1. (8 pts) **Label** all of the sp² hybridized atoms within the following molecules.

1 point each correct label

a)

![Image of molecule a)

b)

![Image of molecule b)
2. (15 pts) **Draw the required structures** in each of the following situations.

a) The **highest energy chair** conformation of trans-1,2-dibromocyclohexane

3 points

b) A Newman projection of a **gauche conformation** of \(n\)-octane along the **C-2 – C-3** bond axis.

3 points

c) The **less stable** isomer of 1,2-diisopropylcyclopropane.

3 points

d) A Newman projection of the **most stable** conformation of \(n\)-hexane along the **C-3 – C-4** bond axis

3 points

e) A **boat** conformation of cyclohexane.

3 points
3. (15 pts) **Give acceptable names** for the following molecules. Trivial or IUPAC names may be used for substituents.

3 points each

a)

\[\text{3-bromo-6-ethyl-5,5-dimethylnonane}\]

b)

\[\text{bicyclo[5.3.0]decane}\]

c)

\[\text{5-chloro-6-isopropyl-2-methylundecane}\]

d)

\[\text{trans-3-tert-butylcyclohexanol}\]

e)

\[\text{6-bromo-3-fluoro-2-heptanol}\]
4. (15 pts) **Give the products** from each of the following acid-base reactions. Then give the acids on each side of the equations **approximate pKa values** and indicate in each case if you expect the reaction to be **exothermic**, **endothermic**, or approximately **thermoneutral** in each case.

3 points each

a) \[ \text{Li} \text{Li} + \text{H}_2\text{O} \rightarrow \text{H} + \text{LiOH} \]
   - **Exothermic**
   - Base: pKa \( \sim 16 \)
   - Acid: pKa \( \sim 60 \)

b) \[ \text{OLi} + \text{OH} \leftrightarrow \text{OLi} + \text{OH} \]
   - **Thermoneutral**
   - Base: pKa \( \sim 16 \)
   - Acid: pKa \( \sim 16 \)

\[ \text{CH}_3-\text{C}=\text{C}-\text{H} + \text{LiN(CH}_3)_2 \rightarrow \text{CH}_3-\text{C}=\text{CLi} + \text{HN(CH}_3)_2 \]
   - **Exothermic**
   - Acid: pKa \( \sim 26 \)
   - Base: pKa \( \sim 36 \)

\[ \text{CH}_3\text{CH}_2\text{NHLi} + \text{HN} \leftrightarrow \text{CH}_3\text{CH}_2\text{NH}_2 + \text{Li} \]
   - **Thermoneutral**
   - Base: pKa \( \sim 36 \)
   - Acid: pKa \( \sim 36 \)

\[ \text{OH} + \text{CH}_3\text{CH}_2\text{CH}_2\text{OK} \rightarrow \text{OK} + \text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \]
   - **Exothermic**
   - Acid: pKa \( \sim 10 \)
   - Base: pKa \( \sim 16 \)
5. (9 pts) **Draw acceptable structures** for each of the following molecules.

3 points each

a) *trans*-1-Ethyl-3-isopropylcyclopentane

![Structure a]

b) Cyclopentylcyclohexane

![Structure b]

c) 2,4,4-Trimethyl-3-octanol

![Structure c]

6. (10 pts) **Draw all of the isomers** possible for \( \text{C}_6\text{H}_{14} \) and then give each an acceptable name.

1 point each structure; 1 point each name

- **n-hexane**
- 2-methylpentane
- 3-methylpentane
- 2,3-dimethylbutane
- 2,2-dimethylbutane
7. (8 pts) For the highlighted atom in the following molecules, fill in the ground state electronic configuration on the left, and then draw a picture on the right of the hybridization model that best explains the bonding of the highlighted atoms.

4 points each

- **Em.:** Energy: up
  - Hybridize: arrows
  - sp

- **Energy:** up
  - Hybridize: arrows
  - sp³

8. (6 pts) Indicate the oxidation number of the highlighted C atoms in each of the following molecules.

1 point each

a) 
  -2
  -3
  CH₃CH₂CH₂CH₃

b) 
  -1
  Br
  +1
  H
  +4
  -2

c) 
  O=C=N-CH₃
9. (6 pts) **Draw a second resonance structure** for the following anions and then an **overall resonance hybrid** for each.

1 point each resonance structure; 2 points each hybrid

\[ \text{a)} \quad \text{O}^- \quad \text{O}^- \quad \text{O}^- \]

\[ \text{b)} \quad \text{O}^- \quad \text{O}^- \quad \text{O}^- \]

10. (8 pts) **Give the major organic product** expected below and then a **draw a complete mechanism**, using curved arrows, that shows each of the bond-breaking and bond-forming events on the way to the product.

2 points for product; 2 points each step of mechanism

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