SpeedLabs

Science

CBSE 9th

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Structure of the Atom Exercise

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

Ans.

Electron		Proton		Neutron	
(i)	Electrons are present outside the nucleus of an atom.	(i)	Protons are present in the nucleus of an atom.	(i)	Neutrons are present in the nucleus of an atom.
(ii)	Electrons are negatively charged.	(ii)	Protons are positively charged.	(ii)	Neutrons are neutral.
(iii)	The mass of an electron is considered to negligible.	(iii)	The mass of a proton is approximately 2000 times as the mass of an electron.	(iii)	The mass of neutron is nearly equal to the mass of a proton.

2. 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.

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

Ans. According to Rutherford's model of an atom, electrons revolve around the nucleus in fixed orbits. But, an electron revolving in circular orbits will not be stable because during revolution, it will experience acceleration. Due to acceleration, the electrons will lose energy in the form of radiation and fall into the nucleus. In such a case, the atom would be highly unstable and collapse.

4. Describe Bohr's model of the atom.

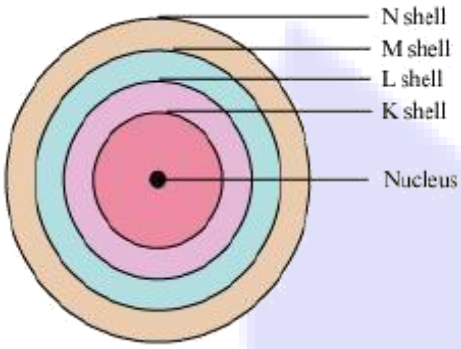
Ans. <u>Bohr's model of the atom</u>

Niels 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.

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

Ans.

Thomson's model	Rutherford's model	Bohr's model
An atom consists of a positively charged sphere with electrons embedded in it.	An atom consists of a positively charged particles concentrated at the center 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.

6. 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

7. 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.

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

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($^{1}_{1}\mathrm{H}$), deuterium($^{2}_{1}\mathrm{H}$), and tritium($^{3}_{1}\mathrm{H}$).

(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 $^{40}_{20}\mathrm{Ca}$, and $^{40}_{18}\mathrm{Ar}$ 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.

9. 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.

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

Ans. It is given that two isotopes of bromine are $^{79}_{35}\mathrm{Br}$ (49.7%) and $^{81}_{35}\mathrm{Br}$ (50.3%). Then, the average atomic mass of bromine atom is given by.

$$79 \times \frac{49.7}{100} + 81 \times \frac{50.3}{100} = \frac{3926.3}{100} + \frac{4074.3}{100} = \frac{8000.6}{100} = 80.006\mathrm{u} = 80\mathrm{u}(\mathrm{appprox})$$

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

Ans. It is given that the average atomic mass of the sample of element X is 16.2 u.

Let the percentage of isotope be $^{18}_{8}\mathrm{X}$ y%. Thus, the percentage of isotope $^{16}_{8}\mathrm{X}$ will be (100 − y) %.

Therefore,

$$18 \times \frac{\mathrm{y}}{100} + 16 \times \frac{(100 - \mathrm{y})}{100} = 16.2$$

$$\Longrightarrow \frac{18\mathrm{y}}{100} + \frac{16(100 - \mathrm{y})}{100} = 16.2$$

$$\Rightarrow \frac{18\mathrm{y} + 1600 - 16\mathrm{y}}{100} = 16.2$$

$$\Rightarrow 18\mathrm{y} + 1600 - 16\mathrm{y} = 1620$$

$$\Rightarrow 2\mathrm{y} + 1600 = 1620$$

$$\Rightarrow 2\mathrm{y} = 1620 - 1600$$

$$\Rightarrow 2\mathrm{y} = 20$$

$$\Rightarrow \mathrm{y} = 10$$

Therefore, the percentage of isotope $^{18}_{8}\mathrm{X}$ is 10%.

And, the percentage of isotope $^{16}_{8}\mathrm{X}$ is (100 − 10) % = 90%.

12. 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.

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. 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.

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

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

Ans. (a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons. (F)

(b) A neutron is formed by an electron and a proton combining together. Therefore, it is neutral. (F)

(c) The mass of an electron is about $\frac{1}{2000}$times that of proton. (T)

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

15. Put tick (✓) against correct choice and cross (×) against wrong choice in the following Question.

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

(a) Atomic nucleus (b) Electron

(c) Proton (d) Neutron

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

(a) Atomic nucleus ✓ (b) Electron ×

(c) Proton × (d) Neutron ×

16. Put tick (✓) against correct choice and cross (×) against wrong choice in the following Question.

Isotopes of an element have

(a) The same physical properties

(b) Different chemical properties

(c) Different number of neutrons

(d) Different atomic numbers

Ans. Isotopes of an element have

(a) The same physical properties ×

(b) Different chemical properties ×

(c) Different number of neutrons ✓

(d) Different atomic numbers ×

17. Put tick (✓) against correct choice and cross (×) against wrong choice in the following Q.

Number of valence electrons in Cl^- ion are.

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

Ans. Number of valence electrons in Cl^- ion are.

(a) 16 × (b) 8 ✓ (c) 17 × (d) 18 ×

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. (d) The correct electronic configuration of sodium is 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**