Chemistry

Class 9 Chapter 2

Important Questions/Answers

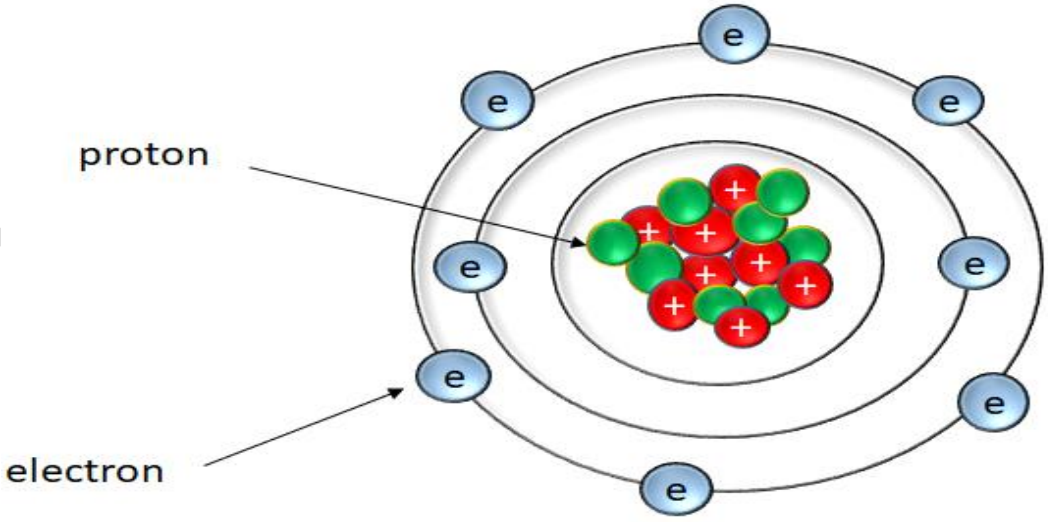
Q. What were the observations of Rutherford's experiment?

Answer

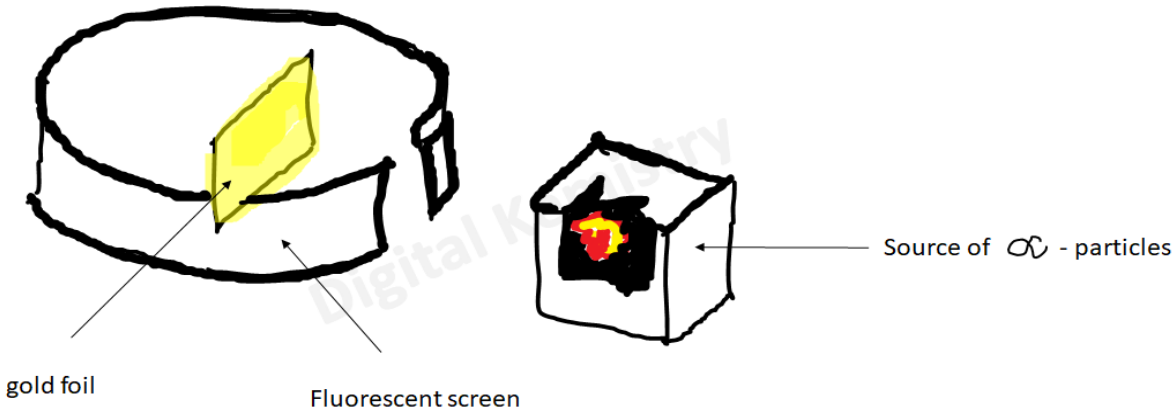
Rutherford atomic model

Discoverer

In the year 1911 Rutherford experimented to know about arrangements of sub-atomic particles such as electrons and protons in an atom.



Rutherford's Gold Foil Experiment

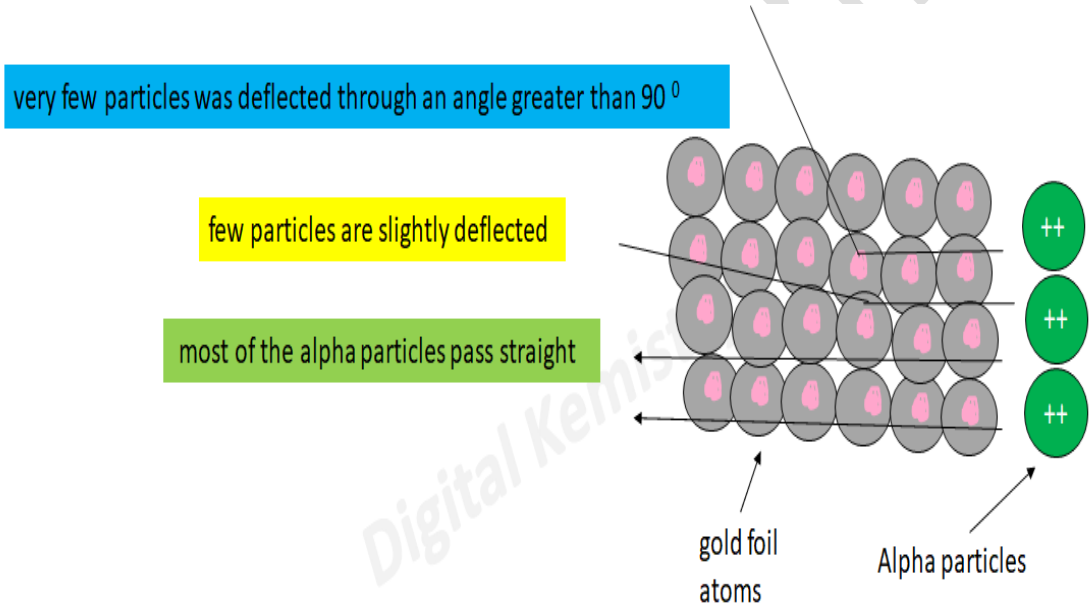


Alpha particles obtained from disintegration of polonium.
Alpha particles are helium nuclei .i.e. He^{++} is doubly positively charged.

- First of all, Rutherford took a gold foil of about 4×10^{-5}cm and bombarded alpha particles on it.
- Alpha particles are helium nuclei with two protons and two neutrons present together.
- The alpha particles that were used in this experiment were obtained from the disintegration of Polonium
- The majority of these particles passed through the foil undeflected so Rutherford hypothesized that most of the space in an atom is empty.
- Because some of the alpha particles were somewhat deflected by the gold sheet, the positive charge in an atom is not spread evenly. An atom's positive charge is confined to a very small volume.
- Only a handful of the alpha particles were deflected back, meaning that their angles of deflection were only about 180 degrees. Consequently, the positively charged particles in an atom only occupy a very tiny portion of the atom's overall volume.

Rutherford scattering experiment conclusion

- An atom's positive charge and the majority of its mass are packed into a very tiny volume. He referred to this part of the atom as the nucleus.
- According to Rutherford's theory, an atom's nucleus is surrounded by electrons that are negatively charged. He also asserted that the electrons that surround the nucleus travel in a circular pattern at extremely high speeds. He named these cyclical routes as "orbits."
- A strong electrostatic force of attraction holds the negatively charged electrons also the positively charged mass that makes up the nucleus together.



What does Rutherford's model explain?

It explains that an atom is made up of a relatively small mass of an atom, known as the nucleus, where all of the atom's mass is concentrated and where the electrons are free to move around easily.

What is Rutherford's atomic model called?

The "Rutherford nuclear atom" and "Rutherford Planetary Model" were other names for the Rutherford atomic model.

Why did Rutherford model of an atom fail?

The stability of electrons moving in a circular direction could not be explained by Rutherford's atomic model. He claimed that while particles in motion would experience acceleration and produce energy radiation, electrons move in a circular manner around the nucleus. Electrons should eventually become less energetic and fall into the nucleus.

Q. What are the defects of Rutherford atomic model?

ANSWER.

Defects in Rutherford atomic model

- Despite being founded on experimental findings, the Rutherford atomic model proved unable to explain several phenomena.
- According to classical physics, an electron being a charged particle an electron should emit energy continuously when it is revolving around the nucleus. So that loses all of its energy and ultimately spirals into the nucleus.
- If a revolving electron emits energy continuously then the spectrum obtained should be continuous but instead, a line spectrum is obtained.

Q.Write down the findings of Bohr in the Bohr atomic model?

Answer.

Discovery

Neil Bohr presented a model of atomic structure in 1913, known as Bohr's atomic model, which depicted an atom as a tiny, positively charged nucleus surrounded by electrons that move in circular orbits around the positively charged nucleus like planets do around the sun in our solar system.

Findings of Bohr theory

- Without emitting radiant energy, electrons move in stable orbits around the nucleus. Each orbit contains a certain amount of energy and is known as an energy level or shell.
- K, L, M, and N shells are used to describe an orbit or energy level. The term "ground state" refers to the electrons lowest energy level.
- When an electron changes its orbit or energy level, it either emits or absorbs energy. It produces energy when it jumps from a higher to a lower energy level, and it absorbs energy when it goes from a lower to a higher energy level.
- According to Plank's equation, the energy received or released is equal to the difference between the energies of the two energy levels (E_1, E_2).

$$\Delta E = E_2 - E_1 = h\nu$$

ΔE = energy received or released
h= Plank's constant
ν= frequency of radiation

- The angular momentum of an electron revolving different orbits is given by:

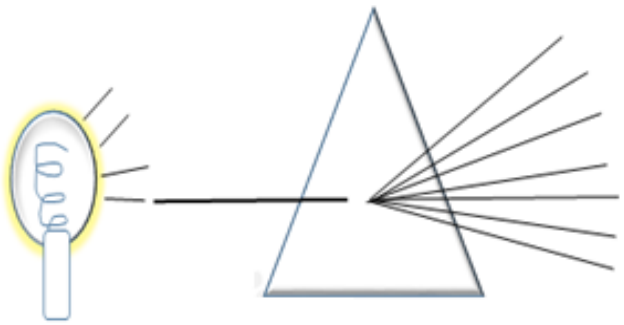
$mvr = nh/2\pi$

Where,
n= number of energy shell; 1, 2, 3 …..
m_e= mass of an electron
v= velocity
r=radius
h= Plank's constant

Q.Describe the limitations of Bohr model.

Answer

- The Heisenberg Uncertainty Principle is violated. Heisenberg states that it is impossible for an object to have both a known location and momentum at the same time
- When bigger atoms are taken into account, the Bohr atomic model theory contains inaccurate spectrum predictions. This is true for smaller atoms like hydrogen



- It was unable to explain the Zeeman phenomenon, which occurs when a magnetic field causes the spectral line to break into many components.
- It was unable to explain the Stark effect, which occurs when an electric field causes the spectral line to break into smaller lines.

Q.What did Bohr discover in his model?

According to the Bohr model, an atom consists of a tiny, positively charged nucleus that is around by orbiting electrons. Bohr was the first to determine that electrons move in different orbits around the nucleus and that an element's properties are determined by the number of electrons in its outer orbit.

Q.Difference between the Rutherford model and the Bohr model of an atom?

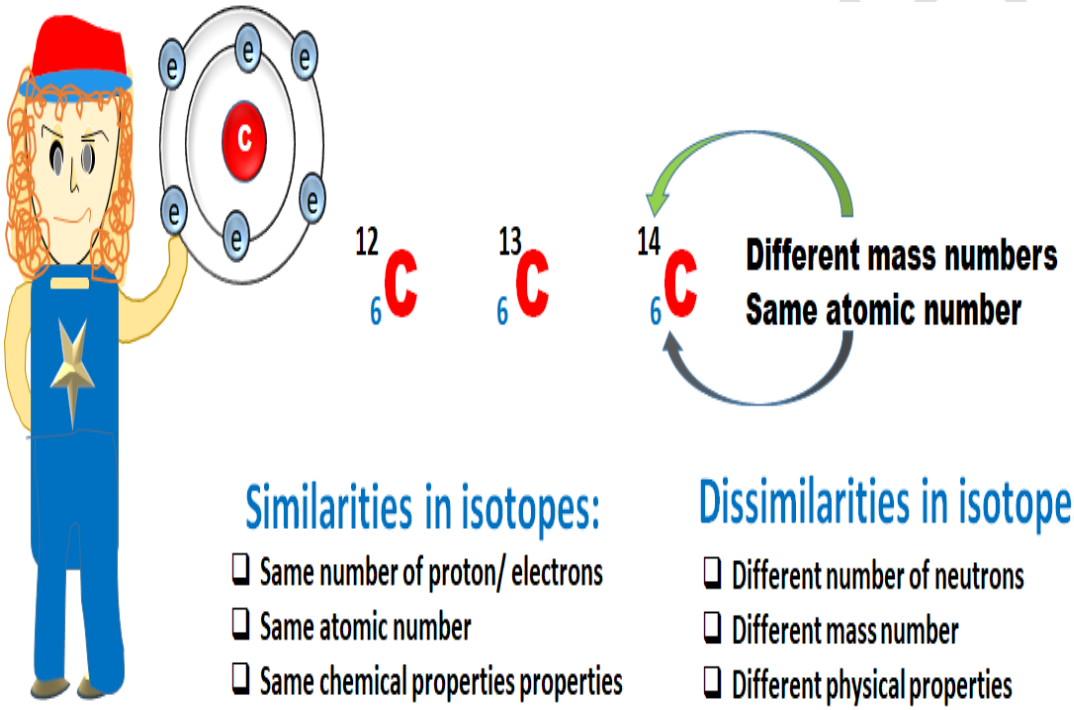
Rutherford's Atomic Theory	Bohr's Atomic Theory
According to the Rutherford theory, an atom has a central nucleus where nearly all of its mass is concentrated, and lighter particles (electron) circulate all around it.	According to Bohr's Theory, electrons always move through particular shells that surround the nucleus and have constant energy.
Rutherford theory based on the observations of gold foil experiment.	Bohr's Theory based on observations of line spectra of hydrogen atom.
It was based upon classical theory.	It was based upon quantum theory.
Electrons revolves around the nucleus	Electrons revolves around the nucleus in orbits of fixed energy.
No idea of orbits was introduced	Orbits had angular momentum .i.e. $mvr = nh / 2\pi$
Atoms should produce continuous spectrum	Atoms should produce line spectrum
Atoms should collapse (break / disintegrate)	Atoms should exist.

Q.What are isotopes?

Answer

Isotope

An isotope is a variation of the same element with a different number of neutrons in its nucleus.



Explanation:

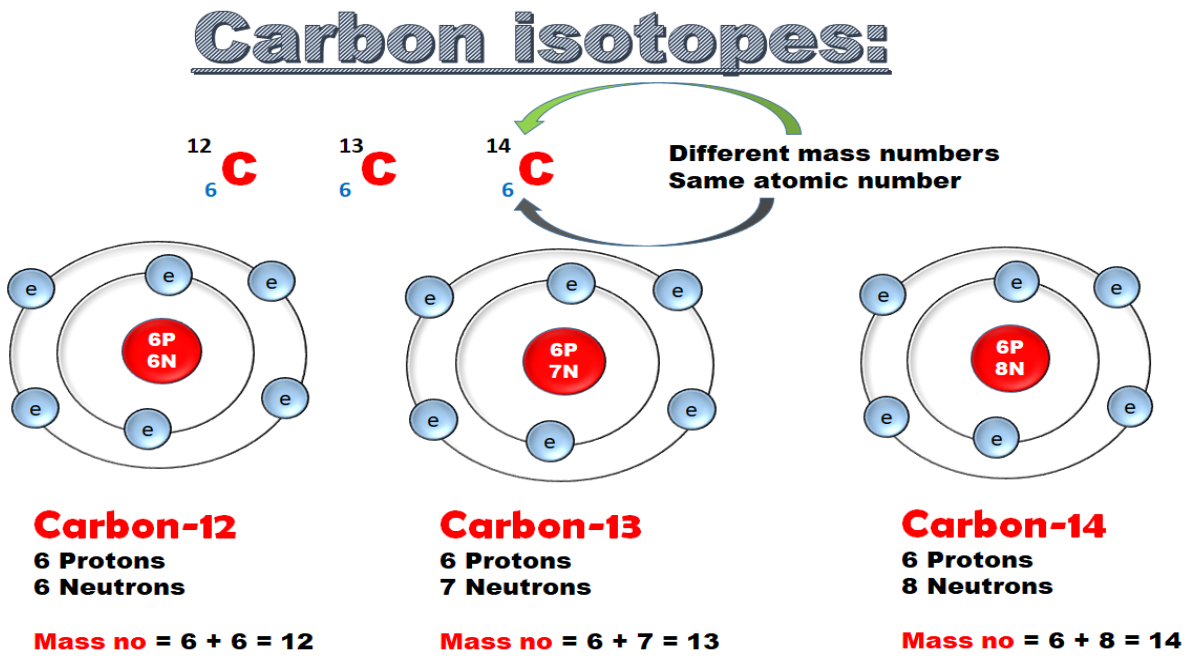
Isotopes are variations of chemical elements that have a variable number of neutrons but the same number of protons and electrons. As a result of a difference in the total number of neutrons in their respective nuclei, isotopes are variations of elements that have different nucleon numbers (total number of protons and neutrons).

Q. What are the 3 main isotopes of carbon?

Answer

There are 3 main isotopes of carbon.

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



Q. What is the atomic number and mass number of oxygen isotopes?

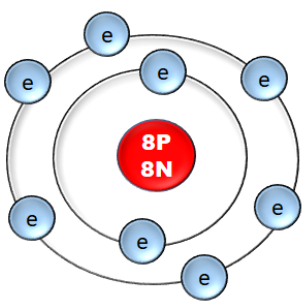
- Oxygen-16
- Oxygen-17
- Oxygen-18

Answer:

Three stable isotopes of the element oxygen (O), $_{16}O$, $_{17}O$, and $_{18}O$, exist in nature. Each of these oxygen isotopes has a nucleus made up of eight protons and either eight, nine, or ten neutrons.

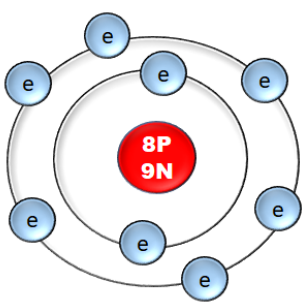
ISOTOPES OF OXYGEN

^{16}O ^{17}O ^{18}O



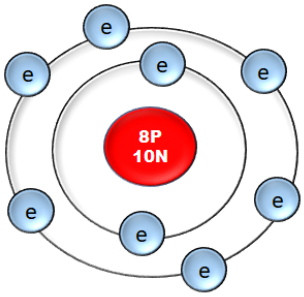
Oxygen-16
8 Protons
8 Neutrons

Mass no = 8 + 8 = 16



Oxygen-17
8 Protons
9 Neutrons

Mass no = 8 + 9 = 17



Oxygen-18
8 Protons
10 Neutrons

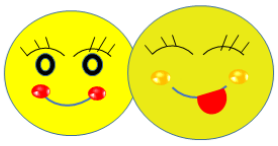
Mass no = 8 + 10 = 18

Why isotopes are unstable?

Isotopes **are unstable because they can not hold together, they have too many or too few neutrons.** The are called radio-isotopes. Large atomic nuclei, with more than 93 protons or neutrons, are unstable. **Uranium** is an examples of such elements

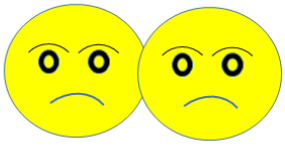
Two types of Isotopes are:

- ❑ **stable**



(Happy to live together)

- ❑ **unstable(radioactive).**



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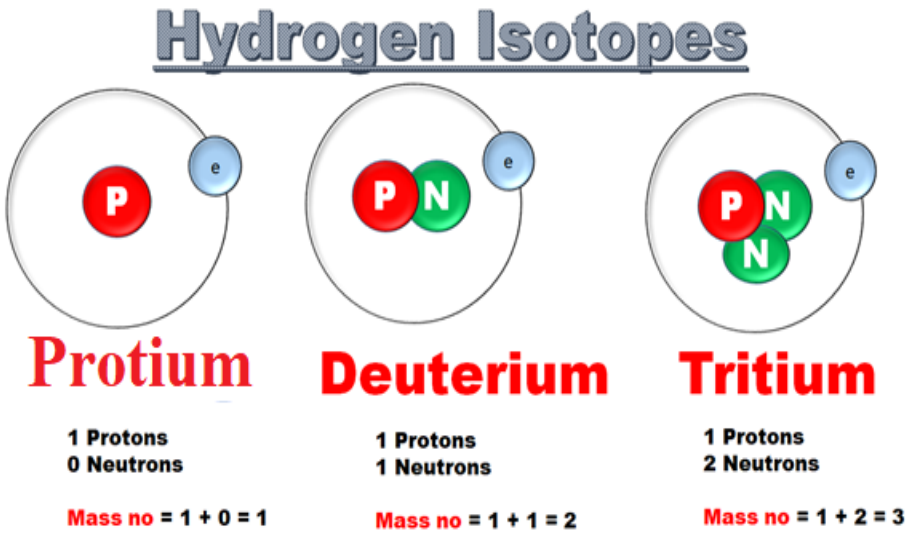
Q. What are the 3 isotopes of hydrogen?

ANSWER

Isotopes of hydrogen



The periodic table's first element, hydrogen, has an atomic number one. Isotopes are defined as elements with the same atomic number but a different mass number. Protium $1H^1$, deuterium $1H^2$ or D, and tritium $1H^3$ or T are the three hydrogen isotopes. All three of them have different mass numbers because the isotopes have varying amounts of neutrons

Protium

It is one of the most prevalent hydrogen isotopes. Natural abundance of protium is 99.98%. Protium has a mass of 1.007825 amu.

Deutrium

Its nucleus contains a proton and a neutron. The deuteron is the name for the hydrogen-2 nucleus. It doesn't emit radiation. Its compounds are utilized as solvents for hydrogen 1 and in chemical analysis. Heavy

water (D_2O) is enhanced with deuterium. It functions as a neutron moderator and coolant. Nuclear fusion also uses hydrogen 2 as a fuel

Tritium

Its nucleus has one proton and two neutrons. The interaction of cosmic rays with atmospheric gases results in minute amounts of tritium, often known as hydrogen 3, appearing in nature. Additionally, they are briefly released when nuclear bombs are tested. The atomic mass of hydrogen 3 is 3.0160492 u.

Q.Write a note on the isotopes of carbon.

Answer

ISOTOPES OF CARBON

Carbon is present at the top of the fourth group in the periodic table having atomic number 6 and mass number 12.

Carbon has 3 isotopes

Carbon-12

The isotope of carbon that is the most abundant is Carbon-12. It contains six protons and six neutrons. Its natural abundance is 98.8%.

Carbon-13

The second isotope of carbon is called Carbon-13 having 7 neutrons in addition to six protons with a natural abundance of 1.1%.

Carbon-14

The third isotope namely Carbon-14 has 8 neutrons plus 6 protons in its nucleus and has a natural abundance of 0.009%.

Q.Write a note on the isotopes of chlorine.

Answer

ISOTOPES OF CHLORINE

Chlorine is the second member of the halogen family and has atomic number 17 and mass number 35.5.

Chlorine has 2 isotopes

Chlorine-35

The first isotope having the greater natural abundance is chlorine-35. It contains 17 protons and 18 neutrons and a percentage abundance of 75.7%

Chlorine-37

The second isotope of chlorine is chlorine-37 containing 17 protons and 20 neutrons and a percentage abundance of 24.3%.

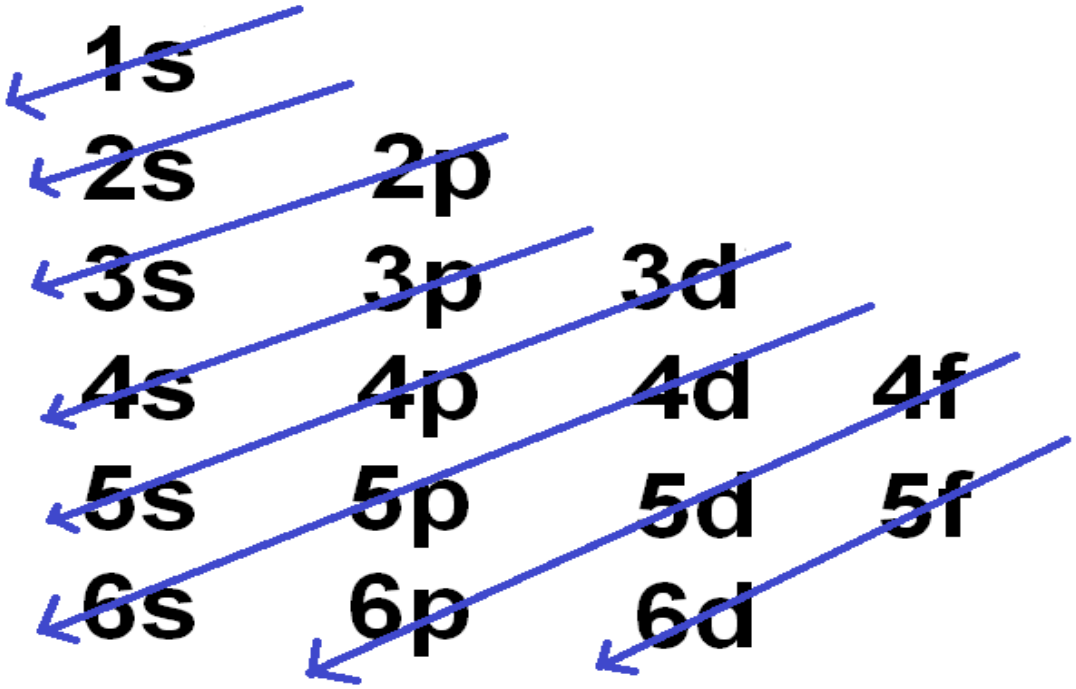
Q.Describe the uses of different isotopes.

Answer

USES

- Radioactive iodine is used in diagnosing thyroid problems
- Cobalt-60 is used in killing cancer cells and also for the shrinkage of tumors
- Some radio-isotopes are used for determining molecular structures.
- They are also used to study different reaction mechanisms.
- Carbon-14 is used to trace the path of carbon in photosynthesis

Q.Write a note on electronic configuration.



ANSWER.

Electronic Configuration

It is the systemic distribution of electrons in various energy levels in the order of increasing energy.

The electrons in the various energy levels, sub-energy levels are distributed according to the Aufbau principle.

1. **Aufbau principle**

It is the process of filling electrons into various energy levels in the order of increasing energy.

The relative energy of various energy levels can be determined by using the following rule.

(n+ l) Rule

According to (n+ l) Rule

i) A sub-shell with the lowest (n+ l) value has the lowest energy and is filled first with electrons.

ii) When two or more subshells have the same (n+ l) value, then the subshell with a lower value of 'n' has the lowest energy and is filled first.
For example consider (n+ l)values for 3d,4p and 5s orbitals.

For 3d subshell n=3 , l=2 and (n+ l) = 3+2 =5
For 4p subshell n=4 , l=1 and (n+ l) = 4+1 =5
For 5s subshell n=5 , l=0 and (n+ l) = 5+0 =5

All the subshells have the same (n+ l) values.
Comparing n- values, the order of filling of the three subshells is :
3d<4p<5s

Uses for electron configurations include:

- Figuring out an element's valency.
- Predicting a set of components' qualities (elements with similar electron configurations tend to share similar properties).
- Analysis of atomic spectra.

Electronic Configuration of Iron :

(SHELL WISE , SUB SHELL WISE)

SHELL WISE:

$_{26}Fe$: K SHELL = 2 , L SHELL = 8 M SHELL. = 14 , N SUB SHELL = 2

SUB SHELL WISE:

$_{26}Fe$ $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^6$

4s filled first than 3d

4s $n+\ell = 4+0 = 4$

3d $n+\ell = 3+2 = 5$

Q.What is a shell in chemistry?

ANSWER

SHELLS

Electrons revolve around the nucleus in a particular circular pattern known as the shell of an atom.

The electron shell is also known as orbit or energy level.

It is denoted by n. Where n is any positive integer.

Each shell has a fixed amount of energy.

n=1 is known as K-Shell

n=2 is known as L-Shell

n=3 is known as M-shell

Maximum number of Electrons in any Shell

The maximum number of electrons in any shell(n) can be found by using the bohr filling formula=$\mathbf{2n^2}$

Q.What is meant by sub-shells?

ANSWER

Subshells

A shell or energy level is further divided into sub-shells. A subshell is defined as (The region where the probability of finding an electron is maximum in the orbit is termed as a subshell.) The n value of a shell is written before the symbol of a sub-shell.

Examples

- For n=1, K-shell contains only one sub-shell 1s
- For n=2, L-shell contains two sub-shells represented as 2s,2p
- For n=3, M-shell contains three sub-shells represented as 3s,3p,3d
- For n=4, N-shell contains four sub-shells represented as 4s,4p,4d,4f

Maximum Electrons in a Subshell

- **s** subshell can accommodate a maximum of **2 electrons**
- **p** subshell can accommodate a maximum of **6 electrons**
- **d** subshell can accommodate a maximum of **10 electrons**
- **f** subshell can accommodate a maximum of **14 electrons**

Q.Distinguish between shell and subshell of an atom?

Shell (Energy level or Orbit)	Sub-shell (Sub-Energy level)
The circular path that electrons take around the nucleus is known as their shell or orbit.	A shell or energy level is further sub-divided into subshells or sub-energy levels.
Each shell is specified (represent) by n value n = 1,2,3,4,5,……	Each sub-shell is specified by the l value. L = 0,1,2,3,4, …..
N= 1 (K shell) N=2 (L shell) N= 3 (M shell) N=4 (N shell)	K shell -> s subshell L shell -> s, p subshells M shell -> s, p, d subshells N shell -> s, p, d, f subshell
Using formula $2n^2$ to determine the total number of electrons in a shell. n= 1 (K shell) 2 $(1)^2$ = $2e^-$ n=2 (L shell) 2 $(2)^2$ = $8e^-$ n= 3 (M shell) 2 $(3)^2$ = $18e^-$ n=4 (N shell) 2 $(4)^2$ = $32e^-$	Number of sub-shells in a shell = value of "n" s = $2e^-$ p= = $6e^-$ d= = $10e^-$ f = $14e^-$

Q.How many subshells are there in N subshell?

The number of sub-shells within a shell = "n" value.

It indicates that there are four subshells named 4s,4p,4d, and 4f for the N shell.

Q. Provide notation for subshells of M shell?

The number of sub-shells within a shell = "n" value.

It indicates that the M shell has three subshells designated 3s, 3p, and 3d.

Q.Describe Aufbau principle.

Answer

Aufbau Principle

Named after the German phrase "Aufbau," which means "to build up,"

According to the Aufbau principle, electrons will first occupy lower-energy orbitals before moving on to those with higher energies

Electronic Configuration According To Aufbau Principle

Oxygen atomic number 8 =	$1s^2\ 2s^2\ 2p^4$
Aluminum atomic number 13 =	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
Silicon atomic number 14 =	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
Phosphorus atomic number 15=	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
Sulphur atomic number 16=	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

Q. What is n+l rule?

n+ℓ *RULE*:

- **A subshell with the lowest n+ ℓ value has the lowest energy and is filled first with electrons.**
- **When two or more subshells have the same n+ ℓ values, then fill in the one that has the lowest n value.**

n + l RULE:

WE KNOW:

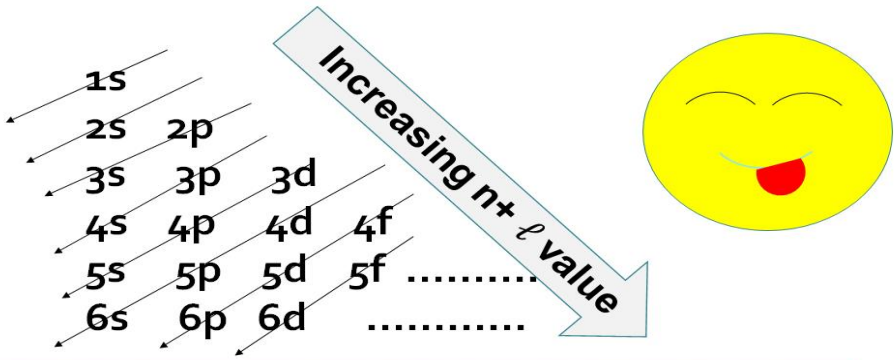
n = 1 ℓ = 0 (s sub shell) n+ ℓ = 1+ 0 = 1

n = 2 ℓ =1 (p sub shell) n+ ℓ = 2 + 1= 3

n= 3 ℓ = 2 (d sub shell) n+ ℓ = 3 + 2 = 5

n = 4 ℓ = 3 (f sub shell) n+ ℓ = 4 + 3 = 7

ENERGY ORDERING OF ORBITALS



Why 4s is filled first than 3d

Why?????

4s filled first than 3d

4s

$n+\ell = 4+0 = 4$

Where:

$n = 4$
$\ell = 0$ (for s sub shell)

3d

$n+\ell = 3+2 = 5$

Where:

$n = 4$
$\ell = 2$ (for d sub shell)