# 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 $[Co(H_2O)_6]^{3+}$ ions are shown in Figure.

(1) Assign the peaks of $\nu_1$ and $\nu_2$ 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 $\Delta$ and Coulomb interaction energy $B$.
(3) Confirm that the ligand field strength obeys the *Spectrochemistry* series.

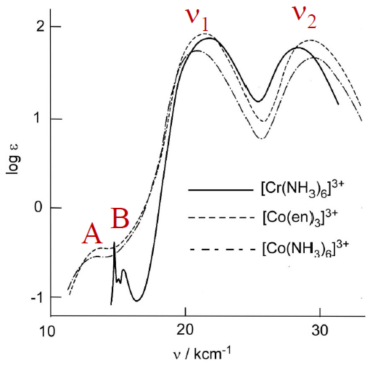


Fig: Electron absorption spectroscopy of Co complexes.

**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. 25.

**Q19**
Confirm the relationship between eV and $cm^{-1}$ units.

**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.