

Atomic Structure

Q1) How are cathode rays produced?

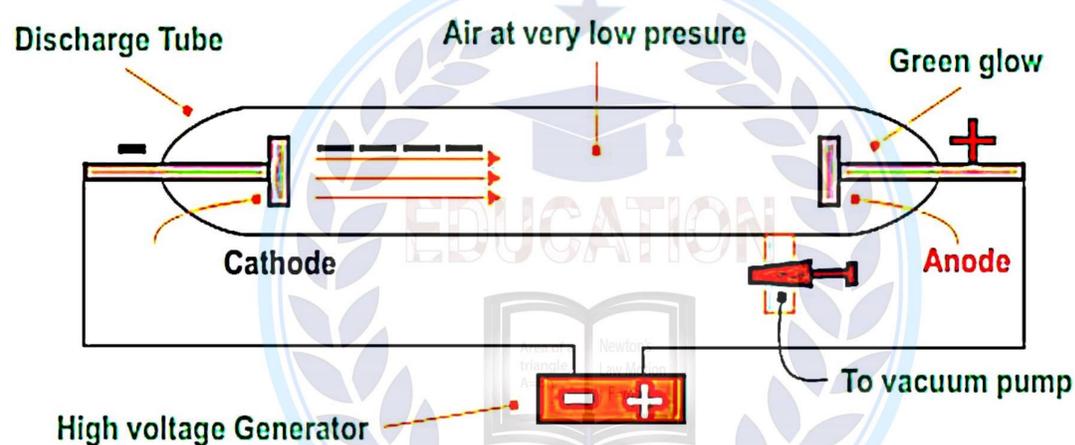
DISCOVERY OF ELECTRONS



Electron is the lightest particle carrying negative charge in an atom discovered by J.J. Thomson and William Crookes.

The apparatus used for this type of experiment is called discharge tube which consists of glass tube fitted with two metal electrodes connected to a high voltage source and a vacuum pump. When electrodes inside evacuated, discharge tube are connected with high voltage source at very low pressure (1mm of Hg), as the high voltage current start passing between electrodes a streak of bluish light originate and travel in straight line from cathode (-ve electrode) to anode (+ve electrode), which cause glow at the wall of opposite end. These rays are called cathode rays.

Discovery of Electrons



J.J. Thomson justified that these rays were deflected towards positive plate in electric and magnetic field which shows that these rays possess negative charge due to this negative charge, particle was named Electron. These electrons were obtained from the gas in discharge tube which proves that electrons are constituent of all matter.

Q2) Give the Properties of Cathode Rays.

PROPERTIES OF CATHODE RAYS

1. They travel in straight line from cathode towards Anode.
2. They produce sharp shadow of an opaque object placed in their path.
3. They have negative charge and bend towards positive plate in electric and magnetic field.
4. These rays when strike with glass and other material cause material glow.
5. The (e/m) charge and mass ratio of cathode particles is 1.7588×10^{18} coulomb per gram. This is same for all electrons, regardless of any gas in discharge tube.

6. They can produce mechanical pressure indicating they possess kinetic energy (K.E).

Q3) Discuss the discovery of protons

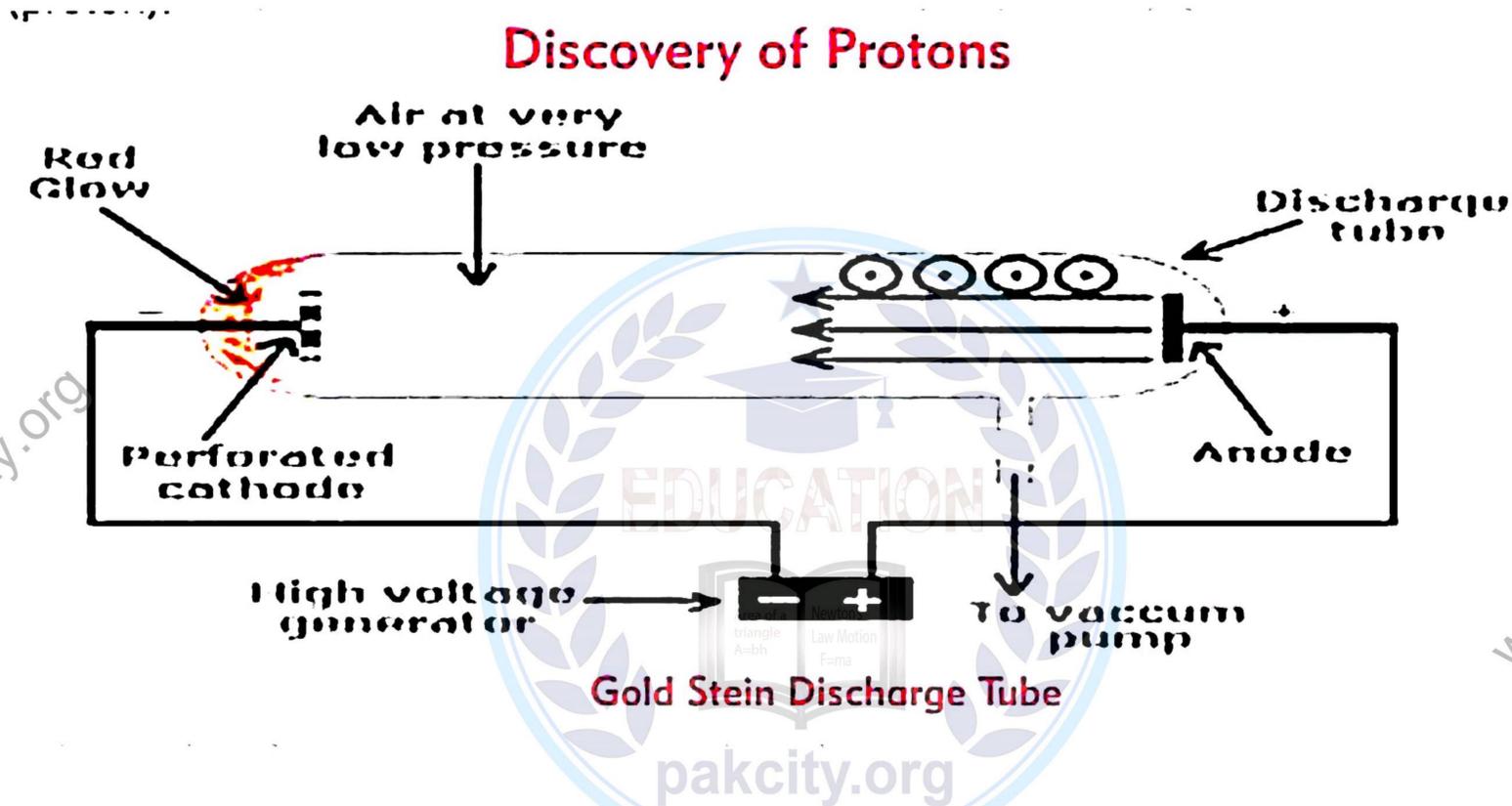
DISCOVERY OF PROTONS



The Proton is positively charge particle discovered by Goldstein in 1886. J.J. Thomson investigate properties of proton in 1897.

Protons were observed in same apparatus of cathode rays tube but with perforated cathode. Goldstein discovered that not only negatively charge cathode rays but positively charge rays are moving in opposite direction by perforating cathode. These positive rays passes through the holes of cathode, where they strike cause the glow of tube. These rays named as Canal rays (proton).

Remember that canal rays are not emitted by anode, but they are result of striking of electron with residual gas molecules in discharge tube.



Q4) Write the properties of protons

PROPERTIES OF CANAL RAYS (PROTONS)

1. They travel in straight line from Anode towards Cathode.
2. They produce sharp shadow of object placed in their path.
3. They have positive charge and bend towards negative plate in electric and magnetic field.
4. The (e/m) charge and mass ratio of positive particles is much smaller than electron. It varies according to nature of gas present in tube.
5. The mass of proton is 1836 times more than electron.

Q5) Discuss the discovery of neutron

DISCOVERY OF NEUTRON

In 1920 Rutherford predicted that atoms must possess another neutral particle with equivalent mass of proton. Different scientists started working on this neutral particle. Later in 1932 Chadwick became successful to discover the neutron. Chadwick found that when alpha (α) particles bombarded beryllium, some penetrating radiations were given out. Chadwick suggested that these radiations were due to a material particle with mass comparable to hydrogen atom but with no charge. These radiations (particle) are called neutrons.

The neutron is a fundamental part of an atom, present in the nucleus with protons and included in atomic mass.



Q6) Write the properties of neutrons

PROPERTIES OF NEUTRONS

1. Neutrons are neutral particles.
2. They have no charge.
3. The mass of a neutron is almost equal to that of a proton.
4. These particles are most penetrating in matter.

Q7) Define atomic number (Z), mass number (A)

ATOMIC NUMBER (Z)

The number of protons in the nucleus of an atom is called the atomic number.

MASS NUMBER (A)

The total sum of protons and neutrons in the nucleus of an atom is called the mass number.

Q8) Discuss Rutherford's gold foil experiment in the light of the structure of an atom.

RUTHERFORD ATOMIC MODEL

Lord Rutherford in 1911 carried out a series of experiments and proposed a new model for the atom.

EXPERIMENT

Rutherford took a thin sheet of gold and bombarded it with alpha (α) particles obtained from a radioactive element (like polonium). These rays scattered from the atom and were examined on a zinc sulphide (ZnS) screen.

OBSERVATIONS

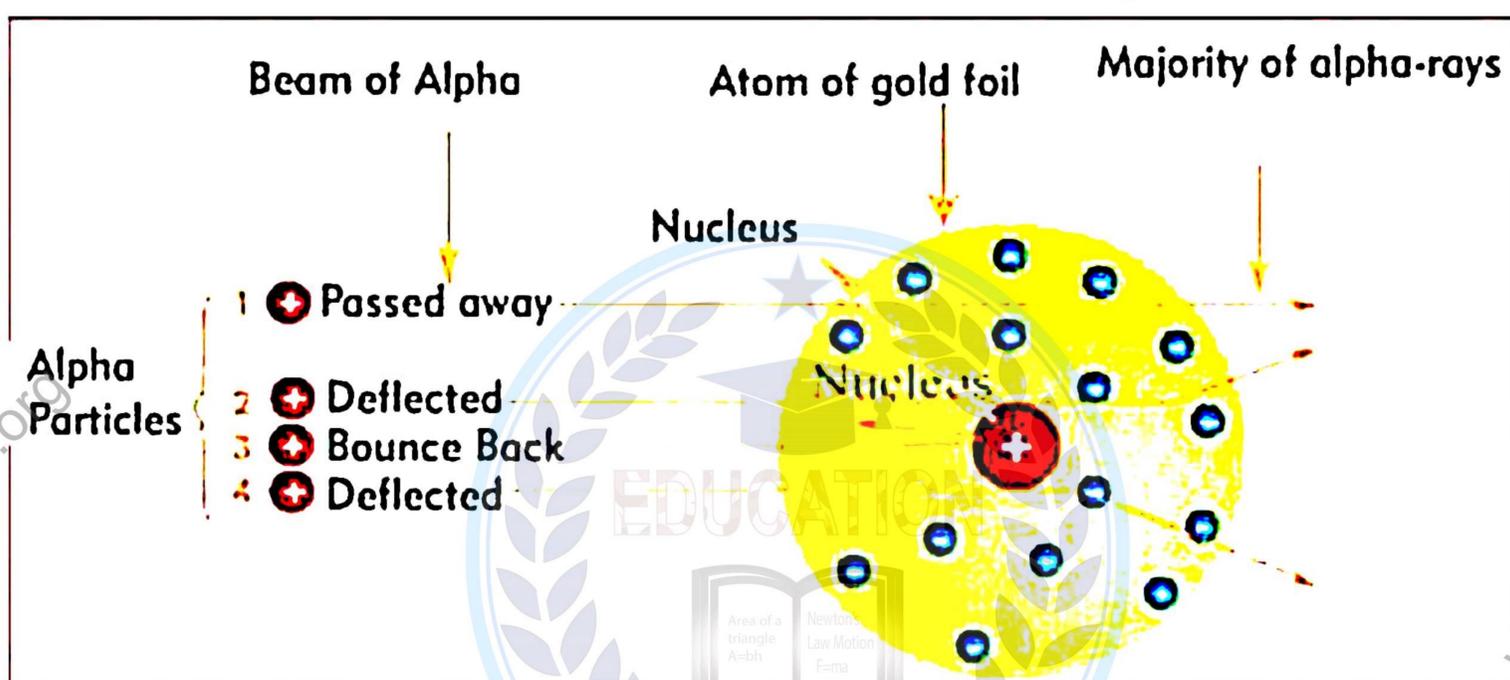
1. Most of the particles passed straight and undeflected through the sheet and produced illumination on the zinc sulphide screen.
2. Very few alpha (α) particles underwent small and strong deflection after passing through the gold sheet.
3. A very few alpha (α) particles (one in 8000) retraced their path.

CONCLUSION

1. According to Rutherford an atom consist of two parts nucleus and extra nuclear part.
2. Majority of the alpha particles passed straight line and un-deflected, shows that most volume occupied by atom is empty.
3. Alpha particles are positively charged and their deflection indicates that the spelling of atom has a positive charge, which is named as nucleus.
4. The mass is concentrated in the nucleus and the electrons are distributed outside the positively charge nucleus.
5. The electrons are revolving around the nucleus in extra nuclear part in orbits.



Conclusion of Rutherford "Gold Foil" experiment



Q9) What are Rutherford postulates?

RUTHERFORD POSTULATES

1. An atom consist of positively charged, dense and very small nucleus containing
2. protons and neutron. The entire mass is concentrated in the nucleus of an atom.
3. The nucleus is surrounded by large empty space which is called extra nuclear part where probability of finding electron is maximum.
4. The electrons are revolving around the nucleus in circular paths with high speed (Velocity).
5. These circular paths were known as orbits (Shells).
6. An atom is electrically neutral because it has equal number of protons and
7. electrons.
8. The size of the nucleus is very small as compared to the size of its original atom.

Q10) Justify that Rutherford atomic model has defects.

DEFECTS OF RUTHERFORD ATOMIC MODEL

1. Rutherford did not explain the stability of an atom.
2. In Rutherford atomic model the negatively charged electrons revolve around the nucleus in circular path and emits energy continuously. Due to continuous loss of energy ultimately falls into the nucleus.
3. If the revolving electron continuous emits energy, then there would be a continuous spectrum but in contrast to it we get line spectrum from the atoms of elements.



Q11) Explain how Bohr's atomic model is different from Rutherford atomic model.

NEIL BOHR POSTULATE

Neil Bohr proposed the following postulates for atomic structure.

1. The atom has fixed orbits in which negatively charged electron is revolving around the positively charged nucleus.
2. These orbits possess certain amount of energy which are called shells and named as K, L, M, N shells.
3. The energy levels are represented by an integer ($n= 1, 2, 3, \dots$) known as quantum number, this quantum range starts from nucleus side, where $n=1$ is lowest energy level.
4. Electrons are revolving in particular orbits continuously, but they are not emits or absorb energy.
5. When electron jumps from lower energy level (E_1) to higher energy level (E_2), it absorbs energy.
6. When electrons jump from higher energy level (E_2) to lower energy level (E_1), it emits energy.
7. The emission or absorption is discontinuous in the form of energy packet called Quantum or Photon.
8. The ΔE difference in energy of higher (E_1) and lower (E_2) energy level.

$$\Delta E = E_2 - E_1$$

$$\Delta E = \nu h = 1 \text{ photon}$$

Here h is planks constant, its value is 6.63×10^{-34} Js and ν is a frequency of light.

9. Stationary state were present in those orbits in which angular moment of electron would be integral multiple of $\frac{h}{2\pi}$

$$mvr = \frac{nh}{2\pi}$$

Where,

n = no of orbits

h =planks constant

m = mass of electron

Q12) What are Limitations of Bohr's Atomic Model?

LIMITATIONS OF BOHR'S ATOMIC MODEL

Bohr's model of an atom failed to explain the Zeeman Effect (effect of magnetic field on the spectra of atoms).

It also failed to explain the Stark effect (effect of electric field on the spectra of atoms).

It deviates the Heisenberg Uncertainty Principle.

It could not explain the spectra obtained from larger atoms.

It explains the mono electronic species like H^{+1} , Li^{+2} , B^{+3} .



Q13) Prove that modern theory of De Broglie is related with Einstein and Plank's equations.

MODERN THEORY OF DE BROGLIE

In 1923 Lois De Broglie extend the wave particle duality to electron, and propose a hypothesis that all matter has particle as well as wave nature at the submicroscopic level. De Broglie combine the Einstein and Planck equations and argued that if

$$E=hg$$

where E = energy, h = plank 'constant, g= frequency of light

$$\text{and } E = mc^2$$

where E = energy, m = mass, c = speed of light

Then

$$hy = mc^2 \text{ OR } \gamma = mc^2/h$$

$$\lambda = h/m\gamma$$

Q14) Describe the Schrodinger atomic model.

SCHRODINGER ATOMIC MODEL

Schrodinger model is just an improvement of Bohr's atomic model. He took an atom of hydrogen because it has one proton and one electron. He proved mathematically that electron can be find in different position around the nucleus and determined by probability.

The quantum mechanical model determines that electron can be find in various

location around the nucleus. He found electrons are in orbit as an electron cloud.

Each energy subshell in an orbit have different shapes which determine the presence of electron.

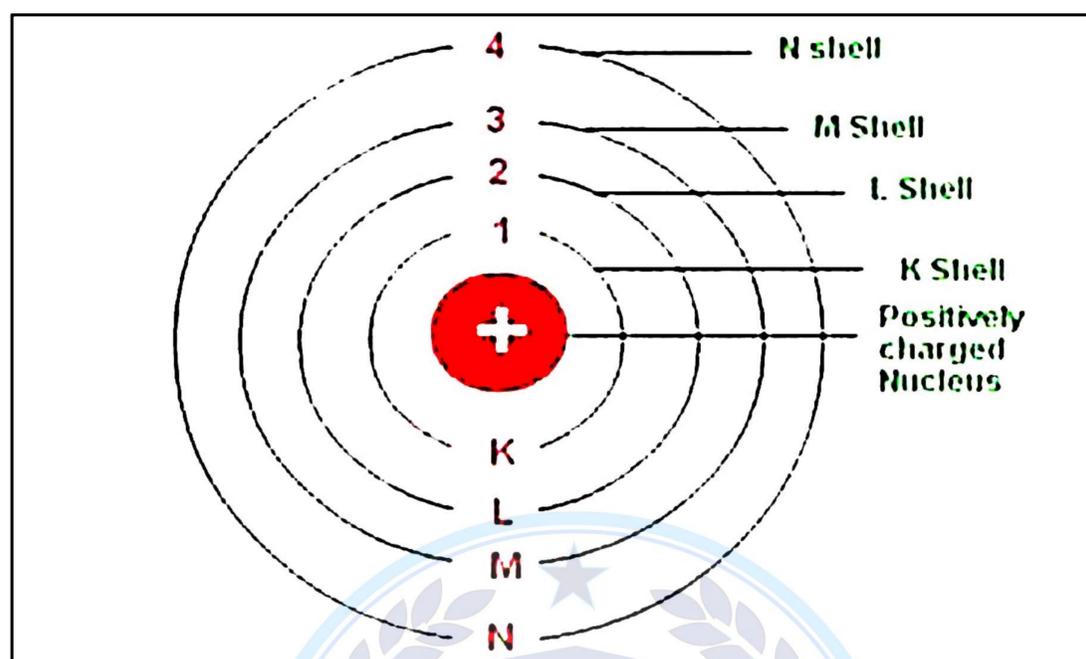
Different subshells of orbitals are orbitals named as s, p, d and f with different shapes as 's' is spherical and 'p' is dumbbell shaped.

The numbers and kind of atomic orbitals depends on the energy subshell.

Q15) What is shell? Explain the concept of shell (K, L, M, N and O)

CONCEPT OF SHELL (K, L, M, N, O & P)

The Energy levels or Shell or Orbit are all possible paths on which electrons are revolving around nucleus. Which shows by 'n'. these shells are named as K, L, M, N, O, P with quantum numbers $n=1, 2, 3, 4, 5, 6$ respectively. These shells have definite amount of energy by means of decreasing shown order as they become away from nucleus.



- First energy level is K shell has less energy.
- Second energy level is L shell has more energy than K shell.
- Third energy level is M shell has more energy than K and L shells.
- Fourth energy level is N shell has more energy than K, L and M shells.
- Fifth energy level is O shell has more energy than K, L, M and N shells.

Q16) Describe wave particle duality of electron of De Broglie Hypothesis

DE BROGLIE HYPOTHESIS

According to De-Broglie a light, or any other electromagnetic wave, can also exhibit the properties of a particle, similarly a particle should also exhibit the properties of a wave, and those two natures are interchangeable.

Q17) Define Electronic Configuration. Give maximum electronic configuration of shell and sub shell.

ELECTRONIC CONFIGURATION

The distribution of electrons among the different orbits/shells and subshells according to some rules is known as the electronic configuration of an atom

The maximum number of electrons that can be accommodated in a shell is represented by the formula $2n^2$, where 'n' is the shell number. The distribution of electrons in different orbits are as follows:



$$\text{K-shell/ 1st orbit (n=1)} = 2(1)^2 = 2$$

$$\text{L-shell/ 2nd orbit (n=2)} = 2(2)^2 = 8$$

$$\text{M-shell/ 3rd orbit (n=3)} = 2(3)^2 = 18$$

$$\text{N-shell/4th orbit (n=4)} = 2(4)^2 = 32 \text{ and so on}$$

They are slight difference in Energy levels of subshells, that way subshell's' filled first then subshell 'p' and onward. The distribution of maximum electrons in subshells is as follows.

2 electrons in 's' subshell

6 electrons in 'p' subshell

10 electrons in 'd' subshell

14 electrons in 'f' subshell

Q18) What is isotopes? Discus the isotopes of Hydrogen

ISOTOPES

Atoms of the same elements having same atomic number but different Mass number are called isotopes.

ISOTOPES OF HYDROGEN

There are three isotopes of Hydrogen. These are known as Protium, deuterium and tritium.

PROTIUM $^1\text{H}_1$

- Its atomic number is 1
- Its mass number is 1
- It has one proton in the nucleus
- It has no neutron in the nucleus
- It has one electron in its shell

DEUTERIUM $^2\text{H}_1$

- Its atomic number is 1
- Its mass number is 2
- It has one proton in the nucleus
- It has one neutron in the nucleus
- It has one electron in its shell

TRITIUM³H₁

- Its atomic number is 3
- Its mass number is 1
- It has one proton in the nucleus
- It has two neutron in the nucleus
- It has one electron in its shell

Q19) Discuss the isotopes of Uranium

ISOTOPES OF URANIUM

There are three common isotopes of uranium with atomic number 92 and mass number 234,235 and 238

Q20) Discuss the isotopes of chlorine



ISOTOPES OF CHLORINE

There are two isotopes of Chlorine with atomic number 17 and mass number 35 and 37.

Chlorine 35 is 75% and chlorine 37 is 25% abundant in nature.

Q21) Discuss the isotopes of carbon

ISOTOPES OF CARBON

There are two stable isotopes and one radioactive isotope of carbon.

- The carbon 12 contain 6 protons and 6 neutrons
- Carbon 13 possess 6 protons and 7 neutrons
- Carbon 14 contain 6 protons and 8 neutrons.
- Carbon 12 is the most abundant (98.89%) isotope.

Q22) Writ down the applications of isotopes in daily life.

NAME OF RADIOACTIVE ISOTOPES

PHOSPHOROUS-32 OR STRONTIUM -90 Treatment of skin cancer

COBALT 60 Treatment of body cancer due to more penetrating power.

LODINE ISOTOPES Detestations of thyroid glands in the neck.

TECHNETIUM To monitor the bone growth in fracture healing.

GAMMA RAY OF COBALT-60 To sterilization of medical instruments and dressings from harmful bacteria.

AMERICIUM-241 Used in back scatter gauges, smoke detectors fill height detectors and measuring ash content of coal.

GOLD-198 AND TECHNETIUM-99 Tracing factory waste causing ocean pollution. Tracing sand movement in rivers and Oceans.

URANIUM-235 Conversion of water energy from steam to generate electricity.

PLUTONIUM-238 Used to stimulate a regular heart beat in heart pose maker.

CARBON-14 Used to estimate the age of fossils.

QUESTION # 1

An atom has 5 electrons in M shell than:

- (a) Find out its atomic number?
- (b) Write Electronic configuration of atom?
- (c) Name the element of atom?

QUESTION # 2

An atom has 2 electrons in M shell than:

- (a) Find out its atomic number?
- (b) Write Electronic configuration of atom?
- (c) Name the element of atom?

QUESTION # 3

An atom has 3 electrons in L shell than:

- (a) Find out its atomic number?
- (b) Write Electronic configuration of atom?
- (c) Name the element of atom?

QUESTION # 4



An atom has 2 electrons in K shell than:

- (a) Find out its atomic number?
- (b) Write Electronic configuration of atom?

(c) Name the element of atom?

QUESTION # 5

How the atoms of O^{17}_8 and O^{18}_8 are similar or different from each other?

QUESTION # 6

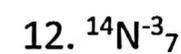
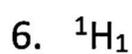
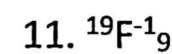
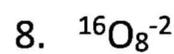
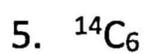
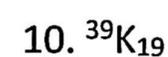
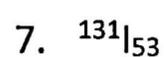
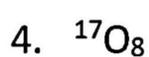
How the atoms of Cl^{35}_{17} and Cl^{37}_{17} are similar or different from each other?

QUESTION # 7

Write down the names of sub atomic particles their masses in a.m.u and gm with their unit charges.

QUESTION # 8

How many protons, neutrons and electrons are present in the following elements?



MULTIPLE CHOICE QUESTIONS

1. In an atom number of protons and neutrons are added to obtain:

(a) number of electrons

(b) number of nucleons

(c) atomic number of element

(d) number of isotopes

2. If proton number is 19, electron configuration will be:

(a) 2, 8, 9

(b) 2, 8, 8, 1

(c) 2, 8, 1

(d) 2, 8, 3

3. If nucleon number of potassium is 39, number of neutrons will be:

(a) 39

(b) 19

(c) 20

(d) 29

4. The isotope C-12 is present in abundance of:

(a) 96.9%

(b) 97.6%

(c) 98.8%

(d) 99.7%

5. Electronic configuration is distribution of:

(a) proton

(b) neutron

(c) electron

(d) positron

6. Which one of the following is most penetrating?

(a) electron

(b) Proton

(c) alpha particle

(d) neutron

7. How many subshells in a L shell:

(a) one

(b) two

(c) three

(d) four

8. De Broglie extend the wave particle duality to electron in:

(a) 1920

(b) 1922

(c) 1923

(d) 1925

9. Name the material of screen which used in Rutherford atomic model :

(a) Aluminum foil

(b) zinc sulphide

(c) sodium sulphide

(d) Aluminum sulphide

10. Which rays are used for sterilization of medical instruments :

(a) α -rays

(b) β -rays

(c) x-rays

(d) γ -rays

