1. Which of the following pairs of compounds can be used as starting materials in the synthesis of 2-phenyl-2-hexanol?

A. CH₃CH₂CH₂CH₂Br and O\text{CCH₃}
B. (CH₃)₂CHCH₂Br and O\text{CCH₃}
C. Br and CH₃CH₂CH₂CCH₃
D. Br and (CH₃)₂CHCH₂CCH₃

2. Which of the following compounds will NOT react with Mg metal in the presence of ether to give a Grignard reagent?

A. CH₃OCH₂CH₂I      B. CH₃CH₂CH₂I      C. CH₂=CHBr      D. HOCH₂CH₂Br

3. Which of the following sequences gives the highest yield in the reaction shown?

\[ \text{CH₂=CHCH₃} \rightarrow \text{CH₂CHCH₂Cl} \]

A. NBS in CCl₄; then Cl₂ in CCl₄
B. Cl₂ in CCl₄; then NBS in CCl₄
C. Br₂/CCl₄; then Cl₂, light
D. Cl₂, light; then Br₂/CCl₄

4. Which of the following compounds is the strongest base?

A. NaNH₂      B. CH₃CH₂MgBr      C. NaOH      D. HC≡CMgBr
5. Which of these compounds gives the SMALLEST number of signals in its proton nmr spectrum?

A. \[\text{OCH}_3\]
B. \[\text{OCH}_3\]
C. \[\text{CH}_3\]
D. \[\text{OCH}_2\text{CH}_3\]

6. An unknown compound gave an IR spectrum containing a peak at 1715 cm\(^{-1}\) and a broad peak between 2500 and 3000 cm\(^{-1}\). Its proton nmr spectrum was:

- triplet, \(\delta 1.3\) (3H)
- quartet, \(\delta 3.7\) (2H)
- singlet, \(\delta 4.1\) (2H)
- singlet, \(\delta 10.9\) (1H).

What is the structure of this unknown?

A. \[\text{CH}_3\text{OCH}_2\text{CH}_2\text{C}–\text{OH}\]
B. \[\text{CH}_3\text{OCH}_2\text{C}–\text{CH}_2\text{OH}\]
C. \[\text{CH}_3\text{CH}_2\text{OCH}_2\text{C}–\text{OH}\]
D. \[\text{CH}_3\text{CH}_2\text{C}–\text{CH}_3\]

7. What is the name of the compound shown?

A. 1-methyl-1,4-cyclohexadiene
B. 2-methyl-1,4-cyclohexadiene
C. 1-methyl-1,3-cyclohexadiene
D. 3-methyl-1,3-cyclohexadiene
8. What is the major organic product of the reaction sequence shown?

\[
\text{CH}_3\text{Br} \quad \text{Br}_3, \text{light} \\
[[\text{CH}_3\text{H}_2\text{CuLi} \quad \longrightarrow \quad \longrightarrow] \quad ?
\]

A. (CH₃)₂CHCH₃  
B. (CH₃)₃CBr  
C. (CH₃)₂CHCH₂Br  
D. (CH₃)₂CBrCH₂Br

9. Which of the following carbocations is the MOST stable?

A. \( \text{CH}_3\text{CH} = \text{CH} - \text{CH} - \text{CHCH}_3 \)  
B. \( \text{CH}_3\text{CH} = \text{CH} - \text{CH}_2 - \text{C} - \text{CH}_3 \)  
C. \( \text{CH}_2 - \text{CH} = \text{CH} - \text{CH}_2\text{CHCH}_3 \)  
D. \( \text{CH}_3\text{CH} = \text{CH} - \text{CH}_2 - \text{CH} - \text{CH}_2 \)

10. What is the major organic product of the sequence of reactions shown?

\[
\text{ether} \quad \text{Br} \quad \text{Mg} \quad \text{H}_3\text{O}^+ \quad \text{H}_2\text{CrO}_4 \\
\longrightarrow \quad \longrightarrow \quad \longrightarrow \quad ?
\]

A. \( \text{C} - \text{OH} \)  
B. \( \text{C} - \text{H} \)  
C. \( \text{C} - \text{O} \)  
D. \( \text{OH} \)

11. Which of the following compounds is NOT a product of the reaction shown?

\[
\text{C} \quad + \text{HCl} \quad \longrightarrow \quad ?
\]

A. \( \text{C} \text{Cl} \)  
B. \( \text{Cl} \text{Cl} \)  
C. \( \text{Cl} \text{Cl} \)  
D. \( \text{Cl} \text{Cl} \)
12. Which of the following compounds has the proton(s) having the HIGHEST chemical shift (value of delta)?

A. CH₄  B. (CH₃)₂C=O  C. CH₃Li  D. (CH₃)₂O

13. An unknown compound having the formula C₄H₈O gave the following proton magnetic resonance spectrum:

- multiplet, δ 1.85 (4H)
- triplet, δ 3.75 (4H)

What is the structure of this unknown?

A. \( \text{CH}_3\text{CH}=\text{CH}-\text{CH}_2\text{OH} \)  B. CH₃CH=CH-CH₂OH  C. \( \text{O} \)
D. CH₂=CH-CH₂CH₂OH

14. Which of the following has the lowest energy per photon?

A. Ultraviolet  B. Microwaves  C. X-rays  D. Infrared

15. Which of the following is a valid resonance structure of the molecule shown?

A. \( \text{CH}_3\text{CH}_2\text{C}—\text{CH}_2 \)  B. \( \text{CH}_3\text{CH}=\text{CH}_2\text{OH} \)  C. \( \text{CH}_3\text{CH}=\text{CH}_2\text{C}=\text{CH} \)  D. \( \text{CH}_3\text{CH}_2\text{C}—\text{CH}_2 \)

16. How many allylic hydrogen atoms are present in the molecule shown?

A. 2  B. 3  C. 4  D. 5
17. Which of the following reaction sequences gives (CH₃)₂CCH₂CH₃ as the major organic product?

A. CH₃CH=CH₂ → Li → CuI → (CH₃)₃CBr → ?
B. (CH₃)₂C=CH₂ → Li → CuI → CH₃CH₂CH₂Br → ?
C. (CH₃)₃CH → Br₂, light → Li → CuI → CH₃CH₂CH₂Br → ?
D. CH₃CH₂CH₃ → Br₂, light → Li → CuI → (CH₃)₃CBr → ?

18. Which of the following dienes has the SMALLEST heat of hydrogenation?

A. CH₂=CH–CH₂CH=CH₂  B. CH₂=C--CH₂CH₂CH₃
C. CH₂=CH–CH=CHCH₂  D. CH₂=CH–C=CH–CH₂CH₃

19. What is the major organic product of the reaction shown?

A. HOCH₂CH₂OH  B. H--CCH₂OH
C. HOCH₂C-OCH₃  D. H--CCHOCH₃

20. What is the major organic product of the reaction shown?

A. CH₃CH₂CH₂C–H  B. CH₃CH₂C–H  C. CH₃CH₂CH₂COH  D. CH₃CH₂COH
21. How many signals are there in the proton nmr spectrum of the following compound?

\[
\text{CH}_3\text{CH}_2\underline{\text{Br}}\text{OCH}_2\text{CH}_3
\]

A. 4 B. 5 C. 6 D. 7

22. Which of these compounds gives a singlet in its proton nmr spectrum?

A. B. C. D.

23. What is the major organic product of the reaction sequence shown?

\[
\begin{array}{c}
\text{OH} \\
\text{C-CH}_3 + \text{MgBr} \\
\text{H}_3\text{O}^+ \\
\end{array}
\]

\[
\begin{array}{c}
\text{OH} \\
\text{C-CH}_3 \\
\text{C-CH}_3 \\
\end{array}
\]

A. B. C. D.

24. What is the major organic product of the reaction shown?

\[
\begin{array}{c}
\text{+} \\
\end{array}
\]

\[
\begin{array}{c}
\text{CH}_3 \\
\end{array}
\]

A. B. C. D.