STRUCTURE OF THE ATOM

Question (1): What is an electron? State its relative mass and charge.

Answer: The electron is a negatively charged particle found in the atoms of all the elements. Its relative mass is 1/1840 a.m.u and relative charge is 1.

Question (2): Define the following terms:

a) Nucleons

b) Atomic number

c) Mass number

d) Nucleus

Answer:

a) Nucleons: The particles found inside the nucleus i.e., protons and neutrons are called nucleons.

b) Atomic number: The number of protons present in the nucleus of an atom is called the atomic number. It is denoted as Z. The number of protons is equal to the number of electrons.

c) Mass number: Mass number is defined as the sum of the number of protons and neutrons in the nucleus of the atom. It is denoted by the alphabet 'A'.

d) Nucleus: The solid core of an atom made up of protons and neutrons, is called the nucleus

Question (3): What are cathode rays? How are they formed?

Answer: Cathode rays are a stream of negatively charged particles. These particles called electrons are shot from the metal cathode of a discharge tube when an electric current is passed through a gas at a very low pressure. A discharge tube is a long glass tube having two metal electrodes. When the pressure of air in the discharge tube is reduced to 0.001 mm of mercury and a high voltage is applied to the electrode, the emission of light by air stops. But it is noticed that the wall of the discharge tube at the end opposite to the cathode begins to glow with greenish light. Since these rays are formed at the cathode they are known as cathode rays.

Question (4): a) Which atom contains only two fundamental particles?

b) Which particle has constant charge to mass ratio for all matter?

Answer: a) The hydrogen atom contains only two fundamental particles.

b) Cathode ray particles i.e., electrons, have constant charge to mass ratio for all matter.

Question (5): What are anode rays? State three properties of anode rays.

Answer: Anode rays are stream of positively charged particles shot out from the anode of a discharge tube when a current is passed through a gas.

- Anode rays travel in straight lines. They cast shadows of the objects placed in their path.
- Anode rays can produce mechanical effects. This is evident by the fact they can rotate a light paddle.

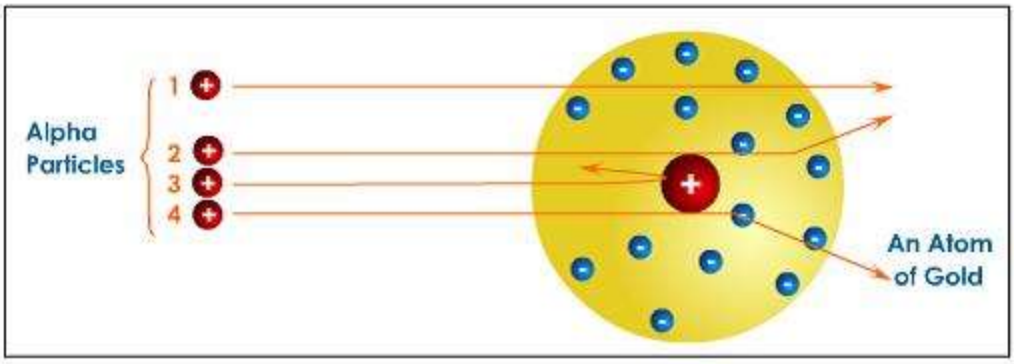
- Anode rays are positively charged as they are deflected towards the negative plate in an electric field.

Question (6): What happens to e/m ratio of positive rays and why?

Answer: The mass and charge of positively charged particles depends upon the gas, which is taken in the discharge tube. Different gases contain particles having different masses and different charges and consequently give different types of positive rays. In other words the charge to mass ratio e/m is not constant.

Question (7): Who discovered the nucleus within an atom? And how?

Answer: Ernest Rutherford discovered the nucleus within an atom in his alpha-ray scattering experiment. The arrangement of the alpha-particle scattering experiment is as follows:



Rutherford produced a narrow beam of particles from a radioactive source (e.g., radium or polonium), which was allowed to strike an extremely thin gold foil. Rutherford proposed that if the spherical model proposed earlier which made for a uniform distribution of positive and negative particles was correct then the alpha particle striking the gold atoms would be uniformly deflected. However the observation were:

- Most of the alpha particles passed straight through the gold foil without suffering any deflection from their original path
- A few of them were deflected through small angles, while a very few deflected to a large extent
- A very small percentage (1 in 100000) was deflected through 90o(turned back)

Question (8): Describe Rutherford's model of an atom.

Answer:

- The atom of an element consists of a small positively charged nucleus which is situated at the centre of the atom and which carries almost the entire mass of the atom.
- The electrons are distributed in the empty space of the atom and are revolving around the nucleus at high speed.

- The number of electrons in an orbit is equal to the number of positive charges (protons) in the nucleus. Hence the atom is electrically neutral.
- The volume of the nucleus is negligibly small as compared to the volume of the atom.
- Most of the space in the atom is empty.
- The arrangement is just like a solar system.

Question (9): What is the drawback of Rutherford's nuclear model of the atom?

Answer: Drawback of Rutherford's nuclear model: It could not explain the stability of the atom because according to the electromagnetic theory if the charged particle undergoes accelerated motion it must lose energy continuously and the electrons should collapse in the nucleus.

Question (10): Name the fundamental particles whose relative charge is a) +1 b) - 1 C) 0

Answer:
- +1 proton
- - 1 electron
- 0 neutron

Question (11): Compare the characteristics of protons, neutrons and electrons.

Answer: Comparison between Proton, Neutron and Electron

Sub-atomic Particle	Relative Mass	Relative Charge	Location in the Atom
Proton	1 a.m.u	+1	In the nucleus
Neutron	1 a.m.u	0	In the nucleus
Electron	$\frac{1}{1840}$ a.m.u	-1	Outside the nucleus

Question (12): Discuss Bohr's model of an atom.

Answer: Neils Bohr, a Danish Scientist, put forth the structure of an atom that provides an explanation for the major drawback of Rutherford's model. The main postulates are:

i) An atom is made up of three particles: electrons, protons and neutrons. Electrons have negative charge; protons have positive charge whereas neutrons are neutral. Due to the presence of equal number of negative electrons and positive protons the atom on the whole is electrically neutral.

ii) 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.

iii) The electrons revolve rapidly round the nucleus in fixed circular paths called energy levels or shells. The energy levels or shells are represented either by numbers 1, 2, 3, 4, 5 and 6 or by letters K, L, M,

N, O and P. The energy levels are counted from centre outwards.

iv) Each energy level is associated with a fixed amount of energy, the shell nearest to the nucleus has minimum energy and the shell farthest from the nucleus has the maximum energy.

v) There is no change in energy of electrons as long as they keep revolving in the same energy level, and the atom remains stable. When an electron jumps from a lower level to a higher level it absorbs energy and when an electron comes down from a higher energy level to a lower energy level it loses energy.

Question (13): Calculate the atomic number of the element that has 12 neutrons and a mass number of 23.

Answer: Number of neutrons = 12

Mass number = 23 = number of protons + number of neutrons

23 = number of protons + 12

Number of protons = 23 - 12 = 11

Question (14): From the symbol $^{31}_{15}P$ State i) Mass number ii) Atomic number iii) Electronic configuration

Answer: i) Atomic mass / mass number - 31

ii) Atomic number - 15

iii) Electronic configuration - 2, 8, 5 K L M

Question (15): What is an electronic configuration of an element?

Answer: The arrangement of electrons in the various shells of an atom of the element is known as electronic configuration of the element.

Question (16): State Bohr-Bury scheme of electronic configuration.

Answer: According to Bohr-Bury scheme:

- The maximum number of electrons that can be accommodated in any energy level of the atom is given by $2n^2$ (n is the number of that energy level). For e.g., 3rd energy level n = 3 Maximum number of electrons = $2n^2$

  $2 \times (3)^2$
  $2 \times 9 = 18$

- The outermost shell of an atom cannot accommodate more than 8 electrons even if it has a capacity to accommodate more electrons.

Question (17): What is the maximum number of electrons that can be accommodated in L shell?

Answer: The maximum number of electrons that can be accommodated in the L shell is 8 electrons.
($2n^2$: n = 2 Therefore, 2 x 2 x 2 = 8 electrons)

Question (18): Write the electronic configuration of elements whose atomic numbers are between 1 and 10.

Answer: Hydrogen (1) : 1

Helium (2) : 2

Lithium (3) : 2, 1

Beryllium (4) : 2, 2

Boron (5) : 2, 3

Carbon (6) : 2, 4

Nitrogen (7) : 2, 5

Oxygen (8) : 2, 6

Fluorine (9) : 2, 7

Neon (10) : 2, 8

Question (19): What is the electronic configuration of a positively charged sodium ion Na^+?

Answer: The electronic configuration of a positively charged (sodium ion) Na^+:

$$Na - 11 - \overset{K}{2},\ \overset{L}{8},\ \overset{M}{1} \qquad Na^+ - \overset{K}{2},\ \overset{L}{8}$$

Question (20): Write short notes on

(a) Isotopes

(b) Valence electrons.

Answer: a) Isotopes are atoms of the same element having the same atomic number but different atomic mass. Isotopes differ in the number of neutrons in the nuclei.

Example :

$^{1}_{1}H$, $^{2}_{1}H$, and $^{3}_{1}H$

Isotopes have same chemical properties but differing physical characteristics.

b) Valence electrons - The outermost shell of an atom that accommodate electrons in orbit is called the valence shell. Electrons present in the valence shell are called valence electrons.

Example: Na (11) - 2, 8, 1. The number of valence electrons is 1.

Question (21): Which of the following elements is a metal and which is a non-metal? $^{23}_{11}X$ and $^{19}_{9}Y$

Answer: X - 11 - 2, 8, 1

Y - 9 - 2, 7

X – Metal Y - Non-metal

Question (22): State the number of valence electrons in a) alkali metals b) alkaline earth metals c) halogens.

Answer:

- Alkali metals = 1 (e.g. sodium)
- Alkaline earth metals = 2 (e.g. calcium)
- Halogens = 1 (e.g. chlorine)

Question (23): Predict the valencies of helium, phosphorus, sulphur and neon.

Answer: Helium - He : 2

K shell has 2 electrons, which is completely filled. Hence its valency is 0.

Phosphorus - P - 15 : 2, 8, 5 Valency = 8 - 5 = 3

Sulphur - S - 16 - 2: 8, 6 Valency - 8 - 6 = 2

Neon - Ne - 10 : 2, 8 Valency is 0

Question (24): How can valency be calculated? Give examples of elements whose valencies are 1, 2, 3 and 4 respectively.

Answer: There are different ways in which valency can be calculated:

(i) The valency of an element can be determined by looking at the group number of the element. Elements having 1, 2 or 3 electrons in the valence shell are metals.

(ii) For non-metals valency is calculated by using the relationship Group number - 8; in case of a non-metal 4 to 7 electrons exist in their valence shell.

(iii) The same relation i.e. (Group number - 8) stands good for rare gases also.

(iv) The valency of an electro positive ion is equal to the positive charge on it.

Example:

ion	valency
Na^+	1
Ca^{2+}	2

(v) The valency of an electro negative ion is equal to the negative charge on it.

ion	valency
Cl^{1-}	1
O^{2-}	2

Example of elements :

Valency - 1: sodium, potassium lithium and chlorine

Valency - 2: magnesium, calcium, zinc

Valency - 3: aluminium, nitrogen, and chromium

Valency - 4: tin, carbon

Question (25): $^{24}_{12}Mg$ and $^{26}_{12}Mg$ are symbols of two isotopes of magnesium. Compare the atoms of these isotopes with respect to the following.

i) The composition of their nuclei.
ii) Their electronic configurations.
iii) Give the reason why the two isotopes of magnesium have different mass numbers.
iv) Explain why the two atoms have the same chemical reactions.

Answer:

$^{24}_{12}Mg$	and	$^{26}_{12}Mg$
i) Protons = 12		Protons = 12
Neutrons = 24 - 12 = 12		Neutrons = 26 - 12 = 14

ii) The electronic configuration of both atoms is the same i.e., 2, 8, 2, since they both have 12 electrons.

iii) Mass number is the number of protons + neutrons. Both the atoms have same number of protons but different number of neutrons. Hence their mass numbers are different.

iv) When chemical reactions take place, only electrons are involved in chemical reactions and the protons and neutrons are not involved. Since both the atoms have same number of electrons, the chemical reactions will be the same for both atoms.