Boranes, compounds of B and H, can exhibit a variety of structures. One interesting borane form is the dodecaborane dianion, \([\text{B}_{12}\text{H}_{12}]^{2-}\), which adopts an icosahedral structure. Replacement of one BH unit in \([\text{B}_{12}\text{H}_{12}]^{2-}\) with a CH moiety gives rise to a monoanion carborane \([\text{B}_{11}\text{CH}_{12}]^{-}\). 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).
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Using the eleven boron atoms as the basis set, fill out the transformation matrix for the $\sigma_v$ operation through the plane perpendicular to the page.
Boranes, compounds of B and H, can exhibit a variety of structures. One interesting borane form is the dodecaborane dianion, \([\text{B}_{12}\text{H}_{12}]^{2-}\), which adopts an icosahedral structure. Replacement of two BH units in \([\text{B}_{12}\text{H}_{12}]^{2-}\) with CH moieties gives rise to neutral compounds called carboranes \([\text{B}_{10}\text{C}_{2}\text{H}_{12}]\).

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

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 \(\sigma_v\) operation through the plane containing both carbon atoms.

\[
\begin{array}{cccccc}
B1 & B2 & B3 & B4 & B5 & B6 \\
B7 & B8 & B9 & B10 & & \\
\end{array}
\]