Symmetry and Group Theory – Exercise Set 4

4.1) Determine the classes of symmetry operations in C_{3v}.

4.2) Show that by carrying out a similarity transform of one representation of a group $G = \{E, A, B, C, \dots\}$, one obtains an isomorphic representation $G' = \{E', A', B', C', \dots\}$.

4.3) Find a three-dimensional representation of the group C_{3v} by considering the corners of an equilateral triangle as a vector $r = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$.

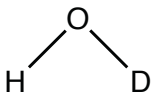
4.4) Reduce the following reducible representation Γ of C_{3v}.

C_{3v}	E	$2C_3$	$3\sigma_v$
A_1	1	1	1
A_2	1	1	-1
E	2	-1	0
Γ	6	3	-2

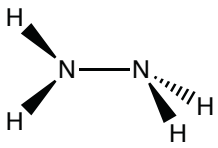
Homework

4.5) Determine the point groups of the following molecules and objects. Which of these molecules and objects can have a permanent dipole moment and which are chiral?

A



B

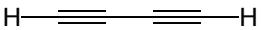


Hydrazine
dihedral angle HNNH = 90°

C

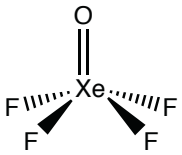
Fidget spinner
(consider as
perfectly symmetric)

D



Diacetylene

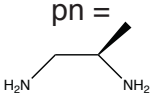
E



F

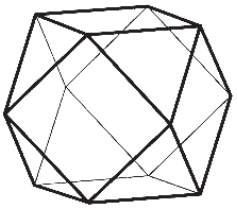
$[Co(pn)_3]^{3+}$

pn =

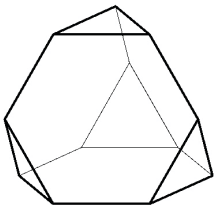


(arrange ligands for
highest symmetry)

G



H



4.6) If the order of a group is h, can that group have a class that also has order h?

4.7) Show that in an Abelian group of order h, all irreducible representations are one dimensional.

4.8) Complete the character table of D_3. Hint: Use the "Five important rules" for character tables that we have derived using the great orthogonality theorem. Explain how you arrive at the solution. Finding the correct labels for the irreducible representations is not required.