1. (3 pts) Which of the following energy diagrams best represents the \textit{slowest} spontaneous reaction? Circle your choice. Give a brief, but clear, explanation for your answer below the diagrams.

\begin{enumerate}
\item \[ \Delta G \]
\item \[ \Delta G \]
\item \[ \Delta G \]
\item \[ \Delta G \]
\end{enumerate}

2. (5 pts) a) Describe in your own words and terms where the origin of the activation barrier comes from and what it represents in a chemical reaction. b) Given the same thermodynamic factors, consider the reaction of two \textit{small} molecules or two \textit{large} molecules with one another. Which pair should have the \textit{higher activation energy}? Why?
3. (3 pts) Consider the following reaction and information:

\[
\text{H}_2\text{C=CH}_2 + \text{CO} + \text{H}_2\text{O} \rightarrow \text{HOOC-CH}_2\text{CH}_3
\]

\[
\Delta G = +100 \text{ kJ/mol} \quad \text{Activation Energy} = +400 \text{ kJ/mol}
\]

Circle the energy curve shown below (R = reactants, P = products) that best represents the reaction described above? Give a brief, but clear, explanation for your answer below the diagrams.

![Energy Curves]

4. (5 pts) Consider the following reaction and kinetic data. Circle the correct kinetic rate expression for this reaction. Show all your work and/or discuss your reasoning.

\[
2\text{A} + \text{B} \rightarrow \text{C} + \text{D}
\]

a) rate = \(k[A][B]\)  

b) rate = \(k[A]^2\)  

c) rate = \(k[B]\)  

d) rate = \(k[B]^2\)  

e) rate = \(k[A][B]^2\)

<table>
<thead>
<tr>
<th>Exp #</th>
<th>[A]</th>
<th>[B]</th>
<th>Initial Rate (Msec(^{-1}))</th>
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5. (5 pts) Consider the following reaction and kinetic data. Circle the correct rate constant for this reaction. Clearly show all your work including the rate law that you determine.

\[\text{A + 2B} \rightarrow \text{C + D}\]

a) \(2.2 \times 10^{-6} \text{ M}^{-1}\sec^{-1}\)  b) \(22 \text{ M}^{-1}\sec^{-1}\)  c) \(220 \text{ M}^{-1}\sec^{-1}\)  d) \(0.05 \text{ M}^{-1}\sec^{-1}\)  e) not enough data

<table>
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<tr>
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<th>[B]</th>
<th>Initial Rate (Msec(^{-1}))</th>
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6. (4 pts) Catalysts can be used on non-spontaneous reactions to lower the activation barrier. If a catalyst lowers the activation barrier too much, however, a serious problem can arise. Consider the diagrams shown below. What is the problem for the catalyzed rxn with the lower activation energy? Why can a “substantial” activation barrier actually help an “uphill” chemical reaction if one wants to make as much product as possible?

7. (5 pts) A reaction has an initial rate of reaction of 0.001 \(\text{M} \text{sec}^{-1}\) at 70°C. This increases to 0.100 \(\text{M} \text{sec}^{-1}\) at 90°C. Calculate the activation energy for this reaction?