1. Choose the major product of the following reaction.

\[
\begin{align*}
\text{O} & \text{O} - \text{CH}_3 \\
\text{C} & \text{6} & \text{H}_4 \\
1. \text{LiAlD}_4 & \\
2. \text{H}_3\text{O}^+ & \\
\end{align*}
\]

\[
\begin{array}{cccc}
\text{A} & \text{B} & \text{C} & \text{D} & \text{E} \\
\text{D} & \text{O} & \text{H} & \text{D} & \text{O} & \text{H} \\
\text{D} & \text{O} & \text{H} & \text{D} & \text{O} & \text{H} \\
\end{array}
\]

2. Choose the most acidic hydrogen of the following compound.

\[
\begin{align*}
\text{A} & \text{C} \\
\text{B} & \text{D} & \text{E} \\
\text{B} & \text{D} & \text{E} \\
\end{align*}
\]

3. Abiraterone is a drug currently under investigation for use in prostate cancer.

\[
\begin{align*}
\text{Stereochemistry? R or S} & \text{ Hybrid orbitals?} \\
\text{A. R and Csp}^3\text{-Csp}^3 & \\
\text{B. R and Csp}^2\text{-Csp}^3 & \\
\text{C. R and Csp}^2\text{-Csp}^2 & \\
\text{D. S and Csp}^3\text{-Csp}^3 & \\
\text{E. S and Csp}^2\text{-Csp}^3 & \\
\end{align*}
\]

Choose the answer that has correctly identified the absolute stereochemistry and hybrid orbitals used at the indicated positions.
4. Choose the major product of the following reaction.

\[
\begin{align*}
\text{CH}_3 &\quad \text{O} \\
&\quad \text{H-Br} \quad \text{H} \\
\end{align*}
\]

A  
B  
C  
D  
E

5. Choose a propagation step in the following free radical reaction.

\[
\begin{align*}
\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} &+ \text{Bu}_3\text{Sn-H} \quad \text{RO-OR} \quad \text{Bu}_3\text{Sn}\text{-Br} \\
\text{A} \quad \text{RO-OR} &\rightarrow 2\text{RO} \cdot \\
\text{B} \quad \text{Bu}_3\text{Sn} \cdot &+ \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} \quad \text{Bu}_3\text{Sn}\text{-CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} \\
\text{C} \quad \text{H} \cdot &\rightarrow \text{H} \\
\text{D} \quad \text{RO} \cdot &+ \text{Bu}_3\text{Sn}\text{-Br} \quad \text{Bu}_3\text{Sn} \cdot + \text{RO-Br} \\
\text{E} \quad \text{Bu}_3\text{Sn} \cdot &+ \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} \quad \text{Bu}_3\text{Sn}\text{-Br} + \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\cdot \\
\end{align*}
\]

6. Choose the major product of the following reaction.

\[
\begin{align*}
\text{CH}_2\text{CH}_2\text{OH} &\quad \text{H-Cl} \\
\end{align*}
\]

A  
B  
C  
D  
E
7. Choose the major product of the following reaction.

\[
\begin{align*}
\text{H} & \quad \text{OEt} \\
\text{Br} & \quad \rightarrow \\
\end{align*}
\]

A \quad B \quad C \quad D \quad E

8. Choose the order that has the following solvents correctly arranged with respect to increasing solubility of potassium cyanide.

\[
\begin{align*}
\text{K} & \quad \text{C} & \quad \text{N} & \quad = \quad \text{potassium cyanide} \\
\end{align*}
\]

i \quad \text{OH} \quad \text{O} \quad \text{CH}_3

A \quad i < ii < iii \quad B \quad i < ii < ii \quad C \quad ii < iii < i \quad D \quad ii < i < iii \quad E \quad iii < i < ii

9. Below is the energy profile for the addition of H-Br to 2-methylpropene.

\[
\begin{align*}
\text{CH}_2= & \quad + \quad \text{H-Br} & \quad \rightarrow & \quad \text{CH}_2\text{CHBr} \quad + \quad \text{Br}^{-} \\
\end{align*}
\]

Choose the energy difference that determines the rate of the reaction.
10. Choose a method that would perform the following transformation in high yield.

```
       \[ \text{1. LiAlH}_4 \rightarrow \text{2. H}_2\text{O} \]

A  \[ \text{1. BH}_3\text{-THF} \rightarrow \text{2. H}_2\text{O}_2/\text{OH} \]

B  \[ \text{1. Hg(OAc)}_2 \rightarrow \text{2. NaBH}_4 \]

C  \[ \text{1. RO}_2\text{H} \rightarrow \text{2. LiAlH}_4 \]

D  \[ \text{3. H}_2\text{O} \]
```

11. Choose the major product of the following reaction.

\[ \text{Br} \quad \text{SH} \quad \text{DMF} \quad \text{?} \]

A
B
C
D
E

12. Choose the order that has the following compounds correctly arranged with respect to increasing electrophilic character of the central carbon.

\[ \begin{align*}
\text{i} & : \text{COH} \\
\text{ii} & : \text{C} \\
\text{iii} & : \text{COH} \\
\end{align*} \]

A. \( \text{iii} < \text{ii} < \text{i} \)
B. \( \text{ii} < \text{i} < \text{iii} \)
C. \( \text{i} < \text{ii} < \text{iii} \)
D. \( \text{i} < \text{iii} < \text{ii} \)
E. \( \text{ii} < \text{i} < \text{iii} \)

13. Choose the order that has the following hydrocarbons correctly arranged with respect to increasing acidity of the indicated proton.

\[ \begin{align*}
\text{i} & : \text{H} \\
\text{ii} & : \text{H} \\
\text{iii} & : \text{H} \\
\end{align*} \]

A. \( \text{iii} < \text{ii} < \text{i} \)
B. \( \text{iii} < \text{i} < \text{ii} \)
C. \( \text{ii} < \text{i} < \text{iii} \)
D. \( \text{ii} < \text{iii} < \text{i} \)
E. \( \text{i} < \text{ii} < \text{iii} \)
14. Choose among the following reactions those that will give a mixture of two diastereomers as the products.

\[ \text{CH}_3\text{Li}\]
\[ \text{CH}_3\text{Li} \rightarrow \text{H}_2\text{O} \]
\[ \text{NaBH}_4 \rightarrow \text{H}_2\text{O} \]

A. i
B. ii
C. iii
D. i + ii
E. ii + iii

15. Choose the order that has the following ketones correctly ordered with respect to increasing reactivity with NaBH₄.

\[ \text{CH}_3\text{C}-(\text{CH}_3)_3 \]
\[ \text{H}^+\text{C}-(\text{CH}_3)_3 \]
\[ \text{CH}_3\text{C}-(\text{CH}_3)_3 \]

A. i < ii < iii
B. i < iii < ii
C. ii < i < iii
D. ii < iii < i
E. iii < i < ii

16. Choose the major product of the following reaction sequence.

\[ \text{CH}_3\text{O} \rightarrow \text{LiAlH}_4 \rightarrow \text{PCC} \]

A
B
C
D
E
17. Choose the major product of the following reaction.

\[
\begin{array}{c}
\text{Br} \\
\text{H} \\
\text{CH}_2\text{CH}_3 \\
\text{H} \\
\text{CH}_3
\\
\text{NaOEt} \\
\text{DMSO}
\end{array} 
\begin{array}{c}
\text{H} \\
\text{CH}_2\text{CH}_3 \\
\text{H} \\
\text{CH}_3
\\
\end{array}
\]

![Chemical structures A to E](image)

18. Two major products are formed in the following reaction. Choose the structures of these major products.

\[
\begin{array}{c}
\text{OEt} \\
\text{EtOH}
\end{array} 
\begin{array}{c}
\text{H}, \text{heat} \\
\text{EtOH}
\end{array}
\]

![Chemical structures i to iv](image)

A ii and iii  
B ii and iv  
C iii and iv  
D i and ii  
E i and iii

19. Select the correct structure for \((S,Z)\)-pent-3-en-2-ol.

![Chemical structures A to E](image)

A  
B  
C  
D  
E

20. Choose the structure of the product of the following reaction.

\[
\begin{array}{c}
\text{O} \\
\text{O-D}
\end{array} 
\begin{array}{c}
\text{D}_2\text{O (excess)}
\end{array}
\]

![Chemical structures A to E](image)

A  
B  
C  
D  
E
21. Provide reagents for performing the following transformations. (These transformations may require more than one step and do not show intermediate structures, just give the reagents for each step.). 10 pts

(a)  

(b)  

22. Give the major product(s) of the following reactions. Carefully show stereochemistry. 10 pts

(a)  

(b)  

23. Give the structures of compounds A-D based on the following data. Compounds A and C are constitutional isomers. Compounds B and D are enantiomers. 10 pts

D \xrightarrow{1. \text{NaH}} C \xrightarrow{\Theta \text{OCH}_3} \text{OCH}_3 \xrightarrow{\Theta \text{CH}_3 \text{OH}} \xrightarrow{\text{H}^\oplus} \text{A} \xrightarrow{1. \text{NaH}} \xrightarrow{2. \text{CH}_3\text{I}} \text{B}

24. Give the structure of compounds E and F based on the following data. 10 pts

E \xrightarrow{\text{H}^\oplus} \xrightarrow{\text{HO-CH}_3} F 

\text{C}_6\text{H}_{12} \xrightarrow{\text{six }^{13}\text{C NMR absorptions}} \xrightarrow{\text{C}_7\text{H}_{16}\text{O} \text{ five }^{13}\text{C NMR absorptions}} 

\text{F} \xrightarrow{\text{H}^\oplus} \text{F} \xrightarrow{1. \text{NaH}} \xrightarrow{2. \text{CH}_3\text{I}} \text{B} 

\text{H NMR spectrum of F}
In 1993 Stony Brook graduate student James Ciaccio and Professor Thomas Bell reported the synthesis of a female lepidopteron sex pheremone. Their reaction sequence began with the twelve carbon aldehyde shown below. Draw the structures of the intermediate G, H, I and of the final pheremone product J. 10 pts

\[
\begin{align*}
R &= \text{C}_{11}H_{23} \\
1. &\text{MgBr} \\
2. &\text{H}_2\text{O} \\
\text{G} &\xrightarrow{\text{ROO}_3\text{H}} \text{H} &\xrightarrow{\text{TsCl, pyridine}} \text{I} &\xrightarrow{\text{H}_2/\text{Lindlar}} \text{J}
\end{align*}
\]

26. Using the curved arrow formalism show the bond making and bond breaking that occurs in the following transformation. Your mechanism must account for the stereochemistry of the product. 10 pts

\[
\begin{align*}
\text{Cl} \quad + \quad \text{H}_2\text{O} : &\quad \rightarrow \quad \text{Cl} \quad + \quad \text{OH} \quad + \quad \text{H}^- \text{Cl} \quad + \quad \text{OH}
\end{align*}
\]

27. Using the curved arrow formalism show the bond making and bond breaking that occurs in the following transformation. 10 pts

\[
\begin{align*}
\text{OH} \quad + \quad \text{H}^+ \quad \rightarrow \quad \text{C} \quad + \quad \text{OH}
\end{align*}
\]

28. The compound 2,6-dimethyloct-7-en-4-one is a component of the odor of Marigolds (*Tagetes lemmonii*).

Propose a synthesis of 2,6-dimethyloct-7-en-4-one from compounds containing four carbon atoms or less and any necessary reagents. 10 pts

\[
\begin{align*}
\text{2,6-dimethyloct-7-en-4-one}
\end{align*}
\]