4 Structure of the Atom

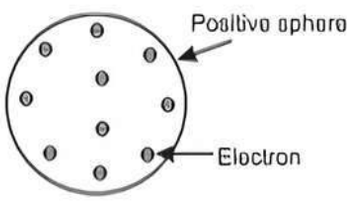
Fastrack Revision

- Atoms and molecules are the fundamental building blocks of matter. Different kinds of atoms combine together in different ways to form different kinds of substances.
- **Dalton** postulated that atom is indivisible *i.e.*, cannot be further divided, which proved to be wrong by the discovery of sub-atomic particles.
- **Charged Particles in Matter**
  - Generally, on rubbing two objects together, they become electrically charged. This reveals the presence of charged particles in an atom or that an atom is divisible and consists of charged particles (electrons and protons).

Characteristics of Electrons and Protons

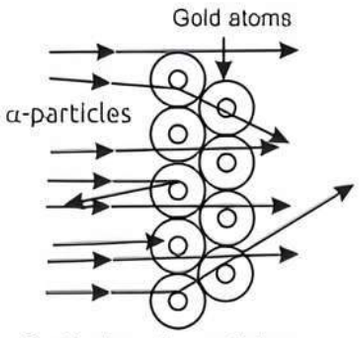
Properties	Electron	Proton
Discovery	J. J. Thomson	E. Goldstein
Symbol	e^-	p^+
Nature	Negatively charged	Positively charged
Relative charge	−1	+1
Absolute charge	-1.6×10^{-19} C	$+1.6 \times 10^{-19}$ C
Relative mass	1/2000 u	1 u
Absolute mass	9.1×10^{-28} g	1.6×10^{-24} g

- **Structure of an Atom:** Various atomic models have been proposed to know about the arrangement of electrons and protons within an atom. These are: **Thomson's model, Rutherford's model** and **Bohr's model.**
  - **Thomson's Model:** In 1903, J. J. Thomson proposed this model.
    - An atom is considered to be a sphere of uniform positive charge and electrons are embedded into it.



    - Total positive charge in an atom is equal to total negative charge due to which an atom is electrically neutral.
  - **Rutherford's Model:** Rutherford performed α-particle scattering experiment (fast moving α-particles were made to fall on a thin gold foil) to find out how electrons are arranged within an atom.

- **Observations of α-particles scattering experiment**



Scattering of α-particles by a gold foil

  - Most of the fast moving α-particles **passed straight** through the gold foil.
  - Some of the α-particles were deflected by **small angles.**
  - One out of every 12000 particles appeared to **rebound.**
- **Conclusions from the Observations**
  - Most of the space inside the atom is **empty** because most of the α-particles passed through the gold foil without getting deflected.
  - Very few particles were deflected from their path, indicating that the **positive charge of the atom occupies very little space.**
  - A very small fraction of α-particles was deflected by 180°, indicating that all the positive charge and mass of the gold atom are **concentrated in a very small volume** within the atom.
  - He also calculated that the **radius of the nucleus** is about 10^5 **times less than the radius of the atom.**
- **Features of Rutherford's Nuclear Model of an Atom**
  - 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.

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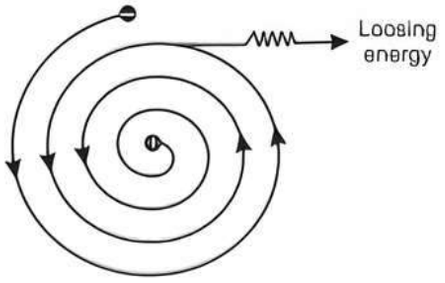
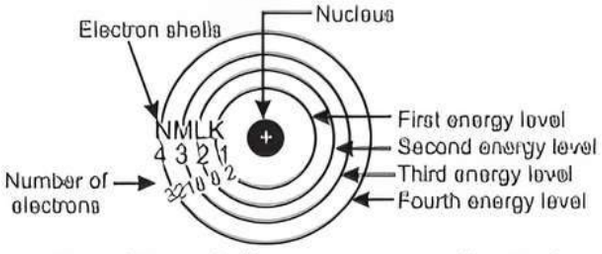
- *α-particles are doubly-charged helium ions and have a considerable amount of energy.*
- *Rutherford selected gold foil because he wanted as thin a layer as possible.*

Drawbacks of Rutherford's Model of the Atom

We know that, any particle in a circular orbit would undergo acceleration. During acceleration, charged particles would **radiate energy**. Thus, the revolving electron would lose energy and finally fall into the nucleus. If this were so, the atom should be highly unstable. Hence, Rutherford's model does not explain the stability of an atom.



- **Bohr's Model:** In 1913, Neil Bohr proposed a model of atomic structure having the following postulates:
  - Electrons revolve around a centrally located heavy, small and positively charged nucleus in certain discrete orbits.
  - While revolving in discrete orbits, the electrons do not radiate energy.



The orbits or shells are represented by the letters K, L, M, N, ... or the numbers n = 1, 2, 3, 4, ...

  - These discrete orbits or shells are called energy levels.

Neutron

Discovery	Location	Symbol
J. Chadwick	Inside the nucleus	n
Relative charge	**Relative mass**	**Absolute mass**
0	1 u	1.6×10^{-24} g

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- *Neutrons are present in the nucleus of all atoms, except hydrogen.*
- *The mass of an atom is given by the sum of the masses of protons and neutrons present in the nucleus.*

Bohr-Bury Scheme for Distribution of Electrons

- The maximum number of electrons present in any shell of an atom is given by the formula $2n^2$, where 'n' is the number of shell as counted from the nucleus *i.e.*, first shell can accommodate 2 electrons, second shell can accommodate 8 electrons, third shell can accommodate 18 electrons and so on.
- Outermost orbit of an atom can accommodate a maximum of 8 electrons.
- Electrons are not accommodated in a given shell, unless the inner shells are filled *i.e.*, the shells are filled in a step-wise manner.

Valency

It is the number of electrons gained, lost or shared so as to make the octet (outermost shell with eight electrons) of electrons in the outermost shell.

The electrons present in the outermost shell of an atom are known as valence electrons.

Valency = Number of valence electrons (in metals) and

Valency = 8 – Number of valence electrons (in non-metals)

Atomic Number:

It is the number of protons present in the nucleus of an atom and is denoted by letter Z.

For atoms,

Atomic number = Number of protons

= Number of electrons

For Ions,

Atomic number = Number of protons

≠ Number of electrons

Mass Number:

It is the number of nucleons (protons + neutrons) present in the nucleus of an atom and is denoted by letter A.

Mass number = Number of protons + Number of neutrons

Atomic number and mass number are represented along with the symbol of element as follows:

Mass Number (A)

Symbol of element (X)

Atomic Number (Z)

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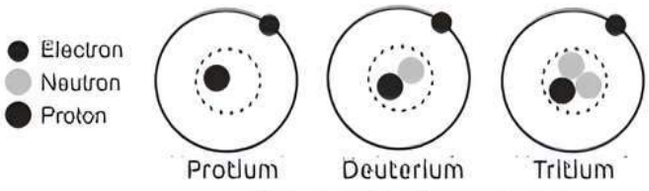
Mass of an individual atom is called atomic mass or atomic weight. It is nearly equal to the mass number and is nearly twice the atomic number for many of the atoms.

Isotopes

are defined as the atoms of the same element, having the same atomic number but different mass numbers.



Isotopes of hydrogen atoms

If an element has no isotopes, then the mass of its atom would be the same as the sum of the masses of protons and neutrons in it.

If an element occurs in isotopic forms, then an average of atomic masses of isotopes is taken.

Calculation of Average Atomic Mass

- Average atomic mass

= Mass of isotope I × (Its fraction)

+ Mass of isotope II × (Its fraction)

Average atomic mass

$$= \frac{\left(\begin{matrix}\text{Atomic mass}\\ \text{of isotope I}\end{matrix}\right) \times \left(\begin{matrix}\text{Its percentage}\\ \text{in nature}\end{matrix}\right) + \left(\begin{matrix}\text{Atomic mass}\\ \text{of isotope II}\end{matrix}\right) \times \left(\begin{matrix}\text{Its percentage}\\ \text{in nature}\end{matrix}\right)}{100}$$

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The fractional atomic masses of elements are due to the existence of their isotopes having different masses.

- **Characteristics of Isotopes**
  - All isotopes are electrically neutral.
  - All isotopes of an element show similar chemical properties.
  - All isotopes of an element show different physical properties.
  - Mass number of different isotopes of an element are different.
  - All isotopes of an element show same valency.
- **Applications of Isotopes:**
  - An isotope of uranium is used as a fuel in nuclear reactors.
  - An isotope of cobalt is used in the treatment of cancer.
  - An isotope of iodine is used in the treatment of goitre.
- **Isobars:** These are atoms of different elements with different atomic numbers but same mass number. *e.g.*, $^{40}_{18}Ar$ and $^{40}_{20}Ca$ are isobars.

Practice Exercise

Multiple Choice Questions

Q 1. Select the correct statements.

(i) An atom is divisible and consists of charged particles.

(ii) It was known by 1900 that the atom was not a simple, indivisible particle but contained at least one sub-atomic particle – the electron.

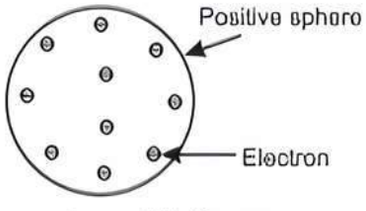
(iii) In 1886, E. Goldstein discovered the presence of new radiations called canal rays which led to the discovery of another sub-atomic particle – the proton.

(iv) Proton had a charge, equal in magnitude but opposite in sign to that of the electron and its mass was approximately 2000 times as that of the electron.

(v) The mass of an electron is considered to be negligible and its charge is minus one.

a. (i), (ii) and (iii)
b. (iii), (iv) and (v)
c. (ii), (iii) and (iv)
d. All the statements are correct.

Q 2. Which model of an atom is depicted by the given figure?



a. Thomson's model of an atom
b. Rutherford's model of an atom
c. Bohr's model of an atom
d. None of the above

Q 3. In the Thomson's model of an 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 stabilise the atom. *(NCERT EXEMPLAR)*

a. (i), (ii) and (iii) b. (i) and (iii)
c. (i) and (iv) d. (i), (iii) and (iv)

Q 4. In Rutherford's gold foil experiment, most of the rays passed through atom showing that:

a. most of the atom is hollow
b. atoms are positively charged at the centre
c. atom is spherical
d. atom is neutral

Q 5. Which of the following statements about Rutherford's model of an atom are correct?

(i) Considered the nucleus as 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. *(NCERT EXEMPLAR)*

a. (i) and (iii) b. (ii) and (iii)
c. (i) and (iv) d. Only (i)

Q 6. The mass of an atom is given by the sum of the masses of ..... and ..... present in the nucleus.

a. protons, electrons b. electrons, neutrons
c. protons, neutrons d. None of these

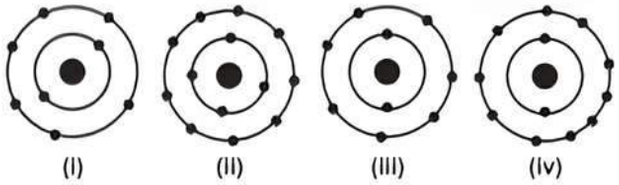
Q 7. Rutherford's experiment on scattering of α-particles showed for the first time that the atom has:

a. nucleus b. electron
c. proton d. neutron

Q 8. The α-particles are the same as:

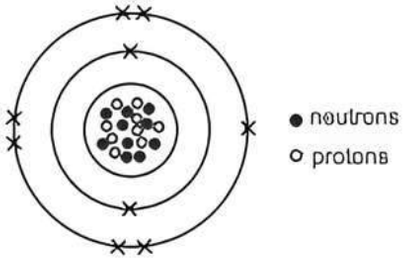
a. protons b. helium atoms
c. helium ions d. lithium nuclei

Q 9. Which of the following do not represent Bohr's model of an atom correctly? *(NCERT EXEMPLAR)*



a. (I) and (II) b. (II) and (III)
c. (II) and (IV) d. (I) and (IV)

Q 10. The diagram given below shows the atomic structure of an atom:



How many protons, neutrons and electrons are present in the atom?

	Number of protons	Number of neutrons	Number of electrons
a.	9	9	10
b.	9	10	9
c.	10	9	10
d.	10	10	9

Q 11. Which of the following correctly represents the electronic distribution in the Mg atom? *(NCERT EXEMPLAR)*

a. 3, 8, 1 b. 2, 8, 2 c. 1, 8, 3 d. 8, 2, 2

Q 12. According to Bohr-Bury scheme, the maximum number of electrons which can be accommodated in a given shell is given by the formula:

a. $2n^2$ b. n^2 c. $3n^2$ d. $2n$

Q 13. The atomic number of an element *X* is 8 and that of element *Y* is 4. Both these elements can exhibit a valency of:

a. 1 b. 2 c. 3 d. 4

Q 14. The number of valence electrons in Al are:

a. 1 b. 2 c. 3 d. 4

Q 15. Elements with valency 'one' are: *(NCERT EXEMPLAR)*

a. always metals
b. always non-metals
c. always metalloids
d. either metals or non-metals

Q 16. Which of the following has one valence electron?

a. Li b. Ca c. Mg d. Be

Q 17. The valency of oxygen with atomic number 8 is:

a. 6 b. 2 c. 4 d. 1

Q 18. Valence electrons in Cl^- ion are: *(NCERT EXEMPLAR)*

a. 16 b. 8 c. 17 d. 18

Q 19. The table given below shows the numbers of protons, neutrons and electrons in four ions. For which ion is the data correct?

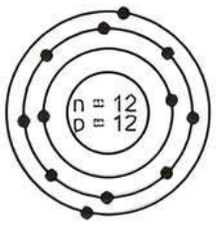
Ion	Number of		
	Protons	Neutrons	Electrons
$^{40}_{20}Ca^{2+}$	20	20	20
$^{19}_{9}F^-$	9	10	8
$^{16}_{8}O^{2-}$	8	8	10
$^{23}_{11}Na^+$	11	12	11

a. $^{40}_{20}Ca^{2+}$ b. $^{19}_{9}F^-$

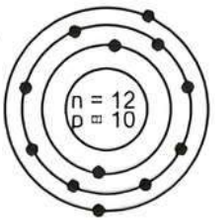
c. $^{16}_{8}O^{2-}$ d. $^{23}_{11}Na^+$

Q 20. Identify the Mg^{2+} ion from the figure where, *n* and *p* represent the number of neutrons and protons respectively. *(NCERT EXEMPLAR)*

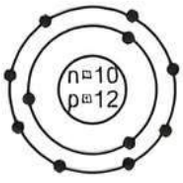
a.



b.

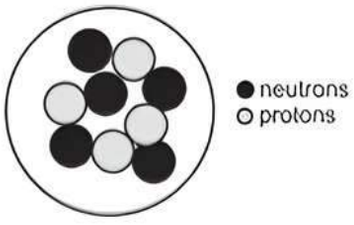


c.



d.

Q 21. The diagram given below shows the sub-atomic particles present in the nucleus of atom *X*.



What is the symbol for atom *X*?

a. $^{9}_{4}X$ b. $^{9}_{4}X$ c. $^{4}_{9}X$ d. $^{9}_{5}X$

Q 22. Which pair of atoms contains the same number of neutrons?

a. Carbon-12 and Nitrogen-14
b. Carbon-14 and Aluminium-27
c. Oxygen-17 and Phosphorus-31
d. Oxygen-18 and Fluorine-19

Q 23. Which pair of atoms contains the same number of neutrons?

a. $^{114}_{48}Cd$ and $^{119}_{50}Sn$ b. $^{59}_{27}Co$ and $^{59}_{28}Ni$

c. $^{133}_{55}Cs$ and $^{132}_{54}Xe$ d. $^{63}_{29}Cu$ and $^{65}_{29}Cu$

Q 24. The atoms of three elements in the periodic table have atomic numbers and mass numbers as follows:

Element	*V*	*W*	*X*
Atomic number	4	5	6
Mass number	9	11	12

Which of the following represents the number of neutrons in the nucleus of each of the elements?

	V	*W*	*X*
a.	4	5	6
b.	5	6	6
c.	8	10	12
d.	9	11	12

Q 25. Which statement is true about protium and tritium?

a. They have no neutrons in the nucleus.
b. They have different chemical properties.
c. They have different number of protons.
d. They have one electron outside the nucleus.

Q 26. Isotopes of the same element have the same number of:

a. neutrons
b. protons
c. protons and neutrons
d. protons, neutrons and electrons.

Q 27. The table given below shows the structure of five atoms:

Atom	Number of electrons	Number of neutrons	Number of protons
V	5	5	5
W	5	6	5
X	6	6	6
Y	7	7	7
Z	6	8	6

Which two pairs of atoms are isotopes?

	First pair	Second pair
a.	*V* and *W*	*X* and *Y*
b.	*V* and *W*	*X* and *Z*
c.	*W* and *X*	*Y* and *Z*
d.	*W* and *Y*	*X* and *Z*

Q 28. Which isotope is used in the treatment of goitre disease?

a. C–12 b. Cl–37 c. I–131 d. None of these

Q 29. The isotope of which element is used for treatment of cancer disease?

a. Uranium b. Cobalt
c. Iodine d. Chlorine

Q 30. Which of the following elements does not consist of isotopes?

a. Carbon b. Neon
c. Chlorine d. Iodine

Q 31. Isotopes of an element contains:

a. similar physical properties
b. different chemical properties
c. different number of neutrons
d. different atomic number

Q 32. The number of protons, neutrons and electrons in four elements I, II, III and IV are as follows:

I. $p = 6, n = 6, e = 6$
II. $p = 6, n = 7, e = 6$
III. $p = 18, n = 22, e = 18$
IV. $p = 19, n = 21, e = 19$

In these,

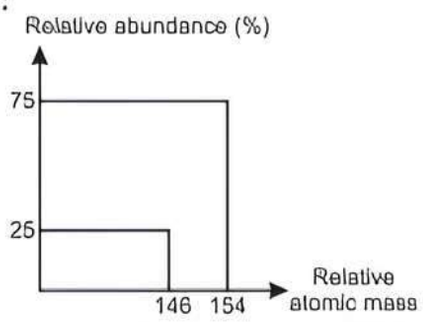
a. elements I and II are isotopes and elements III and IV are isobars.
b. elements I and II are isotopes but elements III and IV are not isobars.
c. elements I and II are isobars and elements III and IV are isotopes.
d. elements I and II are isobars but elements III and IV are not isotopes.

Q 33. 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** *(NCERT EXEMPLAR)*

a. (i) and (ii) b. (i) and (iii)
c. (ii) and (iii) d. (ii) and (iv)

Q 34. An element *E* exists in two isotopic forms as shown below:



What is the relative atomic mass of *E*?

a. 150 b. 152 c. 151 d. 153

Assertion & Reason Type Questions

Directions (Q. Nos. 35-44): *Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:*

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
c. Assertion (A) is true but Reason (R) is false.
d. Assertion (A) is false but Reason (R) is true.

Q 35. Assertion (A): Thomson's atomic model is known as 'raisin pudding' model.
Reason (R): The atom is visualised as a pudding of positive charge with electrons (raisins) embedded in it.

Q 36. Assertion (A): Most of the space in an atom is empty.
Reason (R): Most of the α-rays in Rutherford's α-scattering experiment passed through a thin gold foil straight.

Q 37. Assertion (A): The size of the nucleus is very small as compared to the size of the atom.
Reason (R): The electrons revolve around the nucleus of the atom in circular paths.

Q 38. Assertion (A): The distribution of electrons in different orbits or shells is governed by a scheme known as Bohr-Bury scheme.
Reason (R): Electrons are filled in the shells in a stepwise manner.

Q 39. Assertion (A): The number of electrons gained, lost or shared by the atom of an element so as to complete its octet is called the valency of the element.
Reason (R): Elements having the same number of valence electrons in their atoms possess different chemical properties.

Q 40. Assertion (A): Na° has completely filled K-and L-shells.
Reason (R): Na° has 10 electrons out of which K-shell contains 2 electrons and L- shell contains 8 electrons.

Q 41. Assertion (A): For noble gases, valency is zero.
Reason (R): Noble gases have 8 valence electrons.

Q 42. Assertion (A): The mass of the total number of protons and neutrons is a measure of the approximate mass of an atom.
Reason (R): The mass of an electron is negligible.

Q 43. Assertion (A): Isotopes are electrically neutral.
Reason (R): Isotopes of an element have equal number of protons and electrons.

Q 44. Assertion (A): Isobars are atoms of different elements having the same mass number.
Reason (R): Isobars have identical chemical properties.

Answers

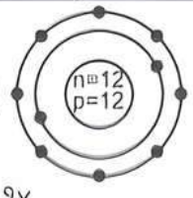
1. (d) All the statements are correct.
2. (a) Thomson's model of an atom
According to Thomson's model of an atom, an atom consists of a sphere of positive charge with negatively charged electrons embedded in it. An atom is electrically neutral as both the positive and negative charges are equal in magnitude.
3. (a) (i), (ii) and (iii)
Thomson's model could be compared with a raisin pudding model according to which the mass of atom is uniformly distributed over the atom in the form of positive charge and electrons are uniformly distributed over the atom. Electrons do not attract each other.
4. (a) most of the atom is hollow
5. (a) (i) and (iii)
Rutherford's model of atom explained presence of nucleus in the centre and electrons around the nucleus revolving in round orbitals like the solar system.
6. (c) protons, neutrons
7. (a) nucleus
8. (c) helium ions
α-particles are doubly charged helium ions.
9. (c) (ii) and (iv)
First shell can accommodate maximum of two electrons and second shell can accommodate maximum of eight electrons.
10. (b) 9 10 9
The electrons (denoted by ×) are outside the nucleus. The diagram shows that there are nine electrons. An atom contains equal number of protons and electrons. Hence, an atom has nine protons (denoted by o). The number of neutrons in the nucleus is ten (denoted by •).
11. (b) 2, 8, 2

	K	L	M
$_{12}Mg$:	2	8	2

12. (a) $2n^2$
13. (b) 2
Distribution of electrons in X = 2, 6
Valency of X = 8 – 6 (valence electrons) = 2
Distribution of electrons in Y = 2, 2
Valency of Y = 2 (valence electrons)
14. (c) 3
15. (d) either metals or non-metals
16. (a) Li
17. (b) 2
18. (b) 8
19. (c) $^{16}_{8}O^{2-}$

Ion	Number of		
	Protons	Neutrons	Electrons
$^{40}_{20}Ca^{2+}$	20	20	18
$^{19}_{9}F^{-}$	9	10	10
$^{16}_{8}O^{2-}$	8	8	10
$^{23}_{11}Na^{+}$	11	12	10

20. (d)



21. (b) $^{9}_{4}X$
Mass number = number of neutrons + number of protons = 5 + 4 = 9
Thus, the symbol for atom X is
Mass number → 9
Atomic number → 4
X
22. (d) Oxygen-18 and Fluorine-19
The symbol for oxygen 18 is $^{18}_{8}O$.
Mass number = number of neutrons + number of protons
Thus, number of neutrons in $^{18}_{8}O$ = 18 – 8 = 10
The symbol for fluorine 19 is $^{19}_{9}F$.
Mass number = number of neutrons + number of protons
Thus, number of neutrons in $^{19}_{9}F$ = 19 – 9 = 10
Number of neutrons in carbon-12 = 12 – 6 = 6
Number of neutrons in nitrogen-14 = 14 – 7 = 7
Number of neutrons in carbon-14 = 14 – 6 = 8
Number of neutrons in aluminium-27 = 27–13 = 14
Number of neutrons in oxygen-17 = 17 – 8 = 9
Number of neutrons in phosphorus-31 = 31 – 15 = 16

23. (c) $^{133}_{55}Cs$ and $^{132}_{54}Xe$

Number of neutrons = mass number – atomic number

$^{114}_{48}Cd$:66 $^{119}_{50}Sn$:69. $^{59}_{27}Co$: 32 $^{59}_{28}Ni$: 31

$^{133}_{55}Cs$: 78 $^{132}_{54}Xe$: 78. $^{63}_{29}Cu$: 34 $^{65}_{29}Cu$: 36

24. (b) 5 6 6

25. (d) They have one electron outside the nucleus.

Protium and tritium are isotopes. The proton number of hydrogen is 1. Hence, both isotopes have one electron outside the nucleus. Protium has no neutrons. Tritium has two neutrons. Isotopes have similar chemical properties but different physical properties. Both isotopes have one proton in their nucleus.

26. (b) protons

Isotopes have the same atomic number, but different mass numbers. Thus, isotopes of the same element have the same number of protons.

27. (b) *V* and *W*, *X* and *Z*

V and *W* are isotopes. *X* and *Z* are isotopes. *V* and *W* have same number of protons but different number of neutrons. *X* and *Z* have same number of protons but different number of neutrons.

28. (c) I-131

29. (b) Cobalt

30. (b) Neon

31. (c) different number of neutrons

32. (a) elements I and II are isotopes and elements III and IV are isobars.

Isotopes are elements having same atomic number (number of protons) but different mass numbers. Isobars are elements having same mass number but different atomic numbers.

33. (d) (ii) and (iv)

Mass number = $p + n$

Atomic number = $p = e$

34. (b) 152

Relative atomic mass of $E = \frac{25 \times 146}{100} + \frac{75 \times 154}{100}$

$= \frac{3650 + 11550}{100} = 152$

35. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

36. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

37. (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

38. (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

39. (c) Reason (R) is false because elements having the same number of valence electrons in their atoms possess similar chemical properties.

40. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

41. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is correct explanation of Assertion (A).

42. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Since the mass of an electron is negligible, the mass of the total number of neutrons and protons (nucleons) is a measure of the approximate mass of an atom.

43. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

44. (c) Reason (R) is false because the chemical properties of isobars are different.

Case Study Based Questions

Case Study 1

Many scientists contributed in revealing the presence of charged particles in an atom.

It was known by 1900 that the atom was indivisible particle but contained at least one sub-atomic particle - the electron identified by J. J. Thomson. Even before the electron was identified, In 1886 E. Goldstein discovered the presence of new radiations in a gas discharge and called them canal rays. These rays were positively charged radiations which ultimately led to the discovery of another sub-atomic particle. This sub-atomic particle had a charge, equal in magnitude but opposite in sign to that of the electron. Its mass was approximately 2000 times as that of the electron. It was given the name of proton. In general, an electron is represented as 'e^-' and a proton as 'p^+'. The mass of a proton is taken as one unit and its charge as plus one. The mass of an electron is considered to be negligible and its charge is minus one.

It seemed that an atom was composed of protons and electrons, mutually balancing their charges. It also appeared that the protons were in the interior of the atom, for whereas electrons could easily be removed off but not protons.

Read the given passage carefully and give the answer of the following questions:

Q 1. Who discovered electron?

a. E. Goldstein b. Bohr

c. J. J. Thomson d. J. Chadwick

Q 2. Which of the following has a charge of +1 and a mass of 1 amu?

a. A neutron b. A proton

c. An electron d. A helium nucleus

Q 3. Mass of proton is:

a. equal to the mass of hydrogen atom

b. less than the mass of hydrogen atom

c. negligible

d. more than the mass of hydrogen atom

Q 4. Proton was discovered by:

a. Thomson b. Rutherford

c. Chadwick d. Goldstein

Q 5. Which statement is true?

a. The nucleus of an atom contains only neutrons.
b. The nucleus of an atom contains only protons and electrons.
c. Protons and neutrons are sub-atomic particles.
d. Protons have the same charge as neutrons.

Answers

1. (c) J. J. Thomson
2. (b) A proton
3. (a) equal to the mass of hydrogen atom
4. (d) E. Goldstein
   E. Goldstein discovered the presence of new radiations in a gas discharge and called them canal rays. These rays were positively charged radiations which ultimately led to the discovery of sub-atomic particle-proton.
5. (c) Protons and neutrons are sub-atomic particles.
   Protons, neutrons and electrons are known as sub-atomic particles. The nucleus of an atom contains protons and neutrons. A proton has a relative charge of +1. A neutron has a relative charge of 0.

Case Study 2

Rutherford conducted an experiment by bombarding a thin sheet of gold (100 nm thickness) with α-particles and then studied the trajectory of these particles after their interaction with the gold foil.

Read the given passage carefully and give the answer of the following questions:

Q 1. Rutherford's α-particles scattering experiment resulted into discovery of:

a. electron
b. proton
c. nucleus in the atom
d. atomic mass

Q 2. ..... was known as the 'Father' of nuclear physics. He is famous for his work on radioactivity and the discovery of the nucleus of an atom with the gold foil experiment.

a. J. J. Thomson
b. Neils Bohr
c. E. Rutherford
d. J. Chadwick

Q 3. Rutherford concluded from the α-particle scattering experiment that:

(i) most of the space inside the atom is empty because most of the α-particles passed through the gold foil without getting deflected.
(ii) very few particles were deflected from their path, indicating that the negative charge of the atom occupies very little space.
(iii) a very large fraction of α-particles were deflected by 180°, indicating that all the negative charge and mass of the gold atom were concentrated in a very small volume within the atom.

Identify the incorrect statements:

a. (i) and (ii)
b. (ii) and (iii)
c. (i) and (iii)
d. (i), (ii) and (iii)

Q 4. Rutherford's a-particle scattering experiment showed that:

(i) electrons have negative charge.
(ii) the mass and positive charge of the atom is concentrated in the nucleus.
(iii) neutron exists in the nucleus.
(iv) most of the space in atom is empty.

Which of the above statements are correct?

a. (i) and (iii)
b. (ii) and (iv)
c. (i) and (iv)
d. (iii) and (iv)

Q 5. Select the correct statements.

(i) The radius of the nucleus is about 10^7 times less than the radius of the atom.
(ii) There is a positively charged centre in an atom called the nucleus. Nearly, all the mass of an atom resides in the nucleus.
(iii) The electrons revolve around the nucleus in circular paths.
(iv) The size of the nucleus is very large as compared to the size of the atom.

a. (i) and (iv)
b. (ii) and (iii)
c. (i), (ii) and (iii)
d. All the statements are correct.

Answers

1. (c) nucleus in the atom
   Rutherford's α-particles scattering experiment resulted into discovery of nucleus in the atom. A large number of particles went straight through the atom while a very small number of particles were deflected back showing the presence of positively charged nucleus.
2. (c) E. Rutherford
3. (b) (ii) and (iii)
   Very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space. A very small fraction of α-particles were deflected by 180°, indicating that all the positive charge and mass of the gold atom were concentrated in a very small volume within the atom.
4. (b) (ii) and (iv)
   Two important observations of Rutherford's α-particles scattering experiment were - (i) The mass and positive charge of the atom is concentrated in the nucleus. (ii) Most of the space in the atom is empty.
5. (b) (ii) and (iii)
   The radius of the nucleus is about 10^5 times less than the radius of the atom. The size of the nucleus is very small as compared to the size of the atom.

Case Study 3

The following rules are followed for writing the number of electrons in different energy levels or shells:

(i) The maximum number of electrons present in a shell is given by the formula $2n^2$, where 'n' is the orbit number or energy level index, 1, 2, 3, ..., Hence, the maximum number of electrons in different shells are as follows: First orbit or K-shell will be $= 2 \times 1^2 = 2$, Second orbit or L-shell will be $= 2 \times 2^2 = 8$, Third orbit or M-shell will be $= 2 \times 3^2 = 18$, Fourth orbit or N-shell will be $= 2 \times 4^2 = 32$, and so on.

(ii) The maximum number of electrons that can be accommodated in the outermost orbit is 8.

(iii) Electrons are not accommodated in a given shell, unless the inner shells are filled *i.e.*, the shells are filled in a stepwise manner.

Read the given passage carefully and give the answer of the following questions:

Q 1. 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?

a. $^{31}_{15}X$ b. $^{31}_{16}X$ c. $^{16}_{15}X$ d. $^{15}_{16}X$

Q 2. How many number of protons and electrons are present in Ca^{2+}?

a. 20 protons; 20 electrons
b. 20 protons; 22 electrons
c. 18 protons; 18 electrons
d. 20 protons; 18 electrons

Q 3. Maximum number of electrons which can be filled in the third shell of an atom is:

a. 8 b. 18 c. 10 d. 32

Q 4. Which pair of molecules has the same number of electrons?

a. N_2 and F_2 b. Cl_2 and CO_2
c. H_2O and H_2S d. O_2 and C_2H_4

Q 5. Which of the following elements has same number of protons, electrons and neutrons?

a. Al b. Mg c. P d. Cl

Answers

1. (a) $^{31}_{15}X$
Number of electrons = 15
Number of neutrons = 16
Hence, atomic number of element *X* is 15 and atomic mass is 31.
Hence, the element is represented as $^{31}_{15}X$.

2. (d) 20 protons; 18 electrons
Atomic number of Ca = 20
Hence, number of protons in Ca^{2+} = 20
and number of electrons in Ca^{2+} = 20 – 2 = 18

3. (b) 18
The maximum number of electrons present in a shell is given by $2n^2$, where $n = 1, 2, 3, ...$
Maximum number of electrons which can be filled in the third shell of an atom is $2 \times (3)^2 = 18$

4. (d) O_2 and C_2H_4
Number of electrons in $O_2 = 2 \times 8 = 16$
Number of electrons in $C_2H_4 = (2 \times 6) + (4 \times 1) = 16$
Number of electrons in $N_2 = 2 \times 7 = 14$
Number of electrons in $F_2 = 2 \times 9 = 18$
Number of electrons in $Cl_2 = 2 \times 17 = 34$
Number of electrons in $CO_2 = 6 + (2 \times 8) = 22$
Number of electrons in $H_2O = (2 \times 1) + 8 = 10$
Number of electrons in $H_2S = (2 \times 1) + 16 = 18$

5. (b) Mg
Mg is represented as $^{24}_{12}Mg$. It has protons, electrons and neutrons equal to 12 (all are same).

Case Study 4

The combining capacity of the atoms of elements, *i.e.*, their tendency to react and form molecules with atoms of the same or different elements, was thus explained as an attempt to attain a fully-filled outermost shell. An outermost shell, which had eight electrons was said to possess an octet. Atoms would thus react, so as to achieve an octet in the outermost shell. This was done by sharing, gaining or losing electrons. The number of electrons gained, lost or shared, so as to make the octet of electrons in the outermost shell, gives us directly the combining capacity of the element, *i.e.*, the valency. For example, hydrogen/ lithium/ sodium atoms contain one electron each in their outermost shell, therefore each one of them can lose one electron. So, they are said to have valency of one. The valency of magnesium and aluminium is two and three, respectively, because magnesium has two electrons in its outermost shell and aluminium has three electrons in its outermost shell.

If the number of electrons in the outermost shell of an atom is close to its full capacity, then valency is determined in a different way. For example, the fluorine atom has 7 electrons in the outermost shell, and its valency could be 7. But it is easier for fluorine to gain one electron instead of losing seven electrons. Hence, its valency is determined by subtracting seven electrons from the octet and this gives us a valency of one for fluorine.

Read the given passage carefully and give the answer of the following questions:

Q 1. Which atom loses two electrons from its valence shell to form an ion?

a. Calcium b. Carbon
c. Chlorine d. Oxygen

Q 2. The element with the atomic number 3 is likely to have similar chemical properties to the element with the atomic number:

a. 5 b. 11 c. 8 d. 20

Q 3. Which of the following has the same number of electrons as an oxide ion (O^{2-})?

a. K^+ b. Mg^{2+} c. Cl^- d. S^{2-}

Q 4. What is the atomic structure of X^{2-} ion in which X has a atomic number of 8 and a mass number of 17?

	Electrons	Protons	Neutrons
a.	8	8	9
b.	10	9	8
c.	10	8	9
d.	10	8	8

Q 5. The ion of an element has 2 positive charges. Mass number of the atom is 24 and the number of neutrons is 12. What is the number of electrons in the ion?

a. 8 b. 10 c. 12 d. 24

Answers

1. (a) Calcium
Calcium has 20 electrons.
Electronic configuration = 2, 8, 8, 2
Carbon has 6 electrons.
Electronic configuration = 2, 4
Chlorine has 17 electrons.
Electronic configuration = 2, 8, 7
Oxygen has 8 electrons.
Electronic configuration = 2, 6

2. (b) 11
Electronic configuration of the element with the atomic number 3 = 2, 1.
Electronic configuration of the element with the atomic number 11 = 2, 8, 1.
Both have same number of electrons in the valence shell, hence show similar chemical properties.

3. (b) Mg^{2+}
O^{2-} has 10 electrons.
K^+ has 18 electrons.
Mg^{2+} has 10 electrons.
Cl^- has 18 electrons.
S^{2-} has 18 electrons.

4. (c)

Electron	Proton	Neutrons
10	8	9

X has a atomic number of 8 and a mass number of 17.
So, number of neutrons is $17 - 8 = 9$
Number of protons = 8
Number of electrons in X^{2-} ion = $(8 + 2) = 10$

5. (b) 10
The ion of an element has 2 positive charges.
$A = 24$, $n = 12$, $p = 24 - 12 = 12$, $e = 12 - 2 = 10$
So, the number of electrons in the ion = 10

Case Study 5

Isotopes are elements with the same number of protons but have different number of neutrons. Since, the atomic number is equal to the number of protons and the atomic mass is the sum of protons and neutrons, isotopes are elements with the same atomic number but different mass numbers. For example, hydrogen has three isotopes namely protium, deuterium and tritium. Other such examples are (i) ${}^{12}_{6}C$ and ${}^{14}_{6}C$, (ii) ${}^{35}_{17}Cl$ and ${}^{37}_{17}Cl$.

Read the given passage carefully and give the answer of the following questions:

Q 1. The average atomic mass of a sample of an element 'X' is 16.2 u. What are the percentage of isotopes ${}^{16}_{8}X$ and ${}^{18}_{8}X$ in the sample?

a. ${}^{16}_{8}X = 80\%$, ${}^{18}_{8}X = 20\%$

b. ${}^{16}_{8}X = 60\%$, ${}^{18}_{8}X = 40\%$

c. ${}^{16}_{8}X = 90\%$, ${}^{18}_{8}X = 10\%$

d. ${}^{16}_{8}X = 45\%$, ${}^{18}_{8}X = 55\%$

Q 2. Which isotope of chlorine has larger number of neutrons than protons?

a. ${}^{35}_{17}Cl$ b. ${}^{37}_{17}Cl$

c. Both a. and b. d. Neither of the two

Q 3. An atom of ..... contains no neutrons.

a. hydrogen b. tritium

c. deuterium d. None of these

Q 4. Which of the following is a property of isotopes?

a. They have the same numbers of electrons.
b. They have different numbers of protons.
c. They have different chemical properties.
d. They have the same mass number.

Q 5. An element with atomic number equal to 1, exists in three isotopes namely ${}^{1}_{1}H$, ${}^{2}_{1}H$ and ${}^{3}_{1}H$. Which one of these has only one electron in its outermost shell?

a. ${}^{1}_{1}H$ b. ${}^{2}_{1}H$ c. ${}^{3}_{1}H$ d. All of these

Answers

1. (c) ${}^{16}_{8}X = 90\%$, ${}^{18}_{8}X = 10\%$

Let the % of isotopes ${}^{16}_{8}X$ and ${}^{18}_{8}X$ in the sample be x and $(100-x)$ respectively.
Average atomic mass,

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

$$16.2 = \frac{16x + 1800 - 18x}{100}$$

$$16.2 \times 100 = 16x + 1800 - 18x$$

$$1620 = 1800 - 2x$$

$$2x = 1800 - 1620 = 180$$

$$x = \frac{180}{2} = 90$$

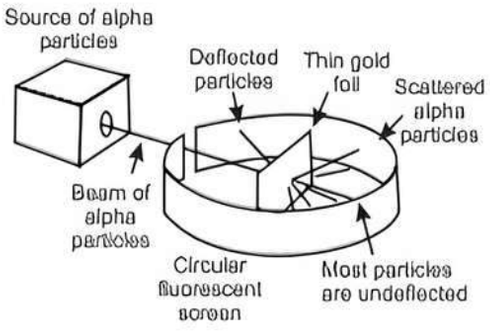
$$(100 - x) \Rightarrow (100 - 90) = 10$$

Thus, % of ${}^{16}_{8}X = 90\%$ and % of ${}^{18}_{8}X = 10\%$

2. (c) Both a. and b.
3. (a) hydrogen
4. (a) They have the same numbers of electrons.
They have the same numbers of protons and electrons. They have different mass numbers.
5. (d) All of these

Case Study 6

A British physicist 'Ernest Rutherford' proposed a model of the atomic structure known as Rutherford's model of an atom. In this experiment, he bombarded fast moving alpha particles (doubly-charged helium ions) on a thin sheet of gold. On the basis of the observations made during the experiment, Rutherford concluded that major space in an atom is empty and the positive charge in an atom is not distributed uniformly and is concentrated in a very small volume. He also concludes that there is a positively charged centre (nucleus) in an atom and the electrons revolve around the nucleus in well defined orbits.



Read the given passage carefully and give the answer of the following questions:

Q 1. What is the charge and mass on the particles used by Rutherford in his experiment?

Q 2. State any two features of the atom as stated by Rutherford.

Q 3. State the observations in α-particle scattering experiment which led Rutherford to make the following conclusions:

(i) Most of the space inside the atom is empty.

(ii) The nucleus of an atom is positively charged.

Q 4. What was the drawback of Rutherford's model of the atom?

Q 5. Which scientist concluded that size of the nucleus is very small as compared to the size of the atom?

Answers

1. α-particles are positively charged (+2) and mass is 4u.
2. (i) Atom consist of a positively charged centre called nucleus.
   (ii) The electrons revolve around the nucleus in circular paths.
3. (i) Most of the rays passed through the gold sheet without getting deflected.
   (ii) Very few rays deflected through larger angles.
4. It could not explain the stability of an atom.
5. Ernest Rutherford.

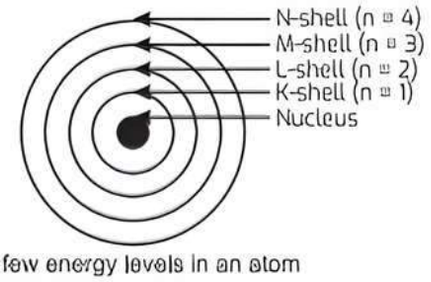
Case Study 7

In order to overcome the objections raised against Rutherford's model of the atom, Neils Bohr put forward the following postulates about the model of an atom:

(i) Only certain special orbits known as discrete orbits of electrons, are allowed inside the atom.

(ii) While revolving in discrete orbits the electrons do not radiate energy.

These orbits or shells are called energy levels. Energy levels in an atom are shown in figure.



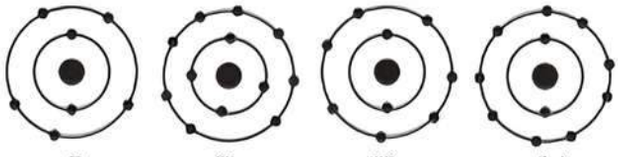
A few energy levels in an atom

These orbits or shells are represented by the letters K, L, M, N,.... or the numbers, $n = 1, 2, 3, 4, \ldots$.

Read the given passage carefully and give the answer of the following questions:

Q 1. A few energy levels in an atom are shown in the above figure. Which model of an atom is represented by the given figure?

Q 2. Which of the following figures do not represent Bohr's model of an atom correctly?



Q 3. Write two important postulates of Bohr's model of an atom.

Q 4. Which shell of an atom can accommodate a maximum of: (i) 8 electrons (ii) 32 electrons?

Q 5. An element has an atomic number of 15 and its mass number is 31. What is the arrangement of electrons in the shells?

Answers

1. Bohr's model of atom.
2. Fig. (ii) contains 4 electrons in K-shell and fig. (iv) contains 9 electrons in L-shell which are not in accordance with Bohr's model.
3. (i) Only certain special orbits known as discrete orbits of electrons, are allowed inside the atom.
   (ii) While revolving in discrete orbits, the electrons do not radiate energy.
4. (i) L-shell (ii) N-shell
5. Electron distribution K L M
   2, 8, 5

Case Study 8

Study the table related to distribution of electrons, neutrons and protons in six atoms/ions (A to F).

Atoms/ Ions	Number of Electrons	Number of Neutrons	Number of Protons
A	4	4	3
B	10	12	11
C	17	18	17
D	17	20	17
E	18	22	18
F	19	21	19

Read the given passage carefully and give the answer of the following questions:

Q 1. Find a pair of ions.

Q 2. Find an atom of a noble gas.

Q 3. Find a pair of isobars.

Q 4. Find a pair of isotopes.

Q 5. Which atom/ions have valency one?

Answers

1. A and B are ions as number of protons not equal to the number of electrons.
2. E is a noble gas.
3. E and F are isobars.
4. C and D are isotopes.
5. C, D and F.

Very Short Answer Type Questions

Q 1. What are canal rays? *(NCERT INTEXT)*

Ans. Canal rays are positively charged radiations consisting of particles which have a charge equal in magnitude but opposite in sign to that of electron. They were discovered by E. Goldstein in 1886.

Q 2. What is a proton? Who discovered it?

Ans. Proton is a positively charged particle present in the nucleus, which was discovered by E. Goldstein.

Q 3. If an atom contains one electron and one proton, will it carry any charge or not? *(NCERT INTEXT)*

Ans. No, it will not carry any charge because magnitude of positively charged particles (proton) is equal to negatively charged particle (electron).

Q 4. Why did Rutherford select a gold foil in his α-ray scattering experiment? *(NCERT EXEMPLAR)*

Ans. It is because gold is highly malleable and thus, a very thin foil of gold can be obtained.

Q 5. How is an α-particle different from a helium atom?

Ans. α-particles are doubly-charged helium ions whereas helium atom is electrically neutral.

Q 6. On the basis of Rutherford's model of an atom, which subatomic particle is present in the nucleus of an atom? *(NCERT EXERCISE)*

Ans. Proton is present in the nucleus of an atom. It is a positively charged particle.

Q 7. What was the drawback of Rutherford's model of an atom?

Ans. The drawback of Rutherford's model of an atom was that it could not explain the stability of atom.

Q 8. Name the three sub-atomic particles of an atom. *(NCERT INTEXT)*

Ans. (i) Electron (ii) Proton (iii) Neutron

Q 9. What are the charge and mass of a neutron?

Ans. Neutron is electrically neutral and it does not have any charge. Its mass is 1.67×10^{-27} kg.

Q 10. According to Bohr-Bury scheme, what is the maximum number of electrons present in M-shell of an atom?

Ans. According to Bohr-Bury scheme, the maximum number of electrons in M-shell is equal to

$$2 \times 3^2 = 2 \times 9 = 18.$$

Q 11. Define valency.

Ans. Valency is the combining capacity of an atom.

Q 12. Write down the electron distribution of chlorine atom. How many electrons are there in the L-shell? (Atomic number of chlorine is 17). *(NCERT EXEMPLAR)*

Ans. Electronic distribution of Cl (17) is 2, 8, 7. The L (second) shell has eight electrons.

Q 13. Helium atom has 2 electrons in its valence shell but its valency is not 2. Explain. *(NCERT EXEMPLAR)*

Ans. Its valency is zero because its first shell is its outermost shell which is complete. Therefore, it cannot lose or gain or share electrons.

Q 14. What is the difference between Na and Na^+ in terms of number of electrons?

Ans. Na atom has 11 electrons, whereas Na^+ ion consists of only 10 electrons.

TiP

An atom can be an ion but not all ions are atoms.

Q 15. One electron is present in the outermost shell of the atom of an element *X*. What would be the nature and value of charge on the ion formed, if this electron is removed from the outermost shell? *(NCERT EXEMPLAR)*

Ans. It will acquire positive charge and value will be equal to +1.

Q 16. In the atom of an element *X*, 6 electrons are present in the outermost shell. If it acquires noble gas configuration by accepting requisite number of electrons, then what would be the charge on the ion so formed?

Ans. It will acquire negative charge and value will be equal to −2 because to attain noble gas configuration, it requires 2 more electrons.

Q 17. Which of the two would be chemically more reactive: element *A* with atomic number 18 or element *D* with atomic number 16 and why?

Ans. Electronic configuration of ${}_{18}A$ = 2, 8, 8. It would be chemically inert due to its complete octet.
Electronic configuration of ${}_{16}D$ = 2, 8, 6
To complete its octet, it will gain 2 electrons. Therefore, it will be more reactive.

Q 18. In the notation of nitrogen ${}^{14}_{7}N$, what do the numbers 14 and 7 denote?

Ans. The number 14 represents its mass number and 7 represents its atomic number.

Q 19. If Mg^{2+} has 12 protons and 12 neutrons, what is its atomic number and mass number?

Ans. Atomic number = p = 12,
Mass number = $n + p$ = 12 + 12 = 24

Q 20. Write the mass number of neon and argon from the data given below:

Elements	Number of Protons	Number of Neutrons
Neon	10	10
Argon	18	22

Ans. Mass number = Number of protons + Number of neutrons
For Neon, mass number = 10 + 10 = 20
For Argon, mass number = 18 + 22 = 40

Q 21. An atom of an element is represented as ${}^{19}_{9}X$. How many electrons and neutrons are present in this atom?

Ans. Number of electrons = 9 = Number of protons = Atomic number
Also, number of neutrons = mass number – atomic number = 19 – 9 = 10

Q 22. Define isotopes.

Ans. Isotopes are atoms of the same element which have different mass numbers.

Q 23. Is it possible for the atom of an element to have 1 electron, 1 proton and no neutrons? If yes, name the element. *(NCERT EXEMPLAR)*

Ans. Yes, protium (${}^{1}_{1}H$) is an isotope of hydrogen that has 1 electron, 1 proton and no neutron.

Q 24. Identify the pair of isotopes from the following ${}^{16}_{8}X$, ${}^{17}_{7}X$, ${}^{17}_{8}X$.

Ans. ${}^{16}_{8}X$ and ${}^{17}_{8}X$ are isotopes as they have same atomic number but different mass number.

Q 25. Will ${}^{35}_{17}Cl$ and ${}^{37}_{17}Cl$ have different valencies? Justify your answer. *(NCERT EXEMPLAR)*

Ans. No, they will have the same valencies because they are isotopes and hence have same atomic numbers and same number of valence electrons.

Q 26. Study the composition of the two nuclei of two atomic species L and M.
L = Protons 20, Neutrons 20
M = Protons 18, Neutrons 22
Give the relation between the two.

Ans. L = nucleons = 20 + 20 = 40
M = nucleons = 18 + 22 = 40
Both have same atomic mass but different atomic number. So, they are isobars.

Short Answer Type-I Questions

Q 1. What are the limitations of J. J. Thomson's model of an atom? *(NCERT EXERCISE)*

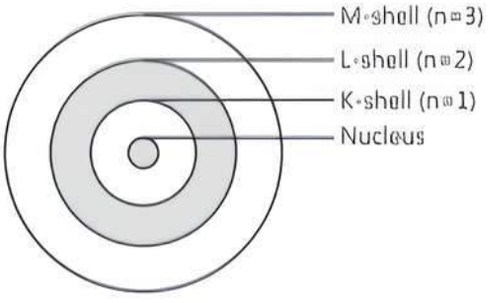
Ans. (i) The results of experiments carried out by other scientists such as Rutherford's experiment could not be explained by this model.
(ii) It couldn't explain the stability of the atom, *i.e.*, how positive and negative charge could remain so close together.

Q 2. 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? *(NCERT INTEXT)*

Ans. If α-particle scattering experiment is carried out using a foil of any metal as thin as gold foil used by Rutherford, there would be no change in observations since, other metals are not so malleable and such a thin foil is difficult to obtain. If a thick foil is used instead of thin one, then more α-particles would bounce back and no idea about the location of positive mass in the atom would be available with such certainty.

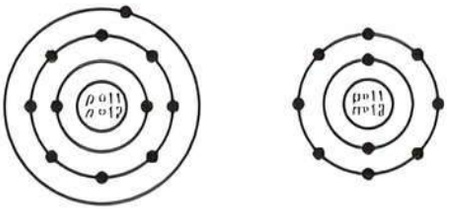
Q 3. Draw a sketch of Bohr's model of an atom with three shells. *(NCERT INTEXT)*

Ans. Bohr's Model of an Atom:



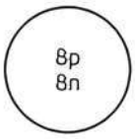
Q 4. Show diagrammatically the electron distributions in a sodium atom and a sodium ion and also give their atomic number. *(NCERT EXEMPLAR)*

Ans. Electronic distribution of sodium atom = 2, 8, 1



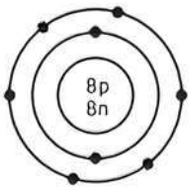
Electronic distribution of sodium ion = 2, 8 (11 – 1 = 10 electrons)
Since, sodium atom and sodium ion contain same number of protons, the atomic number is 11 of sodium atom and sodium ion.

Q 5. Given below is a diagram of the nucleus of the atom:



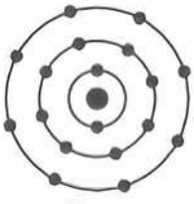
(i) Complete the diagram to show the electronic arrangement of this atom.
(ii) Write the electronic configuration of the element.

Ans. (i)



(ii) Electronic configuration = 2, 6

Q 6. Find out the valency of the atoms represented by the figures (i) and (ii). *(NCERT EXEMPLAR)*



(i)  **(ii)**

Ans. Atom (i) has valency equal to zero as its octet is complete, *i.e.*, it has 8 electrons in its valence shell.
Atom (ii) has valency equal to 1 as it has 7 valence electrons. It can gain or share 1 electron to become stable.

Q 7. Why do helium, neon and argon have zero valency? *(NCERT EXEMPLAR)*

Ans. Helium has 2 electrons in its valence shell whereas neon and argon have 8 electrons in their valence shells. As, they have maximum number of electrons in their valence shells, they do not have any tendency to gain or lose or share electrons with other elements. Therefore, they have zero valency.

Q 8. 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? *(NCERT INTEXT)*

Ans. (i) Atomic number = Number of protons = 8
(ii) Charge on atom is zero because the number of electrons is equal to the number of protons.

Q 9. The atom of an element has 9 protons, 9 electrons and 10 neutrons.
(i) What is the atomic number of the element?
(ii) What is the mass number of the element?
(iii) Name the element and give its electronic configuration.
(iv) Predict the valency of the element.

Ans. (i) Atomic number = Number of protons = 9
(ii) Mass number = Number of protons + Number of neutrons = 9 + 10 = 19
(iii) The element is fluorine (F). Its electronic configuration is 2, 7.
(iv) Valency of fluorine = 8–7 = 1

Q 10. Give two points of difference between isotopes and isobars.

Ans.

Basis of Difference	Isotopes	Isobars
Definition	These are the atoms of same element.	These are the atoms of different element.
Atomic number	They have same atomic number.	They have different atomic numbers.
Mass number	They have different mass numbers.	They have same mass numbers.
Chemical and physical properties	Their chemical properties are similar but physical properties are different.	They have different chemical and physical properties.

(Any two)

Q 11. 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? *(NCERT EXERCISE)*

Ans. Mass number of '*X*' = 6 + 6 = 12.
Mass number of '*Y*' = 6 + 8 = 14.
The species are isotopes as their mass numbers are different but atomic numbers are same.

Q 12. The two isotopes of chlorine have mass number 35 and 37 and number of neutrons 18 and 20, respectively. Which one will have a higher valency? Do they have the same physical or chemical properties?

Ans. Number of protons in ^{35}Cl = 35 – 18 = 17
Number of electrons = Number of protons = 17
Similarly, number of protons in ^{37}Cl = 37 – 20 = 17
Number of electrons = 17
∴ Both have same number of electrons, *i.e.*, 17.
Hence, they will have the same valency, *i.e.*, 1.
Since, both are isotopes of chlorine, so they will show the same chemical properties but may show some different physical properties.

Q 13. If bromine atom is available in the form of, say, two isotopes $^{79}_{35}Br$ (49.7%) and $^{81}_{35}Br$ (50.3%), calculate the average atomic mass of bromine atom. *(NCERT EXERCISE)*

Sol. Average atomic mass of Bromine

$$= \left(\text{Atomic mass of } {}^{79}_{35}Br \times \text{Percentage} + \frac{\text{Atomic mass of } {}^{81}_{35}Br \times \text{Percentage}}{100}\right)$$

$$= \frac{79 \times 49.7 + 81 \times 50.3}{100} = \frac{3926.3 + 4074.3}{100}$$

$$= \frac{8000.6}{100} = 80.006u$$

Q 14. (i) Identify which of the following pairs are isotopes and which are isobars? Give reasons for your choice.

$$^{58}_{26}A,\ ^{58}_{28}B,\ ^{79}_{35}X,\ ^{80}_{35}Y$$

(ii) Do isobars also have identical chemical properties like isotopes? State reason.

Ans. (i) $^{58}_{26}A$ and $^{58}_{28}B$ are isobars as they are atoms of different elements having the same mass number. $^{79}_{35}X$ and $^{80}_{35}Y$ are isotopes as they are atoms of same element (same atomic number) having different mass numbers.

(ii) No, isobars do not have identical chemical properties, as they have different atomic numbers and electronic configurations as well.

Short Answer Type-II Questions

Q 1. Compare the properties of electrons, protons and neutrons. *(NCERT EXERCISE)*

Ans.

Properties	Electron	Proton	Neutron
Discovery	J.J. Thomson	E. Goldstein	J. Chadwick
Location	Present around the nucleus	Present inside the nucleus	Present inside the nucleus
Symbol	e^-	p^+	n
Nature	Negatively charged	Positively charged	Neutral
Relative charge	−1	+1	0
Absolute charge	-1.6×10^{-19} C	$+1.6 \times 10^{-19}$ C	0
Relative mass	1/1838 u	1u	1 u
Absolute mass	9.1×10^{-31} kg	1.67×10^{-27} kg	1.67×10^{-27} kg

(Any six)

Q 2. State the observations in α-particle scattering experiment which led Rutherford to make the following conclusions:

(i) Most of the space in an atom is empty.

(ii) Whole mass of an atom is concentrated in its centre.

(iii) Centre is positively charged.

Ans. The observations are as follows:

(i) Most of the alpha rays passed through a thin gold foil straight.

(ii) A very few rays returned back to the same path.

(iii) Some rays were deflected through larger angles.

Q 3. Give reasons:

(i) Mass number of an atom excludes the mass of an electron.

(ii) Nucleus of an atom is charged.

(iii) α-particle scattering experiment was possible by using gold foil only and not by foil of any other metal.

Ans. (i) Because the mass of electron is negligible.

(ii) Nucleus of an atom consists of positively charged protons and neutrons which do not have charge, hence net charge on nucleus is positive.

(iii) It is because gold metal is highly malleable and very thin foil of gold was taken.

Q 4. Describe Bohr's model of the atom. *(NCERT EXERCISE)*

Ans. In 1913, Neil Bohr proposed a model of atomic structure having the following postulates:

(i) Electrons revolve around a centrally located heavy, small and positively charged nucleus in certain discrete orbits.

(ii) While revolving in discrete orbits, the electrons do not radiate energy.

(iii) These discrete orbits or shells are called energy levels. These orbitals or shells are represented by the letters K, L, M, N.... or the numbers 1, 2, 3, 4.....

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

Ans.

J. J. Thomson	Rutherford	Bohr
Atom consist of a sphere of positive charge.	Atom consist of a small positively charged part, called nucleus, at the centre. The entire mass of an atom is concentrated in the nucleus.	The protons are located in a small nucleus at the centre of the atom.
Electrons are embedded in the sphere of positive charge.	Electrons revolve around the nucleus in circular paths.	Electrons revolve around the nucleus in discrete orbits and do not radiate energy.

The positive and negative charges are equal in magnitude, due to which an atom is electrically neutral.	Size of nucleus is very small as compared to the size of the atom. Atom is electrically neutral.	These orbits are called energy levels and represented by letters K, L, M, N ... or the numbers 1, 2, 3, 4...

Q 6. (i) Explain Bohr-Bury scheme for distribution of electrons into different shells.

(ii) Draw the electronic structure of element *X* with atomic number 16 and element *Y* with atomic number 17.

Ans. (i) **Bohr-Bury Scheme for Distribution of Electrons:**

(a) The maximum number of electrons present in any shell of an atom is given by the formula $2n^2$, where '*n*' is the number of shells as counted from the nucleus *i.e.*, first shell can accommodate 2 electrons, second shell can accommodate 8 electrons, third shell can accommodate 18 electrons and so on.

(b) Outermost orbit of an atom can accommodate a maximum of 8 electrons.

(c) Electrons are not accommodated in a given shell unless the inner shells are filled *i.e.*, the shells are filled in a step-wise manner.

(ii) **Electronic Structures:**

X (Atomic number 16) = 2,8,6

Y (Atomic number 17) = 2,8,7

Q 7. An atom of an element has 7 electrons in its L-shell.

(i) What is its atomic number?

(ii) State its valency.

(iii) Identify the element.

Ans. (i) Its atomic number will be equal to 2 + 7 = 9.

(ii) Its valency is equal to one because it can gain 1 electron to become stable.

(iii) The element is fluorine.

Q 8. Two elements are represented as $^{35}_{17}X$ and $^{24}_{12}Y$.

(i) Write the electronic configurations of *X* and *Y*.

(ii) Which of these elements will lose and gain electrons?

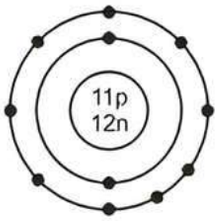
(iii) What is the number of electrons an atom loses, gains or shares called?

Ans. (i) Electronic configuration of *X* (Atomic number = 17) is 2, 8, 7.
Electronic configuration of *Y* (Atomic number = 12) is 2, 8, 2.

(ii) *Y* will lose 2 electrons and X will gain 1 electron.

(iii) The number of electrons lost, gained or shared by an atom is called its valency.

Q 9. Given below is the atomic structure of an atom of element $^{23}_{11}A$, according to Bohr's model of atom.



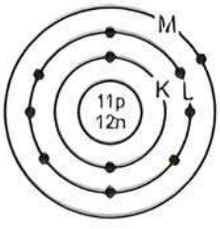
(i) What is wrong with this structure of atom?

(ii) Draw a correct representation of this atom.

(iii) Write the chemical formula of the chloride of this element.

Ans. (i) The element *A* is Na has three shells K, L and M but here only 2 shells are given. Further, L-shell cannot have more than 8 electrons but here 9 electrons are given.

(ii) The correct structure is

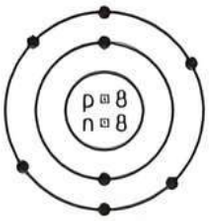


(iii) As Na has 1 valence electron, thus it has a valency of +1 and chlorine has a valency of −1. Hence, the formula of its chloride is ACl, *i.e.*, NaCl.

Q 10. (i) Write the name of an element whose atom has same number of sub-atomic particles. Draw the atomic structure of the atom.

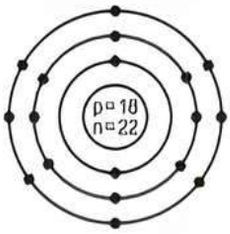
(ii) Draw atomic structure of an atom with same number of electrons in L and M-shells.

Ans. (i) Name of element: Oxygen ($^{16}_{8}O$)
Number of electrons = 8
Number of protons = 8
Number of neutrons = 16 − 8 = 8



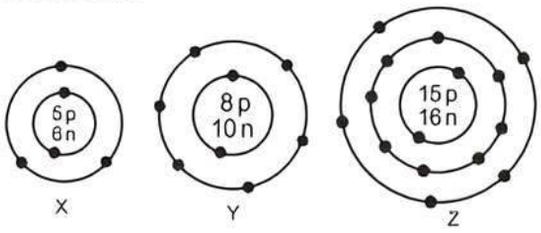
(ii) Name of element: Argon

	K	L	M
Atomic number (18) =	2,	8,	8



Number of electrons in L-shell = 8
Number of electrons in M-shell = 8

Q 11. What information do you get from the figure about the atomic number, mass number and valency of atoms *X*, *Y* and *Z*. Give your answer in a tabular form ? *(NCERT EXEMPLAR)*



Ans. The tabular form is as below:

Element	Atomic Number (= no. of p)	Mass Number (= no. of (p+n))	Number of Electrons (= no. of p)	Electronic Configuration	Valency
X	5	5+6 = 11	5	2, 3	3
Y	8	8+10 = 18	8	2, 6	2
Z	15	15+16 = 31	15	2, 8, 5	3, 5

Q 12. Complete the table on the basis of information available in the symbols given below.

(i) $^{35}_{17}Cl$ (ii) $^{12}_{6}C$ (iii) $^{81}_{35}Br *(NCERT EXEMPLAR)*

Elements	n_p	n_n

Ans. Atomic number is written on the lower left side of the symbol of element whereas mass number is written on the upper left side of the symbol of element.

Number of protons (n_p) = Atomic number of atoms and number of neutrons (n_n) = Mass number − atomic number.

	Elements	n_p	n_n
(i)	$^{35}_{17}Cl$	17	35 − 17 = 18
(ii)	$^{12}_{6}C$	6	12 − 6 = 6
(iii)	$^{81}_{35}Br$	35	81 − 35 = 46

Q 13. In the following table, the mass number and the atomic number of certain elements are given:

Elements	Mass No.	Atomic No.
A	2	1
B	3	1
C	3	2
D	6	3
E	9	4
F	11	5
G	19	9
H	23	11

(i) How many neutrons are present in '*F*'?
(ii) Which atoms are isotopes of the same element?
(iii) Which atoms will form positively charged ions?
(iv) Which is the atom of an inert gas?
(v) Which atom will form negatively charged ion?
(vi) Which of these has 11 electrons?

Ans. (i) Number of neutrons in '*F*' = 11 − 5 = 6
(ii) '*A*' and '*B*' are isotopes of the same element.
(iii) '*D*' and '*H*' will form positively charged ions.
(iv) Element '*C*' is an inert gas.
(v) '*G*' will form a negatively charged ion.
(vi) '*H*' has 11 electrons.

Q 14. Sulphur dioxide (SO_2) is a colourless pungent smelling gas and is a major air pollutant.

(i) Write the electronic configuration of its constituent elements 'sulphur and oxygen' (Given: $^{32}_{16}S$, $^{16}_{8}O$).
(ii) Write the valency of sulphur and oxygen.
(iii) Are sulphur and oxygen isotopes of same element? Explain your answer.

Ans. (i) Electronic configuration of sulphur (S) = 2, 8, 6 and of oxygen (O) = 2, 6
(ii) Valency of both sulphur and oxygen is 2, as they both have 6 valence electrons.
(iii) Isotopes are the elements having the same atomic number but different mass numbers. Therefore, sulphur and oxygen are not isotopes, as their atomic numbers are different.

Q 15. (i) Chlorine occurs in nature in two isotopic forms with masses 35 u and 37 u in the ratio of 3 : 1. Calculate the average atomic mass of chlorine atom on the basis of this data.

(ii) Give any three uses of isotopes.

Ans. (i) Average atomic mass of chlorine atom
= (35 × 3 + 37 × 1) / 4
= (105 + 37) / 4
= 142 / 4 = 35.5 u

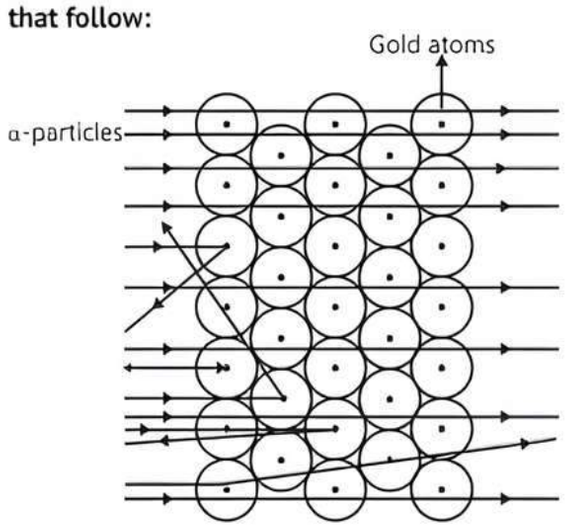
(ii) Uses of Isotopes:
(a) An isotope of uranium (uranium-235) is used as a fuel in nuclear reactors.
(b) An isotope of cobalt (cobalt-60) is used in the treatment of cancer.
(c) An isotope of iodine (iodine-131) is used in the treatment of goitre.

TiP

Cobalt-60 is a hard gray-blue metal that is solid under normal conditions and is produced by neutron bombardment of stable cobalt in a nuclear reactor.

Long Answer Type Questions

Q 1. Observe the given figure and answer the questions that follow:



(i) Which experiment is represented by the given figure?

(ii) List three observations of this experiment.

(iii) State conclusions drawn from each observation of this experiment.

(iv) What were the drawbacks of this model of an atom?

Ans. (i) Rutherford's α-particle scattering experiment is represented by the given figure.

(ii) Observations:

(a) Most of the fast moving α-particles passed straight through the gold foil.

(b) Some of the α-particles were deflected by the foil by small angles.

(c) One out of every 12000 particles appeared to rebound.

(iii) Conclusions:

(a) Most of the space inside the atom is empty because most of the α-particles passed through the gold foil without getting deflected.

(b) Very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space.

(c) A very small fraction of α-particles were deflected by 180°, indicating that all positive charge and the mass of the gold atom were concentrated in a very small volume within the atom.

(iv) Drawbacks: It can't explain the stability of an atom. As per the model, revolving electrons in orbits will undergo acceleration and radiate energy. This will result in loss of energy of electrons and finally they will fall into the nucleus.

Q 2. (i) Answer the following:

(a) What is the maximum number of electrons that can be accommodated in the outermost energy shell in an atom?

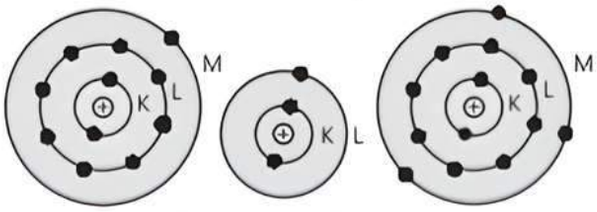
(b) An element has five electrons in the N-shell which is the outermost shell. Write its electronic configuration.

(ii) Show diagrammatically the electron distributions in sodium, lithium and aluminium atoms.

Ans. (i) (a) The maximum number of electrons that can be accommodated in the outermost shell is 8.

(b) The electronic configuration of element is 2, 8, 8, 5.

(ii) Electron Distributions in Na, Li and Al:



TiP

Permissible orbits are allowed energy states for an electron in the atom.

Q 3. Explain with examples, (i) Atomic number, (ii) Mass number, (iii) Isotopes and (iv) Isobars. Give any two uses of isotopes. *(NCERT EXERCISE)*

Ans. (i) Atomic number is defined as the number of protons present in the nucleus of an atom. For example, there are 6 protons in carbon, so the atomic number of carbon is 6.

(ii) Mass number is defined as the sum of the total number of protons and neutrons present in the nucleus of an atom. For example, there are 6 protons and 6 neutrons in the nucleus of carbon, so its mass number is 12.

(iii) Isotopes are atoms of the same element thus having same atomic number but different mass number. For example, chlorine has two isotopes with atomic number 17 but mass number are 35 and 37 represented as $^{35}_{17}Cl$ and $^{37}_{17}Cl$ respectively.

(iv) Isobars are such atoms which have the same mass number but different atomic numbers. Thus, isobars are different elements. For example, Ca has atomic number 20 and Ar has atomic number 18, but both of them have mass numbers 40 represented by $^{40}_{20}Ca$ and $^{40}_{18}Ar$, respectively.

Uses of Isotopes:

(I) The cobalt-60 isotope is used in the treatment of cancer.

(II) The uranium-235 isotope is used as a fuel in nuclear reactors.

Q 4. Complete the following table:

Atom	Atomic symbol	Mass number	Atomic number	Number of		
				Electrons	Protons	Neutrons
Sodium	Na	23			11	12
Carbon					6	
Oxygen						8
Potassium		39				20
Iron		56	26			
Neon					10	10

Ans.

Atom	Atomic symbol	Mass number	Atomic number	Number of		
				Electrons	Protons	Neutrons
Sodium	Na	23	11	11	11	12
Carbon	C	12	6	6	6	6
Oxygen	O	16	8	8	8	8
Potassium	K	39	19	19	19	20
Iron	Fe	56	26	26	26	30
Neon	Ne	20	10	10	10	10

Q 5. Use the information to answer the following questions:

Elements	P	Q	R	S	T	U	V
Proton numbers	7	8	10	12	15	18	19

(i) Which of these elements have four filled electron shells?

(ii) Which of these elements have a complete outermost shell?

(iii) Which of these elements have 5 valence electrons?

(iv) Which of these elements have 2 valence electrons?

(v) Write the valencies of each of the elements.

K L M N

Ans. (i) Electron distribution of V = 2, 8, 8, 1

Thus, V has four filled electron shells.

(ii) Electron distribution of R = 2, 8

Electron distribution of U = 2, 8, 8

Thus, R and U have a complete outermost shell.

(iii) Electron distribution of P = 2,5

Electron distribution of T = 2, 8, 5

Thus, P and T have 5 valence electrons.

(iv) Electron distribution of S = 2, 8, 2

Thus, S has 2 valence electrons.

(v) Electron distribution of Q = 2, 6

Valency of P = 8 – 5 = 3, Valency of Q = 8 – 6 = 2

Valency of R = 0, Valency of S = 2

Valency of T = 8–5 = 3, Valency of U = 0

Valency of V = 1

Q 6. (i) An element *X* has atomic number 12 and atomic mass number 26. Draw a diagram showing the distribution of electrons in the orbits and the nuclear composition of the neutral atom of the element. What is the valency of the element and why?

(ii) If this element *X* combines with another element *Y* whose electronic configuration is 2, 8, 7, what will be the formula of the compound thus formed? State how you arrived at this formula?

Ans. (i) **Nuclear Composition:**

$\because$ Mass number = 26

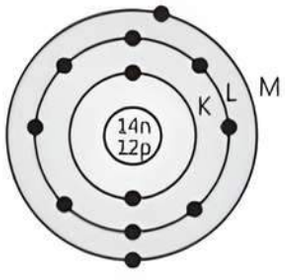
$\therefore$ $p + n = 26$

But p = atomic number = 12

$\therefore$ $12 + n = 26$

$\Rightarrow$ $n = 26 - 12 = 14$

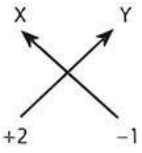
Valency of this element is 2 because it can donate two electrons easily to complete its octet and hence, becomes stable.



K = 2, L = 8, M = 2

Electron Distribution in the Orbits

(ii) Y has electronic configuration 2, 8, 7. Therefore, valency = 1, *i.e.*, it is monovalent.



Formula: XY_2

Q 7. Give reasons for the following:

(i) Isotopes of an element are chemically similar.

(ii) An atom of Argon has zero valency.

(iii) Noble gases have least reactivity.

(iv) Isotopes of hydrogen are chemically alike.

(v) Ions are more stable than atoms.

Ans. (i) Isotopes of an element have same atomic number and electronic configuration. The elements with similar configuration will have similar properties as chemical properties of elements are related to electronic configurations. So, the isotopes of an element are chemically similar.

(ii) Atomic number of Argon = 18
Its electronic configuration will be 2, 8, 8.
So, it has 8 electrons in its valence shell. Hence, its valency = 8 − 8 = 0 *i.e.*, an atom of Argon has zero valency.

(iii) The atoms of noble gas elements have complete outermost shells. So, they are least reactive.

(iv) Hydrogen has three isotopes $^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$ which are chemically alike because they have same atomic number, *i.e.*, same number of valence electrons.

(v) When an atom changes into an ion, either a cation or an anion, the valence shell of the ion has a complete duplet or an octet. So, Ions are more stable than atoms.

Chapter Test

Multiple Choice Questions

Q 1. An α-particle has:

a. charge = +4, mass = 2 u
b. charge = +2, mass = 4 u
c. charge = +2, mass = 2 u
d. charge = +4, mass = 4 u

Q 2. The isobars among the following is:

a. $^{40}_{20}Ca$ $^{23}_{11}Na$ b. $^{16}_{8}O$ $^{18}_{8}O$

c. $^{20}_{18}Ar$ $^{20}_{19}K$ d. $^{19}_{7}X$ $^{13}_{7}Y$

Q 3. An atom of an element has two electrons in the M shell. Identify its atomic number.

a. 10 b. 15 c. 12 d. 14

Q 4. There are 42 protons and 53 neutrons in the atom of an element. The element is represented as:

a. $^{95}_{42}X$ b. $^{53}_{42}X$ c. $^{42}_{53}X$ d. $^{42}_{95}X$

Assertion and Reason Type Questions

Directions (Q. Nos. 5-6): *Each of the following questions consists of two statements, one is* ***Assertion*** *(A) and the other is* ***Reason*** *(R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:*

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
c. Assertion (A) is true but Reason (R) is false.
d. Assertion (A) is false but Reason (R) is true.

Q 5. Assertion (A): The mass number of an atom is the sum of number of protons and neutrons it contains.
Reason (R): The mass number of an atom can never be smaller than the atomic number.

Q 6. Assertion (A): According to Rutherford, very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space.
Reason (R): The entire mass of an atom is concentrated in the nucleus.

Case Study Based Question

Q 7. Atomic number and mass number are always whole numbers because they are obtained by counting whole objects (protons, neutrons and electrons). The number of protons in the nucleus of an atom determines an element's atomic number. In other words, each element has a unique number that identifies how many protons are in one atom of that element. For example, all carbon atoms and only carbon atoms, contain six protons and have an atomic number of 6.
The mass number is the number of neutrons in an atom of a specific element plus the number of protons in an atom of that element. For example, the mass number of a regular carbon atom is 12, since a carbon atom has 6 protons and 6 neutrons in its nucleus. The mass number is approximately equal to the atomic mass, which is the mass of a single atom of an element measured in atomic mass units (amu).

Read the given passage carefully and give the answer of the following questions:

(i) The mass number of an atom is because of:

a. electrons and protons
b. electrons and neutrons
c. neutrons and protons
d. electrons, neutrons and protons

(ii) For an atom of given element, the number of electrons is equal to:

a. the number of protons + the number of neutrons
b. the atomic number of element
c. the number of protons − the number of neutrons
d. the mass number of element

(iii) Which of the following is not true for atomic number?

a. It indicates the number of protons in the nucleus.
b. It is represented by Z.
c. It is identical with mass number.
d. It is constant for a given element.

(iv) Which of the following is not true for $^{27}_{13}Al$?

a. It has 14 neutrons.
b. It has 13 protons.
c. 27 is the mass number.
d. 27 is the atomic number.

Very Short Answer Type Questions

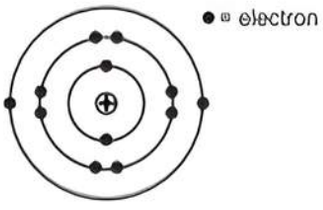
Q 8. Explain why chlorine has relative atomic mass of about 35.5u?

Q 9. If $Z = 3$, what would be the valency of the element?

Short Answer Type-I Questions

Q 10. (i) What is an octet?

(ii) The diagram shows the electronic configuration of an element *X*.



How many protons does the nucleus of the atom contain?

Q 11. What were the conclusions of Rutherford's α-particle scattering experiment ?

Q 12. What are isotopes? Write the isotopes of carbon and chlorine.

Short Answer Type-II Questions

Q 13. Define mass number and atomic number. How are these represented around the symbol of an element? The mass number and atomic number of an isotope of Uranium (U) are 235 and 92 respectively. Calculate the number of protons and neutrons in the nucleus of the atom.

Q 14. (i) What was J. J. Thomson's model of an atom? Also, state its limitations.

(ii) Which of the following are isotopes and which are isobars? Argon, Protium, Calcium, Deuterium.

Q 15. State three rules suggested by Bohr and Bury for the distribution of electrons into different orbits of an atom.

Long Answer Type Questions

Q 16. (i) The element boron occurs in nature as two isotopes having atomic masses 10 u and 11 u. What are the percentage abundances of these isotopes in a sample of boron having average atomic mass of 10.8 u?

(ii) Draw the electronic structures of sodium (atomic number = 11) and lithium (atomic number = 3). Compare the structures and state one similarity and one difference between them.

Q 17. (i) Compare the properties of electrons, protons and neutrons.

(ii) Explain why $^{3}_{1}H$ and $^{3}_{2}He$ are not considered isotopes.

(iii) Which subatomic particle was not present in Thomson's model of the atom?

(iv) State one drawback of Rutherford's model of the atom.