CHAPTER: No.2

Rutherford's Atomic model:-

In 1911 Rutherford performed an experiment in order to know the arrangement of electrons and protons in atoms.

Rutherford's Experiment:-

Rutherford bombarded a very thin gold foil of about 0.0004cm thickness with α- particles. α -particles are doubly positively charged helium nuclei (He^{++}).

Observation:-

1. Rutherford observed that most of the αrticles passed straight through the gold foil.
2. Only few particles were slightly deflected.
3. One out of one million particles was deflected through angle greater than 90^o from their straight path.

Conclusions:-

1. Since majority of the α - particles passed through the foil un-deflected so most of the space occupied by an atom is empty.
2. The deflection of α- particles through an angle greater than 90^o shows that these α - particles and the central part of the atom both are positively charged.
3. Massive α- particles are not deflected by electrons.

Atomic Model and discovery of Nucleus:-

One the basis of conclusions drawn from the experiments Rutherford proposed a planetary model for an atom.

According to this atomic model an atom is neutral particle. The total mass of an atom lies in central part of the atom. This central part is positively charged and it is called nucleus. Electrons are revolving around the nucleus in circles. These circles are called orbits.

Deffect's in Rutherford's Atomic Model:-

Rutherford atomic model has following defects.

1. According to classical physics the electrons are charged particles and they emit energy continuously while revolving around the nucleus. Due to release of energy the orbit of electrons become smaller and smaller untill it would fall in to the nucleus. This would collapse the atomic structure.
2. If the revolving electron emit energy continuously then it should form a continuous spectrum but in this case a line spectrum is obtained..

Bohr's Atomic Theory:-

In 1913 Neil Bohr proposed a model for an atom. The main postulates of Bohr atomic theory are given as.

1. The electron in an atom revolves around the nucleus in one of the circular orbits. Each orbit has a fixed energy so each orbit is called energy level.

2. The energy of the electron in an orbit is directly proportional to its distance from the nucleus. The further the electron is from the nucleus the more energy it has.

3. The electron revolves only on those orbits for which the angular momentum of the electron is an integral multiple of $\frac{h}{2\pi}$. Where 'h' is planks constant and its value is 6.62 x 10-34 J.sec.

4. When an electron jumps to higher energy orbit then light is absorbed and when an electron falls into lower energy orbit then light is emitted. The electron present in a particle orbit does not lose or gain energy.

5. The energy of the light emitted is equal to the difference between the energies of the orbits.

$$\triangle E = E_2 - E_1$$

Where

$\triangle E$ = Difference of energy

E_1 = Energy of first orbit

E_2 = Energy of second orbit

Isotopes:-

The atoms of an element which has same atomic number but different mass umber are called isotopes.

Isotopes have same number of protons but different number of neutrons.

Isotopes of Hydrogen:-

There are three isotopes of hydrogen.

1. Protium.

2. deutrium

3. Tritium

1. Protium:-

Protium is the first isotope of hydrogen. It has one proton but no neutron. Its symbole is.

$^{1}_{1}H$

2. Deutrium:-

Deutrium is the second isotope of hydrogen. It has one proton and one neutron. Its symbol is $^{2}_{1}H$

3. Tritium:-

Tritium is the third isotope of hydrogen. It has one proton and two neutrons. Its symbol is $^{3}_{1}H$

Isotopes of carbon:-

There are three isotopes of carbon.

1. Carbon - 12
2. Carbon – 13
3. Carbon - 14

1. Carbon - 12:-

Carbon – 12 is the first isotope of carbon. It has six protons and six neutrons. Its symbol is $^{12}_{6}C$

2. Carbon - 13:-

It is the second isotope of carbon. It has six protons and seven neutrons. Its symbol is $^{13}_{6}C$

3. Carbon - 14:-

It is the third isotope of carbon. It has six protons and eight neutrons. Its symbol is $^{14}_{6}H$

Isotopes of Chlorine:-

There are two isotopes of chlorine.

1. chlorine - 35
2. chlorine- 37

1. Chlorine - 35:-

Chlorine -35 is the first isotope of chlorine. It has '17' protons and 18 neutrons. Its symbol is $^{35}_{17}Cl$

2. Chlorine - 37:-

Chlorine-37 is the second isotope of chlorine. It has '17' protons and '20' neutrons. Its symbol is

1. Isotopes of Uranium:-

There are three isotopes.

1. Uranium – 234
2. Uranium – 235
3. Uranium – 238

1. Uranium - 234:-

Uranium-234 is the first isotope of uranium. It has '92' protons and '142' neutrons. It is naturally present about 0.0006%. Its symbol is $^{234}_{92}U$

2. Uranium - 235:-

Uranium-235 is second isotope of uranium. It has '92' protons and 143 neutrons. It is naturally present about 0.721It is also used in nuclear reactors and atomic bomb. Its symbol is $^{235}_{92}U$

3. Uranium - 238:-

Uranium-238 is third isotope of uranium. It has 92 protons and 146 neutrons. It is naturally present about 99.27%. Its symbol is. $^{238}_{92}U$

When uranium-238 decays in to thorium-234 then it emits alpha particles. Alpha particle is doubly positively charged helium nucleus.

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

Energy obtained from Uranium - 235:-

The nuclear energy released by the fission of one kilogram of uranium-235 is equal to the chemical energy produced by burning more than 17000kg of coal.

Question

Why isotope of an element have similar chemical properties?

Ans: We know that chemical properties of an element depends upon number of protons and electrons. But chemical properties does not depends upon number of neutrons. Since all the isotopes of an element have same number of protons and electrons therefore isotopes of an element have similar chemical properties.

Uses of Isotopes

First Use:-

Radioactive iodine-131 is used as a tracer in diagnosing thyroid problem.

Second Use:-

Na-24 is used to trace flow of blood and the changes that occur in circulatory system.

Third Use:-

Iodine-123 is used to image the brain.

Fourth Use:-

Cobalt-60 is used to decrease cancer cells.

Fifth Use:-

Carbon-14 is used to trace the path of carbon in photosynthesis.

Sixth Use:-

Radioactive isotopes are used to determine the molecular structure of elements. For example sulphur-35 is used to study the structure of thiosulphate.

Seventh Use:-

Radioactive isotopes are used to study the mechanism of chemical reactions.

Eight Use:-

Radioactive isotopes are used to find age of rocks, soils, mummies and different archeological objects.

Shells and Sub shell:-

Sub shell:-

According to bohr's atomic theory the electron in an atom revolves around the nucleus in circles. These circles are called orbits or shells. Each shell has a fix energy so each shell is called energy level. Shells are normally represented by K, L, M and N

For K shell , n = 1
For L shell , n = 2
For M shell , n = 3
For N shell , n = 4

Sub shell:-

A shell or energy level is sub- divided into different circles. These sub divided circles are called sub-shells. Sub shells are normally represented by

s – sub shell
p – sub shell
d – sub shell
f – sub shell

s – sub shell can have maximum 2 electrons
p – sub shell can have maximum 6 electrons
d – sub shell can have maximum 10 electrons
f – sub shell can have maximum 14 electrons

Electronic Configuration:-

The arrangement of electrons in sub shell is called as electronic configuration.

Auf Bau Principle:-

Auf bau principle is used to fill electrons in different sub-shells. According to this principle the electrons fill the lowest energy sub-shell that is available first.

"Electronic Configuration":-

~~1S~~
~~2S~~ 2P
~~3S~~ ~~3P~~ 3d
~~4S~~ 4p ~~4d~~ 4f
~~5s~~ 5p 5d 5f
~~6s~~ 6p 6d 6f

s ⟶ 2 electrons
p ⟶ 6 electrons
d ⟶ 10 electrons
f ⟶ 14 electrons

Example 1

Write electronic configuration of following elements.

1. **$_1$A**

$_1A = 1s^1$

2. **$_2$B**

$_2B = 1s^2$

3. **$_3$C**

$_3C = 1s^2, 2s^1$

4. **$_4$D**

$_4D = 1s^2, 2s^2$

5. **$_5$E**

$_5E = 1s^2, 2s^2, 2p^1$

6. **$_6$F**

$_6F = 1s^2, 2s^2, 2p^2$

7. **$_7$G**

$_7G = 1s^2, 2s^2, 2p^3$

8. $_8$H

$_8H = 1s^2, 2s^2, 2p^4$

Example 2

Write electronic configuration of following elements.

1. $_{9}A$

   $_{9}A = 1s^2, 2s^2, 2p^5$

2. $_{10}B$

   $_{10}B = 1s^2, 2s^2, 2p^6$

3. $_{11}C$

   $_{11}C = 1s^2, 2s^2, 2p^6, 3s^1$

4. $_{12}D$

   $_{12}D = 1s^2, 2s^2, 2p^6, 3s^2$

5. $_{13}E$

   $_{13}E = 1s^2, 2s^2, 2p^{6,} 3s^2, 3p^1$

6. $_{14}F$

   $_{14}F = 1s^2, 2s^2, 2p^6, 3s^2, 3p^2$

7. $_{15}G$

   $_{14}G = 1s^2, 2s^2, 2p^6, 3s^2, 3P^4$

8. $_{16}H$

   $_{16}H = 1s^2, 2s^2, 2p^6, 3s^2, 3p^4$

Example 3

Write electronic configuration of following elements.

1. $_{17}A = 1s^2, 2s^2, 2p^6, 2s^2, 3p^5$
2. $_{18}B = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6$
3. $_{19}C = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$
4. $_{20}D = 1s^2, 2s^2, 2p^6, 3s^{2,} 3p^6, 4s^2$
5. $_{21}E = 1s^2, 2S^2, 2P^{6,} 3s^2, 3p^6, 4s^2, 3d^1$
6. $_{22}F = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^2$
7. $_{23}G = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^3$
8. $_{24}H = 1s^2, 2s^2, 2p^6, 3s^2, 3P^6, 4s^2, 3d^4$
9. $_{25}I = 1s^2, 2s^2, 2p^6, 3s^2, 3P^6, 4s^2, 3d^5$
10. $_{26}J = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^7$
11. $_{27}K = 1s^2, 2s^2, 2p^6, 3s^2, 3P^6, 4s^2, 3d^7$
12. $_{28}L = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^8$
13. $_{29}M = 1s^2, 2s^2, 2p^6, 3s^2, 3P^6, 4s^2, 3d^9$
14. $_{30}N = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}.$

Page No. 43 Self Assessment Exercise No. 2.3

Write electronic configuration for following elements.

1. **Al (Atomic number 13)**
   $_{13}Al = 1s^2, 2s^2, 2p^6, 3s^2, 3p^1$
2. **Si (Atomic number 14)**
   $_{14}Si = 1s^2, 2s^2, 2p^6, 3s^2, 3p^2$
3. **P (Atomic number 15)**
   $_{15}P = 1s^2, 2s^2, 2p^6, 3s^2, 3p^3$
4. **S (Atomic number 16)**
   $_{16}S = 1s^2, 2s^2, 2p^6, 3s^2, 3p^4$
5. **CI (Atomic number 17)**
   $_{17}Cl = 1s^2, 2s^2, 2p^6, 3s^2, 3p^5$
6. **Ar (Atomic number 18)**
   $_{18}Ar = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6$

Page No. 43 Self Assessment Exercise No. 2.4

Write electronic configuration for following elements.

1. $^{14}_{6}C$.

   $= 1s^2, 2s^2, 2p^2,$
2. $^{35}_{17}Cl$.

   $= 1s^2, 2s^2, 2p^6, 3s^2, 3p^5$

Page No. 46 (Exercise Questions) Q No. 2

1. **Shells and Sub shell:-**

Sub shell:-

According to bohr's atomic theory the electron in an atom revolves around the nucleus in circles. These circles are called orbits or shells. Each shell has a fix energy so each shell is called energy level. Shells are normally represented by K, L, M and N

For K shell n = 1
For L shell n = 2
For M shell n = 3
For N shell n = 4

Sub-shell:-

A shell or energy level is sub divided into different circles. These sub divided circles are called sub-shells. Sub shells are normally represented by

s – sub shell can have maximum 2 electrons
p – sub shell can have maximum 6 electrons
d – sub shell can have maximum 10 electrons
f – sub shell can have maximum 14 electrons

2. An atom is electrically neutral, Why:-

Ans. We know that the total number of electrons are equal to total number of proton's. The electrons carry negative charge and the protons carry positive charge. It means that total number of negative charges. Therefore the net charge of an atom is zero. Hence an atom is electrically neutral.

3. How many sub-shell are there in N shell:-

Ans. We know that in case of atomic shell

For K – shell n = 1
For L - shell n = 2
For M – shell n = 3
For N – shell n = 4

Since for N shell n = 4. Therefore N - shell has four sub shells

4. Give notation for sub shell of M shell?

Ans. We know that in case of atomic shells

For K – shell n = 1
For L - shell n = 2
For M – shell n = 3

5. List the sub shells of M shell in order of increasing energy?

Ans. We know that in case of atomic shells.

For K – shell n = 1
For L - shell n = 2
For M – shell n = 3

Since for M-shell n = 3 so M-shell has three sub shells

3s, 3p, 3d

The sub – shell in increasing energy order will be

3s < 3p < 3d

6. Can you identify an atom without knowing number of neutrons in it?

Ans. Yes, we can identify an atom without knowing the number of neutrons in it because we know that

number of neutron = atomic mass - atomic number.

Where

Atomic mass = Number of protons + Number of neutrons

And

Atomic number = Number of protons

Questions No. 3

The electronic configuration listed are incorrect. Explain what mistake has been made in each and write correct electronic configurations.

x = $1s^2, 2s^2, 2p^4, 2s^2, 3p^2$

y = $1s^2, 2s^1, 2p^4, 2p^1$

z = $1s^2, 2s^2, 2p^5, 3s^1$

Ans. According to Auf Bau principal the electron fill the lowest energy sub-shell that is available first. It means that the electron will fill the sub-shell in following order.

1S then 2s, then 2p the 3s then …….

1s<2s, < 29 < 3S < 3p, 4s, 3d, …….

x = $1s^2, 2s^2, 2p^4, 3p^2$

Correct electronic configuration is

Correct electronic configuration is

Correct electronic configuration is

Page No. 47 Questions No. 4

Which orbital in each of the following pairs is lower in energy?

a. 2s, 2p

The energy of 2s is less than 2p

$2s < 2p$

b. 3P, 2P

The energy of 2p is less than 3p

$2p < 3p$

c. 3S, 4S

The energy of 3s is less than 4S

$3S < 4s$

Questions No. 5

Draw Bohr's Model for the following atom including location for electrons, protons and neutrons:

Part a.

Potassium (Atomic No. 19, Mass No. 39)

We know that Atomic number = number of electrons

Also

Atomic number = Number of protons

So

Number of electrons = 19

Number of protons = 19

And

Number of neutrons = mass number –Atomic number

Number of neutrons = 39 – 19

= 20

Now

Bohr's Model for potassium is in

k- shell = 2 electrons

l - shell = 8 electrons

m - shell = 8 electrons

n - shell = 1 electron

Part b.

Silicon (Atomic number = 14, Mass number = 28)

We know that Atomic Number = Number of electrons = Number of protons

So,

Number of electrons = 14

Number of protons = 14

Now,

Number of neutrons = mass number –Atomic number

Number of neutrons = 28 – 14

Number of neutrons = 14

Now

Bohr's Model for potassium is in

K- shell = 2 electrons

L - shell = 8 electrons

M - shell = 4 electrons

Part c.

Argon (Atomic no. = 18, Mass no. 39)

We know that Atomic Number = Number of electron = Number of protons

So

Number of electrons = 18

Number of protons = 18

Now,

Number of neutrons = mass number –Atomic number

Number of neutrons = 39 – 18

Number of neutrons = 21

Now

Bohr's Model for Argon is

k- shell = 2

l - shell = 8

m - shell = 8

Questions No. 8

Explain how Bohr's atomic theory differed from Rutherford's theory?

Ans.

Rutherford's atomic Theory	Bohr's atomic Theory
1. Rutherford's atomic theory based on classical theory.	**1.** Bohr's atomic theory was based on quantum theory.
2. According to Rutherford's atomic theory the electrons revolve around the nucleus.	**2.** According to Bohr's atomic theory the electrons revolve around the nucleus in orbits. Each orbit has a fined energy
3. Rutherford's atomic theory does not gives any information about orbits.	**3.** Bohr's atomic theory give information about every orbit.
4. According to Rutherford's atomic theory atoms should produce continuous spectrum.	**4.** According to Bohr's atomic theory atoms should (form) produce line spectrum.

Questions No. 9

Describe the importance of sub-shell in a shell?

Ans.

According to Bohr's atomic theory the electron in an atom revolves around the nucleus in circular paths. These circular paths are called orbits or shells. Each shell is subdivided into different circles. These sub divided circles are called sub-shells

Sub shells are normally represented by s, p, d and f

s- sub shell can have maximum of 2- electrons

p- sub shell can have maximum of 6- electrons

d- sub shell can have maximum of 10- electrons

f- sub shell can have maximum of 14- electrons

The increasing order of energy far

Sub shells is

1S < 2S < 2p < 3S<3p

Questions No. 10

The atomic number of an element is 23 and its mass number is 56.

a. How many proton & Electron does atom have

b. How many Neutron atom have

Atomic number = 23
Mass number = 56
Number of protons = ?
Number of neutrons = ?

We know that

Number of electrons = Atomic number
Number of electron = 23

We know that

Number of neutrons = Mass number – Atomic number
Number of neutrons = 56-23
Number of neutrons = 33

Questions No. 11

The Atomic symbol of Aluminum is written as Al. What information do you get.

Ans. Aluminum Al

Atomic number = 13
Mass number = 27

We know that

Number of protons = Atomic number
Number of protons = 13

Also

Number of electrons = Atomic number
Numbers of electrons = 13

We know that

Number of neutrons = Mass number – atomic number
Number of neutrons = 27 – 13
Number of neutrons = 14

Questions No. 12

How testing prevailing theories bring about changes in them?

Ans. When some ideas of scientist are not correct then scientist did not reject these ideas. But they use those ideas for new discoveries. That is why we can say that testing prevailing theories bring about changes.