ATOMIC STRUCTURE

LEARNING OBJECTIVES:

- Fundamental particles
- Atomic Number & Mass Number
- Isotopes,Isobars & Isoelectronic species
- Radioactivity & Electro Magnetic Radiation
- Atomic models
- Plank's quantum theary - Photo electric effect
- Bohr's model
- Spectra and Hydrogen spectrum

Real life applications:

Φ Atomic structure has several applications in various fields like Nuclear Physics, Chemical Engineering etc....

Φ Structure of atom helps to know about the Radioactive disintegrations, All the living & processes on the earth

§§ **Characteristics of fundamental particles:**

PROPERTY	ELECTRON	PROTON	NEUTRON
1. MASS	0.00054 a.m.u. $9.11X10^{-28}g$ $9.11x10^{-31}g$	1.00728 a.m.u. $1.672X10^{-24}g$ $1.672x10^{-27}g$	1.008665 a.m.u. $1.675X10^{-24}g$ $1.675x10^{-27}g$
2. MASS RELA -TIVE TO ELECTRON	1	1837	1840
3. MASS OF 1 MOLE	0.55mg	1.007g	1.008g
4. CHARGE	$-1.602X10^{-19}C$ $-4.8X10^{8}$ esu -1(relative)	$+1.602X10^{-19}C$ $+4.8x10^{8}$ esu +1(relative)	0
5. SPECIFIC CHARGE (e/m)	$1.76x10^{8}c/g$	$9.58x10^{4}c/g$	0

S.NO	ELECTRON	PROTON	NEUTRON	ALPHA
CHARGE	1	1	0	2
MASS	1	1840	1840	4X1840
e/m	1	1/1840	0/1840	2/(4x1840)

Increasing order of specific gravity: n<alpha<p<e-

§§ **Important Formulae:**

⇒ $m_e = \frac{e}{e/m_e} = \frac{1.60x10^{-19}}{1.758820x10^{11}ckg^{-1}}$

⇒ $V=\frac{C}{\lambda}$ or $\lambda=\frac{C}{v}$

⇒ $E = hv = \frac{hc}{\lambda} = hc\bar{v}$

⇒ $hv=hv_0+\frac{1}{2}m_eV^2$

⇒ Rydberg equation $\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$

⇒ Maximum number of lines produced when an electron jumps from nth level to ground level $=\frac{n(n-1)}{2}$.

⇒ Angular momentum of an electron : $mvr = n\frac{h}{2\pi}$

⇒ The radius of Bohr's orbit $r=\frac{n^2h^2}{4\pi^2\,m\,Ze^2}$

⇒ The energy of Bohr's orbit $E=\frac{-2\pi^2 mZ^2e^4}{n^2h^2}$

⇒ Difference of energy between two Bohr orbits of hydrogen like atoms & ions

$\Delta E=Z^2Rhc\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$

⇒ Velocity of electron in atom $V=\frac{2\pi Ze^2}{nh}=\frac{2.188\times10^8}{n}cm/sec$

⇒ For H atom, like ions, Ionisation potential $=\frac{-E_1\times Z^2}{n^2}$

§§ **ATOMIC NUMBER AND MASS NUMBER:**

A neutral atom contains equal number of electrons and protons.The number of electrons or photons present in an atom of an element is called its atomic number. Atomic number is denoted by Z.

Atomic number is equal to the nuclear positive charge of an element.The sum of protons and neutrons in the atom of an element is called its mass number.

It is denoted by A.

Number of neutrons = A - Z.

Mass number is always a whole number.

Atoms of elements having the same atomic number but different mass numbers are called isotopes. Isotopes of an element have the same number of protons and electrons but differ in the number of neutrons.

§§ **ISOTOPES :**

Atoms with identical atomic number but different mass numbers are known as isotopes. Isotopes exhibit similar chemical properties.

Eg:-1) Isotopes of hydrogen : Protium $\left({}_1H^1\right)$

Deuterium $\left({}_1H^2\right)$ or ${}_1D^2$

Tritium $\left({}_1H^3\right)$ of ${}_1T^3$

2) Isotopes of chlorine are ${}_{17}Cl^{35}$ and ${}_{17}Cl^{37}$

It is evident that difference between the isotopes is due to the presence of different number of neutrons present in the nucleus.

For example, considering of hydrogen atom again, 99 985% of hydrogen atoms contain only one proten. This isotpe is called protium $\left({}_1^1\mathrm{H}\right)$.Rest of the percentage of hydrogen atom contains two other isotopes, the one containing 1 proton and 1 neutron is calle deuterium $\left({}_1^2\mathrm{D},0\,015\%\right)$ and the other one possesing 1 proton and 2 neutrons is called tritium $\left({}_1^3\mathrm{T}\right)$. The latter isotope is found in trace amounts on the earth.

§§ **ISOBARS :**

Atoms with same mass number with different atomic number are known as isobars

Eg : ${}_6C^{14}, {}_7N^{14}$.

§§ **ISOTONES :**

The species which are having same number of neutrons are called isotones.

(or)

Atoms of different elements having same number of neutrons but differs in atomic number and mass number.

Eg: ${}_9F^{19}$, ${}_{10}Ne^{20}$

Eg: ${}_{19}K^{39}$, ${}_{20}Ca^{40}$

§§ **ISOELECTRONIC SPECIES:**

The species which are having same number of electrons are called isoelectronic species.

Eg: CN^- and N_2

Eg: Al^{+3} and N^{-3}

INTRODUCTION

The term atom was proposed by John Dalton Acording to Dalton's atomic theory , all types of matter is made up of small particles called atoms.Dalton's theory assumed that the atoms were indivisible New experimental facts established that atoms can be further divided into sub atomic particles

1) Electrons 2)Protons 3)Neutrons

Dalton' Theory is able to explain law of consersation of mass, law ofconstant composition and law of multiple proportions . Dalton's law is failed to explain the experiments like when glass or ebonite rubbed with silk or fur generate electricity.

Above experiment indicates that there is a presence of subatomic particles like electron ,

neutron proton present in the atom.

Electrons, protons and neutrons are the fundamental particles of atom.Protons and neutrons are present in the nucleusand are called nucleons.Electrons are the negatively charged particles with unit charge and negligible mass. Neutrons are the neutral particles with unit mass.

§§ DISCOVERY OF ELECTRON:

Atomic structure was obtained from theexperiments on electrical discharge through gases.During the discharge tube experiment "Crookes" observed that rays were found to pass fromnegatively charged filament (cathode) to positivelycharged plate (anode) Cathode ray tube is made of glass containing twothin piece of metal, called electrodes, sealed in it.The electical discharge through the gases could be oserved only at very low pressure and at very high voltage. By maintaining low pressure and high voltaindischarge tube current or stream of particlesmoving in the tube from cathode to anode.That rays are known as cathode rays or cathode ray particles.

§§ PROPERTIES OF CATHODE RAYS

Cathode rays starts from cathode and move towards anodeThese rays themselves are not visible but their behaviour can be observed with the help ofcertain kind of material (fluorsecent or phosphorescent) wich glow when hit by them Rays travel straight lines in the absence of electric and magnetic field In the presence of electric and magnetic field they are deflected indicates that cathode rays contain negatively charged particles known as electrons Cathode rays found to be independent of nature of the cathode material and nature of the gas in the tube.

¶¶ CHARGE TO MASS RATIO OF ELECTRON:

J.J. Thomson measured e/m ratio of the electron based on following points Greater the magnitude of the charge on the particle greater is the deflection when electric and mag netic field is applied Lighter the mass of the particle greater will be the deflection The deflection of electrons from its original path increases when voltage increases from the above points Thomson was able to determine the value of charge to mass ratio as 1.758820×10^{11} ckg^{-1}.

¶¶ CHARGE OF ELECTRON:

Mullikan determined the charged of the electron by an oil drop experiment .By carefully measuring the effect of the electrical field on the movement of many droplets.charge on the oildrops was always an integral multiple of 1.60×10^{-19} C

$$m_e = \frac{e}{e/m_e} = \frac{1.60x10^{-19}}{1.758820x10^{11} ckg^{-1}}$$

$$= 1094x10^{-31} kg$$

The air inside the chamber was ionized by passing a beam of X-rays through it. The electrical charge on these oil droplets was acquired, accelerated or made stationary
depending upon the charge on the droplets and the polarity and strength of the voltage applied to the plate. By carefully measuring the effects of electrical field strength on the motion of oil droplets. Milkan concluded that the magnitude of electrical charge, q, on the droplets is always an integral multiple of the electrical charge, e, that is q = ne, where n = 1,2,3.....

¶¶ ANODE RAYS(DISCOVERY OF PROTON):

Atom is electrically neutral, there must be some positively charged particles present in the atom to neutralise the negative charges of electrons.Its been confirmed by experiments that atoms contain positively charged particles also.These particles are called ***protons.***

GOLDSTEIN experimented with a discharge tube fitted with a perforated cathode and found that a new type of rays came out through the holes in the cathode.

When this experiment is conducted , a faint red glow is observed on the wall behind the cathode. Since these rays originate from the anode, they are called ***anode rays.***
Initially these rays were called ***canal rays*** bacause they pass through the canals or holes of the cathode. ***J.J.Thomson*** called these rays positive rays as they are ***positively charged***.

§§ **Properties of anode rays:**

1. ***Anode rays travel along straight paths*** and hence they cast shadows of objects placed in their path.
2. ***They rotate a light paddle wheel placed in their path*** .This shows that anode rays are made up of material particles.
3. ***They are deflected towards the negative plate of an electric field.*** This shows that these rays are positively charged.
4. For different gases used in the discharge tube, **the charge to mass ratio (e/m) of the positive particles constituting the positive rays is different.** When **hydrogen gas** is taken in the discharge tube, the e/m value obtained for the positive rays is found to be **maximum**. Since the value of charge (e) on the positive particle obtained from different gases is the same, the value of m must be minimum for the positive particles obtained from the hydrogen gas.Thus,the positive particle obtained from hydrogen gas is the lightest among all the positive particles obtained from different gases. This particle is called the ***proton.***

¶¶ **Origin of positive rays:**

In the discharge tube the atoms of gas lose negatively charged electrons.These atoms, thus, acquire a positive charge. The positively charged particle produced from hydrogen gas was called the proton.

$$H \xrightarrow{-e} H^{+} \text{ (Proton)}$$

¶¶ **Characteristics of protons:**
1. A Proton is a positively charged particle present in the atoms of all elements.
2. The mass of a proton is ***1838*** times that of an electron. The relative mass of an proton is equal to ***1.005757 amu*** which is taken to be equal to 1 amu. The absolute mass of a proton is $\boldsymbol{1.672 \times 10^{-24} g}$
3. The charge on a proton is equal in magnitude but opposite in sign to that of an electron. The charge carried by a proton is equal to $\boldsymbol{1.602 \times 10^{-19} C}$ Which is taken to be one unit of positive charge(i.e., +1). Thus , a proton is said to carry a positive charge.

¶¶ **Discovery of neutron:**

The helium has 2 electrons and 2 protons . So, the mass of the helium atom was expected to be twice the mass of the hydrogen atom, Which was 1 electron and 1 proton. But, actually the mass of the helium atom is four times that of the hydrogen atom. It was found that atoms of all the elements (except hydrogen) were at least twice as heavy as could be explained by the number of protons they had. To explain that it was predicted that other particles with no charge, but mass equal to that of a proton , must be present in all atoms except hydrogen.This prediction was proved to be correct with the discovery of the neutron.
In 1932, ***James Chadwick*** bombarded the beryllium with α - particles. He observed the emission of a radiation with the following properties.
1. The radiation was highly penetrating.
2. The radiation remained uneffected in an electric or magnetic field, i.e., the radiation was neutral.
3. The particles constituting the radiation had same mass as that of the proton. Thus the relative mass of sucha particle = 1 amu and the absolute mass = 1.6x10-24g. Because of their electrical neutrality, these particles were called ***neutrons.***

§§ **X - Rays,**

Roentgen in 1895 showed tha when electrons strike a material in the cathode ray tubes produce rays which can cause fluorescence in the fluorescent materials placed outside the cathode ray tube. Since Roentgen did not know the nature of the radiation he name then x-rays.

X-rays are not deflected by the electric and magnetic fields

X-rays have a very high penetrating power through the matter so these are used to study the interior of the object, X-rays have very short wavelength (0.1nm)

§§ **Phenomenon of radio activity (α - rays , β - rays , γ - rays)**

Henri Becqueral observed that there are certian elements which emit radiation (α,β,γ) on their own and named this phenomenon as the radioactivity and the elements known as radioactive elements. α - rays consists of high energy particles carrying two units positive charge and four units of atomic mass (Helium nucle). β -ray are negatively charged particle similar to electrons. γ -rays are high energy radiations like X-rays. Penetrating power order of these radiation is $\alpha < \beta < \gamma$.

§§ **NATURE OF ELECTRO MAGNETIC RADIATION:**

Cosmic rays, $\gamma -$ rays, X - rays, UV light, visible light, Infrared light, micro waves, TV waves and radio waves are called electromagnetic radiation because they are made up of electric and magnetic fields propagating in perpendicular directions in one another.Electromagnetic radiations have wave characteristics and no medium is required for their propagation. They can travel through the vacuum.

§§ **WAVE LENGTH (λ) :** The distance between two neighbouring troughs or crests in waves is known as wave length.

The units wave length are m, cm, $\mathbf{A^0}$, nm, $m\mu$.

$$\mathbf{1A^0 = 10^{-8}\,cm = 10^{-10}\,m}$$

$$\mathbf{1nm = 10^{-9}\,m = 10^{-7}\,cm}$$

$$\mathbf{1nm = 1m\mu = 10A^0}$$

§§ **FREQUENCY : $(\mathbf{v})$:** The number of waves that pass through a given point in one second is called frequency.

The units of frequency are $\sec^{-1}$, cycles per second (cps) or Hertz (Hz).1cps = 1 Hz

§§ **WAVE NUMBER $(\overline{\mathbf{V}})$:** The number of wave lengths per centimetre or the reciprocal wve lengths is called wave number. The unit of wave number is cm^{-1}.

§§ **AMPLITUDE** (a) : The height of the crest or depth of the through of a wave is called amplitude. Amplitude is a measure of the intensity or brightness of a beam of light.

§§ **VELOCITY (C) :** The distance travelled by a wave in one second is called its velocity.

The units of velocity are m/sec or cm/sec.

All types of electromagnetic radiation have the same velocity which is equal to

$\mathbf{3x10^{10}}$**cm/sec or** $\mathbf{3x10^{8}}$ **m/sec**

§§ **RELATIONSHIP BETWEEN WAVE CHARACTERISTICS:**

$V = \frac{C}{\lambda}$ or $\lambda = \frac{C}{v}$ ..... (1)

$$\bar{V} = \frac{1}{\lambda} = \frac{v}{C} .....(2)$$

Where v = frequency in sec^{-1}

$\lambda =$ wavelength in cm

C = velocity of light = 3×10^{10} cm/sec

$\bar{v} =$ wave number in cm^{-1}

The wave length of UV light is

1800 - 3800 A^0

The wave lengths of visible light is $3800 - 7600\, A^0$

The wave length of IR radiation is $7600 - 3x10^6\ A^0$

TEACHING TASK

I. Single answer type questions

1. The particle with zero specific charge is

1) electron 2) neutron 3) proton 4) α -particle

2. The e/m value of electron is

1) 1.758820×10^{-11} ckg^{-1} 2) 1.75882×10^{-11} ckg^{-1}

3) 1.758802×10^{-12} $kg^{-1}c$ 4) 1.75882×10^{13} $kg^{-1}c$

3. Charge of electron electron is determined by

1) J.J. Thomson 2) Mulikan 3)Crookes 4) Chadwick

4. $\frac{e}{m}$ value of anode rays is maximum when the gas taken in discharge tube is

1) Helium 2) Hydrogen 3) Oxygen 4) Neon

5. Neutrons are discovered by

1) J.J. Thomson 2) Gold Stein 3) Crookes 4) Chardwick

6. Change of one mole of alpha particle is

1) +2 units 2) +1 units 3) +2 faraday 4) +2 coulombs

7. The ratio of $\frac{e}{m}$ of proton and $\alpha -$ particle is

1) 2 : 1 2) 1 : 2 3) 1 : 1 4) 1 : 3

8. The ion that is isoelectron with carbon monoxide is

1) CN^- 2) O^{2+} 3) O^-_2 4) N_2^+

9. Among $_{10}A^{20}$ $_{11}B^{21}$ $_{11}C^{22}$ and $_{12}D^{22}$ the isobar combination is

1) A and B 2) B and C 3) C and D 4) A and D

10. U^{235} and U^{238} are seperated by

1) Sublimation 2) Gaseous diffusion 3) Precipitation 4) Electrolysis

11. Lighest isotope in the periodic table is

1) Tritium 2) Deuterium 3) Protium 4) All the above

12. The lighest radioactive isotope in periodic table is
1) Tritium 2) Deuterium 3) Protium 4) All the above

13. Isotopes exhibits similar
1) Physical properties 2) Chemical properties
3) Physical and chemical 4) neither physical nor chemical properites

14. Isotopes differ in
1) Physical properties 2) raido active properties
3) mass number 4) all the above

15. Isotopes are seperated by
1) Atmolysis 2) Diffifusion method 3) electrolysis method 4) both 1 & 2

16. The number of neutrons in the radio active isotope of hydrogen is
1) 2 2) 3 3) 5 4) 1

17. The nucleus of tritium(T), the unstabel isotopes of hydrogen consists of :
1) 1 Proton +1 Neutron 2) 1 Proton +3 Neutron
3) 1 Proton +0 Neutron 4) 1 Proton +2 Neutrons

18. The number of neutron present in the deuterium isotope of hydrogen is
1) 2 2) 3 3) 5 4) 1

19. The atomic weight of an element is 23 and its atomic number is 11. The number of protons, electrons and respectively present in the atom of the element are:
1) 11,11 2) 12,12 3) 11,12 4) 12,11

II. Multi answer type questions

- *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

20. Pick out the isoelectronic structure from the following
i) CH_3^+ ii) H_3O^+ iii) NH_3 iv) CH_3^-
1. i & iii 2. i & ii 3. iii & iv 4. ii, iii & iv

21. Among the following, unpaired electrons present in
i) KO_2 ii) Al_2O^{-2} iii) BaO_2 iv) NO_2^+
1. i & iii 2. i & ii 3. iii & iv 4. ii, iii & iv

III. Assertion and reasoning type questions

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

1. Both A & R are true and R is the correct explanation of A
2. Both A & R are true and R is not the correct explanation of A
3. A is true, R is false.
4. A is false, R is true.

22 **A:** Atom is electrically neutral
R: A nuetral particle, neutron is present in the nucleus of an atom.

23. **A:** Cathode rays are deflected towards positive plate in an electrical feild
R: These consist of negatively charged particles.

24. **A:** Electromagnetic radiations around 1015 Hz are called as visible light.
R: This is the only part of electromagnetic radiation which is visible to eyes.

IV. Matching type

- *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

  *If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

25.

Column-I	Column-II
a) J.J. Thomson	1) Discovery neutron
b) Mosley	2) Nuclear model of atom
c) Chadwick	3) Cathode rays
d) Rutherford	4) X-ray spectra
	5) Radioactivity

26.

Column I	Column II
a) Electron	1) Atom is electrically neutral
b) Proton	2) Negative charge
c) Thomson model of atom	3) Positive charge
d) Muliken's oil drops experiment	4) Quantization of charge

V. Comprehension type:

- *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

Cathode rays consists of negatively charged material particles called electrons. These electrons are fundamental sub atomic particles carrying negative charge and having mass 9.1×10^{-31} kg. Discovered by J.J Thomson.Charge to mass $(\frac{e}{m})$ ratio of an electron is 1.76×10^{8} C/g.

Charge to mass $(\frac{e}{m})$ ratio for an proton is 9.55×10^{4} C/g.

27. Particles in cathode rays have same charge to mass ratio as:

1) α - particles 2) β - particles 3) γ - rays 4) Protons

28. The ratio of specific charge of a proton and that of an α - particle is:

1) 1 : 2 2) 1 : 1 3) 2 : 1 4) 1 : 4

29. Which of the following particles has maximum charge to mass ratio?]

1) Electrons 2) Protons 3) α - particles 4) Neutons

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single answer type questions.

30. What is wrong about anode rays
a)Their e/m ratio constant b)They are deflected by eletrical and magnetic field
c) They are produced by ionisation of molecules of the residual gas
d) They do not originate from the anode

31. Canal rays is name for beam of
a) electrons b) protons c)neutrons d)positively charged ions

32. The mass of the neutrons is of the order of
a)10^{-23} kg b)10^{-24} kg c)10^{-26} kg d)10^{-27} kg

33. The space between a proton and electron in hydrogen atom is
a) full of air b) full of ether
c) full of electromagnetic radiations d) empty

34. The introduction of a neutron into the nucleus of an atom would lead to a change in
a) The number of electrons also b) The chemical nature of atom
c) Its atomic number d) Its atomic weight.

35. If the mass number of an element is W and its atomic number is N, then
a) Number of e^{-1}=W-N b) Number of ${}_1H^1$ =W-N
c) Number of ${}_0n^1$=W-N d) Number of ${}_0n^1$=N

36. Most elements have a fractional atomic masses because
a) They have isotopes b) Their isotopes have diffrent masses
c) Their isotopes have non-integral masses
d) Their constituent neutrons, protons and electrons combine to give fractional masses

37. The fundamental particles which are responsible for keeping neucleons together is
a) mason b)anti proton c)positron d)electron

38. Two nuclides x and Y isotonic to each other with mass numbers 70 and 72 respectively. If the atomic number of X is 34, then that of Y would be
a)32 b)34 c)36 d)38

39. An isotone of ${}^{76}_{32}Ge$ is
a) ${}^{76}_{32}Ge$ b) ${}^{77}_{33}As$ c) ${}^{77}_{34}Se$ d) ${}^{81}_{36}Kr$

40. Number of neutrons in heavy Hydrogen atom is
a) 0 b)1 c)2 d)3

41. The volume of nucleus is about
a)10^{-5} times that of an atom b) 10^{-10} times that of an atom
c) 10^{-15} times that of an atom d) 10^{-20} times that of an atom

42. The increasing order of specific charge of electron (e), proton (p), alpha particle (α) and neutron (n) is
1) e, p, n, α 2) n, p, e, α 3) n, α , p, e 4) n, p, α , e

43. The ratio between the number of neutrons present in C^{12} and Si^{30} atoms is
1) 3 : 8 2) 2 : 5 3) 3 : 7 4) 1 : 1

44. The nitride ion in lithium nitride is composed of
1) 7 protons + 7 electrons 2) 10 protons + 7 electrons
3) 7 protons + 10 electrons 4) 10 protons + 10 electrons

45. The Z and A values of an element are 25 and 55. The number of electrons protons and neutrons in its most stable ion respectively are

1) 25,25,30 2) 23,25,30 3) 22,25,30 4) 20,25,30

46. Which of the following statement is correct
1. Sulphur atom, sulphide ion have same no. of electrons
2. Sulphur atom, sulphide ion have same electron configuration
3. Sulphur atom, sulphide ion have same no. of neutrons
4. Sulphur atom, sulphide ion differ in their nuclear charges

47. Among the following which is not isoelectronic with others
1) HF 2) H_2O 3) NH_3 4) CO

48. The charge on the atom containing 17 protons, 18 neutrons and 18 electrons is
1) -1 2) -2 3) 0 4) +1

49. Which of the following is correct for cathode rays in discharge tube
1) independent of the nature of the cathode
2) independent of the nature of the gas
3) is observed in pressence of electric and magnetic field. 4) all

50. The e/m value of proton is
1) less than e/m value of electron 2) equal than e/m value of electron
3) greater than e/m value of electron 4) all the above.

51. The α-particles are
1) high energy electrons 2) positively charged hydrogen atoms
3) nuclei of helium atoms 4) high energy radiations

52. Nucleons are
1) only protons 2) only neutrons
3) both protons and neutrons 4) electrons, protons and neutrons

53. The number of electrons, protons, neutrons present in the tripositive ion of $_{27}CO^{59}$ respectively are
1) 27,59,27 2) 27,26,32 3) 24, 27,32 4) 27,25,32

54. The ion which is not iso electronic with argon atom is
1) chloride ion 2) calcium ion 3) sulphide ion 4) sodium ion

55. Set of iso electronic ions among the following is
1) Na^+, Cl^-, O^{--} 2) K^+, Ca^{++}, F^- 3) Cl^-, K^+, S^{--} 4) H^+, Be^{++}, Na^+

56. One of the fundamental particles is missing in one of the isotopes. And the particle and isotope are respectively
1) neutron, protium 2) neutron, tritium
3) proton, protium 4) electron, tritium

57. Which of the following contains more no of neutrons
1) S^{32} 2) Na^{23} 3) Fe^{56} 4) Ca^{40}

58. Tritium atom contains
1) 1e, 1p, 1n 2) 1e, 1p, 2n 3) 2p, 2e, 1n 4) 1e, 1p, 3n

59. The massive particle among the following is
1) α - particle 2) deuteron 3) proton 4) β - particle

60. The coloured radiation with lowest energy is
1)Red 2) Blue 3)green 4) Yellow

61. Which of the following is not correct according to planck's quantum theory?
1)Energy is emitted or absorbed discotinuously
2)Energy of quantum is directly proportional to its frequency
3) A photon is also a quantum of light

4) Energy less than a quantum can also be emitted or absorbed.

62. The product of which of the following is equal to the velocity of light
1) wave length and wave number 2) wave length and frequency
3) frequency and wave number 4) wave length and amplitude

63. All types of electromagnetic radiations possess same
1) Wave length 2) Frequency
3) Energy 4) Velocity when they passed through vacuum

64. The frequency of green light is 6 X 10^{14}Hz its wavelength
1) 50nm 2) 5nm 3) 5000nm 4) 500nm

ACHIEVERS (Level - II)

DESCRIPTIVE TYPE QUESTIONS

65. How many protons,electrons and neutrons present in 0.15g of $_{15}P^{30}$?

66. Calculate the frequency and wave number of light of the following wave length
a)4000A^{O} b)600nm

67. Find out of the wave length and wave number of the light of the following frequencies
a)50MHz b)7.5x10^{15} sec^{-1}

68. Calculate the frequency and the wave length of the light of the following wave numbers
a)2x$10^{4}$$cm^{-1}$ b)6x$10^{5}$$m^{-1}$

EXPLORERS (Level - III)

Multi answer type questions:

- *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

69. 1 angstrom = ?
1) 10^{-10} m 2) 10^{-8} cm 3) 10^{-6} m 4) None of the above

70. Which of the following are the units of wavelength ?
1) Angstrom 2) Nanometer 3) Picometer 4) Microns

71. Which of the following properties are proportional to the energy of electromanagement wave
i) wave length ii) wave number iii) number of photons iv) frequency
1. i & iii 2. i & ii 3. iii & iv 4. ii, iii & iv

72. Which of the following two ions have the same number of unpaired electrons
i) Mn^{+2} ii) Fe^{+3} iii) Cr^{+3} iv) Ti^{+3}
1. i & iii 2. i & ii 3. iii & iv 4. ii, iii & iv

Assertion and reasoning type questions:

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

1. Both A & R are true and R is the correct explanation of A
2. Both A & R are true and R is not the correct explanation of A

3. A is true, R is false.

4. A is false, R is true.

73. **A:** Atomic weights of elements are non-intergal

R: Elements contain isotopes of different masses.

74. **A:** The atoms of different elements having same mass number but different atomic number are known as isobars.

R: The sum of protons and neutrons in the isobars is always different.

75. **A:** The mass of the nucleus can be either less than or more than the sum of masses of nucleons present in it

R: The whole mass of the atom is considered in the nucleus

76. **A:** Electrons in the atoms are held due to coulumb forces

R: The atom is stable only becuase the centripetel force due to columb's law is balanced by the centrifugal force

IV. Matching type

- *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

  *If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

77.

Column-I	**Column-II**
a) Electron	1) Goldstein
b) Proton	2) Thomson
c) Neutron	3) Mosely
d) Atomic number	4) Chadwick
	5) Neils Bohr

78.

Column-I	**Column-II**
a) Nucleus	1) cm
b) Electro magnetic radiation	2) Visible light
c) Wave length	3) Rutherford
d) Frequency	4) Sec^{-1}
	5) Einstein

V. Comprehension type

- *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

The frequency (ν), wavelength (λ) and velocity of light (c) are related by the equations $c = \nu\lambda$. The other commonly used quantity specially in spectroscopy is the wavenumber($\bar{\nu}$).

79. Which of the following relations are correct?

1) Frequency × wavelength = Velocity of light

2) $\bar{\nu} = \frac{1}{\lambda}$ 3) $\lambda = \frac{c}{\nu}$ 4) All of these

80. Light or any electro magnetic radiation travels in vaccum or air with a speed of :

1) 3×10^8 m/s 2) 3×10^2 m/s 3) 2×10^8 m/s 4) 1×10^8 m/s

81. The wave number of a radiation is 97540 cm^{-1}. Calculate its frequency.

1) $2.926 \times 10^{10} s^{-1}$ 2) $2.926 \times 10^{15} s^{-1}$ 3) $2.926 \times 10^{2} s^{-1}$ 4) $2.926 \times 10^{20} s^{-1}$

HOTS:

82. The nucleus of tritium (T), the unstable isotope of hydrogen consists of :

1) 1Proton +1 Neutron +1 electron 2) 1Proton +3 Neutron +1 electron
3) 1Proton +0 Neutron +1 electron 4) 1Proton +2 Neutron +1 electron

83. The frequency of a wave light is $1.0 \times 10^6 \ sec^{-1}$. The wave length for this wave is

1) 3×10^4 cm 2) 3×10^{-4} cm 3) 6×10^4 cm 4) 6×10^6 cm

84. If the wavelength of green light is about $5000 A^0$, then the frequency of its wave is

1) $16 \times 10^{14} \ sec^{-1}$ 2) $16 \times 10^{-14} \ sec^{-1}$ 3) $6 \times 10^{14} \ sec^{-1}$ 4) None

85. The radiation having maximum wave length is

1) Ultraviolet rays 2) Radio waves
3) X-rays 4) Infra-red rays

86. The frequency of strong yellow line, in the spectrum of sodium is 5.09 x 10^{14} c.p.s. The wave number of the line is [C = 3 x 10^{10} cm/sec]

1) 1.69 x 10^4 cm 2) 1.69 x 10^{-4} cm^{-1} 3) 1.69 x 10^{24} cm^{-1} 4) 1.69 x 10^{14} cm^{-1}

KEY

ΦΦ TEACHING TASK :

1.2	2.1	3.2	4.2	5.4	6.1	7.1	8.2	9.3	10.2	11.3	12.1
13.2	14.4	15.2	16.1	17.4	18.4	19.1	20.4	21.4	22.2	23.1	24.1
25.3,4,1,2		26.2,3,1,4		27.2	28.1	29.1					

ΦΦ LEARNER'STASK :

□ **BEGINNERS :**

30.1	31.4	32.4	33.4	34.4	35.3	36.2	37.1	38.3	39.2	40.2
41.3	42.3	43.1	44.3	45.1	46.4	47.4	48.1	49.3	50.1	51.3	52.3
53.3	54.4	55.3	56.1	57.3	58.2	59.1	60.1	61.4	62.1	63.4	64.4

□ **EXPLORERS :**

69.1,2	70.1,2,3	71.4	72.2	73.4	74.3	75.4	76.1	77.2,1,4,3
78.3,2,1,4	79.4	80.1	81.2	82.4	83.1	84.3	85.2	86.3

§§ ATOMIC MODELS:

1. THOMSON ATOMIC MODEL:

The first atomic model was proposed by ***J.J. Thomson,*** in 1898. An atom is electrically neutral. It contains positive charges as well as negative charges.According to Thosmon atom is like water melon and elctron's are embeded like seeds in water melon. The positive charge is distributes like fibrous material of water melon. An important feature of this model is that the mass of the atom is assumed to be uniformly distributed over then atom.

Defects:

It can not explain the results of rutherford's gold foil scattering experiment.

2. RUTHERFORDS MODEL OF ATOM:

Rutherford proposed atomic model is based on $\alpha-$ ray scattering experimentScattering of a narrow beam of $\alpha-$ particles as they passed through a thin gold foil and it is covered with fluorescent ZnS screen. When $\alpha-$ particles struck the screen then flash of light was produced at that point.

OBSERVATIONS :

Most of the $\alpha-$ particles passes through the foil underflected

A small fraction of $\alpha-$ particles were deflected by small angles

A very few $\alpha-$ particles bounced back were deflected by 180^0.

CONCLUSIONS:

Most of the space in the atom is empty. A few positive charges were deflected the deflection must be due to enornmous repulsive forces showing that the positive charge of the atom is non speard out the atom.

Main postulates in Rutherford's model

All the positive charge and mass of the atom is present in a very small region at the centre of the atom. It is called nucleus.The size of the nucleus is very small in comparison of the size of the atom.Most of the space outside the nucleus is empty.The electrons revolve round the nucleus like planets revolve round the sun.The centrifugal force arising due to fast moving electrons balances the coulombic force of attraction of the nucleus and the electrons.

Rutherford's atomic model is comparable with the ***solar system.*** So it is called ***planetary model.***

DEFFECTS :

1. Stability of atom is not explained.

2. It fails to explain the atomic spectrum or line spectrum.

3. PLANCK'S QUANTUM THEORY :

Substances absorbor emit light discontinuously in the form of small packets or bundles.

The smallest packet or energy is called quantum.The radiation is propagated in the form of waves. The energy of a quantum is directly proportional to the frequency of the radiation. $\mathbf{E \propto v}$

The energy of a quantum is

$$E = hv = \frac{hc}{\lambda} = hc\bar{v}$$

Where E = Energy in ergs

h = Planck's constant $=6.625 \times 10^{27}$ erg.sec (or) 6.625×10^{-34} Joule.sec

C = Velocity of light $= 3 \times 10^{10}$ cm/sec . $= 3 \times 10^{8}$ m/sec

v = Frequency of radiation in $\sec^{-1}$

λ = Wavelength in cm

$\bar{v}$ = Wave number in cm^{-1}

A body can absorb or emit in wholenumber of quantum

§§ **PHOTO ELECTRIC EFFECT :**

Substances absorb or emit light discontinuously in the form of small particles of energy.The smallest particle of energy is called photon.The energy of a photon in directlyproportional to frequency of the adiation.

The energy of a photon is

$$E = hv = \frac{hc}{\lambda} = hc\,\bar{v}$$

$E = \frac{12375}{\lambda}$; Where E = Energy in eV , $\lambda =$ wavelength in A^0

The radiation is propagated in the form of photons.

Planck's equations determines both wave nature and particle nature of light. The increase in wave length or decrease in energy of the X - rays after scattering from an object is called the compton effect.

When light is exposed to clean metallic surface, electrons are ejected from the surface. This effect is called photo electric effect.Ejection of electrons from the surface of a metal by irradiating it with light of suitable frequency.

The photo electric effect is readily exhibited by alkali metals like K and Cs.

A part of the energy of photon is used to escape the electron from the attractive forces and the remaining energy is used in increasing the kinetic energy of electron.

$$hv = W + KE$$

$$K.E = \frac{1}{2}m_e v^2, \qquad w = hv_0$$

$$\therefore hv = hv_0 + \frac{1}{2}m_e V^2$$

$m_e =$ mass of the electron, V = velocity of the ejected electron

v_0 = Threshold frequency

"In photo electric effect the ***number of photo electrons emitted is proportional to intensity of incident light. Kinetic energy of photo electrons depends only on the frequency of incidnet light and not on the intensity of light. The minimum energy required for emission of photo electrons is called threshold energy or work function."***

TEACHING TASK

I. Single answer type questions

1. Einstein photo electric effect is represented in the form of equation is

1) w = hv +K.E 2) hv = w - K.E 3) K.E = w + hv 4) hv = w + K.E

2. In the equation $hv = hv_0 + 1/2\ m_e v^2$, v_0 is known as

1) work function 2) velocity of ejected electron
3) threshold frequency 4) frequency of photon

3. What is the energy of photons that corresponds to a wave number of $2.5\times10^{-5}\,cm^{-1}$

1) 2.5×10^{-20} erg 2) 5.1×10^{-23} erg 3) 5.1×10^{-21} erg 4) 8.5×10^{-2} erg

4. What is the wavelength (in m) of a particle of mass $6.62\times10^{-29}\,g$ moving with a velocity of $10^3\,ms^{-1}$? $\left(h = 6.62\times10^{-34}\ j.s.\right)$

1) 6.62×10^{-4} 2) 6.62×10^{-3} 3) 10^{-5} 4) 10^{5}

II. Comprehension Type:

It was Einstein who explained the photoelectric effect on the basis of quantum theory. According to him electrons in metals are held by some attractive forces. To overcome these forces certain minimun amount of energy is required which is characteristic of the metal. This is called photoelectric work function, W_0.

Now to cause ejection of electrons, the photons of incident light should have energy equal to or greater than this work function. We know from the quantum theory that energy of photon is directly proportional to frequency of the radiation. So the incident photons should have certain minimum frequency called threshold frequency or critical frequency (ν_0).

$h\nu_0$ = Photoelectric work function, W_0

5. Einstein was awarded the nobel prize in physics in 1921 for his:

1) Theory of relativity.
2) Concept of mass - energy relation ship.
3) Explanation of the photoelectric effect.
4) Explanation of the nucleus struture.

6. Which of the following is/are correct about photo electric effect?

1) Photoelectric effect takes place only when wavelength of incident radiation is > critical wavelength.
2) The number of photo electrons emitted is α intensity of the incident radiation.
3) The maximum kinetic energy of the photoelectrons emitted is α frequency of the incident radiation.
4) Both 2 and 3.

7. Kinetic energy of photoelectrons increases linearly with:

1) Temperature. 2) Frequency of the incident light.
3) Wave length of the incident light. 4) Atomic number.

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single answer type questions

8. In Rutherford α- rays scattering experiment gold foils are used due to
1) high maeliability 2) ductability 3) high melting point 4) high ionisation energy

9. Rutherford's experiment on scattering of partifcles showed for the first time that the atom has
1)Nucleus 2) Electron 3) Proton 4) Neutron

10. The metal which gives photoeletrons most easily is
1) Lithilum 2) Sodium 3) Calcium 4) Cesium

11. In the photo-electric effect, the number of photoelectrons emitted per unit time depends upon
1) Energy of incident rediations 2) Frequency of incident radiations
3) Intensity of incident radiations 4) Both frequency and intensity of incident radiation

12. In the photo-electron emission, the energy of the emitted electron is
1) grater that the incident photon 2) same as that of the incident photon

3) smaller than the incident photon 4) proportional to the intencity of incident photon

13. The ratio of energy to frequency of electromagnetic radiation is called
1) Bohr's constant 2) Rydberg's constant
3) Planck's constant 4) Ritz constant

14. As the frequency of the light increases, the momentum of its Photon.
1) increases 2) decreases 3) remains same 4) cannot be predicted

15. The energy a photon is 3 x 10^{-12} ergs, Its wavelength in nm
1) 662 2) 1324 3) 66.2 4) 6.62

ACHIEVERS (Level - II)

Solve the following:

16. Calculate the energy of the following radiations
a) wave length of 7000A^0 b) Frequency of 1.5x10^{14}Hz

17. Which has a higher energy, a photon of violet light with wave length 4000A^0 or a photon of red light with wave length 7000 A^o

18. Electromagnetic radiation of wavelength 242nm is just sufficient to ionise the sodium atom. Calculate the ionisation energy in KJ/mole (h=6.625x10^{-34} Jsec)

19. The minimum energy required over come the attractive forces between an electron and the surface of Ag metal is 7.52x10-19 J. What will be the maximum kinetic energy of electrons ejected out from Ag which is being exposed to UV light of λ =360A^0

20. If threshold wavelength for ejection of electron of electron from metal is 330nm, then the work function for the photo electric emission is?

EXPLORER (Level - III)

Multi answer type questions

- *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

21. Consider the following statement
i) A hallow sphere coated inside with platinum black with an aperture in the wall is perfect black body.
ii) λ_{max} in black body shifts towards the lower side with increase in temperature
iii) Radiations emitted from black body is not continuous
1. i,ii & iii 2. ii, iii 3. i , iii 4. i, ii

22. According to Ruther ford's model
i) The size of the nuecleus is very large in comparision of the size of the atom.
ii) Electrons revolve around the nucleus like planets revolve round the sun
iii) It fails to explain the atomic spectrum or line spectrum
1. i,ii & iii 2. ii, iii 3. i , iii 4. i, ii

Assertion and reasoning type questions

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

1. Both A & R are true and R is the correct explanation of A

2. Both A & R are true and R is not the correct explanation of A
3. A is true, R is false.
4. A is false, R is true.

23. **A:** The energy of quantum of radiation is given by E=hV.

R: Quantum in the energy equation signifies the principal quantum number

24. **A:** The kinetic energy of the photo electron ejected increases with increase in intensity of incident light

R: Increase in intensity of incident of light increases the rate of emission

25. **A:** Threshold frequency is a characteristic for a metal

R: Threshold frequency is a maximum frequency required for the ejection of electron from the metal surface

26. **A:** The kinetic energy of the photo electron ejected increases with increase in intensity of incident light.

R: Increase in intensity of incident light increases the rate of emission.

Matching type

- *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

  *If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

27.

List - I	**List -II**
A) Velocity of light	1) Energy particle
B) Plank's constant	2) Energy packet
C) Wave number	3) 3×10^{8} m/sec
D) Photon	4) 6.625×10^{-34} J -sec
	5) cm^{-1}

28.

List - I	**List -II**
A) a-ray scattering experiment	1) mosely
B) Quantum theory	2) Planck
C) Theory of photo electric effect	3) deBroglie
D) a-particle equal to	4) He^{+2}
	5) Rutherford

Comprehension type

- *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

According to Plank's quantum theory, a body can emit or absorb energy not continuously but discontinuously in the form of small packets called quanta. In case of light a quantum is known as a photon.

Energy of photon, $E = h\nu = \frac{hc}{\lambda} = hc\nu$

Photoelectric effect: Ejection of electrons from the surface of a metal by irradiating it with light of suitable frequency.

Maximum K.E of photoelectrons

$$= h\nu - h\nu_0 = h(\nu - \nu_0)$$

$$= \frac{hc}{\lambda} = \frac{hc}{\lambda_0} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right).$$

29. Determine the wave length of a photon of electromagnetic radiation having energy 2.99×10^{12} erg mol^{-1} ($h=6.625 \times 10^{-34}$).

1) 100 A° 2) 150 A° 3) 4A° 4) 200 A°

30. When a certain metal was irradiated with a light of frequency 1.5×10^{16} Hz, the photoelectrons emitted had twice the kinetic energy as did photoelectrons emitted when the same metal was irradiated with light of frequency 1.0×10^{16} Hz. Find **threshold frequency** for the metal.

1) 3×10^{15} Hz 2) 5×10^{15} Hz 3) 1.5×10^{15} Hz 4) 7×10^{15} Hz

31. Calculate the kinetic energy of the electron emitted by an atom by 400 nm light when its threshold wavelength is 600 nm

(n = 6.63×10^{-34} Js and c = 3×10^{8} ms^{-1}).

1) 1.656×10^{-15} J 2) 4.656×10^{-19} J 3) 5.656×10^{-19} J 4) 3.656×10^{-19} J

HIGHER ORDER THINKING SKILLS (HOTS):

32. The energy corresponding to a wave number of $1m^{-1}$ is

1) $2x10^{-25}$ J 2) $2x10^{25}$ J 3) $2 x 10^{-16}$ J 4) $2 x 10^{16}$ J

33. Ultraviolet light of 6.2eV falls on aluminium surface (work function = 4.2eV). The kinetic energy in joules of the fastest electron emitted is approximately

1) $3x10^{-21}$ 2) $3x10^{-19}$ 3) $3x10^{-17}$ 4) $3x10^{-15}$

34. If the wave length of an electromagnetic radiation is 2000 A°. What is the energy in __ergs

1) 9.94×10^{-12} 2) 9.94×10^{-10} 3) 4.97×10^{-12} 4) 4.97×10^{-19}

35. The work function of a metal is $4.2\,eV$. If radiation of $2000A^0$ falls on the metal, then the kinetic energy of the fastest photo electrons is

1) $165.625\times10^{-19}J$ 2) $16\times10^{10}J$ 3) $3.2\times10^{-19}J$ 4) $6.4\times10^{-10}J$

36. Treshold frequency for a metal is $5\times 10^{14}S^{-1}$ calculate the K.E of exulted electron when radiation of frequency v = $3 \times 10^{15}S^{-1}$

1) $16.5625x10^{-14}$J 2) $165.625\times10^{19}J$ 3) $16.5625\times10^{19}J$ 4) $165.625\times10^{-19}J$

KEY

ΦΦ TEACHING TASK :	1.4	2.1	3.3	4.3	5.3	6.1,2,3	7.2	
ΦΦ LEARNER'STASK :								
☐ **BEGINNERS :**	8.4	9.1	10.4	11.3	12.3	13.3	14.1	15.1
☐ **BEGINNERS :**	21.3	22.2	23.1	24.4	25.1	26.4	27.3,4,5,2	28.5,2,2,4
	29.3	30.2	31.1	32.1	33.2	34.1	35.3	36.1

§§ BOHR'S MODEL

¶¶ Postulates of Bohr's atomic model:

The electrons in an atom revolve round the nucleus in definite circular orbits or shells or energy levels.

So far an electron revolves in a certain orbit, its energy remains constant and does not radiate energy. These orbits are called stationary orbits or stationary states.

Electrons can revolve only in those stationary orbits in which their angular momentum is equal to integral multiple of $\frac{h}{2\pi}$.

$$mvr = n\frac{h}{2\pi}$$

where m = mass of electron
v = velocity of electron
r = radius of orbit
n = 1 , 2 , 3 ,4 .....
h = Plank's constant

When an electron drops from a higher orbit to a lower orbit, energy is released when an electron jumps from a lower orbit to a higher orbit, energy is absorbed. ***The absorbed or evolved energy is equal to the difference in energies of two orbits, which is equal to Quanta.***

$$\Delta E = E_2 - E_1 = h\nu$$

where E_2 = Energy of higher orbit

E_1 = Energy of lower orbit

h = Plank's constant

ν = Frequency of radiation

¶¶ Merits of Bohr's model:

i. It is successfully explains the hydrogen spectrum and spectra of ions having one electron.

ii. The experimental values of the energies and radii of possible orbits in hydrogen atom are in good agreement with that calculated on the basis of Bohr's theory.

iii. The experiment value of Rydberg constant for hydrogen is in good agreement with that calculated from Bohr's theory.

iv. The calculated value of ionisation energy of hydrogen using Bohr's theory is very close to the experimental value.

¶¶ Limitations of Bohr's model:

i. It failed to explain the spectra of multi electron atoms.

ii. The fine structure of spectral lines cannot be explained by Bohr's theory.

iii. It failed to explain Zeeman effect and Stark effect.

iv. It is against to Heisenberg's uncertainty principle.

v. The splitting of spectral lines of an atom into a group of fine lines under the influence of a magnetic field is called **Zeeman effect.**

vi. The splitting of spectral lines of an atom into group of fine lines under the influence of an electric field is called **Stark effect.**

vii. It could not explain the ability of atoms to form molecules by chemical bonds.

TEACHING TASK

I. Single answer type questions

1. Angular momentum of an electron is quantised according to
1) Plank 2) Rutherford 3) Bohr 4) Thomson

2. Boh's model of atom explains
1) zeeman effect 2) photo electric effect
3) stark effect 4) hydrogen atomic spectrum .

3. Bohr's model of an atom is Contradicted by
1) Pauli's exclusive principle 2) Planck's quantum theory
3) Heisenberg's uncertainty principle 4) all the above

4. According to Bohr'[s theory energy is ..... when an electron moves from a lower to a higher orbit.
1) Absorbed 2) emitted 3) No change 4) both 1 and 2

5. To which of the following is Bohr's theory applicable
1) He^{+} 2) Li^{+2} 3) Tritium 4) Be^{+2}

6. The angular momentum of an electron present in the excited state of Hydrogen is $\frac{1.5h}{\pi}$. The electron present in
1) Third orbit 2) Second orbit 3) Fourth orbit 4) Fifth orbit

7. Which one of the following statement is ***not*** correct ?
1) Rydberg's constant and wave number have same units
2) Lyman series of hydrogen spectrum occur in the ultraviolet region
3) The angular momentum of the electron in the ground state hydrogen atom is equal to $\frac{h}{2\pi}$
4) The radius of first Bohr orbit of hydrogen atom is 2.116×10^{-8} cm.

II. Multi answer type questions

- *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

8. To Which of the following is bohr;s theory applicable
1.He^{+} 2.Li^{+2} 3.Tritium 4.Be^{+3}

9. Bohr's theory is not applicable to
1.Helium 2.Li^{+2} 3.He^{+2} 4.H-atom

10. Bohr could not explain the--------
1) Zeeman effect 2) Stark effect
3) Wave nature of electron 4) Spectra of atoms having more than one electron

III. Assertion and reasoning type questions

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

1) Both (A) and (R) are true and (R) is the correct explanation of(A)
2) Both (A) and (R) are ture and (R) is not the correct explanation of (A)

3) (A) is true but (R) is false

4) (A) is false but (R) is true

11. **A:** In an atom, the velocity of electrons in the higher orbits keeps on decreasing
R: Velocity of electron is inversely prportional to the radius of the orbit.

12. **A:** Each principal level of quantum number n contains a total of n sub levels
R: Each orbital can hold two electrons and each sub level of quantum number l contains a total of 2l +1 orbitals

13. **A:**Bohr's orbits are called stationary orbits.
R:Electrons remain stationary in these orbits for some time.

14. **A:** Bohr theory is not applicable to ionised hydrogen atom
R: H^+ is devoid of electron

IV. Matching type

*This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

*If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix should be as follows:*

15.

Column I		**Column II**	
a)	Bohr model of atom	1)	Electrons are present in extra nuclear region
b)	According to Sommerfeld model L =	2)	$(kh/2\pi)$
c)	Azimuthal quantum number	3)	k
d)	Principal quantum number	4)	n
		5)	*l*

LEARNER'S TASK

BEGINNERS (Level - I)

I. Single answer type questions

16. As we move away from nucleus, the energy of orbit
1) decrease 2) increase 3) remain unchanged 4) none of the above

17. Which of the following electronic transition in a hydrogen atom will require the largest amount of energy
1) From n=1 to n=2 2) from n= 2 to 3 3) From n= ∞ to 1 4) From n= 3 to n= 5

18. According to Bohrs theroy, the angular momentum for an electron in 5 th orbit is
1)2.5 h/Π 2) 5 h/Π 3) 25 h/Π 4) $5\Pi/2h$

19. Energy difference between two adjacent orbits is minimum if they are
1) K,L - shells 2) L,M - shells 3) M,N - shells 4) N,O - shells

20. Bohr's model of atom can explain the spectrum of all except
1) H 2) He^+ 3) Li^{++} 4) He

ACHIEVERS (Level - II)

DESCRIPTIVE TYPE QUESTIONS

21. Describe bohr's postulates

22. bohr's limitations and drawbacks?

EXPLORERS (Level - III)

Multi answer type questions

- *This section contains multiple choice questions. Each question has 4 choices (A), (B), (C),(D), out of which **ONE or MORE** is correct. Choose the correct options*

23. Bohr's model of atom cannot explain:

1) Splitting of spectral lines in presence of magnetic field.
2) Splitting of spectral lines in presence of electric field.
3) Linear spectrum of hydrogenic species.
4) Fine spectrum of hydrogenic species.

24. According to Bohr's theory, which of the following quantities can take up only discrete values

1) Kinetic energy 2) Potential energy
3) Angular momentum 4) Momentum

Assertion and reasoning type questions

- *This section contains certain number of questions. Each question contains Statement – 1 (Assertion) and Statement – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct Choose the correct option.*

1) Both (A) and (R) are true and (R) is the correct explanation of(A)
2) Both (A) and (R) are ture and (R) is not the correct explanation of (A)
3) (A) is true but (R) is false
4) (A) is false but (R) is true

25. **A:**Bohr's model could not explain even hydrogen spectrum obtained using high resolution spectroscopes.

R:Bohr's model ignored dual character of electron.

26. **A:** Energy of radiation is large if it's wave length is large

R: Energy is equal to hv

27. **A:** The angular momentum of an electron in an atom is quantised

R: In an atom only those are orbits are permitted in which angular momentum of the electron is whole number mulptiple of h/2Π

Matching type

- *This section contains Matrix-Match Type questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in **Column–I** have to be matched with statements (p, q, r, s) in **Column–II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

  *If the correct matches are A-p,A-s,B-r,B-r,C-p,C-q and D-s,then the correct bubbled 4*4 matrix*

should be as follows:

28.

Column I	**Column II**
A) Number of electrons present in an orbit	1.2
B) Number of orbitals in an orbit	2. n
C) Number of electrons in an orbital	3. n^2
D) Number of Sub shells in an orbit	4. $2n^2$
	5. n+1

Comprehension type

- *This section contains paragraph. Based upon each paragraph multiple choice questions have to be answered. Each question has 4 choices (A) , (B) ,(C) and (D) out of which **ONLY ONE i**s correct. Choose the correct option.*

Bohr's theory could not explain the wave nature of electron estblished later by de Broglie.It could not explain the Zeeman and stark effects.Bohr's theory correlates velocity of light,electronic mass,plancks constant and electronic charge.

29. Splitting of spectral lines in a strong electric field is known as:

1) Zeeman effect 2)Stark effect 3) Fine spectrum 4) All of these

30. Who established the wave nature of electron ?

1) Bohr 2) de-Broglie 3) Sommerfeld 4) Thomson

31. Bohr's theory correlates the _____

1) Velocity of light 2) Electronic mass 3) Plancks constant 4)All of these

HOTS

32. The first use of quantum theory to explain the structure of atom was made by

1.plank 2.Einstein 3.Bhor 4.Heisenberg

33. Bhor theory is applicable to

1.Li^{+2} 2.Li^{+} 3)He^{+} 4)both1 and 3

34. Bhors theory is not applicable to

1.H 2.He^{+} 3. Li^{+2} 4. H^{+}

35. In antom when an electron jumps from K- Shell to M- shell

1. Energy is absorbed
2.energy is emited
3. Energy is neither absorbednot enmitted
4. Some times energy is absorbed and some times emitted

36. Bohr explained the stability of an atom basedon:

1.stationary orbits 2.quantisation of angular momentum
3.plancks quantum theory 4.all

Additional type questions:

1. The velocity of photon is

1. Dependent on its wavelength 2. Dependent its source
3. Equal to Cube of amplitude 4. Independent of its wavelength

2. The element with maximum number of electron in the valence shell has atomic number

1. 15 2) 3 3) 9 4). 2

3. Bohr's concept of the orbit in atom was contradicted by

1. Debrog lie relationship 2. Un certainity principal

3. Plancks hypothesis 4. Hundes Rule

4. The ubnrelated memeber of the following group is

1) Hellium ion 2. Neutron 3) Proton 4)Cyclotron

5. theyellow colour impaired by Sodium to flalme is due to

1) The emission of exess of energy in the visible region

2) Its sublimition to give yellow vaqpours

3) Its low I.E

4) Its Photo Sensitivity

6. a quantum of energy is

1)Inversely proportional to its wavelength

2) Drirectly proportional to its Velocity

3) Drirectly proportional to its Wavelength

4) A constant quantity

7. which of the folowing atom has a non - spherical outer most orbital

1) H 2) Li 3) Be 4) D

8. The photo electric emission of eloectron from metaals surface starts only when the incident light has a certain minimum

1) Wave length 2) Velocity 3) Frequency 4) Acceleration

9. One mole of electrons =

1) One amp-sec 2)1 3) Faraday 4) Curie

10. The wavelength of an electron

1) is equal to that of light 2) Remain constant with velocity

3) Decreases with increasing velocity 4) Increases with decreasing velocity

RESEARCHERS (Level - IV)

1. Electromagnetic radiation of wavelenght 300nm is just sufficient to ionise a sodium atom. Calculate the energy corresponding to this wavelength and the ionisation potential of Na.

1.6.626x10^{-19}j 2.398.7kj 3.6.626x10^{-20}j 4.400kj

2. The wavelength associated with a golf ball weighing 200 g and moving at a speed of 5 mh^{-1} is of the order. **(IIT- 2010)**

1) 10^{-10} m 2) 10^{-20} m 3) 10^{-30} m 4) 10^{-40} m

3. Calculate the kinetic energy of the electron emitted by an atom by 400 nm light when its threshold wavelength is 600 nm ($n = 6.63 \times 10^{-34}$ Js and $c = 3 \times 10^{8}$ ms^{-1}). **(IIT- 2009)**

1) 1.656×10^{-17} J 2) 4.656×10^{-19} J 3) 5.656×10^{-19} J 4) 3.656×10^{-19} J

4. Calculate the wave length(in nanometre) associated with a proton moving at 1x10^{3}m/sec (M_p= 1.67x10^{-27}Kg) **(AIEEE -2009)**

1) 0.032nm 2) 40 nm 3) 2.5nmn 4) 14.0nm

5. The threshold frequency ν_0 for a metal is $7.0 \times 10^{14} s^{-1}$. Calculate the kinetic energy of an electron emitted when radiation of frequency $\nu = 1.0 \times 10^{15} s^{-1}$ hits the metal.

6. What will be the wavelength of a ball of mass 0.1 kg moving with a velocity of 10 ms^{-1}.

7. The debroglie wave length of atennis ball of mass 60g moving with avelocity of 10m/s sec is approximately **(AIEEE-2011)**

1) 10^{-16}m 2) 10^{-25}m 3) 10^{-33}m 4) 10^{-31}m

8. Elecrtons with kinetic energy of 6.02×10^4 j/mol are evolved form the surface of the metal, when exposed to radition of wavelength 600 n.m . the minimum amount of energy required to remove an electron from the metal atom is

1). 2.315×10^{-19}j 2) 3×10^{-19} j 3) 6.02×10^{-19} j 4) 6.62×10^{-34}j

9. Naturally occurring boron consists of two isotopes whose atomic weights are 10.01 and 11.01. The atomic weight of natural boron is 10.81. Calculate the percentage of each isotope in natural boron.

10. Rutherford's experiment, which established the nuclear model of the atom, used a beam of

(A) β-particles, which impinged on a metal foil and got absorbed

(B) γ-rays, which impinged on a metal foil and ejected electrons

(C) helium atoms, which impinged on a metal foil and got scattered

(D) helium nuclei, which impinged on a metal foil and got scattered

KEY

ΦΦ TEACHING TASK : 1.3 2.4 3.4 4.1 5.4 6.1 7.4 8.1,2,3,4
9.1 10.1,2,3,4 11.1 12.2 13.3 14.1 15.2,1,5,4

ΦΦ LEARNER'STASK :

☐ **BEGINNERS :** 16.2 17.3 18.1 19.4 20.4

☐ **EXPLORERS :** 23.1,2 24.1,2,3 25.2 26.4 27.1 28.4,3,1,2 29.2
30.2 31.4 32.1 33.4 34.4 35.1 36.4

Additional type questions:

1-4 2-4 3-2 4-4 5-1 6-1 7-4 8-3 9-3 10-3

☐ **EXPLORERS :**

1- 2 2-3 3-1 4-2 5- 2×10^{39} 6- 6.625×10^{-34}m 7-3
8-1 9-80%,20% 10-4