Comparison of L-S & J-J coupling Schemes

	L-S coupling	J-J coupling
1.)	The interaction between l_i^* (or s_i^*) of various electrons is strong & the interaction between their resultants L^* and S^* is weak to give $J^* (l_1^*, l_2^* ---)(s_1^*, s_2^* ---) = (L^* S^*) = J^*$	The interaction between $l_i^* s_i^*$ of individual electron is strong & the interaction between various j_i^* is weak to give rise to $J^* (l_1^* s_1^*)(l_2^* s_2^*), --- = (j_1 j_2) = J^*$
2.)	The strong spin-orbit interaction gives rise to singlet & triplet terms with relatively large energy difference. The small spin-orbit interaction splits the triplet into three closely spaced fine structure ~~atom~~. terms.	The strong spin-orbit interaction gives rise to widely separated $(j_1^* j_2^*)$ terms. when weak j_1^*, j_2^* interaction is taken into account each terms is splitted into two closely spaced components having different J-values.
3.)	The L-S coupling Scheme is valid in the most of the lighter atoms.	The jj coupling scheme is valid in very heavy atoms.

* Symmetric & Anti-symmetric wave function:

Symmetric wave function:- Wave function which does not change the sign when two identical particles are exchanged called symmetric wave function and denoted by.

$$\psi_S = \frac{1}{\sqrt{2}}\left(\psi_\alpha(1)\,\psi_\beta(2) + \psi_\alpha(2)\,\psi_\beta(1)\right)$$

Anti-Symmetric Wave function:- A wave function which changes their sign due to the exchange of particles is called antisymmetric wave function and denoted by

$$\psi_A = \frac{1}{\sqrt{2}}\left(\psi_\alpha(1)\,\psi_\beta(2) - \psi_\alpha(2)\,\psi_\beta(1)\right)$$

but S having 2 values in two e^- system 0 & 1 gives singlet and triplet state.

* Para helium & Orthohelium:-

Parahelium :- Parahelium corresponds to helium atom in singlet states or having antiparallel spins. parahelium atom can gain excitation energy in ~~Orthol~~ a collision.

Orthohelium :- Orthohelium corresponds to helium atom in triplet states or ~~having~~ having parallel spins. ~~Parahe~~ Ortho helium atom can loose excitation energy in collision and become one of parahelium.

* Identical particles :- In a system, the particles are said to be identical if they donot change in the system when they are interchanged.

. identical particles can be distinguished only if their wavepackets donot overlap or if their spin is aligned in different directions

4.)	The Lande interval rule is applicable for triplet fine structure separations.	The Lande interval rule is not applicable.
5.)	L and S are good quantum numbers in this coupling scheme	The L and S are not good quantum numbers in this coupling scheme.

* equivalent electrons:- electrons having same value of principal quantum no. n and orbital quantum no. l.

* Non-equivalent electrons:- electrons having different value of n and l.

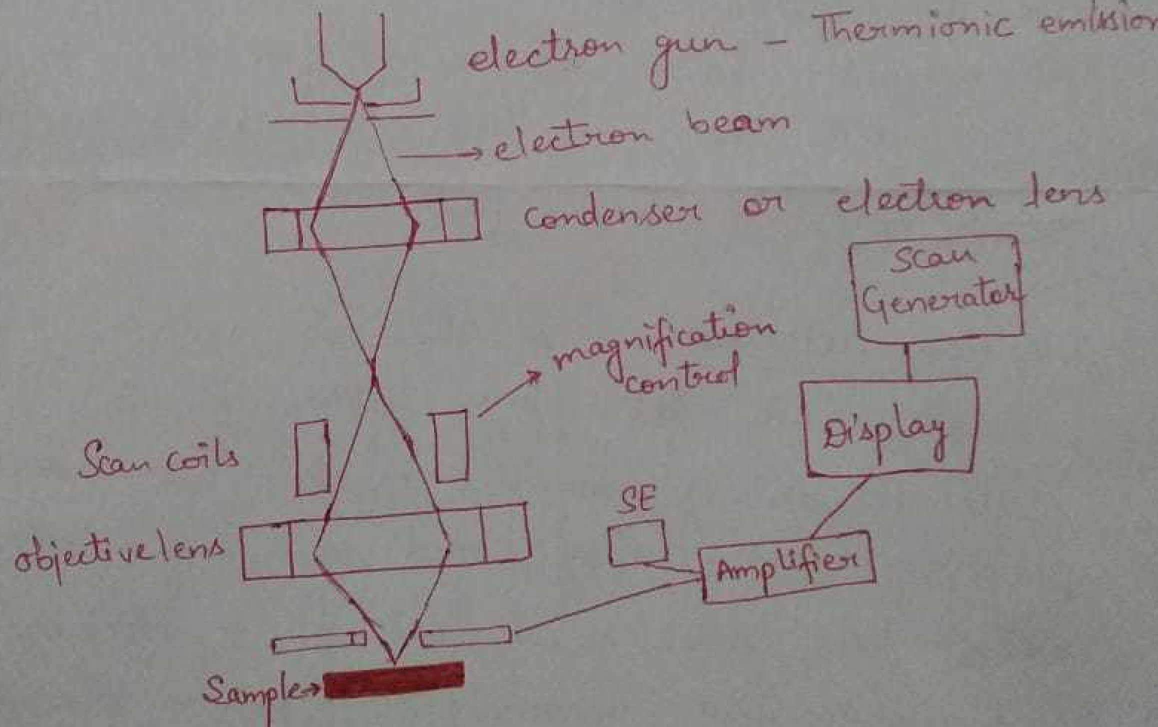
* Multiplicity:- no. of possible orientation of the total spin 'S' relative to the total orbital angular momentum 'L'.

(2S+1) gives the multiplicity of a state
If (2S+1) → 1, 2, 3, 4, 5 then atoms are in singlet state, doublet triplet quartets & quintets respectively.

SEM

Scanning Electron Microscope:-

In this type of electron microscope, the images of the samples are obtained by scanning it with the help of high energy e⁻ beam. The high energy electrons, when incident upon an ultrathin sample, result in image resolution of the order of 1-2 Å. This method can be used to determine the composition of the sample, measuring the shape and size of the particles and topography of the sample surface.



Construction & Working:-

Electron Gun:- The electron gun generates a stable thermionically emitted beam of electrons. This beam is heated upto 2000-2800 through a tungsten wire, when at -ve potential.

Electron Lenses:- To avoid scattering of electrons inside the CRT, the process of focussing of electrons is performed magnetically through magnetic field generated by an electric current through the coil moved across the condenser lens and objective lens. The prime function of this current is to deflect the electron towards the axis. At a point, the beam starts bending towards the point where it crosses the lens axis.

Scan coils:- Scan coil perform the function of Scanning. This is done by using a scan generator. The scan coils move the electron beam across the sample, by exerting electromagnetic force. The scan generator is connected to CRT and the magnifier. This helps to obtain the Image of the sample portions.

Electron detector:- As the e's move through the sample, we get two types of e's. The back-scattered e's of energies larger or smaller than primary beam energy and secondary electrons of few eV or less than 10 eV and these electrons originate within a few nanometers from the Surface. Some Secondary electrons are also emitted by the sample. These are detected with the help of a detector.

The SEM is used to generate high resolution images of sample Surface. It helps to detect the Smallest of the details of the sample which may be of the order 1nm in Size. Since e^- beam is very narrow, the large field depth helps to obtain a three dimensional micrograph.

Construction & Working:-

Electron gun:- e^- beam is emitted by an e^- gun from a tugsten wire through thermoinic emission. This beam passes through the specimen which is taken as an ultrathin film.

Electromagnetic lens:- electromagnetic lenses are used to focus the e's so that an ultrafine beam of e's is produced.

Detectors:- The e's emitted by e^- gun are made to fall on the sample are scattered as they pass through the sample, are detected with the help of different detectors.

Viewing Screen:- As e's pass through the specimen, they interact with the specimen particles. According to the density of the material, some e's may get scattered. The remaining e's travel to ~~the~~ strike a fluorescent screen. An image of the specimen formed on the screen, This image is studied for properties of the specimen.

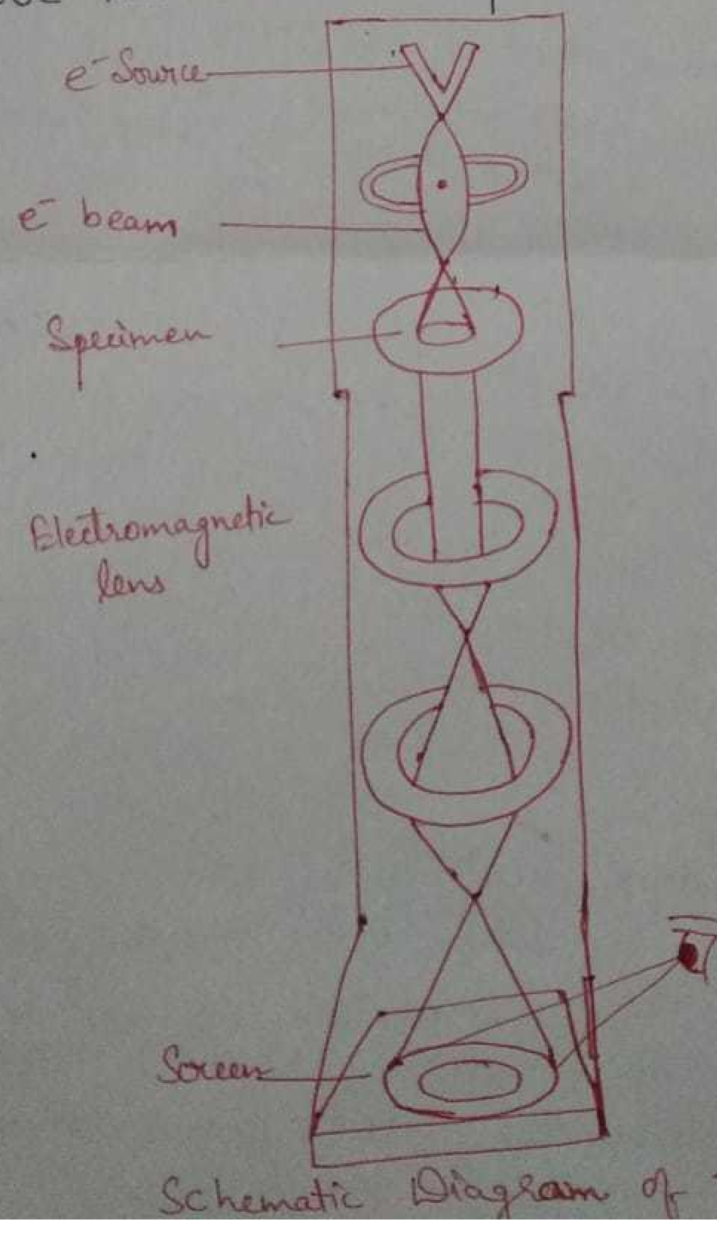
Limitations of TEM:-

1) It has limited depth resolution.
2) The preparation of the sample is the most difficult aspect & it is less so for nanomaterials.
3) TEM can achieve much greater resolution than SEM. But TEM is costlier than SEM, because much work is required to prepare a sample for a TEM than for a SEM.

TEM

Transmission Electron Microscope (TEM) :-

The basic principle of operation of a TEM is same as that of a light microscope. The TEM uses e's as a source of light in TEM. Since visible light used in a light microscope has a larger wavelength, which limits the resolution so produced, this problem gets rectified in a TEM. An e^- beam having much lower wavelength can improve the resolution upto 1000 times in a TEM.



Schematic Diagram of the TEM.