SHORT ANSWER (15 pts each)

1. Classify the following reactions as either oxidation or reduction:

   (a) \[ \text{NaBH}_4, \text{H}_2\text{O} \rightarrow \text{C-H} \quad \rightarrow \quad \text{C-H} \]

   (b) \[ \text{1. LiAlH}_4, \text{Et}_2\text{O} \quad \rightarrow \quad \text{Ph-OH} \]

   (c) \[ \text{H}_2\text{CrO}_4, \text{acetone} \quad \rightarrow \quad \text{C=O} \]

   (d) \[ \text{PCC, CH}_2\text{Cl}_2 \rightarrow \text{C-H} \quad \rightarrow \quad \text{C-H} \]

   (e) \[ \text{Br}_2, \text{hv} \quad \rightarrow \quad \text{C-Br} \]

2. Predict the product(s) of the following reactions:

   (a) \[ \text{MeO} \quad \text{NaBH}_4, \text{H}_2\text{O} \rightarrow \text{C=O} \]

   (b) \[ \text{EtO} \quad \text{1. LiAlH}_4, \text{Et}_2\text{O} \quad \rightarrow \quad \text{EtO} \]

   \[ \text{2. H}_3\text{O}^+ \]
3. A chemist carries out the following synthetic sequence. Show the products (A-E) that would be formed in each successive step. Here is some narrative to help you: treatment of isopropyl alcohol with phosphorous tribromide gives compound A. Treatment of A with magnesium metal in diethyl ether gives Grignard reagent B. Treatment of B with benzaldehyde, followed by an aqueous acidic work-up affords compound C. Treatment of C with Jones reagent gives D, which has a strong sharp signal in the IR spectrum at about 1700 cm\(^{-1}\). Treatment of D with \(n\)-butyllithium in diethyl ether followed by an aqueous acidic work-up gives the final product E, which shows a broad signal in the IR spectrum at about 3450 cm\(^{-1}\).

4. Show a reasonable synthesis of ethyl cyclopentane using dialkylcuprate chemistry.
MULTIPLE CHOICE (8 pts each)

5. The hybridization state of a carbonyl carbon is:
   (a) sp   (b) sp²   (c) sp³   (d) sp³d   (e) none of these

6. The correct order of reactivity of carbonyl compounds towards reducing agents
   and/or nucleophiles is:
   (a) aldehyde > ketone > ester > carboxylic acid
   (b) carboxylic acid > ester > ketone > aldehyde
   (c) ketone > ester > carboxylic acid > aldehyde
   (d) ester > carboxylic acid > aldehyde > ketone

7. In organic chemistry which of the following statements about oxidation is NOT true?
   (a) Oxidation corresponds to increasing the oxygen content of a molecule.
   (b) Oxidation corresponds to increasing the content of any element more
       electronegative than carbon.
   (c) Oxidation corresponds to increasing the hydrogen content of a molecule.
   (d) None of the above.

8. Which of the following is NOT an organometallic compound?
   (a) Me₂CuLi   (b) H₂CrO₄   (c) CH₃CH₂Li   (d) CH₃CH₂CH₂MgBr

9. Treatment of a 1° alcohol with which reagent will produce an aldehyde?
   (a) Jones reagent   (b) KmnO₄   (c) NaBH₄   (d) Pyridinium chlorochromate (PCC)

**Bonus: (+8 pts): What is the product of the following synthetic sequence?**

\[
\begin{array}{c}
\text{OH} \\
\text{PBr}_3 \\
\text{Mg} \\
\text{Et}_2\text{O} \\
\text{Jones reagent}
\end{array}
\]

A → B → C → ?