Chapter 2 Atomic Structure

Section A Multiple Choice Questions (M.C.Qs)

Tick mark (✓) the correct answer:

01. *In an atom number of protons and neutrons are added to obtain:*
(a) number of electrons (b) number of nucleons
(c) the atomic number of element (d) number of isotopes

02. *If the proton number is 19, electron configuration will be:*
(a) 2, 8, 9 (b) 2, 8, 8, 1 (c) 2, 8, 1 (d) 2, 8, 3

03. *If the nucleon number of potassium is 39, the number of neutrons will be:*
(a) 39 (b) 19 (c) 20 (d) 29

04. *The isotope C-12 is present in the abundance of:*
(a) 96.9% (b) 97.6% (c) 98.8% (d) 99.7%

05. *Electronic configuration is a distribution of:*
(a) proton (b) neutron (c) electron (d) positron

06. *Which one of the following is most penetrating?*
(a) Electron (b) Proton (c) Alpha particle (d) Neutron

07. *How many subshells in a L shell?*
(a) one (b) two (c) three (d) four

08. *De Broglie extend the wave-particle duality to an electron in:*
(a) 1920 (b) 1922 (c) 1923 (d) 1925

09. *Name the material of screen used in Rutherford atomic model:*
(a) aluminum foil (b) zinc sulphide (c) sodium sulphide (d) aluminum sulphide

10. *Which rays are used for sterilization of medical instruments:*
(a) α–rays (b) β–rays (c) γ–rays (d) χ–rays

11. *The word atom is derived from a Greek word ATOMOS means:*
(a) unbreakable (b) indivisible (c) inconsequential (d) insignificant

12. *The word atom is derived from a word ATOMOS, which was first described by Greek philosopher:*
(a) Socrates (b) Aristotle (c) Plato (d) Democritus

13. *Democritus belief that all matter consists of very small indivisible particles which are known as:*
(a) atoms (b) molecules (c) ions (d) electrons

14. *This English chemist suggested the fundamental atomic theory.*
(a) J.J. Thomson (b) John Dalton (c) William Crooks (d) M. Faraday

15. *The first subatomic particle, electron, was discovered by:*
(a) M. Faraday & Chadwick (b) J. J. Thomson & Rutherford
(c) M. Faraday, J.J. Thomson & Chadwick (d) M. Faraday, William Crooks & J.J. Thomson

16. *Goldstein and Ernest Rutherford identified the subatomic particle,:*
(a) electron (b) proton (c) neutron (d) nucleus

17. *The third sub-atomic particle, neutron, was revealed by:*
(a) J.J. Thomson (b) William Crooks (c) Chadwick (d) Rutherford

18. *Which particle is the lightest in the following?*
(a) Electron (b) Proton (c) Neutron (d) α – particles

19. *It was discovered in discharge tube experiment.*
(a) α – particles (b) Neutron (c) Proton (d) Electron

20. *Cathode rays consist of fast moving:*
(a) atoms (b) electrons (c) protons (d) neutrons

21. *In discharge tube, cathode rays travel in straight line from:*
(a) cathode towards anode (b) anode towards cathode
(c) cathode to all directions (c) anode to all directions

22. *Which one of the following has a negative charge?*
(a) Neutrons (b) Protons (c) Electrons (d) Nucleus

23. *The charge and mass ratio (e/m) of cathode particles (or electrons) is:*
(a) 1.7588×10^{8} coulomb per gram (b) 6.63×10^{-34} Js
(c) 9.11×10^{-26} coulomb per gram (d) 1.67×10^{-25} Js

24. *Cathode rays (or electrons) can produce mechanical pressure indicating they possess:*
(a) mass (b) charge (c) potential energy (d) kinetic energy

25. *Which one of the following particles has positive charge?*
(a) Neutrons (b) Protons (c) Electrons (d) Nucleus

26. *Goldstein justify that atoms are electrically:*
(a) positive (b) negative (c) neutral (d) None of these

27. *In discharge tube, canal rays (or protons) travel in straight line from:*
(a) cathode towards anode (b) anode towards cathode
(c) cathode to all directions (c) anode to all directions

28. *The charge and mass ratio (e/m) of protons is:*
(a) is much smaller than an electron (b) is much greater than electron
(c) is equal to the e/m ratio of electron (d) None of these

29. *The mass of a proton is 1836 times more than the mass of:*
(a) atom (b) neutron (c) α – particle (d) electron

30. *In 1932, he become successful to discover Neutron.*
(a) Goldstein (b) J.J. Thomson (c) Rutherford (d) Chadwick

31. *The neutrons have:*
(a) negative charge (b) positive charge (c) no charge (d) None of them

32. *The mass of a neutron is almost equal to that of:*
(a) proton (b) electron (c) nucleus (d) All of them

33. *These particles are most penetrating in matter.*
(a) protrons (b) neutrons (c) electrons (d) atoms

34. *All atoms can be identified by their:*
(a) number of protons they contain (b) number of neutrons they contain
(c) number of electrons they contain (d) atomic shells

35. *The number of protons in the nucleus of an atom is called:*
(a) atomic mass (b) atomic weight (c) atomic charge (d) atomic number

36. *Atomic number represented by:*
(a) N (b) NA (c) Z (d) None of these

37. *The elements are identify by their:*
(a) atomic weight (b) atomic number (c) atomic mass (d) valency

38. *Different elements have different atomic numbers because of different number of:*
(a) protons (b) electrons (c) neutrons (c) shells

39. *Atomic number of Carbon (C) is 6. Each carbon atom has:*
(a) 3 protons & 3 neutrons (b) 3 protons & 3 electrons
(c) 6 protons & 6 neutrons (d) 6 protons & 6 electrons

40. *The total sum of proton and neutrons in the nucleus of an atom is called:*
(a) atomic weight (b) atomic number (c) mass number (d) valency

41. *Mass number represented by:*
(a) N (b) NA (c) Z (d) A

42. *The sodium (Na) atom has Z = 11 and mass number A = 23. It has:*
(a) 11 protons and 12 neutrons (b) 11 protons and 23 neutrons
(c) 23 protons and 11 neutrons (d) 12 protons and 11 neutrons

43. *Uranium, Radium and Polonium are:*
(a) metals (b) non–metals
(c) radioactive elements (d) gases

44. *An atom consist of a positively charged, dense and very small nucleus containing protons and neutron. The entire mass is concentrated in the nucleus of an atom. It is a postulate of:*
(a) Rutherford Atomic Model (b) Bohr's Atomic Model
(c) Modern Atomic Model (d) None of them

45. *The electrons are revolving around the nucleus in circular paths. These circular paths are known as:*
(a) orbits (b) shells (c) Both 'a' & 'b' (d) None of them

46. *The energy levels are represented by an integer (n = 1, 2, 3....) known as:*
(a) Avogadro's number (b) atomic number
(c) mass number (d) quantum number

47. *The emission or absorption is discontinuous in the form of an energy packet called:*
(a) quantum (b) photon (c) Both 'a' & 'b' (d) None of these

48. *In 1900, quantum theory was presented by:*
(a) Neil Bohr (b) Max Planck (c) Louis De Broglie (d) Schrodinger

49. *He proposed a relationship between mass and energy to explain the photoelectric effect by wave-particle duality as $E = mc^2$.*
(a) Louis De Broglie (b) Albert Einstein (c) Schrodinger (d) Max Planck

50. *He proposed a hypothesis that all matter has particle as well as wave nature at the submicroscopic level.*
(a) Louis De Broglie (b) Albert Einstein (c) Schrodinger (d) Max Planck

51. *M shell has:*
(a) 1 subshell (b) 2 subshells (c) 3 subshells (d) 4 subshells

52. *The maximum number of electrons that can be accommodated in a shell is represented by the formula:*

(a) $2n$ (b) $2n^2$ (c) $2n^3$ (d) $2n^4$

53. *The electronic configuration of oxygen is:*

(a) $1s^2\ 2s^2\ 2p^1$ (b) $1s^2\ 2s^2\ 2p^2$ (c) $1s^2\ 2s^2\ 2p^3$ (d) $1s^2\ 2s^2\ 2p^4$

54. *Electronic configuration of sodium is:*

(a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ (b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ (c) $1s^2\ 2s^2\ 2p^6\ 3s^2$ (d) $1s^2\ 2s^2\ 2p^6\ 3s^1$

55. *Isotopes are atoms of the same element having the:*

(a) same atomic number but the different mass number
(b) same atomic number and mass number
(c) same mass number but different atomic number
(d) Both 'a' & 'b'

56. *Isotopes have the:*

(a) same number of neutrons but different number of electrons
(b) same number of neutrons but different number of protons
(c) same number of protons but the different number of neutrons
(d) Both 'a' & 'b"

57. *Isotopes have the:*

(a) same physical properties but different chemical properties
(b) same chemical properties but different physical properties
(c) same chemical and physical properties
(d) None of them

58. *Hydrogen has:*

(a) two isotopes (b) three isotopes (c) four isotopes (d) No isotopes

59. *Carbon 13 possess:*

(a) 6 protons and 7 neutrons (b) 6 protons and 6 neutrons
(c) 7 protons and 7 neutrons (d) 7 protons and 7 electrons

60. *Cholrine has:*

(a) two isotopes (b) three isotopes (c) four isotopes (d) No isotopes

61. *Number of protons + Number of neutrons of an element is:*

(a) atomic number (b) formula number (c) mass number (d) isotopes

62. *A - Z indicates the number of:*

(a) electrons (b) protons (c) neutrons (d) α – particles

Answers

01.	(a)	11.	(b)	21.	(a)	31.	(c)	41.	(d)	51.	(c)	61.	(c)
02.	(b)	12.	(d)	22.	(c)	32.	(a)	42.	(a)	52.	(b)	62.	(c)
03.	(c)	13.	(a)	23.	(a)	33.	(b)	43.	(c)	53.	(b)		
04.	(c)	14.	(b)	24.	(d)	34.	(a)	44.	(a)	54.	(d)		
05.	(c)	15.	(d)	25.	(b)	35.	(d)	45.	(c)	55.	(a)		
06.	(d)	16.	(b)	26.	(c)	36.	(c)	46.	(d)	56.	(c)		
07.	(b)	17.	(c)	27.	(b)	37.	(b)	47.	(c)	57.	(b)		
08.	(c)	18.	(a)	28.	(a)	38.	(a)	48.	(b)	58.	(b)		
09.	(b)	19.	(d)	29.	(d)	39.	(d)	49.	(b)	59.	(a)		
10.	(c)	20.	(b)	30.	(d)	40.	(c)	50.	(a)	60.	(a)		

Section B&C — Short & Detailed Answer Questions

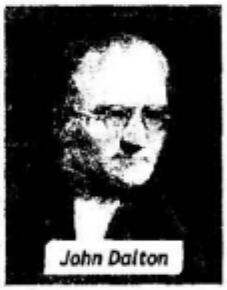
Q.1 What do you know about atoms?


Democritus

Ans: *Atoms:* The word atom is derived from a Greek word ATOMOS means indivisible, which was first described by the Greek philosopher Democritus. Democritus believed that all matter consists of very small indivisible particles which are known as atoms. Johan Dalton an English school teacher and chemist suggested the fundamental atomic theory, which explains that all elements are made up of indivisible particles called atoms. Dalton assumed that no particles smaller than an atom exist, but by the passage of time, new experiments show that an atom is composed of even smaller particles which are known as subatomic particles. After that these subatomic particles were discovered and named electron, proton and neutrons.

Q.2 Who discovered electron, proton and neutron?

Ans: At the end of the 19th century sub-atomic particles were discovered by different scientists. First subatomic particle 'electron' discovered by M. Faraday, William Crooks and J.J. Thomson, the second sub-atomic particle 'proton' identified by Goldstein and Ernest Rutherford, while the third sub-atomic particle 'neutron' revealed by Chadwick.


John Dalton

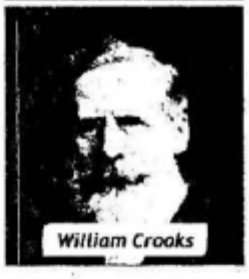
Q.3 What does Dalton's atomic theory explain?

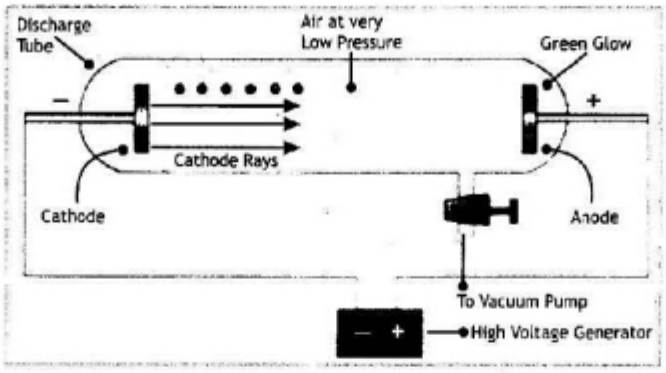
Ans: Dalton's atomic theory explains the chemical nature of matter and the existence of indivisible atoms, but all of these findings were a milestone in the knowledge of atomic structure which we have now.

Q.4 Describe the discharge tube (Cathode rays) experiment for the discovery of electrons.

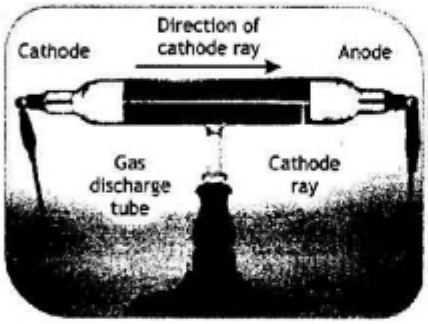
Ans: *Discovery of Electrons:* Electron is the lightest particle carrying negative charge in an atom discovered by J.J.Thomson and William Crooks.
Discharge Tube Experiment and the Cathode Rays: The apparatus used for this type of experiment is called a discharge tube which consists of a glass tube fitted with two metal electrodes connected to a high voltage source and a vacuum pump. When electrodes inside evacuated, discharge tube are connected with a high voltage source at very low pressure (1mm of Hg), as the high voltage current start passing between electrodes a streak of bluish light originate and travel in a straight line from the cathode (–ve electrode) to the anode (+ve electrode), which cause glow at the wall of the opposite end. These rays are called cathode rays.


J.J. Thomson


William Crooks



J.J. Thomson justified that these rays were deflected towards the positive plate in an electric and magnetic field which shows that these rays possess negative charge due to this negative charge, the particle was named electron. These electrons were obtained from the gas in the discharge tube which proves that electrons are constituent of all matter.



Q.5 Describe the properties of Cathode Rays.

Ans: ***Properties of Cathode Rays (Electrons):***

(i) They travel in a straight line from the cathode towards the anode.
(ii) They produce a sharp shadow of an opaque object placed in their path.
(iii) They have a negative charge and bend towards the positive plate in electric and a magnetic field.
(iv) These rays when striking with glass and other material cause material glow.
(v) The (e/m) charge and mass ratio of cathode particles is 1.7588×10^8 coulomb. per gram. This is the same for all electrons, regardless of any gas in the discharge tube.
(vi) They can produce mechanical pressure indicating they possess kinetic energy (K.E).

Q.6 Describe Goldstein's experiment for the discovery of protons.

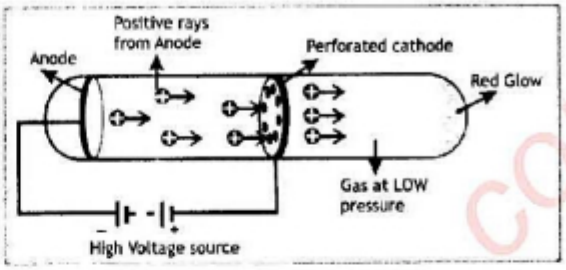
Ans: ***Discovery of Protons:*** The proton is a positive charge particle discovered by Goldstein in 1886. J.J. Thomson investigated the properties of proton in 1897. Protons were observed in the same apparatus of cathode rays tube but with a perforated cathode. Goldstein discovered that not only negatively charge cathode rays but positively charge rays are moving in the opposite direction of perforating cathode. These positive rays pass through the holes of the cathode, where they strike cause the glow of the tube. These rays named Canal rays (proton).

Canal rays are not emitted by anode, but they are the result of striking electron with residual

gas molecules in the discharge tube. Electrons ionize the gas molecules as follows.

$$M + e^- \longrightarrow M^{+1} + 2e^-$$

Goldstein justifies that atoms are electrically neutral, while electrons carry a negative charge. It means for each electron there must be one equivalent positive charge to neutralize that electron. This particle is called proton and it is a fundamental particle of all atoms.



Q.7 *Write the properties of Canal rays.*

Ans: ***Properties of Canal Rays (Protons)***

(i) They travel in a straight line from the anode towards the cathode.
(ii) They produce a sharp shadow of an object placed in their path.
(iii) They have a positive charge and bend towards a negative plate in an electric and magnetic field.
(iv) The (e/m) charge and mass ratio of positive particles are much smaller than an electron. It varies according to the nature of gas present in the tube.
(v) The mass of a proton is 1836 times more than an electron.

Q.8 *Describe Chadwick's experiment for the discovery of neutrons.*

Ans: ***Discovery of Neutrons:*** In 1920 Rutherford predict that an atom must possess another neutral particle with an equivalent mass of a proton. Different scientists started working on this neutral particle. Later in 1932, Chadwick becomes successful to discover Neutron. Chadwick found that when alpha (α)particles bombarded on Beryllium some penetrating radiations were given out. Chadwick suggested that these radiations were due to material particle with a mass comparable to hydrogen atom but have no charge. These radiations (particle) are called Neutron. It can be expressed in the equation as follows.

$$^{9}_{4}Be + ^{4}_{2}He \longrightarrow ^{12}_{6}C + {}_{0}n^{1}$$

The neutron is a fundamental part of an atom, present in the nucleus with proton and includes in atomic mass.

Q.9 *Write at least four properties of neutrons.*

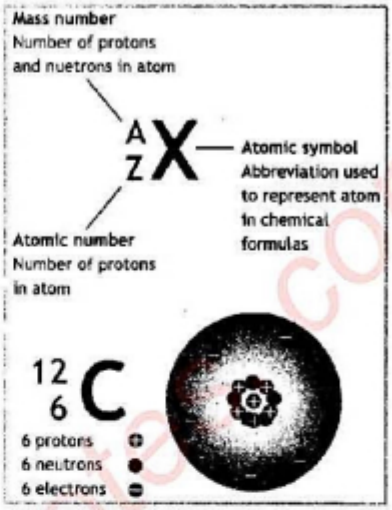
Ans: ***Properties of Neutrons***

(i) The neutrons are neutral particles.
(ii) They have no charge.
(iii) The mass of a neutron is almost equal to that of a proton.
(iv) These particles are most penetrating in the matter.

Q.10 *How Atomic Number (Z) and Mass Number (A) are related to the number of proton and neutron?*

Ans: An atom consists of three particles electron, proton and neutron. All atoms can be identified by their number of protons they contain. No two elements have the same number of protons. ***Atomic Number (Z):*** The number of protons in the nucleus of an atom is called the atomic

number. The atomic number represented by Z. The elements are identified by their atomic number. Different elements have different atomic numbers because of the different number of protons. In neutral atoms number of protons are equal to the number of electrons, so the atomic number also indicates the total number of electrons outside the nucleus. For example, the atomic number of Carbon(C) is 6. It means that each carbon atom has 6 protons and 6 electrons in it.



Atomic number = Z = Number of proton in nucleus
= Total number of electron around nucleus

Atomic number (Z) is written as a subscript on the left-hand side of the chemical symbol e.g C_6. Some other examples are as follows:

Li_3, O_8, H_1

Mass Number (A): The total sum of proton and neutrons in the nucleus of an atom is called the mass number. The mass number represented by A. For example, the mass number (A) is written as a superscript on the left-hand side of the chemical symbol. e.g $^{23}_{11}Na$.

Mass number = A = number of protons (Z) + number of neutrons (N) OR

Mass number $A = Z + N$

And the number of neutron $N = A - Z$

Q.11 ***If all atoms have the same fundamental particles, then why the atoms of one element different from the atoms of another element? OR How does an atom of carbon(C) is different from an atom of Nitrogen (N)?***

Ans: Normally, the number of electrons is equal to the number of protons, which makes atoms electrically neutral. The number of protons in an atom is the defining feature of an atom. It's what makes one element different from another. The number of protons in an atom is called its atomic number. The number of protons in an atom determines what element we have. For instance, nitrogen has seven protons, carbon has six.

Q.12 ***Do you know any element which has no neutron in its atom?***

Ans: There is only one stable atom that does not have neutrons. It is an isotope of the element hydrogen called protium. Protium, which contains a single proton and a single electron, is the simplest atom. All other stable atoms contain some number of neutrons.

Q.13 ***What are radioactive elements?***

Ans: Radioactive elements are unstable isotopes that release subatomic particles or energy as they decay.
For example, uranium, radium and polonium.

Q.14 ***Describe Rutherford's (gold foil) experiment for the discovery of the nucleus.***

Ans: ***Rutherford Atomic Model:*** Lord Rutherford in 1911, carried out series of experiments and proposed a new model for the atom.

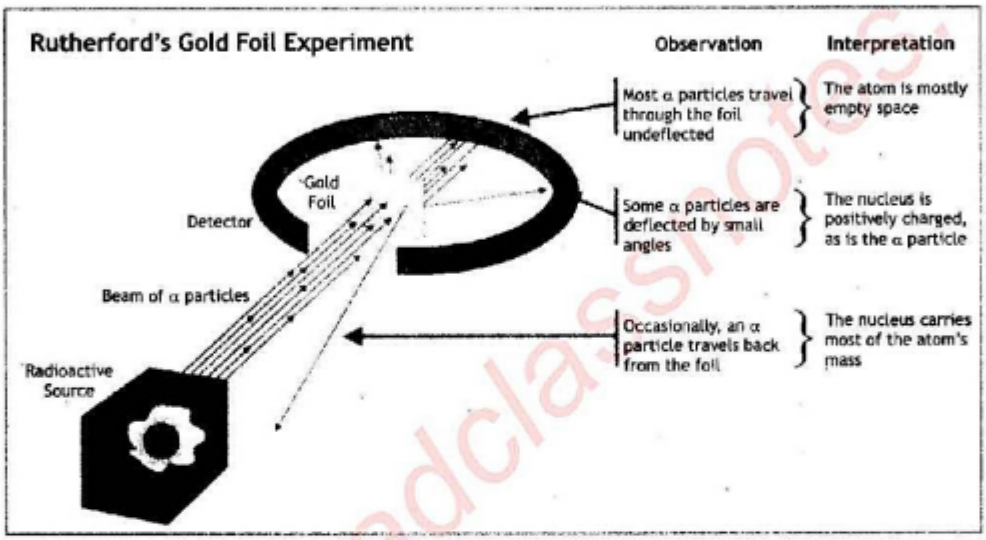
Experiment: Rutherford took a thin sheet of gold and bombarded it with alpha (α) particles obtained from a radioactive element (like Polonium). These rays scattered from the atom and examined on a zinc sulphide (ZnS) screen.

Observations:

(i) Most of the particles passed straight and undeflected through the sheet and produced illumination on the zinc sulphide screen.

(ii) Very few alpha (α) particles undergo small and strong deflection after passing through the gold sheet.

(iii) A very few alpha (α) particles (one of 8000) retraced their path.



Conclusion:

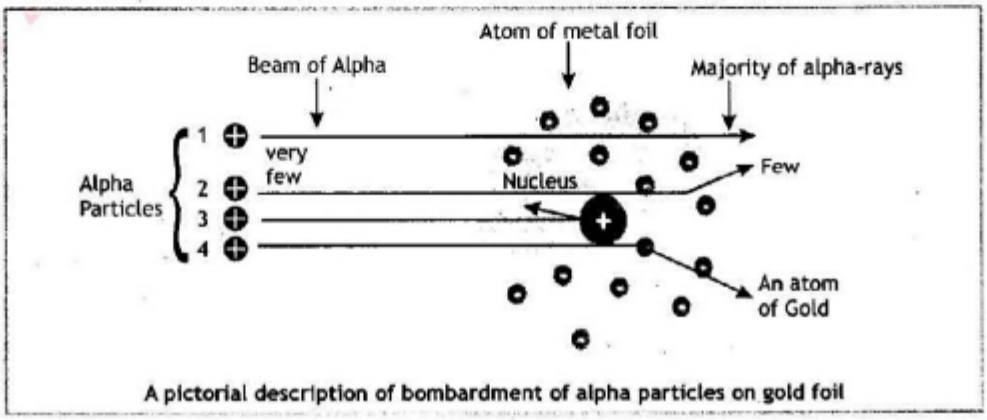
(i) According to Rutherford an atom consists of two parts nucleus and an extra nuclear part.

(ii) Majority of the alpha particles passed a straight line and un-deflected, show that most volume occupied by an atom is empty.

(iii) Alpha particles are positively charged and their deflection indicates that the center of atom has a positive charge, which is named as a nucleus.

(iv) The mass is concentrated in the nucleus and the electrons are distributed outside the positive charge nucleus.

(v) The electrons are revolving around the nucleus in the extra nuclear part in orbits.



A pictorial description of bombardment of alpha particles on gold foil

Q.15 What are the postulates of Rutherford's Atomic Model?

Ans: ***Main (Important) Postulates of Rutherford's Atomic Model***

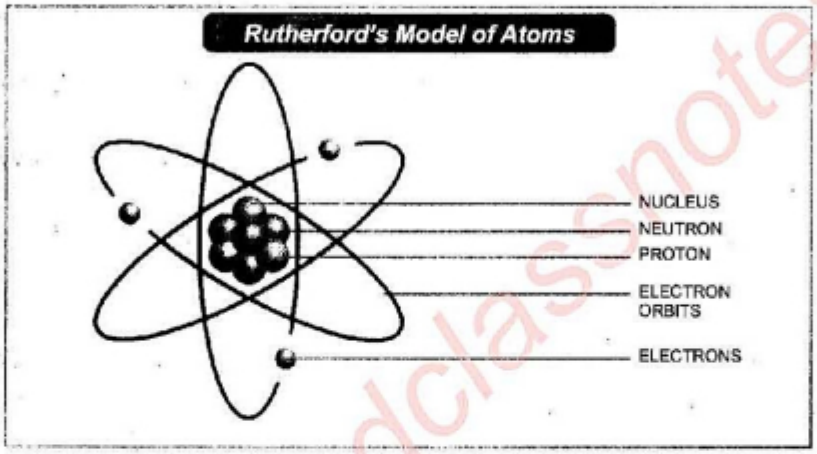
(i) An atom consists of a positively charged, dense and very small nucleus containing protons and neutron. The entire mass is concentrated in the nucleus of an atom.

(ii) The nucleus is surrounded by a large empty space which is called the extra nuclear part where the probability of finding an electron is maximum.

(iii) The electrons are revolving around the nucleus in circular paths with high speed (velocity).

(iv) These circular paths were known as orbits (shells).

(v) An atom is electrically neutral because it has an equal number of protons and electrons.



(vi) The size of the nucleus is very small as compared to the size of its original atom.

Q.16 Describe weaknesses (defects or drawbacks) of Rutherford's atomic model.

Ans: ***Defects of Rutherford Atomic Model***

(i) Rutherford did not explain the stability of an atom.

(ii) In Rutherford's atomic model the negatively charged electrons revolve around the nucleus in a circular path and emit energy continuously. They must fall into the nucleus because of the constant emission of energy.

(iii) If the revolving electron continuous emits energy, then there would be a continuous spectrum but in contrast to it, we get a line spectrum from the atoms of elements.

Q.17 Define Spectrum.

Ans: A beam of light is allowed to pass through a glass prism, it splits into several colours. This phenomenon is called dispersion and the band of colours is called a spectrum, which is classified according to its wavelength.

There are two types of the spectrum: Emission spectrum and Absorption spectrum.

The emission spectrum also has two types: Continuous spectrum and Line spectrum.

Q.18 Describe the main postulates of Bohr's Atomic Model.

Ans: ***Bohr's Atomic Model:*** In 1913 Neil Bohr proposed another atomic model. This atomic model was different in this manner that it shows two folds, first to remove the defects of Rutherford atomic model and second explain the line spectrum of Hydrogen atom based on the quantum theory of Max Planck.


Neil Bohr

Main (Important) Postulates of Bohr's Atomic Model: Niel Bohr proposed the following postulates for atomic structure.

(i) The atom has fixed orbits in which a negatively charged electron is revolving around the positively charged nucleus.

(ii) These orbits possess a certain amount of energy which are called shells and named K, L, M, N shells.

(iii) The energy levels are represented by an integer (n = 1, 2, 3....) known as the quantum number, this quantum range starts from the nucleus side, where n = 1 is the lowest energy level.

(iv) Electrons are revolving in particular orbits continuously, but they do not emit or absorb energy.

(v) When an electron jumps from a lower energy level (E_1) to a higher energy level (E_2), it absorbs energy.

(vi) When electrons jump from higher energy level (E_2) to lower energy level (E_1), it emits energy.

(vii) The emission or absorption is discontinuous in the form of an energy packet called Quantum or Photon.

(viii) The ΔE difference in energy of higher (E_1) and lower (E_2) energy level.

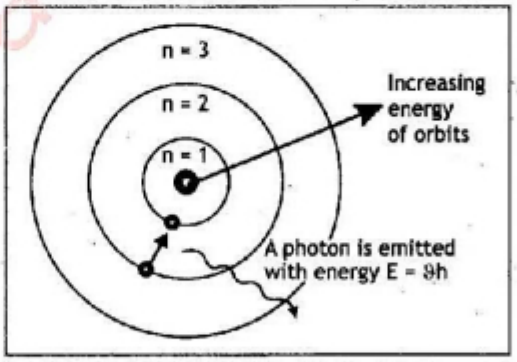
$$\Delta E = E_2 - E_1$$

$$\Delta E = \vartheta h = 1 \text{ photon}$$

Here 'h' is planks constant, its value is 6.63×10^{-34}Js and 'ϑ' is a frequency of light.

(ix) Stationary state were present in those orbits in which the angular moment of an electron would be an integral multiple of $h/2\pi$.

$mvr = nh/2\pi$ (where n = no of orbits h = Planks constant m = mass of electron)



Niel Bohr's Atomic model

Q.19 *Explain the limitation of Bohr's Atomic Model.*

Ans: *Limitations of Bohr's Atomic Model:*

(i) Bohr's model of an atom failed to explain the Zeeman Effect (effect of magnetic field on the spectra of atoms).

(ii) It also failed to explain the Stark effect (effect of electric field on the spectra of atoms).

(iii) It deviates from the Heisenberg Uncertainty Principle.

(iv) It could not explain the spectra obtained from larger atoms.

(v) It explains the monoelectronic species like H^{+1}, Li^{+2}, B^{+3}.

Q.20 *What is quantum?*

Ans: A discrete quantity of energy proportion that can exist independently.

Q.21 Which particles show the mass of an atom?

Ans: Protons and neutrons are the fundamental particles whose masses are mainly responsible for the mass of an atom.

Q.22 Describe the modern theories of atomic structure.

Ans: ***Modern Theories of Atomic Structure:*** In the year 1900 Max Planck proposed the quantum nature of radiations and energy ina photon wave $E = h\upsilon$ as quantum theory. This quantum theory accepted by Albert Einstein in 1905 and proposed a relationship between mass and energy to explain the photoelectric effect by wave-particle duality as $E = mc^2$. In 1913 Niel Bohr continued to use quantization of radiation with the angular momentum of electrons. Bohr predicted and explained the line spectrum of a Hydrogen atom.


Louis De Borglie

De Broglie Hypothesis: In 1923 Louis De Broglie extended the wave particle duality to electron, and proposed a hypothesis that all matter has particle as well as wave nature at the submicroscopic level. De Broglie combined the Einstein and Planck equations and argued that if,

$E = h\upsilon$ where E = energy, h = Plank's constant, υ = frequency of light

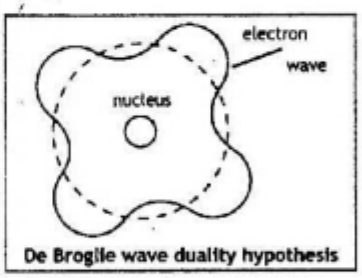
And $E = mc$ where E = energy, m = mass, c = speed of light

Then

$$h\upsilon = mc^2 \quad OR \quad \upsilon = mc^2/h$$

$$\lambda = h/m\upsilon$$

The wave nature of a particle is quantified by De-Borglie wavelength defined as $\lambda = h/p$ where p is the momentum of the particle.



De Broglie wave duality hypothesis

According to De-Borglie a light, or any other electromagnetic wave, can also exhibit the properties of a particle, similarly, a particle should also exhibit the properties of a wave, and those two nature are interchangeable.

Schrodinger Atomic Model: In 1926 Erwin Schrodinger, an Austrian physicist, took Bohr's atomic model one step forward. Schrodinger used mathematical equations to describe the likelihood of finding an electron in a certain position. This atomic model is known as the quantum mechanical model of the atom. Schrodinger model is just an improvement of Bohr's atomic model. He took an atom of hydrogen because it has one proton and one electron. He proved mathematically that electron can be found in different position around the nucleus and determined by probability.


Erwin Schrodinger

(i) The quantum mechanical model determines that electron can be found in various location around the nucleus. He found electrons are in orbit as an electron cloud.

(ii) Each energy subshell in an orbit has different shapes which determine the presence of electron.

(iii) Different subshells of orbitals are orbitals named as s, p, d and f with different shapes as 's' is spherical and 'p' is dumbbell-shaped.

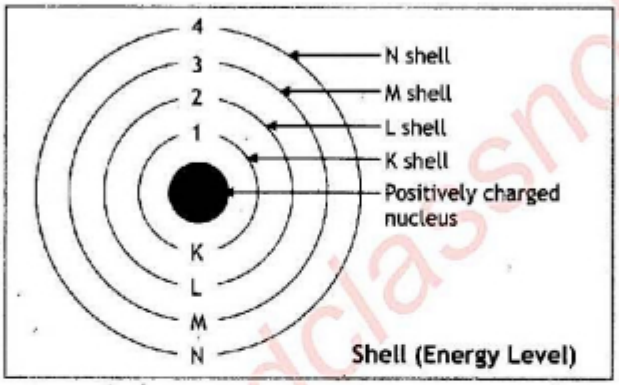
(iv) The numbers and kind of atomic orbitals depend on the energy subshell.

According to the quantum, mechanical model, the probability of finding an electron within a certain volume of space surrounding the nucleus can be represented as a fuzzy cloud. The cloud is denser the probability of finding an electron is high which are called atomic orbitals.

Q.23 Define shells and subshells.

Ans: We know that nucleus is present in the centre of an atom and around the nucleus electrons are revolving. These electrons are revolving around the nucleus at different levels according to their potential energy.

Concept of Shells: The Energy levels or shells or orbits are all possible paths on which electrons are revolving around the nucleus which shows by 'n'. These shells are named K, L, M, N, O, P with quantum numbers n = 1, 2, 3, 4, 5, 6 respectively. These shells have a definite amount of energy by means of decreasing shown order as they become away from the nucleus.



The first energy level is K shell has less energy.
The second energy level is L shell has more energy than the K shell.
The third energy level is M shell has more energy than K and L shells.
The fourth energy level is N shell has more energy than K, L and M shells.
The fifth energy level is O shell has more energy than K, L, M and N shells.

Concept of Sub Shells: When atomic spectra of substances were observed in a high powered spectroscope, it was found that they consist of two or more lines closely packed with each other as discussed in Zemen and Stark effects. These lines mean that electrons in the same shell may differ in energy by a small amount. Thus main energy levels are divided into sub energy levels and known as subshells. When electrons are many in numbers in a shell they show repulsion and the main shell splits into subshell which named s, p, d and f subshells. The number of subshells in a shell is according to the value of that shell, which are given in the following table.

Values of shell and subshell

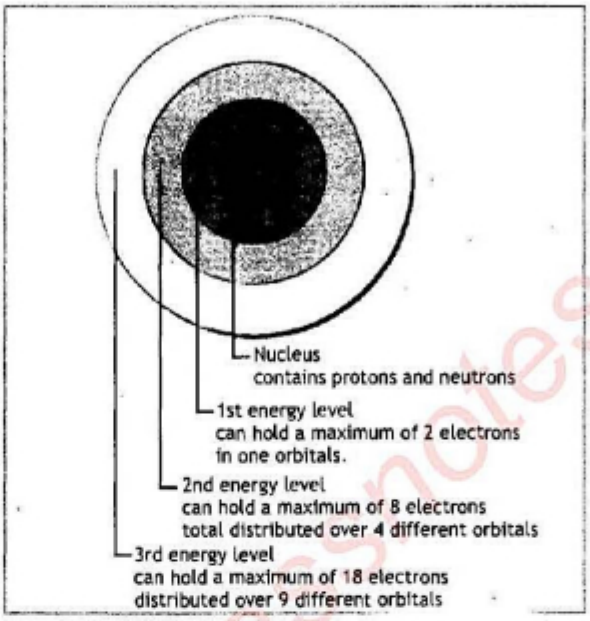
Value of 'n'	Shell	Sub shell
1	K	Only s
2	L	s, p
3	M	s, p, d
4	N	s, p, d, f

Q.24 Explain the electronic configuration of the first 18 elements.

Ans: ***Electronic Configuration of the First 18 Elements:*** The distribution of electrons among the different orbits/shells and subshells according to some rules is known as the electronic configuration of an atom. Generally, the most stable electronic configuration represented

when an atom is at the ground state with less energy level. Electrons filled in increasing order from lower to higher energy levels as

Filling of energy level



The maximum number of electrons that can be accommodated in a shell is represented by the formula $2n^2$, where 'n' is the shell number. The distribution of electrons in different orbits are as follows:

K-shell/ 1st orbit (n = 1) = $2(1)^2 = 2$ L-shell/ 2nd orbit (n = 2) = $2(2)^2 = 8$

M-shell/ 3rd orbit (n =3) = $2(3)^2 = 18$ N-shell/ 4th orbit (n = 4) = $2(4)^2 = 32$ and so on

There is a slight difference in energy levels of subshells, that way subshell's' filled first then subshell 'p' and onward. The distribution of maximum electrons in subshells is as follows:

2 electrons in 's' subshell 6 electrons in 'p' subshell

10 electrons in 'd' subshell 14 electrons in 'f' subshell

Whenever we write electronic configuration, we should always remember the following points:

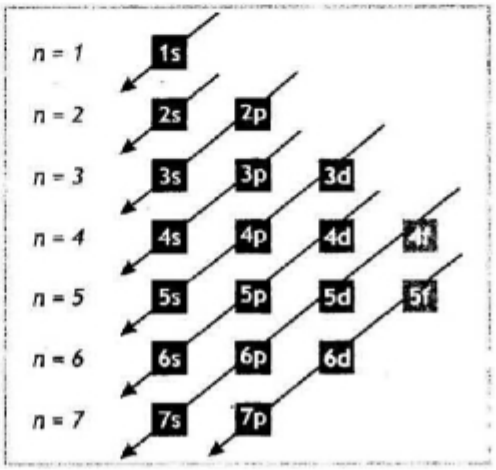
(i) Number of Electrons in an Atom.

(ii) Arrangement of shells and subshells according to energy levels.

(iii) Maximum number of electrons for shells and subshells.

The electronic configuration of different subshell of an atom is written as $1s^2$, $2s^2$, $2p^6$, $3s^2$, 2p as shown in the following figure.

Order of Filling of Electrons in Subshells



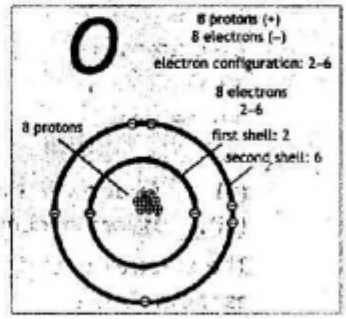
Where coefficient shows the number of shell, s,p are subshells and superscript is the number of electrons in subshells. The electronic configuration of the first 18 elements is given inthe following table.

Elements	Symbol	Atomic Number (number of electrons)	Electronic Configuration
Hydrogen	H	1	$1s^1$
Helium	He	2	$1s^2$
Lithium	Li	3	$1s^2, 2s^1$
Beryllium	Be	4	$1s^2, 2s^2$
Boron	B	5	$1s^2, 2s^2, 2p^1$
Carbon	C	6	$1s^2, 2s^2, 2p^2$
Nitrogen	N	7	$1s^2, 2s^2, 2p^3$
Oxygen	O	8	$1s^2, 2s^2, 2p^4$
Fluorine	F	9	$1s^2, 2s^2, 2p^5$
Neon	Ne	10	$1s^2, 2s^2, 2p^6$
Sodium	Na	11	$1s^2, 2s^2, 2p^6, 3s^1$
Magnesium	Mg	12	$1s^2, 2s^2, 2p^6, 3s^2$
Aluminum	Al	13	$1s^2, 2s^2, 2p^6, 3s^2, 3p^1$
Silicon	Si	14	$1s^2, 2s^2, 2p^6, 3s^2, 3p^2$
Phosphorus	P	15	$1s^2, 2s^2, 2p^6, 3s^2, 3p^3$
Sulphur	S	16	$1s^2, 2s^2, 2p^6, 3s^2, 3p^4$
Chlorine	Cl	17	$1s^2, 2s^2, 2p^6, 3s^2, 3p^5$
Argon	Ar	18	$1s^2, 2s^2, 2p^6, 3s^2, 3p^6$

Q.25 ***Write down the electronic configuration of an element that has 8 electrons.***

Ans: For this element first of all electrons will be filled in K shell which has a maximum capacity of 2 electrons, then the remaining electrons will be filled in L shell which has a maximum capacity of 8 electrons. Now arrangement of electrons will be entered into.

K	L	M
2	6	0



The above element is Oxygen which has 8 electrons. In writing electronic configuration first two electrons will go in the '1s' subshell of K shell which holds two electrons. The next two electrons for oxygen go in the 2s subshell of L shell and the remaining four electrons will go 2p subshell of L shell. Now the electronic configuration of oxygen is $1s^2\ 2s^2\ 2p^4$.

Q.26 ***In the distribution of electrons of an atom, which shell filled first and why?***

Ans: An atom of any element is most stable when it has minimum energy. An atom will first fill the lowest energy level to attain the state of minimum energy. Gradually, the electrons will fill the higher energy levels. Therefore, electrons will first fill the K shell, then the L shell, M shell, N shell, and so on.

Q.27 ***What are isotopes?***

Ans: As we know that atom is composed of three particles electrons, protons and neutron. In most of the elements, the number of electrons is equal to the number of protons due to this their atomic number and mass numbers are the same but in few elements, atomic number and mass numbers are different in the same elements.

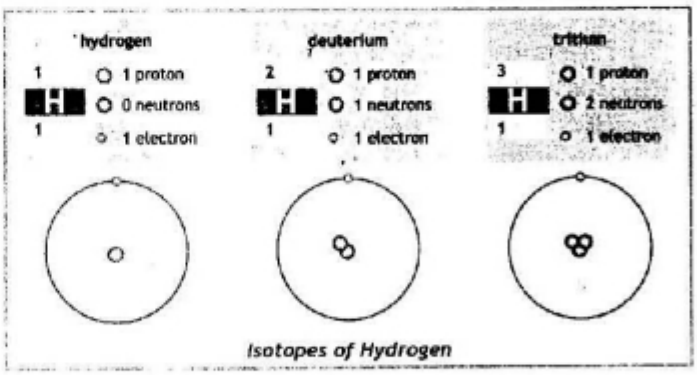
Definition: Atoms of the same element having the same atomic number but a different mass number are called isotopes. They have the same atomic number and number of protons, but a different number of neutrons. These elements have the same chemical properties due to the same electronic configuration but different physical properties due to difference in mass number.

Q.28 *Describe the isotopes of hydrogen.*

Ans: ***Isotopes of Hydrogen:*** There are three isotopes of hydrogen. They are known as:

1. Protium (ordinary hydrogen)
2. Deuterium (heavy hydrogen)
3. Tritium (radioactive hydrogen)

1. ***Protium (ordinary hydrogen):***
   - (i) The isotope of hydrogen which contains only one electron and one proton is known as protium or ordinary hydrogen.
   - (ii) It is represented by H or $_1H^1$
   - (iii) Its atomic number is 1 and atomic mass is also 1.
   - (iv) It has no neutron.
   - (v) It is the most common type of hydrogen.
2. ***Deuterium (heavy hydrogen):***
   - (i) The isotope of hydrogen which contains one electron, one proton and neutron is known as Deuterium or Heavy Hydrogen.
   - (ii) It is represented by $_1H^2$ or $_1D^2$.
   - (iii) Its atomic number is 1 and atomic mass is 2.
   - (iv) It has one neutron.
   - (v) For every 7000 atoms of ordinary hydrogen, only one atom of deuterium exists.
3. ***Tritium (radioactive hydrogen):***
   - (i) The isotope of hydrogen which contains one electron, one proton and two neutron is known as Tritium or Radioactive Hydrogen.
   - (ii) It is represented by $_1H^3$ or $_1T^3$.
   - (iii) Its atomic number is 1 and atomic mass is 3.
   - (iv) It has two neutron.
   - (v) For every 10^9 atoms of ordinary hydrogen, only one atom of tritium exists.



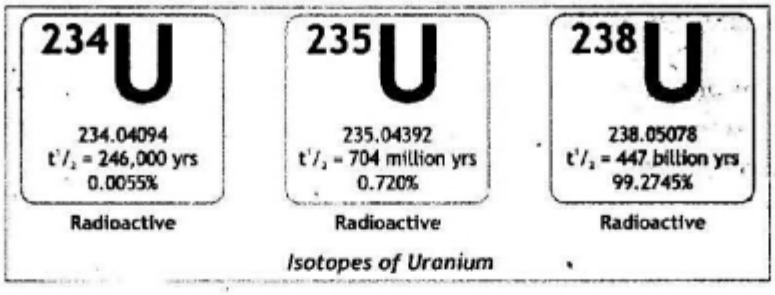
Isotopes of Hydrogen

Q.29 *Describe the isotopes of Uranium.*

Ans: ***Isotopes of Uranium:*** There are three isotopes of Uranium. They are given below:

1. $_{92}U^{234}$ 2. $_{92}U^{235}$ 3. $_{92}U^{238}$

Symbol	No. of Protons	No. of Electrons	No. of Neutrons	Atomic Mass
$_{92}U^{234}$	92	92	142	234
$_{92}U^{235}$	92	92	143	235
$_{92}U^{238}$	92	92	146	238



Isotopes of Uranium

Uranium is found 99% in nature.

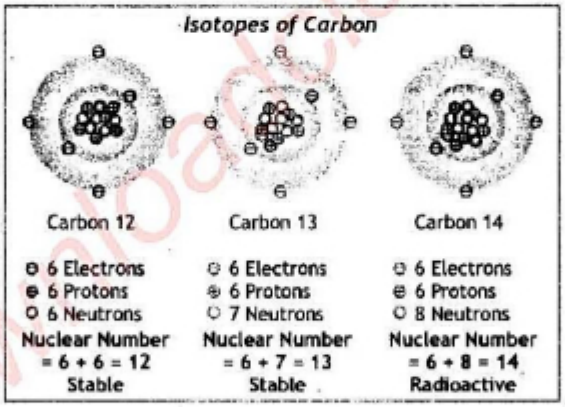
Q.30 Describe the isotopes of Carbon.

Ans: ***Isotopes of Carbon:*** There are three isotopes of Carbon. They are given below:

1. $_6C^{12}$ 2. $_6C^{13}$ 3. $_6C^{14}$

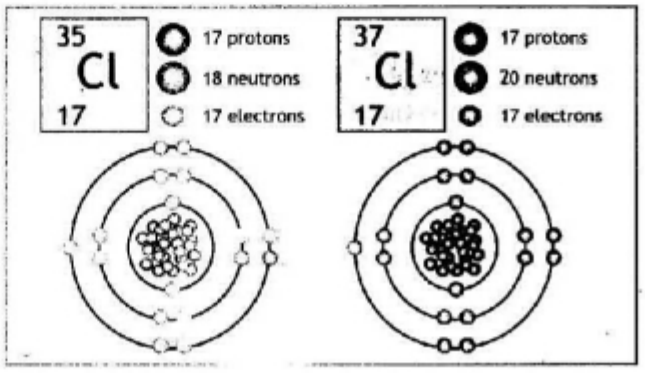
Symbol	No. of Protons	No. of Electrons	No. of Neutrons	Atomic Mass
$_6C^{12}$	6	6	6	12
$_6C^{13}$	6	6	7	13
$_6C^{14}$	6	6	8	14

There are two stable isotopes and one radioactive isotope of carbon. Carbon 12 is the most abundant (98.89%) isotope.



Q.31 Describe the isotopes of Chlorine.

Ans: ***Isotopes of Chlorine:*** There are two isotopes of Chlorine with atomic number 17 and mass number 35 and 37 as shown in the following figure. Chlorine 35 is 75% and chlorine 37 is 25% abundant in nature.



Isotopes of Chlorine

Q.32 Write the applications of isotopes.

Ans: ***Applications of Isotopes:*** Isotopes are used as tracers in physical and biological researches as well as in the treatments and diagnoses of disease like cancer. They are applied to help in.

(i) Selecting seeds of better quality.
(ii) Detecting the absorption of medicine.
(iii) Detecting the inner fault and probable age of machines.
(iv) Diagnoses and treatment of many diseases.

S. No.	Name of Radioactive Isotopes	Fields	Uses
(1)	Phosphorous-32 or strontium-90	Radiotherapy	• Treatment of skin cancer.
(2)	Cobalt-60	Radiotherapy	• Treatment of body cancer due to more penetrating power.
(3)	Iodine isotopes	Radiotherapy	• Detestations of thyroid glands in he neck.
(4)	Technetium	Radiotherapy	• To monitor the bone growth in fracture healing.
(5)	Gamma ray of cobalt-60	Medical instrumentation	• To sterilization of medical instruments and dressings from harmful bacteria.
(6)	Americium-241	safety measures & industries	• Used in back scatter gauges, smoke detectors fill height detectors and measuring ash content of coal.
(7)	Gold-198 and Technetium-99	Sewage & liquid waste movement for water pollution	• Tracing factory waste causing ocean pollution. • Tracing sand movement in rivers and oceans.
(8)	Uranium-235	Power Generation	• Conversion of water energy from steam to generate electricity.
(9)	Plutonium-238	Medicine	• Used to stimulate a regular heart beat in heart pace maker.
(10)	Carbon-14	Archaeology and Geology	• Used to estimate the age of fossils.

Q.33 Which of the isotopes of hydrogen contains a greater number of neutrons?

Ans: The isotope of hydrogen, tritium, contains a greater number of neutrons, 2.

Q.34 Why do isotopes of the same elements have the same chemical but different physical properties?

Ans: Different isotopes of an element generally have the same chemical properties because they have the same numbers of protons and electrons. Isotopes of an element have different physical properties including mass, melting or boiling point, density, and freezing point, because they have different mass numbers.

Differences

(1.) *Differentiate between shell and subshell with examples.*

Ans: *Difference Between Shell and Subshell*

Shell	Subshell
Shell is the pathway followed by electrons around an atom's nucleus. These are also called energy levels.	A subshell is an area in which an electron moves within a shell.
Scientists have named these shells using quantum numbers. Each shell has its own quantum number. The quantum number given for the shells is named the principal quantum number.	These are named according to the angular momentum quantum number.
The maximum number of electrons that any shell can hold is 32.	The maximum number of electrons it can hold depends on the type of subshell.
To recognize these shells, they are named K, L, M, N, etc.	Four major types of subshells can be found in a shell. They are named as s, p, d, f. Each subshell is composed of several orbitals.

(2.) *Differentiate between Bohr's Atomic Model and Rutherford's Atomic Model.*

Ans: *Difference Between Bohr's Atomic Model and Rutherford's Atomic Model*

Rutherford Atomic Model	Bohr Atomic Model
Rutherford model states that an atom is composed of a central core where nearly the whole mass of that atom is concentrated, and lightweight particles move around this central core.	Bohr model explains that the electrons always travel in specific shells or orbits which are located around the nucleus and these shells have discrete energy levels.
The model was based on observations of the gold foil experiment.	This model was based on observations of line spectra of the hydrogen atom.
This model does not describe the presence of discrete energy levels.	This model describes the presence of discrete energy levels.
It does not explain the relationship between orbital size and the energy of the orbital.	Explains the relationship between orbital size and the energy of the orbital; the smallest orbital has the lowest energy.

Section D Numericals:

Solved Examples of the Textbook

(1.) *What is the atomic number of an oxygen atom which has 8 electrons and 8 protons?*

Ans: Number of electrons = 8
Number of protons = 8
Atomic number = Z = ?
We know that
Atomic number = Z = Number of proton in nucleus = Total number of electron around nucleus
Therefore, the atomic number of an oxygen atom = Z = 8

(2.) ***Find the mass number of chlorine which have 17 protons and 18 neutrons?***

Ans: Number of protons = 17
Number of neutrons = 18
Mass number = A = ?
We know that

Mass number = A = number of protons (Z) + number of neutrons (N) = Z + N
= 17 + 18 = 35

(3.) ***How many electrons, protons and neutrons are present in Co?***

Ans: Name of the element = Cobalt
Atomic number = Z = 27
Mass number = A = 58.933 ≃ 59
We know that
Atomic number = Z = Number of proton in nucleus = Total number of electron around nucleus

Therefore, the number of protons and the number of electrons in Co are 27.

And Mass number = A = number of protons (Z) + number of neutrons (N)
59 = 27 + number of neutrons
number of neutrons = 59 - 27 = 32

(4.) ***What is the maximum number of electrons that can be accommodated in 's' shell?***

Ans: The innermost orbital shell is 's' shell which can accommodate only two electrons.

(5.) ***How many electrons will be in the L shell of an atom having atomic number 11?***

Ans: Sodium (atomic number 11) has its 11 electrons distributed in the first three shells as follows: the K and L shells are completely filled, with 2 and 8 electrons respectively, while the M shell is only partially filled with one electron. Therefore, the L shell has 8 electrons.

(6.) ***If both K and L shells of an atom are completely filled, what is the total number of electrons are present in them?***

Ans: The maximum number of electrons in the first orbit or K-shell will be $2n^2 = 2(1)^2 = 2$ and the second orbit or L-shell will be $2n^2 = 2(2)^2 = 8$. Hence, if K and L shells are full, the total number of electrons in the atom will be 2 + 8 = 10.

(7.) ***How many protons, neutrons and electrons are present in the following elements?***

(i) Fe_{26}^{56} ***(ii)*** O_8^{17} ***(iii)*** Cl_{17}^{37} ***(iv)*** U_{92}^{235}
(v) C_6^{14}

Ans: (i) Atomic Number = Z = 26
Mass number = A = 56
We know that

Atomic Number = number of protons = number of electrons

Therefore, number of protons = number of electrons = 26

We know that

Mass number = A = number of protons (Z) + number of neutrons (N)

A = Z + N

Therefore, N = A − Z

Number of neutrons (N) = 56 − 26 = 30

(ii) Atomic Number = Z = 8
Mass number = A = 17
We know that
Atomic Number = number of protons = number of electrons
Therefore, number of protons = number of electrons = 8
We know that
Mass number = A = number of protons (Z) + number of neutrons (N)
A = Z + N
Therefore, N = A − Z
Number of neutrons (N) = 17 − 8 = 9

(iii) Atomic Number = Z = 17
Mass number = A = 37
We know that
Atomic Number = number of protons = number of electrons
Therefore, number of protons = number of electrons = 17
We know that
Mass number = A = number of protons (Z) + number of neutrons (N)
A = Z + N
Therefore, N = A − Z
Number of neutrons (N) = 37 − 17 = 20

(iv) Atomic Number = Z = 92
Mass number = A = 235
We know that
Atomic Number = number of protons = number of electrons
Therefore, number of protons = number of electrons = 92
We know that
Mass number = A = number of protons (Z) + number of neutrons (N)
A = Z + N
Therefore, N = A − Z
Number of neutrons (N) = 235 − 92 = 143

(v) Atomic Number = Z = 6
Mass number = A = 14
We know that
Atomic Number = number of protons = number of electrons
Therefore, number of protons = number of electrons = 6
We know that
Mass number = A = number of protons (Z) + number of neutrons (N)
A = Z + N
Therefore, N = A − Z
Number of neutrons (N) = 14 − 6 = 8

A given isotope of Nitrogen (N) contains 7 electrons, 7 protons and 8 neutrons.
(a) What is its mass number? (b) What is its atomic number?

Data: Number of electrons = e = 7
Number of protons = P = 7
Number of neutrons = N = 8
(a) Mass Number = A = ?
(b) Atomic Number = Z = ?

Solution: Atomic Number = Z = No. of protons (p)

$\Rightarrow$ Z = 7

Mass number = A = Z + N

$\Rightarrow$ A = 7 + 8

$\Rightarrow$ A = 15 (a.m.u.)

9. ***C–14 and N–14 have same mass number yet they are different elements. Explain.***

	C–14:		*N–14*	
Solution:	Mass number	= A = 14	Mass number	= A = 14
	Atomic number	= Z = 6	Atomic number	= Z = 7
	Number of electrons	= e = 6	Number of electrons	= e = 7
	Number of protons	= P = 6	Number of protons	= P = 7
	Number of neutrons	= N = 8	Number of neutrons	= N = 7

Ans: Hence proved, that C–14 and N–14 are different elements because their atomic numbers are different from each other. In the isotopes of same element, atomic number remains same but atomic mass or mass number may be different. Thus it should be necessary to be same atomic number for same elements.

10. ***Give the names and symbols for the following elements:***

(a) An element with atomic number 6.

(b) An element with 18 protons in the nucleus.

(c) An element with 17 electrons.

(a) Data: Atomic number = Z = 6

Solution: Name of element = Carbon

Symbol of element = C

(b) Data: Number of protons = Z = 18

Name of element = ?

Symbol of element = ?

Solution: Number of protons = Z = 18

Name of element = Argon

Symbol of element = Ar

(c) Data: Number of protons = 17

Name of element = ?

Symbol of element = ?

Solution: Number of electrons = Number of protons (Z)

Number of electrons = Z = 17

Name of element = Chlorine

Symbol of element = Cl

11. ***How many electrons and protons are there in each atom of the following:***

(a) Carbon (b) Aluminum (c) Argon

(d) Fluorine (e) Potassium (f) Sulphur

(a) Data: Atomic Number = Z = 6

Number of protons = ?

Number of electrons = ?

Solution: Z = No. of protons = No. of electrons

Atomic Number = Z = 6

Number of protons = 6

Number of electrons = 6

(b) Data: Atomic number = Z = 13
Number of protons = ?
Number of electrons = ?

Solution: Z = No. of protons = No. of electrons
Atomic Number = Z = 13
Number of protons = 13
Number of electrons = 13

(c) Data: Atomic Number = Z = 18
Number of protons = ?
Number of electrons = ?

Solution: Z = No. of protons = No. of electrons
Atomic Number = Z = 18
Number of protons = 18
Number of electrons = 18

(d) Data: Atomic Number = Z = 9
Number of protons = ?
Number of electrons = ?

Solution: Z = No. of protons = No. of electrons
Atomic Number = Z = 9
Number of protons = 9
Number of electrons = 9

(e) Data: Atomic Number = Z = 19
Number of protons = ?
Number of electrons = ?

Solution: Z = No. of protons = No. of electrons
Atomic Number = Z = 19
Number of protons = 19
Number of electrons = 19

(f) Data: Atomic Number = Z = 16
Number of protons = ?
Number of electrons = ?

Solution: Z = No. of protons = No. of electrons
Atomic Number = Z = 16
Number of protons = 16
Number of electrons = 16

(12.) *How many protons, neutrons and electrons are present in the following atoms:*

(a) $_7N^{15}$ (b) $_{27}Co^{60}$ (c) $_{53}I^{131}$ (d) $_{82}Pb^{207}$

(a) Data: $(_7N^{15})$
Mass number = A = 15 Atomic number = Z = 7
Number of protons = P = ? Number of electrons = e = ?
Number of neutrons = N = ?

Solution: Atomic number = Z = No. of electron = No. of proton
No. of electrons = e = 7
No. of protons = P = 7
Number of neutrons (N) = Mass number (A) – Atomic Number (Z)
$\Rightarrow N = A - Z$
$\Rightarrow N = 15 - 7$
$\Rightarrow N = 8$

(b) Data: $(_{27}Co^{60})$
Mass number = A = 60 Atomic number = Z = 27
Number of electrons = e = ? Number of protons = P = ?
Number of neutrons = N = ?

Solution: Atomic number = Z = No. of electron = No. of proton
No. of electrons = e = 27 No. of protons = P = 27
Number of neutrons (N) = Mass number (A) – Atomic Number (Z)
$\Rightarrow N = A - Z$
$\Rightarrow N = 60 - 27$
$\Rightarrow N = 33$

(c) Data: $(_{53}I^{131})$
Mass number = A = 131 Atomic number = Z = 53
Number of electrons = e = ? Number of protons = P = ?
Number of neutrons = N = ?

Solution: Atomic number = Z = No. of electron = No. of proton
No. of electrons = e = 53 No. of protons = P = 53
Number of neutrons (N) = Mass number (A) – Atomic Number (Z)
$\Rightarrow N = A - Z$
$\Rightarrow N = 131 - 53$
$\Rightarrow N = 78$

(d) Data: $(_{82}Pb^{207})$
Mass number = A = 207 Atomic number = Z = 82
Number of electrons = e = ? Number of protons = P = ?
Number of neutrons = N = ?

Solution: Atomic number = Z = No. of electron = No. of proton
No. of electrons = e = 82 No. of protons = P = 82
Number of neutrons (N) = Mass number (A) – Atomic Number (Z)
$\Rightarrow N = A - Z$
$\Rightarrow N = 207 - 82$
$\Rightarrow N = 125$

Summary

- The Electron is the lightest particle carrying a negative charge in an atom discovered by J.J. Thomson and William Crooks.
- The proton is a positive charge particle discovered by Goldstein in 1886. J.J. Thomson investigated the properties of proton in 1897.
- In 1932 Chadwick became successful to discover Neutron.
- Lord Rutherford in 1911, carried out series of experiments and proposed a new model for the atom that an atom contains a nucleus at the centre and electrons revolve around this nucleus.
- In 1913 Neil Bohr proposed another atomic model. This atomic model was different in this manner that it shows two folds, first to remove the Rutherford atomic model and second explain the line spectrum of Hydrogen atom based on the quantum theory of Max Planck.
- In 1923 Lois De Broglie extend the wave-particle duality to electron, and propose a hypothesis that all matter has particle as well as wave nature at the sub-microscopic level.
- The Energy levels or Shell or Orbital are all possible paths on which electrons are revolving around the nucleus which shows by 'n'. These shells are named K, L, M, N, O, P.
- The main energy levels are divided into sub energy levels and known as subshells.
- The distribution of electrons among the different orbits/shells and subshells is known as the electronic configuration of an atom.
- Atoms of the same element having the same atomic number but different atomic masses are called isotopes. They have the same number of electron and the same number of protons, but a different number of neutrons.
- The Isotopes are used in worldwide applications of daily life. Research laboratories, medical centres, industrial facilities, food irradiation plants and many consumer products all use or contain isotopes.

Solution of Textbook Exercise

SECTION-A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer:

See "Multiple Choice Questions (M.C.Qs)" - (i) to (x)

SECTION-B: SHORT QUESTIONS:

1. ***Draw the structure of isotopes of chlorine to justify the definition of isotopes***

Ans: See 'Short & Detailed Answer Questions' - Q.30

2. ***An atom has 5 electrons in M shell than:***
   (a) Find out its atomic number? (b) Write Electronic configuration of the atom.
   (c) Name the element of the atom.

Ans: (a) It means the element has 2 electrons in the K shell, 8 electrons in the L shell and 5 electrons in the M shell. The atomic number of that element is 15.

(b) Electronic Configuration: $1s^2$ $2s^2 2p^6$ $3s^2 3p^3$
K shell L shell M shell

(c) Name of the element: Phosphorus

3. ***Justify that Rutherford atomic model has defects.***

Ans: See 'Short & Detailed Answer Questions' - Q.16

4. ***Describe wave-particle duality of electron of De Broglie Hypothesis.***

Ans: See 'Short & Detailed Answer Questions' - Q.22 'De Broglie Hypothesis'

5. ***What are the limitations of Bohr's Atomic Model?***

Ans: See 'Short & Detailed Answer Questions' - Q.19

6. ***Differentiate between shell and subshell with examples?***

Ans: See 'Differences' - Q.1

7. ***How the atoms of O_8^{17} and O_8^{16} are similar or different from each other?***

Ans: ***Isotopes of Oxygen***: There are three isotopes of Oxygen. They are given below:

Symbol	No. of Protons	No. of Electrons	No. of Neutrons	Atomic Mass
$_8O^{16}$	8	8	8	16
$_8O^{17}$	8	8	9	17
$_8O^{18}$	8	8	10	18

8. ***Write down the names of subatomic particles their masses in a.m.u. with their unit charges.***

Ans:

Name	Symbol	Relative Charge	Charge in (C)	Mass (a.m.u.)	Mass in (kg)	Location
Proton	P^+	+1	$+1.6 \times 10^{-19}$	1.007	1.67×10^{-27}	nucleus
Neutron	n^o	0	Neutral	1.009	1.67×10^{-27}	nucleus
Electron	e^-	−1	-1.6×10^{-19}	5.486×10^{-4}	9.11×10^{-31}	outside nucleus

SECTION-C: DETAILED QUESTIONS

1. ***Discuss Rutherford's gold foil experiment in the light of the structure of an atom.***

Ans: See 'Short & Detailed Answer Questions' - Q.16

2. ***Write down the applications of isotopes in daily life.***

Ans: See 'Short & Detailed Answer Questions' - Q.31

3. ***Explain how Bohr's atomic model is different from Rutherford atomic model.***

Ans: See 'Differences' - Q.2

4. ***Prove that the modern theory of De Broglie is related to Einstein and Plank's equations.***

Ans: See 'Short & Detailed Answer Questions' - Q.22 'De Broglie Hypothesis'

5. ***How are cathode rays produced? What are their major characteristics?***

Ans: See 'Short & Detailed Answer Questions' - Q.4 & Q.5

6. ***Describe the Schrodinger atomic model.***

Ans: See 'Short & Detailed Answer Questions' - Q.22 'Schrodinger Atomic Model'

7. ***Describe briefly the experiments which provide clue and evidence of electron, proton and neutron in an atom.***

Ans: See 'Short & Detailed Answer Questions' - Q.4, Q.6 & Q.8

8. ***How many protons, neutrons and electrons are present in the following elements?***
   (i) Fe_{26}^{56} (ii) O_8^{17} (iii) Cl_{17}^{37} (iv) U_{92}^{235} (v) C_6^{14}

Ans: See 'solved numericals' - Q.7