CHAPTER

2

Atomic Structure

Atomic Theory of Matter

In 1808, John Dalton gave his atomic theory of matter. According to this theory,

- Atom is the smallest indivisible particle of an element.
- Atom can neither be created nor be destroyed.
- Atoms of different elements differ in mass, size and chemical properties.
- The 'number' and 'kinds' of atoms in a given compound is fixed.
- Atoms of the same elements can combine in more than one ratio to form different compounds.

Atom

- Smallest particle of an element that can take part in chemical reaction.
- Atoms are made up of electrons, protons and neutrons.
- **Electron** ($_{-1}e^{0}$) has negative charge (discovered by JJ Thomson in 1897), charge on electron $= 1.6 \times 10^{-19}$ C. Mass of electron $= 9.1 \times 10^{-28}$ g. The magnitude of negative charge on electron was determined by Millikan.
- **Proton** ($_1H^1$) has positive charge (discovered by E. Goldstein). Charge on proton ($_1H^1$) $= 1.6 \times 10^{-19}$C. Mass of proton ($_1H^1$) $= 1.6 \times 10^{-24}$ g.
- **Neutron** ($_0n^1$) has no charge (discovered by Chadwick). Mass of neutron $= 1.6 \times 10^{-24}$g.

Molecule

- It is the smallest particle of a compound.
- Molecules of a compound contain two are more different types of atoms, *e.g.*, ammonia (NH_3), water (H_2O) etc.

Properties of Cathode Rays

- These travel in straight line, cast shadows of object placed in their path.
- These are negatively charged and produce mechanical effects.
- Charged particles present in cathode rays are electron.

Properties of Anode Rays

- These travels in straight line and can also produce mechanical effects. These are positively charged.

Nucleus (Discovered by Rutherford)

- Nucleus is positively charged and present at the centre of an atom.
- Entire mass of atom is concentrated in the nucleus.

Atomic Number

It is the number of protons in one atom of an element.

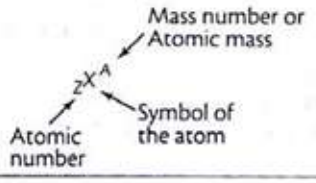
Number of protons = number of electrons (in case of neutral atom).

Mass number

It is the total number of protons and neutrons present in one atom of an element.

Mass number = number of protons + number of neutrons
= atomic number + number of neutrons
= number of electrons + number of neutrons

Representation of An Atom



Valence Electrons

- Valence electrons are located in the outermost shell of an atom. Elements having same number of valence electrons have similar chemical properties.

When an atom loses electron, it gets converted into **cation**, *i.e.*, carries one positive charge and if it gains one electron, it carries one negative charge, *i.e.*, converted into **anion**.

- Elements having 1, 2 or 3 valence electrons in their atoms are metals while those having 4, 5, 6 or 7 are non-metals.

Isotopes

Atoms of the same element having the same atomic number but different mass number are called isotopes *e.g.*

- $_1H^1$, $_1H^2$, $_1H^3$ are isotopes of hydrogen.
- $_6C^{12}$, $_6C^{13}$, $_6C^{14}$ are isotopes of carbon.
- $_8O^{16}$, $_8O^{17}$, $_8O^{18}$ are isotopes of oxygen.
- $_{10}Ne^{20}$, $_{10}Ne^{21}$, $_{10}Ne^{22}$ are isotopes of neon.

Isobars

- Atoms with the same mass number but different atomic number are called isobars *e.g.*, $_1H^3$ and $_2He^3$, $_{18}Ar^{40}$ and $_{19}K^{40}$ and $_{20}Ca^{40}$, $_{52}Te^{130}$ and $_{56}Ba^{130}$ and $_{54}Xe^{130}$.

Isotones have the same number of neutrons

Exercise

1. A body is charged negatively. It implies that **(CDS 2011 I)**
   (a) it has lost some of its protons
   (b) it has acquired some electrons from outside
   (c) it has lost some of its electrons
   (d) None of the above

2. The atoms of the elements which have same number of neutrons are called
   (a) isobars (b) isotopes
   (c) isotones (d) None of these

3. An electron carries
   (a) no charge (b) negative charge
   (c) positive charge (d) All of these

4. Neutron was discovered by
   (a) JJ Thomson (b) Chadwick (c) Rutherford (d) Priestley

5. A proton carries
   (a) a unit positive charge (b) a negative charge
   (c) no charge (d) None of these

6. Whose experiment proved that the speed of light was always the same?
   (a) James Clark Maxwell
   (b) Michelson and Morley
   (c) Miller and Stanley
   (d) Werner Heisenberg

7. The radioactive isotope of hydrogen is called
   (a) deuterium (b) protium
   (c) radium (d) tritium

8. **Assertion (A)** X-rays are not deflected by electric field.
   Reason (R) X-rays travels with the velocity of light.
   (a) Both A and R are true and R is the correct explanation of A.
   (b) Both A and R are true but R is not the correct explanation of A.
   (c) A is true but R is false.
   (d) A is false but R is true.

9. Cathode rays have
   (a) mass and charge (b) charge
   (c) mass (d) None of these

10. Isotopes are atoms showing same
    (a) mass number (b) atomic mass
    (c) number of neutrons (d) atomic number

11. Electromagnetic radiation with maximum wavelength is
    (a) ultraviolet (b) radio waves
    (c) X-rays (d) infrared

12. Neutrons are present in all atoms except
    (a) He (b) C
    (c) H (d) Ne

13. The valency of an element of mass number 27, which has 13 neutrons is
    (a) 6 (b) 4
    (c) 3 (d) 0

14. Positive rays in a discharge tube with perforated cathode travel
    (a) parallel to the anode
    (b) parallel to the cathode
    (c) from cathode to anode
    (d) from anode to cathode

15. Match the following columns.

Column I	Column II
A. Proton	1. Chadwick
B. Neutron	2. Millikan
C. Charge of electron	3. Goldstein
D. Shelled nature of atom	4. Rutherford
	5. Madam Curie

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	5	3	(b)	3	1	5	4
(c)	5	2	1	4	(d)	3	1	2	4

16. Consider the following rays
    1. X-rays
    2. Gamma rays
    3. Ultraviolet rays
    4. Beta-rays

    On the path of which of these rays does the application of electric and magnetic fields has no influence?
    (a) 1, 2 and 3 (b) 2, 3 and 4
    (c) 1, 3 and 4 (d) 1, 2 and 4

17. Meson particles were predicted by
    (a) Bohr (b) Mosley
    (c) H Yukawa (d) Perrin

18. Emission of which one of the following will produce isobars?
(a) Alpha particles (b) Beta particles
(c) Gamma rays (d) X-rays

19. Taking into account three isotopes of hydrogen and three isotopes of oxygen occurring in nature, how many different kinds of water molecules can, we expect on the earth?
(a) Six (b) Nine
(c) Twelve (d) Eighteen

20. Which of the properties of the element is a whole number?
(a) Atomic mass (b) Atomic number
(c) Atomic radius (d) Atomic volume

21. Isotopes of the same elements have
(a) same number of neutrons
(b) same number of protons
(c) same atomic mass
(d) different chemical properties

Answers

1. (b)	2. (c)	3. (b)	4. (b)	5. (a)	6. (b)	7. (d)	8. (b)	9. (b)	10. (d)
11. (b)	12. (c)	13. (b)	14. (d)	15. (d)	16. (a)	17. (c)	18. (b)	19. (b)	20. (b)
21. (b)									

Hints and Solutions

1. Electrons are negatively charged and protons are positively charged particles. In any atom number of electrons and protons are equal, therefore, atoms are neutral. When an atom loses electron, it becomes positively charged and when an atom gains electron, it becomes negatively charged. Hence, a body is charged negatively when it has acquired some electrons from outside.

16. X-rays, gamma rays and UV rays all are electromagnetic radiation and neutral thus remain unaffected by electric and magnetic field.