Organic Cumulative Exam (November 5, 2020)
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1. **(20 Points)** Aryne-based annulation is a powerful tool to synthesize functionalized arenes. Consider the structure of the substrates and the reaction conditions, provide a reasonable mechanism of the following transformation.

\[
\begin{array}{c}
\text{NC} \quad \text{O} \\
\text{Ph} \quad \text{Ph} \\
\text{Ph} \quad \text{Ph} \quad \text{M}_{\text{TMS}} \\
\text{TMS} \quad \text{OTf} \\
\end{array}
\xrightarrow{\text{TBAT (6.0 equiv)}}
\begin{array}{c}
\text{Ph} \\
\text{Ph} \\
\text{CN} \\
\text{CN} \\
\end{array}
\]

2. **(20 Points)** On the basis of the catalytic action of the given phosphoric acid as a proton source, provide a reasonable mechanism for following transformation.

3. **(20 Points)** Conformation of cyclic structures is one of the most important factors for the reactivity and selectivity. Considering the conformation of trans- and cis-limonene oxide shown below, explain why trans-isomer selectively reacts over the cis-isomer under the given conditions.

\[
\begin{array}{c}
\text{trans} \\
\text{cis} \\
\end{array}
\xrightarrow{\text{kinetic separation}}
\begin{array}{c}
\text{i. 0.5 MRR'} \\
\text{ii. NH}_4\text{Cl or H}_2\text{O} \\
\end{array}
\]
4. **(20 Points)** Considering the electronic character of diazo compound, provide an arrow-pushing mechanism for the following reaction.

![Reaction Mechanism](image)

4. **(20 Points)** Considering the structure of the substrate and the provided reagents, predict the product of the following reaction.

![Reaction Mechanism](image)