

## NCERT Solutions for Class 9 Science Chapter 4 Structure of The Atom

**Q. 1.** What are canal rays?

**Answer:**

Canal rays are the positively charged radiations which consist of positively charged particles of atoms. they can pass through the perforated ( pierced ) cathode and then travel towards another cathode in a gas discharge tube.

They were given the name Canal rays by E. Goldstein in 1866 who discovered these radiations.

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

**Answer:**

The proton is a positively charged particle and the electron is a negatively charged particle. their magnitude is equal and hence net charge in an atom is zero.

### NCERT free solutions for class 9 science chapter 4 Structure of the Atom

#### Topic 4.2 The structure of an atom

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

**Answer:**

According to Thomson's model of an atom, an atom consists of a sphere of a positive charge.

The positive charge in the atom is spread all over like the red edible part of a watermelon, while the electrons are studded in the positively charged sphere, just like the seeds in the watermelon.

As negative and positive charges are equal in magnitude, they balance each other and thus the atom becomes electrically neutral as a whole.

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

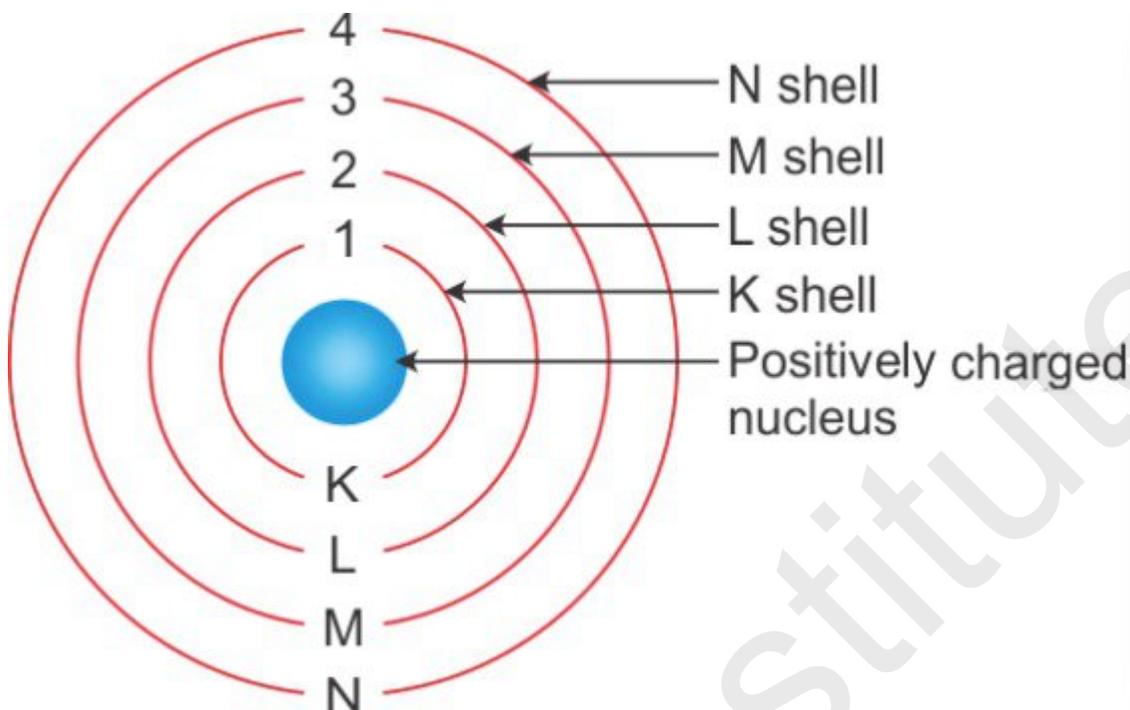
**Answer:**

On the basis of Rutherford's model of an atom, the subatomic particle which is present in the nucleus of an atom is Proton which is a positively charged particle.

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

**Answer:**

The sketch of Bohr's model of an atom with three shells:



**Q. 4.** What do you think would be the observation if the  $\alpha$ -particle scattering experiment is carried out using a foil of a metal other than gold?

**Answer:**

If a foil of a heavy metal like platinum is used, then the observations in the alpha-particle scattering experiment would be the same as that in the gold foil experiment.

If a foil of a light metal like lithium is used, then the observations in the alpha-particle scattering experiment would not be the same because these metal are not so malleable so the thin foil is difficult to obtain.

The problem with not using thin foil is that the number of the alpha particle will bounce back from the thick foil and the location of positive mass would be difficult to find.

**CBSE NCERT solutions for class 9 science chapter 4 Structure of the Atom**

### Topic 2.4.2 Neutron

**Q. 1.** Name the three sub-atomic particles of an atom.

**Answer:**

The three sub-atomic particles of an atom are :

1. Electron: a negatively charged particle
2. Proton: a positively charged particle
3. Neutron: a neutral particle

**Q. 2.** Helium atom has an atomic mass of 4 u and two protons in its nucleus. How many neutrons does it have?

**Answer:**

The atomic mass of Helium = 4 u

No. of protons = 2

As atomic mass = no. of protons + no. of neutrons

No. of neutrons = At. mass - no. of protons

= 4 - 2

= 2

Hence Helium atom has 2 neutrons.

**Solutions for NCERT class 9 science chapter 4 Structure of the Atom**

### Topic 4.3 How are electrons distributed in different orbits(shells)?

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

**Answer:**

Number of electrons in carbon atom = 6

Number of electrons in sodium atom = 11

Electron Distribution:

Element	First Orbit or K-shell	Second Orbit or L-shell	Third Orbit or M-shell
Carbon	2	4	0
Sodium	2	8	1

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

**Answer:**

Maximum Number of electrons in K-shell = 2

Maximum Number of electrons in L-shell = 8

The total no. of electrons in the atom = 2 + 8

= 10

If *K* and *L* shells of an atom are full, then the total number of electrons in the atom will be 10.

## NCERT solutions for class 9 science chapter 4 Structure of the Atom

### Topic 4.4 Valency

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

**Answer:**

Valency is basically the minimum number of the electron we have to add or remove such that every shell in the atom is completely filled.

Mathematically,

when the outermost shell of an atom contains 4 or less than 4 electrons, its valency is equal to the number of valence electrons in the outermost shell and when the outermost shell contains more than 4 electrons, the valency of the atom is equal to 8 - no. of valence electrons in the atom.

Chlorine :

Atomic No. of Cl = 17

Its electronic configuration = 2, 8, 7

Valency of Cl =  $8 - 7 = 1$

Sulphur :

Atomic no. of S = 16

Its electronic configuration = 2, 8, 6

Valency of S =  $8 - 6 = 2$

Magnesium:

Atomic no. of Mg = 12

Its electronic configuration = 2, 8, 2

Valency of Mg = 2

## **NCERT textbook solutions for class 9 science chapter 4 Structure of the Atom**

### **Topic 4.5 Atomic number and Mass number**

**Q. 1.(i)** If the number of electrons in an atom is 8 and the number of protons is also 8, then

(i) what is the atomic number of the atom?

**Answer:**

Given,

Number of electrons in the atom = 8

Number of proton in the atom = 8

The atomic number of an atom is equal to the number of proton in that atom. hence the atomic number of the given atom is 8.

**Q. 1. (ii)** If the number of electrons in an atom is 8 and the number of protons is also 8, then

(ii) what is the charge on the atom?

**Answer:**

In the given atom, the total number of positive charges is equal to the total number of negative charge.

Number of Protons (8) = Number of electrons (8)

They both will neutralize each other. So, the atom will not possess any charge.

**Q. 2.** With the help of Table 4.1, find out the mass number of oxygen and sulphur atom.

Table 4.1: Composition of Atoms of the First Eighteen Elements with Electron Distribution in Various Shells										
Name of Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Number of Electrons	Distribution of Electrons				Valency
						K	L	M	N	
Hydrogen	H	1	1	-	1	1	-	-	-	1
Helium	He	2	2	2	2	2	-	-	-	0
Lithium	Li	3	3	4	3	2	1	-	-	1
Beryllium	Be	4	4	5	4	2	2	-	-	2
Boron	B	5	5	6	5	2	3	-	-	3
Carbon	C	6	6	6	6	2	4	-	-	4
Nitrogen	N	7	7	7	7	2	5	-	-	3
Oxygen	O	8	8	8	8	2	6	-	-	2
Fluorine	F	9	9	10	9	2	7	-	-	1
Neon	Ne	10	10	10	10	2	8	-	-	0
Sodium	Na	11	11	12	11	2	8	1	-	1
Magnesium	Mg	12	12	12	12	2	8	2	-	2
Aluminium	Al	13	13	14	13	2	8	3	-	3
Silicon	Si	14	14	14	14	2	8	4	-	4
Phosphorus	P	15	15	16	15	2	8	5	-	3,5
Sulphur	S	16	16	16	16	2	8	6	-	2
Chlorine	Cl	17	17	18	17	2	8	7	-	1
Argon	Ar	18	18	22	18	2	8	8	-	0

**Answer:**

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.

**CBSE NCERT solutions for class 9 science chapter 4 Structure of the Atom**

## Topic 4.6 Isotopes

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

**Answer:**

H, D, and T are the three isotopes of hydrogen with the same atomic number and different mass numbers of 1, 2 and 3 respectively.

Element	Symbol	Number of Electrons	Number of Protons	Number of Neutrons
Hydrogen	H	1	1	0
Deuterium	D	1	1	1
Tritium	T	1	1	2

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

**Answer:**

**Isotopes :**

Isotopes are the atoms with the same number of proton and different atomic mass. The difference in atomic mass arises due to the different number of neutrons present in the atom.

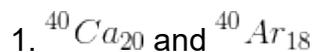
Some Examples of Isotopes are :



**Isobar:**

Isobars are the atom with the same atomic mass and different atomic number.

Some example of Isobars are :



### **NCERT solutions for class 9 science chapter 4 Structure of the Atom: Solved Exercise Questions**

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

**Answer:**

The Comparison of Properties between Electron, Proton, and Neutron:

<b>Properties</b>	<b>Electrons</b>	<b>Protons</b>	<b>Neutrons</b>
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Charge	Negatively charged	Positively charged	No charge
Weight	Negligible	1 a.m.u	1 a.m.u
Location in atom	Outside the nucleus	Inside the nucleus	Inside the nucleus
Reaction with a charged particle	Attracts positive charge	Attracts negative charge	gives no reaction to any charge

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

**Answer:**

The limitations of J.J. Thomson's model of the atom are:

1. Thomson's model of the atom could not explain the results of alpha particle scattering experiment carried out by Rutherford. this model failed to depict why most of the alpha particle passes through gold foil and why some of them got diverted in different angles and some of them rebounded and returned back to their paths.
2. It was solely based on the imagination and did not have any experimental evidence.

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

**Answer:**

The limitations of Rutherford's model of the atom is that It does not explain the stability of the atom. As we know now, when charged bodies move in a circular motion, they emit radiations.

This means that the electrons revolving around the nucleus (as suggested by Rutherford) would lose energy and come closer and closer to the nucleus, and a stage will come when they would finally merge into the nucleus.

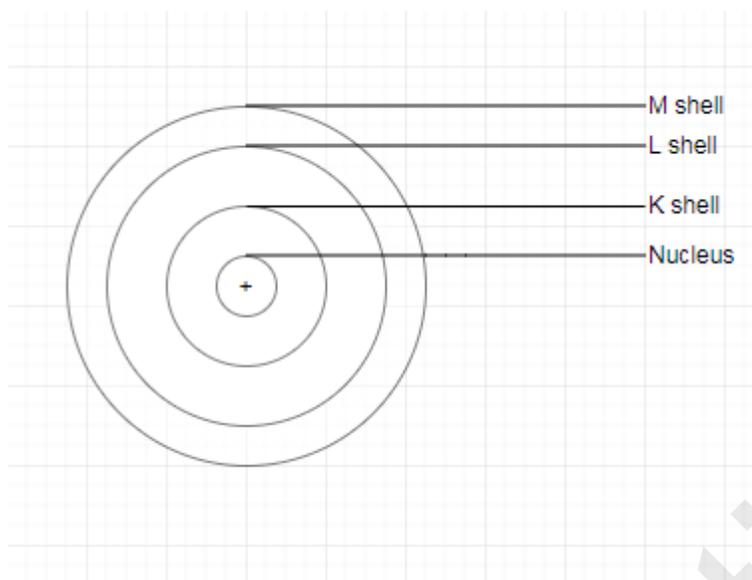
This makes the atom unstable, which is clearly not the case. The electrons do not fall into the nucleus, atoms are very stable and do not collapse on their own.

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

**Answer:**

In order to overcome the objections raised against Rutherford's model of the atom, Neils Bohr put forward his model of the atom. According to Bohr's model of the atom,

1. An atom holds the nucleus in the center. the whole mass of the atom is concentrated at the nucleus.
2. The negatively charged particle revolves around the nucleus in definite circular paths known as orbits or which are designated as K, L, M, N, etc. or numbered as  $n = 1, 2, 3, 4, \text{etc.}$  (outward from the nucleus).
3. While revolving in discrete orbits, the electrons do not radiate energy. But when an electron jumps from one energy level to another, the energy of the atom changes.

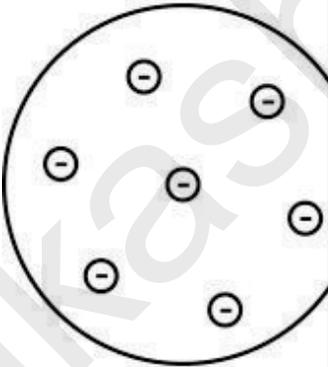
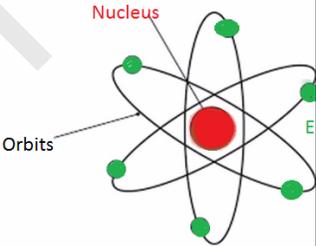
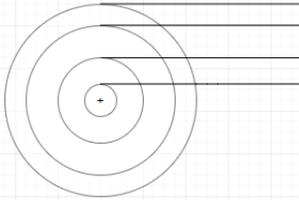


**Q. 5.** Compare all the proposed models of an atom given in this chapter.

**Answer:**

Comparison of different proposed Model:

Feature	Thomson's Model	Rutherford's Model	Bohr's Model
Positive Charge	The Positive charge is distributed in Sphere	The positive charge is concentrated at the core of the atom, which is called the nucleus	The positive charge is present in the core of the atom, called nucleus.

<p>Negative Charge</p>	<p>The electrons are embedded in the positively charged sphere of an atom, like the seeds in a watermelon.</p>	<p>The nucleus is surrounded by electrons, and the electrons and the nucleus are held together by the electrostatic force of attraction</p>	<p>The electrons move in discrete orbits, and each orbit is associated with a definite amount of energy.</p>
<p>Limitation</p>	<p>This model could not explain the results of an alpha particle scattering experiment</p>	<p>This model could not explain the stability of the atom.</p>	<p>This model perfectly explains the stability of an atom</p>
<p>Diagrammatic representation</p>			

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

**Answer:**

The Bohr and Bury scheme for the distribution of electrons in an atom is based on the following rules :

1. The maximum number of electrons that a shell can have is represented by  $2n^2$ , where n is the quantum number of that particular energy shell. Thus, the maximum number of electrons in the first four shells are :

$$\text{1st (K) shell } 2 \times 1^2 = 2$$

$$\text{2nd (L) shell } 2 \times 2^2 = 8$$

$$\text{3rd (M) shell } 2 \times 3^2 = 18$$

$$\text{4th (N) shell } 2 \times 4^2 = 32$$

2. The outermost shell, which is also called valence shell, can have a maximum of 8 electrons.

3. If permitted by rule 1, The shell inner to the outermost shell (the second last shell ) can accommodate a maximum of 18 electrons.

4. Electrons are not taken in unless the inner shells are filled, i.e., the shells are filled in a step-wise manner.

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

**Answer:**

The definite combining capacity of an atom of an element, in which electrons are lost, gained or shared with other atoms to complete the octave in the outermost shell is defined as valency.

In other words,

Valency is basically the minimum number of the electron we have to add or remove from or in the outermost shell such that every shell in the atom is completely filled.

And Mathematically,

when the outermost shell of an atom contains 4 or less than 4 electrons, its valency is equal to the number of valence electrons in the outermost shell and when the outermost shell contains more than 4 electrons, the valency of the atom is equal to  $8 - \text{no. of valence electrons in the atom}$ .

The valency of Silicon:

Atomic number = 14

Distribution of electron :

K = 2

L = 8

M = 4

Number of electrons in outermost shell = 4

Valency =  $8 - 4 = 4$ .

The valency of Oxygen:

Atomic number = 8

Distribution of electrons:

$$K = 2$$

$$L = 6$$

The number of electron in outermost shell = 6

$$\text{Valency} = 8 - 6 = 2$$

**Q. 8.(i)** Explain with examples

(i) Atomic number,

**Answer:**

**Atomic Number :**

An atomic number of an atom is the total number of protons present within the nucleus of an atom is known as the atomic number. it is denoted by symbol Z.

**Example:** As the Oxygen atom has 8 protons in its nucleus, its atomic number is 8.

**Q. 8.(ii)** Explain with examples

(ii) Mass number,

**Answer:**

**Mass Number :**

The mass number of an atom is the sum total of the masses of all the nucleons present in the nucleus of an atom, i.e.,

$$\text{Mass Number} = \text{No. of Protons} + \text{No. of Neutrons}$$

It is denoted by A.

**Example:** As a sodium atom has 11 protons and 12 neutrons in its nucleus,

So, its mass number =  $11 + 12 = 23$ .

**Q. 8.(iii)** Explain with examples

(iii) Isotopes

**Answer:**

Isotopes:

Isotopes are the atoms of the same element having the same atomic number but a different mass number.

**Example:** Carbon molecule exists as  $^{12}\text{C}_6$  and  $^{14}\text{C}_6$ .

**Q. 8.(iv)** Explain with examples

(iv) Isobars.

**Answer:**

Isobar:

Isobars are the atoms of different elements having the same mass number but different atomic numbers.

Example:  $^{40}\text{Ca}_{20}$  and  $^{40}\text{Ar}_{18}$ . Mass numbers of calcium and argon atoms have different atomic numbers (20 and 18) but the same mass number 40.

Two uses of isotopes are:

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

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

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

**Answer:**

The atomic number of Na = 11

No. of electrons in Na atom = 11

In  $\text{Na}^+$ , the positive charge is obtained due to the loss of one electron from the M shell of Na atom.

So, No. of electrons in  $\text{Na}^+$  ion = 11 - 1 = 10

Hence, electronic configuration of  $\text{Na}^+$  = 2, 8

In  $\text{Na}^+$ , K and L shells are completely filled since K shell can have a maximum of 2 electrons and L shell can have a maximum of 8 electrons.

**Q. 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.

**Answer:**

Given, two isotopes  ${}^{79}_{35}\text{Br}$ (49.7%) and  ${}^{81}_{35}\text{Br}$ (50.3%) .

Average atomic mass:

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

$$= \frac{3926.3}{100} + \frac{4074.3}{100}$$

$$= \frac{8000.6}{100}$$

$$= 80.006u .$$

**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?

**Answer:**

Given, the average atomic mass of a sample of an element  $X$  is  $16.2 u$  .

Two isotopes of element =  ${}^{16}_8X$  and  ${}^{18}_8X$

Now, Let's percent of isotope  ${}^{16}_8X$  be  $x$  and percent of  ${}^{18}_8X$  be  $100 - x$

So, According to the question,

Average Atomic Mass :

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

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

$$-1.8 = -\frac{2x}{100}$$

$$2x = 180$$

$$x = 90$$

Hence the percentage of isotope  ${}^8_{16}\text{X}$  is 90 % and the percentage isotope  ${}^8_{16}\text{X}$  is 10%.

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

**Answer:**

Given

the Atomic number,  $Z = 3$

Distribution of electrons :

$K = 2,$

$L = 1$

So, Valency = 1 .

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?

**Answer:**

As we know,

the mass number of an atom = No. of protons + No. of Neutrons

So,

The mass number of  $X$  = No. of protons of  $X$  + No. of Neutrons of  $X$

$$= 6 + 6$$

$$= 12$$

The mass number of  $Y$  = No. of protons of  $Y$  + No. of Neutrons of  $Y$

$$= 6 + 8$$

$$= 14$$

As both  $X$  and  $Y$  have the same atomic number (6) but different numbers (i.e., 12 and 14 respectively), 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 a proton.

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

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

**Answer:**

- (a) The statement is False.
- (b) The statement is False.
- (c) The statement is True.
- (d) The statement is True.

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

- (a) Atomic Nucleus
- (b) Electron
- (c) Proton
- (d) Neutron

**Answer:**

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

Hence, option **(a)** is the correct answer.

**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

**Answer:**

Isotopes of an element have a different number of neutrons.

Hence option **(c)** is correct.

**Q. 17.** A Number of valence electrons in  $Cl^-$  ion are:

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

**Answer:**

The Electronic configuration of  $Cl^-$  ion is :

K = 2

L = 8

M = 8

Hence Number of valance electron in  $Cl^-$  ion = 8.

Hence, option (b) is the correct answer.

**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.

**Answer:**

The atomic number of sodium = 11

The electronic configuration of the sodium :

K = 2

L = 8

M = 1

Hence, option (d) is correct.

**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	-

**Answer:**

**First row:**

atomic number = 9

so, the element is Fluorine.

Atomic no. = No. of protons = no. of electrons = 9

Mass number = no. of protons + no. of neutrons = 9 + 10 = 19

**Second row:**

Since atomic no. is 16 so, no. of protons = no. of electrons = 16

No. of neutrons = Mass no. - no. of protons = 32 - 16 = 16

**Third row:**

No. of protons = Atomic no. = 12

So, the element is Magnesium.

No. of electrons = no. of protons = 12

No. of neutrons = Mass no. - no. of protons = 24 - 12 = 12

**Fourth row:**

No. of protons = Atomic no. = 1

So, the element is Deuterium.

No. of electrons = no. of protons = 1

No. of neutrons = Mass no. - no. of protons = 2 - 1 = 1

**Fifth row:**

No. of protons = Atomic no. = 1

The element is Protium since the mass number is 1.

So the Table becomes,

<b>Atomic number</b>	<b>mass number</b>	<b>Number of neutrons</b>	<b>Number of protons</b>	<b>Number of electrons</b>	<b>Name of the element</b>
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulfur
12	24	12	12	12	Magnesium

1	2	1	1	1	Deuterium
1	1	1	1	0	Hydrogen ion

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