Before you begin this exam: First: You are allowed to have a simple model set at your seat. Please put away all other materials. Second: Place your student identification on your desk. A proctor will come around to check everyone’s ID. Third: Read through the entire exam. Your goal, as always, is to score as many points as possible. Do not waste time on problems that you can’t do if there are others that look easy. Fourth: READ EACH QUESTION CAREFULLY. Be sure you answer the question that is asked. Fifth: Once the start time is announced, you have one hour to complete this exam. There will be no extensions, so budget your time carefully.

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1. (15 points) Insert lone pair electrons, single bonds, double bonds, and/or triple bonds in the neutral structures below in an arrangement that gives no formal charges on any atom. Assume connectivity as implied by atom position.

```
H   H   H   H   H
N   B   C   C
H   H   H   H
```

2. (20 points) All lone pairs and and atoms are drawn in the structures below. Label any formal charges. If there are no formal charges in a given structure, write the word “none” below the structure.

```
H₂C=NO⋅
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H₃C-O⋅
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H-B-H
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3. (15 points) Predict the geometry (in words, not degrees or hybridization) at each indicated C atom.

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4. (15 points) Draw a Lewis structure for the following neutral skeletal structures. Include implied C and H atoms and implied lone pairs.

\[ \text{B-N-B-N-B} \quad \text{Cyclic} \quad \text{C=C=O} \]

5. (30 points) Using curved arrow notation and the appropriate arrow between structures, draw the second best resonance structure for each of the molecules drawn below.

\[ \text{CH}_3\text{CH}_3 \quad \text{Cl} \quad \text{CH}_3 \quad \text{Cyclic} \]
6. (15 points) Draw the skeletal structures for molecules with the following names. Do not include implied C and H atoms.

1,3,5-trimethylcycloheptane  2-hydroxypentane  1,2-dimethy propane

7. (15 points) Draw neutral skeletal structures from each condensed structure that do not have formal charges. Do not include implied lone pairs. Do not include implied C and H atoms or implied bonds.

(CH₃(CH₂)₄)₃N  (CH₃(CH₂)₂)₂O  CH₃CH₂COOH

8. (10 points) Draw one skeletal structure for each the following. There may be more than one correct answer. If you draw more than one answer, only the first answer will be graded.

(a) an ester with the formula C₆H₁₂O₂

(b) an alkane with the formula C₅H₁₀
9. (15 points) Identify the circled functional groups in amoxicillin, an antibiotic.

10. (5 points) How many degrees of unsaturation are in 1-cyano-2-methylbenzene, shown below?

\[ \text{C} \quad \text{CH}_3 \]
11. (10 points) Draw 4 constitutional isomers of cyclohexene, shown below. If you draw more than 4 isomers, only the first 4 will be graded. *None of your answers should be stereoisomers of each other.*

![Cyclohexene structure]

12. (15 points) Label the following pairs of structures as constitutional isomers, enantiomers, diastereomers, the same, or neither.

- [Ketone structure] [Alkene structure]
- [Cyclohexane structure] [Cyclohexane structure]
- [Alkane structure] [Alkane structure]
13. (10 points) Mark each C atom as “stereogenic” or “nonstereogenic.” For any stereogenic C atom(s), label them as R or S.

14. (10 points) From the Newman Projection shown below, draw the corresponding skeletal structure. Implied C atoms and lone pairs should not be included. Implied H atoms should only be included to assist in identifying stereocents. Include wedges and dashes only when they are needed to show stereochemistry.