EngineeringRise

Valence bond theory, crystal field theory, colour and magnetic properties

Formulas and units, JEE Main. Status: Reviewed on 2026-11-20.

Result	Formula	Units or note
Spin-only moment	mu = sqrt(n(n + 2)) Valid when: spin-only value; n = unpaired electrons, orbital contribution ignored	Bohr magneton (BM)
Octahedral orbital energies	t2g = -0.4 Delta_o; eg = +0.6 Delta_o Valid when: octahedral crystal field; energies measured from the average level	energy (Delta_o)
Tetrahedral orbital energies	e = -0.6 Delta_t; t2 = +0.4 Delta_t; Delta_t = (4/9) Delta_o Valid when: tetrahedral field; Delta_t = 4/9 Delta_o for same metal and ligand	energy (Delta_t)
CFSE octahedral	(-0.4 n(t2g) + 0.6 n(eg)) Delta_o (pairing energy excluded) Valid when: octahedral complexes; pairing energy not included	Delta_o
High or low spin	low spin if Delta_o > P (d4 to d7 only) Valid when: octahedral d4 to d7 ions; Delta_o > P low spin, else high spin	n/a (comparison of energies)
Energy of absorption	Delta = N_A h c / lambda Valid when: wavelength of d-d absorption taken as the splitting Delta	J mol^-1 or kJ mol^-1
d-electron count of first-row ion	d = Z - 18 - charge (4s emptied first) Valid when: first-row cations of charge +2 or more, once 4s is emptied	dimensionless integer
Hybridisation by geometry	octahedral d2sp3 / sp3d2; tetrahedral sp3; square planar dsp2 Valid when: VBT: d2sp3 low spin, sp3d2 high spin, dsp2 strong-field d8 square planar	n/a (text)

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/chemistry/coordination-compounds/valence-bond-theory-crystal-field-theory-colo

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