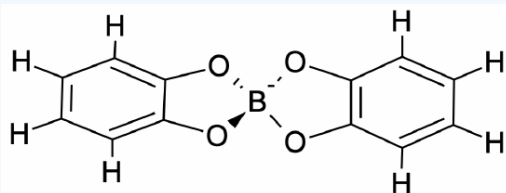
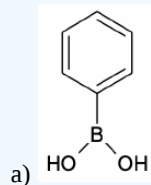


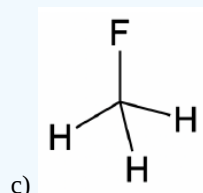
3.3: Unit 3 Practice Problems

Exercise 1

Determine all symmetry elements and all unique symmetry operations of the following molecules:

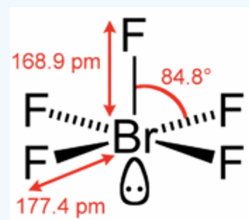


Note: The boron is tetrahedrally coordinated by O.

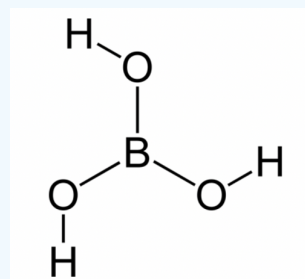


d) ethane (staggered conformation)

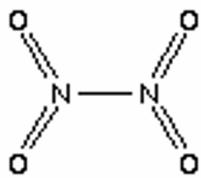
e) bromine tetrafluoride



f) Boric acid



g) Dinitrogen tetroxide



h) PtCl_4^{2-} (square planar)

i) bromobenzene

j) SF_4

k) ClF_3

l) CO_2

m) benzene

Answer

Elements: $E, C_2, \sigma_v, \sigma_v'$

a) Operations: $E, C_2, \sigma_v, \sigma_v'$

Elements: $E, S_4, C_2, 2\sigma_v$

b) Operations: $E, S_4^1, S_4^3, C_2, 2\sigma_v$

Elements: $E, C_3, 3\sigma_v$

c) Operations: $E, C_3^1, C_3^2, 3\sigma_v$

Elements: $E, C_3, 3 C_2, i, S_3, 3\sigma_d$

d) Operations: $E, C_3^1, C_3^2, i, 3 C_2^1, S_6^1, S_6^5, 3\sigma_d$

Elements: $E, C_4, C_2, 2 \sigma_v, 2 \sigma_v'$

e) Operations: $E, C_4^1, C_4^3, C_2^1, 2\sigma_v, 2 \sigma_v'$

Elements: E, C_3, σ_h, S_3

f) Operations: $E, C_3^1, C_3^2, \sigma_h, S_3^1, S_3^5$

Elements: $E, C_2, C_2', C_2'', i, \sigma_h, 2\sigma_v$

g) Operations: $E, C_2^1, C_2'^1, C_2''^1, i, \sigma_h, 2\sigma_v$

Elements: $E, C_4, C_2, 2C_2', 2C_2'', i, S_4, \sigma_h, 2\sigma_v, 2\sigma_d$

h) Operations: $E, C_4^1, C_4^3, C_2^1, 2C_2'^1, 2 C_2''^1, i, S_4^1, S_4^3, \sigma_h, 2\sigma_v, 2\sigma_d$

Elements: $E, C_2, \sigma_v, \sigma_v'$

i) Operations: $E, C_2^1, \sigma_v, \sigma_v'$

Elements: $E, C_2, \sigma_v, \sigma_v'$

j) Operations: $E, C_2^1, \sigma_v, \sigma_v'$

Elements: $E, C_2, \sigma_v, \sigma_v'$

k) Operations: $E, C_2^1, \sigma_v, \sigma_v'$

Elements: $E, C_\infty, \infty C_2, \infty \sigma_v, \sigma_h, S_\infty, i$

l) Operations: $E, \infty C_\infty, \infty C_{2\perp}, \infty \sigma_v, \sigma_h, \infty S_\infty, i$

Elements: $E, C_6, C_3, C_2, 6C_2', \sigma_h, 6\sigma_v, i, S_6, S_3$

m) Operations: $E, C_6^1, C_6^5, C_3^1, C_3^2, C_2^1, 6C_2'^1, \sigma_h, 6\sigma_v, i, S_6^1, S_6^5, S_3^1, S_3^5$

Exercise 2

When is a molecule chiral?

- a) It has no mirror planes
- b) It has no inversion center
- c) It has no principal axis
- d) It has no rotation reflections (improper rotations)

Answer

- d) It has no rotation reflections (improper rotations)

Exercise 3

If a molecule has a principal axis C_n , and n additional C_2 axes standing perpendicular to C_n then it belongs to

- a) A dihedral point group
- b) A rotational point group
- c) A low symmetry point group
- d) A high symmetry point group

Answer

- a) A dihedral point group

Exercise 4

Which of the following molecules are chiral:

- a) CH_4
- b) $CHCl_3$

- c) HCFCIBr
- d) HOF
- e) BHFCI

Answer

- c) HCFCIBr

Exercise 5

Determine the point groups of the molecules at symmetry.otterbein.edu/challenge/index.html until you feel that you can determine point groups effortlessly

Dr. Kai Landskron ([Lehigh University](#)). If you like this textbook, please consider to make a donation to support the author's research at Lehigh University: [Click Here to Donate](#).

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