

(11) **Today**

4.1 Symmetry elements and Operations

4.2 Point Groups *Finish polarity*

(13) **Second Class from Today**

Test 1

Next Class (12)

4.1 Symmetry elements and Operations

4.2 Point Groups

Third Class from Today (14)

4.3 Character Tables

Why care?

Infrared Spectroscopy - vibrations that change the dipole of a molecule absorb infrared light

Raman Spectroscopy - vibrations that change the polarizability of a molecule are Raman active

Formation of molecular orbitals requires the interaction of atomic orbitals with the appropriate symmetry

Electronic transitions are also ruled by symmetry

Symmetry operations are the motions: rotation, reflection, etc

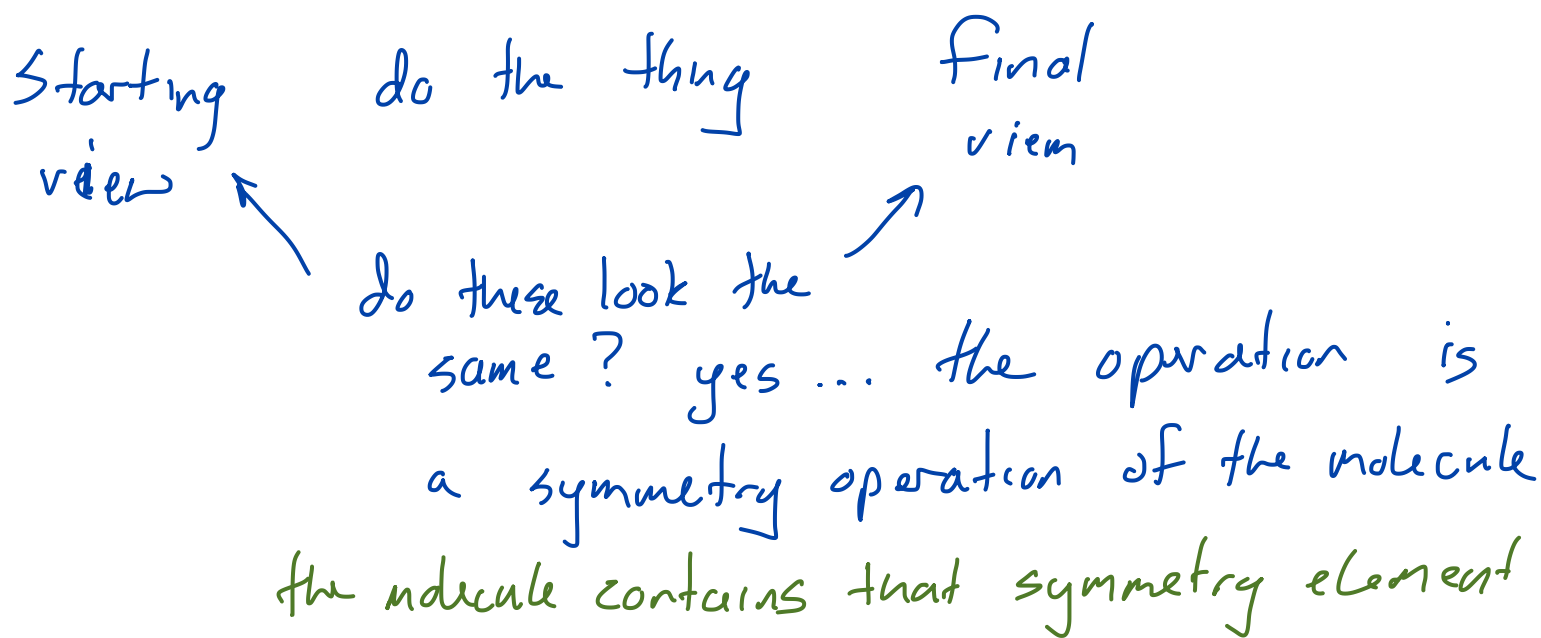
Symmetry elements are the thing about which the motion occurs: the axis of rotation, the plan of reflection

When you perform a rotation operation the object rotates about an axis, that's the element

Symmetry operation of a molecule are those motion which when perform produce a result indistinguishable from the original

Starting view do the thing Final view

do these look the same? yes ... the operation is a symmetry operation of the molecule
the molecule contains that symmetry element



E do nothing to the molecule
mathematically all coordinates of the parts of
the molecule are multiplied by 1

Rotation around an axis

Section 4.1

↓ symbol

C_n

Where $n = 360^\circ /$ (degrees through which the object is rotated)

what is the symbol used to represent a

120° rotation? C_3

$$n = \frac{360}{120}$$

a C_6 is a ... 60° rotation rotation = $\frac{360}{n}$

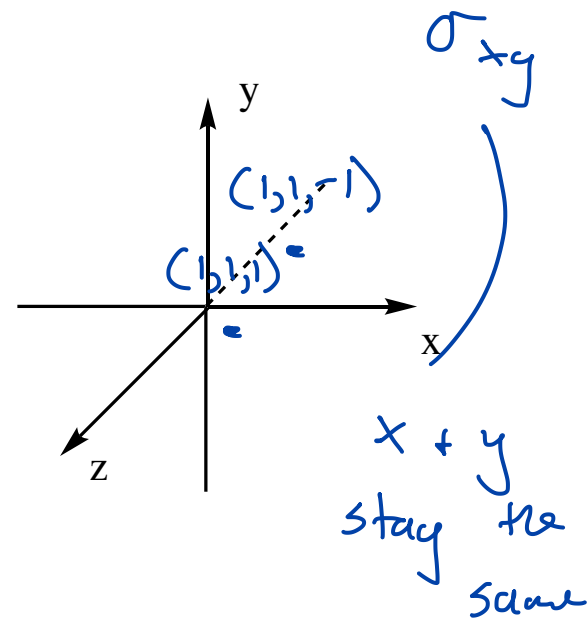
C_2 ... about face 180°

Reflection through a plane

σ_h horizontal mirror plane

σ_v vertical mirror plane

σ_d dihedral mirror plane ... a kind of vertical mirror plane



front/back

top/bottom

left/right

things on top stay on top

top + bottom are flipped

thing on each side stay on each side

every thing else stays

the same

i all parts of the molecule move through a point and come out the opposite side at the same distance

$$(1, 1, 1) \rightarrow (-1, -1, -1)$$

S_n

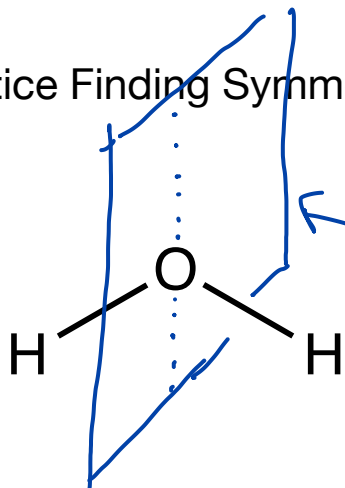
Where $n = 360^\circ /$ (degrees through which the object is rotated)

S_3 would be a 120° rotation on an axis followed by a reflection through a mirror plane \perp to the axis of rotation

E C_n σ i S_n

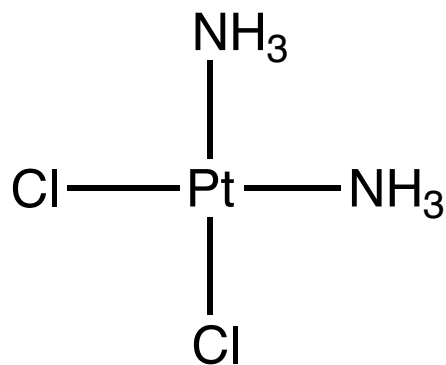
Practice Finding Symmetry Elements

Section 4.1



mirror in between two H's coming out of the screen and vice versa reflects right H to left H's position and vice versa

there is a second mirror plane the plane that contains the atoms reflects the top half of the atom to the bottom half + vice versa



all planar molecules possess a mirror plane, which is the plane of the molecule