1. (4) Prepare the following alkene using two different routes, both of them utilizing a Wittig reagent. You do not have to show how the phosphonium ylide is prepared.

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

2. (4) Which enantiomer is formed when a Grignard reaction with CH\(_3\)MgBr attacks the S/i face of butanal? You must show your work.
3. (10) Provide the missing starting material(s) or product(s).

\[
\text{CH}_2=\text{CHC}O\text{H}_3 + \text{CH}_2=\text{CHC}=\text{H} + \text{CHCH}_2\text{C}=\text{H} \rightarrow \text{SCH}_3
\]

\[
\text{CH}_2=\text{CHCOCH}_3 \xrightarrow{1) 2 \text{CH}_3\text{CH}_2\text{MgBr}} \xrightarrow{2) \text{H}_3\text{O}^+} \rightarrow
\]

\[
\text{H}_2 \rightarrow \text{H}_2\text{SO}_4 \rightarrow \text{PCC} \rightarrow \text{CHCl}_2 \rightarrow \text{Na}_2\text{Cr}_2\text{O}_7 \rightarrow \text{H}_2\text{SO}_4
\]

\[
\text{Raney Ni}
\]

\[
\text{Raney Ni}
\]

\[
\text{Raney Ni}
\]
4. (6) Classify each of the following reactions as either an oxidation, reduction, or neither.

\[
(\text{CH}_3)_3\text{COH} \quad \text{HCl} \quad (\text{CH}_3)_3\text{CCl} \quad + \quad \text{H}_2\text{O}
\]

\[
(\text{CH}_3)_2\text{C}≡\text{C}(\text{CH}_3)_2 \quad \text{Cl}_2 \quad \text{CCl}_4 \quad (\text{CH}_3)_2\text{C}–\text{C}(\text{CH}_3)_2
\]

\[
\text{H}_3\text{C}–\text{C}≡\text{C}–\text{CH}_3 \quad \text{Na} \quad \text{NH}_3 \quad \text{H}
\]

Bonus:

In Chapter 17 we introduced the concept of prochirality, and it sometimes arises with the carbon in carbonyl groups (C=O). Carbonyl carbons are not the only atoms that are potentially prochiral. For instance, carbons of C=C bonds can be prochiral. Circle all the alkenyl carbons on the quiz that are prochiral.