동등, E (identity operation)

: 분자에 아무런 변화를 일으키지 않는다.

C_1 조작 (360°)을 하면 조작전과 같은 분자로 된다.

: 2회 연속적 C_2 조작은 동등이다.

$$C_2 \times C_2 = E \rightarrow C_2^2 = E$$

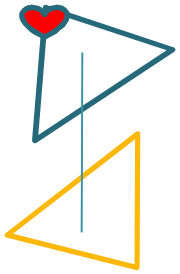
: 3회 연속적 C_3 조작은 동등이다.

$$C_3 \times C_3 \times C_3 = E \rightarrow C_3^3 = E$$

회전 반사 (반사회전), S_n (rotation-reflection operation)

: 360°/n 회전과 그 뒤를 잇는 회전축에 수직한 평면(σ_h)에 대한 반사의

두 단계 회전.



S_6

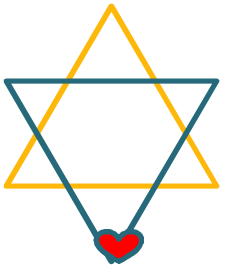
$S_6^3 = i$

S_6^1

$C_6^1 \sigma_h^1$

S_6^2

$C_6^2 \sigma_h^2$



S_6^3

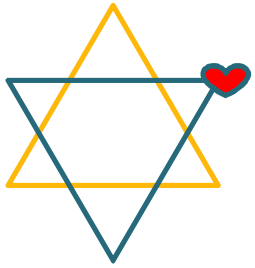
$C_6^3 \sigma_h^3$

$= C_2 \sigma^2 \sigma$

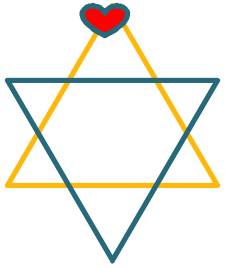
$= C_2 E \sigma = C_2 \sigma = i$

S_6^4

$C_6^4 \sigma_h^4$

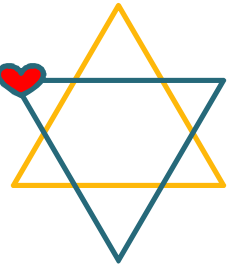


S_6^5



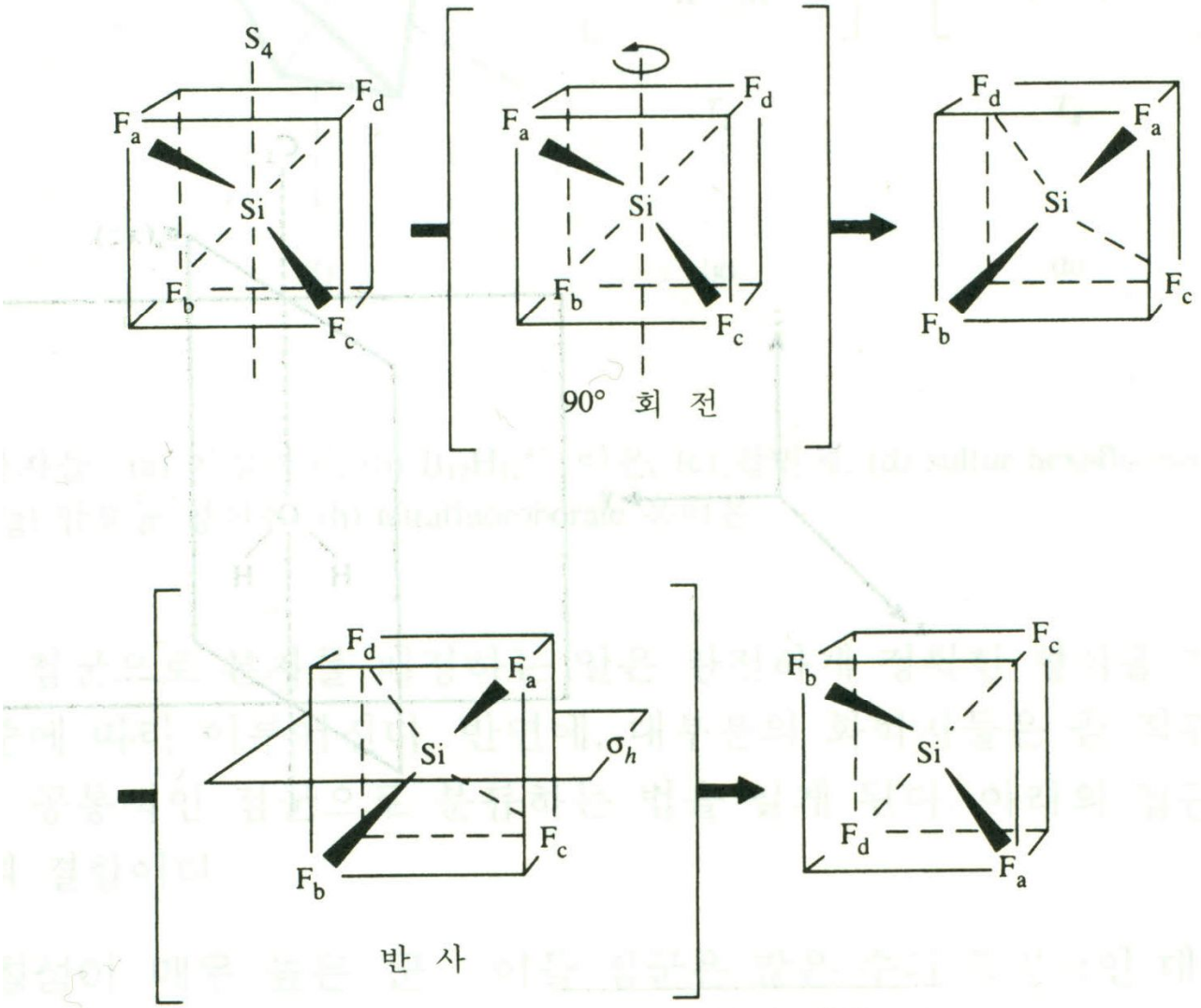
S_6^6

$= E$



$= C_3^2 E^2$

$= C_3^2$



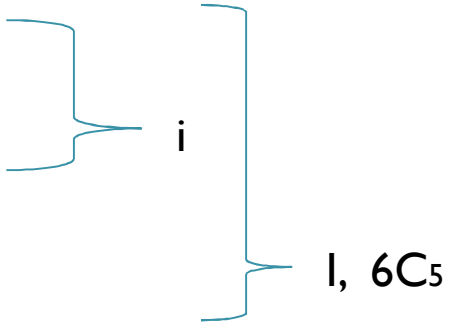
S4

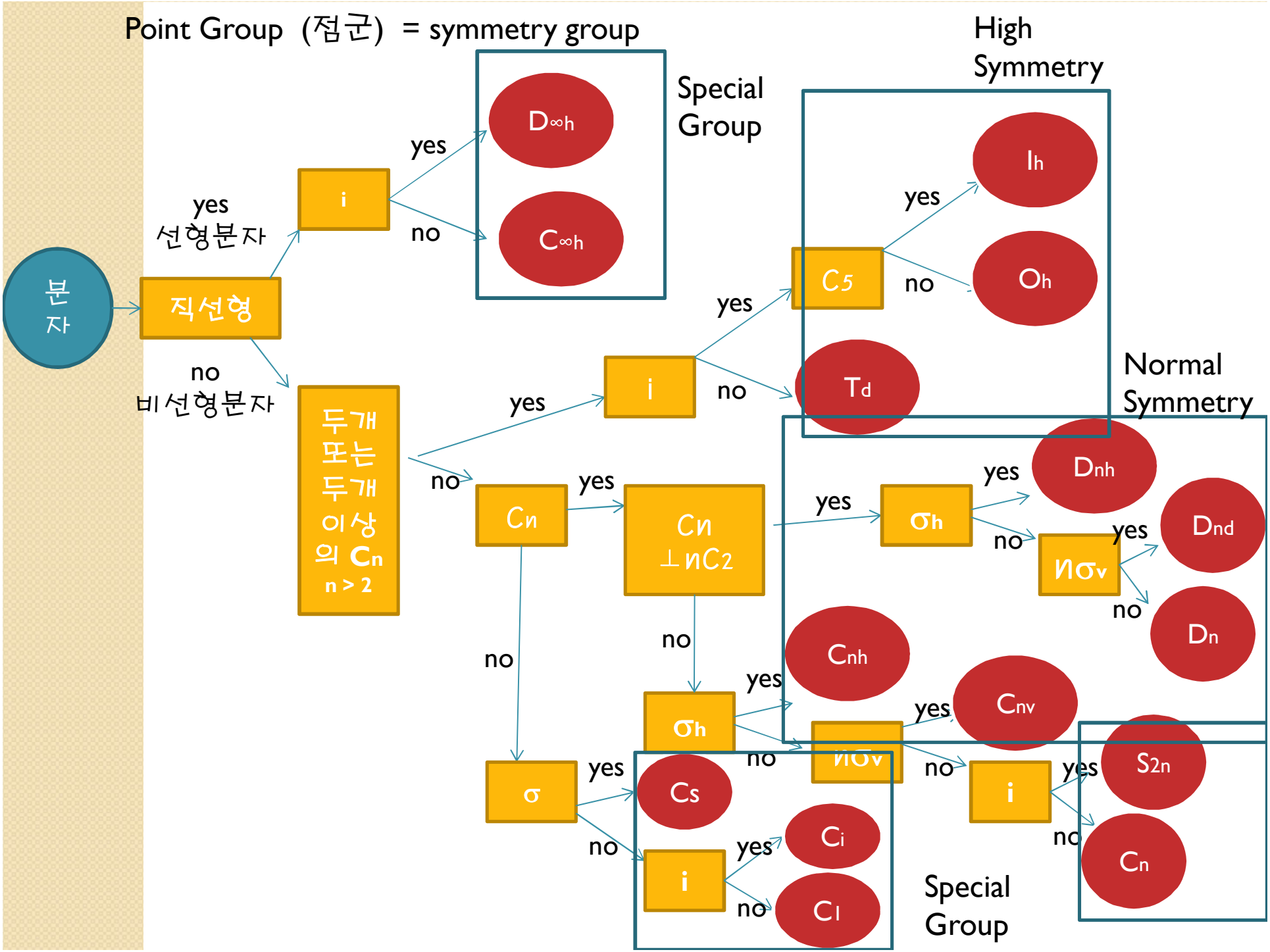
대칭성이 매우 높은 군

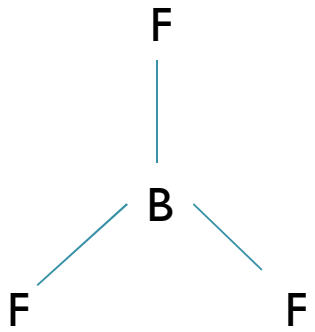
정사면체, T_d

정팔면체, O_h

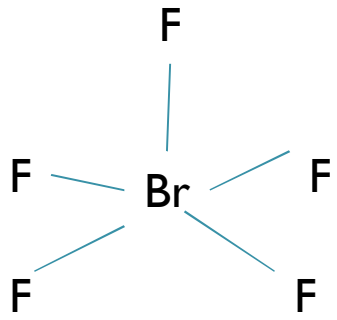
정이십면체, I_h



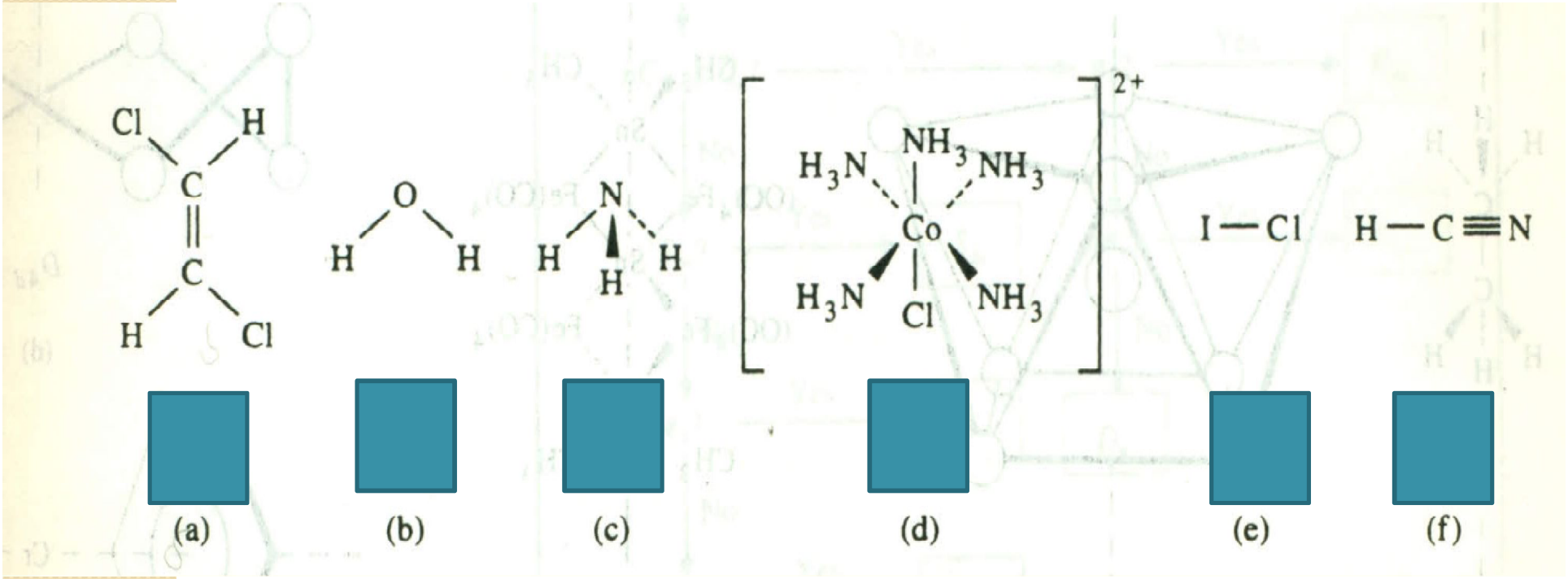

Point Group (점군) = symmetry group
분자
직선형
yes
선형분자
no
비선형분자
i
yes
no
D∞h
C∞h
Special Group
두개 또는 두개 이상의 Cn
n > 2
yes
i
yes
no
High Symmetry
Ih
Oh
C5
yes
no
Td
Normal Symmetry
no
Cn
yes
Cn ⊥nC2
yes
σh
yes
Dnh
no
nσv
yes
Dnd
no
Dn
no
σh
yes
Cnh
yes
Cnv
nσv
no
σ
yes
Cs
no
i
yes
Ci
no
Cl
Special Group
no
i
yes
S2n
no
Cn



D_{3h}



C_{4v}


Cl
H
C
C
H
Cl
O
H
H
N
H
H
H
2+
NH_3
H_3N
NH_3
Co
H_3N
Cl
NH_3
I—Cl
H—C≡N
(a)
(b)
(c)
(d)
(e)
(f)

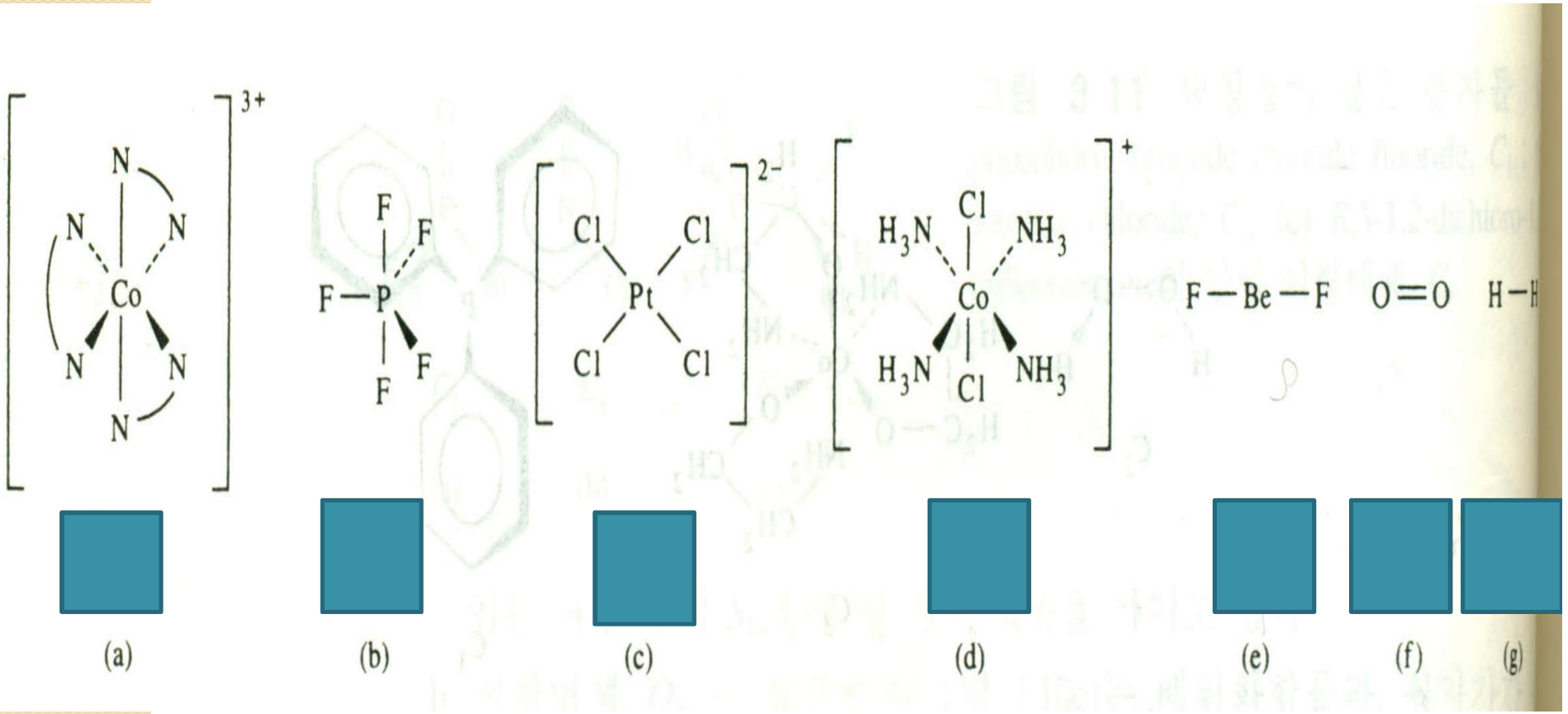
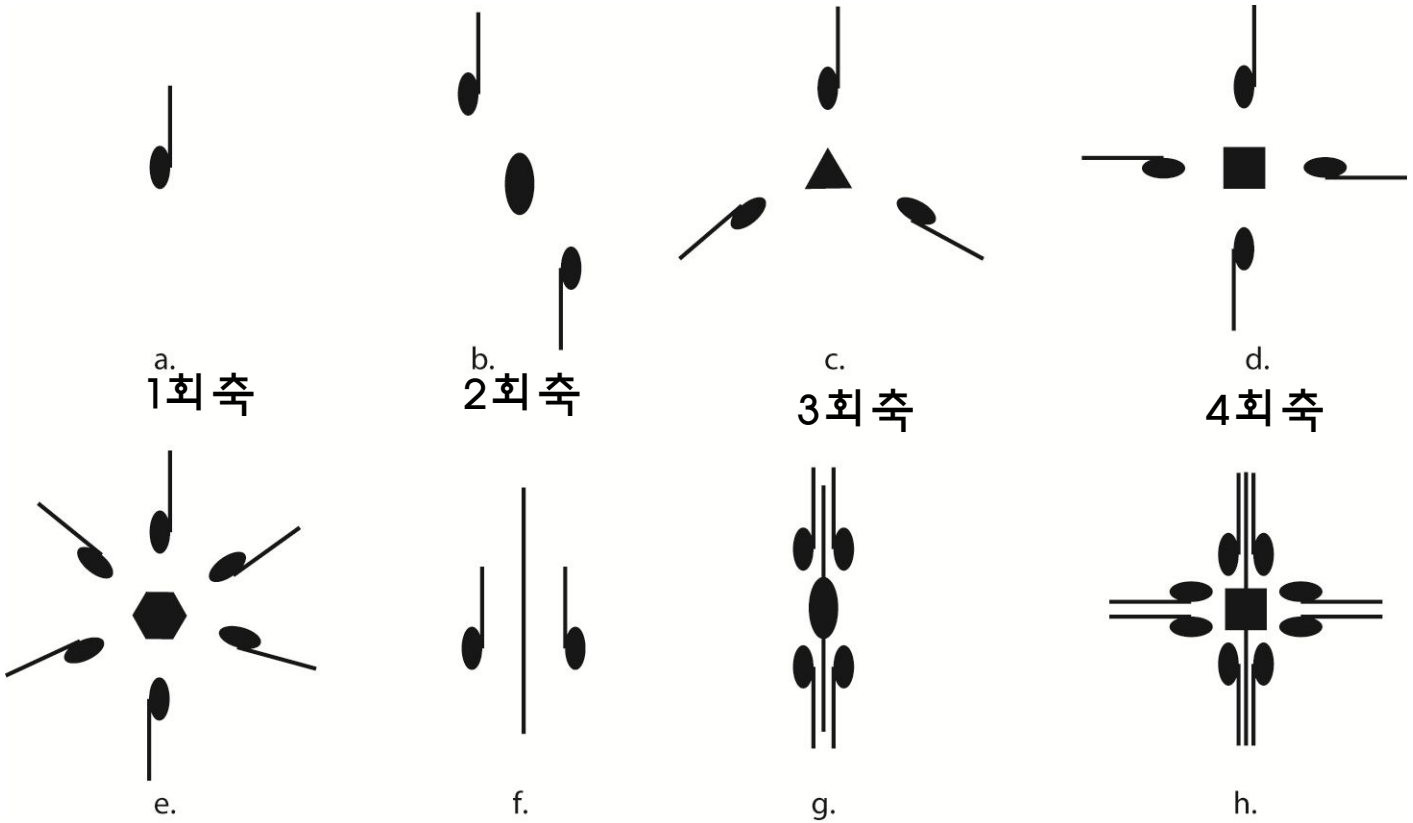

3+
N
N
N
Co
N
N
N
F
F
F
P
F
F
2-
Cl
Cl
Pt
Cl
Cl
+
Cl
H_3N
NH_3
Co
H_3N
NH_3
Cl
F—Be—F
O=O
H—H
(a)
(b)
(c)
(d)
(e)
(f)
(g)

그림2-9 결정학에서 대칭조작.
점군표기는 따옴표가 있다.



a. 1회축
b. 2회축
c. 3회축
d. 4회축
e. 6회축
f. 거울면 m
g. 거울더하기 2회축 2m
h. 거울더하기 4회축 4m