

# Structure of Atom

## Long Answer Questions

Q1. How are cathode rays produced? What are its major characteristics?

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Ans. Cathode rays and Discovery of Electron

In 1895 Sir William Crooks performed experiments by passing electric current through gases in a discharge tube at very low pressure.

He took a glass tube fitted with two metallic electrodes, which were connected to a high voltage battery. The pressure inside the tube was kept  $10^{-4}$  atm. When high voltage current was passed through the gas, shiny rays were emitted from the cathode towards the anode as shown in figure. These rays were given the name of 'cathode rays' as these were

The major characteristics of cathode rays are given below

- i. These rays travel in a straight line perpendicular to the cathode surface.
  - ii. They can cast a sharp shadow of an opaque object if placed in their path.
  - iii. They are deflected towards positive plate in an electric field showing that they are negatively charged.
  - iv. They raise temperature of the body on which they fall.
  - v. J.J. Thomson discovered their charge/mass ( $e / m$ ) ratio.
  - vi. Light is produced when these rays hit the sides of the discharge tube.
- Conclusions

- i. All these properties suggested that the nature of cathode rays was independent of the nature of the gas present in the discharge tube or material of the cathode.

ii. The fact that they cast the shadow of an opaque object suggested that these are not rays but they are fast moving, material particles. They were given the name electrons.

iii. Since all the materials produce same type of particles, it means all the materials contain electrons.

i". As we know materials are composed of atom's, hence the electrons are fundamental particles of atoms.

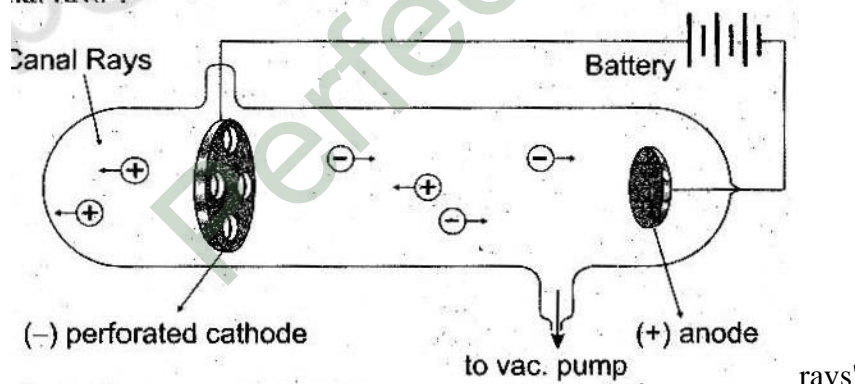
Q2. How it was proved that electrons are fundamental particles of an atom?

Ans. In 1895, Sir William Crooks performed experiments by passing electric current through gases in a discharge tube at very low pressure. When high voltage current was passed through the gas, shiny rays were emitted from the cathode towards the anode. These rays were given the name cathode rays.

These rays were given the name electrons after finding their  $e/m$  ratio which come to be same as electrons that was same of electrons "By changing the material of electrodes, it was proved that always same rays were produced," Hence it was proved that electrons are fundamental particles of an atom.

Q3. Draw a labeled diagram to show the presence of protons in the discharge tube and explain how canal rays were produced. Ans. Discovery of Proton

In 1886 Goldstein observed that in addition to cathode rays, other rays were also present in the discharge tube. These rays were traveling in opposite direction to cathode rays. He used a discharge tube having perforated cathode as shown in figure. He found that these rays passed through holes present in the cathode and produced a glow on the wall. He called these rays as "canal rays".



The properties of positive rays or canal rays

i. These rays travel in a straight line in a direction opposite to cathode rays.

ii. Their deflection in electric and magnetic field proved that these were positively charged

vii. It was found that the same type of rays were emitted no matter which gas and which cathode was used in the discharge tube.

- iii. The nature of canal rays depends upon the nature of gas, present in the discharge tube.
- iv. These rays do not originate from the anode. In fact these rays are produced when the cathode rays or electrons collide with the residual gas molecules present in the discharge tube and ionize them as follows:



v. Mass of these particles was found equal to that of a proton or simple multiple of it. The mass of a proton is 1840 times more than that of an electron. Results

- These rays are made up of positively charged particles.
- The mass and charge of these particles depend upon the nature of the gas in the discharge tube.

iii. Hence, different gases produce different types of positive rays having particles of different masses and different charges.

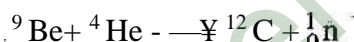
iv. Hence particles produced by a gas will be of the same type i.e. positive rays produced by the lightest gas hydrogen contain protons.

Q4. How neutrons were discovered? Write their properties. Ans.

Discovery of Neutron

Rutherford observed that atomic masses of the element could not be explained on the basis of the masses of electron and proton only. He predicted in 1920 that some neutral particle having mass equal to that of proton must be present in an atom. Thus scientists were in search of such a neutral particle. Eventually in 1932 Chadwick discovered neutron, when he bombarded alpha particles on a beryllium target. He observed that highly penetrating radiations were produced.

These radiations were called neutron.



Properties of neutron

- Neutrons carry no charge i.e. they are neutral
- They are highly penetrating.
- Mass of these particles was nearly equal to the mass of a proton.

Q5 How Rutherford discovered that atom has a nucleus located at the centre of an atom

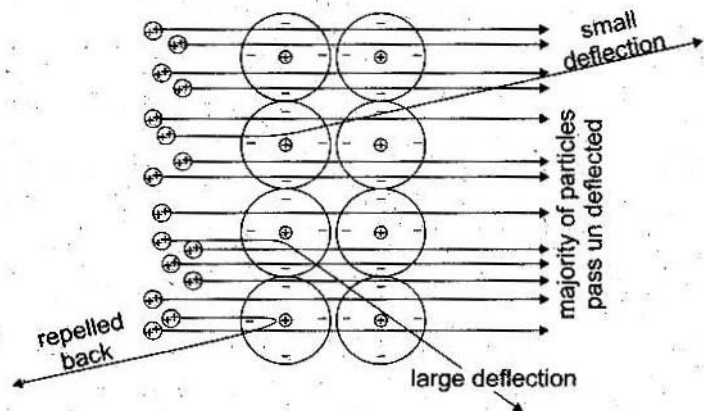
Ans. Rutherford's Atomic Model

Rutherford performed 'Gold Foil' experiment to understand how negative and positive charges could coexist in an atom. He bombarded alpha particles on a 0.00004 cm thick gold

oil. Alpha particles are emitted by radioactive elements like radium and polonium. These are <sup>n</sup>  $\alpha$  particles. They can penetrate th

•tually helium nuclei ( $\text{He}^{2+}$ ). They can pass through matter to some extent.

He the effects of  $\alpha$ -particles on a photographic plate or a screen coated with zinc sulphide as shown in figure. He proved that the 'plum-pudding' model of the atom was not correct.



**Fig. Scattering of alpha particles by the atoms of gold foil.**

#### Observations

Observations made by Rutherford were as follows:

- i. Almost all the particles passed through the foil un-deflected.
- ii. Out of 20,000 particles, only a few were deflected at fairly large angles and very few bounced back on hitting the gold foil.

#### Results of the experiment

Keeping in view the experiment, Rutherford proposed planetary model for an atom and concluded following results:

- i, Since most of the particles passed through the foil Lin-deflected, therefore most of the volume occupied by an atom is empty.
- ii. The deflection of a few particles proved that there is a 'center of positive charges' in an atom, which is called 'nucleus' of an atom.
- iii. The complete rebound of a few particles show that the nucleus is very dense and hard.
- iv. Since a few particles were deflected it shows that the size of the nucleus is very small as compared to the volume of an atom.
- v. The electrons revolve around the nucleus.
- vi. An atom as a whole is neutral, therefore the number of electrons in an atom is equal to the

number of protons.

vii. Except electrons, all other fundamental particles that lie within a nucleus are known as nucleons

Q6. Write defects of Rutherford's Model.

Ans. Defects in Rutherford's Model

Although Rutherford's experiment proved that the 'plum-pudding' model of an atom was not correct, yet it had following defects:

- i. According to classical theory, electrons being the charged particles should release or emit energy continuously and they should ultimately fall into the nucleus.
- ii. If the electrons emit energy continuously, they should form a continuous spectrum but in fact, line spectrum was observed.

Although the scientists had objections on the atomic model presented by Rutherford, yet it cultivated thought provoking ideas among them.

Q7. Write postulates of Bohr's Atomic Model.

OR

How did Bohr prove that an atom must exist?

Ans. Bohr's Atomic Theory

Keeping in view the defects in Rutherford's Atomic Model, Neil Bohr presented another model of atom in 1913. The Quantum Theory of Max Planck was used as foundation for this model. According to Bohr's model revolving electron in an atom does not absorb or emit energy continuously. The energy of a revolving is 'quantized' as it revolves only in orbits of fixed energy called 'energy levels' by him. The Bohr's atomic model is shown in figure.

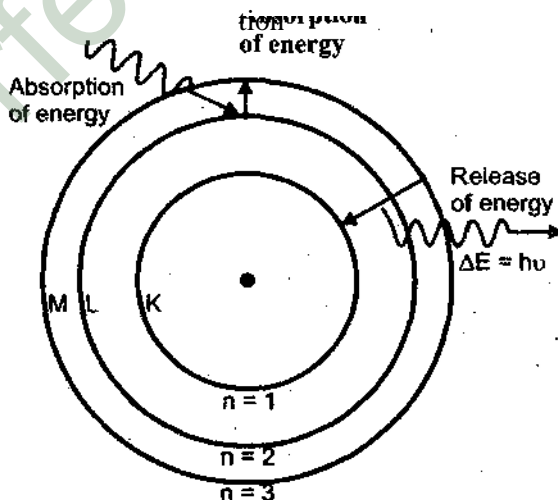


Fig. Bohr's atomic model showing orbits.

The Bohr's atomic model was based upon the following postulates;

- I. The hydrogen atom consists of a tiny nucleus and electrons are revolving in one of circular orbits of radius  $r$  around the nucleus.
2. Each orbit has a fixed energy that is quantized.
3. As long as electron remains in a particular orbit it does not radiate or absorb energy. The energy is emitted or absorbed only when an electron jumps from one orbit to another.
4. When an electron jumps from lower orbit to higher orbit it absorbs energy and when it jumps back from higher orbit to lower orbit it radiates energy.

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This change in energy,  $\Delta E$  is given by following Planck's equation  $\Delta E = E_2 - E_1 = h\nu$

Where  $h$  is Planck's constant equal to  $6.63 \times 10^{-34}$  Js, and  $\nu$  is frequency of light.

5. Electron can revolve only in orbits of a fixed angular momentum  $mvr$ , given as:

$$mvr = n \frac{h}{2\pi r}$$

Where 'n' is the quantum number or orbit number having values 1,2,3 so on.

(28. Write differences between Rutherford and Bohr's atomic theory.

Ans. Differences between Rutherford and Bohr's theories:

| Rutherford's Atomic Theory                    | Bohr's Atomic Theory  |
|---|---|
| i. It was based on classical theory.          | i. It was based upon quantum theory.                                |
| ii. Electrons revolve around the nucleus.     | ii. Electrons revolve around the nucleus in orbits of fixed energy. |
| iii. No idea about orbits was introduced.     | iii. Orbits had angular momentum.                                   |
| iv. Atoms should produce continuous spectrum. | iv. Atoms should produce line spectrum.                             |
| v. Atoms should collapse.                     | v. Atoms should exist.  |

(29. Write a note on shell and subshell?

Ans. Shell electrons revolve around the nucleus e.g. K,L,M etc.

Explanation

Atom consists of a tiny nucleus lying in the center and electrons revolving around the nucleus. The electrons revolve around the nucleus in different energy levels or shells according to their respective energies (potential energy).

Energy levels are represented by 'n' values 1,2,3 and so on. While shells are designated by the alphabets or shells K, L, M and so on. A shell closer to the nucleus is of minimum energy. Since K shell is closest to the nucleus, the energy of shells increases from K shell onwards. Such as:

1<sup>st</sup> energy level is K shell; it has the lowest energy.

2<sup>nd</sup> energy level is L shell; it has more energy than K shell.

3<sup>rd</sup> energy level is M shell; it has more energy than K and L shell.

4<sup>th</sup> energy level is N shell; it has more energy than K, L and M shell.

In simple words shells are the main energy levels that electrons occupy. Shells are represented by circles around the nucleus. They are counted from the center to outward as

shown in the figure. The number of electrons that a shell can accommodate is given by  $2n^2$ ,

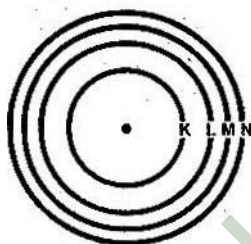


Fig. Showing different energy levels or shells counted from the centre outwards.  
Subshell

A shell also consists of subshells or orbitals. Each subshell or orbital is designated by a small alphabetical letter s, p, d, f, etc.

i. First energy level or K shell has only one sub-shell called s subshell.

ii. Second energy level or L shell has two subshells s and p.

iii. Third energy level M shell has three subshells s, p and d.

iv. Fourth energy level or N shell has four subshells s, p, d and f.

| n value | Shell | Sub-Shell |
|---------|-------|-----------|
| 1       | K     | Only s    |
| 2       |       | s,p       |
| 3       |       | s,p,d     |
| 4       | N     | s,p,d,f   |

Q10. What do you mean by electronic configuration? What are basic requirements while writing electronic configuration of an element?

Ans. Electronic Configuration

The distribution of electrons around the nucleus in various shells and subshells according to their increasing energy, is called electronic configuration.



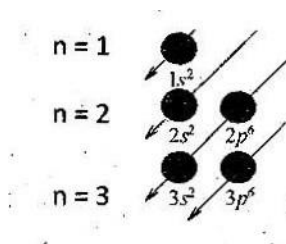


Fig. Filling sequence of electrons in subshells according to energy levels Rules:

The most stable or ground state electronic configuration of an atom is the one in which electrons are present in the lowest possible energy level. The electrons fill the shells in order of their increasing energy, i.e. lower energy level is occupied first then the higher energy level and so on. The maximum capacity of shells to accommodate the electrons as following: K shell can accommodate 2 electrons.

L shell can accommodate 8 electrons.

M shell can accommodate 18 electrons.

N shell can accommodate 32 electrons.

As we know there is a slight difference between the energies of the subshells or orbitals within a shell, therefore, filling of electrons in subshells of a shell is such as that s" subshell is filled first and then its "p" subshell and then other subshells are filled.

The maximum capacity of subshells to accommodate electrons is:

i. 's' orbital can accommodate 2 electrons, ii.

'p' orbital can accommodate 6 electrons, iii.

'd' orbital can accommodate 10 electrons, iv. 'f

orbital can accommodate 14 electrons.

While writing the electronic configuration of the elements and their ions, we should know three things:

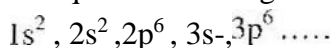
i. The number of electrons in an atom.

ii. The sequence of shells and sub shells according to the energy levels.

iii. The maximum number of electrons that can be placed in different shells and subshells, QII. Draw electronic configuration of first 18 elements.

Ans. The electronic configuration of first 18 elements

The sequence of filling of electrons in different subshells is as following:



Where number represents the shell number, while letters (s and P) represent subshells. The superscript shows the number of electrons in a subshell. The sum of superscripts number is the total number of electrons in an atom. i.e. atomic number of an element. The electronic configuration of first 18 elements is shown in the Table

Table: Electronic Configuration of First Eighteen Elements

| Element   | S m bol | Atomic Number | Electronic Confiauraüon |
|-----------|---------|---------------|-------------------------|
| Hydrogen  |         | 1             | Is                      |
| Helium    |         | 2             | Is                      |
| Lithium   |         | 3             |                         |
| Beryllium | Be      | 4             |                         |
| Boron     |         | 5             | Is                      |
| Carbon    | c       | 6             | $1s^2, 2s^2, 2p^2$      |
| Nitrooen  |         |               | $1s^2, 2s^2, 2p^3$      |
| Oxygen    | O       | 8             | $1s^2, 2s^2, 2p^4$      |
| Fluorine  |         | 9             | $1s^2, 2s^2, 2p^5$      |
| Neon      |         | 10            | ,2s .2P                 |

|            |    |    |                                |
|------------|----|----|--------------------------------|
| Sodium     |    | 11 | $1s^2, 2s^2, 3s^1$             |
| Magnesium  | Mg | 12 | $1s^2, 2s^2, 2p^6, 3s^2$       |
| Aluminium  | Al | 13 | $1s^2, 2s^2, 2p^6, 3s^2, 3p^1$ |
| Silicon    |    |    | $1s^2, 2s^2, 2p^6, 3s^2, 3p^2$ |
| Phosphorus |    | 15 | $1s^2, 2s^2, 2p^6, 3s^2, 3p^3$ |
| Sulphur    |    | 16 | $1s^2, 2s^2, 2p^6, 3s^2, 3p^4$ |
| Chlorine   | Cl | 17 | $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$ |
| Argon      | Ar | 18 | $1s^2, 2s^2, 2p^6, 3s^2, 3p^6$ |

(212, What is an isotope? Describe the isotope of Hydrogen, Carbon, Chlorine and Uranium.

Ans. Isotopes

Isotopes are defined as the atoms of an element that have same atomic number but different mass numbers.

Properties of isotopes

- They have same electronic configuration and number of protons.
- They differ in their number of neutrons.
- Isotopes have similar chemical properties because these depend upon electronic configuration.
- They have different physical properties because these depend upon atomic masses.
- All isotopes of an element occupy same position in the periodic table.

Examples

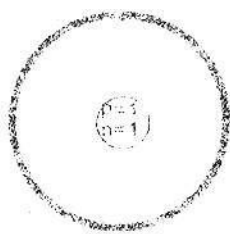
i. Isotopes of Hydrogen

The naturally occurring hydrogen is a combination of its three isotopes, present in different abundances. The three isotopes of hydrogen are named as protium ( $^1_1\text{H}$ ), deuterium ( $^2_1\text{H}$  or D) and tritium ( $^3_1\text{H}$  or T). Each one of them has 1 proton and 1 electron, but number of neutrons is different.

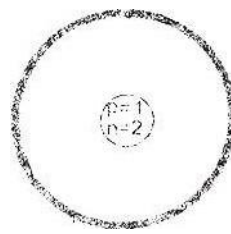
The isotopes are represented as:



protium ( ${}^1_1\text{H}$ )



deuterium ( ${}^2_1\text{H}$ )



tritium ( ${}^3_1\text{H}$ )

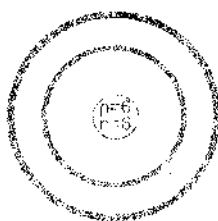
${}^R\text{H}$

## ii. Isotopes of Carbon

There are two stable isotopes of carbon

${}^{12}\text{C}$  and one radioactive isotope  ${}^{14}\text{C}$ .

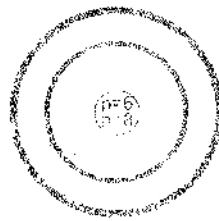
The isotope  ${}^{12}\text{C}$  is present in abundance of 98.9% while  ${}^{13}\text{C}$  and  ${}^{14}\text{C}$  are both present only 1.1% in nature. All of them have the same number of protons and electrons but differ in number of neutrons. They are represented as follows:



protium ( ${}^1_1\text{H}$ )



deuterium ( ${}^2_1\text{H}$ )



tritium ( ${}^3_1\text{H}$ )

### iii. Isotopes of Chlorine

There are two isotopes of chlorine,  ${}^{35}_{17}\text{Cl}$ ,  ${}^{37}_{17}\text{Cl}$

### iv) Isotopes of Uranium

There are three isotopes of uranium i.e.  ${}^{234}_{92}\text{U}$ ,  ${}^{235}_{92}\text{U}$ ,  ${}^{238}_{92}\text{U}$ . The  ${}^{238}_{92}\text{U}$  is found in nature nearly 99% pure.

| Symbol             | Atomic Number | Mass Number | No. of proton | No. of Neutron |
|--------------------|---------------|-------------|---------------|----------------|
| ${}^1\text{H}$     | 1             | 1           | 1             | 0              |
| ${}^2\text{H}$     | 1             | 2           | 1             | 1              |
| ${}^3\text{H}$     | 1             | 3           | 1             | 2              |
| ${}^{12}\text{C}$  | 6             | 12          | 6             | 6              |
| ${}^{13}\text{C}$  | 6             | 13          | 6             | 7              |
| ${}^{14}\text{C}$  | 6             | 14          | 6             | 8              |
| ${}^{35}\text{Cl}$ | 17            | 35          | 17            | 18             |
| ${}^{37}\text{Cl}$ | 17            | 37          | 17            | 20             |
| ${}^{234}\text{U}$ | 92            | 234         | 92            | 142            |
| ${}^{235}\text{U}$ | 92            | 235         | 92            | 143            |
| ${}^{238}\text{U}$ | 92            | 238         | 92            | 146            |

(213. Write down the uses of radioactive isotopes.

Ans. Uses of radioactive isotopes

With the advancement of the scientific knowledge, the isotopes have found many applications in our lives. Following are the major Fields in which Isotope, have vast applications:

### i. Radiotherapy (Treatment of Cancer)

For the treatment of skin cancer, isotopes like P-32 and Sr-90 are used because they emit less penetrating beta radiations. For cancer, Co-60, affecting within the body, is used because it emits strongly penetrating gamma rays.

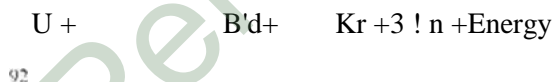
ii. Tracer for Diagnosis and Medicine  
The radioactive isotopes are used as tracers in medicine to diagnose the presence of tumor in the human body. Isotopes of Iodine-131 are used for diagnosis of goiter in thyroid gland. Similarly technetium is used to monitor the bone growth.

iii. Archaeological and Geological Uses  
The radioactive isotopes are used to estimate the age of fossils like dead plants and animals and stones etc. The age determination of very old objects based on the half-lives of the radioactive isotope is called radioactive-isotope dating. An important method of age determination of old carbon containing objects (fossils) by measuring the radioactivity of C-14 in them is called radio-carbon dating or simply carbon dating.

iv. Chemical Reaction and Structure Determination  
The radioisotopes are used in a chemical reaction to follow radioactive element during the reaction and ultimately to determine the structure. For example: C-14 is used to label. As is used by the plants for photosynthesis to form  $C_6H_{12}O_6$ , its movement is detected through the various intermediate steps up to glucose.

### v. Applications in Power Generation

Radioactive isotopes are used to generate electricity by carrying out controlled nuclear fission reactions in nuclear reactors. For example, when U-235 is bombarded with slow moving neutrons, the uranium nucleus breaks up to produce Barium-139 and Krypton-94 and three neutrons.

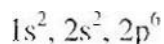


A large amount of energy is released which is used to convert water into steam in boilers. The steam then drives the turbines to generate electricity. This is the peaceful use of atomic energy for development of a nation.

(214. Describe the electronic configuration of  $\text{Na}^+$ ,  $\text{Mg}^{2+}$  and  $\text{Al}^{3+}$  ion. Do they have the same number of electrons in the outermost shell? Ans. (i) Na

Electronic Configuration

In terms of sub shells



(ii) Mg

Electronic configuration

2 8

In terms of sub shells  $1s^2$

$2s^2 2p^6$

(iii)

Electronic configuration

In terms of sub shells

$1s^2$ ,  $2p^6$

It is proved that all have eight electrons in their outermost shell.

(215. One of the postulates of Bohr's atomic model is that angular momentum of a moving electron is quantized. Explain its meaning and calculate angular momentum of third orbit (i.e.  $n=3$ ).

Ans. Angular momentum of a moving electron is quantized means that "electron can revolve only in orbits of a fixed angular momentum  $mvr$ , given as

$$\text{Angular momentum } mvr = (1) \frac{nh}{2\pi}$$

$$n = 3$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

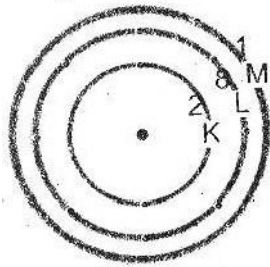
$$2\pi = 3.14$$

Putting values in equation (1)

$$\text{Angular momentum } (mvr) = \frac{3 \times 6.63 \times 10^{-34} \text{ Js}}{2 \times 3.14}$$
$$3.16 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$$

Angular momentum =

Q16. Write the electronic configuration of an element having 11 electrons.



**Solution:**

Keep in mind that all the electrons do not have the same energy. Therefore, they are accommodated in shells according to increasing energy and capacity of the shell. First of all,

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the electrons will go to K shell which has minimum energy. It can accommodate 2 electrons. After this, electrons will go to L shell that can accommodate 8 electrons. Thus K and L shells have accommodated 10 electrons. The remaining 1 electron will go to M shell, the outermost shell of maximum energy in this case.

The electronic configuration will be written as:

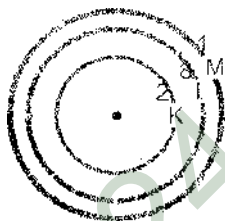
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Therefore, it is simply written as 2, 8 and 1. Further distribution of electrons in subshells will be:  $1s^2, 2s^2, 2p^6, 3s^1$ .

Q17. Write down the electronic configuration of \_\_\_\_\_ ion.

Solution:

We know that chlorine has 17 electrons and chloride ion ( $Cl^-$ ) has  $17 + 1 = 18$  electrons. Its electronic configuration will be 2, 8, 8, which is presented in the figure. The further distribution of electrons in subshells will be  $1s^2, 2s^2, 2p^6, 3s^2, 3p^6$ .



## Short Answer Questions

Q1. What is the nature of charge on cathode rays?

Ans. Cathode rays are negatively charged particles. J.J. Thomson discovered the  $e/m$  (charge/mass) ratio of cathode rays and found it equal to electron.

Q2. Give five characteristics of cathode rays.

Ans. i. These rays travel in straight line perpendicular to the cathode surface. ii. They can cast a sharp shadow of an opaque object if placed in their path. iii. They raise temperature of the body on which they fall. iv. J.J. Thomson discovered their  $e/m$  ratio. v. Light is produced when these rays hit the sides of the discharge tube.

Q3. The atomic symbol of phosphorous ion is given as  $^{31}_{15}P^{3-}$ .

i. How many protons, electrons and neutrons are there in the ion? ii.

What is name of the ion.

iii. Draw electronic configuration of the ion.

iv. Name the noble gas which has the same electronic configuration as the has.

31

15

Ans. a. No. of Protons 15

No. of neutrons =  $31 - 15 = 16$

No. of electrons = 18 ( $P^{3-}$  has three more electrons)

b. Phosphide ion

c. KL M

2 8 8

In the form of sub shells:  $1s^2, 2s^2, 2p^6, 3s^2, 3p^6$

d. Argon

(24. Differentiate between shell and sub-shell with example. Ans.

| Shell   | Sub Shell  |
|---|--|
| 1. Each principle energy level is called shell. | 1. Each shell further contains one or more sub shells. |
| 2. These are represented by K, L, M, N etc.     | 2. These are represented by s, p, d, f.                |

(25. An element has an atomic number 17. How many electrons are present in K, L and M shells of the atom?

Ans. Atomic number of element = 17, Its electronic configuration will be

KL M

Or  $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$ .

2 8 7

(26. Write down the electronic configuration of Al. How many electrons are present in its outermost shell?

Ans. Atomic number of Aluminium = 13, Its electronic configuration is:

KL M

2 8 3

But  $Al^{3+}$  ion is formed by losing 3 electrons from Al atom and hence has electronic configuration.

In terms of sub shells.  $1s^2,$

$2s^2, 2p^1$ .

It has 8 electrons in its outermost shell.

Q7. Magnesium has electronic configuration 2,8,2.

(i) How many electrons are in its outer most shell?

(ii) In which sub shell of the outer most shell electrons are present? (iii)

Why magnesium tend to lose electrons? Ans. (a) K L M

2 8 2

It has two electrons in the outer most shell.

(b)  $1s^2, 2s^2, 2p^6, 3s^2$

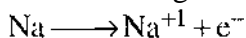
It has electron in s-subshell.

(c) Magnesium is electropositive in character. It has the ability to lose its two electrons from its outer most shell.



Q8. What will be the nature of charge on an atom when it loses an electron or when it gains an electron?

Ans. When an atom loses an electron, It acquires positive charge due to more number of protons in the nucleus e.g.



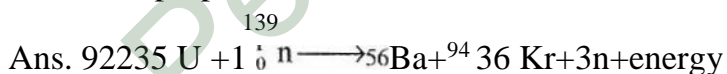
2,8,1    2,8

When an atom gains an electron, It possesses negative charge due to more electron than protons in the atom e.g.



2,8,7    2,8,8

Q9. For what purpose is U-235 used?



A large amount of energy is released which is used to convert water into steam in boilers. The steam then drives the turbines to generate electricity. This is peaceful use of atomic energy.

Q10. A patient has goiter, how will it be detected?

Ans. Isotopes of iodine-131 are used for diagnosis of goiter in thyroid gland.

QII. Give three properties of positive rays.

Ans. (i) They travel in straight line in a direction opposite to cathode rays.

(ii) Their deflection in electric and magnetic field proved that these were positively charged.

(iii) Mass of these particles was found equal to that of proton or simple multiple of it.

Q12. What are the defects of Rutherford's atomic model?

Ans. It had following defects:

- (i) According to classical theory, electrons being the charged particles should release or emit energy continuously and they should ultimately fall into the nucleus.
- (ii) If the electrons emit energy continuously, they should form a continuous spectrum but in fact, line spectrum was observed.

Q13. As long as electron remains in an orbit; it does not emit or absorb energy. When does it emit or absorb energy?

Ans. The energy is emitted or absorbed only when an electron jumps from one orbit to another. When an electron jumps from lower orbit to higher orbit it absorbs energy and when it jumps back from higher orbit to lower orbit, it radiates energy. This change in energy is given by following Planck's equation.

Where  $E_2$  Energy of higher energy orbit

$E_1$  = Energy of lower energy orbit  $h$  is Planck's constant its value is  $5.63 \times 10^{-34}$  Js.  $\nu$  is frequency of light.

Q14. Define plum pudding model. Who presented it?

Ans. Thomson put forth his plum pudding theory.

According to this theory.

Atoms are solid structures of positively charge with tiny negative particles stuck inside.

It is like plums in the pudding.

Q15. Who discovered neutrons and how?

Ans. Chadwick discovered neutrons in 1932. He bombarded beryllium with alpha particles. He observed that highly penetrating radiations were produced. These rays were called neutrons.



Q16. Write three properties of neutrons. Ans. The properties of neutrons are.

- (i) Neutrons carry no charge.
- (ii) They are highly penetrating.
- (iii) Mass of neutrons are nearly equal to the, mass of proton.

Q17. Write electronic configuration of an element having 11 electrons.

Ans. The electronic configuration can be written as

**KL M**

2 8 1

Further distribution of electrons in sub shell will be  $1s$ ,  $2s^2$ ,  $2p^6$ ,  $3s^1$ .

Q18. Write down the electronic configuration of  $Cl^-$  ion.

Ans. Chlorine has 17 electrons while chloride ( $Cl^-$  ion) has  $17+1=18$  electrons. Therefore its electronic configuration will be

$Cl^-$  = KL M  
Ion

2 8 8

In sub shells electronic configuration will be  $1s^2$ ,  $2s^2$ ,  $2p^6$ ,  $3s^2$ ,  $3p^6$

Q19. An element has 5 electrons in M shell. Find out its atomic number.

Ans. To have 5 electrons in M shell means its K and L shell are completely filled. Hence its electronic configuration will be

KL M

2 8 5

It means it has

$2 + 8 + 5 = 15$  electrons

As we know that no. of electrons in an atom = no. of protons = atomic number

Therefore its atomic number is 15.

Q20. Write electronic configuration of Fluorine.

Ans.  $9F = 1s^2$ ,  $2s^2$ ,  $2p^5$ .

Q21. Write electronic configuration of Aluminium.

Ans.  $13Al = 1s^2$ ,  $2s^2$ ,  $2p^6$ ,  $3s^2$ ,  $3p^1$ . (222. Define isotopes.

Ans. Atoms of an element that have same atomic number but different atomic masses are called isotopes e.g. Hydrogen has three isotopes

Protium (1H) Deuterium (2H) Tritium (3H)

(223. Write names of two isotopes used for the treatment of skin cancer.

Ans. 1 - Phosphorous — 32 or P-32

2 — Strontium — 90 or Sr-90

These isotopes emit less penetrating beta radiations.

Q24. Write use of Co-60.

Ans. Cobalt-60 emits strongly penetrating gamma rays and hence used for cancer treatment within the body.

Q25. Define radioactive-isotope dating.

Ans. The age determination of very old objects based on the half-lives of the radioactive isotope is called radioactive-isotope dating.

Q26. What is meant by radio carbon dating or carbon dating?

Ans. This is an important method of age determination of old carbon containing objects (fossils) by measuring the radioactivity of C-14 in them is called radio-carbon dating or simply carbon dating.

Q27. What is Dalton's atomic theory?

Ans. In the beginning of 19<sup>th</sup> century John Dalton put forward atomic theory. According to it.

1. All matter is made up of very small indivisible particles called atoms.
  2. An atom is indivisible, hard, dense sphere
  3. Atoms of same element are alike
  4. They combine in different ways to form compounds
- (228. Write contribution of J.J. Thomson.)

Ans. J.J. Thomson (1856-1940) was a British physicist. He was awarded the 1906 Nobel Prize in Physics for the discovery of electron and for his work on the conduction of electricity in gases,

(229. What is meant by plum pudding Model?)

Ans. Thomson put forth his "plum pudding" theory. He postulated that atoms were solid structures of positive charge with tiny negative particles stuck inside. It is like plums in the pudding.

Q30. Write contribution of Sir William Crookes.

Ans. Sir William Crookes (1832-1919) was a British chemist and physicist. He was pioneer of vacuum tubes. He worked on spectroscopy.

(231. Write the contribution of Rutherford.)

Ans. Rutherford was a British-New Zealand chemist. He performed a series of experiments using alpha particles. He won the Nobel Prize in Chemistry in 1908. In 1911, he proposed the nuclear model of the atom and performed the first experiment to split an atom. Because of his great contributions, he is considered the father of nuclear science.

Q32. Write contribution of Neil Bohr.

Ans. Neil Bohr was a Danish physicist who joined Rutherford in 1912 for his post doctoral research. In 1913, Bohr presented his atomic model based upon Quantum theory. He won the 1922 Nobel Prize for Physics for his work on the structure of an atom.

Q33. What is meant by Quantum?

Ans. Quantum means fixed energy. It is the smallest amount of energy that can be emitted or absorbed as electromagnetic radiation. Quanta are plural of quantum.

(234. Write contribution of max Planck.

Ans. In 1918 Noble prize in physics was awarded to German physicist Max Planck (1858-1947) for his work on the quantum theory

Q35. What is the maximum number of electrons that can be accommodated in p-subshell?

Ans. p-subshell can accommodate maximum six electrons.

Q36. How many subshells are there in second shell?

Ans. There are two subshell[s are present in second shell that is s and p subshells.

Q37. Why does an electron first fill 2P orbital and then 3s orbital?

Ans. An electron first fill 2P orbital because the electrons fill the shells in order of their increasing energy, i.e. lower energy level is occupied first then the higher energy level. So 2P orbital as lower energy level then 3s orbital.

(238. If both K and L shells of an atom are completely filled what is the total number of electrons present in them?

Ans. There are 10 total number of electrons present in K and L shells.

Q39. How many electrons can be accommodated in M shell?

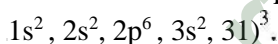
Ans. M shells can accommodate maximum 18 electrons.

(240. What is the electronic configuration of hydrogen atom?

Ans. The electronic configuration of hydrogen atom is  $1s^1$ .

(241. What is atomic number of phosphorus? Write down its electronic configuration.

Ans. The atomic number of phosphorus is 15 and its electronic configuration is



Q42. If an element has atomic number 13 and atomic mass 27; how many electrons are there in each atom of the element?

Ans. There are 13 electrons are present in each atom of the element.

(243. How many electrons will be in M shell of an atom having atomic number 15.

Ans. There are 5 electrons present in M shell.

Q44. What is maximum capacity of a shell?

Ans. The maximum capacity of shells to accommodate the electrons is as following:

K shell can accommodate 2 electrons.

L shell can accommodate 8 electrons.

M shell can accommodate 18 electrons.

N shell can accommodate 32 electrons.

Q45. How was it proved that the whole mass of an atom is located at its centre?

Ans. Rutherford observed that atomic mass of the element could not be explained on the basis of the masses of electron and proton only. He predicted in 1920 that some neutral particle having mass equal to that of proton must be present in an atom. He proved in his experiment that nucleus is an extremely small positively charged part. It is situated at the center of an atom and carries nearly the whole mass of an atom.

Q46. How was it shown that atomic nuclei are positively charged?

Ans. Rutherford observed in his experiment, that the deflection of a few particles proved that there is a center of positive charges in an atom, which is called 'nucleus' of an atom.

Q47. Name the particles which determine the mass of an atom.

Ans. Proton and neutron are the particles which determine the mass of an atom. These are also known as nucleons.

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Q48. What is the classical theory of radiation? How does it differ from quantum theory? Ans.

| Classical theory  | Quantum theory  |
|---|---|
| According to classical theory, electrons being the charged particles should release or emit energy continuously and they should ultimately fall into the nucleus. | Quantum means fixed energy. It is the smallest amount of energy that can be emitted or absorbed as electromagnetic radiation. |

Q49. How can you prove that angular momentum is quantized?

Ans. Let angular momentum (mvr) of orbit is  $mvr = \frac{nh}{2\pi}$  by putting the values of h and  $2\pi$

$$mvr = \frac{6.63 \times 10^{-34}}{2 \times 3.14} = 1.0 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$$

[Rt angular momentum (mvr) of 2<sup>11</sup> orbit is  $mvr = \frac{nh}{2\pi}$

by putting the values of h and  $2\pi$

$$mvr = \frac{2 \times 6.63 \times 10^{-34}}{2 \times 3.14} = 2.08 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$$

(250, Do you know any element having no neutrons in its atoms?

Ans. Yes the isotope of hydrogen (Protium) has no neutron. (251.

Who discovered an electron, proton and neutron?

Ans. In 1886, Goldstein discovered positively charged particles called protons. In 1897, J.J.

Thomson found in an atom, the negatively charged particles known as electrons. In 1932

Chadwick discovered neutron.

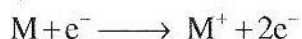
Q 52. How does electron differ from a neutron?

Ans.

| Electrons                                | Neutrons                          |
|--|-----------------------------------|
| Electron is the negative charge particle | Neutron is the neutral particle   |
| Electron is revolving around the nucleus | Neutron is present in the nucleus |

(253. Explain how anode rays are formed from the gas taken in the discharge tube.

Ans. Anode rays do not originate from the anode. In fact these rays are produced when the cathode rays or electrons collide with the residual gas molecules present in the discharge tube and ionize them as follows:



Q54. Why do the isotopes of an element have different atomic masses?

Ans. Because the isotopes of an element have different number of neutrons

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(255. How many neutrons are present in C- 12 and C -13?

Ans. In C— 12 there are six neutrons present and in C-13 there are seven neutrons present in the nucleus.

Q56. Which of the isotopes of hydrogen contains greater number of neutrons?

Ans. Isotopes of hydrogen tritium has greater number of neutrons. It has 2 neutrons.

(257 Give one example each of the use of radioactive isotope in medicine and radiotherapy.

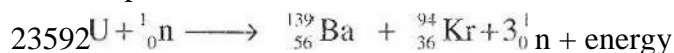
Ans. A radioactive Isotope used in medicine IS Iodine-131. Radioactive Isotope used in Radiotherapy is P-32, Sr-90 and Co-60.

(258. How is the goiter in thyroid gland detected?

Ans. Isotope of Iodine- 131 is used for diagnosis of goiter in the thyroid gland.

Q59. Define nuclear fission reaction.

Ans. Nuclear fission is the type of nuclear reaction in which an isotopic element is bombarded with slow moving neutrons that isotope of element emits three neutrons and split into same other isotopic elements.



Q60. When U-235 breaks up, it produces a large amount of energy. How is this energy used?

Ans.  ${}_{92}^{235}\text{U} + \text{n} \longrightarrow \text{Ba} + \text{Kr} + 3\text{n} + \text{energy}$ .

During this reaction, a large amount of energy is released which may be used to convert water into steam in boilers. The steam then drives the turbines to generate electricity. In this way, this energy is used for peaceful development of a nation.

Q61. How many neutrons are produced in the fission reaction of U-235. Ans.

${}_{92}^{235}\text{U} + {}_0^1\text{n} \longrightarrow {}_{56}^{139}\text{Ba} + {}_{36}^{94}\text{Kr} + 3{}_0^1\text{n} + \text{energy}$  During this reaction three neutrons are produced.

(262. U-235 fission produces two atoms of which elements?

Ans.  ${}_{92}^{235}\text{U} + {}_0^1\text{n} \longrightarrow {}_{56}^{139}\text{Ba} + {}_{36}^{94}\text{Kr} + 3{}_0^1\text{n} + \text{energy}$

The isotopes of barium and krypton are produced by the fission of U-235.

# Multiple Choice

## Questions

1. Which one of the following results in the discovery of proton?  
(a) Cathode rays (b) Canal rays  
(c) X-rays (d) Alpha rays
2. Which one of the following is the most penetrating?  
(a) Protons (b) Electrons  
(c) Neutrons (d) Alpha particles
3. The concept of orbit was used by  
(a) J J. Thomson (b) Rutherford  
(c) Bohr (d) Planck
4. Which one of the following consists of three subshells.  
(a) O shell (b) N shell  
(c) L shell (d) M shell
5. Which radio isotope is used for the diagnosis of tumor in the body?  
(a) Cobalt-60 (b) Iodine- 131  
(c) Strontium-90 (d) Phosphorous-32
6. When U-235 breaks up, it produces:  
(a) Electrons (b) Neutrons  
(c) Protons (d) Nothing
7. The p subshell has  
(a) One orbital (b) Two orbitals  
(c) Three orbitals (d) Four orbitals
8. Deuterium is used to make (a) Light water (b) Heavy water  
(c) Soft water (d) Hard water
9. The isotope C-12 is present in abundance of  
(a) 96.9% (b) 97.6%  
(c) 99.7% (d) None of these
10. Who discovered the proton?  
(a) Gold stein (b) J.J. Thomson  
(c) Neil Bohr (d) Rutherford
11. The name atom was derived from the Latin word 'Atomos' meaning  
(a) Divisible (b) Indivisible  
(c) Reactive (d) Stable
12. John Dalton put forward his atomic theory in the beginning of  
(a) 16<sup>th</sup> century (b) 17<sup>th</sup> century  
(c) 18<sup>th</sup> century (d) 19<sup>th</sup> century
13. In 1897, who found electrons in atom?  
(a) Goldstein (b) Dalton  
(c) J..J. Thomson (d) William Crooks
14. Plum pudding theory was put forward by:  
(a) Thomson (b) Goldstein  
(c) Crooks (d) Soddy
15. Sir William Crooks performed experiments in a discharge tube at low pressure in  
(a) 1893 (b) 1895  
(c) 1896 (d) 1897
16. Canal rays were discovered by  
(a) Goldstein (b) Thomson

(c) Dalton (d) Crooks 17. How many times the mass of a proton is more than an electron?

- (a) 1820 (b) 1830  
(d) 1850  
12

(b)  $d^+e$

19. Chadwick discovered neutrons in

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- (a) 1925 (b) 1930  
(c) 1932 (d) 1934
20. Who predicted in 1920 that some neutral particle having mass equal to that of proton in an atom?  
(a) Bohr (b) Rutherford  
(c) Chadwick (d) Goldstein
21. Rutherford used a gold foil in his experiment, which has a thickness of  
(a) 0.002cm (b) 0.00004cm  
(c) 0.0001 cm (d) 0.001 cm
22. Neil Bohr presented his model in  
(a) 1914 (b) 1918  
(c) 1913 (d) 1926
23. Neil Bohr won the noble prize in  
(a) 1914 (b) 1918  
(c) 1922 (d) 1926
24. In 1912 Neil Bohr joined for post doctoral research with  
(a) Rutherford (b) Chadwick  
(c) Newton (d) Goldstein
25. Rutherford won noble prize in  
(a) 1902 (b) 1906  
(c) 1908 (d) 1910
26. Who performed first experiment to split atom?  
(a) Soddy (b) Rutherford  
(c) Bohr (d) Newton
27. The value of Planck's constant is  
(a)  $5.63 \times 10^{-34}$  Js (b)  $5.62 \times 10^{-24}$  Js  
 $5.62 \times 10^{-19}$  (c) Js (d)  $5.62 \times 10^{-12}$  Js
28. Quantum means  
(a) Variable energy  
(b) Fixed energy  
(c) High energy  
(d) Minimum energy
29. According to Rutherford's atomic theory atom should produce  
(a) Line spectrum  
(b) Continuous spectrum  
(c) Both a & b  
(d) None of these
30. Who described the concept of line spectrum in his atomic model?  
(a) Rutherford (b) Bohr  
(c) Both a & b (d) Chadwick
31. The number of electrons that a shell can accommodate is given by formula.  
(a)  $2n^2$  (b)  $3n^2$  (c)  $2n^2$  (d)  $3n^2$
32. How many sub shells are there in first energy level or k shell?  
(a) 01 (b) 02  
(c) 03 (d) 04
33. How many electrons can be accommodated in L-shell?  
(a) 18 (b) 32 (c) 18 (d) 32
34. How many electrons can be accommodated in N-shell?  
(a) 02 (b) 08 (c) 18 (d) 32
35. How many electrons can be accommodated in ruorbital?  
(a) 02 (b) 06

(c) 10

(d) 14

36. Electronic configuration of Boron is

(a)  $1s^2, 2s$

(b)  $1s^2, 2s^2$

(c)  $1s^2, 2s^2, 2p^1$  (d)  $1s^2, 2p^1$

37. Symbol for Deuterium is

38.  $^{13}\text{C}$  and  $^{14}\text{C}$  are both present in nature

(a) 0.1 %

(b) 0.9 %

(c) 1.1 %

(d) 1.5 %

39. The percentage of pure  $^{238}\text{U}$  is

(a) 97 %

(b) 98 %

(c) 99 % (d) 100 % 40.

Which isotope is used for diagnosis of goiter?

(a) Iodine-131

(b) Cobalt-60.

(c) P-32

(d) Sr-90

found in nature

## Answer Key

|     |   |     |   |     |   |     |   |     |   |
|-----|---|-----|---|-----|---|-----|---|-----|---|
| 1.  | b | 2.  | c | 3.  | c | 4.  | d | 5.  | b |
| 6.  | b | 7.  | c | 8.  | b | 9.  | d | 10. | a |
| 11. | b | 12. | d | 13. | c | 14. | a | 15. | b |
| 16. | a | 17. | c | 18. | c | 19. | c | 20. | b |
| 21. | b | 22. | c | 23. | c | 24. | a | 25. | c |
| 26. | b | 27. | a | 28. | b | 29. | b | 30. | b |
| 31. | c | 32. | a | 33. | b | 34. | d | 35. | b |
| 36. | c | 37. | b | 38. | c | 39. | c | 40. | a |