- **Molecular mass :** Sum of the atomic masses of all the atoms in a molecule of the substance.
- **Formula unit mass :** Sum of the atomic masses of all the atoms in a formula unit of a compound.

Example 1

(a) A sample of vitamin C is known to contain 2.58×10^{24} oxygen atoms. How many moles of oxygen atoms are present in the sample ?

(b) Write one word for the following :

(i) In a balanced chemical equation, the sum of the masses of reactants and products remains unchanged.

(ii) A group of atoms carrying a fixed charge on them.

(c) Write chemical formulae of the following compounds :

(i) Sodium phosphate

(ii) Ammonium carbonate

Solution:

Step I: (a) Number of moles

$$= \frac{\text{Given no. of particles}}{\text{Avogadro number}}$$

$$= \frac{2.58 \times 10^{24}}{6.022 \times 10^{23}}$$

$$= 0.4284 \times 10$$

$$= 4.284 \text{ moles}$$

Step II: (b) (i) Law of conservation of mass.

(ii) Polyatomic Ion

Step III: (c) (i) Na_3PO_4

(ii) $(NH_4)_2CO_3$

(1 + 2 + 2 = 5)

CHAPTER-4

STRUCTURE OF ATOM

Revision Notes

- An atom is divisible and consists of charged particles.
- Ionization of gases in the discharge tube proved that atoms have sub-atomic particles.
- **Summary of characteristics of electrons, protons and neutrons:**

Characteristics	Electron	Proton	Neutron
Symbol	e	p	n
Relative charge	– 1	+ 1	0
Nature	Negatively charged	Positively charged	Neutral
Discovered by	J. J. Thomson	E. Goldstein	James Chadwick
Mass	1/2000 times mass of hydrogen atom	1 unit	Mass is nearly equal to that of proton

- **Thomson's model of atom:**

(i) An atom is a uniform sphere of positive charges (due to the presence of protons) as well as negative charges (due to the presence of electrons) which are embedded in it. This model is often called the 'Water Melon Model'.

(ii) An atom, as a whole, is electrically neutral because the negative and positive charges are equal in magnitude.

- **Limitations of Thomson's model of atom:** The model failed to explain how protons and electrons could be arranged in an atom so close to each other.
- α-particles are charged particles having two units of positive charge and four units of mass, i.e., they are double-charged helium ions (He^{2+}).
- **Observations predicted from α-particle scattering experiment by Rutherford based on Thomson's model of atom are:**

(i) Rutherford expected that if the model proposed earlier by J. J. Thomson, according to which there is uniform distribution of positive and negative charge, was correct then α-particles striking the gold atoms would be uniformly deflected which was not the case.

(ii) Since the α-particles were much heavier than the protons, he did not expect to see large deflections.

- **Selection of gold metal for Rutherford's α-particle scattering experiment:** Gold is easily malleable and can be beaten into very thin sheets.
- **Observations made by Rutherford from α-particle scattering experiment:**
  - **(i)** Most of the α-particles passed straight through gold foil without suffering any deflection from their original path.
  - **(ii)** Some of the α-particles were deflected by the foil at small angles.
  - **(iii)** One out of every 12000 particles appeared to rebound.
- **Conclusions from Rutherford's α-particle scattering experiment:**
  - **(i)** Most of the space inside the atom is empty. Hence, it allows the α-particles to pass straight through it without any deflection.
  - **(ii)** Very few particles were deflected from their path, which suggests that the positive charge of the atom occupies very little space.
  - **(iii)** The total volume occupied by a nucleus is very small compared to the total volume of the atom, as very few α-particles are reflected by 180^{o}, and all the positive charge and mass of the gold atom were concentrated in a very small volume within the atom.
- **Rutherford's nuclear model of an atom:**
  - **(i)** There is a positively charged centre in an atom called the nucleus and the entire mass of atom resides in the nucleus.
  - **(ii)** Electrons revolve around the nucleus in well-defined circular orbits.
  - **(iii)** Size of the nucleus is very small as compared to the size of an atom.
- **Defects in Rutherford's model of atom:**
  - **(i)** Rutherford had proposed that electrons move around a positively charged nucleus at a very high speed in circular orbits. Electron would have to be accelerated centripetally (tending to move toward a center) to remain in a circular orbit, but according to electromagnetic theory, if charged body (electron) is accelerated around another charged body (nucleus) then there would be continuous radiation of the moving body (i.e., electron). This loss of energy would slow down the speed of electron and eventually electron would fall into nucleus. But Rutherford's model could not explain such a collapse.
  - **(ii)** Rutherford had proposed that electrons revolve around the nucleus in fixed orbits. He did not specify the number of electrons in each orbit.
- **Postulates put forward by Bohr regarding model of atom:**
  - **(i)** Electrons revolve around the nucleus in a limited number of orbits called discrete orbits of electrons that are also called as permissible orbits.
  - **(ii)** While revolving in discrete orbits, the electrons do not radiate energy i.e., energy of an electron remains constant so long as it stays in a given orbit. Electrons present in different orbits have different energies.
  - **(iii)** When an electron jumps from lower energy level to higher energy level, some energy is absorbed, while energy is released when electron jumps from higher energy level to lower one.
- Orbits or shells are represented by the letters K, L, M, N... or the numbers, $n = 1, 2, 3, 4....$
- **Bohr-Bury scheme for distribution of electrons in different orbits:**
  - **(i)** Maximum number of electrons that can be accommodated in a shell is given by $2n^2$, where n is the shell number i.e., first shell can accommodate two electrons, second shell can accommodate eight electrons, third shell can accommodate 18 electrons and so on.

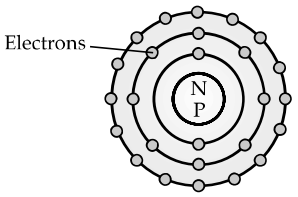

Fig. Distribution of electrons in different orbit.

(ii) Outermost orbit of an atom can accommodate a maximum number of eight electrons.

(iii) 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.

- Outermost shell of an atom is called **valence shell**.
- Neutrons are situated in the nucleus of all the atoms, except hydrogen.
- If the outermost shell of an atom is completely filled, its valency is 0.
- **Valency of elements having 1 to 4 electrons in the outermost shell are generally determined by the rule:** Valency = Number of electrons in the outermost shell.
- **Valency of elements having number of electrons in outermost shell close to 8 is determined by the formula:** Valency = 8 – Number of electrons in the outermost shell.
- **Significance of valence electrons:**
  - **(i)** Valence electrons are responsible for chemical changes.
  - **(ii)** Elements having same number of valence electrons in their atoms possess similar chemical properties because chemical properties of an element are determined by the number of valence electrons in an atom.
  - **(iii)** Elements having different number of valence electrons in their atoms possess different chemical properties.
- Protons and neutrons together are called **nucleons**.
- All atoms of an element have the same atomic number.
- Atomic number is denoted by 'Z' ($Z = n_p$).
- For a neutral atom, number of protons and electrons are equal.
- Mass number is denoted by 'A' ($A = n_p + n_N$).

  n_p = No. of protons

  n_N = No. of neutrons
- **Isotopes:**
  - **(i)** Isotopes are the atoms of same element having same atomic number but different mass number.
  - **(ii)** Isotopes have similar chemical properties because they have same number of valence electrons.
  - **(iii)** Isotopes have different physical properties such as boiling point and melting point because they have different mass numbers.
  - **(iv)** Atomic masses of elements are fractional, due to the fact that all elements have isotopes.
  - **(v) Applications of isotopes:**
    1. An isotope of uranium is used in nuclear reaction.
    2. An isotope of cobalt is used to remove brain tumours and their treatment.
    3. Isotope of sodium has been used to diagnose restricted circulation of blood.
  - **(vi) Example:** 3 isotopes of hydrogen–protium, deuterium and tritium.
- **Isobars:** Isobars are the atoms of different elements with different atomic numbers, but same mass number. Example: $_{20}Ca^{40}$, $_{18}Ar^{40}$.

Key Words

- **Canal rays:** Positively charged radiations discovered by Goldstein in a gas discharge tube at low pressure and high voltage.
- **Electron:** Negatively charged particle.
- **Proton:** Positively charged particle.
- **Neutron:** Neutral particle.
- **Energy level:** Possible locations around an atom where electrons having specific energy values may be found.
- **Octet:** Shell which has eight electrons in the outermost shell.
- **Valency:** Combining capacity of an atom.
- **Valence shell:** Outermost shell of an atom.
- **Valence electrons:** Electrons present in the valence shell.
- **Atomic number:** Total number of protons present in the nucleus of an atom.
- **Nucleons:** A nucleon is one of the particles that make up the atomic nucleus.
- **Mass number:** Sum of the total number of protons and neutrons present in the nucleus of an atom.

Example 1

Define the terms (a) isotope, (b) isobar giving one example of each.

Name the element whose isotope is used in (i) nuclear reactor, (ii) treatment of cancer.

Solution:

Step I: (a) The atoms of same element having same atomic number, but different mass numbers are called isotopes.

e.g., $_1H^1$, $_1H^2$, $_1H^3$.

(any other example) 1

(b) The atoms of different elements with same mass number and different atomic numbers are called isobars.

e.g., $_{20}Ca^{40}$, $_{18}As^{40}$. **(any other example)**

Step II: Mass number is same (*i.e*, 40) **1**

(i) Uranium

(ii) Cobalt ½ + ½

UNIT – II: ORGANISATION IN THE LIVING WORLD

CHAPTER-5

CELL BASIC UNIT OF LIFE

Topic-1 Cell-Prokaryotic, Eukaryotic and Multicellular organisms

Revision Notes

- In 1665, Robert Hooke first discovered and introduced the term 'cell'.
- Cell is the structural and functional unit of all living organisms.
- Organisms may be unicellular or multicellular. A single cell constitutes the unicellular organism whereas many cells coordinately function in case of multicellular organism.
- The size, shape and volume of the cells are related to the specific function that they perform.
- A cell generally shows plasma membrane, nucleus and cytoplasm.
- In 1674, Leeuwenhoek observed the living cells in protists and bacteria.
- In 1831, Robert Brown discovered the nucleus in the cell.
- Purkinje coined the term "Protoplasm" for the fluid substance of the cell in 1839.
- The cell theory that all the plants and animals are composed of cells and the cell is the basic unit of life was proposed by Schleiden and Schwann .
- Virchow (1855) expanded the cell theory by suggesting that all cells arise from pre-existing cells.
- Plasma membrane is the outer covering of the cell which separates the cellular components from the external environment.
- In plants, cell wall is present external to the cell membrane which is rigid and made up of cellulose.
- **Prokaryotic cell:** The primitive cells in which well-defined nuclear membrane is absent and genetic material lies as a single chromosome, i.e., nucleoid is known as a prokaryotic cell. The cell locks membrane - bound cell organelles. Nucleoid as hereditary material lies freely in the cytoplasm. For, e.g., Bacteria, Cyanobacteria.
- **Eukaryotic cell:** The cells that have well-defined nucleus and membrane bound organelles are celled eukaryotic cells. The hereditary material is covered by nuclear envelope. For, e.g., Plants, animals and protozoans.
- **Unicellular and Multicellular organisms:** Single celled organisms are known as unicellular organisms for, e.g., protozoans, *Chlamydomonas*, bacteria etc., and they perform all the life processes like digestion, respiration, excretion and reproduction by a single cell.

  Multicellular organisms are made up of a number of cells specialized for performing different functions. They consists of tissues, organs and organ systems. For, e.g., Plants, Animals, Fungi etc.

Structure Of Atom

Q.1. Identify the incorrect statement.

(a) According to the alpha particle scattering experiment, very few alpha particles retrace their own path

(b) According to Niels Bohr's atomic model, the energy of the second orbit is more than the energy of the first orbit.

(c) According to Thomson's atomic model, electrons are embedded in uniform positive charge.

(d) According to Rutherford's atomic model, electrons revolve around the nucleus in circular as well as elliptical paths

Q.2. A tripositive ion has 23 electrons and 30 neutrons. What is the atomic mass of the element?

(a) 56 (b) 53

(c) 50 (d) 55

Q.3. What would be the radius of the nucleus if 10-8 cm is the radius of the atom

(a) 10-8 cm (b) 10-13 cm

(c) 10-5 cm (d) 105 cm

Q.4. Identify the element(s) whose A-Z value is 14.

(i) Aluminium (ii) Silicon

(iii) Phosphorus (iv) Sulphur

(a) Only I (b) i and ii

(c) i, ii and iv (d) iii and iv

Q.5. Which of the following experiments led to the discovery of neutrons?

(a) Discharge tube experiment

(b) Alpha ray scattering experiment

(c) Chadwick's experiment

(d) Oil drop experiment

Q.6. Match column A with column B.

Column A	Column B
Atomic number	Valency
(A) 12	(i) 3
(B) 17	(ii) 0
(C) 10	(iii) 2
(D) 15	(iv) 1

(a) A → ii, B → iv, C → iii, D → i

(b) A → iii, B → iv, C → ii, D → i

(c) A → iii, B → iv, C → i, D → ii

(d) A → iii, B → ii, C → i, D → iv

Q.7. Out of 1000 atoms of chlorine, 750 atoms have atomic mass 35u and 250 atoms have atomic mass What is the average atomic mass of chlorine atom?

(a) 35.5u (b) 36u

(c) 36.5u (d) 35.7u

Q.8. What is the total mass of neutrons present in Fe-56 atom? (Atomic number of iron is 26)

(a) 30 u (b) 56 u

(c) 26 u (d) 40 u

Q.9. Identify the decreasing order of specific charges of the particles: Electron(e), proton(p), neutron(n) and α particle.

(a) e, p, n, α (b) p, e, n, α

(c) e, p, α, n (d) n, α, p, e

Q.10. Which of the following set of elements ratio of atomic numbers is 1:2:3:4?

(a) H, He, Li, B (b) He, Be, C, Ne

(c) Be, O, Mg, Ca (d) B, Ne, P, Ca

Q.11. In the valence shell, which of the following pairs contains duplet and octet configuration respectively?

(a) Ne, Ar (b) Ca+2 , O-2

(c) Li+1 , N-3 (d) Mg+2 , Be+2

Q.12. The maximum number of electrons that a valence shell of an atom can possess is

(a) 32 (b) 18

(c) 8 (d) 2

Q.13. Which of the following has a similar electronic configuration as that of argon?

(i) Potassium ion (ii) Sulphide ion

(iii) oxide (iv) chloride

(a) i and iii (b) i, ii and iv

(c) ii and iv (d) i, iii and

Q.14. The correct electronic configuration of potassium is ……?

(a) 2, 8, 4 (b) 2, 8, 8, 6

(c) 2, 8, 8, 18 (d) 2, 8, 8, 1

Q.	Ans	Q.	Ans
1	(d)	9	(c)
2	(a)	10	(d)
3	(b)	11	(c)
4	(b)	12	(c)
5	(c)	13	(b)
6	(b)	14	(d)
7	(a)	15	(a)
8	(a)		