For the following reactions what is the product. Show stereochemistry as appropriate. Specify all unique stereoisomers produced.

1. 

![1](image1)

2. 

![2](image2)

cis 2-butene

3. 

![3](image3)

4. 

![4](image4)

C\textsubscript{6}H\textsubscript{5}CHCH\textsubscript{2} \quad \text{C}_{16}H\textsubscript{16}
5. 

\[
\begin{align*}
\text{excess Br}_2 & \quad \rightarrow \\
\text{CH}_3 & \quad \text{CH}_3
\end{align*}
\]

use additional templates exactly the same as the one above as required.

6. 

\[
\begin{align*}
\text{CH}_3 & \quad \text{CH}_3 \\
\text{H}_3\text{C} & \quad \text{B}_2\text{H}_6 \\
\text{H}_3\text{C} & \quad \text{H}_2\text{O}_2 \\
\text{aq. base} & \\
& \quad \text{Na}_2\text{Cr}_2\text{O}_7 \\
& \quad \text{CH}_3\text{MgBr} \\
& \quad \text{acid} \\
& \quad \text{room temp.}
\end{align*}
\]

7. 

\[
\begin{align*}
\text{CH}_3\text{COCl} & \quad \text{NaO}I \\
\text{AlCl}_3 & \quad \rightarrow \\
& \quad \rightarrow \\
\text{C}_16\text{H}_{20}
\end{align*}
\]

8. 

\[
\begin{align*}
2 & \quad \text{Cyclic Reaction} \\
& \quad \rightarrow \\
& \quad \text{C}_16\text{H}_{20}
\end{align*}
\]
9. 
\[ \text{HOCH}_2\text{CH}_2\text{OH} \quad \text{dry HCl} \]

10. 
\[ \text{propyne} + 2\text{HCl} \]

11. 
\[ \text{CH}_2\text{OH} \quad \text{PCC} \quad \text{conc. NaOH} \]

12. 
A) What is the **mechanism** of the following reaction?

\[ \text{CH}_2=\text{CHCH}_3 \quad \text{NBS} \quad \text{CH}_2=\text{CHCH}_2\text{Br} \]

B) Draw resonance structures of the intermediate involved and sketch the molecular orbital that holds only a single electron.

13. Write the **mechanism** of the following reaction.

\[ \text{CH}_3\text{CHO} + 2\text{C}_2\text{H}_5\text{OH} \quad \text{acid} \quad \text{CH}_3\text{CH}((\text{OC}_2\text{H}_5)_2) \]
Provide an efficient, reasonable synthesis of the following compounds. You may synthesize the carbon skeleton from alcohols having four or fewer carbons.

- You do not have to synthesize a compound twice. If you wish to use a compound that you made earlier simply provide a reference to it.
- You may freely use a compound whose synthesis was requested in an earlier compound.

14. 3-pentanone

15. 3-ethyl-3-pentanol

16. 3,4-diethylhexane

17. propyne

18. A student attempts to prepare 1-bromobutane by refluxing 1-butanol, water and NaBr together for 45 minutes. Upon distilling the mixture only the original alcohol was obtained. What went wrong? Why?

19. Ethanal is oxidized by dichromate yielding acetic acid and Cr(III). Write a balanced reaction