1. (6 pts) Insert any missing formal charges into the following molecules.

\[
\text{HO} : \text{N} = \text{O} : \\
\text{H} \cdot \text{C} = \text{N} \cdot \text{O} : \\
\text{O} : \text{O} : 
\]
2. (15 pts) Give acceptable names for each of the following molecules. You may use either IUPAC or "trivial" names for substituents.

a. 

b. 

c. 

d. 

e. 
3. (6 pts) **Draw and name** all of the possible isomers of C₅H₁₂.

4. (9 pts) Draw structures that correspond to each of the following:


   b. The *lowest energy* conformation of 1-ᵣ-butyl-1-methylcyclohexane.

   c. The *most stable* stereoisomer of 1,2-diethylcyclopropane.
5. (6 pts) Give a second resonance structure (including all charges and lone pairs) for each of the following systems.

![Resonance structure 1](image1)

![Resonance structure 2](image2)

6. (10 pts) Consider the cis- and trans- isomers of 1-t-butyl-3-ethylcyclohexane.

   a. Draw the lowest energy ring conformation for both isomers and explain why you chose those particular conformations.

   ![Conformation](image3)

   b. Indicate which isomer is less stable and explain your reasoning using a diagram to highlight any destabilizing interactions.
7. (20 pts) For each of the following reactions draw “curved arrows” to show how the bonds are formed and broken and give the expected products on the right hand side. Then, using your knowledge of pKa values, indicate which side of the reaction will be favored.

a. \[
\text{\text{O}} \quad \text{O-H} \quad + \quad \text{NaOCH}_3 \quad \rightarrow
\]

b. \[
\text{CH}_3\text{Li} \quad + \quad \begin{array}{c}
\text{N}
\end{array} \quad \rightarrow
\]

c. \[
\text{O} \quad \text{H} \\
\text{H} \\
\text{N} \\
\text{Na}
\quad + \quad \text{H} \quad \rightarrow
\]

d. \[
\text{H} \\
\text{H} \\
\text{H}
\quad + \quad \text{NaNH}_2 \\
\rightarrow
\]

e. \[
\text{ONa} \\
\quad + \quad \text{H-Cl} \\
\rightarrow
\]
8. (15 pts) **Draw acceptable structures** for each of the following molecules.
   
   a. *cis*-1-Bromo-3-chlorocyclopentane
   
   b. 2-Fluoro-3,5-dimethylcycloheptanol
   
   c. 2,3,4,5-Tetramethyl-1-octanol
   
   d. Bicyclo[3.3.0]octane
   
   e. *trans*-4-Methylcyclohexanol
9. (7 pts) Using curved arrows show a complete mechanism for how the following conversion takes place. On your diagram circle the structure that corresponds to the reactive intermediate that is formed.

\[
\text{OH} \quad \text{H-Br} \quad \text{(- H}_2\text{O}) \quad \text{Br}
\]

10. (6 pts) Indicate what classification (i.e. 1°, 2° or 3°) applies to each of the following alcohols or alkyl halides.

- \[
\text{OH}
\]
- \[
\text{Br}
\]
- \[
\text{F}
\]
- \[
\text{Cl}
\]
- \[
\text{OH}
\]
- \[
\text{OH}
\]