Grade Sheet:

Page 3: (14 pts) __________
Page 4: (8 pts) __________
Page 5: (8 pts) __________
Page 6: (6 pts) __________
Page 7: (10 pts) __________
Page 8: (20 pts) __________
Page 9: (12 pts) __________
Page 10: (32 pts) __________

Total: __________
Section 1: Multiple Choice and Fill in the Blank (40 pts)

1. (4 pts) How many valence electrons will there be in a neutral atom of the elements below?

H  _____  N  _____  Be  _____  O  _____  B  _____  F  _____  C  _____  Ne  _____

2. (4 pts) How many covalent bonds are predicted for each atom below (assuming that the formal charge on that atom is zero)?

H  _____  N  _____  Be  _____  O  _____  B  _____  F  _____  C  _____  Ne  _____

3. (2 pts) Circle the compound with highest boiling point.

A.  
B.  
C.  
D.  

4. (2 pts) Circle the compound with the highest melting point.

A.  
B.  
C.  
D.  

5. (2 pts) The compound below has a formal charge of (circle the best answer):

A. –1 on O  
B. +2 on O  
C. –1 on B  
D. +1 on F  
E. none of the above
6. (2 pts) Choose the structure(s) that is/are resonance structures for the given compound. Circle ALL that apply. There could be more than one answer.

A.  
B.  
C.  
D.  

For questions 7–9, refer to Table 2.1 and determine if the equilibrium will favor the formation of the reactants or the products in each reaction (circle the best answer).

7. (2 pts)
\[ \text{H}_2 + \text{:CH}_3^- \rightleftharpoons \text{:H}^- + \text{CH}_4 \]

A. Reactants  
B. Products

8. (2 pts)
\[ \text{H}_2\text{O} + \text{CH}_3\text{CH}_2\text{O}^- \rightleftharpoons \text{HO}^- + \text{CH}_3\text{CH}_2\text{OH} \]

A. Reactants  
B. Products

9. (2 pts)
\[ \text{H}-\text{C}≡\text{C}-\text{H} + \text{NH}_2^- \rightleftharpoons \text{H}-\text{C}≡\text{C}: + \text{NH}_3 \]

A. Reactants  
B. Products
10. (2 pts) Which hydrogen atom in the structure below is most acidic?

![Structure Diagram]

A. Hydrogen A  
B. Hydrogen B  
C. Hydrogen C  
D. Hydrogen D  
E. none of the above

11. (2 pts) Name the structure below (circle the best answer):

![Structure Diagram]

A. 3-sec-butyl-6-methylheptane  
B. 2,3-diethyl-6-methylheptane  
C. 4-ethyl-3,7-dimethyloctane  
D. 5-ethyl-2,6-dimethyloctane  
E. none of the above

12. (2 pts) Which structure is a correct chair structure the compound below (circle the best answer):

![Structure Diagram]

A.  
B.  
C.  
D.  
E. none of the above

13. (2 pts) Which structure is an enantiomer of the compound below (circle the best answer):

![Structure Diagram]

A.  
B.  
C.  
D.  
E. none of the above
14. (2 pts) What is the relationship between the two compounds named below (circle the best answer):

\[(3R,5R)-5\text{-ethyl-3-methylnonane}\]
\[(3R,5S)-5\text{-ethyl-3-methylnonane}\]

A. identical
B. constitutional isomers
C. enantiomers
D. diastereomers
E. none of the above

15. (2 pts) What is the relationship between the compounds shown below:

A. identical
B. constitutional isomers
C. enantiomers
D. diastereomers
E. none of the above

16. (2 pts) Which are the correct designations for the labeled stereocenters in the molecule below? (circle the best answer)

A. Stereocenter 1 is S
B. Stereocenter 2 is R
C. Stereocenter 3 is S
D. Both A and B
E. Both B and C
F. none of the above
17. **(2 pts)** Which of the following statements are true concerning compounds A and B? (circle ALL that apply, there could be more than one answer)

A. A and B are enantiomers
B. A and B are diastereomers
C. A is meso
D. A is chiral
E. B is chiral

18. **(2 pts)** Researchers are trying to find efficient ways to convert the greenhouse gas CO$_2$ into CH$_3$OH that can be used for fuel. This reaction is best classified as a/an: (circle the best answer)

\[ \text{O=O} \rightarrow \text{CH}_3\text{OH} \]

A. oxidation
B. reduction
C. both A and B
D. none of the above

Section 2: Drawing Structures (70 pts)

19. **(3 pts)** Doxycycline is a commonly prescribed antibiotic. Place a * next to each stereocenter in the structure of doxycycline as given below.

20. **(3 pts)** Draw the skeletal structure of 4-ethyl-5-isobutyl-2,6-dimethyloctane.
21. (5 pts) Draw two unique resonance structures for the molecule shown below.

\[
\text{+} \quad \text{CH}_3 \quad \text{CH}_3
\]

22. (5 pts) Label each reactant as electrophile or nucleophile. Used curved arrows to show the electron movement and draw the product of the reaction.

\[
\text{CH}_3 \quad + \quad \text{HO} \quad \rightarrow
\]

23. (5 pts) Label each reactant as electrophile or nucleophile. Used curved arrows to show the electron movement and draw the product of the reaction.

\[
\text{H} - \text{C} \equiv \text{C} - \text{H} \quad + \quad : \text{H}^{-} \quad \rightarrow
\]

24. (5 pts) Label each reactant as electrophile or nucleophile. Used curved arrows to show the electron movement and draw the product of the reaction.

\[
\text{ cyclopropane } \quad + \quad \text{H-Cl} \quad \rightarrow
\]
25. (12 pts)
   Part 1: Draw a stereoisomer of the compound below in box A.
   Part 2: Draw the mirror image of A in box B.
   Part 3: Draw a diastereomer of A in box C.
   Part 4: Draw the mirror image of C in box D.
   \[
   \begin{array}{c}
   \text{CH}_3 \quad \text{H} \\
   \text{I} - \text{C} \quad \text{I} \\
   \text{H} \quad \text{CH}_2\text{CH}_3
   \end{array}
   \]

   A   |   B
   ---|---
   C   |   D

   Fill in the blank with enantiomers, diastereomers, or identical.

   A and B are: ____________________________
   A and D are: ____________________________
   A and C are: ____________________________
   C and D are: ____________________________
   B and C are: ____________________________
26. (32 pts) **Part 1.** Draw all possible stereoisomers for 2,3-dimethylcyclohexan-1-ol (using dashes and wedges) in boxes A-H. **Part 2.** Label each stereocenter as R or S. **Part 3.** For each unique stereoisomer, draw the most stable chair conformation.

"2,3-dimethylcyclohexan-1-ol"

**Part 1 and 2.** Draw Stereoisomers and Label each stereocenter R or S. **Part 3.** Draw the most stable chair conformation for each stereoisomer.