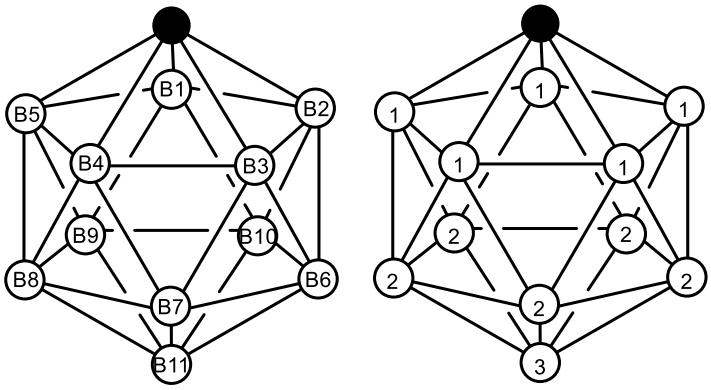
Ch112 Inorganic Chemistry
September 29, 2016
In-Class Problem A

Boranes, compounds of B and H, can exhibit a variety of structures. One interesting borane form is the dodecaborane dianion, $[B_{12}H_{12}]^{2-}$, which adopts an icosahedral structure. Replacement of one BH unit in $[B_{12}H_{12}]^{2-}$ with a CH moiety gives rise to a monoanion carborane $[B_{11}CH_{12}]^{-}$. On the left, each boron is given a unique label. On the right, symmetry equivalent borons are given identical numerical labels.



Using the eleven boron atoms as the basis set, fill out the transformation matrix for the C_5^2 operation (clockwise rotation).

0	0	1	0	0	0	0	0	0	0	0		B1	B3
0	0	0	1	0	0	0	0	0	0	0		B2	B4
0	0	0	0	1	0	0	0	0	0	0		B3	B5
1	0	0	0	0	0	0	0	0	0	0		B4	B1
0	1	0	0	0	0	0	0	0	0	0		B5	B2
0	0	0	0	0	0	0	1	0	0	0	•	B6	= B8
0	0	0	0	0	0	0	0	1	0	0		B7	B9
0	0	0	0	0	0	0	0	0	1	0		B8	B10
0	0	0	0	0	1	0	0	0	0	0		B9	B6
0	0	0	0	0	0	1	0	0	0	0		B10	B7
0	0	0	0	0	0	0	0	0	0	1		B11	B11

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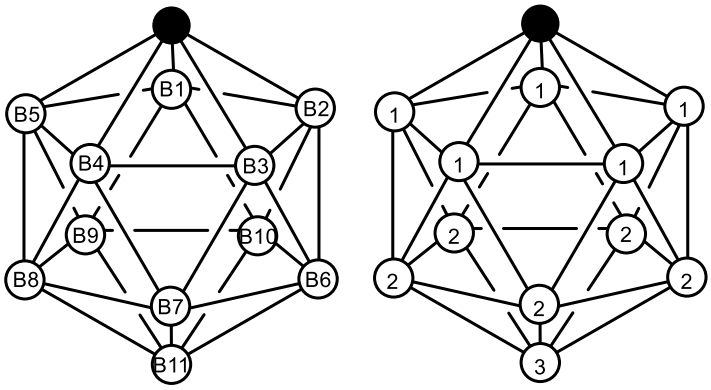
In-Class Problem B

Boranes, compounds of B and H, can exhibit a variety of structures. One interesting borane form is the dodecaborane dianion, $[B_{12}H_{12}]^{2-}$, which adopts an icosahedral structure. Replacement of one BH unit in $[B_{12}H_{12}]^{2-}$ with a CH moiety gives rise to a monoanion carborane $[B_{11}CH_{12}]^{-}$. On the left, each boron is given a unique label. On the right, symmetry equivalent borons are given identical numerical labels.



Using the eleven boron atoms as the basis set, fill out the transformation matrix for the σ_v operation through the plane perpendicular to the page.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} B1 \\ B2 \\ B3 \\ B4 \\ B5 \\ B6 \\ B7 \\ B8 \\ B9 \\ B10 \\ B11 \end{bmatrix} = \begin{bmatrix} B1 \\ B5 \\ B4 \\ B3 \\ B2 \\ B8 \\ B7 \\ B6 \\ B10 \\ B9 \\ B11 \end{bmatrix}$$

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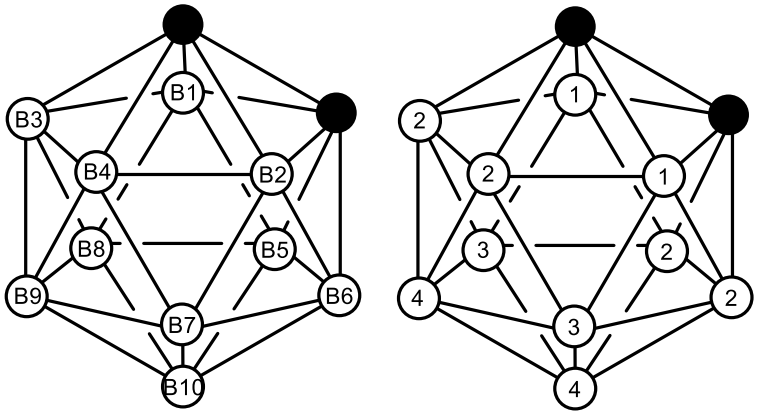
In-Class Problem C

Boranes, compounds of B and H, can exhibit a variety of structures. One interesting borane form is the dodecaborane dianion, $[B_{12}H_{12}]^{2-}$, which adopts an icosahedral structure. Replacement of two BH units in $[B_{12}H_{12}]^{2-}$ with CH moieties gives rise to neutral compounds called carboranes $[B_{10}C_2H_{12}]$.

The *ortho* isomer is shown below. On the left, each boron is given a unique label. On the right, symmetry equivalent borons are given identical numerical labels.



Using the ten boron atoms as the basis set, fill out the transformation matrix for the C_2 operation.

$$\begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} B1 \\ B2 \\ B3 \\ B4 \\ B5 \\ B6 \\ B7 \\ B8 \\ B9 \\ B10 \end{bmatrix} = \begin{bmatrix} B2 \\ B1 \\ B6 \\ B5 \\ B4 \\ B3 \\ B8 \\ B7 \\ B10 \\ B9 \end{bmatrix}$$

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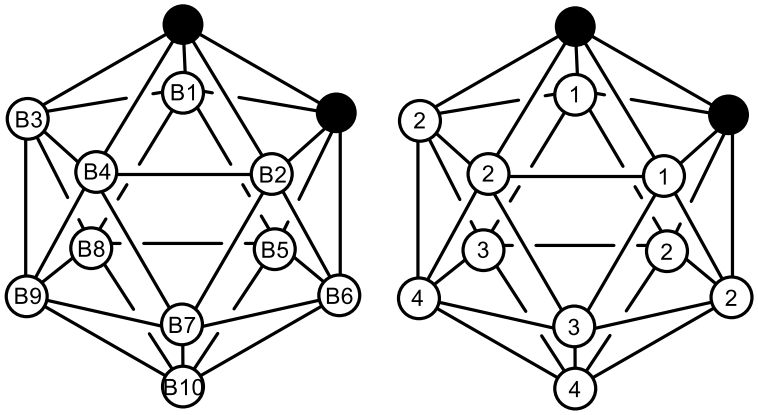
In-Class Problem D

Boranes, compounds of B and H, can exhibit a variety of structures. One interesting borane form is the dodecaborane dianion, $[B_{12}H_{12}]^{2-}$, which adopts an icosahedral structure. Replacement of two BH units in $[B_{12}H_{12}]^{2-}$ with CH moieties gives rise to neutral compounds called carboranes $[B_{10}C_2H_{12}]$.

The *ortho* isomer is shown below. On the left, each boron is given a unique label. On the right, symmetry equivalent borons are given identical numerical labels.



Using the ten boron atoms as the basis set, fill out the transformation matrix for the σ_v operation through the plane containing both carbon atoms.

$$\begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} B1 \\ B2 \\ B3 \\ B4 \\ B5 \\ B6 \\ B7 \\ B8 \\ B9 \\ B10 \end{bmatrix} = \begin{bmatrix} B2 \\ B1 \\ B4 \\ B3 \\ B6 \\ B5 \\ B8 \\ B7 \\ B9 \\ B10 \end{bmatrix}$$