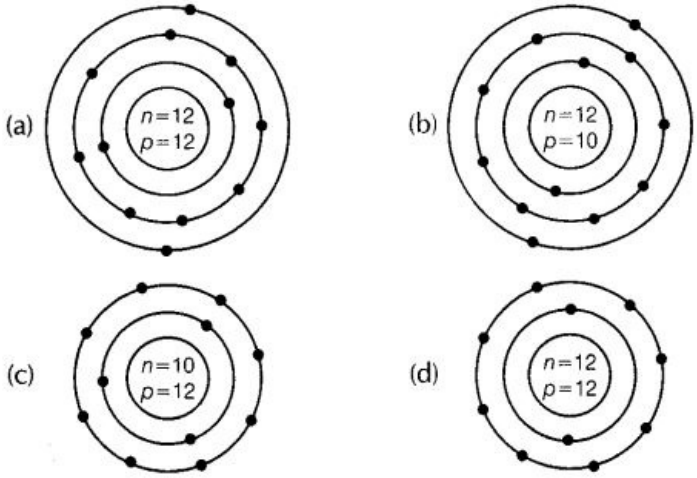
Atomic number = mass number – number of neutrons = 27-14 = 13 This is the atomic number of aluminium.

Therefore, this element is aluminium (Al).

Number of electrons in the Al atom = 13 Number of electrons in the Al^{3+} ion = 13 – 3 = 10. As it is formed from the neutral atom by loss of 3 electrons.

Question 10:

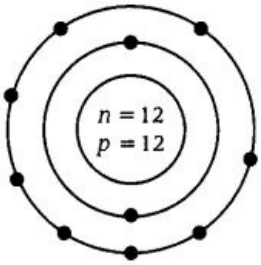
Identify the Mg^{2+} ion from the figure where, n and p represent the number of neutrons and protons respectively.



Answer:

(d) K,L,M

Electronic configuration $_{12}Mg$ atom = 2, 8,2 and that of Mg^{2+} ion = 2, 8



Number of protons in Mg atom = 2+ 8 + 2 = 12

Number of neutrons in Mg atom = 24 -12 = 12

[as mass number of Mg atom = 24 and number of neutrons = mass number – number of protons]

Therefore, option (d) is the correct answer,

Question 11:

In a sample of ethyl ethanoate ($CH_3C00C_2H_5$) 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 have 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

Answer:

(c) The two O-atoms in $CH_3COOC_2H_5$ can have different number of neutrons only if the two O-atoms are isotopes. It is because, isotopes of an element have same number of protons (and electrons) but different number of neutrons

Question 12:

Elements with valency 1 are

(a) always metals (b) always metalloids

(c) either metals or non-metals (d) always non-metals

Answer:

(c) Metals and non-metals both can have valency 1.

Metals which have 1 valence electron and non-metals which have 7 valence electrons, have valency 1. It is because, metals loose their 1e“ and non-metals gain 1e“ to complete their octet.

Question 13:

The first model of an atom was given by

(a) N Bohr (b) E Goldstein (c) Rutherford (d) JJ Thomson

Answer:

(d) The first model of an atom was given by JJ Thomson. According to him, an atom consists of a sphere of positive charge with negatively charged electrons embedded in it.

Question 14:

An atom with 3 protons and 4 neutrons will have a valency of

(a) 3 (b) 7 (c) 1 (d) 4

Answer:

(c) Given that, number of protons in an atom = 3 and number of neutrons = 4

K L

Electronic configuration of $_3Li$ = 2, 1

As, it has one valence electron, therefore its valency is also 1.

Question 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

Answer:

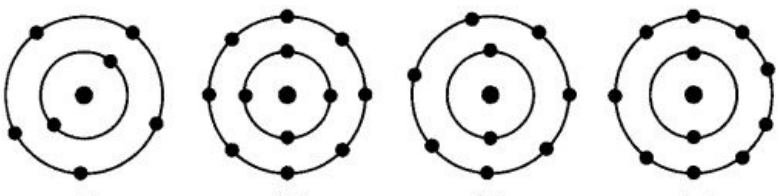
(a) Aluminium atom has 13 protons and 13 electrons.

K L M

Therefore, Electronic configuration of $_{13}AI$ = 2, 8, 3

Question 16:

Which of the following in figure do not represent Bohr’s model of an atom correctly?



(i) (ii) (iii) (iv)

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

Answer:

(c) Figures (ii) and (iv) not correctly represent the Bohr's model of an atom.
It is because maximum number of electrons in K (I) shell is 2, not 4, so (ii) is wrong and maximum capacity of L (II) shell is 8 electrons, not 9. So, (iv) is also wrong.

Question 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
Answer:
(a) Atom is electrically neutral. It is possible only if an atom has equal number of protons and electrons.

Question 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)
Answer:
(c) The correct order of the improvements in atomic models is as Thomson's atomic model (ii), Rutherford's atomic model (i) and Bohr's atomic model (iii).

Short Answer Type Questions

Question 19:
Is it possible for the atom of an element to have one electron, one proton and no neutron. If so, name the element.
Answer:
The element is protium]H (an isotope of hydrogen). (H (protium) has one electron, one proton and no neutron.

Question 20:
Write any two observations which support the fact that atoms are divisible.
Answer:
'Atoms are divisible' is supported by the following facts
(i) Formation of ionic compounds is possible due to the formation of ions which involves the transfer of electrons.
(ii) Presence of isotopes for the same element is possible due to the difference in the number of neutrons.
Above observations show that atom is formed by different particles such as electrons, protons and neutrons, i.e., atom is divisible.

Question 21:
Will ^{35}Cl and ^{37}Cl have different valencies? Justify your answer.
Answer:
No, ^{35}CI and ^{37}CI have same valency. ^{35}CI and ^{37}CI are the isotopes. So, they have same number of protons and electrons and have the same atomic number viz. 17 Hence, their electronic configuration and valencies are also the same
K L M

Electronic configuration = 2, 8, 7 Valency 8-7 = 1
Therefore, both of them have valency = 1

Question 22:

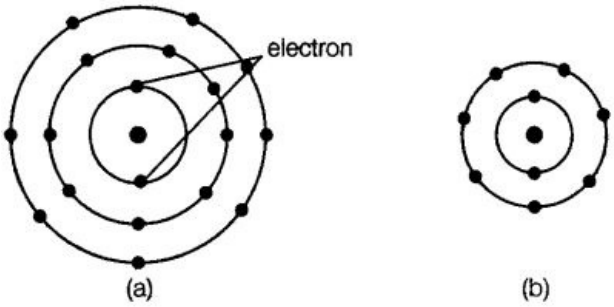
Why did Rutherford select a gold foil in his a-ray scattering experiment?

Answer:

Gold is a heavy metal with high mass number. A light metal cannot be used because on being hit by fast moving a-particle, the atom of light metal will be simply pushed forward and no scattering can occur.
Moreover, gold is the best malleable metal. A very thin foil (=1000 atoms thick) can be made from gold to get the clear observations.

Question 23:

Find out the valency of the atoms represented by the Figure (a) and (b).



Answer:

(a) It has electronic configuration

K	L	M
2	8	8

Its outer shell has complete octet.
Hence, its valency = 0

(b) It has electronic configuration

K	L
2	7

It can easily gain one electron to complete its outermost octet.
Hence, its valency = 1

Question 24:

One electron is present in the outermost 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 outermost shell?

Answer:

An element X is a metal because one electron is present in the outermost shell i.e., 1 valence electron. When this valence electron is removed from the outermost shell, a cation (positive ion) will be formed with a charge of + 1.

Question 25:

Write down the electron distribution of chlorine atom. How many electrons are there in the /.-shell?
Atomic number of chlorine is = 17.

Answer:

Atomic number of chlorine atom = 17
So, its electronic configuration is
K L M

2 8 7

L shell of chlorine contains 8 electrons.

Question 26:

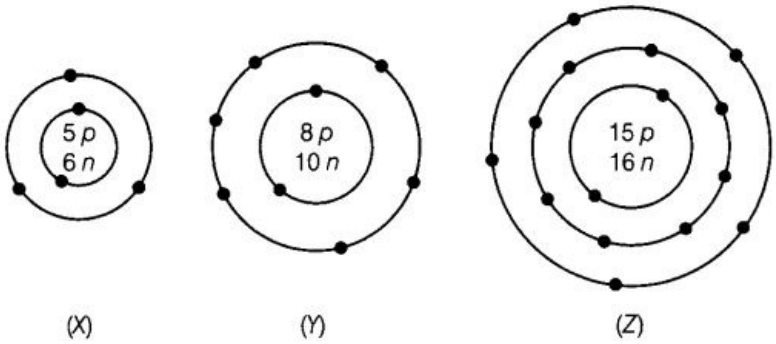
In the atom of an element X, 6 electrons are present in the outermost shell. If it acquires noble gas configuration by accepting requisite number of electrons, then what would be the charge on the ion so formed?

Answer:

Element X has 6 electrons in the outermost shell. In order to acquire noble gas configuration, element X requires 2 electrons. So, the charge on the anion (X^{2-}) so formed is-2.

Question 27:

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



Answer:

Element	Atomic number (= no. of p)	Mass number = {no. of (p + n)}	Number of electrons (= no. of p)	Electronic configuration	Valency
X	5	5 + 6 = 11	5	2, 3	3
Y	8	8 + 10 = 18	8	2, 6	2
Z	15	15 + 16 = 31	15	2, 8, 5	3, 5

Question 28:

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.

Answer:

The given statement is not correct.

According to this statement

p> n > e

But actually, number of protons is never greater than the number of neutrons. Number of neutrons can be equal to or greater than the number of protons because mass number is equal to double the atomic number or greater than double the atomic number.

Of course, number of neutrons can be greater than the number of electrons because number of electrons = number of protons in the neutral atom.

Question 29:

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

Answer:

${}^{31}_{15}X$ represents

Atomic number, Z = 15

Mass number, A = 31

Number of neutrons = A- Z= 31-15=16

Question 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.

	Column A		Column B
(a)	Ernest Rutherford	(i)	Indivisibility of atoms
(b)	JJ 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

Answer:

	Column A	Column B
(a)	Ernest Rutherford	Concept of nucleus
(b)	JJ Thomson	Discovery of electrons
(c)	Dalton	Indivisibility of atoms
(d)	Neils Bohr	Stationary orbits
(e)	James Chadwick	Neutron
(f)	E Goldstein	Atomic number
(g)	Mosley	Canal rays

Question 31:

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?

Answer:

Mass number of calcium 40 *i.e.*, $^{40}_{20}C$

Mass number of argon 40 *i.e.*, $^{40}_{18}Ar$

A pair of elements having same mass number but different atomic number is called isobars.

Question 32:

Complete the table on the basis of information available in the symbols given below.

(a) $^{35}_{17}CI$ (b) $^{12}_{6}C$ (c) $^{81}_{35}Br$

Element	n_p	n_n

Answer:

	Element	n_p	n_n
(a)	$^{35}_{17}Cl$	17	35 – 17 = 18
(b)	$^{12}_{6}C$	6	12 – 6 = 6
(c)	$^{81}_{35}Br$	35	81 – 35 = 46

Question 33:

Helium atom has 2 electrons in its valence shell but its valency is not 2. Explain.

Answer:

Helium atom has only one shell (K shell) which can have maximum 2 electrons. Thus, its shell is already complete called duplet. It can neither lose electrons nor gain electrons.

Hence, its valency is 'zero'. It is called noble gas or inert gas.

Question 34:

Fill in the blanks in the following statements.

(a)Rutherford's a-particle scattering experiment lead to the discovery of the…….

(b)Isotopes have same…… but different…….

(c)Neon and chlorine have atomic numbers 10 and 17 Their valencies will be……. and…….. respectively.

(d)The electronic configuration of silicon is…….. and that of sulphur is……..

Answer:

(a) nucleus.

(b) atomic number, mass number.

(c) zero, one.

$_{10}$Ne- Electronic configuration 2, 8. Its outermost shell is completely filled.

Hence, its valency is zero.

$_{17}$Cl – Electronic configuration 2, 8, 7

It can complete its outermost shell by gaining 1 electron.

Hencer its valency = 1

(d) 2, 8, 4 and 2, 8, 6.

Question 35:

An element X has a mass number 4 and atomic number 2. Write the valency of this element.

Answer:

Atomic number = 2

Hence, number of electrons = 2

Thus, the elements has only K shell containing 2 electrons i.e., a complete duplet Hence, its valency = 0 The element X is $_{2}^{4}$He (noble gas).

Long Answer Type Questions

Question 36:

Why do helium, neon and argon have a zero valency?

Answer:

Helium (He), neon (Ne) and argon (Ar) have completely filled outermost shell, *i.e.*,

$_{2}$He ⟶ K: 2 (duplet) $_{10}$Ne ⟶ K: 2, L: 8 (octet)

$_{18}$Ar ⟶ K: 2, L: 8, M: 8 (octet)

Thus, they have stable electronic configuration. They neither lose electrons nor gain electrons. Hence, their valency is zero.

Thus, they have stable electronic configuration. They neither lose electrons nor gain electrons. Hence, their valency is zero.

Question 37:

The ratio of the radii of hydrogen atom and its nucleus is ~10^5. Assuming the atom and the nucleus to be spherical.

(a)What will be the ratio of their sizes ?

(b)If atom is represented by planet earth 'R_e' = 6.4 x 10^6m, estimate the size of the nucleus.

Answer:

(a) Atomic size is represented in terms of atomic radius, $\frac{r_H}{r_n} = 10^5$

As volume of sphere $= \frac{4}{3}\pi r^3$, therefore, $V_H = \frac{4}{3}\pi r_H^3$ and $V_n = \frac{4}{3}\pi r_n^3$

Thus, the ratio of volumes $\frac{V_H}{V_n} = \frac{\frac{4}{3}\pi r_H^3}{\frac{4}{3}\pi r_n^3} = \frac{r_H^3}{r_n^3} = \left(\frac{r_H}{r_n}\right)^3 = (10^5)^3 = 10^{15}$

(b) $$\frac{V_n}{V_H} = 10^{-15} \text{ or } V_n = 10^{-15} \times V_H$$

If atom is represented by planet earth with $R_e = 6.4 \times 10^6 \text{m}$

Then, volume of atom $(V_H) = \frac{4}{3}\pi R_e^3 = \frac{4}{3} \times 3.14 \times (6.4 \times 10^6 \text{m})^3$

$$= 1097.5 \times 10^{18} \text{m}^3 = 1.0975 \times 10^{21} \text{ m}^3$$

$\therefore$ Volume of nucleus $= 10^{-15} \times (1.0975 \times 10^{21}) \text{ m}^3$

$$= 1.0975 \times 10^6 \text{ m}^3$$

Question 38:

Enlist the conclusions drawn by Rutherford from his a-ray scattering experiment.

Answer:

Conclusion of Rutherford's a-rays scattering experiment

(i) Most of the space inside the atom is empty because most of the a-particles passed through the gold foil without getting deflected.

(ii) Very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space.

(iii) Avery small fraction of a-particles were deflected by 180°, indicating that all the positive charge and mass of the gold atom were concentrated in very small volume within the atom.

Question 39:

In what way is the Rutherford's atomic model different from that of Thomson's atomic model?

Answer:

According to Thomson's model, an atom is a positively charged sphere in which electrons were embedded which neutralise the positive charge so that, the atom as a whole is electrically neutral.

According to Rutherford's model of atom, the positive charge and mass of the atom are concentrated in the small nucleus in the centre of the atom and negatively charged electrons are distributed (revolving) around the nucleus.

Question 40:

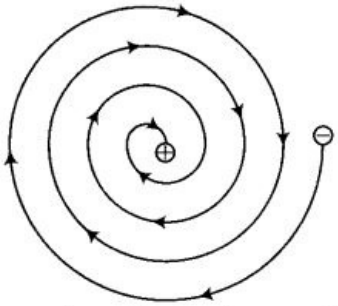
What were the drawbacks of Rutherford's model of an atom?

Answer:

Rutherford's model could not explain the stability of the atom. This is because according to Rutherford's model, an atom consists of a small heavy positively charged nucleus in the centre and the electrons were revolving around it.

These revolving electrons would loose energy as they are the charged particles and due to acceleration charged particles would radiate energy.

Thus, the orbit of the revolving electron will keep on becoming smaller and smaller, following a spiral path as shown in figure and ultimately the electron should fall into the nucleus. In other words, the atom should collapse.



Continuous loss of energy by a revolving electron

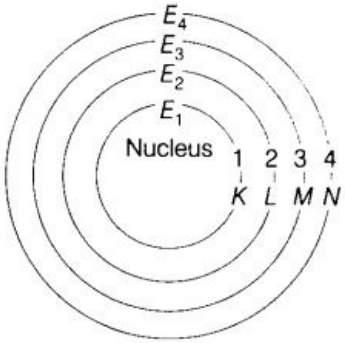
Question 41:

What are the postulates of Bohr's model of an atom?

Answer:

The postulates of Bohr's model of atom are as follows

(i) In an atom, the electrons revole around the nucleus in certain definite circular paths called orbits or shells. These are represented by the letters K, L, M, N…….. or the numbers n = 1,2, 3, 4……..



Circular orbits or energy levels or shells around the nucleus

(ii) The maximum number of electrons present in a shell is given by the formula$2n^2$, where W is the orbit number or energy level index, 1,2, 3…. Hence, the maximum number of electrons in different shells are as follows.

First orbit (K shell) will be = 2 x 1^2 = 2, second orbit (or L shell) will be = 2 x 2^2 = 8, third orbit (M shell) will be = 2 x 3^2 =18 and so on.

(iii) The maximum number of electrons that can be accomadated in the outermost orbit is 8.

(iv) Electrons are not accomodated in a given shell, unless the inner shells are filled. That is the shells

are filled in a step-wise manner.

(v) While revolving in discrete orbits the electrons do not radiate energy.

Question 42:

Show diagramatically the electron distributions in a sodium atom and a sodium ion and also give their atomic number.

Answer:

Atomic number of sodium (Z) = 11

Mass number of sodium (A) = 23

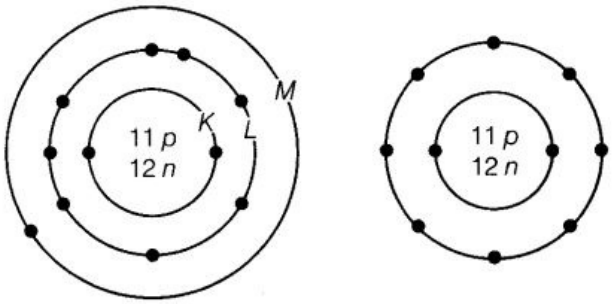
∴ Number of protons in the nucleus = 11

Number of neutrons in the nucleus = 23 -11 = 12

Number of electrons = 11

∴ Electronic configuration of Na atom = $\underset{2}{K}\ \underset{8}{L}\ \underset{1}{M}$

Na^+ ion is formed from sodium atom by loss of an electron (present in the outermost shell). Hence, its electronic configuration is $\underset{2}{K}\ \underset{8}{L}$. However, number of protons and neutrons remains the same.



Sodium atom **Sodium ion**

Question 43:

In the gold foil experiment of Geiger and Marsden, that paved the way for Rutherford's model of an atom, ~ 1.00% of the a-particles were found to deflect at angles > 50°. If one mole of a-particles were bombarded on the gold foil, compute the number of a-particles that would deflect at angles less than 50°.

Answer:

Total number of α-particles used for bombardment = 1 mole

$$1 \text{ mole} = 6.022 \times 10^{23} \text{ particles.}$$

Number of α-particles deflected at angles greater than

$$50° (> 50°) = 1\% \qquad \text{(Given)}$$

∴ Number of α-particles deflected at the angles less than

$$50° = 100 - 1 = 99\%$$

∴ Actual number of α-particles deflected at the angles less than

$$50° = \frac{99}{100} \times 6.022 \times 10^{23}$$

$$= 5.96 \times 10^{23}$$