ATOMIC STRUCTURE

Introduction

The concept of an atom is originated from Greek philosophers like Democritus and John Dalton. Democritus studied the nature of matter and the constituents of all the substances. In 1808 John Dalton put forward atomic theory to explain the laws of chemical combination. According to him, an atom is the smallest unit of matter which takes part in a chemical reaction. He considered that atoms are indivisible particles. At the end of 18th and early 20th centuries modern concept an atom developed by scientists like J.J Thomson, Goldstein, Ruther ford, Bohr and others.

Modern concept of an atom

Atom consists of smaller particles (sub atomic particles) like electron, proton and neutron. These particles are called as fundamental particles. The atom contains nucleus at its center, which has positively charged protons and neutrons. Electrons are revolving around the nucleus and they carry negative charge.

Fundamental particles of an atom

1. electron (e⁻)

J.J Thomson discovered electrons in 1897

Mass of electron \( = 9.107 \times 10^{-28} \) g

\( = 9.107 \times 10^{-31} \) kg

Charge of electron = Unit negative charge

\( = 1.602 \times 10^{-19} \) coulombs

The charge of e⁻ was measured by R.A. Millikan in 1939

2. proton

E. Goldstein discovered proton in 1836

Mass of proton \( = 1.672 \times 10^{-24} \) g

\( = 1.672 \times 10^{-27} \) kg
Charge of proton = Unit positive charge
               = 1.602 x 10^{-19}

3. neutron
James Chadwick discovered neutron in 1932

Mass of neutron = 1.675 x 10^{-24} g
                = 1.675 x 10^{-27} kg

Charge of neutron = carry no charge i.e. neutral

Concept of orbit and orbitals
Orbit: orbit is a well defined circular path around the nucleus in which an electron revolves. Orbit of definite energy levels called shells. These shells are named as K, L, M and N and numbered as 1, 2, 3, and 4 respectively from the nucleus. An orbit (shell) can accommodate electrons equal to 2n^2.

For K Shell, n = 1
maximum no of e’s in K shell = 2n^2
= 2(1)^2
= 2
Therefore maximum no of e’s in K shell = 2

Similarly for L shell, n = 2, Therefore maximum no of e’s = 8
for M shell n = 3, Therefore maximum no of e’s = 18
for N shell n = 4, Therefore maximum no of e-s = 32

Orbital: Orbital is the three dimensional region around the nucleus where the probability of finding electron density is maximum. All orbitals have definite shape and each can accommodate maximum of 2 electrons in it. Orbital are named as s, p, d and f.
s orbital can accommodate 2 electrons. There are three p orbital, each can accommodate two electrons therefore totally p orbital can accommodate 6 electrons. There are five d orbital so it can accommodate maximum of 10 electrons and there are seven f orbital and it can accommodate 14 electrons.
Energy level Diagram

The relative energies of various orbital can be shown by an arrangement is called as energy level diagram.

Schematic diagram to remember sequence of filling atomic orbitals.
Electronic Configuration

Distribution of electrons in various orbitals is called as electronic configuration.

Electronic Configuration for the elements up to atomic number 20

<table>
<thead>
<tr>
<th>Elements</th>
<th>Symbol</th>
<th>Atomic Number</th>
<th>No of Electrons</th>
<th>Electronic configuration</th>
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<tbody>
<tr>
<td>Hydrogen</td>
<td>H</td>
<td>1</td>
<td>1</td>
<td>1s¹</td>
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<tr>
<td>Helium</td>
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<td>2</td>
<td>1s²</td>
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<td>11</td>
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<td>20</td>
<td>20</td>
<td>1s² 2s² 2p⁶ 3s² 3p⁶ 4s²</td>
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</table>

EXERCISES

1. What is an Atom?

2. Name the fundamental particles of an Atom?

3. Who discovered Electron?

4. What is the charge of an Electron?

5. What is the Mass of an Electron?

6. Who measured the charge of an Electron?
7. Who discovered Proton?

8. What is the Mass of Proton?

9. What is the charge of Proton?

10. Who discovered Neutron?

11. What is the Mass of Neutron?

12. Do the Neutron have charge?

13. What is an Orbit? Mention different Orbits.

14. How many number of electrons can be accommodated in

   (a) “L” Shell  (b) “N” Shell

15. Write the formula to accommodate maximum number of electrons in a shell.

16. What is an Orbital? Mention different Orbitals.

17. What do you mean by Energy Level Diagram?

18. Write the schematic Diagram to remember sequence of filling atomic orbitals.

19. Write the Electronic configuration for the following elements.

   (a) Nitrogen (Atomic number 7)
   (b) Magnesium (Atomic number 12)
   (c) Argon (Atomic number 18)
   (d) Calcium (Atomic number 20)