DIRECTIONS: This examination is in two parts. PART I consists of fifteen multiple choice questions (each worth 4 points). Circle the correct answer. PART II (140 points) involves questions requiring write-up on your part. Be brief, clear and to the point.

RELAX, STAY CALM AND DO YOUR BEST

GOOD LUCK

PART I: MULTIPLE CHOICE QUESTIONS

(60 pts.)

1. Which of the following compounds is most acidic?

(a) 2-nitrobenzenol
(b) benzenol
(c) 4-methoxybenzenol
(d) 4-methylbenzenol
(e) 4-nitrobenzenol

2. Which type of NMR will be useful to distinguish isomeric substances 1-hexene, 2-hexene and 3-hexene. (Consider only the number of signals; disregard stereochemistry.)

(a) proton NMR
(b) $^{13}$C NMR
(c) both proton and $^{13}$C NMR
(d) neither (a) nor (b)

3. The correct IUPAC name for neopentyl amine is:

(a) 2, 2-dimethylpropaneamine
(b) 2, 3-dimethylpropaneamine
(c) 1, 2-dimethylpropaneamine
(d) 3 - methyl - 1 butanamine
(e) None of these
4. For each pair, pick out the one with the lower value for dipole moment:

(1) \[ \Delta HCOO \text{C} \equiv \text{C} \text{O} \text{OH} \]
   or B

(2) C
   \[ H_{\text{3}} \text{C} \equiv \text{N} \text{O}_2 \]
   or D

(3) E
   \[ \text{O} \equiv \text{C} \]
   or E

(a) A, C, E  
(b) B, C, E  
(c) B, C, F  
(d) B, D, E  
(e) B, D, F

5. A and B are:

a) constitutional isomers
b) enantiomers
c) diastereomers
d) not isomeric
e) conformers

6. Which of the following molecule(s) can be optically active?

(a) 1,2-dichloropentane  
(b) (2R, 3S)-2,3-dichlorobutane  
(c) (3R, 4S)-3,4-dichlorohexane  
(d) 3-chloropentane  
(e) More than one of these

7. Which molecule(s) has (have) a plane of symmetry?

(a) \[ HC-C\equiv CH = C=CH-CH_3 \]

(b)

(c)

(d) b and c

(e) All of these
8. How many stereoisomers are possible for 2,3,4-trinitrohexane?
   (a) 2  
   (b) 3  
   (c) 4  
   (d) 8  
   (e) it has no isomers.

9. Which of the following is(are) not aromatic?

   ![Chemical Structures](image)

   (a) all five  
   (b) 1, 3 and 4  
   (c) 1, 3, 4 and 5  
   (d) 3, 4 and 5  
   (e) 1, 2 and 5

10. Arrange the following molecules in order of increasing acidity:

   ![Chemical Structures](image)

   (a) 4, 3, 2, 1  
   (b) 2, 4, 3, 1  
   (c) 4, 1, 3, 2  
   (d) 3, 4, 2, 1  
   (e) 2, 3, 1, 4
11. Which of the following compounds would you expect to be the **strongest base**?

(a) ![Chemical Structure](image)

(b) ![Chemical Structure](image)

(c) ![Chemical Structure](image)

(d) ![Chemical Structure](image)

(e) ![Chemical Structure](image)

12. Which of the following(s) can be **present** in the **isomeric aromatic compounds** with the molecular formula C$_7$H$_9$N

(a) primary amine
(b) secondary amine
(c) tertiary amine
(d) heterocyclic amine
(e) all of the above

13. Which of the following statements regarding IR spectroscopy is **not true**:

(a) involves light of wave number 6000-400 cm$^{-1}$.
(b) involves interaction of light.
(c) involves changes in vibrational modes.
(d) involves light of lower energy than the energy of visible light.
(e) involves electronic excitation.
14. An organic amine with M.F. C₄H₁₁N showed five kinds of proton NMR signals. Which of the following fits this data.

(a) 1, 2 and 4  
(b) 2, 3 and 4  
(c) 4 and 5  
(d) 2, 3 and 6  
(e) 3 and 6

15. Which of the following molecules is achiral?

(a)  

(b)  

(c)  

(d)  

(e)
PART II WRITE UP TYPE QUESTIONS

II. Circle the appropriate response in each of the following pairs. Explain your reasoning briefly, but clearly.

(35 pts.)

1. Greater Solubility in water: $\text{H}_2\text{N}-\text{( )-COOH and H}_2\text{N}-\text{( )-COOC}_2\text{H}_5$

2. Greater Aromaticity:

3. Stronger Base:

4. Stronger Acid: $\text{F}_3\text{C-CH}_2\text{-OH and F}_3\text{C-OH}$
5. Solubility in HCl: \[
\begin{align*}
\text{HC} & - \text{CH}_2 - \text{CO} - \text{NH}_2 \\
\text{and} & \quad \text{CH}_3 - \text{CO} - \text{CH}_2 - \text{NH}_2
\end{align*}
\]

6. Spectroscopic Differentiation between:

7. Stronger \textbf{+R effect} of the substituent on benzene ring.

III. Draw all the isomeric structures for dimethyl 2,3,4-trimethylpentane 1,5-dioate. Circle those which are optically \textbf{active} and cite your \textbf{reasoning} for or against chirality. (12 pts.)
IV. Briefly, but clearly explain each of the following observations: (10 pts)

1. 2,5-Cyclohexadienone readily dissolves in aqueous sodium hydroxide solution.

2. Trans 3,4-Dimethyl-3-hexene (I) on hydrogenation with pt/H₂ gives a racemic product, whereas the cis isomer of I affords a non-resolvable product.

V. Write correct IUPAC name for each compound represented by the formula shown. (15 pts.)

1. \[ \text{Structure} \]

2. \[ \text{Structure} \]

3. \[ \text{Structure} \]
Write a condensed structural formula for each of the following substances:
(Use blank by the side of name) (15 pts.)

1. oxalic acid

2. Butane 1,4- diamide

3. Bicyclo [3.1.0] hexane -1- carbonitrile

4. 4-(4-Chlorophenyl) 2,3-butadienoic acid

5. Benzyl crotonate
VII. A cyclic hydrocarbon with molecular formula $C_4H_6$, shows 4 proton nmr signals, and 4 carbon-13 nmr signals. Deduce the structure of the hydrocarbon. Show your reasoning clearly but briefly. (12 pts)

VIII. Using any organic reagents, any solvent, any C$_1$-C$_4$ hydrocarbon, cyclopentane and cyclohexane show how you can synthesize the following hydrocarbons. Specify reaction conditions for each step you propose. (16 pts)

(1) 

(2)
IX. Predict the major organic product(s) in each of the following reactions. Write NR for no reaction. Indicate Stereochemistry of the product wherever applicable.

(1) \[ \text{XXXCH} \xrightarrow{\text{D}_{2} \text{O}} \]

(2) \[ \text{XXX} + \text{Li}, \text{then CuBr, then} \xrightarrow{\text{Br}} \]

(3) \[ + \text{Br}_{2}, \text{HBr} \xrightarrow{\text{then TgO}} \]

(4) \[ \text{XXX} + \text{Mg/Et}_{2} \text{O} \xrightarrow{\text{then TgO}} \]

X. An organic compound of M.F. C_{10}H_{18}O_{2} showed strong absorption about 1700 cm\(^{-1}\) in IR spectrum, and gave no absorption in 3400cm\(^{-1}\) region. It gave only one NMR signal at \(\delta=1.2\). Propose a structure for this compound and show your reasoning clearly. (12 pts)

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