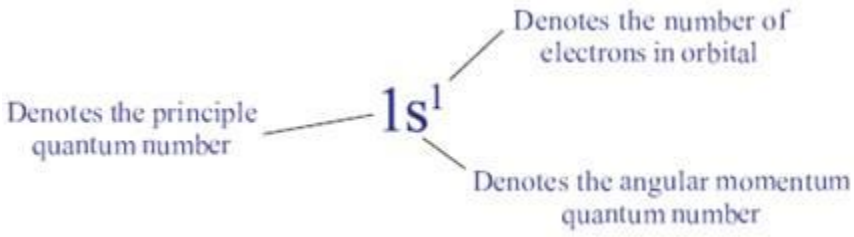
# Structure of Atom

## Improve your learning

**Q. 1. What information does the electronic configuration of an atom provide?**

**Answer :** Electronic configuration gives the information regarding the manner in which electrons in an atom occupy the shells, sub shells and orbitals of that atom.

The short hand notation - $nl^x$ - consists of principal energy level (n), the letter representing sub level (l) like s,p,d,or f and number of electrons in that sub level are written as superscript (x). example of hydrogen is given below-




**Q. 2 A. How many maximum number of electrons that can be accommodated in a principle energy shell?**

**Answer :** If n is the number of principle energy shell, then maximum number of

electrons that can be accommodated is given as $2n^2$ .

For first shell n = 1, so maximum number of electrons is $2(1)^2 = 2$

Second shell n = 2 , so maximum number of electrons is $2(2)^2 = 8$….so on

**Q. 2 B. How many maximum number of electrons that can be accommodated in a sub shell?**

**Answer :** The maximum number of electrons that can be accommodated in a sub shell is 2(2l + 1), where l = 0,1,2,3…so on for s,p,d,f sub shells respectively.

**For example,**

**i.** s sub shell, l = 0 , number of electrons accommodated are 2

**ii.** p sub shell, l = 1 , number of electrons accommodated are 6…….so on

**Q. 2 C. How many maximum number of electrons can be accommodated in an orbital?**

**Answer :** The maximum number of electrons that can be accommodated in an orbital is 2.

“s” sub shell has 1 orbital, so its occupancy is 2.

“p” sub shell has 3 orbitals, so its occupancy is 6 electrons and so on .

**Q. 2 D. How many sub shells present in a principal energy shell?**

**Answer :** If n is the number of principle energy shell , n subshells are present in it.

For example first shell has one subshell , i.e. s subshell

Second shell (n = 2) has 2 sub shells , i.e. s and p sub shells

Third shell (n = 3) has 3 sub shells , i.e. s,p and d sub shells and so on…

**Q. 2 E. How many spin orientations are possible for an electron in an orbital?**

**Answer :** Two spin orientations are possible for an electron in an orbital. Positive and negative spin which are represented as + 1/2 and -1/2 respectively.

**Q. 3. In an atom the number of electrons in M-shell is equal to the number of electrons in the K and L shell. Answer the following questions.**

**a. Which is the outer most shell?**
**b. How many electrons are there in its outermost shell?**
**c. What is the atomic number of element?**
**d. Write the electronic configuration of the element.**

**Answer : (a)** M shell.

**(b)** 10 electrons. K shell has 2 electrons and L shell has 8 electrons. So, as given M shell has electrons equal to the number of electrons in K and L shells. So, its 2 + 8 = 10.

**(c)** Atomic number is equal to total number of electrons . so total electrons is equal to electrons in K, L and M shells, i.e. 2 + 8 + 10 = 20

**(d)** $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ – calcium

**Q. 4. Rainbow is an example for continuous spectrum explain.**

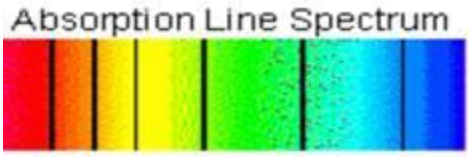
**Answer :** Rainbow is a natural spectrum of colors caused by the dispersion of sun light by tiny water droplets present in atmosphere. This spectrum has no sharp boundaries in between colors. It consists of different wavelengths with no gap. That's why rainbow is an example of continuous spectrum.

**Q. 5. How many elliptical orbits are added by Sommerfeld in third Bohr's orbit? What was the purpose of adding these elliptical orbits?**

**Answer :** Two elliptical orbits are added by Sommerfeld in third Bohr's orbit. In an attempt to account for the structure (splitting) of line spectra known as fine spectra, Sommerfeld added these elliptical orbits.

**Q. 6. What is absorption spectrum?**

**Answer :** The spectrum of electromagnetic radiation transmitted through a substance showing dark bands due to absorption at specific wavelengths is called absorption spectrum.




**Q. 7. What is an orbital? How is it different from Bohr's orbit?**

**Answer :** The region of space around a nucleus where the probability of finding an electron is maximum is called an orbital whereas Bohr's orbits refer to the fixed defined paths around nucleus, which electrons follow based on their energies.

**Q. 8. Explain the significance of three Quantum numbers in predicting the positions of an electron in an atom.**

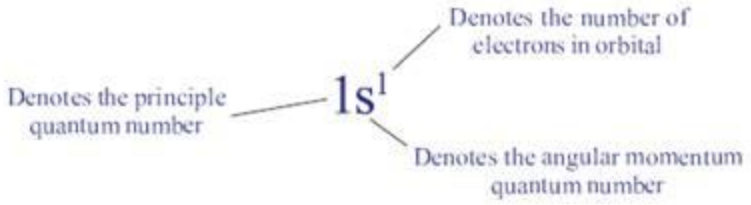
**Answer : 1.** principle quantum number – n- determines the main shell which contains electron. Determines its distance from nucleus and its energy.

**2.** angular momentum quantum number – l – determines the sub shell in which electron is present, i.e. s or p or d or f sub shell .

**3.** magnetic quantum number – m- determines the orbital of electron in that sub shell.

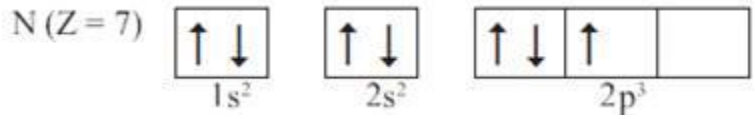
**Q. 9. What is of $nl^x$ method? How it is useful?**

**Answer :** The short hand notation – $nl^x$ - consists of principal energy level (n), the letter representing sub level (l) like s,p,d,or f and number of electrons in that sub level are written as superscript (x). example of hydrogen is given below-




This is used to write electronic configuration of atoms of element.

**Q. 10. Following orbital diagram shows the electron configuration of nitrogen atom. Which rule does not support this?**




**Answer :** Hund's rule doesn't support this. According to Hund's rule electron pairing in orbital starts only when all available empty orbitals of same energy are singly occupied. Here, in 2p subshell, pairing started without electrons filling the other orbitals.

**Q. 11. Which rule is violated in the electronic configuration $1s^0 2s^2 2p^4$?**

**Answer :** Aufbau's principle is violated here. According to this principle electrons should fill orbitals in increasing order of energy. 1s has lower energy than 2s and 2p. so, electron filling should happen at 1s first followed by 2s and 2p.

**Q. 12. Write the four quantum numbers for the differentiating electron of sodium (Na) atom**

**Answer :** Sodium atomic number is 11.

Its configuration is $1s^2 2s^2 2p^6 3s^1$

The differentiating electron is $3s^1$

n = 3

l = 0

m = 0

spin = -1/2 or + ½

**Q. 13. Why there are exemptions in writing the electronic configuration of Chromium and copper?**

**Answer :** In these cases, a completely full ($d^{10}$) or half full ($d^5$) d-orbital is more stable than a partially filled d sub shell, so an electron from 4s gets excited and rises to 3d orbital. This makes them stable.

Expected configurations based on Aufbau principle –

Cr – $[Ar]4s^2 3d^4$

Cu – $[Ar]4s^2 3d^9$

Actual configurations

Cr – $[Ar]4s^1 3d^5$

Cu – $[Ar]4s^1 3d^{10}$

**Q. 14. What is emission spectrum?**

**Answer :** The spectrum of frequencies (bright bands seen) of electromagnetic radiation emitted due to atomic transition in an element from high to low energy state.


**Q. 15. i. An electron in an atom has the following set of four quantum numbers to which orbital it belong to:**

| n | l | $m_l$ | $m_b$ |
|---|---|---|---|
| 2 | 0 | 0 | + 1/2 |

**ii. Write the four quantum numbers for 1s' electron.**

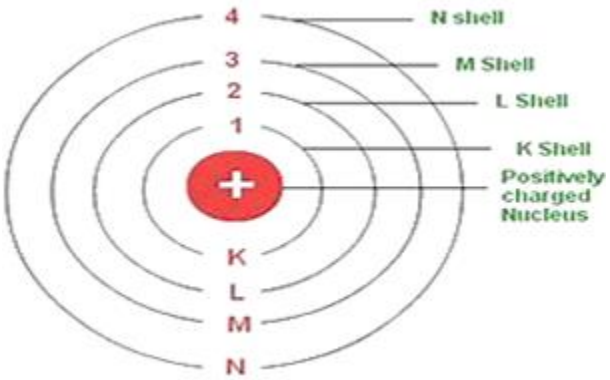
**Answer : (i)** l = 0 means s sub shell, n = 2 means second principle shell.

So, its orbital lies in 2s (the one and only orbital in s subshell) with m = 0

**(ii)** n = 1, l = 0, $m_l = 0$ , $m_b = + ½$

**Q. 16. Which electronic shell is at a higher energy level K or L?**

**Answer :** L is at a higher energy level. Far the shell from nucleus, more is its energy. K represents shell 1, which is next to nucleus followed by L,M,N respectively. So, energy of K<L<M<N…..so on. Larger shells have more energy.




**Q. 17. Collect the information regarding wave lengths and corresponding frequencies of three primary colors red, blue and green.**

**Answer :**

| Colour | Wavelength (1 nm = $10^{-9}$ m) | Frequency (1 THz = $10^{12}$ Hz) |
|---|---|---|
| Red | 620-750 nm | 400-484 THz |
| Blue | 450-495 nm | 606-668 THz |
| Green | 495-570 nm | 526-606 THz |

**Q. 18. The wave length of a radio wave is 1.0m. Find its frequency.**

**Answer :** we know that

$$\frac{c}{\lambda} = \mu$$

Where c = velocity of light = $3 \times 10^8$ m/s

λ = wavelength, given as 1m

μ = frequency = ?

so, $\frac{c}{\lambda} = \frac{3 \times 10^8 \text{ m/s}}{1 \text{ m}} = 3 \times 10^8 \text{ Hz}$

note: $s^{-1} = 1$ Hz