Question 1.

a) Circle the strongest base from the list below.

\[ \text{H}_2\text{O} \quad \text{Br} \quad \text{N(CH}_3\text{)}_3 \quad \text{butane} \]

b) Circle the strongest nucleophile from the list below.

\[ \text{H}_2\text{O} \quad \text{Br} \quad \text{NH}_4^+ \quad \text{butane} \]

c) A sample of phenylsuccinic acid is measured to have an optical rotation of \( [\alpha]_D = -16.8^\circ \). If pure (+)-phenylsuccinic acid has an optical rotation of \( [\alpha]_D = 168^\circ \), what is the percent enantiomeric excess (%ee) of the sample?

d) What percent of the sample from part (c) is (+)-phenylsuccinic acid?

e) Briefly explain why the following compound does not exist.

\[ \text{HO} \quad \text{Li} \]
Question 2. *trans*-1,4-Dimethylcyclohexane is shown below:

![Diagram of trans-1,4-Dimethylcyclohexane]

a) In the boxes below, draw the two chair forms of *trans*-1,4-dimethylcyclohexane.

A

B

d) Estimate the energy difference (in kcal/mol) between the two structures that you drew in part (a)

c) At room temperature, approximately what percentage of *trans*-1,4-dimethylcyclohexane is in chair form “A” and what percentage is in chair form “B”?
Question 3. For each of the following pairs of compounds, circle the compound that will undergo the indicated reaction faster and give a brief explanation for your answer.

a) Faster to undergo $S_N2$:  

Explanation:

b) Faster to undergo $S_N1$:

Explanation:

c) Faster to undergo both $S_N1$ and $S_N2$:

Explanation:
Question 4. Provide a complete mechanism (curved arrows showing electron movement) for the following reaction. *Don’t skip any steps!*

[Diagram showing the reaction with curved arrows indicating electron movement]
Question 5. In the boxes, provide the missing reagents, starting materials, products and/or reaction type (S_N1, S_N2, or “no reaction”) to complete the equations below.

a) 

\[
\begin{align*}
\text{starting material:} & \quad \text{product:} \\
\text{Reaction Type:} & \quad \text{H}_2\text{O}^+ \\
\end{align*}
\]

b) 

\[
\begin{align*}
\text{starting material:} & \quad \text{product:} \\
\text{Reaction Type:} & \quad \text{S_N2} \\
\end{align*}
\]

c) 

\[
\begin{align*}
\text{starting material:} & \quad \text{product:} \\
\text{Reaction Type:} & \quad \text{S_N1} \\
\end{align*}
\]
d) 

\[
\begin{align*}
\text{Product:} \\
\text{Reaction Type} \\
(2\text{nd step only}): \\
\end{align*}
\]