(1) Explain the following observations.

(a) The diester \( A \) can be isomerized as shown below. Under the same conditions, the diamide \( B \) does not isomerize.

\[
\begin{align*}
A & \quad \xrightarrow{1. \text{ base}} \quad 1. \text{ base} \\
& \quad \xrightarrow{2. \text{ H}_3\text{O}^+} \quad 2. \text{ H}_3\text{O}^+
\end{align*}
\]

(b) Compound \( C \), an important intermediate for the generation of \( \beta \)-acetoxycarbene, was prepared from the ester \( D \) by Martin J. Schnermann '02. Can you guess how Marty made \( C \)?

\[
\begin{align*}
C & \quad \text{from} \\
D & \quad \text{from}
\end{align*}
\]

(c) Jonathan Mann '02 prepared the ester \( E \), a precursor to \( \alpha \)-acetoxycarbene, from the acid \( F \). Show the steps that Jon might have used for the synthesis.

\[
\begin{align*}
E & \quad \text{from} \\
F & \quad \text{from}
\end{align*}
\]
(2) Provide a mechanism for the following reaction and predict what would happen if the product were heated in aqueous acid.

\[
\text{Br} + \ \text{CO}_2\text{Et} + \ \text{HN} - \text{Ph} \rightarrow \text{NaOEt/EtOH} \rightarrow \text{Ph} \text{Ph}
\]

(3) The 1968 Kentucky Derby winner, Dancer's Image, was initially disqualified because traces of a pain killer, phenylbutazone, were found in his urine. Several months later, in a bizarre turn of events, the horse was reinstated as the winner due to doubts about the testing methods of the state chemist. However, the prize money of $122,600 was denied!

Given below is a patented procedure for the synthesis of phenylbutazone. Show how the product could be formed in the reaction.