Week 7 Worksheet

1. Consider the Newman projections (A-D) for four-carbon carbohydrates. How is each pair of compounds related: (a) A and B; (b) A and C; (c) A and D; (d) C and D? Choose from identical molecules, enantiomers, or diastereomers.

ANSWER:

a. A and B are identical.
b. A and C are enantiomers

c. A and D are diastereomers.
d. C and D are diastereomers.
2. How is each compound (B-D) related to A? Choose from enantiomers, diastereomers, identical molecules, constitutional isomers, or not isomers of each other.

![Chemical structures of A, B, C, and D](image)

**ANSWER:**

![Chemical structures of A, B, C, D with labels](image)

3. Consider the following energy diagram mechanism for the conversion of A to G.

**ANSWER:**

A. Which points on the graph correspond to transition states?
   Points B, D, and F correspond to transition states. Periods of high energy, the activation energy reaches a peak transition state in order to catalyze the formation of the reactive intermediates and/or final product.

B. Which points on the graph correspond to reactive intermediates?
   Points C and E correspond to reactive intermediates.

C. How many steps are present in the reaction mechanism?
There are three steps present - one from A to C, one from C to E, and one from E to G.

D. Label each step of the mechanism as endothermic or exothermic
   Step 1, from reactant A to reactive intermediate C, is endothermic, as the intermediate product C has an energy greater than that of A.

   Step 2, from reactive intermediate C to reactive intermediate E, is exothermic, as reactive intermediate E has a slightly lower energy than C.

   Step 3, from reactive intermediate E to final product G, is exothermic, as it has a lower energy than intermediate E.

E. Label the overall reaction as endothermic or exothermic
   Overall reaction is exothermic, as starting energy of reactant A is greater than the final energy of product G, indicating a release of energy.

(Smith 6th Ed., Ch. 6, #45)

4. The following is a concerted, bimolecular reaction: CH₃Br + NaCN → CH₃CN + NaBr

ANSWER:

A. What is the rate equation for this reaction?
   Rate = k[CH₃Br][NaCN]

B. What happens to the rate of the reaction if [CH₃Br] is doubled?
   The rate would double

C. What happens to the rate of the reaction if [NaCN] is halved?
   The rate would be halved

D. What happens to the rate of the reaction if [CH₃Br] and [NaCN] both increased by a factor of five?
   The rate would increase by a factor of 25

(Smith 6th Ed., Ch. 6, #48)

5. Consider the conversion of alkyl halide A to ether B
A. Classify the conversion of A to B as substitution, elimination, or addition.
B. The reaction rate depends on the concentration of A alone. Write the rate equation for the reaction, and explain why the reaction mechanism must involve more than one step.
C. Heterolysis of the polar bond in A forms a resonance-stabilized intermediate. Draw all reasonable resonance structures for this intermediate.

(Smith 6th Ed., Ch. 6, #51)

**ANSWER:**

A. Conversion of A to B is a substitution reaction, as the Br is substituted by the CH₃OH
B. Rate = k[CH₇H₇Br] Since one of the reactants appears in the product but not the rate equation itself, this reactant cannot be part of the rate-determining step, so this reaction must have more than one step.

C.

6. The Diels-Alder reaction, a powerful reaction discussed in Chem 51B, occurs when a 1,3-diene such as A reacts with an alkene such as B to form the six-membered ring in C.

a. Draw curved arrows to show how A and B react to form C.
b. What bonds are broken and formed in this reaction?
c. Would you expect this reaction to be endothermic or exothermic?
d. Does entropy favor the reactants or products?
e. Is the Diels-Alder reaction a substitution, elimination, or addition?

(Smith 6th Ed., Ch. 6, #53)

**ANSWER:**

b. Two p bonds in A are broken and one p bond in B is broken. Two new s bonds in C are formed (in bold), as well as a new p bond.
c. The reaction should be exothermic because more energy is released in forming two new C–C s bonds than is required to break two C–C p bonds.
d. Entropy favors the reactants for two reasons. There are two molecules of reactant and only one product. The reactants are both acyclic and the product has a ring with fewer degrees of freedom.
e. The Diels–Alder reaction is an addition reaction because p bonds are broken and new s bonds are formed.