1. FUNDAMENTALS OF CHEMISTRY

# Atomic Structure

**FUNDAMENTAL PARTICLES OF AN ATOM:**

**Characteristics:**

**1.Electrons:-**

1. It was discovered by **J.J.Thomson**
2. It has **1** unit **–ve** charge
3. It’s charge is **-1.602 x 10-19  coulombs**
4. It’s mass is **9.11 x 10-31 kg**

**2.Protons:-**

1. It was discovered by **E.Gold stein**
2. It has **1** unit **+ve** charge
3. It’s charge is **+1.602 x 10-19  coulombs**
4. It’s mass is **1.672 x 10-27 kg**

**3.Neutron:-**

1. It was discovered by **James Chadwick**
2. It has **neutral** charge
3. It’s charge is **0**
4. It’s mass is **1.675 x 10-27kg**

**Atomic number:**The number of protons (or) electrons in an atoms are called as atomic number

* It is denoted by “Z”
* Z=The no.of protons (or) electrons
* Ex:- The atomic number of “Na” (Z) =11

The number of protons =11

The number of electrons =11

**Mass number:- The total number of protons and neutrons in an atom is known as mass number**

* **It is denoted by “A”**
* **A=The number of protons + The number of neutrons**

**A=Z + The number of neutrons**

**The no.of neutrons = A-Z**

**Applications:-**

**Model-1:-**

**Calculate the number of protons , electrons and neutrons for.**

1. **2He4**
2. **8O16**

**Answers:-**

1. **Given that: 2He4**

**here , Z=2 , A=4.**

**The no.of protons = 2**

**The no.of electrons =2 , The no.of neutrons = A-Z**

**= 4-2 =2.**

**MODEL-2:-**

**Calculate the number of protons , electrons and neutrons.**

1. **Mg**
2. **Al**

**Answers:-**

1. **Given that : 12Mg24**

**we know that, Z=12 , A=24.**

**The no.of protons = 12**

**The no.of electrons = 12**

**The no.of neutrons = A-Z**

**= 24-12**

**= 12.**

**MODEL-3:-**

**Calculate the number of Protons,Electrons and Neutrons for:**

1. **Na+**
2. **Mg2+**
3. **Cl-**
4. **O2-**

**Answers:**

1. **Given that: Na+**

**We Know that, Z=11,A=23**

**The no.of Protons=11**

**The no.of Electrons=11-1=10**

**The no.of Neutrons=A-Z**

**=23-11**

**=12**

1. **Given that:O2-**

**We know that , Z=8,A=16**

**The no.of Protons=8**

**The no.of Electrons=8+2=10**

**The no.of neutrons =A-Z**

**=16-8**

**=8.**

**MODEL-4:**

**Find the atomic number (Z), mass number (A) of an element having protons : 11 and 12 neutrons in it nucleus.**

**Given that , “11” protons , “12” neutrons**

**The atomic number (Z) =11**

**The mass number (A)= The no.of protons + The no.of neutrons**

**A=11+22**

**A=23.**

**So, Z=11 , A=23 the atom is “Na”**

**BOHR’S ATOMIC THEORY:-** **In 1913 , NEILS BOHR proposed a theory based on the planck’s quantum theory**

**POSTULATES:-**

1. **The electrons revolve around nucleus with high velocity in circular paths is called orbit (or) shell.**
2. **Each orbit has some amount of energy . So , these are called as energy levels . They are represented as n=1,2,3,…. (or) K,L,M,N…**
3. **As ‘n’ value increases , the size of orbit also increases.**
4. **As long as the electrons revolve in an orbit , it’s energy is constant . Hence , the orbits are called stationary orbits.**
5. **The angular momentum of an electron is equal to integral multiple of h/2π.**

**i.e, mvr=nh/2π**

**where,**

**m=mass of electron**

**v=velocity of electron**

**r=radius of orbit**

**n=principal quantum number**

**h=planck’s constant**

**(h=6.626 x 10-27 erg sec)**

**(or)**

**(h=6.626 x 10-34 j sec)**

**π =22/7**

1. **When the electrons jumps from lower energy level to higher energy level , then the energy absorbs in the form of quanta.**
2. **When the electrons jumps from higher energy level to lower energy level , then the energy released in the form of quanta.**

**ΔE=E2-E1=h*v***

**where, ΔE=change of energy**

**E1=energy of lower orbit**

**E2=energy of higher orbit**

**h=planck’s constant**

***v=*frequency**

**Merits:- 1. It explains the stability of an atom.**

**2.It explains the spectrum of hydrogen.**

**Limitations (or) demerits:**

1. **It could not explain the spectra of multi electron atoms like He,Li,Be,…….**
2. **It could not explain the zeeman effect and stark effect.**
3. **It could not explain the fine spectrum.**
4. **It could not explain the formation of chemical bonds**
5. **It could not justify the quantisation of angular momentum**
6. **It is against the wave nature of electron**

**Quantum numbers:-**

**Def:- The numbers used for completely characterizing each electron of an atom is called quantum numbers.**

**There are four quantum numbers:**

1. **Principal quantum number**
2. **Azimuthal quantum number**
3. **Magnetic quantum number**
4. **Spin quantum number**

**Principal quantum number:-**

* **It was proposed by “Neil’s Bohr”.**
* **It is denoted by “n”.**
* **It’s values are n=1,2,3,…….∞**

**Significance :-**

1. **It gives the size and energy of the orbit .**
2. **As “n” value increases , the size and energy of orbit also increases.**
3. **The maximum number of electrons in a given orbit is “2n2”.**

**AZIMUTHAL QUANTUM NUMBER:-**

* **It was proposed by “Sommer field”.**
* **It is denoted by “l”.**
* **It’s values are l=0,1,2,3,…….,(n-1).**

**Significance :-**

* **It gives the shape of orbital**
* **If l=0 :- s-orbital :- spherical**

**l=1 :- p-orbital :- dumb-bell**

**l=2 :- d-orbital :- double dumb-bell**

**Magnetic quantum number:-**

* **It was proposed by “Lande”.**
* **It is denoted by “m”.**
* **It’s value are “m= -l to +l (or) (2l+1)”.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No** | **‘l’ value** | **‘m’ value** | **orbital** | **orientation** |
| **1.** | **l=0** | **m=0** | **“s”** | **1** |
| **2.** | **l=1** | **m= -1,0,1** | **“p”** | **3**  **(px,py,pz)** |
| **3.** | **l=2** | **m=-2, 1,0,1,2** | **“d”** | **5**  **(dxy,dyz,dzx,dx2-y2,dz2)** |

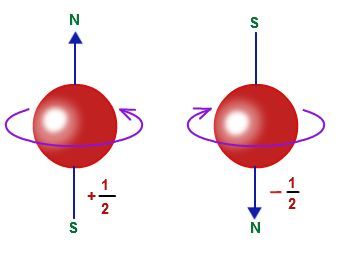
**Significance:-**

1. **It gives the orientation of orbitals**
2. **It also explains the zeeman effect and stark effect**

**Spin quantum number:-**

* **It was proposed by “ Uhlenbeck & Goud smit”**
* **It is denoted by “s”.**
* **It’s values are s= +1/2 (or) -1/2.**

**Significance:-**

1. **It gives the spin of electron**
2. **The spin of electron may be clockwise( ↑ ) (or) anticlockwise ( ↓ )** ****

**Clockwise Anticlockwise**

**Calculation of quantum numbers:-**

* **Calculate the set of four quantum numbers for electrons in ‘H’ atom**

**Ans: Given that: H-atom**

|  |
| --- |
| **↑** |

**Z=1 1S1**

**n=1**

**l=0**

**m= -l to +l**

**= -0 to +0**

**m=0**

**s=+1/2**

**Electronic configuration :-** **The arrangement of electrons in various orbitals of an atom is called electronic configuration.**

**Auf-Bau principle:-** **“The electrons enter into the orbitals in the increasing order of their energy” is called auf-bau principle.**

**(or)**

**“The electrons occupy lowest energy orbital first” is called auf-bau principle.**

**Ex:-**

**Let , us consider 4s,3d orbitals**

**4s= n+l = 4+0 = 4.**

**3d = n+l = 3+2 = 5.**

**So , the electrons first enter into 4s orbital and then enter into 3d orbital.**

**Hund’s rule:-** **“Pairing of electrons takes place when all the degeneration orbitals are filled with one electron each” is called hund’s rule.**

**Ex-1:-**

**Oxygen (O)**

**Z=8 1S2 2S2 2P4**

|  |  |  |
| --- | --- | --- |
| **↑↓** | **↑** | **↑** |

**EX-2:-**

**Fluorine (F)**

**Z=9 1S2 2S2 2P5**

|  |  |  |
| --- | --- | --- |
| **↑↓** | **↑↓** | **↑** |

**PAULI’S PRINCIPLE:-** **“No two electrons in an atom can have the same set of four quantum numbers” is called pauli’s principle.**

**EX:-**

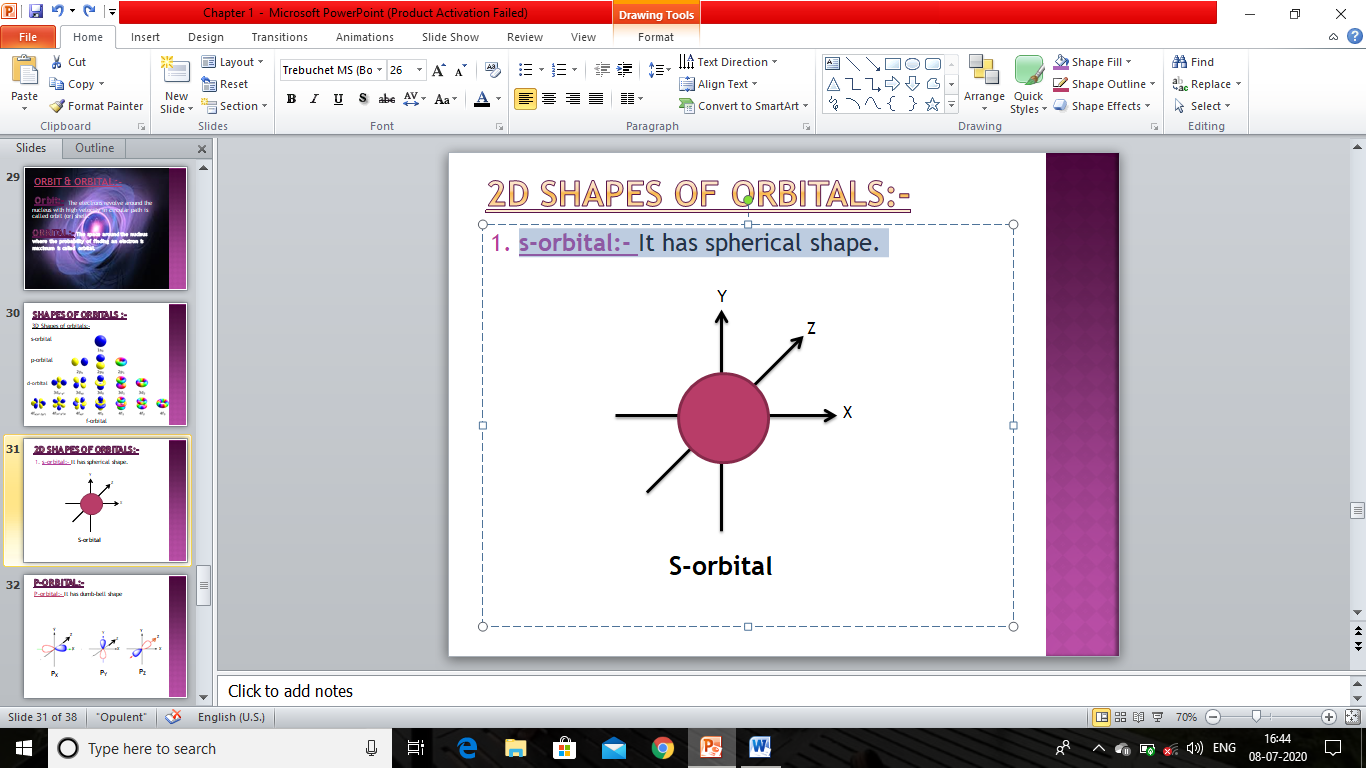
**Helium (He)**

**Z=2 1S2**

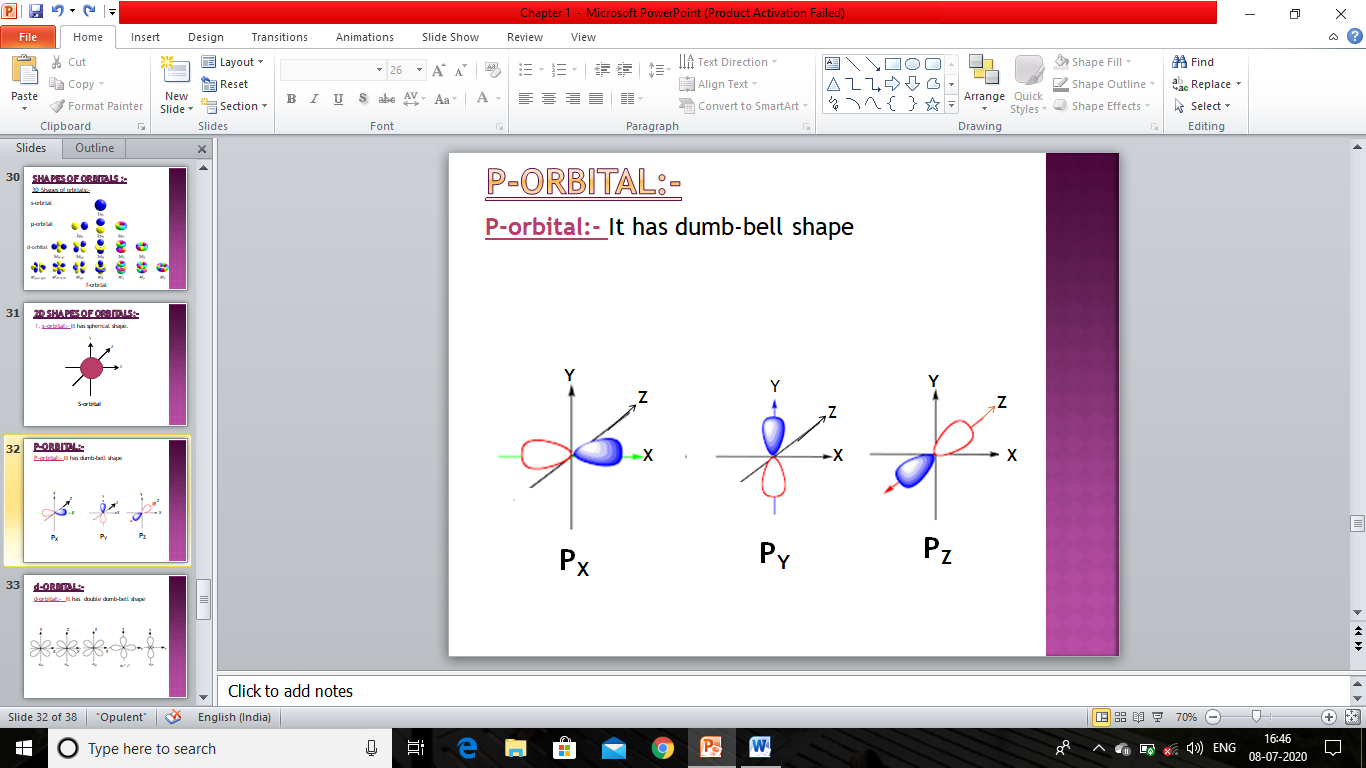
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **He - atom** | **n** | **l** | **m** | **s** |
| **1st e-** | **1** | **0** | **0** | **+1/2** |
| **2nd e-** | **1** | **0** | **0** | **-1/2** |

**ORBIT:-The electrons revolve around the nucleus with high velocity in circular path is called orbit (or) shell.  
orbital:- The space around the nucleus where the probability of finding an electron is maximum is called orbital.**

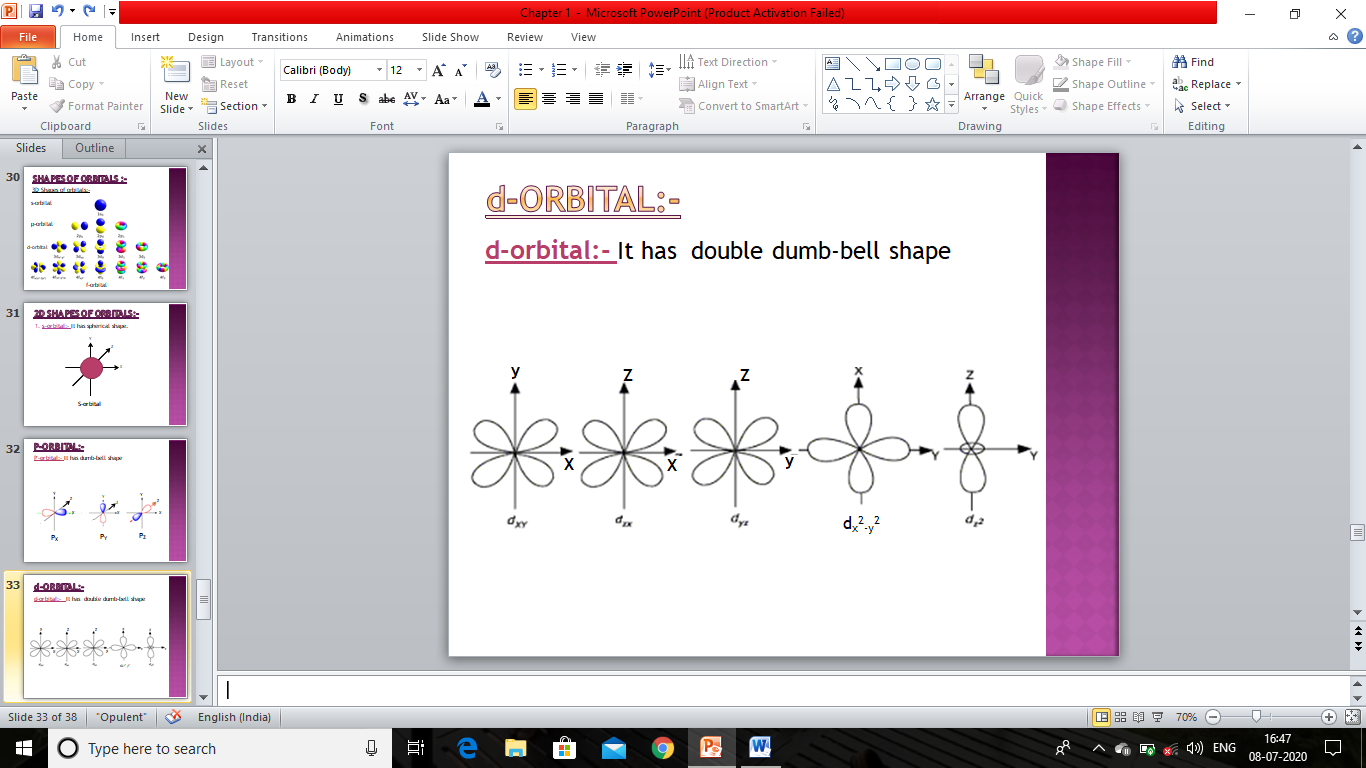
**s-orbital:- It has spherical shape.**

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**P-orbital:- It has dumb-bell shape**

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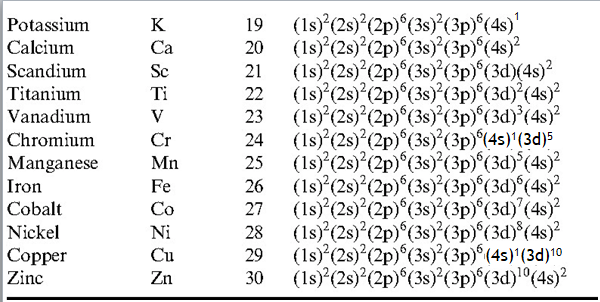
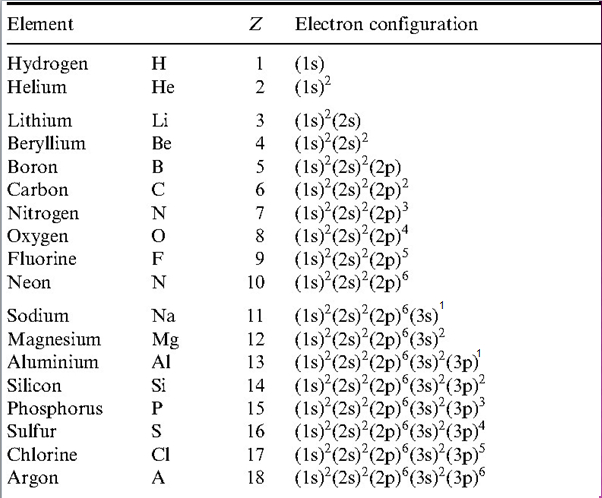
**d-orbital:- It has double dumb-bell shape**

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**DISTUNGUISH BETWEEN ORBIT & ORBITAL:-**

|  |  |  |
| --- | --- | --- |
| **S.No** | **Orbit** | **Orbital** |
| **1.** | **The electrons revolved around the nucleus with high velocity in circular paths is called orbit.** | **The space around the nucleus where the probability of finding an electron is maximum is called orbital.** |
| **2.** | **It has circular shape** | **It has different shape:**  **S-orbital :- spherical**  **P-orbital :- dumb-bell**  **d-orbital :- double dumb-bell** |
| **3.** | **It was 2 dimensional way** | **It was 3 dimensional way** |
| **4.** | **It is denoted by “n”.** | **It is denoted by n,l,m,s.** |
| **5.** | **The maximum number of electrons present in an orbit is “2n2”.** | **The maximum number of electrons present in an orbital is “2”.** |

**Electronic configuration From Hydrogen – zinc :**

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