1. Rank the molecules according to their expected mp/bp. Use 1 for least and 3 for highest mp/bp. (6 pts)

[Images of three molecules with OH groups]

2. Circle the molecule in the pair that is expected to have higher boiling/melting point. (8 pts)

a) CH₃CH₂F; HF
   b) [Image of benzene ring with COOH groups]

3. Write the Henderson – Hasselbach equation for the following equilibrium. Define the terms involved. (12 pts)

   \[ \text{PhCOOH} + \text{H}_2\text{O} \iff \text{PhCOO}^- + \text{H}_3\text{O}^+ \]

4. In few sentences, explain why I is expected to have lower pKa than II. (6 pts)

   [Images of two molecules with different substituents]
5. Rank the molecules/ions in each series according to their pKa values. Use 1 for the least pKa value, 2 for the next higher and so on. (18 pts)

a) $\text{O}_2\text{N-CH}_2\text{-CH}_2\text{-COOH}$  $\text{CH}_3\text{-CH-COOH}$  $\text{CH}_3\text{-CH-COOH}$

b) ![Chemical structures]

c) $\text{F-CH}_2\text{-COOH}$  $\text{CH}_3\text{-COOH}$  $\text{Br-CH}_2\text{-COOH}$

6. The molecule underneath is potential diagnostic marker for an anti-estrogenic agent. Indicate the Kier-Hall electronegativity values of the following atoms. (8 pts)

<table>
<thead>
<tr>
<th>Kier-Hall eN Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-O- of phenolic OH</td>
</tr>
<tr>
<td>I-</td>
</tr>
<tr>
<td>S</td>
</tr>
<tr>
<td>F of CF$_2$</td>
</tr>
</tbody>
</table>

7. In few sentences, explain why the bp of I is expected to be higher than that of II. (6 pts)

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

8. Amyl nitrite is a nitrovasodilator. The structure of amyl nitrite is (CH$_3$)$_2$CHCH$_2$CH$_2$-O-N=O. Write the electronic structure of its nitrogen and the double bonded oxygen atoms and indicate their hybridization states. (8 pts)

The electronic structure of N is __________________________
The hybridization state of N is __________________________

The electronic structure of =O is __________________________
The hybridization state of =O is __________________________
9. Indicate whether the following drugs or biological molecules will exhibit good water solubility at pH 7.2-7.4. Circle the correct answer. (16 pts)

A) Soluble OR Insoluble

[Diagram of Gemfibrozil]

CH₃
CH₃
O
CH₃
COOH

Gemfibrozil

B) Soluble OR Insoluble

[Diagram of Cholesterol]

HO

Cholesterol

C) Soluble OR Insoluble

[Diagram of Aspirin]

COOH

OCOCOCH₃

Aspirin

D) Soluble OR Insoluble

[Diagram of Ibuprofen]

CH₃
CH₃
COOH

Ibuprofen

10. Azidothymidine (below) is an inhibitor of HIV reverse transcriptase enzyme. Write the hybridization state of non-hydrogen atoms marked ‘a’ (oxygen), ‘b’ (nitrogen), ‘c’ (carbon), ‘d’ (nitrogen), ‘e’ (oxygen) and ‘f’ (nitrogen). Also indicate the type of geometry corresponding to the hybridization. (12 pts)

[Diagram of Azidothymidine]

<table>
<thead>
<tr>
<th>Hybridization state</th>
<th>Type of Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>a =</td>
<td></td>
</tr>
<tr>
<td>b =</td>
<td></td>
</tr>
<tr>
<td>c =</td>
<td></td>
</tr>
<tr>
<td>d =</td>
<td></td>
</tr>
<tr>
<td>e =</td>
<td></td>
</tr>
<tr>
<td>f =</td>
<td></td>
</tr>
</tbody>
</table>