1. Which Wittig reagent and aldehyde or ketone could you use to synthesize the compound shown below?

\[
\text{\begin{tikzpicture}
  \node (plop) at (0,0) {\includegraphics[width=2cm]{pentane.png}};
  \node (arrow) at (2,0) {\rightarrow};
  \node (questionmark) at (3,0) {?};
\end{tikzpicture}}
\]

2. Show the structure of the product that would result from a Bayer-Villiger oxidation of cyclopentanone.

\[
\text{\begin{tikzpicture}
  \node (plop) at (0,0) {\includegraphics[width=2cm]{cyclopentanone.png}};
  \node (arrow) at (2,0) {\rightarrow};
  \node (questionmark) at (4,0) {?};
  \node (peroxide) at (3,0) {\text{ROOH}};
\end{tikzpicture}}
\]

3. Show the mechanism of the following reaction:

\[
\text{\begin{tikzpicture}
  \node (plop) at (0,0) {\includegraphics[width=2cm]{aldehyde.png}};
  \node (arrow) at (2,0) {\rightarrow};
  \node (phosphonium) at (2,0) {\text{P(Ph)}_3\text{Br}};
  \node (product) at (4,0) {\includegraphics[width=2cm]{product.png}};
  \node (phosphine) at (5,0) {\text{Ph}_3\text{PO}};
\end{tikzpicture}}
\]
4. The structure of the sex pheromone (attractant) of the female tsetse fly has been confirmed by the following synthesis. Compound C appears to be identical to the natural pheromone in all respects (including the response of the male tsetse fly). Provide structures for A, B and C.
MULTIPLE CHOICE (4 pts each):

5. What is the product of the reaction shown below?

\[
\text{HOOC} + \text{BrCH_2CO_2Et} \xrightarrow{1. \text{Zn}} \xrightarrow{2. \text{H}_3\text{O}^+} \text{HOOC} \text{Et}
\]

(a) \(\text{HOOC} \text{Et}
\)
(b) \(\text{BrCH_2CO_2Et}
\)
(c) \(\text{HOOC} \text{Et}
\)
(d) \(\text{BrCH_2CO_2Et}
\)

6. The Bayer-Villiger oxidation of the compound shown gives primarily what?

\[
\text{CH_3CH_2CH_2C=O} \xrightarrow{\text{OOH}} \text{CH_3CH_2CH_2C=O}
\]

(a) \(\text{CH_3CH_2CH_2C=O}
\)
(b) \(\text{CH_3CH_2CH_2C=O}
\)
(c) \(\text{CH_3CH_2CH_2C=O}
\)
(d) \(\text{CH_3CH_2CH_2C=O}
\)

7. The Reformatsky reaction involves the reaction of an aldehyde or ketone with this type of organometallic compound:

(a) \(\text{RLi}
\)
(b) \(\text{R}_2\text{CuLi}
\)
(c) \(\text{BrZn-CH}_2\text{CO}_2\text{R}
\)
(d) \(\text{RMgBr}
\)
(e) \(\text{Ph}_3\text{P}
\)
8. Which of the following reactions does NOT produce an alkene product?
   (a) Wittig          (c) Bayer-Villiger
   (b) Horner-Wadsworth-Emmons          (d) E2 elimination of an alkyl halide

9. Which of the following groups has the highest migratory aptitude?
   (a) phenyl-  (b) methyl-  (c) t-buty1-  (d) H-

10. The Tollens’ oxidation (or Tollens’ test) is a method for detection of which functional group?
    (a) alcohol  (b) aldehyde  (c) ketone  (d) alkene

11. A neutral molecule that has a carbanion adjacent to a positively-charged heteroatom is called a(n):
    (a) oxaphosphetane  (b) betaine  (c) ylide  (d) β-hydroxy ester

12. The Horner-Wadsworth-Emmons modification of the Wittig reaction employs what type of nucleophilic species?
    (a) phosphorus ylide  (c) Ph₃P
    (b) anion of a phosphonate ester  (d) n-Butyllithium

13. Heating a β-hydroxy ester in the presence of acid gives:
    (a) an aldehyde  (c) an α,β-unsaturated ester
    (b) a ketone  (d) an alkane

14. In a ¹H NMR spectrum of any aldehyde, a characteristic signal appears at:
    (a) 6.5-7 ppm  (b) 9-10 ppm  (c) 2-3 ppm  (d) 5-6 ppm

**Bonus (+8 pts): Identify the structure of the unknown compound with molecular formula C₈H₈O and the ¹H NMR spectrum shown: