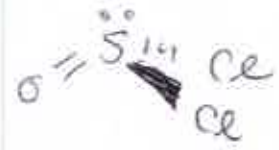
$SOCl_2$

a)  trigonal pyramidal geometry** (tetrahedral also acceptable)

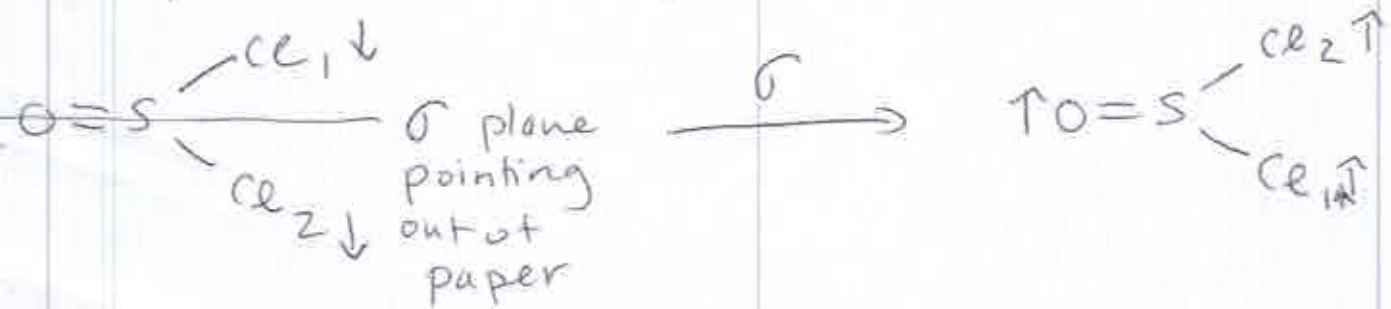
b) E, σ

c) E

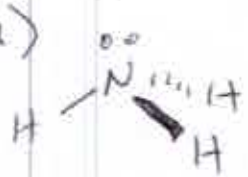
σ

σ plane goes through S=O bond, is in between the two S-Cl bonds

Alternately, draw from a different perspective; from above, looking down at lone pair.



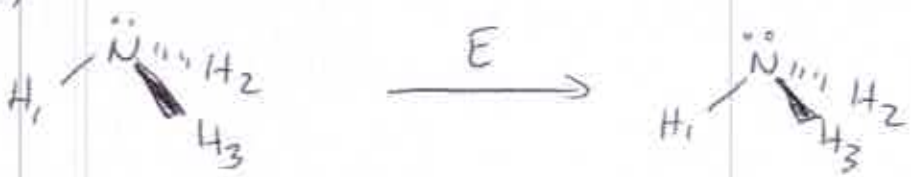
NH_3

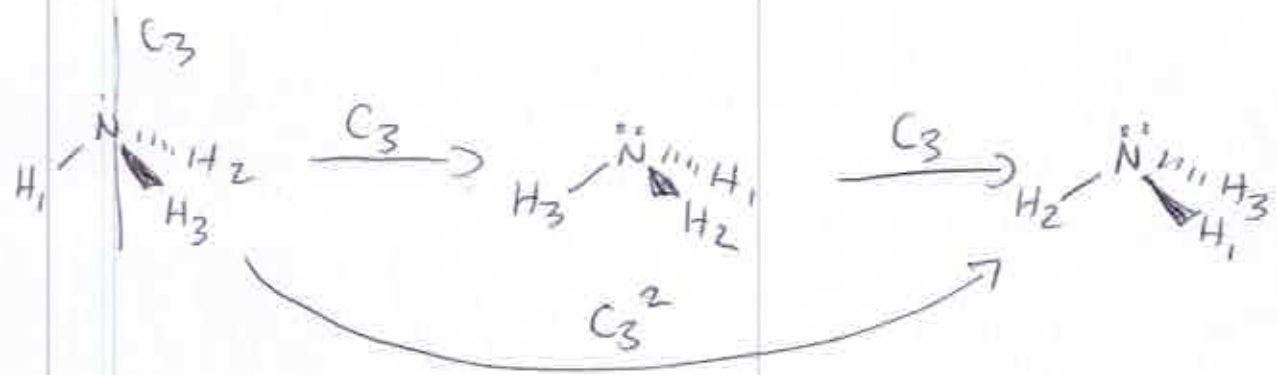
a) 

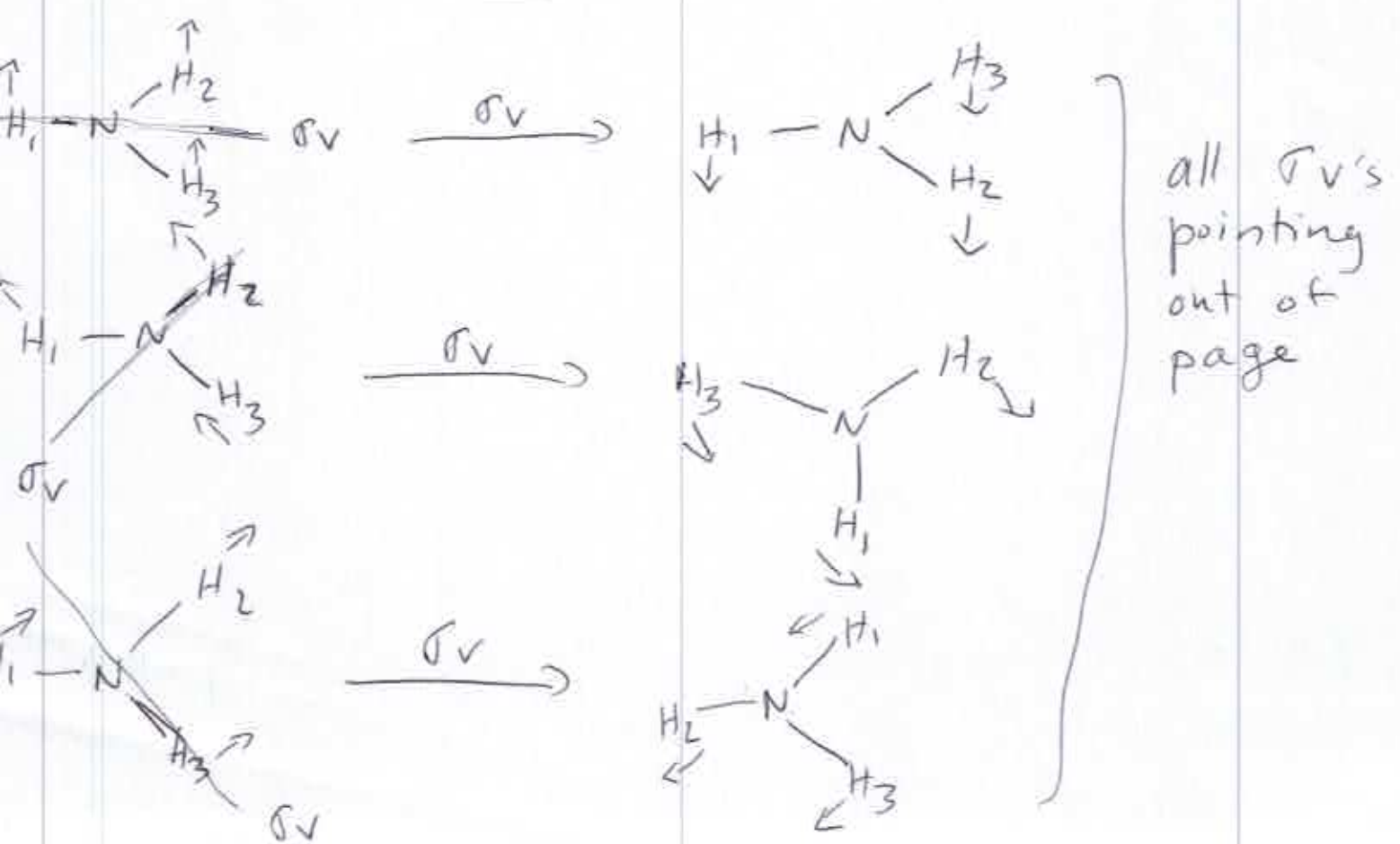
trigonal pyramidal
(tetrahedral also acceptable)

b) E, C_3, C_3^2, $3\sigma_v$] 6 operations total

c)

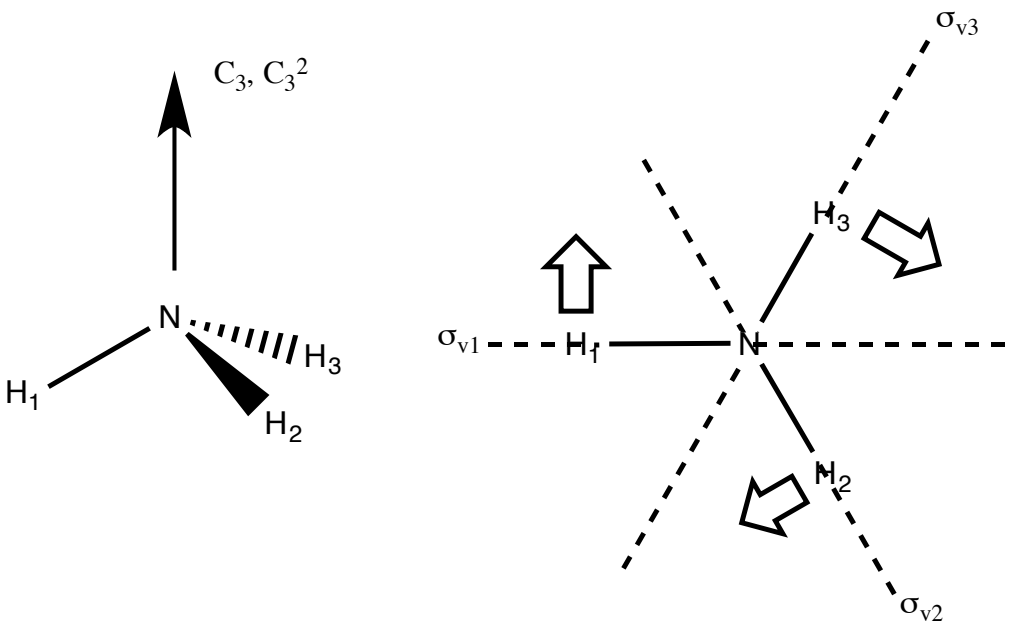






all σ_v's pointing out of page

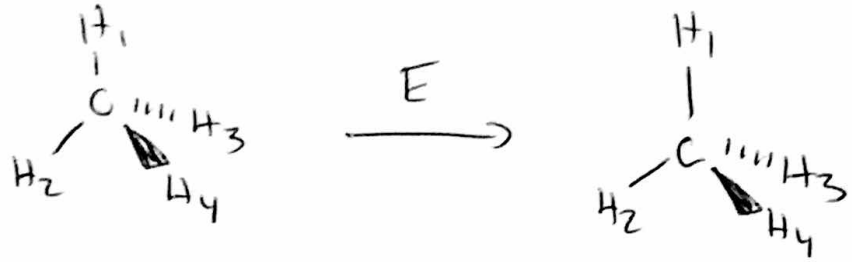
Fill out the following multiplication table for the operations contained in NH_3: E, C_3, C_3^2, σ_{v1}, σ_{v2}, and σ_{v3} (see depictions below). Arrows have been added to the structure to help you think about the orientation of each of the H atoms. Think of each arrow as being perpendicular to an N-H bond. Hint: start by determining the outcomes of applying single operations, then combine two together.

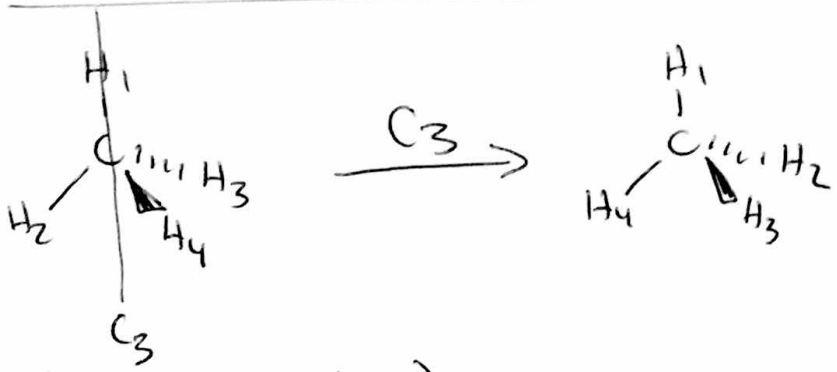


mirror planes pointing out of the page

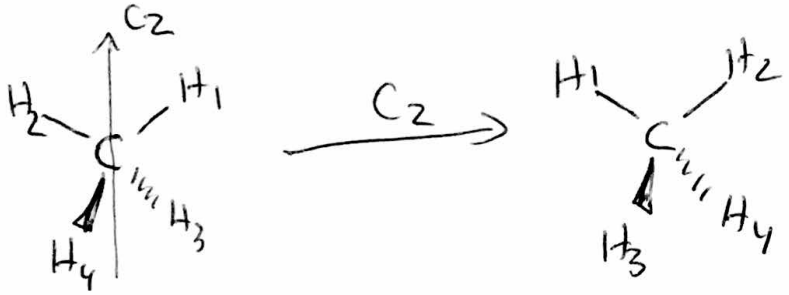
	E	**C_3**	**C_3^2**	**σ_{v1}**	**σ_{v2}**	**σ_{v3}**
E	E	C_3	C_3^2	σ_{v1}	σ_{v2}	σ_{v3}
C_3	C_3	C_3^2	E	σ_{v2}	σ_{v3}	σ_{v1}
C_3^2	C_3^2	E	C_3	σ_{v3}	σ_{v1}	σ_{v2}
σ_{v1}	σ_{v1}	σ_{v3}	σ_{v2}	E	C_3^2	C_3
σ_{v2}	σ_{v2}	σ_{v1}	σ_{v3}	C_3	E	C_3^2
σ_{v3}	σ_{v3}	σ_{v2}	σ_{v1}	C_3^2	C_3	E

What is the inverse for each operation? The inverse of operation X is defined as the operation Y such that X*Y = E. Look for E products in the multiplication table, this will allow you to determine the inverses.

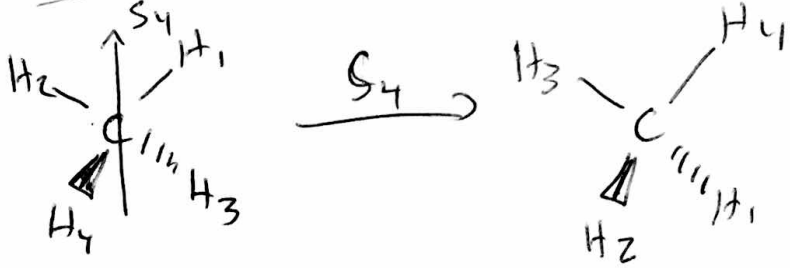




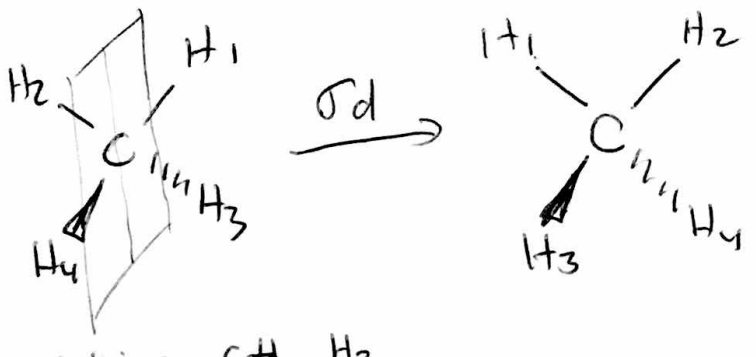
There are 4 C_3 axes, each one along a different C–H bond



There are 3 C_2 axes, bisecting H_2–C–H_1, H_3–C–H_1, and H_4–C–H_1



There are 3 S_4 axes in similar positions to C_2s



There are 6 σ_d planes, containing the following atoms:

1) C, H_3, H_4
2) C, H_1, H_2
3) C, H_1, H_3
4) C, H_2, H_4
5) C, H_1, H_4
6) C, H_2, H_3