Organic Chemistry Practice Problems

Organic Chemistry I Practice Set #1 (Chapter 1 – Carey)

Consider the following acid-base reaction:

\[ \text{CH}_3\text{CH}_2\text{O}^- \text{K}^+ + \begin{array}{c} \text{acid} \\ \text{base} \end{array} \rightleftharpoons \text{CH}_3\text{CH}_2\text{OH} + \begin{array}{c} \text{conjugate acid} \\ \text{conjugate base} \end{array} \text{K}^+ \]

To decide on which side the equilibrium lies:
1) Identify conjugate acid-base pairs (connect above with lines);
2) If you know the pK_a values (or they are given), the equilibrium lies **AWAY FROM THE STRONGER ACID**. The stronger acid has lower pK_a.

Instructions: **Draw the correct Lewis Structures for each acid and conjugate base in the table below. Place a * (star) next to each one that has resonance structure(s). HA = acid; A^- = conjugate base**

<table>
<thead>
<tr>
<th>HA</th>
<th>pK_a</th>
<th>A^-</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI</td>
<td>-10</td>
<td>I^-</td>
</tr>
<tr>
<td>HBr</td>
<td>-6</td>
<td>Br^-</td>
</tr>
<tr>
<td>HCl</td>
<td>-4</td>
<td>Cl^-</td>
</tr>
<tr>
<td>CF_3SO_3H</td>
<td>-6</td>
<td>CF_3SO_3^-</td>
</tr>
<tr>
<td>H_2SO_4</td>
<td>-5</td>
<td>HSO_4^-</td>
</tr>
<tr>
<td>H_2O^+</td>
<td>-2</td>
<td>H_2O</td>
</tr>
<tr>
<td>HSO_4^-</td>
<td>2</td>
<td>SO_4^{2-}</td>
</tr>
<tr>
<td>H_3PO_4</td>
<td>2</td>
<td>H_2PO_4^-</td>
</tr>
<tr>
<td>HF</td>
<td>3.5</td>
<td>F^-</td>
</tr>
<tr>
<td>CH_3CO_2H</td>
<td>4.7</td>
<td>CH_3CO_2^-</td>
</tr>
<tr>
<td>PhNH_3^-</td>
<td>4.6</td>
<td>PhNH_2</td>
</tr>
<tr>
<td>C_5H_5N^(+)(pyridinium)</td>
<td>5.2</td>
<td>C_5H_5N</td>
</tr>
<tr>
<td>H_2CO_3</td>
<td>6.4</td>
<td>HCO_3^-</td>
</tr>
<tr>
<td>H_2PO_4^-</td>
<td>7</td>
<td>HPO_4^{2-}</td>
</tr>
<tr>
<td>H_2S</td>
<td>7</td>
<td>HS^-</td>
</tr>
<tr>
<td>PhSH</td>
<td>7</td>
<td>PhS^-</td>
</tr>
<tr>
<td>NH_4^+</td>
<td>9</td>
<td>NH_3</td>
</tr>
<tr>
<td>(CH_3CO)_2CH_2</td>
<td>9</td>
<td>(CH_3CO)_2CH^-</td>
</tr>
<tr>
<td>HCN</td>
<td>9</td>
<td>CN^-</td>
</tr>
<tr>
<td>PhOH</td>
<td>10</td>
<td>PhO^-</td>
</tr>
<tr>
<td>HCO_3^-</td>
<td>10</td>
<td>CO_3^{2-}</td>
</tr>
<tr>
<td>CH_3SH</td>
<td>11</td>
<td>CH_3S^-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HA</th>
<th>pK_a</th>
<th>A^-</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH_3CH_2NH_3^+</td>
<td>11</td>
<td>CH_3CH_2NH_2</td>
</tr>
<tr>
<td>CH_3COCH_2CO_2CH_2CH_3</td>
<td>11</td>
<td>[CH_3COCHCO_2CH_2CH_3^-]</td>
</tr>
<tr>
<td>HPO_4^{2-}</td>
<td>12</td>
<td>PO_4^{3-}</td>
</tr>
<tr>
<td>(CH_3CH_2O_2C)_2CH_2</td>
<td>13</td>
<td>(CH_3CH_2O_2C)_2CH^-</td>
</tr>
<tr>
<td>(NH_2)_2C=NH_2^-</td>
<td>13</td>
<td>(NH_2)_2C=NH</td>
</tr>
<tr>
<td>CH_3CONH_2</td>
<td>14</td>
<td>CH_3CONH^-</td>
</tr>
<tr>
<td>H_2O</td>
<td>15.7</td>
<td>H^-</td>
</tr>
<tr>
<td>CH_3OH</td>
<td>15.2</td>
<td>CH_3O^-</td>
</tr>
<tr>
<td>CH_3CH_2OH</td>
<td>16</td>
<td>CH_3CH_2O^-</td>
</tr>
<tr>
<td>(CH_3)_2CHOH</td>
<td>17</td>
<td>(CH_3)_2CHO^-</td>
</tr>
<tr>
<td>(CH_3)_3COH</td>
<td>18</td>
<td>(CH_3)_3CO^-</td>
</tr>
<tr>
<td>CH_3COCH_3</td>
<td>19</td>
<td>CH_3COCH_3^-</td>
</tr>
<tr>
<td>CH_3CO_2CH_2CH_3</td>
<td>25</td>
<td>CH_3CO_2CH_2CH_3^-</td>
</tr>
<tr>
<td>HC=CH</td>
<td>26</td>
<td>HC=CH^-</td>
</tr>
<tr>
<td>H_2</td>
<td>35</td>
<td>H^+</td>
</tr>
<tr>
<td>NH_3</td>
<td>36</td>
<td>NH_3^-</td>
</tr>
<tr>
<td>PhCH_3</td>
<td>41</td>
<td>[PhCH_2]^+</td>
</tr>
<tr>
<td>CH_2=CHCH_3</td>
<td>43</td>
<td>[CH_2=CHCH_2]^+</td>
</tr>
<tr>
<td>PhH</td>
<td>43</td>
<td>Ph^+</td>
</tr>
<tr>
<td>CH_2=CH_2</td>
<td>45</td>
<td>CH_2=CH^-</td>
</tr>
<tr>
<td>CH_3CH_3</td>
<td>62</td>
<td>[CH_3CH_2]^-</td>
</tr>
</tbody>
</table>

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### Organic Chemistry Practice Problems

#### Acids

- HBr
- HI
- HCl
- CF₃SO₃H
- H₂SO₄
- H₃O⁺
- HSO₄⁻
- H₃PO₄
- HF
- CH₃CO₂H
- PhNH₃⁺
- C₅H₅N⁺

#### Organic Chemistry I Answers to Practice Set #1 (Chapter 1 - Carev)

- Br⁻
- I⁻
- Cl⁻
- *** CF₃SO₃⁻
- *** HSO₄⁻
- H₂O
- *** H₂PO₄⁻
- F⁻
- *** CH₃CO₂⁻
- *** PhNH₂
- *** C₅H₅N⁻

#### Conjugate Bases

- Br⁻
- I⁻
- Cl⁻
- CF₃SO₃⁻
- HSO₄⁻
- H₂O
- H₂PO₄⁻
- F⁻
- CH₃CO₂⁻
- PhNH₂
- C₅H₅N⁻

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Organic Chemistry Practice Problems

Acids

Organic Chemistry I Answers to Practice Set #1 (Chapter 1 - Carey)

Conjugate Bases

H₂CO₃

*** HCO₃⁻

H₂PO₄⁻ ***

*** HPO₄²⁻

H₂S

HS⁻

PhSH ***

*** PhS⁻

NH₄⁺

NH₃

(CH₃CO)₂CH

*** (CH₃CO)₂CH⁻

HCN

CN⁻

PhOH ***

*** PhO⁻

HCO₃⁻ ***

*** CO₃²⁻

CH₃SH

CH₃S⁻

CH₃CH₂NH

CH₃CH₂NH₂

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Acids

Organic Chemistry I Answers to Practice Set #1 (Chapter 1 – Carey)

Conjugate Bases

ethyl 3-oxobutanoate

HPO₄²⁻ ***

diethyl malonate

(NH₂)C=NH₂⁺ ***

CH₃CONH₂

OH⁻

H₂O

CH₃OH

CH₃CH₂OH

(CH₃)₂CHOH

(CH₃)₃COH

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### Organic Chemistry Practice Problems

#### Acids

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<tr>
<th>Chemical Structure</th>
<th>Formula</th>
<th>Conjugate Base</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Structure" /></td>
<td>CH₃COCH₃</td>
<td>*** CH₃COCH₂⁻</td>
</tr>
<tr>
<td><img src="image2" alt="Structure" /></td>
<td>CH₃CO₂H</td>
<td>*** CH₃CO₂⁻</td>
</tr>
<tr>
<td><img src="image3" alt="Structure" /></td>
<td>HC≡CH</td>
<td>HC≡CH⁻</td>
</tr>
<tr>
<td><img src="image4" alt="Structure" /></td>
<td>NH₃</td>
<td>NH₂⁻</td>
</tr>
<tr>
<td><img src="image5" alt="Structure" /></td>
<td>PhCH₃</td>
<td>*** PhCH₂⁻</td>
</tr>
<tr>
<td><img src="image6" alt="Structure" /></td>
<td>CH₂=CHCH₃</td>
<td>*** CH₂=CHCH₂⁻</td>
</tr>
<tr>
<td><img src="image7" alt="Structure" /></td>
<td>PhH</td>
<td>*** Ph⁻</td>
</tr>
<tr>
<td><img src="image8" alt="Structure" /></td>
<td>CH₂=CH₂</td>
<td>*** CH₂=CH⁻</td>
</tr>
<tr>
<td><img src="image9" alt="Structure" /></td>
<td>CH₃CH₃</td>
<td>CH₃CH₂⁻</td>
</tr>
</tbody>
</table>

#### Conjugate Bases

<table>
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<th>Chemical Structure</th>
<th>Formula</th>
<th>Conjugate Base</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image10" alt="Structure" /></td>
<td>CH₃COCH₂⁻</td>
<td>*** CH₃CO⁻</td>
</tr>
<tr>
<td><img src="image11" alt="Structure" /></td>
<td>CH₃CO₂⁻</td>
<td>*** CH₃CO₂⁻</td>
</tr>
<tr>
<td><img src="image12" alt="Structure" /></td>
<td>HC≡CH⁻</td>
<td>HC≡CH⁻</td>
</tr>
<tr>
<td><img src="image13" alt="Structure" /></td>
<td>NH₂⁻</td>
<td>NH₂⁻</td>
</tr>
<tr>
<td><img src="image14" alt="Structure" /></td>
<td>PhCH₂⁻</td>
<td>*** Ph⁻</td>
</tr>
<tr>
<td><img src="image15" alt="Structure" /></td>
<td>CH₂=CHCH₂⁻</td>
<td>*** CH₂=CHCH₂⁻</td>
</tr>
<tr>
<td><img src="image16" alt="Structure" /></td>
<td>Ph⁻</td>
<td>Ph⁻</td>
</tr>
<tr>
<td><img src="image17" alt="Structure" /></td>
<td>CH₂=CH⁻</td>
<td>*** CH₂=CH⁻</td>
</tr>
<tr>
<td><img src="image18" alt="Structure" /></td>
<td>CH₃CH₂⁻</td>
<td>CH₃CH₂⁻</td>
</tr>
</tbody>
</table>

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