5. The Structure of an atom

Exercises

1 A. Question

Answer the following questions.

What is the difference between the models of the atom proposed by Thomson and by Rutherford?

Answer

Difference between the models of the atom proposed by Thomson and by Rutherford-

Thomson model	Rutherford model
1. Thomson proposed a theory.	Rutherford conducted an experiment.
2. He compared an atom to a	He bombarded a very thin layer of gold
watermelon.	with positively charged alpha rays (α-
	rays).
He shows that the electrons are	He shows that electrons are in motion.
stationary.	
4. The electrons are present within the	The electrons move around the nucleus.
positive sphere.	
5. Thomson model of atom does not	Rutherford model of an atom shows details
give any detail about the nucleus.	about the nucleus.
$\begin{array}{c} & & + \\ & + \\ & + \\ & + \\ & + \\ & - \\ & + \\ & + \\ & - \\ & + \\ & - \\ & + \\ & - \\ & + \\ & - \\ & + \\ & - \\ & + \\ & - \\ & + \\ & - \\ & + \\ & - \\ & + \\ & -$	nucleus (contains protons) empty space

1 B. Question

Answer the following questions.

What is the characteristic property of the element hydrogen?

Answer

The characteristic property of hydrogen:

Hydrogen has atomic number 1 and has 1 electron and 1 proton.



The element hydrogen has three isotopes and have different properties

First isotope is Protium which has 1 atomic mass.

Second isotope is Deuterium which has 2 atomic mass.

Third isotope is Tritium which has 3 atomic mass.



Note: Isotopes- In certain elements, some atoms have the same atomic number but different atomic mass number. Such atoms of an element are called isotopes of that element.

1 C. Question

Answer the following questions.

What is meant by valency?

Answer

Every element has some capacity to join or combine with other elements. The capacity of the element for joining or combining is called valency of that element.

i. The valency of the element is always a whole number.

ii. For example,

The atomic number of sodium = 11

The electronic configuration of $_{11}Na = 2,8,1$



The atomic number of potassium = 19

The electronic configuration of $_{19}K = 2,8,8,1$



Hence, sodium and potassium have a same valency (electrons in the outermost shell) of 1.

1 D. Question

Answer the following questions.

What is meant by atomic mass number?

Answer

Atomic mass number is the sum of number of protons (p) and neutrons (n) in the nucleus. It is represented by the symbol 'A'.

Atomic mass number = Number of protons + Number of neutrons

$\mathbf{A} = \mathbf{p} + \mathbf{n}$

By the above formula, we can easily calculate the atomic mass number of any element.

Example:-

i. A lithium atom contains 3 protons and 4 neutrons. Its atomic mass number is A = 3 + 4 = 7

ii. In a sodium atom, there are 11 protons and 12 neutrons. Thus, its atomic number is A = 11 + 12 = 23

iii. A magnesium atom contains 12 protons and 12 neutrons. Its atomic mass number is A = 12 + 12 = 24

iv. A hydrogen atom contains 1 proton and 0 neutron. Its atomic mass number is A = 1 + 0 = 1

1 E. Question

Answer the following questions.

Name the fundamental particles in an atom.

Answer

The fundamental particles in an atom are protons, neutrons and electrons.

i. Protons(p) = Proton is the positively charge fundamental particle and is resides in the nucleus. The positive charge of proton(p^+) is of the same magnitude as that of electron's negative charge(e^-).

ii. Neutron(n) = Neutron has no charge and is also resides in the nucleus. The mass of a neutron is almost equal to that of proton.

iii. Electron(e^{-}) = Electron is a negatively charge fundamental particle and it moves around the nucleus in particular orbits.



Representation of fundamental particles of an atom

2 A. Question

Give reasons.

In Rutherford's experiment, some alpha rays collide with the gold sheet and are turned back.

Answer

In Rutherford's experiment, some alpha rays collide with the gold sheet and are turned back because:

i. The atom might contain positively charged particles.

ii. The space occupied by the positive charge is very small in the atom.

iii. Hence, when alpha rays come closer to this point, they suffer a force of repulsion and deviate from their paths and turned back.

2 B. Question

Give reasons.

During ion formation, an electric charge develops on the elements.

Answer

Ion formation:

i. Electrons revolve around the nucleus in particular orbits.

ii. Among the orbits, the outermost orbits participate in chemical reaction.

iii. Sometimes the outermost shell is incomplete which causes the giving and taking of electrons.

iv. In a chemical reaction, metals give electrons whereas non-metals receive electrons.

v. For example: (for positive electric charge)

Lithium(Li) has 3 protons.

The electronic configuration of sodium is 2,1.

This means that lithium has 1 electron in outermost orbit which is incomplete. During a chemical reaction, lithium (a metal) gives away the outermost electron.

Now, the no. of protons (3) in the nucleus is greater than the remaining no. of electrons (2). Hence, Li atom will get positive electric charge.

 $Li \rightarrow Li^+ + e^-$

For example: (for negative electric charge)

Oxygen(O) has 16 protons.

The electronic configuration of sodium is 2,8,6.

This means that oxygen has 6 electrons in the outermost orbit which is incomplete. During a chemical reaction, oxygen (a non- metal) receives two electrons.

Now, the no. of protons (16) in the nucleus is less than the no. of electrons (18). Hence, oxygen atom will get negative electric charge.

 $0 + 2e^- \rightarrow 0^2$

2 C. Question

Give reasons.

Why does ionization take place?

Answer

Ionization takes place due to the following reasons:

i. The atoms or molecules ionize to stabilize themselves.

ii. They stabilize themselves by giving and taking of electrons.

iii. For example:

Al has 3 electrons in the outermost shell (2,8,3). To stabilize (complete the shell) itself, aluminum try to loose 3 electrons.

As a result, it achieves 2,8 configurations (complete outermost shell)

iv. Another example is:

Lithium has 1 electron in the outermost shell (2,1). To stabilize (complete the shell) itself, lithium tries to loose 1 electron. As a result, it achieves 2 configurations (complete outermost shell)



Li atom with 3 electrons

Li⁺ ion with only 2 electrons

v. If the outermost shell of an element is complete, the element will be highly stable.

2 D. Question

Give reasons.

All the mass of an atom is concentrated in the nucleus.

Answer

All the mass of an atom is concentrated in the nucleus:

i. In the Rutherford's model, since most of the alpha rays went straight and pass through the gold sheet.

ii. This means that there must be a very large empty space within the atom.

iii. The positively charged heavy mass which occupies only a small volume in an atom is called nucleus. It is supposed to be present at the center of the atom.

iv. Thus, most of the mass of the atom is concentrated in the nucleus.

3. Question

Fill in the blanks.

(a) If the valency of carbon is 4 and that of hydrogen is 1 then the molecular formula of methane is

(b) There are two electrons in the outermost orbit of the magnesium atom. Hence, the valency of magnesium is

(c) 35 Cl and are isotopes of chlorine.

(d) Isotopes of uranium are used as in atomic reactors.

Answer

(a) If the valency of carbon is 4 and that of hydrogen is 1 then the molecular formula of methane is CH_{h}

Explanation:

The valency of carbon is 4

The valency of hydrogen is 1

Thus, the molecular formula will be:

Symbol of element 4

Valency of element

Molecular formula: CH₄

(b) There are two electrons in the outermost orbit of the magnesium atom. Hence, the valency of magnesium is 2.

Explanation:

Valency is the combining capacity of the element.

We can calculate the valency of an element by counting the no. of electrons in the outermost shell.

As magnesium has two electrons in the outermost shell, thus

its valency is 2.

(c) $_{35}^{17}$ Cl and $_{37}^{17}$ Cl are isotopes of chlorine.

Explanation:

Chlorine has two isotopes (having same atomic number and different atomic mass number).

In $_{35}$ ¹⁷Cl, the atomic mass number of chlorine is 35.

In $_{37}^{17}$ Cl, the atomic mass number of chlorine is 37.



(d) Isotopes of uranium are used as fuel in atomic reactors.

Explanation:

Isotopes of uranium ($_{92}^{235}$ U, $_{92}^{238}$ U and $_{92}^{234}$ U) are used as fuels in atomic reactors due to their significant features in the nuclear reactors.

4. Question

Match the following.

`A'	'B'
(a) Isotopes of cobalt	1. Three
(b) Valency of nitrogen	2. Treatment of cancer
(c) Non-metal	3. Electrons in the outermost orbit
(d) Metal	4. Receives electrons
(e) Valency	5. Loses electrons

Answer

(a) Isotopes of cobalt - Treatment of cancer

Explanation:

Isotopes of cobalt are used in the treatment of thyroid cancer and some cancer which occurs rarely.

(b) Valency of nitrogen - Three

Explanation:

The atomic number of nitrogen = 7

The electronic configuration of $_7N=$ 2,5

The valency of nitrogen is 3 because it combines with other element and receives three electros to complete the outermost shell (8-5=3)

(c) Non – metal – Receives electrons

Explanation:

Non- metals tend to receive electrons to complete their outermost shell. Outermost shell is the only shell which participates in the chemical reaction.

(d) Metal – loses electrons

Explanation:

Metals tend to loose electrons to complete their outermost shell.

(e) Valency - Electrons in the outermost orbit

Explanation:

Valency is the number of electrons in the outermost shell.

For example, carbon has 4 electrons in the outermost shell. Thus, the valency of carbon is 4.

Activities

1. Question

Find out about the scientific works of Dr Homi Bhabha.

Answer

The scientific works of Dr. Homi Bhabha:

He did excessive research at Cambridge on atomic energy.

He discovered and prepared some scientific papers on "The Adsorption of cosmic radiation".

He was the one to perform the calculation of electron- positron scattering to find out the the cross section.

In honor of Dr. Bhabha, in quantum physics, the name of electron-positron scattering was changed to Bhabha scattering.

He also shows the verification of Albert Einstein's theory of relativity.

He explained that how the cosmic rays produce particles from outer space when they interact with upper atmosphere.

He predicted that a limitless power of industries would be found through nuclear fusion's control.

He promoted the nuclear energy control in India.

