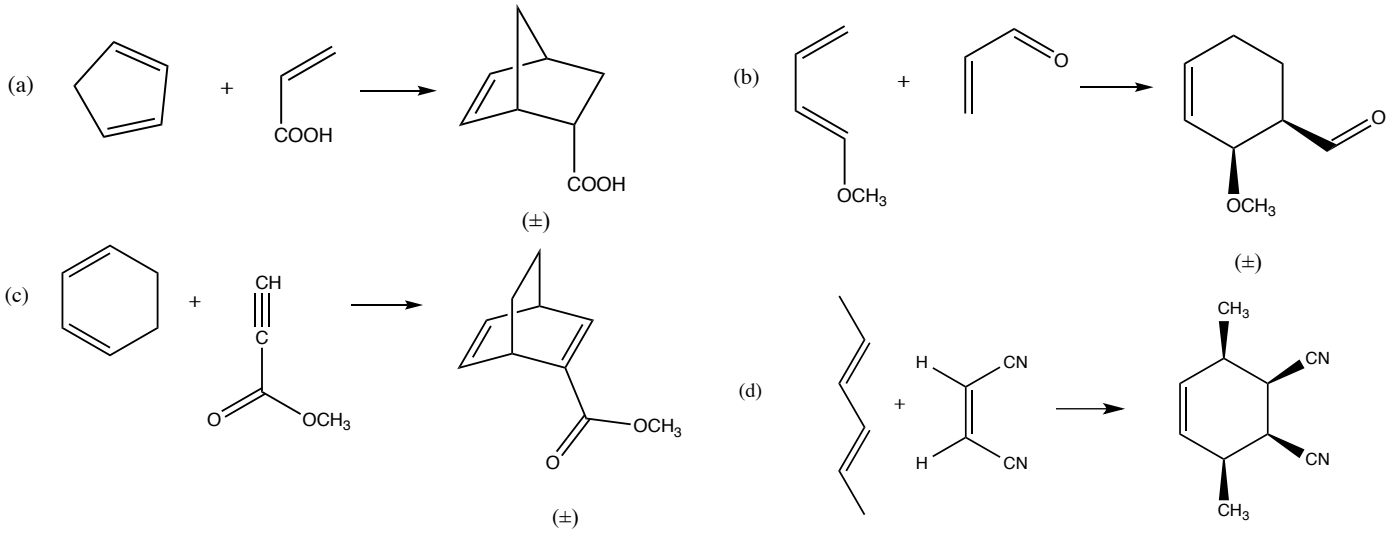
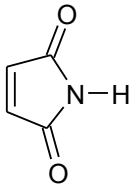
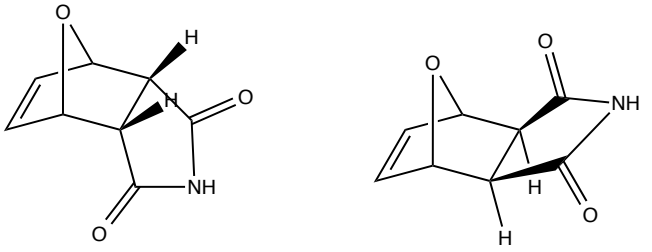
Practice Problems on Diels-Alder Reactions – **Answers**

1. Predict the product of the following Diels-Alder reactions; under kinetic control. Include the stereochemistry where appropriate.



2. Furan and maleimide, shown below, react to produce and adduct via a Diels-Alder reaction. At 25°C the isomer produced is the *endo* product, however at 90°C the *exo* isomer predominates. Additional studies have shown that at 90°C the equilibrium between the *endo* and *exo* products favors the *exo* isomer.

   a) Draw each isomeric product, *endo* and *exo*. furan:  maleimide: 



endo exo

   b) Which isomer would you expect to usually form in this reaction? Why is that isomer usually preferred?

The *endo* product is the preferred outcome of the Diels-Alder reaction under kinetic control. The transition state to the *endo* product has lower activation energy than transition state of the *exo* product.

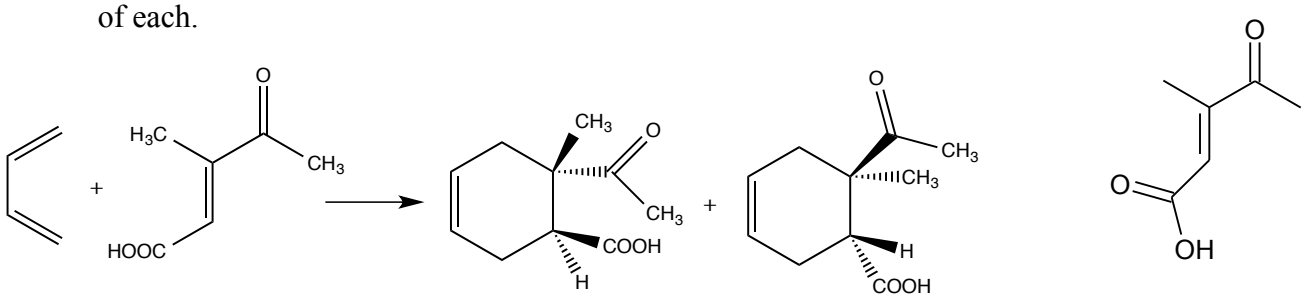
   c) Is your answer to question 4(b) dependent on a kinetically or thermodynamically controlled reaction?

Yes. Each of the conditions is dependent on different aspects of a chemical reaction. While in kinetically controlled conditions the products formed depend on the difference in activation energy; thermodynamic conditions depend on the energy difference of the products.

d) Explain why the *endo* isomer predominates when the reaction takes place at 25°C and why the *exo* isomer at 90°C.

The reaction at 25°C is under kinetic control, therefore the product whose transition state activation energy is lower will be the predominant which in this case is the *endo* product.

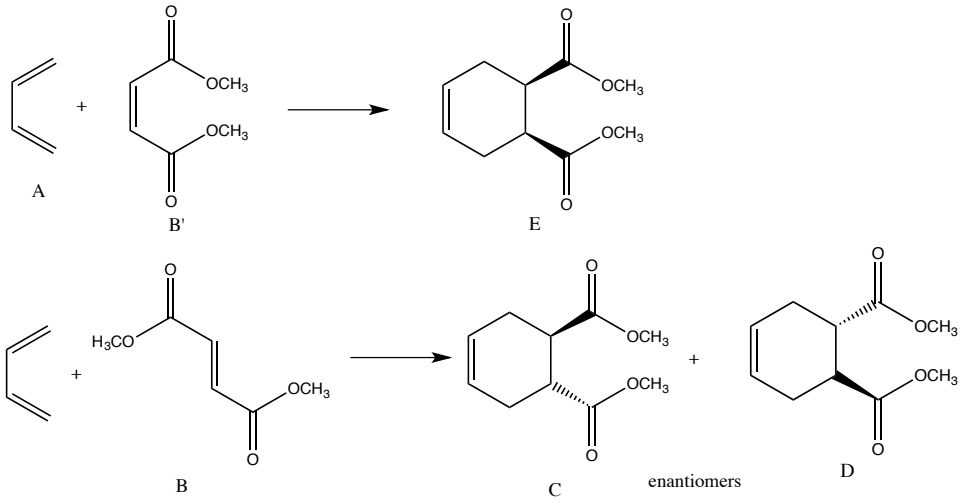
3. When 1,3-butadiene reacts with compound **D** two products are formed. Draw the structures of each.



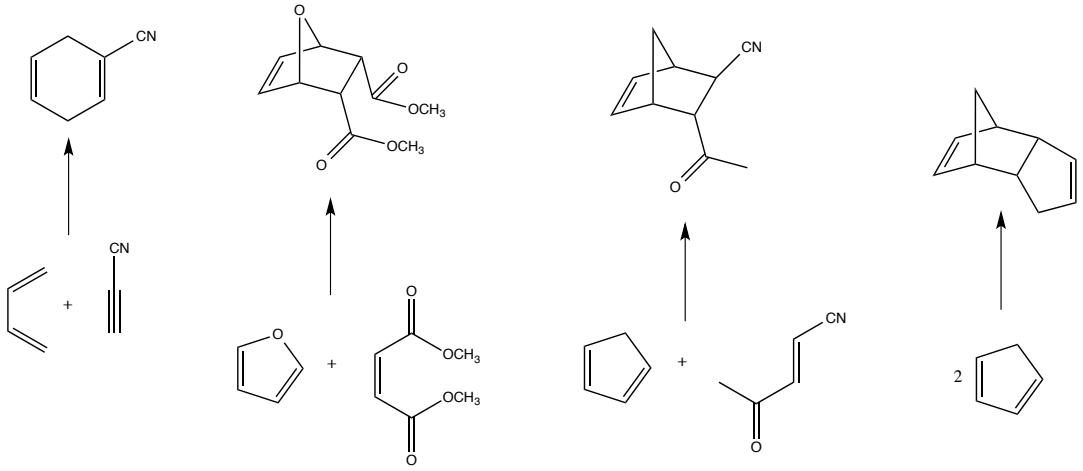
enantiomers

D

4.Compound **A**, C_4H_6, reacts with one of the diastereomers, **B**, of $CH_3O_2CCH{=}CHCO_2CH_3$ to form 2 enantiomeric products, **C** & **D**. On the other hand when B' (the other diastereomer) reacts with A only one product is formed, **E**. Determine the identity of compounds **A** through **E**.



5. Which diene and dienophile could be used in the synthesis of each of the following.



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