Grade Sheet:

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Total: __________
1. (2 pts) Classify the reaction below. (circle the best answer)

\[
\text{TsO} + \text{K}_2\text{CO}_3 \rightarrow \text{O} + \text{O}
\]

A. Substitution  
B. Elimination  
C. Addition  
D. none of the above

2. (2 pts) Classify the reaction below. (circle the best answer)

\[
\text{Br} + \text{NaN}_3 \rightarrow \text{N}_3
\]

A. Substitution  
B. Elimination  
C. Addition  
D. none of the above

3. (2 pts) Classify the reaction below. (circle the best answer)

\[
\text{H} + \text{BH}_3 \rightarrow \text{H}_2\text{B} + \text{H}
\]

A. Substitution  
B. Elimination  
C. Addition  
D. none of the above

The equilibrium constant for the reaction below was measured to be \( K_{eq} = 4.0 \)
Considering this value, answer questions 4–5.

4. (2 pts) This reaction favors formation of (circle the best answer):

A. Reactants  
B. Products  
C. neither  
D. none of the above

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5. (2 pts) The $\Delta G^o$ of this reaction is (circle the best answer):

A. Negative  
B. Positive  
C. Zero  
D. none of the above

Refer to the energy diagram below for questions 6–8.

6. (2 pts) The mechanism for this reaction has (circle the best answer):

A. 1 step  
B. 2 steps  
C. 3 steps  
D. 4 steps  
E. none of the above

7. (2 pts) This overall reaction is (circle the best answer):

A. Endothermic  
B. Exothermic  
C. none of the above

8. (2 pts) Which step is rate limiting (circle the best answer)?

A. Step 4  
B. Step 3  
C. Step 2  
D. Step 1  
E. none of the above
9. (2pts) Name the structure below (circle the best answer):

![Structure](image)

A. \((R)-2\text{-iodo-5,5-dimethylheptane}\)
B. \((R)-6\text{-iodo-3,3-dimethylheptane}\)
C. \((S)-6\text{-iodo-3,3-dimethylheptane}\)
D. \((S)-2\text{-iodo-5,5-dimethylheptane}\)
E. none of the above

10. (2 pts) Name the structure below (circle the best answer):

![Structure](image)

A. \((2S)-4\text{-ethyl-5-methyl-2-octanol}\)
B. \((2R)-4\text{-ethyl-5-methyl-2-octanol}\)
C. \((7S)-5\text{-ethyl-4-methyl-7-octanol}\)
D. \((2S)-4\text{-ethyl-2-hydroxy-5-methyloctane}\)
E. none of the above

11. (2 pts) Which alkyl halide will undergo the fastest S\(_{N}\)2 reaction (circle the best answer)?

A. ![Structure](image)
B. ![Structure](image)
C. ![Structure](image)
D. ![Structure](image)
12. (2 pts) Which alkyl halide will undergo the fastest $S_N1$ reaction (circle the best answer)?

A.  

B.  

C.  

D.  

13. (2 pts) Which of the following would be predicted to increase the rate of the $S_N2$ reaction below (circle ALL that apply, there could be more than one answer)?

A. The leaving group is changed from Cl$^-$ to Br$^-$  
B. The solvent is changed from DMSO to CH$_3$OH  
C. The alkyl halide is changed from 3-chloropentane to 1-chloropentane  
D. The concentration of NaN$_3$ is decreased.  
E. none of the above

14. (2 pts) Which of the following would be predicted to increase the rate of the $S_N1$ reaction below (circle ALL that apply, there could be more than one answer)?

A. The leaving group is changed from I$^-$ to Br$^-$  
B. The concentration of CH$_3$OH is increased.  
C. The alkyl halide is changed from 3-iodopentane to 1-iodopentane  
D. The concentration of CH$_3$OH is decreased  
E. none of the above
15. (2 pts) For the **E2 reaction** below, identify the MAJOR product (circle the best answer).

![Chemical structure](image)

A. ![Structure A](image)

B. ![Structure B](image)

C. ![Structure C](image)

D. ![Structure D](image)

E. none of the above

16. (2 pts) For the **E2 reaction** below, identify the MAJOR product (circle the best answer).

![Chemical structure](image)

A. ![Structure A](image)

B. ![Structure B](image)

C. ![Structure C](image)

D. ![Structure D](image)

E. none of the above
17. (4 pts) Which mechanisms would you predict for the following reaction (circle ALL that apply, there could be more than one answer):

\[ \text{Br} \text{C}_7 \xrightarrow{\text{H}_2\text{O}} \text{H}_2\text{O} \]

A. S\text{N}_1  
B. S\text{N}_2  
C. E1  
D. E2  
E. none of the above  

18. (4 pts) Which mechanisms would you predict for the following reaction (circle ALL that apply, there could be more than one answer):

\[ \text{I} \text{C}_7 + \text{NaOH} \xrightarrow{\text{}} \text{H}_2\text{O} \]

A. S\text{N}_1  
B. S\text{N}_2  
C. E1  
D. E2  
E. none of the above  

19. (4 pts) Which mechanisms would you predict for the following reaction (circle ALL that apply, there could be more than one answer):

\[ \text{Cl} \text{C}_7 + \text{OC(CH}_3)_3 \xrightarrow{\text{}} \text{H}_2\text{O} \]

A. S\text{N}_1  
B. S\text{N}_2  
C. E1  
D. E2  
E. none of the above  

20. (3 pts) Which mechanisms would you predict for forming the indicated product in the following reaction (circle ALL that apply, there could be more than one answer):

\[ \text{OH} \text{C}_7 \xrightarrow{\text{H}_2\text{SO}_4} \text{H}_2\text{SO}_4 \]

A. S\text{N}_1  
B. S\text{N}_2  
C. E1  
D. E2  
E. none of the above  

21. (3 pts) Which mechanisms would you predict for forming the indicated products in the following reaction (circle ALL that apply, there could be more than one answer):

\[ \text{HO} \text{C}_7 \xrightarrow{\text{H}_2\text{SO}_4} \text{C}_7 + \text{C}_7 \]

A. S\text{N}_1  
B. S\text{N}_2  
C. E1  
D. E2  
E. none of the above
Section 2: Drawing Structures

22. (5 pts) Draw two unique resonance structures for the molecule drawn below.

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24. (5 pts) Assume the reaction below goes by an $\text{S}_\text{N}2$ mechanism. Draw the mechanism and products. Be sure to indicate the stereochemistry.

25. (5 pts) Assume the reaction below goes by an $\text{E}_2$ mechanism. Draw the mechanism and products. Be sure to indicate the stereochemistry.
26. (5 pts) Draw the two major products from an $S_N1$ reaction below in box A and B. Then draw a stepwise mechanism to form product A.

(2.5 pts) A and B are ____________________ (identical, constitutional isomers, enantiomers, or diastereomers):

![SN1 Reaction](image)

27. (5 pts) Draw two products formed from an $E1$ reaction below in box A and B. Then draw a stepwise mechanism to form product A.

(2.5 pts) A and B are ____________________ (identical, constitutional isomers, enantiomers, or diastereomers):

![E1 Reaction](image)
28. (5 pts) Draw a stepwise mechanism leading to the formation of the major product in the dehydration reaction below. Be sure to indicate stereochemistry.

![Dehydration Reaction](image)

29. (5 pts) Draw the two major elimination products from the following reaction. Be sure to indicate stereochemistry.

![Elimination Reaction](image)
30. (5 pts) Draw the major products from the following reactions nucleophilic substitution reactions. Be sure to indicate stereochemistry.

Extra Credit:

31. (5 pts) Cadaverine is produced from decomposing bodies (i.e. zombies) and is responsible for the aroma of the dead (and why zombies don't eat each other). Draw a molecule in the box that could react with ammonia to form cadaverine.

32. (5 pts) Latia luciferin is a molecule that is responsible for the bioluminescence of certain sea snails (and the devil's skin). Considering that the functionality indicated is acid-sensitive, what reagents would you use to prepare latia luciferin from the alcohol shown below (draw reagents in the box). Which configuration at the indicated carbon would give a higher yield of the product (circle R or S).