Tutorials and supplemental reading on resonance and carbocations can be found on the course web site.

1. (a) 

\[
\begin{align*}
\text{No additional significant resonance contributors.}
\end{align*}
\]

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{CH}_3 \\
\text{H}_3\text{C} & \quad \text{CH}_3 \\
\text{H}_3\text{C} & \quad \text{OH} \\
\text{H}_3\text{C} & \quad \text{OH}
\end{align*}
\]

\[
\begin{align*}
\text{(CH}_3)_2\text{CN(CH}_3)_2 & \quad \text{same as} \\
\text{H}_3\text{C} & \quad \text{CH}_3 \\
\text{H}_3\text{C} & \quad \text{CH}_3 \\
\text{H}_3\text{C} & \quad \text{N} \\
\text{H}_3\text{C} & \quad \text{CH}_3
\end{align*}
\]

The benzene ring resonance does not delocalize the positive charge so it does not influence the relative stability of the carbocation.

\[
\begin{align*}
\text{No additional significant resonance contributors.}
\end{align*}
\]

Not every six-membered ring is a benzene ring.

(b) Fundamental rules for carbocation stability:

- Carbocation stability increases with an increasing number of carbon groups bonded to the carbon with the open octet.

  Stability: \(\text{CH}_3^+\) (methyl; least stable) < \(\text{RCH}_2^+\) (1°) < \(\text{R}_2\text{CH}^+\) (2°) < \(\text{R}_3\text{C}^+\) (3°)

- Resonance is more important than alkyl substitution. For example, a carbocation that is primary with resonance is generally more stable than a secondary carbocation without resonance. Review the general resonance contributor preference rules from Chem 14C if necessary.

Applying these rules, the relative stabilities are:
Carbocations A and B are both secondary with resonance, so we might expect them to be of equal stability. However, nitrogen is less electronegative than oxygen and therefore more willing to share electron density by resonance. Greater electron donation to a neighboring electron-deficient carbon atom results in greater stabilization of the positive charge, so cation A is more stable than cation B. Cations D and E are both secondary, and so we might predict them to be of equal stability. The benzene ring resonance of cation E does not delocalize the positive charge, so it does not enjoy any extra stabilization, and cations D and E are of about equal stability. (In fact, a benzene ring is an inductive electron-withdrawing group, so carbocation D is actually a bit more favorable than carbocation E.)

2. Capture a nucleophile:

Be deprotonated; form a pi bond:

Rearrange: