4. Structure of the atom

Check Point 01

1. Question

When we rub two objects together they become electrically charged. Where did this electric charge come from?

Answer

(i) On rubbing two objects together they become electrically charged due to the fact that the frictional charging takes place between them.

(ii) The atoms are composed of many charged particles like electrons, neutrons, protons, etc. as identified by J.J Thompson.

(iii) The charges are already not present in the objects because, in the atoms the positively charged particles that are protons are equal in number to the negatively charged electrons which leads to the cancelation of their respective charges.

(iv) So any object is electrically neutral. The electrons are somewhat loosely packed than protons.

(v) On rubbing the two different objects there is transfer of the electrons between them due to which there is increase of electrons in one of the objects and decrease in the other which disturbs the equal charge in an atom which appears as the charge on the object.

2. Question

How cathode rays are different from anode rays?

Answer

Cathode Rays	Anode Rays
1. Emitted from the cathode.	1. Emitted from the anode.
2. Contain negatively charged particles.	2. Contains positively charged particles.
3. Attracted towards the anode.	3. Attracted towards the cathode.
4. Negatively charged particles are electrons.	4. Positively charged particles are H^+ ions.

3. Question

Name the discoveror of electrons, protons and neutrons.

Answer

Discovery of electrons was done by J.J Thompson.

Discovery of proton was done by Ernest Rutherford.

Discovery of neutron was done by James Chadwick.

4. Question

What conclusion would be drawn by Rutherford when he observed that most of the fast moving α-particles passed straight through the gold foil?

Answer

(i) Ernest Rutherford did an experiment to know the structure of the atom inside the atom.

(ii) He conducted a Gold Foil experiment, in which he attached very thin gold foil with fast moving atoms are known as the alpha(α) particles, with the mass of 4u.

(iii) These alpha particles are charged Helium ions with mass of 4u.

(iv) Rutherford concluded the observations from the experiment and gave his interpretation of the inside structure of atom.

(v) One of the observations made by Rutherford form the experiment was that, the majority of the fast moving α particles passed straight through the layer of foil.

(vi) The conclusion that Rutherford made from this was, inside the atom, there are lot of empty spaces present because the majority of alpha particles passed through the foil without any deflection from the foil.

5. Question

Nucleus of an atom is positively charged and electrons around it are negatively charged. Then why do electrons not just fall to the nucleus out of attraction?

Answer

(i) The nucleus of any atom composed of protons and neutrons is positively charged and the electrons revolve around it are negatively charged.

(ii) There is an attraction between the nucleus and electron which act as a centrifugal force for the electrons to keep revolving.

(iii) The electrons should fall into the nucleus due the attraction. But this will not happen because of the Bohr's theory.

(iv) According to the theory the electrons revolve around the nucleus in specified orbits, he called them as the discrete orbits.

(v) He also stated that the electrons while moving in these orbits do not radiate energy.

(vi) Due to which the electrons will keep on revolving in the discrete orbits because there is no loss of energy from the electrons until any external force is applied.

6. Question

What do you understand by the term 'discrete orbit'?

Answer

(i) Discrete orbit was the term given by Neils Bohr to specify the imaginary path of the electrons moving around the nucleus without losing energy.

(ii) For the atom to be stable it is important that it has the minimum energy and be electrically neutral.

(iii) For this the electron have to be constantly revolving around the nucleus without radiating or gaining any energy.

(iv) Neils Bohr gave the postulate that electron will only revolve in the paths or orbits in which it will not radiate any energy and hence the atom will be stable.

(v) So, the special orbits that are present inside the atom in which the electron revolves is given the term of 'discrete orbit'.

7. Question

Draw a sketch of Bohr's model of an atom with four shells.

Answer

The Bohr's model of atom consisted a positively charged nucleus in the center of the atom and electron revolving in the discrete orbits or shells which are concentric and have specific number of electrons in it.

The first shell or orbit nearest to the nucleus was numbered as 1 and named K similarly the rest of shells were named and numbered.

Like n = 1, 2, 3…… ; K, L, M, N,……..

Where n is the shell number.

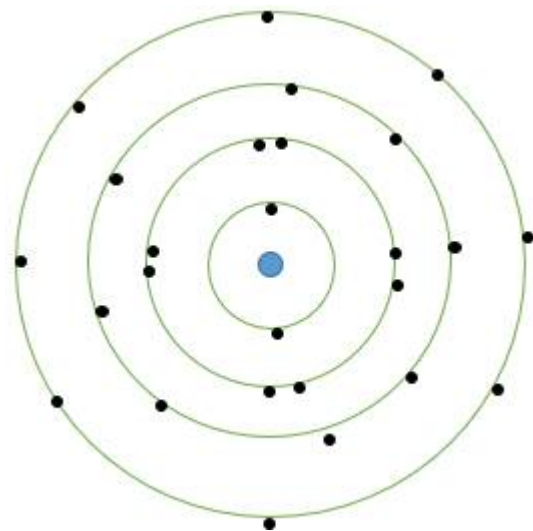For Bohr's model with 4 shells, the electrons no. are as follows:

First shell: 2 electrons

Second shell: 8 electrons

Third shell: 18 electrons

Fourth shell: 18 electrons

But maximum electrons in any shell can only be 8 due to octet rule.

Check Point 02

1. Question

What can be the maximum number of electrons in the outermost orbit?

Answer

(i) The number of electrons in any orbit can be determined by the general formula $2(n^2)$, where n = 1, 2, 3….. and so on. Here 'n' represents the number of shell like 1 for the first, 2 for the second and so on.

(ii) So to determine the maximum number of electron in any orbit we can use the formula $2(n^2)$.

(iii) For first orbit n = 1 maximum electron are $2(1^2)$ = 2 electrons.

(iv) Similarly if we take third or fourth shell n = 3 or 4, maximum electrons will be $2(3^2)$ = 18 and $2(4^2)$ = 32.

(v) For n = 4 the maximum electrons come out to be 32 and for n = 3 it is 18 but that is not possible as the repulsion forces between the electrons will be very large and the atom will become unstable.

(vi) So maximum number of electrons in any outermost orbit cannot be more than 8, because of the octet rule which states maximum 8 electrons can be present in any orbit for the atom to be stable.

2. Question

Find out the number of electrons present in the last shell of an atom having atomic number 15.

Answer

The atomic number of the atom = 15

Number of protons = 15

A number of electrons = 15 because the atom is neutral.

So representing the electrons by electronic configuration,

K = 2 electrons

L = 8 electrons

M = 5 electrons

The M shell has 5 electrons and it is the last shell of the atom, so the number of the electrons in the last shell of an atom with atomic number 15 is 5.

3. Question

In an atom first four shells (K, L, M, and N) are completely filled. Then what is the total number of electrons in that atom?

Answer

(i) If in an atom the first four shells are completely filled then the total number of the electrons in the atom would be 26.

(ii) This is because the first four shells of the atom are K, L, M and N. using the formula $2(n^2)$ we can find out the maximum electron in each shell which comes out to be

K = 2 electrons

L = 8 electrons

M and N = 18 electrons as

(iii) The maximum number of the electrons in outermost orbit cannot be more than 8.

(iv) So the total number of electrons for first four completely filled shells is 26.

4. Question

Why helium and neon do not take part in chemical reactions?

Answer

(i) Helium and Neon are both gases and belong to the group of elements called the noble gases.

(ii) Both the elements Helium and Neon have completely filled outermost shells and are fully stable in this state.

(iii) The atomic number of Helium is 2 which means it has only 2 electrons which are present in the K shell and Neon has atomic number 10 and has 10 electrons, its electronic configuration is K = 2, L = 8 electrons.

(iv) As we can see the outermost shells for both the atoms are completely filled so they are not required to share their electrons or share the electrons of other atoms to complete their outermost shell and become stable.

(v) As their last energy shells are full they are inert and does not take part in reactions.

5. Question

A non-metal has 6 electrons in its outermost shell. Predict its valency.

Answer

(i) Valency for any atom can be defined as the number of electrons required by the atom to complete its outermost shell and have a maximum number of valence electrons and become stable.

(ii) They can do this by sharing their electrons with other atoms or can share the electrons from other atoms of suitable valency.

(iii) A non-metal with 6 electrons in its outermost shell will have the valency of 2.

(iv) That is because it only needs 2 electrons to make its valence electrons 8 which is the maximum number of valence electrons in an atom. It can combine with any element with only 2 valence electrons and become stable.

Check Point 03

1. Question

What are the number of protons, neutrons, and electrons in $_8^{16}O$ and $_{18}^{40}Ar$? What are their atomic number and mass number?

Answer

Any element can be represented with its atomic number, symbol and its atomic mass using a simple representation. Any element 'X' having the atomic number 'A' and atomic mass 'M' can be represented as $_M^AX$.

For $_8^{16}O$:

No. of protons = 8

No. of electrons = 8

No. of neutrons = (16 – 8) = 8 (atomic mass minus the protons is neutrons)

Atomic no. = 8

Mass no. = 16

For $_{18}^{40}Ar$:

No. of protons = 18

No. of electrons = 18

No. of neutrons = (40 – 18) = 22

Atomic no. = 18

Mass no. = 40

2. Question

The atomic number of Al and Cl are 13 and 17 respectively. What will be the number of electrons in Al^{3+} and Cl^-?

Answer

The atomic numbers of aluminium Al and chlorine Cl are given as 13 and 17 respectively. In their present state the number of electrons in Al will be 13 and in Cl will be 17.

Number of electrons in Al^{3+} will be 10 because it has the valency of 3^+ which means it has lost 3 electrons to complete the outermost shell.

Similarly the number of electrons in Cl^- will be 18 because its valency is 1^- which shows that it has taken 1 electron in its valence shell to complete the orbit.

3. Question

Lithium atom has an atomic mass of 6u and three protons in its nucleus. How many neutrons does it have?

Answer

Atomic mass of Lithium (Li) = 6u

Number of protons in nucleus = 3

Number of neutrons = atomic mass – the protons

= 6 – 3 = 3

Lithium has 3 neutrons in the nucleus.

4. Question

An atom has an atomic mass of 7u. It has 2 electrons in K-shell and one electron in L-shell. How many neutrons does it have?

Answer

Atomic mass of atom = 7u

Electrons in K shell = 2

Electrons in L shell = 1

Total electrons = 2 + 1 = 3

Total protons = 3

The no. of electrons and proton and neutrons in any neutral atom are equal.

Total neutrons = atomic mass – protons

= 7 – 3 = 4

Atom has 4 neutrons.

5. Question

Why are atomic masses of most of the elements are fractional and not whole numbers?

Answer

(i) Atomic masses of most of the elements have a value that is not a whole number but is fractional, this is because of the occurrence of isotopes of that element in the nature.

(ii) Isotopes are those elements which have the same atomic number but have different mass.

(iii) There can be two or more isotope same element because they all have the same number of protons.

(iv) The atomic masses for any elements are taken as the average of masses of all of its commonly occurring or stable isotopes which comes out to be a fractional number in most cases.

(v) It is called the relative atomic mass. Example: there are two stable isotopes of chlorine (Cl) which are $_{17}^{35}Cl$ and $_{17}^{37}Cl$ the isotopes have atomic mass of approximately 35 and 37 respectively. The relative atomic mass is calculated by formula,

(vi) Relative atomic mass = (percent isotopic composition × atomic mass of isotope 1) + (percent isotopic composition × atomic mass of isotope 2) + …..so on.
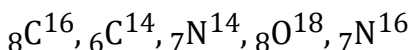
For chlorine relative atomic mass is =

(75/100)×35 + (25/100)×37 = 35.5u

Hence the atomic masses are fractional for most of the elements due to its isotopes.

6. Question

Identify the isotopic pair(s) out of the following species?

$_8C^{16}, _6C^{14}, _7N^{14}, _8O^{18}, _7N^{16}$

Answer

The isotopic pairs out of the following $_8C^{16}, _6C^{14}, _7N^{14}, _8O^{18}, _7N^{16}$ are:

$_8C^{16}$ and $_8O^{18}$ also $_7N^{14}$ and $_7N^{16}$. These are the only pairs in the given elements which are isotopic.

Isotopes have the same number of proton and different number of neutrons, in all the pairs the protons are the same but the atomic masses are different.

7. Question

(i) Name the isotope used as a fuel in nuclear reactors.

(ii) What is the number of sub-atomic particles in this isotope?

Answer

(i) Isotope used as a fuel in the fuel in the nuclear reactor is Uranium-235

(ii) Sub particles in Uranium-235 are :

Protons = 92

Neutrons = 143

Electrons = 92

Chapter Exercise

1. Question

Why are anode rays called so?

Answer

Anode rays are called so only because they are emitted from the anode which is the positively charged electrode and the rays contain the positively charged ions.

2. Question

Mention the charge present on the nucleus of an atom.

Answer

The nucleus of any atom has positive charge on it because it is composed of proton which are positively charged and neutral neutrons.

3. Question

How can an α-particle be represented?

Answer

Alpha particle is the isotope of Helium atom, it has a mass of 4u. It can be represented as $_2^4He$.

4. Question

Does the nucleus contain neutrons also?

Answer

Yes, the nucleus of an atom is made up of protons and neutrons. The numeric sum of the protons and neutrons determines the mass number.

5. Question

An element X has 5 electrons in its M-shell. What is its atomic number?

Answer

No. of electrons in the M shell of element X = 5. By electronic configuration before going to the M shell the shells K and L should be completely filled. Electrons that can be occupied by K and L shells are 2 and 8 respectively. So, the atomic number of the element X is 15 because 2 + 8 + 5 = 15.

6. Question

give the number of neutrons in an atom of element $_{47}^{107}Ag$.

Answer

Element, $_{47}^{107}Ag$

Number of protons are 47

Atomic mass is 147

So the neutrons are 107 – 47 = 60

7. Question

An element has mass number = 35 and atomic number = 17 find

(i) The number of neutrons in the element,

(ii) The number of electrons in the outermost shell.

Answer

Mass number given = 35

Atomic number of element = 17

(i) Neutrons = 35 – 17 = 18

(ii) To find number of electrons in outermost shell we will have to find the electronic configuration of the element.

For atomic number 17,

K = 2

L = 8

M = 7

The number of electrons as we can see from the electronic configuration is 7.

8. Question

If an atom of an element has atomic number = 15 and, mass number = 31, find the number of protons, electrons, neutrons in its atoms.

Answer

Atomic number of element = 15

Mass number = 31

Number of protons = 15

Number of electrons = 15

Number of neutrons = 31 – 15 = 16

9. Question

Why do isotopes of an element have different physical properties?
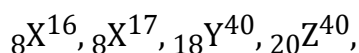
Answer

(i) All the isotopes of any element have the same atomic number that is the number of the protons is the same but have different mass number due to a different number of neutrons.

(ii) As the physical properties of any element like boiling temperature, melting temperature, density, etc. are determined by the mass number of the element.

(iii) The physical properties of isotopes differ from each other because they have a different mass number but their chemical properties are the same because they are determined by an atomic number.

10. Question

How are the following pairs of atoms related?

$_8X^{16}, _8X^{17}, _{18}Y^{40}, _{20}Z^{40},$

Answer

Elements $_8X^{16}$ and $_8X^{17}$ are isotopes because of a same number of protons.

Elements $_{18}Y^{40}$ and $_{20}Z^{40}$ are isobars because of the same mass number.

11. Question

Why is electron known as a universal particle?

Answer

The electron is known as the universal particle because:

(i) The electron is present in all the matter which have mass.

(ii) The charge on the electron is fixed and cannot be changed no matter what the source of the electron is.

(iii) The electron is the universal particle because only it is responsible for any atom to be stable and complete its valence shell. Any atom can only lose or share their electrons with other elements but not the protons or the neutrons.

(iv) The nature of the electrons remains the same in every condition and it has the same properties everywhere.

(v) The mass number or the atomic number of any atom does not affect the electron's nature.

12. Question

How an element is represented using its mass number and atomic number. Give some examples.

Answer

The representation of an element with is atomic and mass number is done by using the symbol of the element an writing atomic number on the sub script and mass number on super script.

Examples: Oxygen: $_8^{16}O$, Chlorine: $_{17}^{35}Cl$, Lithium: $_3^6Li$, Neon: $_{10}^{20}Ne$

13. Question

List two difference between electron, proton, and neutron.

Answer

Electron	Proton	Neutron
1. Discovered by J.J Thompson.	1. Discovered by Ernest Rutherford.	1. Discovered by James Chadwick.
2. It is negatively charged.	2. It is positively charged.	2. It is neutral and has no charge.
3. The number is equal to a number of protons.	3. The number is equal to the atomic number.	3. It may or may not be equal to proton.
4. mass of an electron is 9.1×10^{-31} Kg.	4. Mass of proton is 1.6727×10^{-27} Kg.	4. Mass of neutron is 1.6750×10^{-27} Kg.

14. Question

Express the combining capacity (valency) of $_{18}^{40}Ar$.

Answer

Valency of element $_{18}^{40}Ar$ can be determined by electhe tronic configuration of the element which is:

K = 2

L = 8

M = 8

The outermost shell of the element is complete with the octet of electrons which means it has 8 valence electrons it does not require sharing of its electron to be stable. So the valency is 0.

15. Question

Which of the two elements would be more reactive, element A of atomic number = 36 or element B of atomic number = 19?

Answer

The atomic number of element A is 36 and that of B is 19, by representing the atom in electronic configuration,

For A:

K = 2

L = 8

M = 18

N = 8

The outermost shell N is complete with the octet so the element is stable in this state and will not be reactive because of the 0 valency and complete octet in the atom.

For B:

K = 2

L = 8

M = 9

The valence electron in the element is 9 so it is not that stable, it will readily lose 1 electron in order to complete its octet of electrons and become stable.

So element B will be more reactive than the element A because of the complete octet in element A.

16. Question

An element has Z = 11, what is the valency of the element? Also, name the element.

Answer

Z is used to represent the atomic number, for Z = 11 the valency of the element is 1 by electronic configuration.

The name of the element is Sodium symbol: Na.

17. Question

In $^{20}_{10}Ne$, determine the number of

(i) neutrons

(ii) number of protons

Answer

(i) Neutrons in $_{10}^{20}Ne$ = 20 – 10 = 10

(ii) Number of protons = 10

18. Question

An ion M^{2-} contains 10 electrons and 10 neutrons. What are the atomic number and mass number of the element M? Name the element.

Answer

Number of electrons in M^{2-} ion = 10

Number of neutrons = 10

Number of electrons in M atom = 10 – 20 = 8 electrons

Number of protons = atomic number = 8

Mass number of the element = 8 + 10 = 18u

The element is Oxygen and the ion is O^{2-} oxide ion.

19. Question

A naturally occurring sample of lithium contains 7.42% of ^{6}Li and 92.58% of ^{7}Li. The relative atomic mass of ^{6}Li is 6.015 and that of ^{7}Li is 7.016. Calculate the atomic mass of a naturally occurring sample of lithium.

Answer

Percentage composition of ^{6}Li = 7.42%

Relative atomic mass of ^{6}Li = 6.015

Percentage composition of the ^{7}Li = 98.58%

Relative atomic mass = 7.016

Atomic mass = (percentage isotopic composition × relative mass of ^{6}Li) + (percentage isotopic composition × relative mass of ^{7}Li)

Atomic mass = (0.0742 × 6.015) + (0.9258 × 7.016)

= 0.446 + 6.49

= 6.936u

20. Question

Describe the essential properties of the atomic nucleus. Compare these with the properties of the electron.

Answer

(i) The nucleus is present at the center of the atom and has protons and neutrons in it.

(ii) Nucleus determines the overall charge on the atom because of the presence of the positively charged protons.

(iii) It is also responsible for the chemical properties of the element like the valency of the atom, reactivity of the element towards any other element and also the atomic number and mass number of the atom.

(iv) While the neutron are electrically neutral it contributes to the mass of the atom.

(v) The atomic mass is the numeric sum of the protons and neutrons. The mass of an atom is responsible for the physical properties like the melting point, boiling point, density, etc.

(vi) The nucleus remains stationery at the centre of atom, on the other hand the electron revolves around the nucleus due to the attraction between the positively charged nucleus and negatively charged electron.

(vii) As the electron moves around the nucleus, it also spins on its axis. The mass of an electron is considered to be negligible as compared to the nucleus but it is responsible for the valency of the atom and determines the atom's capability to take part in any chemical reaction.

21. Question

The electronic configurations of some elements are given below. Name the elements.

(i) 2, 8, 5

(ii) 2, 8, 8, 2

(iii) 2, 8, 1

Answer

(i) The electronic configuration is given as 2, 8, 5

The atomic number = total number of electrons

= 2 + 8 + 5 = 15

And, the element is Phosphorous with atomic number 15.(ii) The electronic configuration is given as 2, 8, 8, 2.

The atomic number = 2 + 8+ 8 + 2 = 20.

And, the element with atomic number 20 is Calcium.(iii) The electronic configuration is given as 2, 8, 1.

Then, atomic number is = 2+8+1 = 11.

And we know that the element is Sodium.

22. Question

An atom X has 4 protons and 5 neutrons with electronic configuration 2, 2.

Give information about its

(i) atomic number

(ii) mass number

(iii) valency

Answer

Number of protons of atom X = 4

Number of neutrons = 5

Electronic configuration = 2, 2

(i) Atomic number of atom X = 4

(ii) Mass number = 4 + 5 = 9

(iii) Valency = 2

23. Question

The number of neutrons and protons present in the nuclei of two atomic species A and B are given below.

Atomic Species	A	B
Protons	8	8
Neutrons	8	10

(i) Write the mass numbers of A and B.

(ii) What is the relation between two species?

(iii) Write the electronic configuration of atoms A and B.

Answer

For atomic species A:

Protons = 8

Neutrons = 8

For atomic species B:

Protons = 8

Neutrons = 10

(i) Mass number of A = 8 + 8 = 16
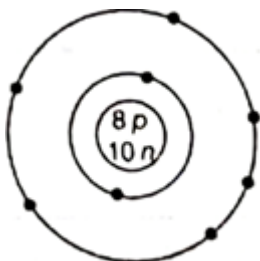
Mass number of B = 8 + 10 = 18

(ii) Both the species are isotopes of an element because they have the same atomic number or the number of protons.

(iii) Electronic configuration of A = 2, 6

Electronic configuration of B = 2, 6

24. Question

What information do you get from the figure given below about the atomic number, mass number and valency of atom X?

Answer

From the figure:

Atomic number can be determined as 8. As the nucleus shows 8 protons also it can be determined because of the 8 electrons in the orbits.

Mass number is 8 + 10 = 18. Because there is written 10n which is 10 neutrons.

Valency can be determined by electronic configuration that is: 2, 6

So the valency is 2 because 2 electrons are required to complete the octet.

25. Question

A certain species X has 17 protons, 18 electrons and 20 neutrons.

(i) What is such a particle called?

(ii) What is the mass number of X?

(iii) What is the atomic number of X?

Answer

Number of protons in species X = 17

Electrons = 18

Neutrons = 20

(i) The particle is called an ion because of the more number of the electrons in the atom. There will be a negative charge on the atom due to more electrons, these type of ions are called anions.

(ii) Mass number of X = 17 + 20 = 37

(iii) Atomic number of X = 17

26. Question

If K and L-shells of an atom are full and in M-shell, there is only one electron, then what would be the total number of electrons in the atom? Name the element. Write the symbol and draw the Bohr model.

Answer

If K and L shells of an atom are full and only one electron is present in the M shell, then the total number of the electrons in the atom would be 11 because the maximum number of electrons that can occupy K and L shells are 2 and 8 respectively. As only 1 electron is present in the M shell the total comes out to be 11.

Corresponding to 11 electrons there will be 11 protons in the atom, so the atomic number of the element will be 11. The element with atomic number 11 is Sodium which has the symbol Na.
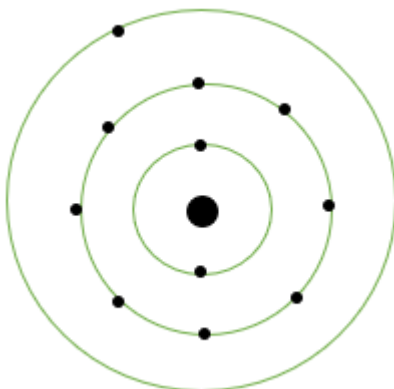
27. Question

An atom of an element has 17 proton, 17 electrons, and 18 neutrons.

(i) Calculate the mass number of the element.

(ii) Write its electronic configuration.

(iii) Find the valency and an atomic number of the element.

Answer

The number of electrons in an atom of element = 17

The number of protons in the atom = 17

Number of the neutron in the atom = 18

(i) Mass number of the element = (protons + neutrons)

= 17 + 18 = 35

(ii) Electronic configuration is 2, 8, 7

(iii) Valency of the element is 1

The atomic number is 17

28. Question

An element X has a mass number = 37 and it contains 17 protons.

(i) Write the symbolic representation of the element.

(ii) Find the number of neutrons and electrons in the element.

(iii) Write the electronic configuration of the element.

Answer

The mass number of the element X = 37

Number of protons = 17

(i) Symbolic representation is
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(ii) Number of neutrons = 37 – 17 = 20

Number of the electrons are = 17

(iii) Electronic configuration is 2, 8, 7

29. Question

The atomic number and the mass number of certain elements are given below in the table.

Element	A	B	C	D	E	F
Atomic number	1	3	8	18	20	1
Mass number	2	7	16	40	40	4

(i) Select a pair of isobar and isotope from the above table.

(ii) What would be the valency of elements B and E?

Answer

(i) Pair of isotope are A and F because they have the same atomic number.

Pair of isobar are D and E because they have the same mass number.

(ii) Valency of element B can be determined by electronic configuration, for the element B is 2, 1. The valency is 1.

Electronic configuration for E is 2, 8, 8, 2. So the valency is 2.

30. Question

What are the features and drawbacks of Rutherford's nuclear model of an atom?

Answer

(i) Ernest Rutherford conducted an experiment to know the arrangement of the electrons inside the atom.

(ii) The experiment he conducted was the gold foil experiment, in which he made fast moving alpha particles to fall on a thin sheet of gold foil.

(iii) Rutherford expected the alpha particle to be deflected by the sub atomic particles in the atom but not by large angles because of the much heavier weight of the alpha particles of 4u.

(iv) The observations made by Rutherford during the experiment were different from what he expected. On basis of the observations and he concluded the structure and arrangement of the atom and the electrons and gave the nuclear model which had the following features:

(a) In every atom, there is a presence of the nucleus in the center of the atom which is positively charged and almost all the mass of the atom reside inside the nucleus.

(b) Electrons inside the atom revolved around the nucleus in a specified path called orbits.

(c) The radius of the nucleus is very small compared to the radius of the atom, so the size of the nucleus is very less as compared to the size of the atom.

However, the nuclear model presented by him had some drawbacks which questioned the overall stability of the atom. The major drawbacks were:

(i) As the electrons revolve around the nucleus they would undergo acceleration and would radiate energy, so the revolution cannot be stable.

(ii) If the electrons radiate energy they would eventually fall into the nucleus which questioned the stability of the atom and the existence of the matter.

These were the major drawbacks that Rutherford could not explain which lead to the dismissal of the Rutherford nuclear model.

31 A. Question

How did the discovery of protons take place?

Answer

(a) The discovery of the protons is credited to Ernest Rutherford, but some give the credit of the protons to Eugene Goldstein.

(b) Goldstein discovered the anode rays, he did an experiment with a discharge tube which had perforated cathode.

(c) He observed that when a high voltage is applied there are streams of negatively charged particles from cathode towards the anode but also rays traveling from anode to the cathode were present.

(d) He found out that the anode rays had positively charged particles or H^+, he did not name the particles.

(e) In 1911 Ernest Rutherford performed the gold foil experiment by bombarding fast moving alpha particles on the gold foil.

(f) He concluded that there must a positively charged mass at the center of the atom to neutralize the negative charge of the atom.

(g) He named the positively charged particle as the proton around which the electron revolves.

(h) He also postulated that the size of the nucleus is very small compared to the atom and all the mass of an atom is present in the nucleus.

By the discoveries of Rutherford, the proton was discovered.

31 B. Question

Why do helium, neon, and argon have zero valencies?

Answer

(a) Helium, Neon, and Argon are the examples of the special group of elements called the noble gases.

(b) This is because of their completely filled valence shell. All these elements have a valency of zero because of their fully filled outermost shells.

(c) Their atomic numbers are 2, 8 and 18 respectively, by their electronic configuration Helium has 2 electrons in the K shell, Neon has 8 in the L shell and Argon has 8 in the M shell.

(d) The K shell in the Helium is filled and the L and M shells in Neon and Argon respectively have a complete octet of electrons which makes them stable, so they do not require sharing their electrons and have the valency of zero.

32. Question

(i) What are inert elements? Why are they called so?

(ii) What is the valency of these elements and why?

(iii) How many electrons can be accommodated in a M and N-shell?

Answer

(i) The elements which belong to the group called the noble gases are considered to be inert elements. These elements are so-called 'inert' because of their reluctance to take part in the chemical reactions. This nature is exhibited mostly by the noble gases because very few of the noble gases take part in the chemical reaction.

(ii) The valency of the inert elements is zero. As most of the inert elements are noble gases they have atomic numbers in which their valence shell is completely filled. Examples are Neon and Argon they have fully filled octet in their outermost shell due to which the valency of the elements is zero.

(iii) The general formula for the maximum number of electrons in any shell is $2(n^2)$ where 'n' is the number of the shell, like n = 1, 2, 3…… for shells K, L, M, N…….

For M and N shells n = 3 and 4 respectively. So the maximum electrons using the formula are 18 and 32. But is difficult for an atom to hold more than 8 electrons in any shell because of the repulsion forces between electrons which affect the stability of the atom.

So only 8 electrons can be accommodated in M and N shells.

33. Question

(i) Draw the atomic structures of the following elements: Magnesium, silicon, sulphur.

(ii) What is the atomic number and mass number of the element whose atomic structure is shown in below?
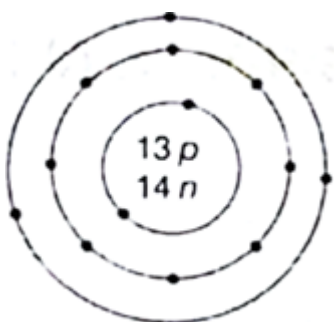
Answer
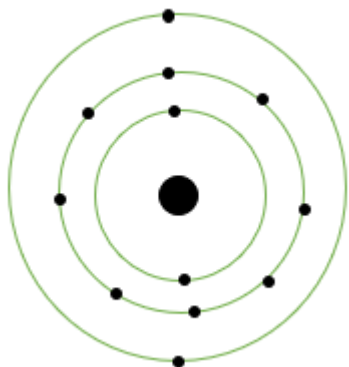
(i) Magnesium: Symbol = Mg

Atomic number = 12

Protons = 12

Electrons = 12

Electronic configuration = 2, 8, 2

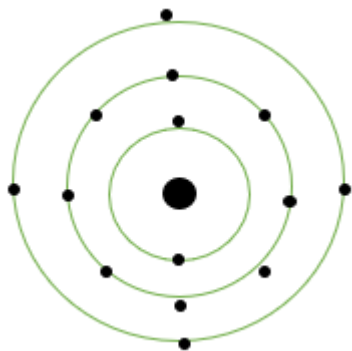Atomic structure:

Silicon: Symbol = Si

Atomic number = 14

Protons = 14

Electrons = 14

Electronic configuration = 2, 8, 4
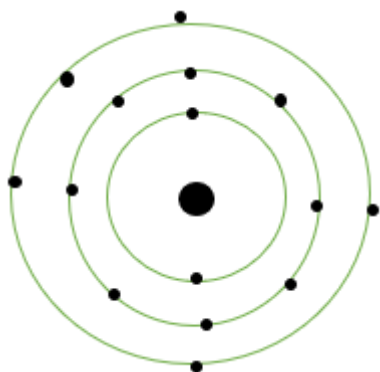
Atomic structure:

Sulphur: Symbol = S

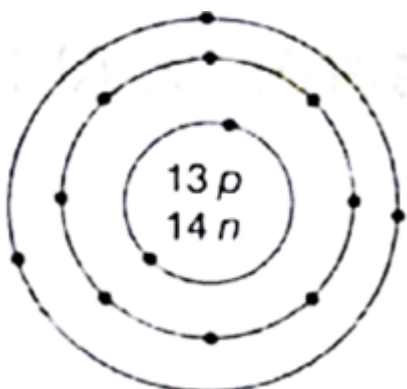Atomic number = 16

Protons = 16

Electrons = 16

Electronic configuration = 2, 8, 6

Atomic structure:

(ii)

Atomic number that can be determined from the atomic structure is 13

Mass number is 13 + 14 = 27

34. Question

Areeba's younger brother is suffering from dehydration. To combat dehydration she suggested him to take non-alcoholic drink like coconut water, barley water, sugarcane juice, glucose water etc., in plenty. Every cell in out body needs water in order to function properly as out body contains about 70% of water.

Read the above passage and answer the questions that follows:

(i) Name the elements present in water.

(ii) Write electronic configuration of both the elements.

(iii) How will you make children aware of taking sufficient amount to liquids and water to prevent dehydration?

Answer

(i) The chemical formula for water is H_2O, so the elements in the water are Hydrogen and Oxygen

(ii) Electronic configurations:

Hydrogen:

Atomic number = 1

Configuration = 1

Oxygen:

Atomic number = 8

Configuration = 2, 6

(iii) Teaching children about the advantages of taking sufficient amount of liquids and drinking water can be done to aware them about importance of water in our bodies. Our bodies are made up of almost 70% water and it is required by our cells for the proper functioning. Also giving the children knowledge about the harmful effects the lack of liquids has on our bodies like dehydration, improper excretion, headaches, etc., are some methods that can be used to spread awareness.

35. Question

A picnic was planned for Class IX students to an amusement park. A chemistry teacher who accompanied the students instructed them to go for a ride as follows: Only two students could go for a first ride. Second ride could accommodate eight students. Third ride could accommodate remaining seven students.

Read the above passage and answer the questions that follows:

(i) The above situation can be compared with the structure of an element. name that element.

(ii) Is this element metal or non-metal? What is its valency?

(iii) What are the values associated with the students?

Answer

(i) The situation can be compared with the element Chlorine. Chlorine has the atomic number of 17 which has the same electronic configuration as the situation presented in the question.

(ii) The element is a non-metal and has a valency of 1.

(iii) Values associated with the students are of discipline and obedience towards the teacher and patience to wait for their turn for the ride.

Challengers

1. Question

In the Thomson's model of the atom, which of the following statements are correct?

(i) The mass of the atom is assumed to be uniformly distributed over the atom.

(ii) The positive charge is assumed to be uniformly distributed over the atom.

(iii) The electrons are uniformly distributed in the positively charged sphere.

(iv) The electrons attract each other to stabilize the atom.

Options || A. (i), (ii) and (iii)

B. (i) and (iii)

C. (i) and (iv)

D. (i), (iii) and (iv)

Answer

The statements (i), (ii) and (iii) all stand true according to the J.J Thompson model for an atom. In his model he considered the atom to be like watermelon with positive charge be the red part distributed all over the atom and electron like the seeds embedded in it.

2. Question

Which of the following statements about Rutherford's model of an atom are correct?

(i) Considered the nucleus are positively charged.

(ii) Established that the α-particles are four times as heavy as a hydrogen atom.

(iii) Can be compared to solar system.

(iv) Was in agreement with Thomson's model.

Options || A. (i) and (iii)

B. (ii) and (iii)

C. (i) and (iv)

D. Only (i)

Answer

The statements (i) and (iii) can be compared to the nuclear model that Rutherford gave for the atom. He concluded after his experiment that the nucleus consists positive charge which attracted the electron and keep the atom neutral. Also, he stated that the revolution of electrons around the positively charged nucleus was in paths called orbits similar to planets revolving around the sun in the solar system.

3. Question

The following diagram depicts Rutherford's experiment.
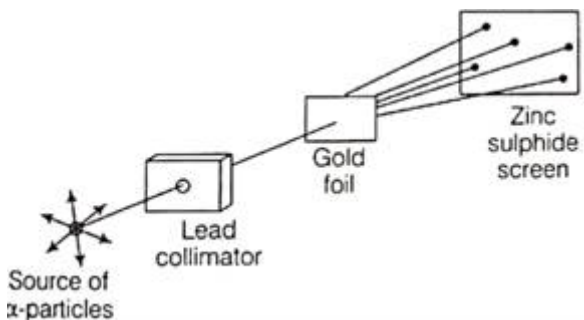
Why was zinc sulphide screen in used in the experiment?

Options || A. To block α-particles from going straight.

B. To detect deflection of α-particles.

C. To further deflect α-particles as the gold foil did.

D. To absorb α-particles and utilise it again.

Answer

Zinc sulphide screen was placed behind the gold foil to detect the deflection of the alpha particles from the gold foil. Every time any alpha particle hits the

Zinc sulphide screen it shows fluorescence in that part which made it easy to detect the deflection of the alpha particles.

4. Question

Atomic models have been improved over the years. Arrange the following atomic models in the order of their chronological order.

(i) Rutherford's atomic model

(ii) Thomson's atomic model

(iii) Bohr's atomic model

A. (i), (ii), and (iii)

B. (ii), (iii) and (i)

C. (ii), (i) and (iii)

D. (iii), (ii) and (i)

Answer

The first model of atom was given by J.J Thompson in 1897, he was also the discoverer of the electron.

Ernest Rutherford was next to give his model of the atom in 1911 with the gold foil experiment. He also discovered proton.

Neils Bohr gave his model in 1913.

5. Question

Which of the following are true for an element?

(i) Atomic number = Number of protons + number of electrons

(ii) Mass number = Number of protons + number of neutrons

(iii) Atomic mass = Number of protons = Number of neutrons

(iv) Atomic number = Number of protons = Number of electrons

Options || A. (i) and (ii)

B. (i) and (iii)

C. (ii) and (iii)

D. (ii) and (iv)

Answer

Mass number is the numeric sum of the protons and the neutrons and the atomic number is equal to the number of protons, because the atom is neutral the number of electrons are also equal to the protons.

6. Question

The number of electrons in an element X is 15 and the number of neutrons is 16. Which of the following is the correct representation of the element?

Options || A. $^{31}_{15}X$

B. $^{31}_{16}X$

C. $^{16}_{15}X$

D. $^{15}_{16}X$

Answer

The number of electrons are equal to the number of protons so the atomic number of the element X will be 15. For the representation purpose $^{31}_{15}X$ is correct for the element.

7. Question

Different isotopes are matched with their uses as

I. Co-60-To treat cancer

II. U-238-To produce electricity

III. I-131-To treat goitre

IV. Na-24-In agricultural research

Options || A. (i) and (ii)

B. (ii) and (iii)

C. (iii) and (iv)

D. (i) and (iii)

Answer

Solution Both Co-60 and I-131 are radioactive elements which emits radioactive radiations. Co-60 is known to emit gamma radiation which is use to destroy tumors and I-131 is used to treat goitre and thyroid cancer.

8. Question

In a sample of ethyl ethanoate ($CH_3COOC_2H_5$) the two oxygen atoms have the same number of electrons but different number of neutrons. Which of the following is the correct reason for it?

A. One of the oxygen atoms has gained electrons.

B. One of the oxygen atoms has gained two neutrons.

C. The two oxygen atoms are isotopes.

D. The two oxygen atoms are isobars.

Answer

Isotopes are the elements which have the same atomic number or protons but different mass numbers. In ethyl ethanoate the two oxygen atoms have same electrons that means have same number of protons but different neutrons which lead to different mass numbers for both of them.