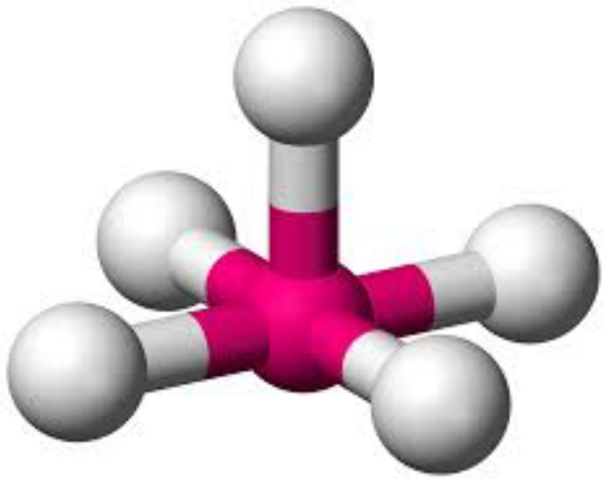
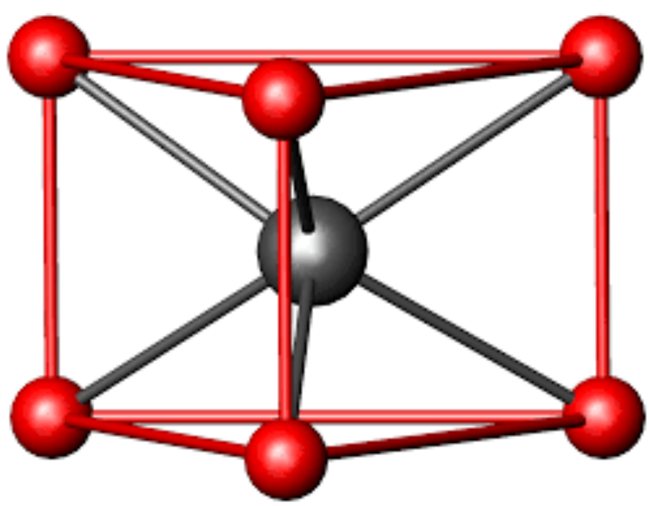
1. Consider a molecule with the general formula ML_5, and a square pyramidal geometry. [See drawing below.] The point group of the molecule is C_{4v}. Determine the symmetry of all molecular motion. Subtract translations and rotations. Of the remaining vibrations, bends and twists, determine which will be infrared active, and which will be Raman active. Clearly show your method. (12 points)



2. Determine the hybridization of a molecule with the general formula ML_6 that has trigonal prismatic symmetry as shown below. The sigma bonds will go from the central atom to each of the six corners (grey lines). The point group is D_{3h} . Be sure to specify all possible hybridization schemes, including the specific p or d orbitals in each hybridization scheme. (8 pts)



3. Consider the complex ion $[Cu(CN)_2Cl_3]^{3-}$. The geometry around the central atom is a trigonal bipyramid. The two cyanide ions may be in the axial positions, or in the trigonal plane. The molecule with the cyanide ions in the axial positions is in point group D_{3h} . The molecule with the cyanide ions in the equatorial plane is in point group C_{2v} (with the cyanide ions in the xz plane, and the chloride bond in the trigonal plane is the C_2 (z) axis). Assuming that both possible structures are stable, determine if IR and Raman spectroscopy of the cyanide stretches only could be used to distinguish between the two structures. Be sure to show your work and clearly indicate the expected results for each molecule. (10 pts)