1. Assign the point groups of following compounds, and determine any of the species is optically active.
   (a) $\text{H}_2\text{O}_2$
   (b) $\text{CBrClFI}$
   (c) $\text{XeOF}_2$
   (d) $\text{C}_6\text{H}_{12}$ (chair form)
   (e) $\text{BFClBr}$

2. Give the symmetry labels for the 3d-, 4s- and 4p-orbitals of the central metal atoms in
   (a) $[\text{CrF}_6]^{3-}$
   (b) $[\text{Cr(en)}F_4]^{-}$, and (c) $[\text{Co(en)}_3]^{3+}$.
   (where “en” is “ethylenediamine”)

3. (a) Show the “molecular orbital energy diagrams” and their “LCAOs” for $\text{AH}_2$ molecule (A is a 2nd row element) (i) in linear and (ii) in bent geometries.
   (b) Draw the “Walsh diagram” for $\text{AH}_2$.
   (c) Based on “Walsh diagram”, judge which geometry will be more stable for $\text{BeH}_2$ and $\text{CH}_2$, respectively.
   (d) Based on “Walsh diagram”, explain why $\text{BH}_2$ is linear whereas $\text{BeH}_2$ is bent in their first excited state.

4. (a) How many total vibrational modes does a planar $\text{PtCl}_4^{2-}$ ion have?
   (b) How many of the vibrational modes are in the plane of the nuclei?
   (c) How many peaks do you expect to observe in the IR and Raman spectra, respectively, of this ion?
   (d) Indicate the symmetry representation of each of the normal modes below.