Test 2
Chemistry 21 – Dr. Kline
November 2, 2015

This test consists of a combination of multiple choice and other questions. There should be a total of 25 questions on seven 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: two carbons, six other atoms and enough bonds to connect them. No calculators. The test will end two hours and fifteen minutes after it starts. An information sheet will be handed out separately.

Multiple-Choice Questions
These 18 questions are worth 3 points each, for a total of 54 points. Unless it is stated otherwise in a given problem, there is only one correct answer for each question. Answer each question by bubbling in letter(s) corresponding to the correct choice(s) on the provided answer sheet. If more than one answer is correct, you should bubble all the correct ones. It is not necessary to show work for these questions; however, you may write on the exam. Note that said work will not be evaluated.

1. Which has the more stable chair structure? Compare the more stable chair structure of each compound; in other words, you are determining which has the more stable more stable chair conformation.

a. b. c. They are degenerate.

2. What is the relationship between the two structures in the box?

a. identical in all respects
b. different conformations of the same molecule
c. constitutional isomers
d. diastereomers
e. enantiomers

3. What is the relationship between the two structures in the box?

a. identical in all respects
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4. Which of the following statements is/are true of the process below? More than one answer may be correct.

a. K>1  b. ΔH>0  c. ΔG<0  d. none of them
5. What is the relationship between the two structures in the box?

\[
\begin{array}{c}
\text{CH}_3\text{CH}_3 \\
\text{H} & \text{Br} & \text{Br} & \text{Br} & \text{H} \\
\text{H} & \text{Br} & \text{Br} & \text{H} & \text{CH}_3 \\
\text{CH}_3 & & & & \\
\end{array}
\]

a. identical in all respects  
b. different conformations of the same molecule  
c. constitutional isomers  
d. diastereomers  
e. enantiomers

6. Which of the following compounds is/are meso? More than one answer may be correct.

\[
\begin{array}{c}
\text{Br} \\
\text{Br} \\
\end{array}
\]

a.  
b.  
c.  
d. none of them

7. Which of the following compounds is/are optically active? More than one answer may be correct.

\[
\begin{array}{c}
\text{CH}_3\text{OH} \\
\text{H} & \text{OH} & \text{OH} & \text{OH} \\
\text{H} & \text{OH} & \text{CH}_3 \\
\end{array}
\]

a.  
b.  
c.  
d. none of them

8. Which is expected to react the most slowly in a reaction with HBr?

\[
\begin{array}{c}
\text{OH} \\
\text{Cl} \\
\text{Br} \\
\text{F} \\
\end{array}
\]

a.  
b.  
c.  
d.  
e. impossible to tell

9. Which of the following is expected to react the fastest in a solvolysis reaction with ethanol (solvent and nucleophile)?

\[
\begin{array}{c}
\text{Br} \\
\text{Br} \\
\text{Br} \\
\text{Br} \\
\end{array}
\]

a.  
b.  
c.  
d.  
e. impossible to tell

10. Which of the following is expected to react the fastest with 1-bromohexane in acetone (solvent)?

\[
\begin{array}{c}
\text{F} \\
\equiv \Theta \\
\text{HS} \\
\text{I} \\
\text{HO} \\
\end{array}
\]

a.  
b.  
c.  
d.  
e.  

11. Which of the following is expected to react the most slowly with NaSH in DMSO (solvent).

\[
\begin{array}{c}
\text{Br} \\
\text{Br} \\
\text{Br} \\
\text{Br} \\
\end{array}
\]

a.  
b.  
c.  
d.  
e. impossible to tell
12. The reaction below produces, as the major product(s)...

\[ \text{NaSH} \quad \text{solvent = acetone} \]

- a. a pair of diastereomers
- b. a pair of enantiomers
- c. a single compound that is chiral
- d. a single compound that is achiral
- e. a pair of enantiomers and a meso compound

13. Which compound is the best match for the infrared spectrum below?

![Infrared Spectrum]

a. 

\( \text{H}_2\text{O} \) 

b. 

\( \text{C}_2\text{H}_5\text{OH} \) 

c. 

\( \text{C}_2\text{H}_4 \) 

d. 

\( \text{C}_2\text{H}_5\text{OH} \) 

e. 

\( \text{H}_2\text{N} - \text{C}_2\text{H}_5 \) 

14. Which of the arrows are pointing to electrophilic centers in the molecule below? Please choose only one letter for your answer!

![Molecule with Arrows]

- a. 1 & 3
- b. 3 & 4
- c. 1 & 2
- d. 2 & 3
- e. none of the above

15. The molecule below is used as a chemical defense mechanism by a sea snail. Which of the following arrows is/are pointing to chirality centers in the S configuration? More than one may be.

![Molecule with Arrows and Carbon Labels]

- a. carbon a
- b. carbon b
- c. carbon c
- d. none of them
16. The process below has \( \Delta H = +42 \text{ kJ} \). Which of the following statements is/are true? More than one answer may be correct.

\[
\begin{array}{c}
\text{Br} \quad \text{H} \quad \rightarrow \\
\cdot \quad \cdot \quad + \\
\text{H-Br}.
\end{array}
\]

a. The C-H bond in ethane is stronger than the H-Br bond.
b. the H-Br bond is stronger than the C-H bond in ethane.
c. This reaction step is exothermic.
d. None of the above is true.

17. Which of the following reactions is expected to have \( \Delta S_{\text{rxn}} > 0 \)? Note that \( \Delta S_{\text{rxn}} = \Delta S_{\text{sys}} \). More than one answer may be correct

a. 

b. 

c. 

d. none of them

18. Which of the following reactions best matches the reaction coordinate diagram in the box? Please choose one and only one.

a. 

b. 

c. 

\[ \text{free energy, \text{kJ/mol}} \]

\[ \text{reaction coordinate} \]

\[ \begin{array}{c}
\text{OH} \quad + \quad \text{HBr} \quad \rightarrow \\
\quad \text{Br} \quad + \quad \text{H}_2\text{O}
\end{array} \]
Other Questions
Each of the following questions is worth the indicated number of points, for a total of 46 points. Please be sure to provide all the information requested for each question.

19  6 points
   a. Draw the structure of (3S,5S)-3-bromo-5-chlorooctane.

   b. Name, including designation of R and/or S in the name. Hint-it may be helpful to redraw the ring as planar.

20. 4 points Draw both chair conformations of the molecule below.

21. 9 points Draw the structure of the major organic product(s) that results from each of the following reactions. Draw structures with correct stereochemistry shown.

   a.  
   
   b.  

   c.  

22. 3 points Provide the other reactant needed for successful completion of the following reaction.

   

   

   

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23. 8 points Write a mechanism that shows the stepwise formation, with curved arrows to show electron movement, of the organic product of the following reaction.

\[
\text{Br} \text{CH}_2=\text{CH}_2 + \text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{CH}=(\text{CH}_2\text{CH_2})\text{O} \rightarrow \text{CH}_3\text{CH}=(\text{CH}_2\text{CH_2})\text{OH} + \text{HBr}
\]

24. 4 points Provide curved arrows for each step of the following mechanism.

\[
\text{O} \overset{\text{H}^+}{\rightarrow} \overset{\text{O}^\cdot}{\rightarrow} \rightarrow \text{CH}_3\text{CH}=(\text{CH}_2\text{CH_2})\text{OH}
\]
25. 12 points Each of the spectra below corresponds to one of the compounds given. Write the structure of the compound for each spectrum to the right the corresponding spectrum and briefly justify each choice. In the IR spectra, the numbers on the scale, from left to right, are 4000, 3000, 2000, 1500, 1000, and 500, all in cm⁻¹.