

CBSE class IX Science
NCERT Solutions
Chapter - 4
Structure of the Atom

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1. What are canal rays?

Ans. E. Goldstein discovered positively charged rays, those rays are called canal rays. These rays travel in a direction opposite to cathode rays. Canal rays led to the discovery of positively charged sub atomic particle known as proton.

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

Ans. That atom will not contain any charge because one negative charge of single electron and one positive charge of single proton are neutralized by each other.

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

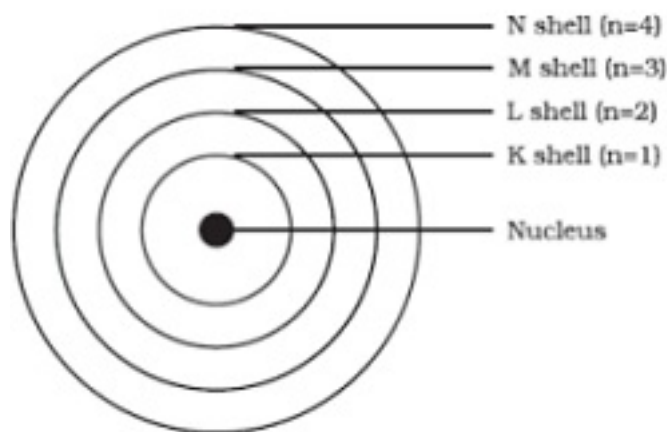
Ans. As per Thomson's model of an atom, the number of electrons (negatively charged) are equal to the number of protons (positively charged) in an atom. Hence the +ve and -ve charges are neutralized by each other that makes atom neutral as a whole.

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

Ans. The sub atomic particle proton is present in the nucleus of an atom according to Rutherford's model of an atom.

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

Ans.



4. 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. No, the observations would have been same even if the α -particle scattering experiment is carried out using a foil of a metal other than gold.

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

Ans. Proton, Neutron and Electron.

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

Ans. The number of neutrons present in a helium atom = atomic mass – no. of protons
 $= 4 - 2 = 2$

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1. Write the distribution of electrons in carbon and sodium atoms.

Ans. Distribution of electrons in carbon atom: atomic number of carbon = 6 = 2,4

Distribution of electrons in sodium atom: atomic number of sodium = 11 = 2,8,1

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

Ans. If K and L shells of an atom are full, then the total number of electrons in the atom will be 10 because K shell can accommodate total 2 and L shell can accommodate maximum 8 electrons that makes a total of 10.

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

Ans. The electrons present in the outermost shell of an atom are known as the valence electrons. Those electrons determine the valency of that atom.

The atomic number of chlorine is $17 = 2,8,7$

so the number of valence electrons for chlorine is 7 and it needs 1 more electron to complete its octet (8). Therefore, its valency is one.

similarly, Sulphur = $16 = 2,8,6$

so the number of valence electrons for sulphur is 6 and it needs 2 more electrons to complete its octet (8). Therefore, its valency is two.

similarly, for magnesium = $12 = 2,8,2$

It becomes easier for magnesium to give away its two valence electrons than to acquire 6 more therefore its valency is two.

2. 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 = number of electrons = 8

(ii) atom will be neutral (no charge) because number of protons(+) is equal to the number of

electrons (-).

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

Ans. mass number of oxygen = number of neutrons + number of protons = $8+8=16$

mass number of sulphur = number of neutrons + number of protons = $16+16=32$

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

Ans.

Symbol	Number of electrons	Number of protons	Number of neutrons
H(Hydrogen)	1	1	0
D (Deuterium)	1	1	1
T (Tritium)	1	1	2

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

Ans. Isotopes of carbon: $^{12}_6\text{C}$ and $^{13}_6\text{C}$ Electronic configuration is 2,4 because both the atoms have the same atomic number and the same number of electrons as 6.

Isobars:

$^{40}_{20}\text{Ca}$ - 2,8,8,2 as atomic number is 20 and $^{40}_{18}\text{Ar}$ - 2,8,8 as atomic number is 18

(Chapter – end)

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

Ans.

Sr. No.	Proton	Neutron	Electron

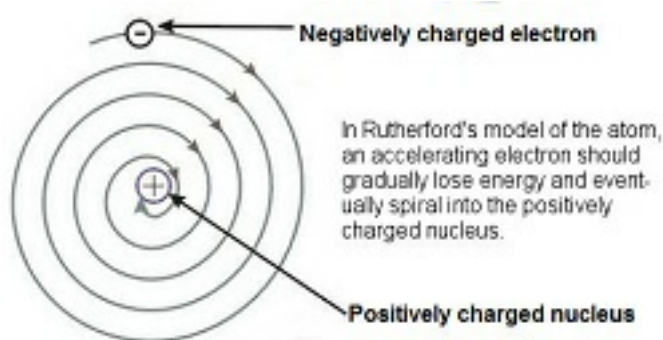
1	It is positively charged.	It is neutral	It is negatively charged.
2	Its mass is equivalent to a hydrogen atom i.e.. 1 a.m.u.	It is equal in mass to a proton	Its mass is $\frac{1}{1838}$ of the mass of a proton.
3	It is present inside the nucleus of the atom.	It is also found inside the atomic nucleus.	It is found outside the nucleus of the atom.

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

Ans. Thomson's model of atom could explain the electrical neutrality of the atom but it failed to explain the results of scattering experiments performed by Rutherford. Consequently, it was rejected in favour of Rutherford's model of atom.

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

Ans. Rutherford's model of atom didn't explain the stability of atom because as per his model revolving charged electrons while moving through orbit should emit energy and this energy loss will shrink the orbit and ultimately the electron would hit the nucleus and thus atom is unstable but it is not true.



4. Describe Bohr's model of the atom.

Ans. To remove the drawbacks of Rutherford's atomic model and to explain structure of atom in detail Neils Bohr in 1912 proposed a model of atom. The special features of Bohr's model are given below:

- An electron revolves in the orbit of atom with well-defined energy.
- Energy of orbits increases from inner shell to the outer shells i.e.. energy for orbit nearest the nucleus is lowest.

- if energy is supplied then electron moves from lower orbit to the higher orbit and if an electron jumps from higher orbit (energy level) to the lower orbit (energy level) then energy is radiated as electromagnetic waves.
- Each orbit or shell represents an energy level. Such orbits are represented as K,L,M,N,O..... and named from centre to outwards.
- The shell or orbits are associated with certain amount of energy and energy of orbits/shells increases from inward to outwards.eg $K < L < M < N < O$

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

Ans. There are total three atomic models each of which tried to explain the atomic structure in a better way. Following table compares the specific characteristics of the models:

Thomson's model	Rutherford's model	Bohr's model
He said that electrons remain embedded in a positive sphere.	He said that electrons revolve around a very tiny nucleus.	This model got more success than the other two. As per this model electrons are distributed in different shells with specific energy around nucleus. With complete atomic shells, atom becomes more stable.

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

Ans. The following rules are followed for writing the number of electrons in different energy levels or shells:

(i) The maximum number of electrons present in a shell is given by the formula $2n^2$, where 'n' is the orbit number or energy level index, 1,2,3,... Hence the maximum number of electrons in different shells are as follows:

first orbit or K-shell will be $= 2 \times 1^2 = 2$,

second orbit or L-shell will be $= 2 \times 2^2 = 8$,

third orbit or M-shell will be $= 2 \times 3^2 = 18$,

fourth orbit or N-shell will be $= 2 \times 4^2 = 32$, and so on.

(ii) The maximum number of electrons that can be accommodated in the outermost orbit is 8.

(iii) Electrons are not accommodated in a given shell, unless the inner shells are filled. That is, the shells are filled in a step-wise manner.

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

Ans. That number of electrons (present in outermost shell) /valence electrons which an atom gives or takes or shares to complete its octet, or acquire stable configuration. Therefore, valency of sulphur = $16 - 2 - 8 = 6$ = 2 electrons can be gained easily hence valency is 2.

valency of oxygen = $8 - 2 - 6 = 2$ electrons can be gained easily hence valency is 2.

8. Explain with examples

(i) Atomic number,

(ii) Mass number,

(iii) Isotopes and

(iv) Isobars.

Give any two uses of isotopes.

Ans. i) Atomic number = It is the number of protons present inside nucleus of the atom.

It is represented as Z. For eg: for hydrogen $Z = 1$, because in hydrogen atom the number of proton is 1.

ii) Mass number = It is the total number of protons and neutrons present inside the nucleus of an atom and is represented by $A = p + n$. Mass of carbon is 12 u because it has 6 protons and 6 neutrons, $6\text{ u} + 6\text{ u} = 12\text{ u}$.

iii) Isotopes = They are atoms of the same element and have same atomic number but different mass number/atomic mass. for example: carbon, $^{12}_6\text{C}$ and $^{13}_6\text{C}$

iv) Isobars = They are atoms of different elements having same mass number but different atomic number. for example, $^{40}_{20}\text{Ca}$ and $^{40}_{18}\text{Ar}$. The number of electrons in these atoms is different, but the mass number of both these elements is 40. That is, the total number of

neutrons is the same in the atoms of this pair of elements.

Two uses of isotopes are as follows:

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

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

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

Ans. Na has atomic number 11, so its electronic configuration is = 2,8,1

When it gives away its outermost shell single electron it changes to $\text{Na}^+ = 10 = 2,8$

The above configuration indicates completely filled K,L shells.

10. If bromine atom is available in the form of, say, two isotopes

$^{79}_{35}\text{Br}$ (49.7%) and $^{81}_{35}\text{Br}$ (50.3%). Calculate the average atomic mass of bromine atom.

Ans. The average atomic mass of bromine = $(79 \times 49.7) + (81 \times 50.3) / 100$

$$= 3926.3 + 4074.3 / 100$$

$$= 8000.6 / 100 = 80 \text{ u}$$

11. The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $^{16}_8\text{X}$ and $^{18}_8\text{X}$ in the sample?

Ans. Since average atomic mass = $16 \times X + 18 \times (100 - X) / 100$

$$16.2 = 16x + 1800 - 18x / 100$$

$$1620 = -2x + 1800$$

$$2x = 1800 - 1620$$

$$x = 180 / 2 = 90$$

When 90% is the X-16 sample so for X-18 sample % = $100-90=10\%$

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

Ans. When $Z = 3$, so that element has 3 electrons in its shells distributed as = 2, 1. Its valency is 1 because it can easily give away its outermost single electron and the element is Lithium(Li).

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?

Ans. The mass number of X = $6+6 = 12$

The mass number of Y = $6+8 = 14$

since their number of protons are same but atomic mass are different so they are isotopes.

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 12000 times that of proton.

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

Ans. (a) false

(b) false

(c) true

(d) false

Put tick (ü) against correct choice and cross (×) against wrong choice in questions 15, 16 and 17

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

(a) Atomic Nucleus

(b) Electron

(c) Proton

(d) Neutron

Ans. (a) atomic nucleus

16. 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) different number of neutrons

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

(a) 16

(b) 8

(c) 17

(d) 18

Ans. (b) 8

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.

Ans. (a) 2,8,1

19. Complete the following table.

Atomic number	Mass number	Number of neutrons	Number of protons	Number of electrons	Name of the atomic species
9	-	10	-	-	-
16	32	-	-	-	Sulphur
-	24	-	12	-	-
-	2	-	1	-	-
-	1	0	1	0	-

Ans.

Atomic number	Mass number	Number of neutrons	Number of protons	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
1	1	0	1	0	Hydrogen ion