DIRECTIONS: This examination is in two parts. **Part I** consists of 16 multiple choice questions (worth 64 points). **Circle the correct answer.** **Part II** (worth 136 Points) involves questions of general nature requiring write-up on your part. Be brief, clear and to the point.

HELP: READ AND UNDERSTAND EACH QUESTION CAREFULLY BEFORE attempting to answer it. IF YOU ARE IN DOUBT ABOUT ANY QUESTION, PLEASE CHECK WITH ME BEFORE YOU ANSWER IT.

GOOD LUCK

RELAX, STAY CALM AND DO YOUR BEST

PART I: MULTIPLE CHOICE QUESTIONS: (64 pts.)

1. The molecules shown are, 
   ![Diagram](image)
   a) constitutional isomers  
   b) enantiomers  
   c) diastereomers  
   d) identical  
   e) none of these

2. Which of the following is a **bicyclo [3.3.0] octane?**
   ![Options](image)
   a)  
   b)  
   c)  
   d)  
   e)
3. How many stereoisomers are possible for 1,2-cyclohexane dicarboxylic acid?
   a) 2
   b) 3
   c) 4
   d) 6
   e) 8

4. The number of \( \sigma \) bonds in \( \text{H}_2\text{C}-\mu\text{H}-\text{CH}_2\text{O}-\text{CO}-\text{COOH} \) are:
   a) 4
   b) 8
   c) 10
   d) 12
   e) None of these

5. The correct IUPAC name for neopentyl alcohol is:
   a) 2 - methyl - 2 - butanol
   b) 2 - methyl - 1 - butanol
   c) 3 - methyl - 2 - butanol
   d) 3 - methyl - 1 - butanol
   e) None of these

6. Which of the following(s) will not include spiro compounds as isomers?

   \[
   \begin{array}{cccc}
   \text{C}_2\text{H}_8 & \text{C}_6\text{H}_{14} & \text{C}_4\text{H}_{12} & \text{C}_6\text{H}_{10} \\
   1 & 2 & 3 & 4
   \end{array}
   \]
   a) 1 and 2
   b) 2 and 3
   c) only 4
   d) only 1
   e) None of these

7. Which of the following is optically active?

   (a)
   (b)
   (c)
   d) All are active
   e) None of the above

8. The molecules shown are:

   a) stereoisomers  b) enantiomers  c) identical  d) diastereomers  e) cononical structures
9. Which compound does not possess a plane of symmetry?

- a) 2 and 5
- b) 1, 2 and 3
- c) 2, 3 and 5
- d) 1, 3 and 4
- e) Only 5

10. For each pair, pick out the stronger base:

1) NaOCH₃ or NaOH
   - A
   - B

2) Ph-CO-NH₂ or Ph-CO-CH₂-NH₂
   - C
   - D

3) NH₂ or NH
   - E
   - F

   (a) A, C, E
   (b) A, D, E
   (c) B, D, F
   (d) B, D, E
   (e) none of these

11. An oxygen containing compound, which shows a characteristic IR absorption band only at 1700 cm⁻¹, is likely to be:

   - a) An aldehyde
   - b) An acid
   - c) An ester
   - d) An ether
   - e) All of the above

12. How many $^{13}$C NMR signals would you expect from:

   - a) 2
   - b) 3
   - c) 4
   - d) 8
   - e) none of these
13. How many $^1$H NMR signals would you expect from
   a) 2
   b) 3
   c) 4
   d) 5
   e) none of these

14. Which proton(s) of the compound below would appear as a doublet in the $^1$H NMR spectrum?

   ![Diagram of a compound with labeled protons]

   a) I
   b) II
   c) III
   d) IV
   e) none of these

15. In which case(s) is (are) the indicated unshared pair of electrons a contributor to the $\pi$ aromatic system(s)?

   ![Diagram of various aromatic structures]

   a) I and II
   b) II and IV
   c) III and V
   d) II and V
   e) I and III

16. Which reagent would you use to carry out the following transformation?

   ![Diagram of a ring transformation]

   a) pd, D$_2$
   b) pd, H$_2$
   c) pd/BaSO$_4$, H$_2$
   d) BaSO$_4$, D$_2$
   e) pd/BaSO$_4$, D$_2$
II. Circle the appropriate response in the sets below: (24 pts.)

1) Weakest Acid

2) Weakest Base

3) Stability of Free Radical (most)

4) Most Aromatic

5) Highest Dipole moment

6) Molecule showing least proton NMR signals

7) Most Soluble in water

CH₃-CH₂-COOH  CH₃-CH₂-COOCH₃  CH₃-CH₂-CO-NH₂
NH₂

8) Weakest Bond (for bond shown)

H₃C-CH₃  H₂C=CH₂  H₃C- NH₂  H₂N- NH₂
III. An organic compound of M.F. C₄H₈O shows the following behavior:

1) No absorption about 1700cm⁻¹ and 3500 cm⁻¹ in IR.
2) Does not add hydrogen on mild catalytic hydrogenation.
3) Shows two kinds of hydrogen in NMR.

Deduce possible structure(s) of the organic compound. Show your reasoning clearly.  (12 pts)

IV. Draw all the isomeric structures for 2-amino-3-pentenoic acid. Circle those which are optically active and cite your reasoning for or against chirality.  (14 pts.)
V. Write the IUPAC name for each of the following substances (use the blank by the side of the structure).  

<table>
<thead>
<tr>
<th>SUBSTANCE</th>
<th>IUPAC NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
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<tr>
<td>(2)</td>
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<tr>
<td>(3)</td>
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<td>(4)</td>
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<td>(5)</td>
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<td>(6)</td>
<td></td>
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</tbody>
</table>

VI. Write structural formula for each of the following substances:  

<table>
<thead>
<tr>
<th>SUBSTANCE</th>
<th>STRUCTURAL FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Diethyl adipate</td>
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</tr>
<tr>
<td>(2) 2(4-methoxyphenyl)butaneamine</td>
<td></td>
</tr>
<tr>
<td>(3) 4-Chloro-1-pentyne-3-one</td>
<td></td>
</tr>
</tbody>
</table>
(4) 1,2,3-trimethylenecyclopropane

(5) Spiro [2.3] 1,4-hexanedicarboxylic acid

(6) Allyl thio ether

VII. Briefly, but clearly explain each of the following observations: (12 pts.)

(1) An optically active compound ‘A’ with molecular formula C\textsubscript{6}H\textsubscript{12} on catalytic hydrogenation gives a compound ‘B’ C\textsubscript{6}H\textsubscript{14} which is optically inactive. Propose structures for A and B which fit this observation.

(2) The dipole moment of 2,4,6-cycloheptatrienone is considerably higher than one might expect for a conjugated carbonyl compound.
VIII. Predict the major organic product(s) in each of the following reactions. Write NR for no reaction. Indicate Stereochemistry of the product wherever applicable. (12 pts.)

(1) \[
\text{C} = \text{C} - \text{C} - \text{H}_3 + \text{pd/BaSO}_4/H_2 \rightarrow 
\]

(2) \[
\text{Mg}/\text{Et}_2\text{O}/\text{then } \text{D}_2\text{O} \rightarrow 
\]

(3) \[
\text{C} + \text{Cl}_2, \text{Br} \rightarrow 
\]

(4) \[
\text{Br} \xrightarrow{\text{(1) Li}} \text{Br} \xrightarrow{\text{(2) CuBr}} \text{Br} \rightarrow 
\]

IX. Show stepwise how you will carry out the following transformations. (Use any inorganic reagent(s) and organic solvent(s)). (12 pts.)

(1) \[
\text{and } \text{X} + \text{H} \xrightarrow{\text{to}} \text{Y} 
\]
X.

An organic compound of M.F. C₇H₄O₂ gave the following spectral data:

**IR:** 1700 cm⁻¹ (s) and 3400 cm⁻¹ (m).

**NMR** signals: δ 1.1 (9H, s); δ 1.3, (2H, t); δ 3.8 (2H, t); and δ 10.1 (1H, s).

Propose a **structure** for this compound. Show your reasoning clearly. (13 pts.)

YOUR COMMENTS ARE WELCOME
(You win this point no matter what you write) (1 pt.)