This test consists of a combination of multiple choice and other questions. There should be a total of 17 questions on six pages; please check now to make sure that they are all here. Do not use your own tables, scratch paper or other information. Please turn off all cell phones, pagers and other communication devices; they will be confiscated if they make noise. No food. No water. No gum. No bathroom breaks. No templates. You may use models as follows: four carbons, ten other atoms (may include carbons) and enough bonds to connect them. No calculators. The test will end two hours after it starts. An information sheet will be handed out separately.

Multiple Choice Questions
These 11 questions are worth 4 points each, for a total of 44 points. Unless it is stated otherwise in a given problem, there is only one correct answer for each question. Answer each question by circling all letter(s) corresponding to the correct choice(s); in other words, if more than one answer is correct, you should circle all of the correct ones. It is not necessary to show work for these questions; however, you may write on the exam.

1. Which of the following is expected to react the fastest in an S_N2 reaction with NaSCH_3?
   a.  
   b.  
   c.  
   d.  
   e. it is impossible to tell

2. Which of the following is expected to react the fastest in an S_N1 reaction with CH_3OH?
   a.  
   b.  
   c.  
   d.  
   e. it is impossible to tell

3. Which of the following cases correspond to a reaction whose equilibrium will certainly favor reactants over products. More than one answer may be correct.
   a. A reaction with ΔG = +43 kJ
   b. An exothermic reaction
   c. A reaction with K = 1.8 × 10^{-5}
   d. An endothermic reaction with a negative ΔS
   e. None of them.

4. Which of the following is/are in the S configuration? More than one may be.
   a.  
   b.  
   c.  
   d.  
   e. None of them.
5. Which of the following is/are meso? More than one may be.

- a. 
- b. 
- c. 
- d. 
- e. None of them.

6. Which of the following is/are optically active (chiral)? More than one may be.

- a. 
- b. 
- c. 
- d. 
- e. None of them.

7. Which of the following is/are true about a reaction that has the reaction coordinate diagram drawn below? More than one may be.

- a. The reaction has two steps
- b. The second step is the rate-determining step.
- c. The transition state of the first step more closely resembles the reactant than the intermediate.
- d. The transition state of the second step more closely resembles the intermediate than the product.
- e. None of the above (a-d) is true.

8. Which of the following alkenes is expected to be the least stable?

- a. 
- b. 
- c. 
- d. 
- e. 

9. For which of the following substrates is an $S_{N}1$ reaction with CH$_3$OH likely to involve carbocation rearrangement? More than one answer may be correct.

- a. 
- b. 
- c. 
- d. 
- e. None of them.

10. Which species is acting as the nucleophile in the reaction below?

- a. The alcohol
- b. The CF$_3$SO$_2$Cl
- c. Neither, because it’s not that kind of reaction.
11. Which of the following reactions will produce a racemic mixture. Solvents that are not also nucleophiles are written under the reaction arrow. If there is nothing written under the reaction arrow then the nucleophile is also the solvent. More than one answer may be correct.

- a. 
- b. 
- c. 
- d. 
- e. None of them

**Other Questions**

Each of the following questions is worth the indicated number of points, for a total of 76 points. Please be sure to provide all of the information requested for each question.

12. **8 points** Provide names for each structure, using one of the naming systems discussed in class. Include E-Z and/or R-S designations if appropriate. Please write the names on the lines provided and the structure below its name.

- a. 
- b. 

13. **4 points** Draw the structure of \((1R,3R)-1\text{-bromo-3-chlorocyclopentane}\)
14. 24 points Indicate the relationship between each of the following pairs of compounds as one of the following: constitutional isomers (CI), enantiomers (E), unrelated (U), diastereomers (D), or identical as far as can be determined from the structures, including conformations (ID). Write your answers on the line to the left of each rectangle.

a. _______

b. _______

c. _______

d. _______

e. _______

f. _______
15. 16 points Draw the structure(s) of the major organic product(s) formed in each of the following reactions.

a. \( \text{Br} \) \( \text{NaCN} \) DMSO

b. \( \text{OH} \) \( \text{SO}_2\text{Cl} \) pyridine

c. \( \text{O} \) \( \text{CH}_3\text{I} \) DMSO

d. \( \text{OH} \) \( \text{HBr} \)

16. 8 points Provide the structures of the reagents (suitable combination of an alkyl halide and a nucleophile) to complete each of the following reaction equations.

a. \( \rightarrow \text{OH} \)

b. \( \rightarrow \text{OH} \)
17. 16 points Write a mechanism to show the formation of the organic product in each of the following reactions. Include curved arrows to show electron movement.

a. \[ \text{HO} + \text{H}_2\text{O} \rightarrow \text{H} + \text{H}_2\text{O} \]

b. \[ \text{Br} + \text{OH} \rightarrow \text{OH} + \text{HBr} \]