Science

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(Chapter – 4) (Structure Of The Atom)

Exercises

Question 1:

Compare the properties of electrons, protons and neutrons.

Answer 1:

Electron	Proton	Neutron
(i) Electron are present outside the nucleus of an atom.	(i) Proton are present in the nucleus of an atom.	(i) Neutron are present in the nucleus of an atom.
(ii) Electron are negatively charged	(ii) Proton are positively charged.	(ii) Neutron 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.

Question 2:

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

Answer 2:

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 center of the atom called the nucleus, and the electrons revolve around the nucleus.

Question 3:

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

Answer 3:

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.

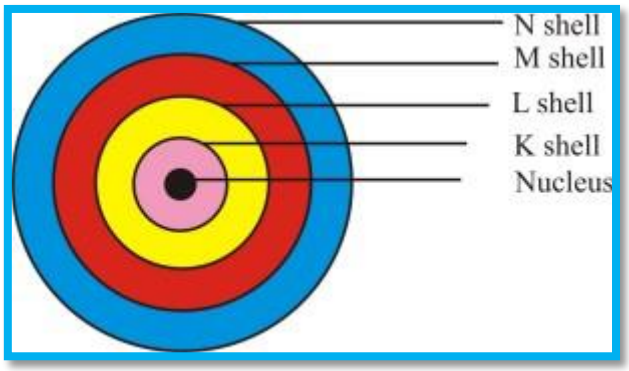
Question 4:

Describe Bohr's model of the atom.

Answer 4:

Bohr's model of the atom 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.

Question 5:

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

Answer 5:

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 electron revolve around the nucleus in well - defined orbits.	• There are only certain orbits know as discrete orbits inside the atom in which electrons revolve around the nucleus. Electrons do not radiate energy while revolving.

Question 6:

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

Answer 6:

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 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 step wise manner i.e., the outer shell is not occupied with electrons unless the inner shells are completely filled with electrons.

Question 7:

Define valency by taking examples of silicon and oxygen.

Answer 7:

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.

Question 8:

Explain with examples

- **(i) Atomic number,**
- **(ii) Mass number,**
- **(iii) Isotopes and**
- **(iv) Isobars.**

Give any two uses of isotopes.

Answer 8:

(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

They are atoms of the same element and have same atomic number but different mass number/atomic mass. For example:

Carbon: ${}^{12}_{6}C$ and ${}^{14}_{6}C$

(iv) Isobars

They are atoms of different elements having same mass number but different atomic number.

For example calcium, atomic number 20 and argon, atomic number 18.

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.

Question 9:

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

Answer 9:

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 Na+ =10= 2, 8

The above configuration indicates completely filled K, L shells.

Question 10:

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

Answer 10:

The average atomic mass of bromine
= (79 x 49.7)+ (81 x 50.3)/100
= (3926.3 + 4074.3)/100
= 8000.6/100
= 80 u

Question 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 11:

Since average atomic mass
= 16 x X + 18 x (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%

Question 12:

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

Answer 12:

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.

Question 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 13:

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.

Question 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 14:

(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 1/2000 times that of proton. (T)
(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine. (T)

Question 15:

Put tick (√) against correct choice and cross (x) 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

Answer 15:

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

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

Question 16:

Put tick (√) against correct choice and cross (x) 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

Answer 16:

Isotopes of an element have

(a) the same physical properties (x)
(b) different chemical properties (x)
(c) different number of neutrons (√)
(d) different atomic numbers (x)

Question 17:

Put tick (√) against correct choice and cross (x) against wrong choice in the following question: Number of valence electrons in Cl^- ion are:

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

Answer 17:

Number of valence electrons in Cl^- ion are:

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

Question 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 18:

(d) The correct electronic configuration of sodium is 2, 8, 1.

Question 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	-

Answer 19:

Atomic Number	Mass Number	Number of Neutrons	Number of Protons	Number of Electrons	Name of the Atomic Species
9	$^{19}_{-}$	10	$^{9}_{-}$	$^{9}_{-}$	$^{\text{Fluorine}}_{-}$
16	32	$^{16}_{-}$	$^{16}_{-}$	$^{16}_{-}$	Sulphur
$^{12}_{-}$	24	$^{12}_{-}$	12	$^{12}_{-}$	$^{\text{Magnesium}}_{-}$
$^{1}_{-}$	2	$^{2}_{-}$	1	$^{1}_{-}$	$^{\text{Deuterium}}_{-}$
$^{1}_{-}$	1	0	1	0	$^{\text{Hydrogen ion}}_{-}$