Final Review

1) Fill in the blank and then label the molecules below as either Lewis Acid/Base and/or Bronsted-Lowry Acid/Base. *(Jacqueline - self-made)*
   a) A **Bronsted-Lowry Acid** is a proton (H⁺) donor and a **Bronsted-Lowry Base** is a proton acceptor.
   b) A **Lewis Base** is an electron pair donor and a **Lewis Acid** is an electron pair acceptor.

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<tr>
<td>H₂SO₄</td>
<td>NH₃</td>
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<tr>
<td>Bronsted-Lowry Acid</td>
<td>Bronsted-Lowry Base</td>
</tr>
<tr>
<td>Lewis Acid</td>
<td>Lewis Base</td>
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<tr>
<td>BF₃</td>
<td>F⁻</td>
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<tr>
<td>Lewis Acid</td>
<td>Lewis Base</td>
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2) Draw the reaction coordinate diagrams for the following general reactions. Label the axes, reactants, products, ΔG, Eₐ, and transition states. *(Jacqueline - self-made)*
   a) A-B + C → A + B-C (one-step, exothermic)
3) Match the following mass spectrum with their respective Mass Spectrum. *(Jacqueline - discussion worksheets + modification)*

![Mass Spectrum Image](image_url)

The molecular ion peak and the M+2 peak are 3:1

\[ A^- + B - C \rightarrow B^+ + A - C \] (two-step - 1st step is rate-determining, endothermic)
The molecular ion peak and the M+2 peak are 1:1

4) Determine the absolute configurations for the following compounds and determine which molecules are enantiomers and diastereomers. (Jacqueline - Discussion Worksheet + modifications)

1  2  3
R  S  R  S  R

1 & 2 are enantiomers; 1 & 3 are diastereomers; 2 & 3 are enantiomers

5) Draw the most stable chair conformation of the following compounds. (Aubrey - past practice exam + modifications)
6) What is the IUPAC name of the following compounds? (Aubrey - past practice exam + modifications)

7-cyclopentane-3-methylheptane

1-ethyl-3-methylcyclohexane

7) Based on the IR below, note any notable peaks that you see. (Aubrey - IR peaks from http://www.orgchemboulder.com/Spectroscopy/Problems/index.shtml and past peer review worksheets)
The IR spectrum allows you to identify which functional groups are in a structure of a molecule. Based on this IR, the notable peaks are the ones around the 3000 cm\(^{-1}\) and 1700 cm\(^{-1}\). Anything below 1500 in the spectra is the fingerprint region and we usually do not look at this area of the IR because it is difficult to identify peaks in this area. At around 3700-3000 cm\(^{-1}\), usually means that there is an OH functional group in the structure and at 1700 cm\(^{-1}\) means that there is a C=O functional group in the structure.
Based on this IR, the notable peaks are the one at 3339 cm\(^{-1}\) and 2957 cm\(^{-1}\). At around 3700-3000 cm\(^{-1}\) means that there is an OH functional group in the molecular structure. At around 2850-3000 cm\(^{-1}\) means there is CH\(_3\) sp\(^3\) group alkane group within the molecular structure.

8) Using the molecular formula, NMR and IR spectrum, draw out the structure of the molecule. For the IR, note any prominent peaks that you see. (Aubrey - IR peaks from http://www.orgchemboulder.com/Spectroscopy/Problems/index.shtml)

a) \(\text{C}_5\text{H}_{10}\text{O}\)
First we need to find the degree of unsaturation. The formula for the degree of unsaturation is \((2C + 2 - H + N)/2\). So, with the molecular formula given it will be \((2 \times 5 + 2 - 10)/2\) which equals 1. This means that there is a double bond or a ring in the molecular structure. Based on the IR, there is a peak at 1718 cm\(^{-1}\) which is the frequency for a C=O bond. As well as C-H sp\(^3\) bonds at around 2964 cm\(^{-1}\).

The NMR is where we can find the actual structure of the molecule. The final structure is

\[
\begin{align*}
\text{C} & \quad \text{A} & \quad \text{B} & \quad \text{D} \\
\text{O} & \quad & & \\
1: 2\text{-pentanone} & \quad & & \\
\end{align*}
\]
9) Which of the following choices indicate a spontaneous reaction? Nadeen
   a. $Keq = 10^{-6}$
   b. $\Delta G^o = -6$ kJ
   c. $Keq = 0.5$
   d. $\Delta G^o = 10^{-6}$

10) Determine whether the starting material or the product is favored at equilibrium, based on the given values. Nadeen

   $Keq = 0.5$ starting material ($Keq < 1$)
   $\Delta G^o = -10$ kJ/mol product ($delta G < 0$)

   $Keq = 18$ product ($Keq > 1$)
   $\Delta G^o = 5.0$ kJ/mol starting material ($delta G > 0$)

   $\Delta S^o = -10$ J/(K·mol) starting material ($delta S < 0$)
   $\Delta H^o = +10$ kJ/mol starting material ($delta H$ is positive)

   $\Delta S^o = +10$ J/(K·mol) product ($delta S > 0$)
   $\Delta H^o = -800$ kJ/mol product ($delta h$ is negative)

11) Nadeen

   a. Which step is the rate determining step? First step (because it’s the slowest)
   b. What is the rate equation of this reaction? $Rate = k[OCH_3^-][CH_3COCl]$
c. If the concentration of $\text{OCH}_3^-$ was increased by 10 times, what would happen to the overall rate of the reaction? **Increase by 10x**

d. If the concentration of $\text{CH}_3\text{COCl}$ was increased by 10 times, what would happen to the overall rate of the reaction? **Increase by 10x**

e. If the concentration of the intermediate between steps 1 and 2 was increased by 10 times, what would happen to the overall rate of the reaction? **Would not change (not in the rate equation)**

f. If the concentrations of each reactant ($\text{OCH}_3^-$ and $\text{CH}_3\text{COCl}$) were increased by 10 times, what would happen to the overall rate of the reaction? **Increase by 100x (10 x 10)**

12) Rank the following molecules in order of the increasing boiling point. **Nadeen**

![Molecules](image)

13) Which molecule has the higher melting point? Why? **Nadeen**

![Molecules](image)

The second one has the higher melting point because it is symmetrical.
14) Label the nucleophile and electrophile in each reaction Nadeen

Left: Nucleophile
Right: Electrophile

Left: Electrophile
Right: Nucleophile

Left: Nucleophile
Right: Electrophile