CHAPTER

4

STRUCTURE OF THE ATOM

CLASS 9TH

NCERT EXERCISE AND SOLUTIONS - SCIENCE

P1 P2

Q. 1. Compare the properties of electrons, protons and neutrons.

ANSWER:-

Electron	Proton	Neutron
It is present outside of the nucleus of an atom	It is present inside the nucleus of an atom	It is present inside the nucleus of an atom
Carry negative charge	Carry positive charge	It is neutral
Its weight is negligible	It weighs around 2000 times as mass of electrons	Weight is the same as a proton

Q. 2. What are the limitations of J.J. Thomson's model of the atom?

ANSWER:-

Limitations of J.J. Thomson's atomic model:

- It does not explain the stability of the atom.
- It overlooks the existence of the nucleus in an atom.
- It does not clarify how positive and negative charges are held together.
- It fails to account for Rutherford's experimental findings.

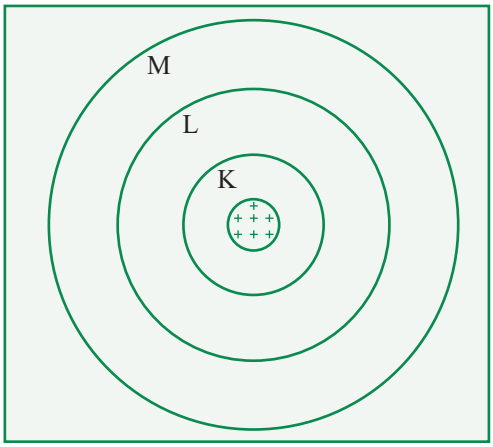
Q. 3. What are the limitations of Rutherford's model of the atom?

ANSWER:-

Rutherford's atomic model does not explain the stability of an atom. He proposed that electrons revolve in circular orbits, and as they do, they would emit energy, causing the atom to become unstable and the electrons to spiral into the nucleus. However, this does not occur in reality, and Rutherford's model fails to account for the reason behind this.

Q. 4. Describe Bohr's model of the atom.

ANSWER:-



Q. 5. Compare all the proposed models of an atom given in this chapter.

ANSWER:-

Thomson's Model	Rutherford's Model	Bohr's Model
In this model, positively and negatively charged ions are dispersed throughout the atom.	This model suggests that all the positive ions are located in the nucleus, while the negative ions revolve around it.	Electrons, or negatively charged particles, move in fixed circular paths known as orbits, without generating energy during their revolution.

Q. 6. Summarise the rules for writing of distribution of electrons in various shells for the first eighteen elements.

ANSWER:-

For the first eighteen elements, the following rules govern the distribution of electrons across various shells:

1. The maximum number of electrons a shell can hold is given by the formula $2n^2$, where n represents the orbit number (n = 1, 2, 3, ...).
2. The maximum number of electrons in the first orbit (n = 1) is $2(1)^2 = 2$. For the second orbit (n = 2), it is $2(2)^2 = 8$. For the third orbit (n = 3), it is $2(3)^2 = 18$.
3. The outermost shell can hold a maximum of eight electrons.
4. Electrons are filled into shells in a sequential manner, starting from the innermost shell and moving outward.

Q. 7. Define valency by taking examples of silicon and oxygen.

ANSWER:-

The valency of an element is defined as the number of electrons in its outermost shell.

For silicon:

- Outermost shell electrons = 4
- If the number of electrons in the outermost shell is less than or equal to 4, the valency is equal to the number of electrons in the outermost shell.
- Therefore, the valency of silicon = 4.

For oxygen:

- Outermost shell electrons = 6
- If the number of electrons in the outermost shell is greater than 4, the valency is calculated as 8 minus the number of electrons in the outermost shell.
- Therefore, the valency of oxygen = 8 - 6 = 2.

Q. 8. Explain with examples

(i) Atomic number,
(ii) Mass number,
(iii) Isotopes and
(iv) Isobars. Give any two uses of isotopes.

ANSWER:-

i. **Atomic Number:** The atomic number of an element is the total number of protons present in the atom of that element.
Example: Oxygen has 8 protons, so its atomic number is 8.

ii. **Mass Number:** The mass number is the sum of the number of protons and neutrons in the atom of an element.
Example: The mass number of oxygen is 8 (protons) + 8 (neutrons) = 16.

iii. **Isotopes:** Isotopes are atoms of the same element with the same atomic number but different mass numbers.
Example: The three isotopes of hydrogen are:
1. Protium (^{1}H)
2. Deuterium ($^{2}_{1}H$)
3. Tritium ($^{3}_{1}H$)

iv. **Isobars:** Isobars are atoms with the same mass number but different atomic numbers, meaning they are atoms of different elements with the same mass number.
Example: Calcium ($_{20}Ca^{40}$) and Argon ($_{18}Ar^{40}$) are isobars.

Q. 9. Na+ has completely filled K and L shells. Explain.

ANSWER:-

The atomic number of Na is 11, which equals the total number of electrons.
The electronic configuration of Na is 2, 8, 1.
For the Na^+ ion, the electronic configuration becomes 2 (in the K-shell) and 8 (in the L-shell).
Thus, the Na^+ ion has fully filled K and L shells.

Q. 10. If bromine atom is available in the form of, say, two isotopes $_{35}Br^{79}$ (49.7%) and $_{35}Br^{81}$ (50.3%), calculate the average atomic mass of bromine atom.

ANSWER:-

The average atomic mass of a bromine atom is calculated as:
$(79 \times 49.7) + (81 \times 50.3)/100$
$= 3926.3 + 4074.3/100$
$= 8000.6/100$
$= 80.006 \approx 80$amu

Q. 11. The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $^{16}_{8}X$ and $^{18}_{8}X$ in the sample?

ANSWER:-

Average atomic mass of an element X = 16.2 u
Let percentage of isotope $^{18}_{8}X$ is y%
Thus, the percentage of isotope $^{16}_{8}X$ is (100 – y)%
Average atomic mass of element X = [Atomic mass of $^{18}_{8}X$ × percentage + Atomic mass of $^{16}_{8}X$ × percentage]
16.2 = [18 x y% +16 (100-y)%]
16.2 = [18 x y/100 + 16 (100-y)/100]
16.2 x 100 = [18y + 1600 – 16y]
1620 = 2y + 1600
y = 10
thus, % of $^{18}_{8}X$ is 10%
% of $^{16}_{8}X$ is 100-10 = 90%

Q. 12. If Z = 3, what would be the valency of the element? Also, name the element.

ANSWER:-

Atomic number (Z) = 3 = 3.
Its electronic configuration is 2, 1.
Hence, the valency of the element is 1 (Since the outermost shell has only one electron). Therefore, the element with Z = 3 is lithium (Li).

Q. 13. **Composition of the nuclei of two atomic species X and Y are given as under**

	X	Y
Protons =	**6**	**6**
Neutrons =	**6**	**8**

Give the mass numbers of X and Y. What is the relation between the two species?

ANSWER:-

Mass number = Number of protons + Number of neutrons
Mass number of X = 6 + 6 =12
Mass number = Number of protons + Number of neutrons
Mass number of Y = 6 + 8 = 14
Atomic number = Number of protons
The atomic number of X= 6 = Atomic number of Y
These two atomic species X and Y have the same atomic number, but different mass numbers. Hence, they are isotopes.

Q. 14. **For the following statements, write T for True and F for False.**

(a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons.
(b) A neutron is formed by an electron and a proton combining together. Therefore, it is neutral.
(c) The mass of an electron is about 1/2000 times that of proton.
(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine.

ANSWER:-

(a) False
(b) False
(c) True
(d) False

Q. 15. **Rutherford's alpha-particle scattering experiment was responsible for the discovery of**

(a) Atomic Nucleus
(b) Electron
(c) Proton
(d) Neutron

ANSWER:-

(a) Atomic Nucleus

Q. 16. **Isotopes of an element have**

(a) the same physical properties
(b) different chemical properties

(c) different number of neutrons
(d) different atomic numbers.

ANSWER:-

(c) different number of neutrons

Isotopes are atoms of the same element having the same atomic number, but different mass numbers.

Q. 17. Number of valence electrons in Cl^- ion are:

(a) 16
(b) 8
(c) 17
(d) 18

ANSWER:-

Atomic number of Cl = 17
Electronic configuration of Cl = 2, 8, 7
Electronic configuration of 1 Cl^- ion = 2, 8, 8
Thus, the number of valence electrons in 1 Cl^- ion = 8

Q. 18. Which one of the following is a correct electronic configuration of sodium?

(a) 2, 8
(b) 8, 2, 1
(c) 2, 1, 8
(d) 2, 8, 1

ANSWER:-

Atomic number of sodium = Number of electrons So, electronic configuration of sodium = 2, 8, 1.

Q. 19. Complete the following table.

Atomic Number	Mass Number	Number of Neutrons	Number of Proton	Number of Electrons	Name of the atomic species
9	-	10	-	-	-
16	32	-	-	-	Sulphur
-	24	-	12	-	-
-	2	-	1	-	-

ANSWER:-

Atomic Number	Mass Number	Number of Neutrons	Number of Proton	Number of Electrons	Name of the atomic species
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulphur
12	24	12	12	12	Magnesium
1	2	1	1	1	Deuterium