#419532

The unit of length convenient on the nuclear scale is a fermi : 1 f = 10^{-15} m. Nuclear sizes obey roughly the following empirical relation :

$$r = r_0 A^{1/3}$$

where, r is the radius of the nucleus, A its mass number, and r_o is a constant equal to about 1.2 f. Show that the rule implies that nuclear mass density is nearly constant for different nuclei. Estimate the mass density of sodium nucleus.

Solution

Radius of nucleus r is given by the relation,

$r = r_0 A^{1/3}$

$r_0 = 1.2f = 1.2 \times 10^{-15} m$

Volume of nucleus, $V = (4/3)\pi r^3 = (4/3)\pi(r_0 A^{1/3})^3 = (4/3)\pi r_0^3 A$ ..... (i)

Now, the mass of a nuclei M is equal to its mass number i.e., $M = A$ amu $= A \times 1.66 \times 10^{-27}$kg.

Density of nucleus $\rho = \dfrac{\text{Mass of nucleus}}{\text{Volume of nucleus}} = \dfrac{A \times 1.66 \times 10^{-27}}{(4/3)\pi r_0^3 A}$

Density of nucleus $= \dfrac{3 \times 1.66 \times 10^{-27}}{4\pi r_0^3 Kgm^{-3}}$

This relation shows that nuclear mass depends only on constant r_0. Hence, the nuclear mass densities of all nuclei are nearly the same.

Density of sodium nucleus is given by,

$\rho_{Sodium} = \dfrac{3 \times 1.66 \times 10^{-27}}{4 \times 3.14 \times (1.2 \times 10^{-15})^3}$

Density of sodium nucleus $= \dfrac{4.98 \times 10^{18}}{21.71}$

Density of sodium nucleus $= 2.29 \times 10^{17} Kgm^{-3}$

#421594

Choose the correct alternative from the clues given at the end of the each statement:

(a) The size of the atom in Thomsons model is .... the atomic size in Rutherfords model. (much greater than/no different from/much less than.)

(b) In the ground state of .... electrons are in stable equilibrium, while in .... electrons always experience a net force. (Thomsons model/ Rutherfords model.)

(c) A classical atom based on .... is doomed to collapse. (Thomsons model/ Rutherfords model.)

(d) An atom has a nearly continuous mass distribution in a .... but has a highly non-uniform mass distribution in .... (Thomsons model/ Rutherfords model.)

(e) The positively charged part of the atom possesses most of the mass in .... (Rutherfords model / both the models.)

Solution

(a) No different from

(b) Thomsons model; Rutherfords model

(c) Rutherfords model

(d) Thomsons model; Rutherfords model

(e) Both the models

The size of the atom in Thomsons model is no different from the atomic size in Rutherfords model.

#421611

Suppose you are given a chance to repeat the alpha-particle scattering experiment using a thin sheet of solid hydrogen in place of the gold foil. (Hydrogen is a solid at temperatures below 14 K.) What results do you expect?

Solution

In the alpha-particle scattering experiment, if a thin sheet of solid hydrogen is used in place of a gold foil, then the scattering angle would not be large enough. This is because the mass of hydrogen (1.67×10^{-27}) is less than the mass of incident α–particles (6.64×10^{-27}). Thus, the mass of the scattering particle is more than the target nucleus (hydrogen). As a result, the α–particles would not bounce back if solid hydrogen is used in the α–particle scattering experiment.

#421661

Answer the following questions, which help you understand the difference between Thomson's model and Rutherford's model better.

(a) Is the average angle of deflection of α-particles by a thin gold foil predicted by Thomson's model much less, about the same, or much greater than that predicted by Rutherford's model?

(b) Is the probability of backward scattering (i.e., scattering of α-particles at angles greater than 90°) predicted by Thomsons model much less, about the same, or much greater than that predicted by Rutherfords model?

(c) Keeping other factors fixed, it is found experimentally that for small thickness t, the number of α-particles scattered at moderate angles is proportional to t. What clue does this linear dependence on t provide?

(d) In which model is it completely wrong to ignore multiple scattering for the calculation of average angle of scattering of α-particles by a thin foil?

Solution

(a) The average angle of deflection of -particles by a thin gold foil predicted by Thomsons model is about the same than that predicted by Rutherfords mode

(b) The probability of backward scattering (i.e., scattering of -particles at angles greater than 90) predicted by Thomsons model much less than that predicted by Rutherfords model.

(c) Scattering is mainly due to single collisions. The chances of a single collision increases linearly with the number of target atoms. Since, the number of target atoms increase with an increase in thickness, the collision probability depends linearly on the thickness of the target.

(d) Thomson's model.
It is wrong to ignore multiple scattering in Thomson's model for the calculation of average angle of scattering of α−particles by a thin foil. This is because a single collision causes very little deflection in this model. Hence, the observed average scattering angle can be explained only by considering multiple scattering.

#422641

Write the complete symbol for the atom with the given atomic number (Z) and atomic mass (A).

(i) Z = 17 , A = 35

(ii) Z = 92 , A = 233

(iii) Z = 4 , A = 9

Solution

(i) The atom with atomic number 17 and mass number 35 is chlorine. Its complete symbol is $^{35}_{17}Cl$.

(ii) The atom with atomic number 92 and mass number 233 is uranium. Its complete symbol is $^{233}_{92}U$.

(iii) The atom with atomic number 4 and mass number 9 is beryllium. Its complete symbol is $^{9}_{4}Be$.

#422779

In Rutherford's experiment, generally the thin foil of heavy atoms like gold, platinum etc. have been used to be bombarded by the α-particles. If the thin foil of light atoms like aluminium etc. is used, what difference would be observed from the above results?

Solution

Heavy nuclei have large positive charges and light nuclei have small positive charges. The repulsion between alpha particles and heavy nuclei is much larger than the repulsion between alpha particles and small nuclei.

More number of alpha-particles will pass as the nucleus of the lighter atoms is small, smaller number of alpha-particles will be deflected as a number of positive charges is less than on the lighter nuclei.

#422782

Symbols $^{79}_{35}Br$ and ^{79}Br can be written, whereas symbols $^{35}_{79}Br$ and ^{35}Br are not acceptable. Answer briefly:

Solution

For a given element, the number of protons is the same for the isotopes, whereas the mass number can be different for the given atomic number.

Hence, the mass number should be written necessarily.

#464502

Compare the properties of electrons, protons and neutrons.

Solution

Protons	Electrons	Neutrons
They are positively charged particles.	They are negatively charged particles.	They are neutral particles.
Charge on protons is +1. Mass of protons is $1.6727 \times 10^{-27} kg$.	Charge on electrons is -1. Mass of electrons is $9.1 \times 10^{-31}\ kg$	They have no charge. Mass of neutrons is $1.675 \times 10^{-27}\ kg$
Protons are present inside the nucleus.	Electrons are present outside the nucleus. They revolve around the nucleus.	Neutrons are present inside the nucleus.

#464503

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

Solution

According to this model, the atom consists of positively charged sphere and the electrons embedded in it. The charges are equal in magnitude but opposite in sign so the atom is neutral.

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

1. It could not explain the alpha scattering experiment done by Rutherford.
2. There was no experimental evidence of the model proposed by J.J Thomson.

#464504

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

Solution

Although Rutherford's atomic model was based on experimental observations it failed to explain certain things. Rutherford proposed that the electrons revolve around the nucleus in fixed paths called orbits. According to Maxwell, accelerated charged particles emit electromagnetic radiations and hence an electron revolving around the nucleus should emit electromagnetic radiation. This radiation would carry energy from the motion of the electron which would come at the cost of shrinking of orbits. Ultimately the electrons would collapse in the nucleus. Calculations have shown that as per Rutherford's model an electron would collapse in the nucleus in less than 10^{-8} seconds. So Rutherford's model was not in accordance with Maxwell's theory and could not explain the stability of an atom. One of the drawbacks of Rutherford's model was also that he did not say anything about the arrangement of electrons in an atom which made his theory incomplete.

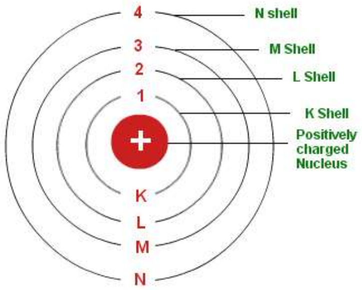
#464505

Describe Bohr's model of the atom.

Solution

The postulates given by Neils Bohr are:

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



#464506

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

Solution

Thompson Model	Rutherford Model	Bohr Model
In this model, an atom consists of positively charged sphere and the electrons embedded in it. The number of electrons is equal to the number of protons so the atom is electrically neutral.	In this model, there is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus. The electrons revolve around the nucleus in circular paths. The size of the nucleus is very small as compared to the size of the atom.	In this model, only certain special orbits known as discrete orbit of electrons, are allowed inside the atom. While revolving the electrons do not radiate energy. These orbits are called energy levels or shells.

#464507

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

Solution

The distribution of elements in different orbits is governed by a scheme called Bohr-Bury scheme. There are following rules.

(i) The maximum number of electrons present in any shell is given by the formula in 1, where n is no.of orbit.

(ii) The maximum no.of electrons that can be accommodated in the outer most shell is 8.

(iii) Electrons in an atom do not occupy a new shell unless all the inner shells are completely filled.

#464508

Define valency by taking examples of silicon and oxygen.

Solution

Valency is defined as the combining capacity of the element. It is determined by the number of valence shell electrons present in the atom. If the number of valence electrons is less than or equal to 4 so the valency is same as the number of electrons present. If the number of valence electrons are more than 4 then the valency is 8-(the number of valence shell electrons).

Silicon has atomic number 14. The electronic configuration of silicon is 2, 8, 4. The number of valence electrons is 4. So the valency is 4.

Oxygen has atomic number 8. The electronic configuration is 2, 6. The valency is (8-6)=2.

#464509

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

Solution

(i) Atomic number: The atomic number is the total number of protons present in the atom. For example, the atomic number of sodium is 11. It contains 11 protons and 11 electrons.

(ii) Mass number: It is the sum of the number of neutrons and the number of protons. For example, the atomic number of magnesium is 12 which is equal to the number of protons, the number of neutrons of magnesium is 12. The mass number is equal to 24 (12+12).

(iii) Isotopes are the elements having same atomic number but different mass number. They have same chemical properties as the number of valence electrons are same. For example, ${}_6C^{12},\ {}_6C^{13},\ {}_6C^{14}$ are the three isotopes of carbon. They have same atomic number but different mass number due to difference in the number of neutrons.

(iv) Isobars: They are elements having the same mass number but different atomic number. For example. ${}_{18}Ar^{40},\ {}_{19}K^{40}$ are isobars having the same atomic mass but different atomic number.

The two uses of isotopes are:

1. Nuclear weapons and nuclear power require large quantities of isotopes of uranium.
2. An isotope of cobalt is used in the treatment of cancer.

#464510

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

Solution

Electronic configuration of Na is 2, 8, 1. One electron is removed for the formation of Na^+. So the new configuration is 2, 8. So 1st(K) and 2nd(L) shells are completely filled.

#464513

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

Solution

By Z=3, we mean that the Atomic number (Z) of element is 3.

it's electronic configuration is 2,1.

Hence, the Valency of this element is 1.(since outermost shell has only one electron).

Therefore the element with Z=3 is Lithium.

#464514

Composition of the nuclei of two atomic species X and Y are given as under

	X	Y
Protons $=$	6	6
Neutrons$=$	6	8

Given the mass numbers of X and Y. What is the relation between the two species?

Solution

Atomic mass=number of protons+number of neutrons

Atomic mass of X = 6+6=12

Atomic mass of Y =6+8=14

Both X and Y have same atomic number but different atomic mass so they are isotopes.

#464515

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.

Solution

(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).

#464516

Put $(\checkmark)$ against correct choice and (x) against wrong choice

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

[✓ **A**] Atomic Nucleus

B Electron

C Proton

D Neutron

Solution

Rutherford's alpha-particle scattering experiment was responsible for the discovery of atomic nucleus. Nucleus contains most of the mass. Most of the atom has empty space.

#464517

Isotopes of an element have:

A the same physical properties

[✓ **B**] same chemical properties

[✓ **C**] different number of neutrons

D different atomic numbers

Solution

Isotopes: Any of two or more forms of a chemical element, having the same number of protons in the nucleus, or the same atomic number, but having different numbers of neutrons in the nucleus, or different atomic weights.

Isotopes show different physical properties but same chemical properties.

#464518

Number of valence electrons in Cl^- ion are:

A 16

[✓ B] 8

C 17

D 18

Solution

The electronic configuration of chlorine is 2, 8, 7 (Atomic number-17).

Cl^- is formed from adding one electron so the new electronic configuration is 2, 8, 8. So the valence electrons is 8.

#464519

Put tick against correct choice and cross (X) against wrong choice

Which one of the following is a correct electronic configuration of sodium?

A 2, 8

B 8, 2, 1

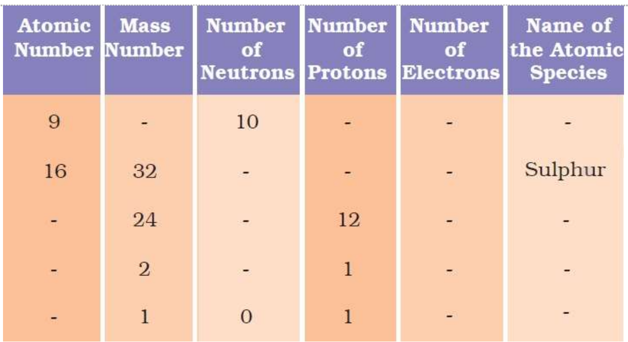
C 2, 1, 8

[✓ D] 2, 8, 1

Solution

Atomic number of sodium is 11. Electronic configuration of sodium is 2, 8, 1.

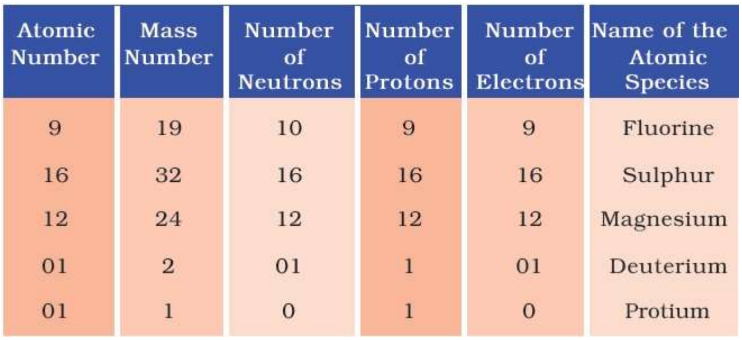
#464520



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	-	-

Complete the following table.

Solution



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
01	2	01	1	01	Deuterium
01	1	0	1	0	Protium