CLASS IX : SCIENCE
Chapter 4 : Structure Of The Atom

Questions & Answers | Page No. 39 - NCERT Books

Q1. What are canal rays?

Ans. Canal rays are beams of positive ions that are created by certain types of gas discharge tubes. They were first observed in Crookes tubes during experiments by the German scientist Eugen Goldstein, in 1886. Later work on anode rays by Wilhelm Wien and J. J. Thomson led to the development of mass spectrometry.

Q2. If an atom contains one electron and one proton, will it carry any charge or not?

Ans. An electron is a negatively charged particle, where as a proton is a positively charged particle. The magnitude of their charges is equal. Therefore, it will be a neutral atom.

Questions & Answers | Page No. 41 - NCERT Books

Q1. On the basis of Thomson's model of an atom, explain how the atom is neutral as a whole.

Ans. J.J. Thomson, the discoverer of the electron believed that the atom is a uniform sphere of positive charge with electron embedded in it. This model explained the electrical neutrality of atom, but it failed to explain how these fundamental particles were arranged in the atom.

Q2. On the basis of Rutherford's model of an atom, which subatomic particle is present in the nucleus of an atom?

Ans. Protons which are positively-charged particles are present in the nucleus of an atom.

Q3. Draw a sketch of Bohr's model of an atom with three shells.

Ans. The Bohr model of the atom, proposed by Niels Bohr in 1915, marked a significant advancement over Rutherford's atomic model. Rutherford's model had introduced the concept of a central, positively charged nucleus surrounded by negatively charged electrons.

Key postulates of Bohr's atomic model include:

1. Electrons, negatively charged particles, orbit the positively charged nucleus in well-defined circular paths known as orbits or shells.
2. Each of these orbital shells possesses a fixed energy level.
3. These energy levels are denoted by an integer (n=1, 2, 3, and so on) referred to as the quantum number. The quantum number sequence starts with n=1, corresponding to the lowest energy level closest to the nucleus. The orbits n=1, 2, 3, 4, etc., are designated as K, L, M, N, and so forth.
4. Electrons can move between energy levels by either absorbing energy to move to a higher level or releasing energy to transition to a lower level.

In summary, Bohr's model provided a structured framework for understanding the behavior of electrons within an atom, particularly their quantized energy levels and the transitions between them.

Q4. What do you think would be the observation if the α-particle scattering experiment is carried out using a foil of a metal other than gold?

Ans. If α-particle scattering experiment is carried out using a foil of any metal as thin as gold foil used by Rutherford, there would be no change in observations. But since other metals are not so malleable. So, such a thin foil is difficult to obtain. If we use a thick foil, then more α-particles would bounce back and no idea about the location of positive mass in the atom would be available with such a certainty.

Questions & Answers | Page No. 41 - NCERT Books

Q1. Name the three sub-atomic particles of an atom.

Ans. The three sub-atomic particles of an atom are: Protons, Electrons and Neutrons.

Q2. Helium atom has an atomic mass of 4 u and two protons in its nucleus. How many neutrons does it have?

Ans. The mass of an atom is given by the sum of the masses of protons and neutrons present in the nucleus. Since helium atom has an atomic mass of 4u and it has two protons, the protons contribute 2u to atomic mass. Hence, it must contain 2 neutrons as each neutron contributes 1u to the nucleus.

Questions & Answers | Page No. 42 - NCERT Books

Q1. Write the distribution of electrons in carbon and sodium atoms?

Ans. The total number of electrons in a carbon atom is 6. The distribution of electrons in carbon atom is given by:

First orbit or K-shell = 2 electrons

Second orbit or L-shell = 4 electrons

Or, we can write the distribution of electrons in a carbon atom as 2, 4.

The total number of electrons in a sodium atom is 11. The distribution of electrons in sodium atom is given by:

First orbit or K-shell = 2 electrons

Second orbit or L-shell = 8 electrons

Third orbit or M-shell = 1 electron

Or, we can write distribution of electrons in a sodium atom as 2, 8, 1.

Q2. If K and L shells of an atom are full, then what would be the total number of electrons in the atom?

Ans. The maximum number of electrons that can occupy K and L-shells of an atom are 2 and 8 respectively. Therefore, if K and L-shells of an atom are full, then the total number of electrons in the atom would be (2 + 8) = 10 electrons.

Questions & Answers | Page No. 44 - NCERT Books

Q1. How will you find the valency of chlorine, sulphur and magnesium?

Ans. (i) Atomic number of chlorine = 17

∴ Distribution of electrons = K L M

2 8 7

Thus, outermost shell has 7 electrons. It can easily complete its octet by gaining one electron. Hence, its valency = 1.

(ii) Atomic number of sulphur = 16

∴ Distribution of electrons = K L M

2 8 6

Thus, outermost shell has 6 electrons.

Hence, valency = 8 – 6 = 2

(iii) Atomic number of magnesium = 12

∴ Distrubution of electrons = K L M

2 8 2

Thus, outermost shell has 2 electrons. It can easily complete its octet by loosing two electrons. Hence, its valency = 2.

Questions & Answers | Page No. 44 - NCERT Books

Q1. If number of electrons in an atom is 8 and number of protons is also 8, then (i) what is the atomic number of the atom and (ii) what is the charge on the atom?

Ans. (i) Atomic number = number of protons.= 8.

(ii) Number of electrons (-ve) = number of protons (+ve) , therefore, the charge on the atom is 0.

Q2. With the help of Table 4.1 find out the mass number of oxygen and sulphur atom.

Ans. For Oxygen:
Number of protons = 8
Number of electrons = 8
Mass number = Number of Protons + Number of neutrons
= 8 + 8
= 16
Hence mass number for Oxygen is 16.
For Sulphur:
Number of protons = 16
Number of electrons = 16
Mass number = Number of Protons + Number of neutrons
= 16 + 16
= 32
Hence Mass number for Sulphur is 32.

Questions & Answers | Page No. 45 - NCERT Books

Q1. For the symbol H, D and T tabulate three sub-atomic particles found in each of them.

Ans.

Symbol	Proton	Neutron	Electron
H	1	0	1
D	1	1	1
T	1	2	1

Q2. Write the electronic configuration of any one pair of isotopes and isobars.

Ans. $^{12}_{6}C$ and $^{14}_{6}C$ are isotopes, have the same electronic configuration as (2, 4).

$^{40}_{20}Ca$ and $^{40}_{18}Ar$ are isobars. They have different electronic configuration as given below:

$^{40}_{20}Ca$ – 2, 8, 8, 2

$^{40}_{18}Ar$ – 2, 8, 8

EXERCISES

Q1. Compare the properties of electrons, protons and neutrons.

Ans. **Electron**

(i) Electrons are present outside the nucleus of an atom.

(ii) Electrons are negatively charged.

(iii) The mass of an electron is considered to be negligible.

Proton

(i) Protons are present in the nucleus of an atom.

(ii) Protons are positively charged.

(iii) The mass of a proton is approximately 2000 times as the mass of an electron

Neutron

(i) Neutrons are present in the nucleus of an atom.

(ii) Neutrons are neutral.

(iii) The mass of neutron is nearly equal to the mass of a proton.

Q2. What are the limitations of J.J. Thomson's model of the atom?

Ans. According to J.J. Thomson's model of an atom, an atom consists of a positively charged sphere with electrons embedded in it. However, it was later found that the positively charged particles reside at the centre of the atom called the nucleus, and the electrons revolve around the nucleus.

Q3. What are the limitations of Rutherford's model of the atom?

Ans. A model of the atom was described by the British physicist Ernest Rutherford in 1911, and is known as the Solar System model. It is very simple, and is still used to teach elementary atomic structure to school children.

- An atom consists of a central nucleus. This nucleus is composed of positively charged protons, and electrically uncharged (neutral) neutrons.
- Negatively charged electrons revolve round the nucleus in definite orbits.
- The orbits themselves can be at any distance from the nucleus.
- In any atom, the number of protons is equal to the number of electrons, and hence it is electrically neutral.

Q4. Describe Bohr's model of the atom.

Ans. Bohr's model of the atom

Neils Bohr proposed the following postulates regarding the model of the atom.

(i) Only certain orbits known as discrete orbits of electrons are allowed inside the atom.

(ii) While revolving in these discrete orbits, the electrons do not radiate energy.

These discrete orbits or shells are shown in the following diagram.

The first orbit (i.e., for n = 1) is represented by letter K. Similarly, for n = 2, it is L shell, for n = 3, it is M shell and for n = 4, it is N shell. These orbits or shells are also called energy levels.

Q5. Compare all the proposed models of an atom given in this chapter.

Thomson's model

Rutherford's model

Bohr's model

Ans. An atom consists of a positively charged sphere with electrons embedded in it.

An atom consists of a positively charged particles concentrated at the centre known as the nucleus. The size of the nucleus is very small as compared to the size of the atom. The electrons revolve around the nucleus in well-defined orbits.

There are only certain orbits known as discrete orbits inside the atom in which electrons revolve around the nucleus. Electrons do not radiate energy while revolving.

Q6. Summarize the rules for writing of distribution of electrons in various shells for the first eighteen elements.

Ans. The rules for writing of the distribution of electrons in various shells for the first eighteen elements are given below.

(i) The maximum number of electrons that a shell can accommodate is given by the formula '$2n^2$', where 'n' is the orbit number or energy level index (n = 1, 2, 3…).

The maximum number of electrons present in an orbit of n = 1 is given by $2n^2 = 2 \times 1^2 = 2$

Similarly, for second orbit, it is $2n^2 = 2 \times 2^2 = 8$

For third orbit, it is $2n^2 = 2 \times 3^2 = 18$

And so on.....

(ii) The outermost orbit can be accommodated by a maximum number of 8 electrons.

(iii) Shells are filled with electrons in a stepwise manner i.e., the outer shell is not occupied with electrons unless the inner shells are completely filled with electrons.

Q7. Define valency by taking examples of silicon and oxygen.

Ans. The valency of an element is the combining capacity of that element. The valency of an element is determined by the number of valence electrons present in the atom of that element.

If the number of valence electrons of the atom of an element is less than or equal to four, then the valency of that element is equal to the number of valence electrons. For example, the atom of silicon has four valence electrons. Thus, the valency of silicon is four.

On the other hand, if the number of valence electrons of the atom of an element is greater than four, then the valency of that element is obtained by subtracting the number of valence electrons from eight. For example, the atom of oxygen has six valence electrons. Thus, the valency of oxygen is (8 – 6) i.e., two.

Q8. Explain with examples (i) Atomic number, (ii) Mass number, (iii) Isotopes and (iv) Isobars. Give any two uses of isotopes.

Ans. (i) Atomic number

The atomic number of an element is the total number of protons present in the atom of that element. For example, nitrogen has 7 protons in its atom. Thus, the atomic number of nitrogen is 7.

(ii) Mass number

The mass number of an element is the sum of the number of protons and neutrons present in the atom of that element. For example, the atom of boron has 5 protons and 6 neutrons. So, the mass number of boron is 5 + 6 = 11.

(iii) Isotopes

Isotopes are atoms of the same element having the same atomic number, but different mass numbers. For example, hydrogen has three isotopes. They are protium, deuterium, and tritium.

(iv) Isobars

Isobars are atoms having the same mass number, but different atomic numbers i.e., isobars are atoms of different elements having the same mass number. For example, $^{40}_{20}Ca$ and $^{40}_{18}Ar$ are isobars.

Two uses of isotopes are:

(i) One isotope of uranium is used as a fuel in nuclear reactors.

(ii) One isotope of cobalt is used in the treatment of cancer.

Q9. Na^+ has completely filled K and L shells. Explain.

Ans. An atom of Na has a total of 11 electrons. Its electronic configuration is 2, 8, 1. But, Na^+ ion has one electron less than Na atom i.e., it has 10 electrons. Therefore, 2 electrons go to K-shell and 8 electrons go to L-shell, thereby completely filling K and L shells.

Q10. If bromine atom is available in the form of Br^{79}, Br^{81}, say, two isotopes (49.7%) and (50.3%), calculate the average atomic mass of bromine atom.

Ans. It is given that two isotopes of bromine are (49.7%) and (50.3%). Then, the average atomic mass of bromine atom is given by :

$\therefore$ Average atomic mass of Br

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

$= 39.263 + 40.743 = 80.006$ u.

Q11. 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?

Ans. Suppose percentage of isotope ${}^{16}_{8}X = x$

Then percentage of isotope ${}^{18}_{8}X = (100 - x)$

$\therefore$ Average atomic mass $= \frac{16 \times x + 18(100 - x)}{100}$

$= \frac{1800 - 2x}{100} = 18 - 0.02\ x$

$\therefore$ $18 - 0.02\ x = 16.2$ (Given)

or $0.02\ x = 1.8$ or $x = \frac{1.8}{0.02} = 90$

Hence, percentage of ${}^{16}_{8}X = 90\%$

and percentage of ${}^{18}_{8}X = 100 - 90 = 10\%$

Q12. If Z = 3, what would be the valency of the element? Also, name the element.

Ans. By Z = 3, we mean that the atomic number of the element is 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.

Q13. 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?

Ans. Mass number of X = Number of protons + Number of neutrons = 6 + 6 = 12

Mass number of Y = Number of protons + Number of neutrons = 6 + 8 = 14

These two atomic species X and Y have the same atomic number, but different mass numbers. Hence, they are isotopes.

Q14. 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 $\frac{1}{2000}$ times that of proton.

(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine.

Ans. (a) (F) (b) (F) (c) (T) (d) (F)

Q15. Choose the correct answer :

Rutherford's alpha-particle scattering experiment was responsible for the discovery of

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

Ans. (a)

Q16. Choose the correct answer :

Isotopes of an element have

(a) The same physical properties

(b) Different chemical properties

(c) Different number of neutrons

(d) Different atomic numbers

Ans. (c)

Q17. Choose the correct answer :

Number of valence electrons in Cl^- ion are

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

Ans. (b)

Q18. 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

Ans. (d)

Q19. Complete the following table.

Atomic no.	Mass number	No. of Neutrons	No of protons	No. of electrons	Name of the Element
9		10			
16	32				Sulphur
	24		12		
	2		1		
	1	0	1	1	

Atomic no.	Mass number	No. of Neutrons	No of protons	No. of electrons	Name of the Atomic
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulphur
12	24	12	12	12	Magnesium
1	2	1	1	1	Deuterium
1	1	0	1	1	Protium