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p>Science > Chemistry > Difference Between Crystal Field Theory and Ligand Field Theory Many scientists and chemists have attempted to formulate theories to explain the bonding of coordination compounds and to justify and predict their properties. The first successful theory is the valence bond theory came out in the 1930s by Linus Pauling. Then in 1929, Hans Bethe proposed a new theory called crystal field theory. The ligand field theory is a modification of the original crystal field theory. In the beginning, the crystal and ligand field theories were largely used to explain the concepts in solid-state physics. However, in the 1950s, chemists started to apply these theories to transition metal complexes. The main difference between crystal field theory and ligand field theory is that crystal field theory describes only the electrostatic interaction between metal ions and ligands, whereas ligand field theory considers both electrostatic interaction and covalent bonding between the metal and its ligand. This article explains .

What is Crystal Field Theory - Theory, Application2. What is Ligand Field Theory - Theory, Application3. What is the difference between Crystal Field Theory and Ligand Field Theory?The crystal field theory describes the electronic structure of metal crystals, where they are enclosed by oxide ions or anions. The symmetry of the electrostatic field depends on the crystal structure. The d orbitals of the metal ions are split by the electrostatic field and the energies of these d orbitals can be calculated in terms of crystal field stabilization energies. Crystal field theory is used to understand the magnetic, thermodynamic, spectroscopic and kinetic properties of the coordination metal complexes. The main three assumptions of crystal field theory include:

- (a) The ligands are considered as point charges.
- (b) No interaction/bonds between orbitals of metal and ligands (c) In a free metal ion, all the sub-shells of a particular d orbital are of equal energy. The interactions between metal ions and their ligands are electrostatic in nature. In this theory, no bonding between the atom and the transition metal is considered. Because of this limitation, the crystal field theory is modified and proposed as ligand field theory. Figure 1: Octahedral splitting The ligand field theory is a combination of both crystal field and molecular orbital theories. It was first proposed qualitatively by Griffith and Orgel. Ligand field theory is used to describe the bonding, orbital arrangement and other important characteristics of coordination metal complexes. Moreover, it describes p bonding and provides more accurate calculations of energy levels in terms of ligand field stabilization energies. More precisely, the ligand field theory is used to judge the electron distribution among d orbitals of metal ions and their stereochemical activeness. The description of covalent bonding is not seen in the crystal field theory. Hence, ligand field theory is taken as a more realistic model that can be applied to describe the properties of coordination complexes. Figure 2: Ligand-Field scheme summarizing o-bonding in the octahedral complex [Ti(H₂O)₆]3+ Definition Crystal Field Theory: The crystal field theory is a theory that describes the electronic structure of metal crystals. Ligand Field Theory: Ligand field theory is a modification of crystal field theory and molecular orbital theory. Focus Crystal Field Theory: Crystal field theory only describes electrostatic interactions between metal ions and ligands. Applications Crystal Field Theory: Crystal field theory provides only electronic structure of transition metals. Ligand Field Theory: Ligand field theory describes both electrostatic interactions and covalent bonding between metal ions and ligands. Realism Crystal Field Theory: Crystal field theory is comparatively unrealistic. Ligand Field Theory: Ligand field theory is more realistic than crystal field theory. Summary - Crystal Field Theory and Ligand Field Theory The crystal field theory is an electrostatic approach that describes the electronic energy levels that govern the UV-visible spectra but does not describe bonding between metal ions and ligands. The ligand field theory is a complete description that is derived from crystal field theory. Unlike the crystal field theory, ligand field theory describes the bonding between metal ions and ligands. This is the difference between crystal field theory and ligand field theory. Reference: 1.Dabrowski, J. C. (2009). Metals in medicine. John Wiley & Sons.2.Huheey, J. E., Keiter, E. A., Keiter, R. L., & Medhi, O. K. (2006). 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