# ATOMIC STRUCTURE

## 2 Marks Questions :

**1) What are the subatomic Particles ?**

A: The particles which are in the atom are known as subatomic particles. Electrons, protons and neutrons are subatomic particles

**2. How many values are permitted for spin quantum number 's' ? what are they ?**

A : The permitted values of spin quantum number 's' are two. They are + ½ and – ½

**3) Write the electronic configuration of 1) Nitrogen 2) Chromium ?**

A) 1) For Nitrogen (7) - $1s^2\ 2s^2\ 2p^3$
2) For Chromium (24) – [Ar] $4s^1\ 3d^5$

**4) Explain why electrons enter into '4s' orbital but not '3d' after filling '3p' orbital.**

A) According to aufbau principle, the orbital with a lower energy is filled up first before the filling of the orbital with a higher energy. Commences

The (n+l) Value of 4s energy level is 4+0 = 4.
The (n+l) value of 3d energy level is 3+2 = 5.

So, 4s is lower energy than 3d. Hence electrons enter into 4s orbital but not 3d after filling 3p orbital

**5) How can you say angular momentum of electron is quantized?**

A) According to Bohr's theory the angular momentum of the electron revolving is a stationary orbit is equal to integral multiples of $h/2\pi$

Angular momentum $L = mvr = nh / 2\pi$

Here n= an integer (n=1,2,3……)
m=Mass of electron
v = Velocity of electron
r = radius of circular orbit
h = Planck's constant

This means that the angular momentum is equal to $1h/2\pi$, $2h/2\pi$, $3h/2\pi$ …… thus the angular momentum is said to be quantized.

**5) How the principle quantum number 'n' and azimuthal quantum number k are related to the ellipse ?**

A) The relation between n, k is

$$\frac{n}{k} = \frac{\text{length of the major axis}}{\text{length of the minor axis}}$$

6) Distinguish between orbit and orbital.

| Orbit | Orbital |
|---|---|
| 1.The specified path of an electron around the nucleons is called orbit. | 1.Atomic orbital is, the region in space where there is a finite probability of finding the electron. |
| 2.The shape of orbit is circular | 2.It has spherical or dumb bell or double damb – bell Shape. |
| 3.The maximum number of electron in any orbit is $2n^2$ | 3.The maximum number of electrons in orbital is 2 |
| 4.It's shape is circular | 4.It is three dimensional. |

**7). What are the important atomic properties ?**

A. The important atomic properties are
   a) atomic radius (or) atomic size
   b) ionization potential (or) ionization energy
   c) electron affinity.
   d) Electro negativity
   e) Electro positive nature
   f) Oxidizing and reducing properties.

**8. Write the sequence of the relative energies of atomic orbitals?**

A) 1s<2s<3s<3p<4s<3d<4p<5s<4d<5p<6s<4f<5d<6p<7s.

## Section – II

**Very short Answer Questions (1Mark each)**

**1) Who discovered electron ?**

A) J.J. Thomson discovered electron.

**2) What is the value of Planck's constant ?**

A) The value of Planck's constant (h) is
6.625X10-27 erg – s (or) 6.625x10-34 J-s

**3) Write the Planck's equation ?**

A) Max Planck proposed a relation between energy (E) of electromagnetic radiation and its frequency (v).

This relation is $E = h v$

Where 'h' is the proportional constant .

**4) What is a stationary orbits?**

A) **Stationary Orbits** :- According to Bohr's model, electrons are revolving around the nucleus in specified paths called orbits. In these permitted orbits they do not radiate or loose energy. Hence these orbits are called stationary orbits.

**5) Who proposed the Principal Quantum number ?**

A) On his stationary states concept Neils Bohr proposed principal Quantum number.

**6) What information does principal quantum number give ?**

A) The principal Quantum number (n) gives the **size** and **energy** of stationary orbits.

**7. What are degenerate orbital's ?**

A) **Degenerate orbital's** :- Orbital's having same energy are called degenerate orbital's.

**8). Who introduced the Azimuthal quantum number ?**

A) Somerfield proposed Azimuthal quantum number as a result of elliptical orbits.

**9. What are the limits of Azimuthal quantum number for a Given 'n'?**

A) The limits of Azimuthal quantum number are 0 - (n -1)

**10) How many 'm' values are possible for l=3?**

A) The magnetic quantum number 'm' value depends on the value of 'l' for a given 'l' value 'm' can have (2l+1) values

If l=3 m= (2x3 +1)= (6+1) = 7. These are -3, -2, -1 0 , +1, +2 +3

**11). What are the upper and lower limits of 'm' for l=4.**

A) For l=4 m=(2x4+1) = 9. Thus 'm' can takes values 9.

The upper limit is + 4
The lower limit is – 4

**12) Who introduced the spin quantum number ?**

A) Uhlenbeck and Goudsmit introduced spin quantum number.

**13. Define atomic orbital ?**

A) **Atomic Orbital** :- An atomic orbital represents a definite region in the three dimensional space around the nucleus where there is high probability of finding an electron of a specific energy E.

**14. How many electrons can be accommodated in 1s orbital .**

A) Two electrons.

**15. What is the shape of 1s orbital ?**

A) Spherical.

**16 Write the designation of any two 'd' orbital's ?**

$d_{xy}$ and $d_{yz}$

**17. How are the three 'p' orbital's designated ?**

A. The three 'p' orbital's are $p_x$, $p_y$ and $p_z$

**18. What is the electronic configuration ?**

A) **<u>Electronic configuration:-</u>** The systematic arrangement of electrons in various orbital's of an atom is called electronic configuration.

**19. State Aufbau's principle ?**

**Aufbau's Principle :-** The electron occupies the orbital's having the lowest energy.

**20.) What is Pauli's Exclusion principle ?**

A) Pauli's Exclusion principle :- It stations that no two electrons will have all the four quantum numbers same.

**21. Define atomic radius ?**

A. **Atomic Radius** :- It is defined as the distance between the centre of the nucleus and the Outermost orbital.

**22. Define ionization energy ?**

A) **Ionization Energy** :- It is the minimum energy required to remove an electron from the outermost orbital of an atom in gaseons state

**23) Define electron affinity ?**

A) **Electron affinity** :- It is defined as the energy released when an electron is added to a neutral gaseous atom in its lowest energy state.

**24. What is the unit of ionization energy ?**

A) The unit of ionization energy is
ev ( electron volt) or K.J. mol $^{-1}$ or K. cal. mol $^{-1}$

**25. What is the unit of electron affinity ?**

The unit of electron affinity is ev or KJ. mol$^{-1}$ or Kcal. mol$^{-1}$

**26) Write the order of electron affinity for halogens?**

A) The electron affinity for halogens follows the order

Cl > F> Br > I.

**27) What the base for Bohr's theory ?**

A. Planck's Quantum theory of radiation.

**28) What is " Zeeman Effect" ?**

A) In the presence of applied magnetic field the atomic spectral lines, split into several magnetic lines. This phenomenon is called Zeeman Effect.

**29) In a magnetic field the 'f' sub state split into how many group ?**

A) Seven.

**30) If 'n' is the principal quantum number, then how many sub energy levels are there?**

A) The sub energy levels are equal to $n^2$

**31 What is the shape of p orbital's ?**

A) The p orbital's have dumb – bell shape

**32. Which gives the information of energies of atomic orbital's ?**

A) Atomic spectra.

**33. What is the correct electronic configuration of lanthanum ( La : 57) ?**

A) Lanthanum (57) electronic configuration

$[Xe]\ 5d^1\ 6s^2$

**34. Write the correct electronic configuration of chromium (cr)**

A) The electronic configuration of chromium (24) is $[Ar]\ 4s^1\ 3d^5$

**35. Write the correct electronic configuration of copper ?**

A. The electronic configuration of copper (29) is $[\ Ar]\ 4s^1\ 3d^{10}$.

**36 How the ionization energy change with nuclear charge ?**

A. Ionization energy depends upon the attraction of the nucleus. If the nuclear charge increases ionization energy also increases.

**37. How the size of the atom influences the ionization energy ?**

A) As the atomic size increases, the ionization decreases.

**38. How the charge on the ion effects the ionization energy (IE)**

A) As the charge on the ion increases, the ionization energy increases.

**40. What is the maximum number of electrons in any orbit ?**

A. $2n^2$

**41. What is the number of orbital's in an orbit ?**

A. $n^2$

**42. What is the use of spin quantum number ?**

A.

The spin quantum number 's' gives information about the direction of spin of electrons.

## SECTION – III

**Long Answer questions (4 Marks)**

**1.Write the important features of Rutherford planetary model.**

A) Rutherford proposed a nuclear model of the atom known as planetary model. According to this model

1. The atoms are spherical in shape.
2. The atom's central core is called nucleus. This nucleus is made up of protons and neutrons. The made up of protons and neutrons. The mass of the atom is almost due to its nucleus.
3. Most of space outside nucleus is empty.
4. Electrons revolve around the nucleus, with fast speed like planets around the sun.
5. The centrifugal force arising due to fast speed of an electron balances columbic force of attraction of the nucleus and electron remains stable in its path.

**2.What are the defects of Rutherford model.**

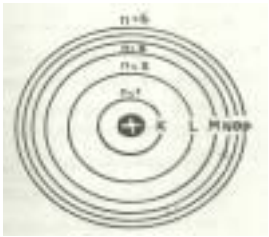
The defects of Rutherford's model of are

1) The exact position of electrons from the nucleus are not mentioned.
2) According to classical laws of physics a moving particle should lose energy and come closer to the nucleus. If it lose energy, it eventually should fall into the nucleus and atom should collapse. But atoms are stable.
3) If the electron loses energy continuously, the atomic spectra should consist of continuous band. Experimentally, atomic spectra are made up of discrete spectral lines.

**3.State the postulates of Bohr's model ?**

Based on the plank's quantum theory of radiation Niel's Bohr put forward atomic model. The postulates of Bohr's atomic model are

1. The electrons continue revolving in their respective paths called orbits or shells, without losing energy. These fore this orbits are called "station ary orbits or stationary shells".



2. Each stationary orbit is associated with definite energy. These stationary orbits are designated by k,L,M,N,o ------ As Shown in the above fig. The farther the orbit from the nucleus, the greater is the energy associated with it
3. Energy is emitted or absorbed by an atom only when an electron moves from one orbit to another.

If $E_2$ and $E_1$ are energies of outer and inner orbits respectively, then the emitted energy as radiation is $E_2 - E_1 = h\,v$

Where h: Planck's constant

v – frequency,

4. The angular momentum of an electron moving around the nuclease is equalized and is equal to integral multiples of $h/2\pi$

Angular momentum $mvr = nh/2\pi$

Where n is an integer ( n=1,2,3……)

m = mass of electron

v = Velocity of electron

r = Radius of circular orbit

h = planks' constant –

**4. What are the defects of Bhor's model ?**

The import defects in the Bohr's model are

1. It does not explain the spectra of atom' having more than one electron such as He, Li, Be, B ……
2. Bohr's atomic model failed to account for the effect of magnetic field ( Zeeman effect) on the spectra of atoms or ions.
3. Bohr's model could not justify the quantization of angular momentum. It should not explain why angular momentum ( mvr) be quantized and be equal to nh/2∏ ( n = 1,2,3 ……..)
4. Bohr's theory could not account for the formation of chemical bonds.

**5.Discuss the features of modern atomic structure pertaining to the nucleus and stationary states?**

**A) The following are the features of modern atomic structure.**

1. Atom consists of several " stationary states or stationary orbits. These states are designated by the 'n' values.
2. Each stationary state is divide into "Sub _ States" These sub – states are called " sub – energy levels " The number of sub states depend on the value of 'n' The sub – states are designated by the l values.
3. The first stationary state n=1 ( k shell) has only one sub – state , the second has two and the third three etc. These sub states are designated as 's', 'p','d', 'f','g'…….. etc. corresponding to l=0, 1,2,3,4 …… etc. These designations are based on the symbols given to spectral series in the atomic spectra
4. Under the influence of magnetic field, these sub states are further spilt into groups of states.
5. The electrons are placed in the sublevels. They revolve around the nucleus and in addition rotate on their own axes clockwise and anti clockwise,

**6. State and explain with one example the aufbau principle?**

A) 1. **<u>Aufbau Principle :-</u>** The electrons enter the various orbital's in the order of increasing energy.

2. In terms of the quantum numbers in an atom the in coming electrons go to an orbital whose (n +l) is minimum.
3. If two orbital's have the same (n+ l) value the orbital having lower 'n' value will be occupied first.
4. This may illustrated in the case of scandium (21) Twenty electrons can be accommodated in 1s, 2s,2p,3s,3d and 4s orbitals.
5. The last electron can enter into either 3d or 4p orbital.
6. The (n+ l) value for these orbital are

| Orbital | (n + l) value |
|---|---|
| 3d | 3+2 = 5 |
| 4p | 4+1 = 5 |

Both the orbital's have same (n+ l) value. But for '3d' orbital the 'n' value is less in 3d ( n = 3) compare to the 'n' value of 4p ( n=4) – Therefore the electron occupies the 3d orbital. Thus the electronic configuration of Sc is [ Ar ] $4s^2$ $3d^1$

**7. State and Explain with one example the Hund's rule of maximum multiplicity ?**

A) Hund's rules tells the filling of electrons into the orbital's belonging to the same sub shell called degenerate orbital's.

**Statement:** Electron pairing takes place only after all the available degenerate orbital's are occupied by one electron each.

**Example:-** Consider carbon atom (z=6) It has six electrons. The first electron goes into the 1s orbital of the K – Shell The second electron will be paired up with the first in the same 1s orbital. Similarly the third and fourth electrons occupy the 2s orbital's of L – Shell. The fifth electron goes into one of the three '2p' orbital's of the L- Shell Let it be $2p_x$. Since the three P orbital's (i.e $2p_x$ , $2p_y$ , $2p_z$ ) are degenerate the sixth electron goes into $2p_y$ or $2p_Z$ but not $2p_x$. Thus the electronic configuration of carbon can be written $1s^2$ $2s^2$ $2p^1_x$ $2p^1_y$

**8) Define ionization energy and mention the factors that influence it.**

**Ionization Energy : -** It is defined as the minimum energy Required to remove an electron from the outermost orbital of an atom in gaseous state.

The following factors are seen to influence ionization energies of various elements.

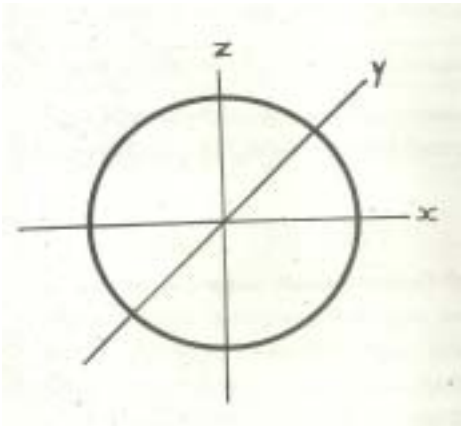
**Nuclear Charge :-** As the nuclear charge increases, the electrostatic force of attraction of nucleus on the outer electron is also increases. Therefore ionization energy also increase

**Size of the atom :-** As the size of the atom increases, the ionization energy decreases. This is due to decrease in the attraction power of nucleus over the valence electrons.

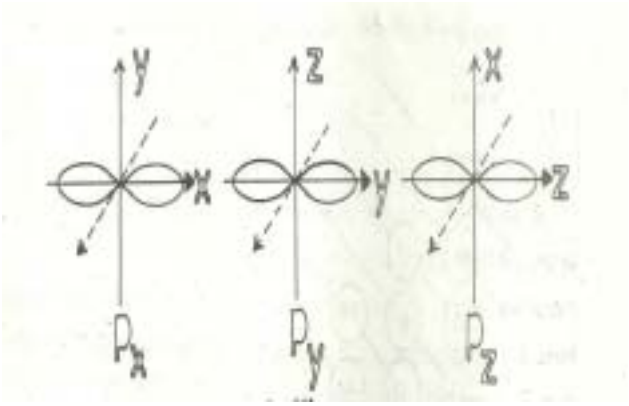
**Charge on the ion :-** As the charge on the ion increase, the ionization energy increases. For instance energy required to remove an electron from uni positive ion is more than the energy required from a neutral atom.

**9. Draw the shapes of s and p orbital's.**

S Orbital

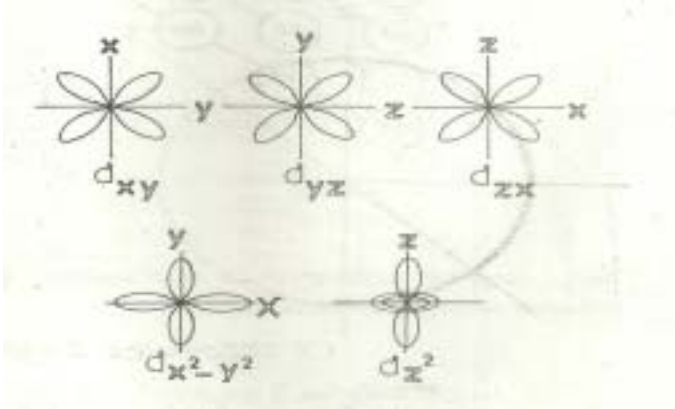



p orbital's



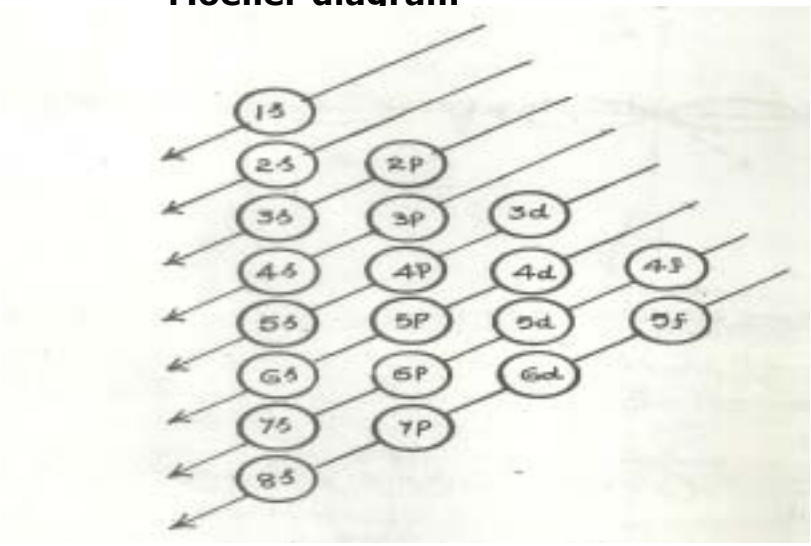

**10. Draw the shapes of five d orbital's**

d orbital's



**10. Draw the diagram showing the sequence of filling of various atomic orbital's**

**Moeller diagram**




## Part - B

### Multiple choice questions (1/2 Marks)

**1) which of the following are nucleons ? ( )**

a) Electro ns, Protons b) Protons, neutrons

c) Electrons, neutrons d) Electrons, Positrons

**2) The value of Planck's constant is ( )**

a) $6.625 \times 10^{-27}$ J-s b) $6.625 \times 10^{-34}$ J-s

c) $6.625 \times 10^{-36}$ J-s d) $6.625 \times 10^{-24}$ J-s

**3) Bohr's theory of atom is based on which of the following theories? ( )**

a) Quantum theory of Radiation

b) Black body radiation

c) Newton's Laws

d) Bernoulli's theorem.

**4) As the radius of orbit increases the energy of the orbit ? ( )**

a) Decreases b) constant

c) Increases d) increases or decreases

**5) The angular momentum of the electron revolving in a stationary orbit is equal to integral multiple of ? ( )**

a) h b) $nh/2\pi$ (c) $n.(2\pi)$ d) $n\ (2\pi/n)$

**6) Who proposed elliptical orbits ? ( )**

a) Bohr b) Rutherford c) Plank d) Somerfield.

**7) The Maximum value of azimuthal quantum number (l) is ( )**

a) n+1 b) n c) n-1 d) n+2

**8) Principal quantum number gives which information of stationary orbit ? ( )**

a) Size and energy b) Size and shape

c) Shape and Nature d) Size and power

**9. If 'l' is Azimuthal quantum number and 'm' is magnetic quantum number then when l=3, then 'm' can takes values ( )**

a) 7 b) 4 c) 8 d) 9

**10. The probability of location of electron in the nodal region is ( )**

a) one b) two c) three d) Zero.

**11. Bohr's theory is valid for ( )**

a) all atoms b) all ions

c) any atom or ion having one electron.

d) all the molecules.

**12. Which of the following shell has the least energy? ( )**

a) k b) M c) K d) N.

**13. Which of the following quantum numbers give size and energy of stationary orbits ( )**

a) n b) l c) m d) s.

**14. The sub- shells present in L – shell is ( )**

a) s and d b) s and p

c) s,p, and d d) s, p, d and f

**15) The maximum value of l for n = 5 is ( )**

a) 5 b) 3 c) -5 d) 4

**16) The number of d orbital's present in n=3 is ( )**

a) 1 b) 3 c) 5 d) 7

**17) f – orbital's are present in ( )**

a) k – shell b) L- shell c) M-Shell d) N- shell

**18) Among 3p, 4s, 3d and 4p having the least energy is ( )**

a) 4s b) 3p c) 3d d) up.

**19 " No two electrons will have all the four quantum numbers same" This is known as ( )**

a) Aufbau principle

b) Hand's rule

c) Pauli's exclusion principle

d) Ampere's rule

**20. The fine structure of atomic spectrum is satisfactorily explained by ( )**

a) Bohr's atomic model.

b) Somerfield's mode,

c) We mechanical model of atom

d) Ruther ford's model of atom.

**Fill up the Blanks :**

1) Rutherford proposed ' planetary model' based on his _____ scattering experiment

2) Quantum theory of radiation is proposed by _____

3) Angular momentum is given by $nh/2\pi$ where 'h' is _____ constant

4) $E_2 - E_1 = h\,v$ where v is _____

5) The number of sub-shells present is L- shell is _____

6) The maximum value of azimuthal quantum number 'l' for the principal quantum number 'n' is _____

7) After filling the 3d orbital, the electron enters into _____ orbital.

8) $3d^{10}\ 4s^1$ is the valence electronic configuration of _____

9) The distance between the nucleus and outermost orbital give the

10) The valence electronic configuration of Cr ( Z=24) is _____

11) The charge of the nucleus is _____

12) The first atomic model was proposed by _____

13) Planetary model or nuclear model was proposed by _____

14) Energy pockets are called _____

15) Planck explained the phenomena of black body radiation using _____

16) According to Rutherford's atomic model atom is _____ in nature

17) The energy of stationary orbits is _____

18) The angular momentum is said to be _____

19) _____ was awarded the Nobel prize for his contribution to atomic structure

20) Bohr's theory of atom could not explain the formation of _____

21) _____ Proposed the dual nature of the electron.

22) The solutions of Schrödinger's wave equation gave birth to the _____

23) The angular momentum (mvr) of the electron revolving in a stationary orbit is equal to nh/2π where r is _____

24) Principal quantum number propped by _____

25) Azimuthal quantum number proposed by _____

26) Azimuthal quantum number is also known as _____

27) Magnetic quantum number is proposed by _____

28) If 'l' is the Azimuthal quantum number then magnetic quantum number can have _____ values.

29) Spin quantum Number was proposed by _____

30) A sublevel can accommodate _____ electrons.

31) The shape of the 's' orbital _____

32) All the P – orbital's have _____ shape

33) The _____ provide information regarding the energies of the atomic orbital

34) The correct electronic configuration of Lanthanum ( La = 57 ) is _____

35) Electron configuration of cr ( z = 24 ) is _____

36) The electron configuration of Cu ( Z=Za) is _____

37) Atomic size depends on the _____ quantum number

38) Atomic size is determined by _____

39) Ionization energy is expressed in units of _____

## MATCHING

| I | **Group – A** | | **Group - B** |
|---|---|---|---|
| 1) Rutherford | ( ) | a) Dual nature |
| 2) Max Planks | ( ) | b) Nuclear model |
| 3) Niels Bohr | ( ) | c) Quantum Theory |

4) Somerfield ( ) d) Elliptical model

5) Louis de Broglie ( ) e) Atomic model

**II Group – A** **Group – B**

1. Principal Quantum number ( ) a) max plank
2. Azimuthal Quantum number ( ) b) Lande
3. Magnetic Quantum number ( ) c) Somerfield
4. Spin Quantum number ( ) d) Neils Bohr
5. Quantum theory ( ) e) Uhlenbeck and Goudsmit.

**Answers :**

**Multiple choice :**

**1**. b **2**. b **3**. a **4**. c **5**. b **6**. d **7**. c **8**. a **9**. a **10**. d **11**. c **12**. c **13**. a **14**. b **15**. d **16**. c **17**. d **18**. b **19**. c **20**. c

**Fill up the Blanks :**

**1**. α– rays, **2**. Max plank **3**. Plank's, **4**. Frequency, **5**. 2, **6**. n-1, **7.** 4p, **8.** Copper, **9.** Atomic Size, **10**. [ Ar ] $4s^1$ $3d^5$ **11**. Positive, **12**. J.J.Thomoson , **13**. Rutherford, **14**. Quanta, **15**. Quantum theory of radiation **16**. Spherical **17**. constant **18.** Quantized **19**. Bohr, **20**. Chemical bonds **21**. de Broglie **22**. Atomic orbital **23**. Integer **24**. Neils Bohr **25**. Somerfield, **26**. Angular momentum quantum number or Subsidiary quantum number **27**. Lande, **28**. (2l + 1) **29**. Uhlenbeck and

Goudsmit, **30**. Two **31**. Spherical **32**. Dumb bell **33**. Atomic spectra **34**. [Xe] $5d^1$ $6s^2$

**35.** [ Ar ] $4s^1$, $5d^5$ **36**. [ Ar ] $4s^1$ $3d^{10}$ **37**. Principal **38**. X – ray diffraction **39**. ev (electron volt)

Matching :

I. 1. b 2. c 3. e 4. d 5 a

II. 1. d 2. c 3. b 4. e 5. a