Multiple Choice (Choose the one best answer for each of the following. Using a #2 pencil, record this answer on the scantron provided.)

1. Which one of the following groups has the highest priority?
   A. -CH(Br)CH₂CH₃   B. -CH₂CH=CH₂   C. -CH₃
   D. -CH₂CH(CH₃)₂   E. -CH₂CH₂CH₂CH₃

2. Which one of the following is the most stable carbocation?
   A.   B.   C.   D.   E. CH₃⁺

3. Which one of the carbocations shown below is MOST likely to undergo a 1,2-hydride shift?
   A.   B.   C.   D.   E. 

4. How many chirality centers in the molecule shown below? Be careful!
   A. zero
   B. one
   C. three
   D. four
   E. 

Which of the following compound(s) is/are chiral?
   A.   B.   C.   D.   E. Both B and C are chiral.
6. Which of the compound(s) in the preceding question is/are meso?

A. A       B. B       C. C
D. D       E. Both A and B.

7. Which one of the following compounds has the S configuration?

A.  
B.  
C.  
D.  
E. All but C are S configuration.

8. An organic molecule has five chirality centers. The maximum number of stereoisomers possible for this molecule is:  

\[ \text{Max } \# \text{ Stereoisomers} = 2^5 = 32 \]

A. five       B. ten       C. twenty
D. thirty two       E. sixty four

9. Diastereomers.....

A. are mirror images of each other. \( \checkmark \)
B. have an opposite R/S designation at every chirality center. \( \checkmark \)
C. have different boiling points and can be separated by distillation. \( \checkmark \)
D. are different constitutional isomers. \( \checkmark \)
E. can be interconverted by rotation about single bonds. \( \checkmark \)

10. The specific rotation and boiling point of (S)-2-iodobutane are +15.90° and 120°C, respectively. Which one of the following statements is TRUE?

A. The specific rotation of (R)-2-iodobutane is +31.80°. \( \checkmark \)
B. The specific rotation of a racemic mixture of (R)-2-iodobutane and (S)-2-iodobutane is 0°.
C. (S)-2-iodobutane is achiral \( \checkmark \)
D. (R)-2-iodobutane will have a different boiling point than (S)-2-iodobutane. \( \checkmark \)
E. (S)-2-iodobutane rotates light by +15.90° independent of concentration. \( \checkmark \)

11. What type of solvent is best for \( \text{SN}_1 \) reactions?

A. polar aprotic       B. nonpolar aprotic       C. nonpolar protic
D. polar protic       E. None of the above.
12. List the following compounds in order of decreasing S$_{1}$ reactivity. The correct order is:

A. I > III > IV > II  
B. II > IV > I > III  
C. III > I > II > IV  
D. IV > III > I > II  
E. IV > II > I > III

13. Homolysis of a C-H bond in cyclopentane (draw it!) would give:

A.  
B.  
C.  
D.  
E.  

14. An equilibrium mixture of t-butylcyclohexane contains the two conformational isomers shown. Since at 25°C $\Delta G^\circ = -20.5$ kJ/mol for interconversion between conformations, the numerical value of $K_{eq}$ for this process is ______ and the ______ conformation is favored at equilibrium.

A. 3920; axial  
B. 0.000255; axial  
C. 3920; equatorial  
D. 0.000255; equatorial  
E. 682; neither
15. Which one of the following is an elimination reaction?

A. \( \text{H}_2\text{C}=\text{CH}_2 + \text{HBr} \rightarrow \text{H}_{\text{Br}\text{odded}} \rightarrow \text{Addn. Substituted for Br}^- \)

B. \( \text{Br}^- \text{Br}^- + \text{NaCCCH}_3 \rightarrow \text{Substitution} \)

C. \( \text{OH}^- + \text{NaNH}_2 \rightarrow \text{Acid Base Rxn} \)

D. \( 2 \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 + 13 \text{O}_2 \rightarrow 8 \text{CO}_2 + 10 \text{H}_2\text{O} \rightarrow \text{Combustion or redux rxn.} \)

E. \( \text{HBr eliminated} + \pi \text{bond formed} \)
Partial Credit (Fill out the remaining questions on the exam itself. Show all work, provide complete explanations, and circle the answer(s) to be graded.)

16. Give a structure (line or structural) for each of the following compounds. Show cis/trans or R/S stereochemistry (3-D directionality) where appropriate.

A. \( \text{vinyl chloride} \)

B. \( \text{(3R)-3-methylhexane} \)

C. \( \text{(2S)-2-bromo-2-chloropentane} \)

17. Give a correct IUPAC name for each of the following structures.

A. \( \text{IUPAC Name: (3S)-3-chlorohexane} \)

B. \( \text{IUPAC Name: (2R)-2-bromo-butane} \)

C. \( \text{IUPAC Name: (1R,2R)-1,2-dichlorocyclobutane} \)

D. \( \text{IUPAC Name: (4R)-2,4,4-trimethylheptane} \)
18. Circle which one of each of the following pairs will proceed faster by an S_N2 mechanism. If both proceed at the same rate, circle both.

A. 1-bromo-1-methylecyclohexane + H_2S vs. bromocyclohexane + H_2S  \(_{2}^{1}\) > \(_{2}^{3}\)
B. CH\(_3\)CH\(_2\)Br + NaSH vs. CH\(_3\)CH\(_2\)I + NaSH  I -> Br^- As C-I strength ↑ S_N2 Rate ↑
C. bromocyclohexane + NaOCH\(_3\) vs. bromocyclohexane + HOCH\(_3\)  As Na strength ↑ Rate ↑
D. CH\(_3\)CH\(_2\)Br + NaSCH\(_3\) (polar protic solvent) vs. CH\(_3\)CH\(_2\)I + NaSCH\(_3\) (polar aprotic solvent)  Optics solvent increases Na strength
E. CH\(_3\)CH\(_2\)Br + NaSCH\(_3\) vs. (CH\(_3\))\(_3\)CCH\(_2\)Br + NaSCH\(_3\)  1° hindered (inhibi)

19. Circle which one of each of the following pairs will proceed faster by an S_N1 mechanism. If both proceed at the same rate, circle both.

A. bromocyclohexane + HOCH\(_3\) (polar protic solvent) vs. bromocyclohexane + HOCH\(_3\) (non-polar solvent)  S_N1 3° > 2° > 1°
B. CH\(_3\)CH(1)CH\(_3\) + H\(_2\)O vs. CH\(_3\)CH(1)CH\(_3\) + NaOH  S_N1 No dependence on Na strength.
C. high conc. (CH\(_3\))\(_3\)C-I + NH\(_3\) vs. low conc. (CH\(_3\))\(_3\)C-I + NH\(_3\)
D. CH\(_3\)CH(1)CH\(_3\) + H\(_2\)O vs. (CH\(_3\))\(_3\)C-Cl + H\(_2\)O

20. Given the reaction profile shown below, determine the following.

A. How many elementary steps are involved in the overall reaction? 2
B. How many transition state species are involved in the overall reaction? 2
C. How many intermediates are involved in this reaction? 1
D. Is the overall reaction exothermic or endothermic? Endothermic
E. Which step is the slow step (first, second, third, fourth step)? This step has the highest activation energy.
21. Specify the mechanism type (S<sub>N</sub>1 or S<sub>N</sub>2) and show detailed step-by-step mechanisms for obtaining the given products. Give as much information as possible and be sure to show movement of electrons using curved arrows, positive or negative formal charges, intermediates, etc. For S<sub>N</sub>2 mechanisms, show the transition state species. Don't skip any steps in the mechanism.

A. 

B. 

C. 

Mechanism?
22. Consider the following pairs of compounds. Label how the compounds are related. Are they constitutional isomers, conformational isomers, diastereomers, enantiomers, or identical?

A. 

B. 

C. 

D. 

E. 

Relationship? **diastereomers**

Relationship? **constitutional isomers**

Relationship? **enantiomers**

Relationship? **identical**

Relationship? **conformational isomers**

These are identical except they are different conformations.