1. For each of the following pairs of compounds, circle the molecule that will react \textit{fastest} in an S_N2 reaction with \( \text{HO}^- \).

(a) \[
\begin{array}{c}
\text{Br} \\
\text{C}_6\text{H}_5 \\
\end{array}
\quad
\begin{array}{c}
\text{Br} \\
\text{C}_6\text{H}_4\text{CH}_2- \\
\end{array}
\]

(b) \[
\begin{array}{c}
\text{CH}_3\text{Cl} \\
\end{array}
\quad
\begin{array}{c}
\text{(CH}_3\text{)}_3\text{CCl} \\
\end{array}
\]

(c) \[
\begin{array}{c}
\text{Br} \\
\text{C}_6\text{H}_5\text{CH}=	ext{CH} \\
\end{array}
\quad
\begin{array}{c}
\text{Br} \\
\text{C}_6\text{H}_5\text{CH}=	ext{CH} \\
\end{array}
\]

\text{primary halide reacts rapidly via S_N2}

\text{tertiary halide does not react via S_N2 because of steric hindrance to backside attack}

\text{Note: halide at sp}^2\text{ carbon DOES NOT react via S_N2}

\fbox{+3pts each} \quad \fbox{(do not need explanation)}

\fbox{+1pts bonus for getting all 3 correct}
2. (a) Rank the following compounds in order of increasing reactivity toward $S_{N2}$ reaction.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Rank</th>
<th>Reactivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_3$I</td>
<td>A</td>
<td>fastest</td>
</tr>
<tr>
<td>CH$_3$F</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>CH$_3$Br</td>
<td>C</td>
<td>slowest</td>
</tr>
</tbody>
</table>

(b) **Briefly** explain the basis for your answer.

- Leaving group ability: $F^-$ < $Br^-$ < $I^-$
- More detailed answer (not necessary): I$^-$ is the weakest base $\Rightarrow$ best leaving group
- HI is the strongest conjugate acid

3. What effect would the following changes have on the rate of the $S_{N1}$ reaction of tert-butyl alcohol with HBr?

(a) The HBr concentration is tripled? Explain.

+3 pts No Change

(b) The HBr concentration is halved, and the tert-butyl alcohol concentration is doubled? Explain.

+3 pts Rate doubles

+2 pts for $S_{N1}$ reaction, rate is linearly dependent on substrate concentration.

10/10/01 R. J. McMahon
4. Reaction of (R)-3-methyl-3-hexanol with HBr yields racemic (±)-3-bromo-3-methylhexane. Propose a mechanism to account for this observation.

- planar, achiral carbocation
- attack on either face is equally probable
- racemic product formed

+10pts fully correct
+7pts OK, but some mistakes
+4pts some problems
+0pts totally wrong or blank

10/10/01 R. J. McMahon
5. In comparing the stability of isomeric alkenes, the more highly-substituted alkene is typically more stable. For example, alkene E is more stable than alkene D. How can you explain the fact that alkene D is formed as the exclusive product in the following reaction?

E2 mechanism requires anti-periplanar alignment of hydrogen and leaving group.

This conformation cannot undergo E2, because there are no H's that are anti-periplanar to the Br substituent.