**Question 1:**

What are canal rays?

* [**Answer**](http://cbse.meritnation.com/study-online/solution/science/44P4eCu2e85OplK@BlstuQ!!#optionContent1)

Canal rays are positively charged radiations. These rays consist of positively charged particles known as protons. They were discovered by Goldstein in 1886.

**Question 2:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/e2qkHAOGNovJJuxXLZIkjQ!!#optionContent1)

An electron is a negatively charged particle, whereas a proton is a positively charged particle. The magnitude of their charges is equal. Therefore, an atom containing one electron and one proton will not carry any charge. Thus, it will be a neutral atom.

**Question 1:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/c@CzyAPZXldI2zHNUrB9$A!!#optionContent1)

According to Thomson’s model of the atom, an atom consists of both negatively and positively charged particles. The negatively charged particles are embedded in the positively charged sphere. These negative and positive charges are equal in magnitude. Thus, by counterbalancing each other’s effect, they make an atom neutral.

**Question 2:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/wLXC@2OqEmJMJR4Ueb3m0A!!#optionContent1)

On the basis of Rutherford's model of an atom, protons (positively-charged particles) are present in the nucleus of an atom.

|  |  |
| --- | --- |
| After the discovery of electrons, J. J. Thomson gave an atomic model. According to Thomson’s model of the atom,   1. an atom consists of a positively charged sphere with electrons embedded in it 2. the negative and positive charges are equal in magnitude (therefore, the atom as a whole is electrically neutral)   Thomson’s model of the atom became very popular as it proved that atoms are neutral entities. However, this model was not able to explain the results of experiments obtained by other scientists such as Earnest Rutherford, who was performing experiments on radioactivity. | http://cbse.meritnation.com/img/lp/1/9/8/116/323/770/735/LP-12-6-2008_Vidushi_Science_9.2.4.1.2_GSX_SG_SS_html_m20f44ccc.png |

Ernest Rutherford, while performing experiments on radioactivity, bombarded fast moving alpha particles on a thin gold foil (about 1000 atoms thick). He selected the gold foil because of its high ductility; and doubly charged alpha particles because of their large amount of energy. He expected to see small deflections of alpha particles by the sub-atomic particles present in gold atoms. The following figureshows the set-up of his experiment**.**

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From the experiment, he made the following observations:

1. Most of the fast moving α-particles passed straight through the gold foil.
2. Some α-particles were deflected through the foil by small angles.
3. Surprisingly, one out of every 12,000 particles rebounded i.e., they got deflected by an angle of 180º.

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| **Deflection pattern of alpha rays as observed by Rutherford** |

Rutherford derived the following conclusions from the gold foil experiment:

**1.** Since most α-particles passed through the gold foil without any deflection, most of the space inside an atom is empty.

**2.** Very few particles suffered a deflection from their path. This means that positive charge occupies very little space inside an atom.

**3.** As a small fraction of particles got deflected completely by the angle of 180º, all positive charge and mass of gold atoms are present within a very small volume inside the atom.

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| http://cbse.meritnation.com/img/lp/1/9/8/116/323/770/735/LP-12-6-2008_Vidushi_Science_9.2.4.1.2_GSX_SG_SS_html_m4a1aa27.png |
| **Explanation of α-particle scattering experiment** |

Based on the above conclusions, Rutherford gave a new atomic model known as the **Rutherford atomic model** or **nuclear model of the atom**. The major features of the model are as follows.

**1** All protons are present inside the nucleus, which is situated at the centre of the atom.

**2.** Electrons reside outside the nucleus and revolve around the nucleus in well-defined orbits.

**3.** The size of the nucleus is very small in comparison to the size of an atom. As per Rutherford’s calculations, the size of the nucleus is 105 times smaller than an atom.

**4.** As the mass of the electron is negligible in comparison to the mass of the proton, almost all the mass of the atom is concentrated in the nucleus.

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| **Rutherford’s atomic model** |

**Drawbacks of Rutherford’s nuclear model**

Rutherford’s model was not able to explain the stability of atoms. This is shown in the following animation.

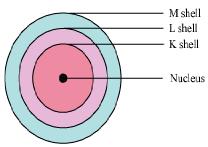
**DO YOU KNOW?**

E. Rutherford is known as the father of nuclear physics. He got accolades for his work on radioactivity and the discovery of the nucleus. In 1908, he won the Nobel prize in chemistry.

**Question 3:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/1lrblI6LbywR1Er$MFKpLg!!#optionContent1)



**Bohr’s model of an atom with three shells**

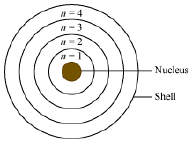
**Bohr&apos;s Model Of Electrons**

Rutherford’s atomic model was able to explain all the observations except the stability of atoms. In 1913, Niels Bohr gave some postulates to explain the structure of atoms and the distribution of charged particles in it.

**Bohr’s postulates:**

1. Only certain special orbits known as discrete orbits of electrons are allowed inside the atom.
2. While revolving in discrete orbits, the electrons do not radiate energy.

Bohr named these orbits as **energy levels**. These orbits or shells are represented by the letters **K, L, M, N**…, or the numbers *n* = 1, 2, 3, 4…etc.



**DO YOU KNOW?**

**Niels Bohr’s atomic model is also known as the planetary model of the atom. His model is a modification of Rutherford’s atomic model. For this reason, the planetary model of the atom is sometimes called the Rutherford-Bohr model.**

**Merits of Bohr’s Model:**

Bohr’s model explains the arrangement and distribution of electrons in an extra nuclear space. He successfully explained the stability of atoms by his proposal of the presence of energy levels around the nucleus of the atoms in which the electrons revolve without radiating energy.

|  |
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| **Discovery of the Neutrons**  In 1932, **J. Chadwick** discovered another subatomic particle and named it **neutron**. It has no charge and has a mass nearly equal to that of a proton. Neutrons are present in the nuclei of all atoms, except hydrogen. It is generally represented by **‘N**’.  The mass of the neutron has been found to be 1.6749 × 10−27 kg, which is slightly more than that of the proton.  Hence, the mass of the atom is equal to the sum of the masses of protons and neutrons present in the nucleus. |

**Distribution of the electrons in the nucleus**

The number of electrons that a particular orbit can accommodate is fixed. Therefore, the number of electrons present in different orbits is different. Let us see how electrons are distributed in different orbits.

|  |
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| Bohr and Bury together suggested certain rules to show how electrons are distributed in different orbits. These rules have to be followed for writing the number of electrons in different energy levels.   1. **First rule:** The maximum number of electrons present in a shell is given by the formula **2*n*²**, where ‘***n***’ is the orbit number or energy level index (1, 2, 3…). Hence, the maximum number of electrons that different shells can accommodate is as follows:    1. First orbit or **K**-shell can accommodate maximally 2 x 1² = 2 electrons.    2. Second orbit or **L**-shell can accommodate maximally 2 x 2² = 8 electrons.    3. Third orbit or **M**-shell can accommodate maximally 2 x 3² = 18 electrons.    4. Fourth orbit or **N-**shell can accommodate maximally 2 x 4² = 32 electrons. 2. **Second rule:** The maximum number of electrons that can be accommodated in the outermost orbit is eight. 3. **Third rule:** Electrons cannot be filled in the outer shell until the inner shells are completely filled. This means that shells are filled in a step-wise manner, starting from the inner shell. |

**Can you tell the electronic configurations of carbon and nitrogen?**

***Valency***

From the Bohr-Bury scheme, we know that the outermost shell of an atom can hold a maximum of eight electrons. The elements, whose atoms have a completely filled outermost shell, have very little chemical activity. Such elements are said to have **zero combining capacity** or **valency**. For e.g., neon atom has eight electrons in its outermost shell. It cannot hold more than eight electrons. Hence, its valency is zero. We all know that neon is inert in nature.

The combining capacity of atoms of the elements is their tendency to react with other atoms of the same or different molecules to attain a filled outermost shell. The outermost shell, which has eight electrons, is said to possess an **octet** and every atom tends to achieve an octet in its outermost shell. This is done by gaining, losing, or sharing its electrons. **The number of electrons gained, lost, or shared by an atom to complete its octet is called the combining capacity or valency of that atom.**

Both hydrogen and sodium contain one electron each in their outermost shells. Thus, both can lose one electron. Hence, their valency is one.

It is not always true that the number of electrons present in the outermost shell of an atom represents its valency. For example, in fluorine, there are seven electrons in the outermost shell, but the valency of fluorine is one. This is because it is energetically suitable for fluorine atom to accept one electron, rather than donate seven electrons. Hence, its valency is obtained by subtracting seven electrons from the octet.

**Can you now calculate the valency of oxygen?**

Valencies of some elements are given in the table below:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Element** | **Number of Protons** | **Number of Neutrons** | **Number of Electrons** | **Distribution of electrons** | | | **Valency** |
| **K** | **L** | **M** |
| Helium(He) | 2 | 2 | 2 | 2 | - | - | 0 |
| Lithium(Li) | 3 | 4 | 3 | 2 | 1 | - | 1 |
| Beryllium(Be) | 4 | 5 | 4 | 2 | 2 | - | 2 |
| Boron(B) | 5 | 6 | 5 | 2 | 3 | - | 3 |
| Carbon(C) | 6 | 6 | 6 | 2 | 4 | - | 4 |
| Nitrogen(N) | 7 | 7 | 7 | 2 | 5 | - | 3 |
| Magnesium(Mg) | 12 | 12 | 12 | 2 | 8 | 2 | 2 |
| Aluminium(Al) | 13 | 14 | 13 | 2 | 8 | 3 | 3 |
| Silicon(Si) | 14 | 14 | 14 | 2 | 8 | 4 | 4 |
| Phosphorus(P) | 15 | 16 | 15 | 2 | 8 | 5 | 3,5 |
| Sulphur(S) | 16 | 16 | 16 | 2 | 8 | 6 | 2 |
| Chlorine(Cl) | 17 | 18 | 17 | 2 | 8 | 7 | 1 |
| Argon(Ar) | 18 | 22 | 18 | 2 | 8 | 8 | 0 |

**Question 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?

* [**Answer**](http://cbse.meritnation.com/study-online/solution/science/9RgnyJBgDgbo2xcYibTMpA!!#optionContent1)

If the α-scattering experiment is carried out using a foil of a metal rather than gold, there would be no change in the observation. In the α-scattering experiment, a gold foil was taken because gold is malleable and a thin foil of gold can be easily made. It is difficult to make such foils from other metals

**Question 1:**

Name the three sub-atomic particles of an atom.

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/YnEhji2$yCy428kvmBu65g!!#optionContent1)

The three sub-atomic particles of an atom are:

**(i)** Protons

**(ii)** Electrons, and

**(iii)** Neutrons

**Question 2:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/fDm8zsubQ@hEXykxraep5g!!#optionContent1)

Helium atom has two neutrons. The mass of an atom is the sum of the masses of protons and neutrons present in its nucleus. Since helium atom has two protons, mass contributed by the two protons is (2 × 1) u = 2 u. Then, the remaining mass (4 − 2) u = 2 u is contributed by http://cbse.meritnation.com/img/curr/1/9/8/116/779/Chapter%204_html_m2572d944.gifneutrons.

**Question 1:**

Write the distribution of electrons in carbon and sodium atoms?

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/Gw3j99LW2z4@UfPl8ZiWhQ!!#optionContent1)

The total number of electrons in a carbon atom is 6. The distribution of electrons in carbon atom is given by:

First orbit or K-shell = 2 electrons

Second orbit or L-shell = 4 electrons

Or, we can write the distribution of electrons in a carbon atom as 2, 4.

The total number of electrons in a sodium atom is 11. The distribution of electrons in sodium atom is given by:

First orbit or K-shell = 2 electrons

Second orbit or L-shell = 8 electrons

Third orbit or M-shell = 1 electron

Or, we can write distribution of electrons in a sodium atom as 2, 8, 1.

**Question 2:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/8Oxptqww3u1Bk17CHIikgQ!!#optionContent1)

The maximum number of electrons that can occupy K and L-shells of an atom are 2 and 8 respectively. Therefore, if K and L-shells of an atom are full, then the total number of electrons in the atom would be (2 + 8) = 10 electrons.

**Question 1:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/ptbhU5rIhhk2Z9ABq7Jikg!!#optionContent1)

If the number of electrons in the outermost shell of the atom of an element is less than or equal to 4, then the valency of the element is equal to the number of electrons in the outermost shell. On the other hand, if the number of electrons in the outermost shell of the atom of an element is greater than 4, then the valency of that element is determined by subtracting the number of electrons in the outermost shell from 8.

The distribution of electrons in chlorine, sulphur, and magnesium atoms are 2, 8, 7; 2, 8, 6 and 2, 8, 2 respectively.

Therefore, the number of electrons in the outer most shell of chlorine, sulphur, and magnesium atoms are 7, 6, and 2 respectively.

Thus, the valency of chlorine = 8 −7 = 1

The valency of sulphur = 8 − 6 = 2

The valency of magnesium = 2

**Question 1:**

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?

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/ktIF9MsgkhVzEWBi2@gvvQ!!#optionContent1)

(i) The atomic number is equal to the number of protons. Therefore, the atomic number of the atom is 8.

(ii) Since the number of both electrons and protons is equal, therefore, the charge on the atom is 0.

**Question 2:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/v2EPmVl55$R@wdVvbE6PDw!!#optionContent1)

Mass number of oxygen = Number of protons + Number of neutrons

= 8 + 8

= 16

Mass number of sulphur = Number of protons + Number of neutrons

= 16 +16

= 32

**Question 1:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/uRebg2o5x0CYroE2rUaMLQ!!#optionContent1)

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Proton** | **Neutron** | **Electron** |
| H | 1 | 0 | 1 |
| D | 1 | 1 | 1 |
| T | 1 | 2 | 1 |

**Question 2:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/$M9dXjAZRXqC1Vs0uH0Xmg!!#optionContent1)

Two isotopes of carbon are http://cbse.meritnation.com/img/curr/1/9/8/116/825/Chapter%204_html_308c5d93.gifandhttp://cbse.meritnation.com/img/curr/1/9/8/116/825/Chapter%204_html_10871d78.gif.

The electronic configuration of http://cbse.meritnation.com/img/curr/1/9/8/116/825/Chapter%204_html_308c5d93.gifis 2, 4.

The electronic configuration of http://cbse.meritnation.com/img/curr/1/9/8/116/825/Chapter%204_html_10871d78.gifis 2, 4.

[Isotopes have the same electronic configuration]

http://cbse.meritnation.com/img/curr/1/9/8/116/825/Chapter%204_html_m4bc69034.gifand http://cbse.meritnation.com/img/curr/1/9/8/116/825/Chapter%204_html_m2de3180e.gifare a pair of isobars

The electronic configuration of http://cbse.meritnation.com/img/curr/1/9/8/116/825/Chapter%204_html_m4bc69034.gifis 2, 8, 8, 2.

The electronic configuration of http://cbse.meritnation.com/img/curr/1/9/8/116/825/Chapter%204_html_m2de3180e.gifis 2, 8, 8.

**Question 1:**

Compare the properties of electrons, protons and neutrons.

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/Zto5fU3GfyAzoAOHrJgC5w!!#optionContent1)

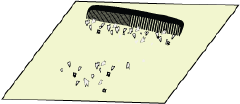
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Electron** | | **Proton** | | **Neutron** | |
| (i) | Electrons are present outside the nucleus of an atom. | (i) | Protons are present in the nucleus of an atom. | (i) | Neutrons are present in the nucleus of an atom. |
| (ii) | Electrons 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. |

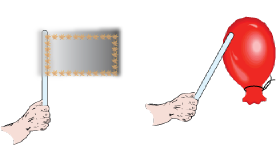
**Thomson&apos;s Model of the Atom**

Atoms and molecules are the fundamental building blocks of matter. The presence of matter around us in different forms is a result of the difference in atoms constituting them. Till the 19th century, Dalton’s atomic theory captured the minds of people. His theory stated that atoms are indivisible, but soon it was observed that atoms are not indivisible.

Let us find out about some indications of the presence of charged particles in matter through the following activities.

**1.** A paper is taken and is cut into very small pieces. The pieces are scattered on a piece of cloth. Then, a comb, after being used on dry hair, is brought near the small pieces of paper. It is observed that the comb attracts the pieces of paper towards itself.

**2.** A glass rod is rubbed with silk cloth for some time, and brought near an inflated balloon. It is observed that the balloon sticks to the glass rod.

From the above activities, it can be concluded that when two things are rubbed together, they become electrically charged, and attract other objects towards themselves. **If an atom is indivisible then what is responsible for this charge?**

Many scientists have performed various experiments to verify the presence of charged particles in atoms. J.J. Thomson identified electrons (negatively charged particles), while E. Goldstein discovered protons (positively charged particles) present in atoms.

As an atom is always neutral, the number of electrons is equal to the number of protons present in an atom. The next challenge for the scientists was to suggest a model for the atoms i.e. an arrangement of the subatomic particles in the atom.

Sir J. J Thomson, credited for the discovery of electrons, proposed the first model for atoms. His proposal stated that the model of an atom is similar to the model of a plum pudding or watermelon.

Thomson’s model can be explained with the help of a watermelon. He said that the positive charge in the atom is spread all over like the red edible part of the watermelon. Also, the electrons are embedded in the positively charged sphere like the seeds in the watermelon (as shown in the given figure).

|  |
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**Figure: Explanation of Thomson’s model.**

Hence, according to Thomson’s atomic model:

1. **An atom consists of a positively charged sphere with electrons embedded in it.**
2. **The negative and positive charges present inside an atom are equal in magnitude. Therefore, an atom as a whole is electrically neutral.**

Thomson’s model of the atom is also known as the **plum pudding model**.

|  |
| --- |
| http://cbse.meritnation.com/img/lp/1/9/8/116/323/769/94/LP-12-6-2008_Vidushi_Science_9.2.4.1.1_GSX_html_m20f44ccc.png |

**Figure: Thomson’s model of the atom**.

**Do You Know:**

**Joseph John Thomson was credited for the discovery of electrons. In 1906, he was awarded a Nobel Prize in Physics.**

**Question 2:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/science/oXbkjZiIl1lzD35075fd9A!!#optionContent1)

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.

**Question 3:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/zfTtMpMI7@hSEIvE$HUpWg!!#optionContent1)

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**](http://cbse.meritnation.com/study-online/solution/Science/xjK2IwMfJ7hOuo4N9dzIBg!!#optionContent1)

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**](http://cbse.meritnation.com/study-online/solution/Science/jUj3mY0bR6gK2ahzUda6UQ!!#optionContent1)

|  |  |  |
| --- | --- | --- |
| **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 centre 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. |

**Question 6:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/rmq1SVqwjN3mvQRQFE6WvA!!#optionContent1)

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 ‘2*n*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 2*n*2 = 2×12 = 2

Similarly, for second orbit, it is 2*n*2 = 2×22 = 8

For third orbit, it is 2*n*2 = 2×32 = 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.

**Question 7:**

Define valency by taking examples of silicon and oxygen.

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/pgqIdLcmFopb42oA87RviA!!#optionContent1)

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**](http://cbse.meritnation.com/study-online/solution/Science/l3knOBXIDxt00la@1CM4mg!!#optionContent1)

(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 protiumhttp://cbse.meritnation.com/img/curr/1/9/8/116/848/Chapter%204_html_7d7dca9d.gif, deuterium,http://cbse.meritnation.com/img/curr/1/9/8/116/848/Chapter%204_html_m46e61f86.gifand tritiumhttp://cbse.meritnation.com/img/curr/1/9/8/116/848/Chapter%204_html_m7291f34b.gif.

(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, http://cbse.meritnation.com/img/curr/1/9/8/116/848/Chapter%204_html_ma90a855.gifandhttp://cbse.meritnation.com/img/curr/1/9/8/116/848/Chapter%204_html_78549fb9.gifare 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.

http://cbse.meritnation.com/img/loader1.gif**Atomic Number and Mass Number**

The symbolic notation of an atom of oxygen is represented as http://cbse.meritnation.com/img/lp/1/9/8/116/324/772/97/LP-12-6-2008_vidushi_Science_9.2.4.2.1_GSX_SG_html_261a0c49.gif, where ‘**O**’ represents the chemical symbol of oxygen atom. **Do you know what the numbers 16 and 8 represent?**

The number 8 represents the atomic number of oxygen, while the number 16 represents the mass number or atomic mass of oxygen. **But what is Atomic Number and Mass Number?**

**The total number of protons present inside the nucleus of an atom is known as the atomic number of the atom.** It is denoted by **‘Z’**.All atoms of an element have the same atomic number. Thus, the atomic number is unique for every atom.

The number of protons present in hydrogen, carbon, and sodium are 1, 6, and 11 respectively. Hence, the atomic number of hydrogen, carbon, and sodium is 1, 6, and 11 respectively.

**MASS NUMBER:**

The mass of an atom is equal to the number of protons and neutrons present in that atom, because the mass of electrons is very less and is considered negligible when compared to the mass of protons and neutrons. Protons and neutrons are present inside the nucleus of an atom. Hence, protons and neutrons are also called **nucleons**. Thus, the mass of an atom resides in its nucleus.

**The mass number is defined as the sum of the total number of protons and neutrons present inside the nucleus of an atom.** Themassnumber is usually denoted by ‘**A**’. The unit used to represent the mass number is unified atomic mass unit i.e. ‘u’.

**Do You Know:**

The mass of proton is 1.672 × 10−27 kg, and that of electron is 9.11 × 10−31 kg. The mass of an electron is approximately 1/2000 of the mass of a proton. Hence, it is considered to be negligible when compared to a proton. The mass of a neutron is 1.6749 × 10−27 kg, which is slightly more than that of a proton**.**

We know that oxygen contains 8 protons and 8 neutrons. Hence, its mass number will be 16 u. Similarly, the mass number of carbon is 12 u (6 protons + 6 neutrons).

The general representation or symbolic notation to represent an atom with its atomic number and mass number is shown below.

http://cbse.meritnation.com/img/lp/1/9/8/116/324/772/97/LP-12-6-2008_vidushi_Science_9.2.4.2.1_GSX_SG_html_m344b5364.gif

Here, **‘E’** is the symbol of the element, ‘**Z’** is the atomic number, and ‘**A’** is the mass number.

**Relation between the Atomic Mass and Mass Number of an Atom:**

Mass number **(A)** of an atom = Number of protons + Number of neutrons

Therefore, Mass number **(A)** = Atomic number **(Z)** + Number of neutrons

Therefore, Number of neutrons = **A - Z**

Hence, the number of neutrons can be calculated if the atomic number and mass number of an element are known.

An atom of sodium contains 11 protons and 12 neutrons. **Can you calculate the mass number of sodium atom?**

Now, mass number **(A)** = number of protons + number of neutrons

Therefore, mass number of sodium atom = 11 + 12

= 23

Hence, the mass number of sodium is 23 u.

An atom of carbon is represented ashttp://cbse.meritnation.com/img/lp/1/9/8/116/324/772/97/LP-12-6-2008_vidushi_Science_9.2.4.2.1_GSX_SG_html_me921f33.gif. **Can you tell the number of neutrons and protons present in carbon atom?**

It is seen from the symbolic notation of carbon that the atomic number and mass number of carbon atom is 6 and 12 respectively.

Now, number of neutrons = mass number − atomic number.

Hence, number of neutrons = 12 − 6

= 6

Since the number of protons is equal to the atomic number of that element.

Thus, the number of protons present in a carbon atom is 6.

Can you calculate the mass number, atomic number, and number of neutrons of the elements given in the table? Also, try to give their symbolic notations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Atomic number**  **(Z)** | **Number of neutrons** | **Mass number (A)** | **Notation** |
| Hydrogen | 1 | **?** | 1 | **?** |
| Nitrogen | 7 | 7 | **?** | **?** |
| Chlorine | **?** | 18 | 35 | **?** |
| Helium | **?** | **?** | **?** | http://cbse.meritnation.com/img/lp/1/9/8/116/324/772/97/LP-12-6-2008_vidushi_Science_9.2.4.2.1_GSX_SG_html_m64726e33.gif |
| Aluminium | **?** | **?** | **?** | http://cbse.meritnation.com/img/lp/1/9/8/116/324/772/97/LP-12-6-2008_vidushi_Science_9.2.4.2.1_GSX_SG_html_m4c474e91.gif |

**Question 9:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/BBapX2yrJvmGPzVAHJvT5Q!!#optionContent1)

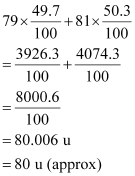
An atom of Na has a total of 11 electrons. Its electronic configuration is 2, 8, 1. But, Na+ ion has one electron less than Na atom i.e., it has 10 electrons. Therefore, 2 electrons go to K-shell and 8 electrons go to L-shell, thereby completely filling K and L shells.

**Question 10:**

If bromine atom is available in the form of, say, two isotopes (49.7%) and (50.3%), calculate the average atomic mass of bromine atom.

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/Tj5cbWgoxE7TV2rSxzqMtA!!#optionContent1)

It is given that two isotopes of bromine are (49.7%) and (50.3%). Then, the average atomic mass of bromine atom is given by:



**Question 11:**

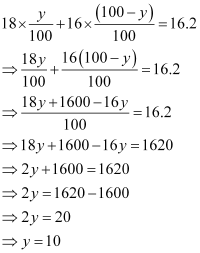
The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes http://cbse.meritnation.com/img/curr/1/9/8/116/856/Chapter%204_html_37e89c1a.gifand http://cbse.meritnation.com/img/curr/1/9/8/116/856/Chapter%204_html_m3f3f4d06.gifin the sample?

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/oULMsURM4LAtl9DQAdh8Dw!!#optionContent1)

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

Let the percentage of isotope http://cbse.meritnation.com/img/curr/1/9/8/116/856/Chapter%204_html_m3f3f4d06.gifbe *y*%. Thus, the percentage of isotope http://cbse.meritnation.com/img/curr/1/9/8/116/856/Chapter%204_html_37e89c1a.gifwill be (100 − *y*) %.

Therefore,



Therefore, the percentage of isotopehttp://cbse.meritnation.com/img/curr/1/9/8/116/856/Chapter%204_html_m3f3f4d06.gifis 10%.

And, the percentage of isotopehttp://cbse.meritnation.com/img/curr/1/9/8/116/856/Chapter%204_html_37e89c1a.gifis (100 − 10) % = 90%.

**Isotopes**

Unlike the mass number, the atomic number is unique for an element. In nature, a number of atoms of some elements have been identified having the same atomic number, but different mass numbers. Such atoms are known as **isotopes**.

**Isotopes are defined as atoms having the same atomic number, but different mass numbers.** These atoms contain an equal number of protons and electrons, but a different number of neutrons.

For example, in nature, hydrogen is found in three forms with different mass numbers, namely protium (http://cbse.meritnation.com/img/lp/1/9/8/116/324/773/98/LP-12-6-2008_Vidushi_science_9.2.4.2.2_GSX_SG_html_62acedc4.gif), deuterium(http://cbse.meritnation.com/img/lp/1/9/8/116/324/773/98/LP-12-6-2008_Vidushi_science_9.2.4.2.2_GSX_SG_html_293e012.gif), and tritium (**http://cbse.meritnation.com/img/lp/1/9/8/116/324/773/98/LP-12-6-2008_Vidushi_science_9.2.4.2.2_GSX_SG_html_m318f11da.gif**). These are the three naturally occurring isotopesof hydrogen. The atomic number of each isotope is 1, but the mass number varies i.e. it is 1, 2, and 3 respectively. Some other examples of isotopes include C- 12 and C-14, which are isotopes of carbon, and Cl-35 and Cl-37, which are isotopes of chlorine.

**Applications**

In nature, an element is found as a mixture of its isotopes. The chemical properties of all isotopes of an element are the same, but physical properties are different. Therefore, the isotopes of some elements have specific properties that make them very useful.

For example, an isotope of uranium exhibits nuclear fission properties. It is used in nuclear reactions as a fuel. An isotope of cobalt is used to treat cancer, and an isotope of iodine is used to treat goitre.

**Isobars**

Isobars are atoms of different elements having the same mass number**.** These elements have an equal number of nucleons, but different number of protons, neutrons, and electrons.

http://cbse.meritnation.com/img/lp/1/9/8/116/324/773/98/LP-12-6-2008_Vidushi_science_9.2.4.2.2_GSX_SG_html_m4a56e7c6.gifare the examples of isobars. Both carbon and nitrogen have the same mass number i.e. 13, but different atomic numbers i.e. 6 and 7 respectively. Some examples of isobars arehttp://cbse.meritnation.com/img/lp/1/9/8/116/324/773/98/LP-12-6-2008_Vidushi_science_9.2.4.2.2_GSX_SG_html_m6f70e40a.gif

**Question 12:**

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/NNaREnHUgc9TVkgOSr611A!!#optionContent1)

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**](http://cbse.meritnation.com/study-online/solution/Science/l1uz7RYP2PrAlWa3qC8rBw!!#optionContent1)

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 http://cbse.meritnation.com/img/curr/1/9/8/116/866/Chapter%204_html_m4f0cd016.giftimes that of proton.

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

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/9Z229L3pyaTv2I$YrlBvBg!!#optionContent1)

(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 http://cbse.meritnation.com/img/curr/1/9/8/116/866/Chapter%204_html_m4f0cd016.giftimes 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 (http://cbse.meritnation.com/img/curr/1/9/8/116/868/Chapter%204_html_66e75ec7.jpg) against correct choice and cross (http://cbse.meritnation.com/img/curr/1/9/8/116/868/Chapter%204_html_m325dbcda.jpg) 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**](http://cbse.meritnation.com/study-online/solution/Science/OOnNiqFzR@nS1YclZYm1ig!!#optionContent1)

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

|  |  |  |  |
| --- | --- | --- | --- |
| (a) Atomic nucleus | http://cbse.meritnation.com/img/curr/1/9/8/116/868/Chapter%204_html_66e75ec7.jpg | (b) Electron | http://cbse.meritnation.com/img/curr/1/9/8/116/868/Chapter%204_html_m325dbcda.jpg |
| (c) Proton | http://cbse.meritnation.com/img/curr/1/9/8/116/868/Chapter%204_html_m325dbcda.jpg | (d) Neutron | http://cbse.meritnation.com/img/curr/1/9/8/116/868/Chapter%204_html_m325dbcda.jpg |

**Question 16:**

Put tick (http://cbse.meritnation.com/img/curr/1/9/8/116/883/Chapter%204_html_66e75ec7.jpg) against correct choice and cross (http://cbse.meritnation.com/img/curr/1/9/8/116/883/Chapter%204_html_m325dbcda.jpg) 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**](http://cbse.meritnation.com/study-online/solution/Science/oHoJlxj8awlBaAxkh9dzEQ!!#optionContent1)

Isotopes of an element have

|  |  |
| --- | --- |
| (a) the same physical properties | http://cbse.meritnation.com/img/curr/1/9/8/116/883/Chapter%204_html_m325dbcda.jpg |
| (b) different chemical properties | http://cbse.meritnation.com/img/curr/1/9/8/116/883/Chapter%204_html_m325dbcda.jpg |
| (c) different number of neutrons | http://cbse.meritnation.com/img/curr/1/9/8/116/883/Chapter%204_html_66e75ec7.jpg |
| (d) different atomic numbers | http://cbse.meritnation.com/img/curr/1/9/8/116/883/Chapter%204_html_m325dbcda.jpg |

**Question 17:**

Put tick (http://cbse.meritnation.com/img/curr/1/9/8/116/884/Chapter%204_html_66e75ec7.jpg) against correct choice and cross (http://cbse.meritnation.com/img/curr/1/9/8/116/884/Chapter%204_html_m325dbcda.jpg) against wrong choice in the following question:

Number of valence electrons in Cl− ion are:

(a) 16

(b) 8

(c) 17

(d) 18

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/9OE3sC6aJGZlzOi1A$CyKA!!#optionContent1)

Number of valence electrons in Cl− ion are:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| (a) 16 | http://cbse.meritnation.com/img/curr/1/9/8/116/884/Chapter%204_html_m325dbcda.jpg | (b) 8 | http://cbse.meritnation.com/img/curr/1/9/8/116/884/Chapter%204_html_66e75ec7.jpg | (c) 17 | http://cbse.meritnation.com/img/curr/1/9/8/116/884/Chapter%204_html_m325dbcda.jpg | (d) 18 | http://cbse.meritnation.com/img/curr/1/9/8/116/884/Chapter%204_html_m325dbcda.jpg |

**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**](http://cbse.meritnation.com/study-online/solution/Science/tdqC1N1$@wL$UUrCsyHmXg!!#optionContent1)

(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 | 1 | − |

* [**Answer**](http://cbse.meritnation.com/study-online/solution/Science/vZn9duXc9EVh8ezrss4lvg!!#optionContent1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 | 1 | **Protium** |