

# STRUCTURE OF ATOMS

## CONTENTS

- Introduction
- Cathode rays
- Anode rays
- Electron
- Proton
- Neutron
- Structure of atom
  - Thomson's Model
  - Rutherford's Model
  - Bohr's Model
- Atomic number
- Mass numbers
- Electrons Distribution
- Isotopes, Isobars & Isotons

### ➤ Introduction

Atoms are made up of three subatomic particles electrons, Protons and neutrons. Electron has negative charge, proton has positive charge, whereas neutron has no charge, it is neutral. Protons and neutrons are present in a small nucleus at the centre of the atom. Electrons are outside the nucleus. The atoms of different elements differ in the number of electrons, protons and neutrons.

### ➤ Cathode rays

A discharge tube is long glass tube. This tube is fitted with metal electrodes on either end across which high voltage can be applied. The

electrode which is connected to the negative terminal of the power source is called cathode while the electrode which is connected to the positive terminal is called anode. The tube is also connected to a vacuum pump for controlling the pressure of gas inside the discharge tube. The gas pressure is reduced to about  $10^{-2}$  atmospheres and a potential difference of about 10000 volts is applied to the electrodes, an electric current flows and at the same time light is emitted by the gas. The fluorescence was caused due to the bombardment of the walls of the tube by rays emanating from cathode. These rays were called cathode rays.

#### ◆ Properties of cathode rays

- ◆ Cathode rays always travel in straight line.
- ◆ Cathode rays consist of material particles and possess energy, hence they can produce mechanical effects.
- ◆ Cathode rays consist of negatively charged particles.
- ◆ Cathode rays can penetrate through thin metallic sheets.
- ◆ Cathode rays ionize the gas through which they travel.
- ◆ Cathode rays heat up the object on which they fall. When they strike an object, a part of the kinetic energy is transferred to the object resulting in a rise in temperature.
- ◆ Cathode rays produce a green fluorescence on glass surface.
- ◆ When cathode rays fall on certain metals like copper, X-rays are produced. X-rays are not deflected by any electrical or magnetic fields but they pass through the opaque material and are only stopped by solid objects like bones.
- ◆ The mass of electrons is very small compared to the mass of an atom. The same type of negatively charged particles are formed even if different gases are taken in the discharge tube or different metals are used as cathode.

## ➤ Anode rays

The pressure in the tube is decreased, it was observed that in addition to cathode rays, a new kind of rays are also found which came through the perforations (holes) of the cathode. These rays travelled in opposite direction of the cathode rays and passed through the holes of the cathode and struck the other end of the discharge tube. When these radiations struck the end of the tube P, the fluorescent radiations were also produced. These rays were called canal rays because they are passed through the holes or canals in the cathode. These were also called anode rays because they move from the anode. It was found that the anode rays consist of positively charged particles. Therefore, these rays were also called positive rays.

### ◆ Properties of Anode Rays

- ◆ Anode rays travel in straight lines.
- ◆ Anode rays consist of material particles.
- ◆ Anode rays are deflected by electric field towards negatively charged plate. This indicates that they are positively charged.
- ◆ Anode rays are deflected by magnetic field. The direction of deflection indicates that they are positively charged.
- ◆ The charge to mass ratio of the particles in the anode rays was determined by W. Wien by using Thomson's technique. Charge to mass ratio of the particles in the anode rays depends upon nature of the gas taken in the discharged tube.
- ◆ The nature of anode rays depend on the nature of the gas taken in discharge tube.

## ➤ Electron

Electron was discovered by J.J. Thomson. Cathode rays consist of small, negatively charged particles called electrons. The electron is a negatively charged particle found in the atoms of all the elements. The electrons are located outside the nucleus in an atom. An electron is usually represented by the symbol  $e^-$

### ◆ Characteristics of an electron

#### ◆ Mass of an electron :

The mass of an electron is about  $\frac{1}{1836}$  of the mass of hydrogen atom. Since the mass of a hydrogen atom is 1 u. The absolute mass of an electron is, however,  $9 \times 10^{-28}$  gram.

#### ◆ Charge of an electron :

The absolute charge on an electron is  $1.6 \times 10^{-19}$  coulomb of negative charge. The relative charge of an electron is,  $-1$

## ➤ Proton

Proton was discovered by Goldstein. The proton is a positively charged particle found in the atoms of all the elements. The protons are located in the nucleus of an atom. Only hydrogen atom contains one proton in its nucleus, atoms of all other elements contain more than one proton. A proton is usually represented by the symbol  $P^+$

### ◆ Characteristics of a proton

- ◆ **Mass of proton :** The mass of proton has been found to be equal to  $1.67 \times 10^{-27}$  kg. This is almost equal to that of an atom of hydrogen. Since the mass of a hydrogen atom is 1 a.m.u., therefore, the relative mass of a proton is also 1 a.m.u.
- ◆ **Charge of proton :** The charge of proton is equal and opposite to the charge of an electron. The value of charge on proton is  $1.602 \times 10^{-19}$  coulomb of positive charge.

## ➤ Neutron

In 1932, Chadwick discovered the fundamental particle neutron. The neutron is a neutral particle found in the nucleus of an atom. The subatomic particle not present in a hydrogen atom is neutron. A hydrogen atom contains only one proton and one electron. A neutron is represented by the symbol  $n$ .

### ◆ Characteristics of a Neutron

- ◆ **Mass of a neutron :** The mass of neutron is equal to the mass of a proton. The relative mass of a neutron is 1 u. The absolute mass of a neutron is  $1.6 \times 10^{-27}$  kg.
- ◆ **Charge of an neutron :** Neutron has no charge. It is electrically neutral.

### Comparison between Proton, Neutron and Electron:

|                  | Electron                     | Proton                       | Neutron                  |
|------------------|------------------------------|------------------------------|--------------------------|
| (i) Symbol       | e/e <sup>-</sup>             | p/p <sup>+</sup>             | n                        |
| (ii) Nature      | Negatively charge            | Positively charge            | Neutral                  |
| (iii) Relative   | 1/1840 of a H atom           | equal to H atom              | equal to H atom          |
| (iv) Actual mass | $9.1 \times 10^{-28}$ g      | $1.67 \times 10^{-24}$ g     | $1.67 \times 10^{-24}$ g |
| (v) Charge       | (- 1)                        | (+ 1)                        | No charge                |
|                  | ( $1.602 \times 10^{-19}$ C) | ( $1.602 \times 10^{-19}$ C) |                          |

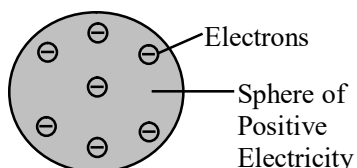
### ➤ Structure of atom

After the discovery of electron and proton, the scientists started thinking of arranging these particles in an atom. J.J. Thomson was the first scientist to propose a model for the structure of atom. Mainly there are three model preposed.

- (A) Thomson's model of an atom
- (B) Rutherford model of an atom
- (C) Bohr's model of an atom

#### (A) Thomson's model of an atom

Thomson was the first to propose a detailed model of the atom. He proposed that an atom consists of a uniform sphere of positive electricity in which the electrons are distributed more or less uniformly. The negative and the positive charge are equal in magnitude. Thus, the atom as a whole is electrically neutral. This model of atom is known as the “**Plum pudding model**”.



### (B) Rutherford model of an atom

Rutherford and his co-workers made a fundamental contribution in understanding the structure of the atom and establishing the presence of a small nucleus in the atom. They performed a number of experiments known as scattering experiments. They took very thin sheets of gold foil (only  $4 \times 10^{-5}$  cm thick) and bombarded it with a stream of alpha ( $\alpha$ ) particles. The alpha particles are positively charged helium ions ( $\text{He}^{2+}$ ) which carry two units of positive charge and mass four times that of an atom of hydrogen (i.e., mass of helium ions = 4 a.m.u.). These are emitted from radioactive elements such as radium.

### ◆ Following important observations :

- ◆ Most of the fast moving  $\alpha$ -particles passed straight through the gold foil without any deflection from their original path.
- ◆ Some of the  $\alpha$ -particles were deflected from their path through small angles.
- ◆ Very few (about 1 in 12,000) did not pass through the foil at all but suffered large deflections (more than  $90^\circ$ ) or even came back in the direction from which they came.

### ◆ The main conclusions of Rutherford's experiment :

- ◆ Most of the space inside the atom is empty. Therefore, most of the  $\alpha$ -particles went through the gold foil without deflecting from their path.
- ◆ There is a positive tiny part in the atom in its centre, which deflects or repels the  $\alpha$ -particles. This must be containing the whole mass of the atom. Moreover, this mass must be occupying a very small space within the atom because only a few  $\alpha$ -particles suffered large deflections. This positively charged heavy mass in the centre of the atom is called nucleus. The  $\alpha$ -particle get deflected from their normal path when they came close to nucleus due to force of repulsion (similar charges).

- The deflections of the  $\alpha$ -particles to large angles indicate that the  $\alpha$ -particles has direct collision with the positively charged nucleus.

It was observed that the volume of the nucleus is very small as compared to the total volume of the atom. The radius of the atom is of the order of  $10^{-10}$  m, while the radius of the nucleus has been estimated to be of the order of  $10^{-15}$  m. This means that the size of the nucleus is extremely small i.e., about  $10^5$  times less than the size of the atom.

- ◆ **Rutherford's Atomic model :** The main features of Rutherford's model of an atom are :
  - ◆ The atom consists of a positively charged centre called the nucleus.
  - ◆ Most of the mass of the atom is concentrated in the nucleus.
  - ◆ The volume of the nucleus is very small as compared to the total volume of the atom.
  - ◆ The nucleus is surrounded by the negatively charged electrons. the electrons balance the positive charge of the nucleus. Therefore, the number of electrons in an atom is equal to the number of protons in it.
  - ◆ The magnitude of the positive charge on the nucleus is different for different atoms.
  - ◆ The electrons are not stationary but they are revolving around the nucleus at very high speeds like planets revolving around the sun. As a result, the electrons are also known as planetary electrons.

◆ **Drawbacks of Rutherford's model :**

Rutherford model failed in view of electromagnetic theory given by Maxwell. According to this theory a charged particle when accelerated emits energy in the form of electromagnetic radiation. According to Rutherford's model, electrons are revolving around the nucleus. This means, electrons would be in a state of acceleration all the time. Since electrons are charged particles, therefore, electron revolving in an orbit should continuously emit radiations. As a result of this, it would slow down and would

no longer be able to withstand the attractive force of the nucleus. Hence, it would move closer and closer to the nucleus and would finally fall in the nucleus by following a spiral path. This means atom would collapse. But actually we know atom is stable. Thus, Rutherford's model failed to explain stability of atoms.

**(C) Bohr's model of an atom**

In 1912, Niels Bohr put forward a model to explain the structure of an atom. The main postulates of the model are:

- ◆ An atom is made up of three particles : electrons, protons and neutrons. Electrons have negative charge, protons have positive charge whereas neutrons have no charge, they are neutral. Due to the presence of equal number negative electrons and positive protons, the atom on the whole is electrically neutral.
- ◆ The protons and neutrons are located in a small nucleus at the centre of the atom. Due to the presence of protons, nucleus is positively charged.
- ◆ The electrons revolve rapidly around the nucleus in fixed circular paths called energy levels or shells. The energy levels or shells are represented in two ways: either by the numbers 1, 2, 3, 4, 5 and 6 or by the letters K, L, M, N, O and P. The energy levels are counted from the centre outwards.
- ◆ There is a limit to the number of electrons which each energy level can hold. For example, the first energy level (or K shell) can hold a maximum of 2 electrons; second energy level (or L shell) can hold a maximum of 8 electrons; third energy level (or M shell) can hold a maximum of 18 electrons and fourth energy level (or N shell) can hold a maximum of 32 electrons.
- ◆ Each energy level (or shell) is associated with a fixed amount of energy, the shell nearest to the nucleus having minimum energy and the shell farthest from the nucleus having the maximum energy.
- ◆ There is no change in the energy of electrons as long as they keep revolving in the same

energy level, and the atom remains stable. The change in the energy of an electron takes place only when it jumps from a lower energy level to a higher energy level or when it comes down from a higher energy level to a lower energy level. When an electron gains energy, it jumps from a lower energy level to a higher energy level, and when an electron comes down from a higher energy level to a lower energy level, it loses energy.

### ➤ Atomic number

The number of protons present in the nucleus of an atom of an element is known as its atomic number.

**Ex.** An atom of carbon has 6 protons so, the atomic number of carbon is 6. The atomic number is denoted by Z. Now positive charge on the nucleus is due to the presence of protons in it and each proton carries one unit of positive charge. Therefore, the atomic number of an element is equal to number of positive charges carried by the nucleus of an atom of the element.

Atomic number of an element (Z)

= Number of protons (p)

= Number of positive charges carried by the nucleus of the atom

or = Number of electrons (e)

### ➤ Mass number

The sum of the number of protons and neutrons in an atom of the element.

Mass number (A)

= No. of protons (p) + No. of neutrons (n)

**Ex.** Helium atom has 2 protons, 2 neutrons and 2 electron. Its mass number is equal to  $2 + 2 = 4$ .

**Ex.** Oxygen has 8 protons, 8 neutrons and 8 electrons. its mass number is 16.

In some cases, particularly heavier elements, the number of neutrons is more than the number of protons.

**Ex.** Mercury has atomic number equal to 80. So, it has 80 protons and 80 electrons. But the mass number of mercury is 200. Therefore, the number of neutrons in mercury is  $200 - 80 = 120$ .

Generally, an atom is represented by its symbol for the element. Atomic number is written on the lower side of the symbol and the mass number is written on the upper side.



A = Mass number

Z = Atomic number

X = Symbol of element

**Ex.** Indicates that lithium has atomic number equal to 3 and mass number equal to 7.

### ◆ Relationship between mass number and atomic number :

Mass number = No. of protons + No. of neutrons

Mass number = Atomic number + No. of neutrons

**Ex.** The atomic nucleus of an element has mass number 23 and number of neutrons 12. What is the atomic number of the element ?

**Sol.** We know that

Mass No. = No. of protons + No. of neutrons

$$23 = \text{No. of protons} + 12$$

$$\therefore \text{No. of protons} = 23 - 12 = 11$$

Now, Atomic No. = No. of protons = 11.

**Ex.** Calculate the number of :

- (i) electrons                      (ii) protons  
(iii) neutrons and                (iv) nucleons in

**Sol.** Mass No. = 39

Atomic No. = 19

(i) We know that

atomic No. = No. of protons = No. of electrons

No. of electrons = 19

(ii) No. of protons = 19

(iii) Mass No. = No. of neutrons + No. of protons

No. of neutrons = mass number – No. of protons

$$= 39 - 19 = 20$$

(iv) Nucleons = No. of protons + No. of neutrons  
 $= 19 + 20 = 39$

### ➤ Electron Distribution

The distribution of electrons in different orbits or shells is governed by a scheme known as **Bohr bury scheme**. The arrangement of electrons in various energy levels of an atom is known as the electronic configuration of the atom. According to this scheme.

- ◆ The electrons are arranged around the nucleus in different energy levels or energy shells. The electrons first occupy the shell with the lowest energy i.e., closest to the nucleus.

- ◆ The first or the innermost energy shell (K or  $n = 1$ ) can take only two electrons.
- ◆ The second shell (L or  $n = 2$ ) can contain upto 8 electrons.
- ◆ From third shell (M or  $n = 3$ ) onwards, the shells become bigger. The third shell can accommodate as many as 18 electrons. In general, the maximum number of electrons that can be present in any shell is  $2n^2$  where  $n$  is the number of energy shell. Thus, the first orbit ( $n = 1$ , known as K shell) can contain  $2 \times 1^2 = 2$  electrons, the second orbit ( $n = 2$ , known as L shell) can contain  $2 \times 2^2 = 8$  electrons.

#### Maximum No. of electrons in different orbits

| Orbit | Value of n | Maximum no. of electrons in the orbit |
|-------|------------|---------------------------------------|
| K     | 1          | $2 \times 1^2 = 2$                    |
| L     | 2          | $2 \times 2^2 = 8$                    |
| M     | 3          | $2 \times 3^2 = 18$                   |
| N     | 4          | $2 \times 4^2 = 32$                   |

- ◆ The outermost shell of an atom cannot have more than 8 electrons and the shell next to the outermost shell cannot have more than 18 electrons.

#### (A) Valence shell

The outermost orbit of an atom is called its valence shell.

#### ◆ Valence electrons

The electrons present in the outermost orbit are called valence electrons.

**Ex.** The electronic configuration of lithium is 2, 1 or it may be represented as :

|   |   |
|---|---|
| K | L |
| 2 | 1 |

the outermost orbit is L shell and the number of electrons in its valence shell is one. Only the valence electrons of an atom take part in chemical reactions because they have more energy than all the inner electrons of the atom.

**(B) Valency :**

Valency of an element is the combining capacity of the atoms of the element with atoms of the same or different elements.

◆ **Types of valency**

There are two types of valency : Electrovalency and covalency. If an element combines by the loss or gain of electrons to form electrovalent compounds (or ionic compounds), its valency is known as electrovalency, and if an element combines by the sharing of electrons to form covalent compounds (or molecular compounds), its valency is known as covalency.

◆ **Electrovalency :** In the formation of an electrovalent compound (or ionic compound), the number of electrons lost or gained by one atom of an element to achieve the nearest inert gas electron configuration is known as its electrovalency. The elements which lose electrons form positive ions, so they have positive electrovalency. So they have positive electrovalency. The elements which gain electrons form negative ions, so they have negative electrovalency.

◆ **Covalency :** In the formation of a covalent compound the number of electrons shared by one atom of an element to achieve the nearest inert gas electron configuration is known as its covalency. If an atom shares 1 electron, its covalency will be 1.

➤ **Isotopes, Isobars & Isotones**

**(A) Isotopes**

Isotopes are atoms of the same element which have the same atomic number but different mass numbers.

**Ex.** Hydrogen is the common example which has three isotopes. These have the same atomic number, one, but different mass numbers 1, 2, and 3. These three isotopes are commonly known as hydrogen or protium, deuterium (D) and tritium (T) respectively. Since atomic number is same for all the three, they all have one electron and therefore, one proton but different neutrons.

(1) Hydrogen      At. No. = 1,    Mass no. = 1

Electrons = 1,    Protons = 1,    Neutrons = 0

It is also represented as  ${}^1_1\text{H}$

(ii) Deuterium      At. No = 1,    Mass no. = 2

Electron = 1,    Protons = 1,    Neutrons = 1

It is also represented as  ${}^2_1\text{H}$  or D

(iii) Tritium      At. No = 1,    Mass no. = 3

Electron = 1,    Protons = 1,    Neutrons = 2

It is also represented as  ${}^3_1\text{H}$  or T.

### Isotopes of hydrogen

|                          | Protium | Deuterium | Tritium |
|--------------------------|---------|-----------|---------|
| Atomic number, Z         | 1       | 1         | 1       |
| Mass number, A           | 1       | 2         | 3       |
| Number of protons        | 1       | 1         | 1       |
| Number of electrons      | 1       | 1         | 1       |
| Number of neutrons       | 0       | 1         | 2       |
| Electronic configuration | K       | K         | K       |
|                          | 1       | 1         | 1       |

#### ◆ Some important points regarding isotopes

- ◆ Isotopes are atoms of same element having the same atomic number but different mass numbers.
- ◆ Isotopes have same number of protons and electrons but different neutrons.
- ◆ Isotopes have same electrical charge on their nuclei
- ◆ Since all the isotopes contain same number of electrons, they have same chemical properties.

**There are two types of isotopes : Stable & unstable.**

#### ◆ Radioactive isotopes :

The isotopes which are unstable (due to the presence of extra neutrons in their nuclei) and emit various types of radiations, are called radioactive isotopes.

**Ex.** Some of the common radioactive isotopes are : Carbon-14, Arsenic-74, Sodium-24, Iodine-131, Cobalt-60 and Uranium-235.

#### ◆ Applications of Radioactive isotopes :

Isotopes are used in almost all the fields such as medicines, agriculture, biology, chemistry, engineering and industry.

- ◆ Radioactive isotopes are used as a fuel in nuclear reactors of nuclear power plants for generating electricity.

**Ex.** Uranium-235 isotope is used as a fuel in the reactors of nuclear power plants for generating electricity.

- ◆ Radioactive isotopes are used as 'tracers' in medicine to detect the presence of tumors and blood clots, etc., in the human body.

**Ex.** Arsenic-74 tracer is used to detect the presence of tumors and sodium-24 tracer is used to detect the presence of blood clots.

- ◆ Radioactive isotopes are used to determine the activity of thyroid gland which helps in the treatment of diseases like goitre.

**Ex.** Iodine-131

- ◆ Radioactive isotopes are used in the treatment of cancer.

**Ex.** Cobalt-60 radioisotope is used to cure cancer.

- ◆ Radioactive isotopes are used in industry to detect the leakage in underground oil pipelines, gas pipelines and water pipes.

### (B) Isobars

- ◆ Isobars are the atoms of different elements having same mass number but different atomic numbers.
- ◆ Since isobars have the same mass number, therefore sum of the protons and neutrons in the nucleus of each is the same. These atoms differ in their atomic number and therefore, they have different number of protons and also different number of neutrons. Due to different atomic numbers, the isobars will have different atomic structures and therefore, will differ in chemical properties.

**Ex.** Argon (atomic number 18) and calcium (atomic number 20) are isobars because they have same mass number 40.

|                                 |                                   |
|---------------------------------|-----------------------------------|
| Argon ( $^{20}_{18}\text{Ar}$ ) | Calcium ( $^{40}_{20}\text{Ca}$ ) |
| At. no. = 18,                   | At. no. = 20,                     |
| Mass no. = 40                   | Mass no. = 40                     |
| No. of electrons = 18           | No. of electrons = 20             |
| No. of protons = 18             | No. of protons = 20               |
| No. of neutrons = 22            | No. of neutrons = 20              |

### (C) Isotones

- ◆ The atoms having same number of Neutrons but different mass number are called Isotones.
- ◆ The atoms have different number of protons of atomic number.
- ◆ The isotones belong to two or more different elements.
- ◆ “(A–Z) is same” “A & Z are different”.

|               |    |    |
|---------------|----|----|
| ↓             | ↓  | ↓  |
| (A–Z) = 5 & 5 | 10 | 10 |

## EXERCISE - 1

### A. Very Short Answer Type Questions

- Q.1** How many times a proton is heavier than an electron ?
- Q.2** Who was the first to discover neutrons ?
- Q.3** The atomic number of oxygen and sulphur are 8 and 16 respectively. What will be the number of electrons in these ?
- Q.4** An element may be represented as  ${}^{40}_{18}\text{X}$ . Find the number of electrons, protons and neutrons in this atom. Give its electronic configuration.
- Q.5** Out of O-16 and O-18 isotopes, which has more number of neutrons ?
- Q.6** The mass number and atomic number of an element is 23 and 11 respectively. What is the number of nucleons present in it ?
- Q.7** An element has atomic number 19 and mass number 39. How many electrons and protons are present in its unipositive ion ?
- Q.8** Give the nuclear composition of  ${}^{18}_8\text{O}$ .
- Q.9** Who determined the charge of the electron for the first time ?
- Q.10** What is the nature of charge on cathode rays ?
- Q.11** Which of the two has larger mass : electron or proton ?
- Q.12** What is the approximate ratio of mass of proton and electron ?
- Q.13** Give one property in which cathode rays and anode rays differ.
- Q.14** Are electrons present in all matter ?
- Q.15** The nucleus of an element contains 17 protons and 18 neutrons. What is its mass number and atomic number ?

### B. Short Answer Type Questions

(About 16–25 words)

- Q.16** What are the characteristic features of Thomson's model of atom ?

- Q.17** Give four properties of cathode rays.
- Q.18** Write the Bohr-Bury scheme to fill the electrons in various energy levels of an atom. Using these rules, write the electronic arrangement of the elements having atomic numbers 6, 11, 15 and 18.
- Q.19** What are the main postulates of Bohr's atomic theory ?
- Q.20** What are the maximum number of electrons that can be present in the K, L and M shells ?
- Q.21** What do you understand by atomic number and mass number ?
- Q.22** Write electronic configuration for the following elements:  
 ${}^{16}_8\text{O}$ ,  ${}^{28}_{14}\text{Si}$ ,  ${}^{35}_{17}\text{Cl}$ ,  ${}^{40}_{18}\text{Ar}$
- Q.23** What are isotopes ? Write three isotopes of hydrogen.
- Q.24** Isotopes have the same chemical properties but different physical properties. Explain.
- Q.25** Name the elements which have the following electronic configuration :  
(i) 2, 6    (ii) 2, 7    (iii) 2, 8, 1  
(iv) 2, 8, 7    (v) 2, 8  
Which of these is chemically inert ?

## EXERCISE - 2

### A. Long Answer Type Questions

(More than 60–70 words)

- Q.1** What is Thomson's model of atom ? Why was it rejected ?
- Q.2** Why is the atom neutral whereas it contains charged particles ?
- Q.3** Explain why atomic masses of most of the elements are fractional
- Q.4** Elemental boron is 20.0% B–10 and 80% B–11. Calculate the atomic mass of boron.
- Q.5** Hydrogen has three isotopes written as  ${}^1_1\text{H}$ ,  ${}^2_1\text{H}$  :  ${}^3_1\text{H}$  and . Explain why :  
 (i) These isotopes have almost identical chemical properties  
 (ii) They are electrically neutral.
- Q.6** Who discovered the presence of electrons in an atom ? Discuss detailed experiment connected with it, How is its mass and charge determined ?
- Q.7** What observations in scattering experiment led Rutherford to make the following conclusions :  
 (i) The most of the space in an atom is empty  
 (ii) The whole mass of an atom is present in the centre of atom.  
 (iii) Nucleus has positive charge.
- Q.8** Give important differences between :  
 (i) Canal rays and cathode rays  
 (ii) Atomic number and mass number  
 (iii) Isotopes and isobars.
- Q.9** The following table lists mass number and atomic number of five elements A, B, C, D and E.

| Element | Mass number | Atomic number |
|---------|-------------|---------------|
| A       | 3           | 1             |
| B       | 7           | 3             |
| C       | 35          | 17            |
| D       | 40          | 18            |
| E       | 37          | 17            |

- (i) How many protons are there in an atom of B ?

- (ii) How many neutrons are there in an atom of A ?  
 (iii) How many electrons are there in an atom of E ?  
 (iv) How many nucleons are there in an atom of D ?  
 (v) Which atoms are isotopes of the same element ?

- Q.10** Compare an electron and a proton in respect of mass and charge.

### B. Fill in the Blanks

- Q.11** The subatomic particle not present in a hydrogen atom is .....
- Q.12** The number of protons in the nucleus of an atom is called its .....
- Q.13** The total number of protons and neutrons in the nucleus of an atom is called its .....
- Q.14** An atom has atomic mass number 23 and atomic number 11. The atom has ..... electrons.
- Q.15** An atom of an element has 11 protons, 11 electrons and 12 neutrons. The atomic mass of the atom is .....

### C. True /False Type Questions

- Q.16** Electrons are present in all matter and carry negative charge.
- Q.17** In  $\text{Na}^+$  number of electrons are more than the number of protons.
- Q.18** The number of neutrons in the atoms of an element is equal to its atomic number.
- Q.19** Isotopes of an element differ in the number of neutrons.
- Q.20** Element having electronic arrangement 2, 7 is fluorine.
- Q.21** Matter is electrical and negative in nature.
- Q.22** Mass of electron is about 1840 times that of proton.
- Q.23** Neutrons were discovered by Henry Becquerel.

# ANSWER KEY

---

## EXERCISE-1

### A. Very Short Type Answer

- |                                                                                 |                   |                  |         |
|---------------------------------------------------------------------------------|-------------------|------------------|---------|
| 1. 1840 times                                                                   | 2. James chadwick | 3. 8 and 16      |         |
| 4. C = 18, P = 18, n = 22, electronic configuration = 2, 8,8,                   |                   | 5. O-18          | 6. 23   |
| 7. p = 19, e = 18                                                               | 8. p = 8, n = 10  | 9. R.A. millikan |         |
| 10. Negative                                                                    | 11. Proton        | 12. 1840 : 1     |         |
| 13. Cathode rays are negatively charged while anode rays are positively charged |                   |                  | 14. Yes |
| 15. Mass number = 35, Atomic number = 17                                        |                   |                  |         |

## EXERCISE-2

- |             |                   |                 |           |
|-------------|-------------------|-----------------|-----------|
| 11. Neutron | 12. Atomic number | 13. Mass number | 14. 11    |
| 15. 23      | 16. True          | 17. False       | 18. False |
| 19. True    | 20. True          | 21. True        | 22. True  |
| 23. False   |                   |                 |           |