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Chapter # 01

Structure of Atom
(TOPIC WISE QUESTIONS)

Q1: What are fundamental particles of an atom?

Ans: Fundamental particles of an atom:

Modern research showed that an atom consists of many subatomic particles. These sub atomic particles Proton, Electron and Neutron are very important to the chemists.

These particles are called fundamental particles.

a. Electron:

Electron is negatively charged particle. Its mass is equal to 0.000548597 amu or 9.11×10^{-31} kg. Charge of an Electron is 1.6022×10^{-19} C with negative sign. Electrons are very light small particles with revolve the nucleus in orbits.

b. Proton:

Proton is positively charged particle. Its mass is equal 1.0072766 amu or 1.6726×10^{-27} kg. Charge of proton is 1.6022×10^{-19} C with positive sign. Proton is 1837 times heavier than an electron. Proton are present in the nucleus of an atom.

c. Neutron:

Neutron is a neutral particle because it has no charge. Its mass is equal to 1.0086654 amu or 1.6749×10^{-27} kg. Neutron is 1842 times heavier than an electron.

Neutrons are present in the nucleus of an atom.

Particle	Symbol	Unit Charges	Charge (C)	Relative mass (amu)	Mass (kg)
Electron	e^-	-1	1.6022×10^{-19}	0.00054859	9.11×10^{-31}
Proton	p^+	+1	1.6022×10^{-19}	1.0072766	1.6726×10^{-27}
Neutron	n^0	0	0	1.0086654	1.6749×10^{-27}

Q2. What is Isotope? Explain by examples.

Ans: **Isotopes:**

Atoms of the same elements having same atomic number but different atomic masses are called isotopes.

Explanation:

The word isotope was first suggested by Soddy scientist since they were occupying the same place in Periodic Table.

In Greek Language “Isos” mean same and “topes” mean place.

In Dutton atomic theory all the atoms of an elements were considered identical but later it was proved that the number of protons in the atoms of an elements remain the same while neutrons number may different therefore, different isotopes will show same chemical properties and their physical properties show variation depends upon the number of Neutrons present in the Nucleus.

Example of Isotopes:

Isotopes of Carbon

Carbon has 3 isotopes, carbon – 12, carob – 13 and carbon – 14

$^{12}C_6$ $^{13}C_6$ C_6

Carbon has atomic number = 6

Carbon – 12 = $^{12}C_6$
Atomic No. = 6
Mass No = 12
No. of electrons = 6
No. of protons = 6
No. of neutrons = 12 – 6 = 6

Carbon – 13 = $^{13}C_6$
Atomic No = 6
Mass No = 13
No. of electrons = 6
No. of protons = 6
No. of neutrons = 13 – 6 = 7

Caron – 14 = $^{14}C_6$
Atomic No = 6
Mass No = 14
No. of electrons = 6
No. of protons = 6
No. of neutrons = 14 – 6 = 8
All the isotopes have same number of electrons and protons
But different number of neutrons.

ii. Isotopes of Chlorine:
Chlorine exist in two isotopes $^{35}Cl_{17}$ and $^{37}Cl_{17}$
The natural abundance of Cl-25 is 75.53% and that of Cl-37 is 24.47%
Chlorine – 35 = $C_{17}^{35}L$
Atomic Number = 17
Mass No = 35
No. of electrons = 17
No. of protons = 17
No. of neutrons = 35 – 17 = 18
Chlorine – 37 = $C_{17}^{37}L$
Atomic Number = 17
Mass No = 37
No. of electrons = 17
No. of protons = 17
No. of neutrons = 37 – 17 = 20

iii. Isotopes of Uranium:
Uranium exist in three isotopes, U_{92}^{234}, U_{92}^{235}, U_{92}^{233}
The percentage composition of U – 234 is 0.005%
The percentage composition of U – 235 is 0.75%
The percentage composition of U – 238 is 99.245%

Uranium – 234 = U_{92}^{234}
Atomic No = 92
Mass No = 234

No. of electrons = 92
No. of protons = 92
No. of neutrons = 234 – 92 = 142

Uranium – 235 = U_{92}^{235}

Atomic no = 92
Mass no = 235
No. of electrons = 92
No. of protons = 92
No. of neutrons = 235 – 92 = 143

Uranium – 238 = U_{92}^{238}

Atomic no = 92
Mass no = 238
No. of electrons = 92
No. of protons = 92
No. of neutrons = 238 – 92 = 146

Note:

Elements of odd atomic number mostly do not more than two stable isotopes. Elements of even atomic number usually contain large number of isotopes.

Q3. What do you mean by the term electronic configuration?

Ans: **Electronic Configuration:**

According to the Bohr's atomic model the arrangement of electrons around the nucleus in various shells and sub-shells is called electronic configuration.

According to the Bohr's atomic model the electrons revolve around the nucleus in different shells orbits. These shells are named as K, L, M, N etc.

Maximum number of electrons in a shell is determined by using $2n^2$ formula where "n" is the number of shell n = 1, 2, 3, 4…….

For example, for the K –shell n = 1 the number of electrons in K-shell is $K=2(1)^2 = 2e$

$L=Shell = (2)^2=8e$

Modern research has shown that the shell is further divided into sub-shells which are s, p, d, f the number of sub-shells in each shell and the number of electrons in each sub-shell are given in the table.

N	Shells	Sub-Shells	No of e	Total no of e
1	K	S	2	2e
2	L	S, P	2 + 6	8e
3	M	S, P, d	2 + 6 +10	18e
4	N	S, P, d, f	2 + 6 + 10 + 14	32e

Q4. Explain the uses of Isotopes?

Ans: **Uses of Isotopes:**

Isotopes are used in chemical, agriculture, and medical research for diagnosing and treatment of diseases. Isotopes of certain elements show radioactivity while others do not.

Some uses of isotopes are given below:

Goiter treatment

i. Iodine – 131 become concentrated in the thyroid gland and is used as cure for goiter.

. **Brain imaging**

ii. Iodine – 123 is used for brain imaging:

Tracer studies:

iii. The heavy hydrogen (deuterium), the heavy carbon (C-13), the heavy nitrogen (N-15) and heavy oxygen (O-18) and Iodine – 131 are used as tracer elements in biochemical and physiochemical research to trace the path of the element to the defective or obstructed part.

Treatment of cancer:

iv. Radio irradiation and cobalt -60 are used in the treatment of cancer and for the diagnosis of tumors

v. Sodium (Na-24) is used for the identification of blood circulatory problems in patients.

vi. Carbon-14 is used to trace the path of carbon in photosynthesis.

. **Smoke detector**:

vii. Americium – 241 is used in smoke detectors. It is also used to determine where oil wells should be drilled.

Finding moisture content

:viii. Californium – 252 is used measure moisture content of soil in road construction. It is also used to inspect airline luggage for hidden explosive.

Use in electrical appliances:

ix. Krypton – 85 is used in clothes washers to measure dust and pollutants levels.

Q5. There are three isotopes of uranium having atomic number 92 and mass number 234, 235 & 238. Calculate the number of neutrons in their nuclei.

i. U-234

A = 234, Z = 92

No. of protons = No. of electron

Number of neutrons = A – Z

234 – 92 = 142

ii. U-235

Number of neutrons A – Z

235 – 92

143 Neutrons

iii. U-238

Number of neutrons = A – Z

283 – 92

146 Neutrons.

Structure of Atom
(LONG QUESTIONS)

Q1: Why Dalton's atomic theory is considered as a base of modern atomic concepts?

Ans: The word 'atom' comes from Atomos which means uncut indivisible or the smallest particle Which are impossible to see with naked eyes. It was an old theory that matter is made of very small particles.

This idea was first proposed by Greek Philosopher Democritus in 400 BC, however no further work was done until 19th century. It was John Dalton, an English school teacher who after a series of experiments concluded that all matter must be composed of tiny particles which are solid balls and that cannot be further sub-divided. He called them atoms. He presented his theory under the title "A New System of Chemical Philosophy".

The main points of Dalton's atomic theory are as follow:

- Matter is composed of smallest tiny indivisible particles called atoms.
- Atom can neither be created nor destroyed.
- Atoms of the same element are identical in size, shape, mass and their properties.
- Atom of different elements is different in their properties.
- Atom combine together in small whole number and in simple ratio to form compounds.
- All chemical reactions are due to combination or separation of atoms.

Q2: Summarize Rutherford's atomic model of an atom and explain how we developed this. Model based on result of his famous gold-foil experiment

Ans: **Rutherford Atomic Model:**

In 1911 Lord Rutherford performed an experiment a-particle (20,000) which carries positive charge and in fact helium nuclei from a radioactive source (polonium metal). He allowed to fall, a beam of α-particle on a thin gold foil (0.00004 cm). The gold foil was surrounded by photographic plate or zinc sulphide (ZnS) fluorescent screen to detect the particles emitting from the radiation.

Observation:

Rutherford observed that most of the α-particles (19990) passed through the foil undeflected or without changing their path but a few particles (8) were deflected at different angels. Only few rays (2) were bounced back at their original way. From the deflection of α-particles bounced back at the same angle.

Conclusion:

Rutherford concluded that there was a positively charged particles present in the center of atom. So α-particles near this portion were repelled. Because α-particles are also positively charged particles and similar charges repel each other. If α-particles pass very closely to nucleus, they deflected through large angles. Similarly, if do no pass close to nucleus they either deflected through very small angles or do not get deflected at all.

Main Points:

i. The positive charge present in the center of an atom called nucleus. It contains electrons and neutrons.
ii. Majority of α-particle passed without changing their path shows that most of the spaces in atom are empty.
iii. The electrons revolving around the nucleus would require centripetal force. The attractive force of the nucleus on electrons provides centripetal force to the electron.
iv. The size of nucleus is so small as compared to the size of an atom.

v. The whole mass of an atom is present in its center called Nucleon mass due to the presence of protons and neutrons.
vi. The negative charged electrons revolved around the nucleus at a very small distance.
vii. An atom is neutral. As the number of electrons is numerically equal to that of protons.
viii. Nucleus is responsible for mass and energy of the atoms.

Defects in Rutherford's Atomic Model:

The major objections raised against his model were the following.

i. Rutherford's model is based on the laws of motion and gravitation, which are applicable to neutral bodies and not on the charged bodies.
ii. According to Maxwell theory, the revolving electrons being a charged particle, must lose energy continuously and ultimately spiral (fall) into the nucleus. However, it does not happen.
iii. The revolving electron radiates energy continuously and the atomic spectrum should be a continuous one but actually it gives a line spectrum.
iv. It does not provide any explanation about the chemical properties of the elements.

Q3: State the postulates which Bohr suggested to overcome the short comings of Rutherford's atomic Model?

Ans: **Neil Bohr's Atomic Theory:**

To overcome the defects of Rutherford's atomic model. Neil Bohr in 1913, presented an atomic theory. Considering Hydrogen atom as a model, the theory is based on the following assumptions.

i. The negative charged electrons revolve around the positively charged nucleus in certain fixed circular paths called shells, orbits or energy levels.
ii. The energy of the electron in orbit is proportional to its distance from the nucleus. The further the electron from the nucleus, the higher will be the energy and vice versa.
iii. Electron does not radiate energy as long as it is present in an orbit i.e. energy of an orbit is fixed.
iv. The electron absorbs or radiates energy whenever it moves from one orbit to another. The energy change of electron on going from one orbit to another is given by the relationship.

$\Delta E = E_2 - E_z = hv$

Where

hv = plants constant

v = frequency of radiation.

E_2 = the lower energy orbit

E_2= the higher energy orbit

ΔE = the energy difference

v. Electron can reside in the orbit for which its angular momentum (mvr) is integral multiple of n/2π i.e. mvr = $\left[\frac{nh}{2\pi}\right]$. Where n is the number of shells i.e. 1,2,3….., m is the mass, v is the velocity of an electron, r is radius of the orbit and h is plank constant (6.6262 x 10^{-34}js).
vi. Electron can reside in any one of the orbits and cannot stay in between them.

Q4: Complete the following table for neutral atoms of specific isotopes:

Ans:

	Isotopic symbol	Atomic number	Mass number	No. of Electron	No. of protons	No. of Neutron (N^0 = A – Z)
A	Xe_{54}^{131}	54	131	54	54	131 -54 = 77
B	Co_{27}^{59}	27	59	27	27	59-27=32
C	Nd_{60}^{144}	60	144	60	60	144-60=84
D	Ti_{22}^{48}	22	48	22	22	48-22=26
E	Hf_{72}^{178}	72	178	72	72	178-72=106
F	Te_{52}^{128}	52	128	52	52	128-52=76
G	Ar_{18}^{40}	18	40	18	18	40-18=22

Q5. (a)Define energy level and sub energy level.

(b) Explain the distribution of electrons in various energy levels and sub energy Lavoisier first four elements of the periodic table.

Ans. **(a)** Energy Levels:

These are definite circular path at a definite path at the definite distance from the nucleus in which the electrons moves in anti-clock wise direction or any direction. The energy levels are also called shells or obits. The number of electrons in an orbit is constant according to$2n^2$formula presented by Bohr's. These orbits are designed as K, L, M, N etc.

Shells	No. of e – (2n2)
1 = K	$2\ (1)^2 = 2e^-$
2 = L	$2\ (2)^2 = 8e^-$
3 = M	$2\ (3)^2 = 18e^-$
4 = N	$2\ (4)^2 = 32e^-$

Sub-Energy Levels:

The various regions in the main shells around the nucleus in three dimensional direction where the possibility of finding electrons is maximum is called Sub-Energy Level.

Group of orbitals around the nucleus having same energy is also called sub-energy levels. Sub energy levels are also called orbitals. These orbitals cannot accumulate more than 2e. There are four types of orbitals namely as s, p, d and f, which stand for sharp, principle diffused and fundamentals respectively. The s-orbital is spherical P orbital is dumbbells while d orbital is double dumbbell and f are more complex in shape.

(b)

i. H = 1

K = 1, $1S^1$

Group = 1A, Period = 1

ii. Li = 3

K = 2, L = 1

$1S^2$, $2S^1$

Group = 1A, Period = 2

iii. Na = 11

K = 2, L = 8, M = 1

$1S^2$, $2S^2$, $2p^6$, $3s^1$

Group 1A, Period = 3

iv. K = 19

K = 2, L = 8, M = 8, N = 1

$1s^2$, $2s^2$, $2p^5$, $3s^2$, $3p^6$, $4s^1$

Group = 1A, Period = 4

Structure of Atom
(SHORT QUESTIONS)

Q1: Aluminum is represented as Al_{13}^{27}. Draw the structure of Aluminum. Write its electronic configuration.

Ans: **Electronic configuration of Aluminum:**

Atomic number of Aluminums is thirteen (13). K=2 es, L=8 es, M=3 es. Its electronic configuration is $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^1$.

Q2. The energy of an electron in K and L shells is same or different. Explain.

Ans: The energy of an electron in K and L shells is different. Because according to Neil Bohr Atomic Model the energy of an electron in orbit is directly proportional to its distance from the nucleus. The farther the electrons of L shell are comparatively farther than the electrons of K shell. So L Shell's electron will have higher energy from K shell's electrons.

Q3. Draw the structure of hydrogen isotopes.

Ans: **Isotopes of Hydrogen:**

Hydrogen has three isotopes

1: Protium of ordinary hydrogen ${}_1^1H$ or ${}_1^1P$

2: Deuterium or heavy hydrogen ${}_2^1H$ or ${}_3^2D$

3: Tritium ${}_3^1H$ or ${}_1^3T$

All three having same atomic number but different number of neutrons.

Protium ${}_1^1H$ =

Ordinary hydrogen or protium have no neutrons.

Atomic No = 1

Mass No = 1

No of Proton = 1

No of Electron = 1

No of Neutron 1 – 1 = 0

Deuterium: ${}_2^1H$

Similarly, deuterium has same number of electrons, proton & neutron

Atomic No = 1

Mass No = 2

No. of Proton = 1

No. of Electron = 1

Neutron 1 – 2 = 1

1. Tritium: ${}_3^1H$:

Atomic No = 1

Mass No = 3

No. of Proton = 3

No. of Electron = 1

No of Neutron = 1 – 3 = 2

Q4. How many electrons are present in each of following atoms? Assuming that each is a neutral atom identifies the element.

a. $1s^2, 2s^2, 2p^6, 3s^1$ b. $1s^2, 2s^2, 2p^6, 3s^2, 3p^5,$ c. $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2$

Ans: a. Total number of electrons are eleven (11) and the element is Sodium (Na) metal.
b. Total number of electrons are seventeen (17) and the element is Chlorine (Cl) nonmetal.
c. Total number of electrons are twenty (20) and the element is calcium (Ca) metal.

Q5. Why atom is considered as neutral particle? Give reason.

Ans: In atom the number of negatively charge electrons are equal to the number of positively charged proton. They are equal in number and cancelled the effect of each other. Therefore, atom as a whole in neutral particle.

Q6. The mass of an atom is present in its nucleus. Can you explain it?

Ans: Nucleus of the atom is composed of protons and neutron. Protons and neutrons are heavy sub-atomic particles of the atom and they occupied central position in the atom. Therefore, most of the mass is present in the center.

Q7. What is the reason that physical properties of the isotopes are different but their chemical properties are the same?

Ans: Isotopes have different number of neutrons or atomic masses, which shows physical chemical properties. There, isotopes have different physical properties but have same chemical properties.

Q8. Draw the structure of carbon isotopes. Then write down the number of proton, neutron and electron.

Ans: Carbon has 3 isotopes, carbon – 12, carbon – 13 and carbon – 14

$C_6^{12} C_6^{13} C_6^{10}$

Carbon has atomic number = 6

Carbon – 12 = C_6^{12}
Atomic No = 6
Mass No = 12
No. of electrons = 6
No. of protons = 6
No. of neutrons = 12 – 6 = 6

Carbon – 13 = C_6^{13}
Atomic No = 6
Mass no = 13
No. of electrons = 6
No. of protons = 6
No. of neutrons = 6
No. of neutrons = 13 – 6 = 7

Carbon- 14 = C_6^{14}
Atomic No = 6
Mass No = 14
No. of electrons = 6
No. of protons = 6

Q9. How many electrons could contained in K, L, M and N energy levels.

Ans:

Number of shell (n)	Name of shell	Formula	No. of electrons
1	K	$2n^2$	$2(1)^2 = 2(1) = 2es$
2	L	$2n^2$	$2(2)^2 = 2(4) = 8es$
3	M	$2n^2$	$2(3)^2 = 2(9) = 18es$
4	N	$2n^2$	$2(4)^2 = 2(16) = 32es$

Q10. Write detailed electronic configurations for Li_3^7, C_6^{12} and Mg_{12}^{24}.

Ans. **Electronic Configurations:**

a. Li_3^7:

Atomic number of Li = 3

K = 2es, L = 1e

$1s^2, 2s^1$

Period = 2^{nd} , Group = 1A

b. C_6^{12}

Atomic number of C = 6

K = 2es, L = 4es

$1s^2, 2s^2, 2p^2$

Period = 2^{nd} , Group = IVA

c. Mg_{12}^{24}

Atomic number of Mg = 12

K = 2es, L = 8es, M = 2es

$1s^2, 2s^2, 2p^6, 3s^2$

Period = 3^{rd} , Group = IIA

Q11. Write the symbol for an isotope:

a. Containing one proton and two neutrons.

b. For which the atomic number is one and there is one neutron.

c. For which the atomic number is one and the mass number is also one.

Ans:

	ISOTOPE NAME	SYMBOL
a	Tritium (T)	$_3H^1$ or T
b	Deuterium (D)	$_2H^1$or D
c	Protium (H)	$_1H^1$