Basic Physical Chemistry I

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Q12
Explain Goodenough-Kanamori rule for $d^3 - d^8$ configurationin O_h symmetry for both 180° and 90° cases. Further, confirm the same results for $d^8 - d^3$ cases.

Q13
For O_h symmetry, confirm the following direct product relation using character table.

$$E \times T_1 = T_1 + T_2$$

Q14
Absorption spectra of $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, and $[Cr(NH_3)_6]^{3+}$ ions are shown in Figure.

(1) Assign the peaks of ν_1 and ν_2 for d^6 low-spin configuration. That is, explain the excitation processes in these peaks by using Tanabe-Sugano diagram.
(2) Determine crystal field splitting Δ and Coulomb interaction energy B.
(3) Confirm that the ligand field strength obeys the *Spectrochemistry* series.

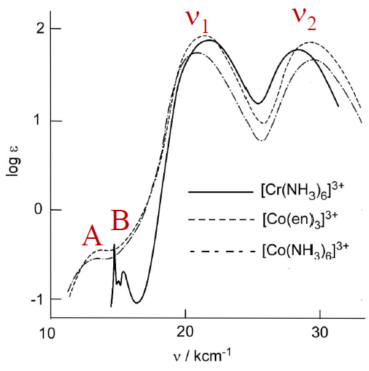

Fig: Electron absorption spectroscopy of Co complexes.

Q15
Describe 45 cases in d^2 configuration for free ions with term symbol (spectrum term). For each configuration, add the term symbol.

Q16
Prove the following relation: Optical transitions are arrowed only in the cases that the difference of orbital angular momentum is ± 1.

$$\Delta L = \pm 1$$

Q17
Prove the 'Lambert-Beer law'. Do not forget to mention the units for each parameter.

Q18
Solve the 5×5 determinant for crystal field splitting shown in p. 34.

Q19
Draw the energy diagram based on molecular orbital method for $[Co(NH_3)_6]^{3+}$. Here, for ligand orbitals of (NH_3), he occupation of a_{1g}, T_{1g}, and e_g states is assumed.

Q20
Plot the ligand field stabilized energy (LFSE) from d^1 to d^9. Horizontal and vertical axes should be d electron number and LFSE, respectively.