Atomic Structure

1. **Who first describe the atom as the smallest particle of a particular element?**
   Ans. In 1808, John Dalton, an English scientist, described the atom as the smallest particle exhibiting all the properties of a particular element.

2. **What are the main features of Dalton's Atomic Theory?**
   Ans. The main features of Dalton's atomic theory are:
   1. Matter consists of very small and indivisible particles called atoms.
   2. Atoms can neither be created nor be destroyed.
   3. The atoms of an element are identical in all respects, i.e. size, mass, density, chemical properties, but they differ from the atoms of other elements.
   4. Atoms of an element combine in small numbers to form molecules of that element.
   5. Atoms of an element combine with the atoms of another element in a simple whole number ratio to form molecules of a compound.
   6. Atoms are the smallest unit of matter that take part in chemical reactions during which only rearrangement of atoms takes place.

3. **Who discovered Electron?**
   Ans. In 1897 English physicist J.J. Thomson first discovered Electrons.

4. **What are the properties of Electron?**
   Ans. The properties of Electrons are:
   a. Electrons are an integral part of all atoms
   b. An Electron is a negatively charged particle. Its charge is one (1) unit negative charge, i.e. $1 \cdot 602 \times 10^{-19}$ coulomb.
   c. Its properties are independent of the nature of the gas in the discharge tube.
   d. An electron has a definite mass and it carries a definite electric charge.
   e. The mass of an electron has been found to be 1/1837 of the mass of a hydrogen atom, i,e. $9 \cdot 108 \times 10^{-28}$ g.

5. **What is the symbol of an Electron?**
   Ans. An electron is denoted by the symbol $_{-1}e^{0}$.
   The superscript 0 represents its mass and the subscript -1 represents its one-unit negative electrical charge.

6. **Who discovered Proton?**
   Ans. E Goldstein

7. **What are the properties of Protons?**
   Ans. The properties of proton are
   a. Proton is a positively charged particle.
   b. The positive charge on a proton is equal to the negative charge on an electron, i.e. $1 \cdot 602 \times 10^{-19}$ coulomb.
   c. The mass of a proton was calculated as being equal to the mass of an atom of hydrogen, i.e. $1 \cdot 672 \times 10^{-24}$ g.

8. **What is the symbol of Proton?**
   Ans. Protons are denoted as $_{+1}p^{1}$, where the superscript 1 represents 1 amu (atomic mass unit) mass and the subscript + I represents one unit positive charge.

9. **What is Plum Pudding Model?**
Ans. J.J Thomson's Atomic model is known as Plum Pudding Model.
According to this model, an atom is a positively charged sphere in which electrons are embedded just like dry fruits are distributed in a pudding.

10. **What is the observation of Rutherford's alpha particles scattering experiment?**
Ans. Following were the observations
- Most of the alpha particles passed straight through the foil without any deflection from their path.
- A small fraction of them were deflected from their original path by small angles.
- Only a few particles bounced back.

11. **What were the conclusion of Rutherford's alpha particles scattering experiment?**
Ans. The conclusion of Rutherford's alpha particles scattering experiment are
- Most of the space in an atom was empty because alpha particles went straight.
- There was a heavy positively charged mass in the atom which caused deflection of a small fraction of alpha particles.
- The positively charged mass is very small and is centrally located because only few particles bounced back. It was named as the nucleus of an atom.

12. **Who discovered Neutron?**
Ans. James Chadwick

13. **What are the properties of Neutrons?**
Ans. Properties of Neutrons are
a. The mass of a neutron is slightly more than that of a proton, i.e. $1{\cdot}676 \times 10^{-24}$ g compared to $1{\cdot}672 \times 10^{-24}$ g of the proton.
b. Electrically a neutron is neutral, i.e. it has no charge.
c. Atoms of same element may differ in the number of neutrons leading to the formation of isotopes.

14. **What is the Modern model of an Atom?**
Ans. According to the modern, standard model of atom
i. An atom consists of the sub-atomic particles called electrons, protons and neutrons.
ii. There are two structural parts of an atom
    a. The nucleus
    b. the orbits or the shells (extra nuclear part) present in the empty space that surrounds the nucleus.
iii. The nucleus is the positively charged, central part of an atom. It contains protons and neutrons. The protons and neutrons (collectively known as nucleons) are held firmly in the nucleus by strong nuclear forces. The entire mass of an atom lies in its nucleus, since electrons have negligible mass. The positive charge of the nucleus is due to the protons present in it. The protons remain unaffected by the neutrons since the latter have no electrical charge.
iv. Orbits traced (or by the shells) are the imaginary path traced by the electrons in the empty space surrounding the nucleus. Each orbit is associated with a fixed amount of energy. Therefore, these circular orbits are also known as energy levels of energy shells. Electrons revolve around the nucleus in these orbits. The shell lying closest to the nucleus carries the lowest amount of energy and the shell that lies farthest from it carries the highest amount of energy.
v. An atom is electrically neutral because the number of protons and the number of electrons present in it are the same, thus balancing the total charge of the atom.

15. What is Atomic Number?

Ans. the number of protons present in the nucleus of the atom of an element is called its Atomic Number.

Since an electrically neutral atom has an equal number of protons and electrons, in such an atom:

Atomic Number (Z)= Number of Proton = Number of Electron

For Example: A n atom of oxygen contain s 8 protons. In its neutral atom, the number of electrons is also 8. Therefore, its atomic number is 8.

16. What is Mass Number?

Ans. The sum of the number of protons and the number of neutrons present in the nucleus of the atom of an element is called the mass number of that element.

It is denoted by the letter A.

Mass number (A) = Number of protons + Number of neutrons.

Example: The symbol of oxygen is 0.

Its mass number is 16 and its atomic number is 8.

Therefore, oxygen is denoted as $^{16}_{8}O$ or $_{8}O^{16}$.

17. What are Isotopes?

Ans. Isotopes are the atoms of the same element with the same atomic number but a different mass number due to the difference in the number of neutrons in their nucleus.

Examples: Three Isotopes of Hydrogen are

Protium ($_1H^1$)

Deuterium ($_1H^2$)

Tritium ($_1H^3$)

18. What are the properties of Isotopes?

Ans. The properties of Isotopes are:

a. The isotopes of an element have the same chemical properties since they all have the same atomic number.
b. Due to the same atomic number, all the isotopes of an element have the same electronic configuration.
c. Isotopes differ from each other only in their physical properties such as density, melting point, boiling point, etc. due to the difference in their mass number.

19. How does the existence of isotopes contradict Dalton's atomic theory?

Ans. Atoms of an element must have the same atomic number, but their mass number can be different due to the presence of different number of neutrons. These atoms of an element having different number of neutrons are called isotopes.

According to Dalton's theory, all atoms of an element are similar to all respects, for example, they have the same shape, size etc. and have similar physical and chemical properties like mass, density and reactivity. Whereas isotopes of an element have atoms that are similar as they have same number of protons and electrons but differ in the number of neutrons.

20. What are the limitations of Dalton's Atomic Theory?

Ans. The limitations of Dalton's Atomic Theory are:

a. Atoms are not undividable, they can be further divided into fundamental particles: Electron, Proton and Neutron.
b. Every atom of an element is not identical. Isotopes are the atoms of the same element with same atomic number but different mass number, that means they have same number of protons and electrons but differ in their number of neutrons.

21. What is Orbit or Shell?

Ans. Electrons revolve around the nucleus in imaginary paths called orbits or shells.

22. Which rules are followed for writing the number of electrons in different energy levels or shells?

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

(1) The maximum number of electrons in each shell or orbit is determined by a formula $2n^2$, where n is the number of shells.

(2) Electrons are not accommodated in a given shell, unless the inner shells are filled. That is, the shells are filled in a step-wise manner.

23. What is Octet Rule?

Ans. The outermost orbit of an electrically neutral atom cannot have more than 8 electrons.

24. What is Duplet Rule?

Ans. If the atom has only one shell, as in case of hydrogen and helium, the outermost (single shell) can have only 2 electrons, called as the duplet rule.

25. What is Valence Shell?

Ans. The outermost shell of an atom is known as its Valence shell or valence orbit.

26. What is Valence Electron?

Ans. The electrons present in the valence shell of an atom are called valence electrons. The number of valence electrons varies from 1 to 8 for the atoms of different elements. The valence electrons of an atom determine the valency of that element.

27. Why do atoms combine to form molecule?

Ans. Atoms combine to form molecules in order to attain chemical stability because they have incomplete valence shell. Elements try to attain a stable electronic configuration of the nearest inert gas [Octet or Duplet] by either gaining or losing electrons or sharing electrons with other atoms.

28. How Ions are formed?

Ans. When an atom loses or gains electron, it develops either a positive or a negative charge because the balance of positive and negative charges becomes unequal. In this way, ions are formed.

Ex:

$$\underset{2,8,1}{Na} \xrightarrow{-e^-} \underset{2,8}{Na^+} \text{ (Cation)}$$

$$\underset{2,8,7}{Cl} + e^- \longrightarrow \underset{2,8}{Cl^-} \text{ (Anion)}$$

Ions are two type

a. Positive Ion (Cations)
b. Negative Ion (Anions)

29. What is Valency?

Ans. Valency is the combining capacity of the atoms of an element with the atoms of other elements to form molecules.
The valency of an element or a radical is the number of hydrogen atoms that will combine with or displace one atom of that element or radical.

Ex: In the compound hydrogen chloride (HCl), one atom of chlorine combines with one atom of hydrogen, hence
valency of chlorine is 1.

30. How do atoms combine?

Ans. Atoms combine with one another according to their combining capacity which is known as valency.

31. What is Variable Valency?

Ans. Some elements exhibit more than one valency. They are said to have variable valency.
Examples: Iron, copper, tin, lead, sulphur, phosphorus, etc.

32. How can we represent variable valency?

Ans. We can represent variable valency of metals and non metals in the following ways

- In the case of metals exhibiting variable valency, we represent the lower valency by adding the suffix 'ous' to the name of the metal; to represent the higher valency, the suffix 'ic' is attached to the name of the metal.
  For example, the metal iron has valences +2 and +3. For the lower valency (+2) we write ferrous (Fe1+) and for the higher valency (+3) we write ferric (Fe3+). Note that the symbol remains the same but the name changes.
- In the case of a non-metallic atom, the number of the other types of atoms attached to it determines its valency.
  For example, Phosphorus has valences 3 and 5. With chlorine it forms two compounds, PCl_3 and PCl_5. Therefore, the molecule of phosphorus trichloride which has three chlorine atoms in it, has the lower valency (3), and the molecule of phosphorus pentachloride, which has five chlorine atoms in it, has the higher valency (5) for phosphorus atom.

33. What are Radicals?

Ans. A radical is an atom of an element or a group of atoms of different elements that behaves as a single unit with a positive or negative charge on it.

- Positive charged radicals are called Basic Radical.
  Ex. Na^+,NH_4^+
- Negatively charged Radicals are called Acid Radicals.
  Ex. NO_3^- , Cl^-

Short Question

1. The smallest particle of matter is the _____.
2. Dalton said that _____could not be divided.
3. English physicist _____ discovered electron in 1897.
4. The charges of one Electron is _____ Coulomb.
5. The mass of an electron has been found to be _____of the mass of a hydrogen atom, i,e. _____ g.
6. An electron is denoted by the symbol _____.
7. _____ discovered Proton.
8. The charge of 1 Proton is _____ Coulomb.
9. Mass of a proton is _____ g.
10. Protons are denoted as _____.
11. Atomic model of J.J Thomson is known as _____.
12. _____ discovered Nucleus.
13. The _____ of an atom is very dense and hard.
14. Neutron is discovered by _____.
15. Mass of the Neutron is _____.
16. _____explain the atomic stability.
17. Total Number of protons present in Nucleus is called _____
18. Atomic Number is denoted by _____.
19. Mass number (A) = _____ + Number of neutrons.
20. Mass Number is denoted by _____.
21. Number of electrons of $_8O^{16}$ are _____.
22. Same element with the same atomic number but a different mass number is called _____
23. The shell closest to the nucleus has the _____ amount of energy and hence contains the _____ number of electrons.
24. The maximum number of electrons in each shell or orbit is determined by a formula ____.
25. $2n^2$ is known as _____.
26. The valence electrons of an atom determine the _____ of that element.
27. Positively charged Ion is called _____.
28. Negatively charged Ion is called _____.
29. Combining capacity of atom is called _____.
30. The outermost shell of an atom is called _____.

Answer

1. Atom
2. Atom
3. J.J. Thomson
4. $1 \cdot 602 \times 10^{-19}$
5. $1/1837, 9 \cdot 108 \times 10^{-28}$
6. $_{-1}e^{0}$
7. E. Goldstein
8. $1 \cdot 602 \times 10^{-19}$
9. $1 \cdot 672 \times 10^{-24}$
10. $_{+1}p^{1}$
11. Plum Pudding Model
12. Lord. Rutherford
13. Nucleus
14. James Chadwick
15. $1 \cdot 672 \times 10^{-24}$ gm
16. Neil Bohr
17. Atomic Number
18. Z
19. Number of protons
20. A
21. 8
22. Isotopes
23. Lowest, least
24. $2n^2$
25. 'Bohr-Bury scheme
26. Valency
27. Cation
28. Anion
29. Valency
30. Valence Shell