# Structure of the Atom: Exercise Questions

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

***Sol.*** Comparison the properties of electrons, protons and neutrons:

| Electron | Proton | Neutron |
|---|---|---|
| Electrons revolve around the nucleus of an atom. | Protons are present in the nucleus of an atom | Neutrons are also present in the nucleus of an atom. |
| It is negatively charged | It is Positively charged | It is neutral. |
| Its mass is negligible compare to proton and neutron. | Its mass is approximately 2000 times as the mass of an electron | Its mass is nearly equal to the mass of a proton. |

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

***Sol.*** *According to* J.J. Thomson's model of an atom, an atom is a positively charged sphere with electrons embedded in it. But, experimentally it was later found that the positively charged particles present at the center of the atom called the nucleus and the electrons revolve around the nucleus.

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

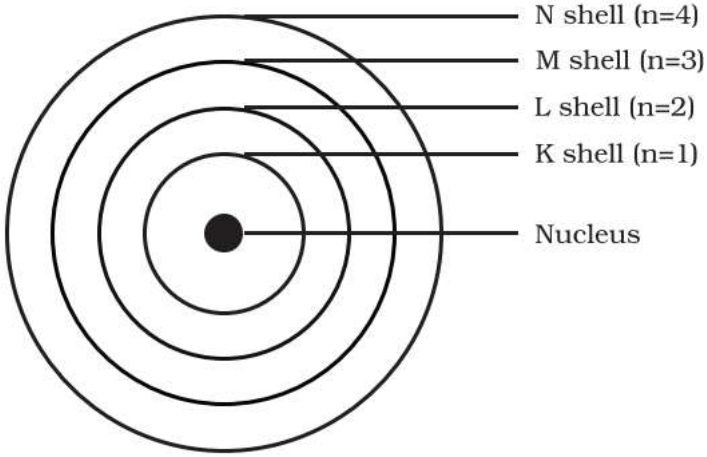
***Sol.*** According to Rutherford's model of an atom, electrons revolve in circular orbits around the nucleus. But, an electron revolving in circular orbit will experience acceleration. Due to this acceleration, the electron will lose energy in the form of radiation and finally fall into the nucleus. In that case, the atom would be highly unstable. But we know that atoms are quite stable.

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

***Sol.*** ***According to*** Bohr's model of the atom:

**(i)** Electrons are allowed inside the atom only certain special orbits known as discrete orbits.

**(ii)** During revolving the electrons in these discrete orbits, they do not radiate energy. These discrete orbits are represented by K, L, M, N as shown in figure.




The first orbit (i.e., for n = 1) : K- shell

Similarly, for n = 2 : L – shell,

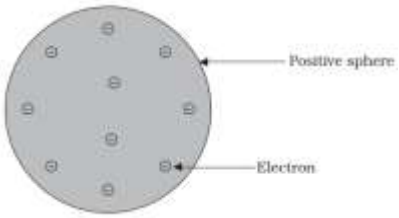
for n = 3 : M – shell

for n = 4 : N – shell.

These orbits or shells are also called energy levels.

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

***Sol.***

| Thomson's model | Rutherford's model | Bohr's model |
|---|---|---|
| An atom is a positively charged sphere with electrons embedded in it.   | An atom contains positively charged particles concentrated at the center known as the nucleus and electrons revolve around the nucleus in well - defined orbits. | Atom consists of certain orbits know as discrete orbits, in which electrons revolve around the nucleus. Electrons do not radiate any energy while revolving. |

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

***Sol.*** The rules for writing of the distribution of electrons in various shells for the first eighteen elements are:

(i) The maximum number of electrons present in a shell is given by the formula '$2n^2$', where 'n' = orbit number (n = 1, 2, 3...).

So, the maximum number of electrons present in different orbits are:
For K shell, n = 1; $2n^2=2\times1^2 = 2$

Similarly, for L shell, n=2; $2n^2 = 2\times2^2 = 8$
For M shell, n = 3; $2n^2=2\times3^2 = 18$
For N shell, n = 4; $2n^2=2\times4^2 = 32$

(ii) The outermost shell can be kept by a maximum number of 8 electrons.

(iii) Electrons are not accommodated in a given shell, unless the inner shells are filled.

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

***Sol.*** The valency of an element is defined as the combining capacity of that element. Electrons are lost, gained or shared to complete the octet of electrons by an atom. These exchange of electrons defines the valency of atom.
Example: finding the valency of silicon (Si): atomic number =14
Electronics configuration: 2, 8, 4
It has four valence electrons and requires four more electrons to complete the octet of electrons. Thus the valency of Silicon is 4.
Example: finding the valency of Oxygen (O): atomic number =8
Electronics configuration: 2, 6
It has six valence electrons and requires two more electrons to complete the octet of electrons. Thus the valency of oxygen is 2.

**Q.8 Explain with examples (i) Atomic number, (ii) Mass number, (iii) Isotopes and (iv) Isobars. Give any two uses of isotopes.**

***Sol.*** **(i) Atomic number:** The atomic number of an element is defined as the number of protons present in nucleus of atom of that element. Example: oxygen has 8 protons in its atom. Therefore, the atomic number of oxygen is 8.

**(ii) Mass number:** The mass number of an element is defined as the sum of the number of protons and neutrons present in the nucleus of atom of that element. Example, the atom of Sodium has 11 protons and 12 neutrons. So, the mass number of Sodium is11 + 12 = 23.

**(iii) Isotopes:** Isotopes are the atoms of the same element which have different number of neutrons but same number of protons.
Example: $_1H^1$, $_1H^2$, $_1H^3$

**(iv) Isobars:** Isobars are atoms of the different elements having the same mass number but different atomic numbers.
Example: $_{20}Ca^{40}$, $_{18}Ar^{40}$

**Two uses of isotopes:**

**(i)** In medical field, isotope of iodine is used in the treatment of disease of goitre.

**(ii)** In energy production, an isotope of uranium is used as a fuel in nuclear reactors.

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

**Sol:** Sodium atom (Na): Atomic number =11
Number of protons =11
Number of electrons = 11
Electronic configuration of sodium: K=2, L=8, M=1
For obtain stable electronic configuration, sodium atom (Na) looses 1 electron from M shell and form $Na^+$ ion.
Now electronic configuration of $Na^+$: K=, L=8
Thus, it has completely filled K and L shells.

**Q.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.**

**Sol:** Given two isotopes of bromine: $^{79}_{35}Br$ (49.7%) and $^{81}_{35}Br$ (50.3%)

Average atomic mass of bromine atom $= \left(79x\frac{49.7}{100}\right)+\left(81x\frac{50.3}{100}\right)$

$= 39.263 + 40.743$

$= 80.006$ u

**Q.11 The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $^{16}_8X$ and $^{18}_8X$ in the sample?**

**Sol: Given** Average atomic mass of an element X = 16.2 u
Let the percentage of $^{16}_8X$ be x and the percentage of $^{16}_8X$ be 100 – x.

$$\left(16x\frac{x}{100}\right)+\left(\frac{18(100-x)}{100}\right)=16.2$$

$$\frac{16x}{100}+\frac{1800-18x}{100}=16.2$$

$$\frac{16x-18x+1800}{100}=16.2$$

$$-2x + 1800 = 16.2 \times 100$$

$$-2x = 1620 - 1800$$

$$-2x = -180$$

$$X = 90$$

$$_6X^{16} = 90\%$$

$$\text{And } _6X^{18} = 10\%$$

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

***Sol.*** If Z = 3, It means that the atomic number of the element is 3.
So, its electronic configuration = 2, 1.
Since the outermost shell has only one electron. So, it loses one electron from the outermost shell and obtains stable electronics configuration. Thus, the valency of the element = 1. Therefore, the element with atomic number 3 is lithium.

**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?**

***Sol. As we know that, Mass number*** = Number of protons + Number of neutrons
Mass number of X = 6 + 6
= 12
Mass number of Y = 6 + 8
= 14
since, both two atomic species X and Y have the same atomic number, but different mass numbers. Thus, 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.**

***Sol.*** (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, itis 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)

**Put tick (√) against correct choice and cross (x) against wrong choice in the following question:**

**Q.15 Rutherford's alpha-particle scattering experiment was responsible for the discovery of**
(a) Atomic nucleus
(b) Electron
(c) Proton
(d) Neutron

***Sol.*** Rutherford's alpha-particle scattering experiment was responsible for the discovery of
(a) Atomic nucleus (√)
(b) Electron (x)
(c) Proton (x)
(d) Neutron (x)

**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

***Sol.*** 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)

**Q.17 Number of valence electrons in Cl– ion are:**

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

***Sol.*** Number of valence electrons in Cl– ion are:

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

**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

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

**Q.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 | - |

***Sol:***

| 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 | Hydrogen Deuterium |
| 1 | 1 | 0 | 1 | 0 | Hydrogen |