1. Which orbitals are used to form the indicated C-C $\sigma$ bonds in the compounds shown below?

   a) CH$_3$CH=CH--CH$_3$
   b) CH$_3$CH=C=CH$_2$
   c) CH$_3$C≡C--CH$_3$

   d) CH$_2$=CH--CH=CH$_2$
   e) CH$_3$C≡C--CH$_2$CH$_3$
   f) CH$_3$CH=CH--C≡CH

2. Explain why the terminal hydrogen of an alkyne can be abstracted by strong base (NaNH$_2$), while no reaction occurs with an alkene or alkane?

   HC≡CH + NaNH$_2$ → HC≡C$^-$ + NH$_3$

   CH$_2$=CH$_2$ + NaNH$_2$ → no reaction

   CH$_3$CH$_3$ + NaNH$_2$ → no reaction

3. Give the product(s) of the reaction between 3-hexyne and each of the following reagents. Indicate regiochemistry and geometry where appropriate.
   a) 1 mole H$_2$ and Lindlar’s catalyst
   b) 2 moles H$_2$ and Pt
   c) 1 mole Br$_2$
   d) 2 moles HCl
   e) NaNH$_2$ in NH$_3$(l)
   f) HgSO$_4$, H$_2$SO$_4$, H$_2$O
   g) Aqueous NaOH
   h) O$_3$, Zn, acetic acid
   i) acidic KMnO$_4$
   j) (Sia)$_2$BH followed by H$_2$O$_2$, HO$^-$
   k) 1 mole Li in NH$_3$(l)

4. Draw the keto tautomer for each of the following vinyl alcohols:

   a) CH$_3$CH=CCH$_3$
   b) CH$_3$CH$_2$CH$_2$C=CH$_2$
   c) OH
   d) OH
5. Suggest a reasonable synthetic scheme for each of the following transformations. Show all intermediate compounds and reagents.

a) \[ \text{Br} \quad \text{CH}_3\text{CH}_2\text{CHCH}_3 \quad \text{from acetylene} \]

b) \[ \text{OH} \quad \text{CH}_3\text{CH}_2\text{CHCH}_3 \quad \text{from acetylene} \]

c) \[ \text{CH}_3\text{C}≡\text{CH} \quad \text{from propane} \]

d) \[ \text{O} \quad \text{H}_3\text{C} - \text{C} - \text{CH}_3 \quad \text{from propane} \]

e) propyne from propene

6. Show how you would complete the following conversion. Show all intermediate compounds and reagents.

\[ \text{Before} \quad \text{After} \]

\[ \text{Before} \quad \text{After} \]