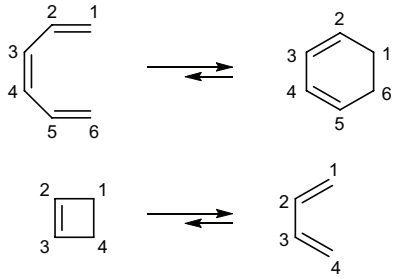
Activity 2 Stereochemistry of Electrocyclic Reactions

Focus Question

What is the correlation between the stereochemistry of, and number of electrons involved in, an electrocyclic reaction?

Model 1

Examples of Electrocyclic Reactions



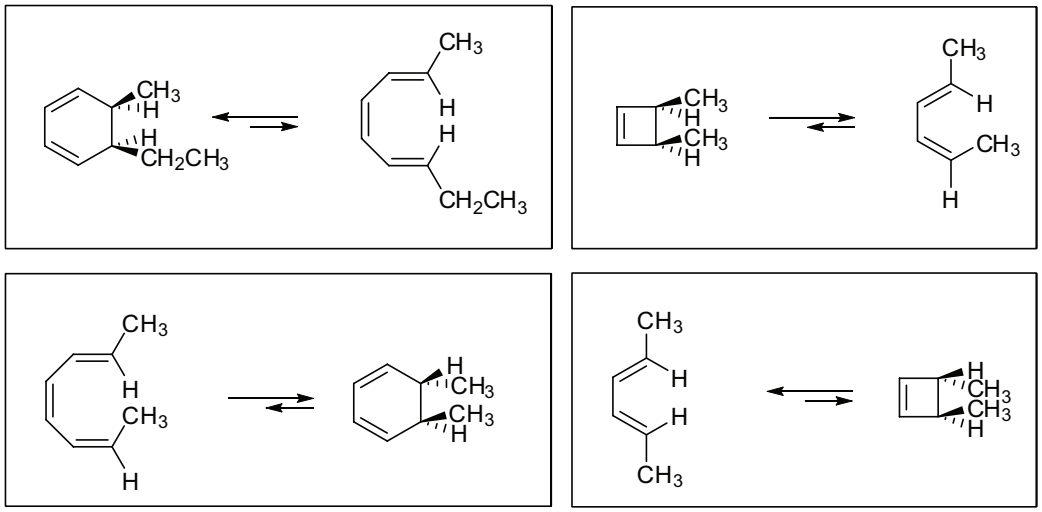
1. Pericyclic reactions are reactions that are concerted (reactions that take place in one step) and go through a cyclic transition state. Electrocyclic reactions are one type of pericyclic reactions. Use curved arrows to show the mechanism for each of the electrocyclic reactions in Model 1.

2. Label the two carbons in the reactant and in the product in each reaction that are involved in the reacting σ bond (the σ bond that is being either formed or broken).

Model 2

Stereochemistry of Electrocyclic Reactions

Electrocyclic reactions can be ring closures or ring openings. During the course of an electrocyclic reaction, both carbons involved in the reacting σ bond must rotate.

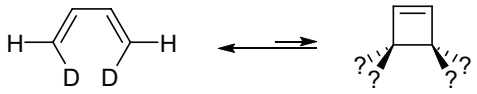


3. Label each forward reaction above as *ring openings* or *ring closures*.

4. Use curved arrows to show electron flow for each reaction.

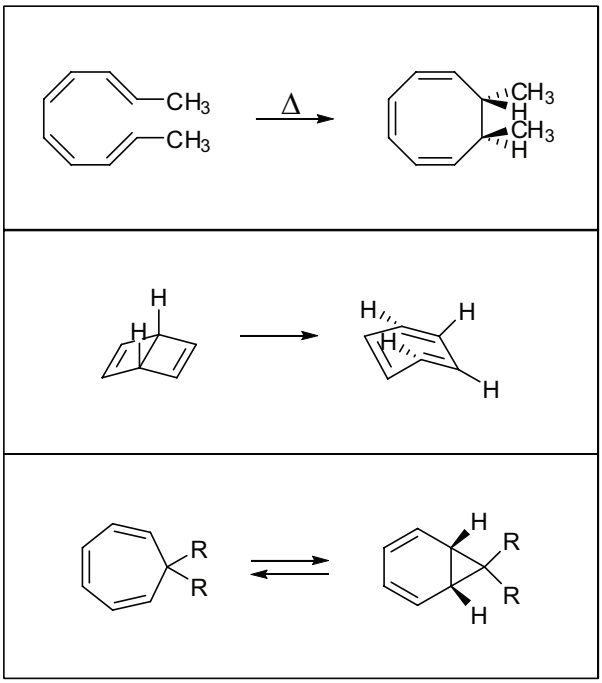
5. Indicate the carbons in each reactant and each product that are involved in the reacting σ bond.

6. Based on the stereochemistry of the product, determine for each of the carbons you labeled in question 4 the type of rotation occurring in the reaction, *clockwise* or *counterclockwise*.
7. Electrocyclic reactions in which both reacting carbons rotate in the same direction (either both clockwise or both counterclockwise, are called conrotatory reactions. Those reactions in which both reacting carbons rotate in different directions (one clockwise and one counterclockwise) are called disrotatory reactions. Label each reaction in Model 2 as *conrotatory* or *disrotatory*.
8. If the following reaction occurs in a disrotatory manner, predict the relative stereochemistry of the product.



Model 3

Predicting Stereochemistry



9. Use curved arrows to show electron flow for each reaction.
10. From the given products above, label each of the carbons in the reacting σ bond as rotating *clockwise* or *counterclockwise*.
11. Determine for each of the above reactions whether it proceeds in a *conrotatory* or *disrotatory* manner.
12. For all of the reactions in Model 2 and Model 3, indicate the number of electrons moving in the reaction.
13. Considering the reactions in Model 2 and Model 3, is there a correlation between the type of process (conrotatory or disrotatory) and the number of elections involved in the reaction? If so, what is it?

14. Using the Hückel number, propose a general rule for determining whether an electrocyclic reaction will occur via a conrotatory or disrotatory process. This is one of the Woodward-Hoffman rules—rules that were originally recognized by Robert B. Woodward and Roald Hoffman.