Structure of the Atom

CHAPTER 4

NCERT FOCUS

ANSWERS

Topic 1

1. The beam of rays which travel in a direction away from anode towards cathode when a gas taken in a discharge tube is subjected to the action of high voltage under low pressure are known as canal rays. It is also called anode rays. It was discovered by E. Goldstein in 1886.

2.

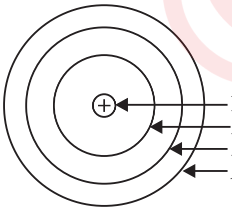
	Property	Electron	Proton	Neutron
(i)	Symbol	e^- or ${}^{0}_{1}e$	p^+ or ${}^{1}_{1}p$	n or ${}^{1}_{0}n$
(ii)	Charge	–1 unit or -1.6×10^{-19} C	+1 unit or $+1.6 \times 10^{-19}$ C	zero
(iii)	Mass	9.1×10^{-31} kg	1.672×10^{-27} kg	1.675×10^{-27} kg
(iv)	Location	present around the nucleus	present in nucleus	present in nucleus
(v)	Discovery	J.J. Thomson	E. Goldstein	Chadwick

3. No, the atom will not carry any charge because the electron has unit negative charge (–1) and the proton has unit positive charge (+1). They neutralise each other.

4. Proton, a positively charged sub-atomic particle is present in the nucleus of an atom according to Rutherford's model of atom.

5. According to Thomson's model of an atom:
(a) An atom consists of a positively charged sphere and the electrons are embedded like the seeds in a watermelon.
(b) The negative and positive charges are equal in magnitude. So, the atom as a whole is electrically neutral.

6.

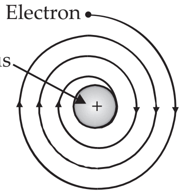


7. On using the foil of heavy metals like gold (*e.g.*, platinum, silver etc.) the observation will be same but if the foil is of light metal (*e.g.*, sodium, magnesium etc.), the massive α-particles may push the nucleus aside and may not be deflected back.

8. The limitations of Thomson's model are described below:
(i) Thomson's model of an atom considers an atom to be a sphere of uniform positive charge. Later researches particularly, Rutherford's α-particle scattering experiment showed that an atom has a positively charged 'core' at its centre.
(ii) According to Thomson's atomic model, mass of an atom is considered to be uniformly distributed. Rutherford's experiment showed that the entire mass of an atom is concentrated inside the core of the atom.

9. The three sub-atomic particles of an atom are : (a) electron (b) proton (c) neutron.

10. The Rutherford model suffers from the following drawbacks :



(i) An electron revolving aroundthe nucleus gets accelerated towards the nucleus. An accelerating charged particle must emit radiation and lose energy. Thus, the electrons in an atom must continuously emit radiation and lose energy. Because of this loss of energy, the electron would slow down and will not be able to withstand the attraction of the nucleus. As a result, the electron should follow a spiral path, and ultimately fall into the nucleus (see figure).
If it happens, then the atom should collapse in about 10^{-8} second. But, this does not happen and atoms are stable. This indicates that there is something wrong in Rutherford's nuclear model of atom.
(ii) Rutherford's model of atom does not say anything about the arrangement of electrons in an atom.

Topic 2

1. Yes, hydrogen has one electron, one proton and no neutron. It is represented as $^{1}_{1}H$.

2. Mass number of helium = 4
Number of protons = 2
Number of neutrons (n)
= Mass number (A) – No. of protons (p)
= 4 – 2 = 2
Thus, no. of neutrons = 2

3. The distribution of elements in different orbits is governed by a scheme called Bohr-Bury scheme. There are following rules :
(i) The maximum number of electrons present in any shell is given by the formula $2n^2$, where n = no. of orbit.
(ii) The maximum number of electrons that can be accommodated in the outermost shell is 8.
(iii) Electrons in an atom do not occupy a new shell unless all the inner shells are completely filled.

4. The number of electrons gained, lost or shared so as to complete the octet of electrons in valence shell is called valency.
Valency of silicon : It has electronic configuration → 2, 8, 4. Thus, 4 electrons are shared with other atoms to complete the octet and so its valency = 4
Valency of oxygen : It has electronic configuration → 2, 6. Thus, It will gain 2 electrons to complete its octet. So its valency = 2.

5. No, both ^{35}Cl and ^{37}Cl will have same valencies, as ^{35}Cl and ^{37}Cl are isotopes. The isotopes have same number of electrons and protons. They differ only in the number of neutrons. Their electron distribution will be same.

6. Atomic number of sodium (Na) = 11
No. of electrons in Na = 11
No. of electrons in Na^+ = 11 – 1 = 10
Electronic configuration of Na^+ → 2, 8
K L
For K - shell ; $2n^2 = 2 \times 1^2 = 2$
For L - shell ; $2n^2 = 2 \times 2^2 = 8$
Thus, in Na^+, K and L shells are completely filled.

7. The maximum number of electrons present in a shell $= 2n^2$
where n = shell number
Value of n for K shell = 1
∴ Maximum number of electrons in K shell
$= 2n^2 = 2(1)^2 = 2$
Value of n for L shell = 2
∴ Maximum number of electrons in L shell
$= 2(2)^2 = 8$
Thus, total no. of electrons = 2 + 8 = 10

8. Isotopes of chlorine : $^{35}_{17}Cl$, $^{37}_{17}Cl$
Electronic configuration of each of them : 2, 8, 7
Isobars : $^{40}_{20}Ca$, $^{40}_{18}Ar$
Electronic configuration of $_{20}Ca$ → 2, 8, 8, 2
Electronic configuration of $_{18}Ar$ → 2, 8, 8

9. (i) Atomic number : The number of protons present in the nucleus of an atom is called atomic number. It is denoted by Z. *e.g.*, in $^{40}_{20}Ca$, atomic number = 20
(ii) Mass number : The sum of the number of protons and neutrons present in the nucleus of an atom is called mass number. It is denoted by A. *e.g.*, in $^{40}_{20}Ca$, mass number = 40

$$^{\text{Mass number }(A)}_{\text{Atomic number }(Z)}X \longleftarrow \text{Element}$$

(iii) Isotopes : The atoms of the same elements having same atomic number but different mass numbers are called isotopes, *e.g.*, $^{35}_{17}Cl$ and $^{37}_{17}Cl$.
(iv) Isobars : The atoms of the different elements having same mass number but different atomic numbers are called isobars, *e.g.*, $^{40}_{20}Ca$ and $^{40}_{18}Ar$.
Uses of isotopes :
(i) As nuclear fuel : An isotope of uranium (U – 235) is used as a nuclear fuel.
(ii) In medical field : An isotope of cobalt is used in the treatment of cancer.

10. Let the % of isotope $^{16}_{8}X = x$ and % of isotope $^{18}_{8}X = 100 - x$
Average atomic mass of an element (X) = 16.2
Average atomic mass =

$$= \frac{\text{Mass of } ^{16}_{8}X \times \text{percentange of } ^{16}_{8}X + \text{Mass of } ^{18}_{8}X \times \text{ percentage of } ^{18}_{8}X}{100}$$

or $$16.2 = \frac{x \times 16 + (100 - x) \times 18}{100}$$

or $$16.2 = \frac{16x + 1800 - 18x}{100}$$

or $1620 = 16x + 1800 - 18x$
or $1620 = -2x + 1800$ or $2x = 1800 - 1620$
or $2x = 180$

∴ $$x = \frac{180}{2} = 90$$

Thus % of isotope ${}^{16}_{8}X = 90\%$

% of isotope ${}^{18}_{8}X = (100 - 90) = 10\%$

11. The electronic configuration of (Z) = 2, 1

Thus, outermost shell has 1 electron.

So, its valency = 1

Atomic number (Z) = 3, So name of the element is lithium.

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

$= 6 + 6 = 12$

Mass number of $Y = 6 + 8 = 14$

The species X and Y are isotopes because their atomic numbers are same and their mass numbers are different *i.e.* ${}^{12}_{6}C$ and ${}^{14}_{6}C$.

13. % of ${}^{79}_{35}Br$ isotope = 49.7

% of ${}^{81}_{35}Br$ isotope = 50.3

Average atomic mass of bromine atom

$$= \frac{49.7 \times 79 + 50.3 \times 81}{100} = \frac{3926.3 + 4074.3}{100}$$

$$= \frac{8000.6}{1000} = 80.006 \text{ u}$$

14.

Isotope	Symbol	Atomic No.	Mass No.	No. of proton	No. of electron	No. of neutron
Hydrogen	H	1	1	1	1	1 – 1 = 0
Deuterium	D	1	2	1	1	2 – 1 = 1
Tritium	T	1	3	1	1	3 – 1 = 2