1) Name the general class of organic molecules that each of these molecules belong to, and circle the most reactive molecule with respect to undergoing nucleophilic attack. (7pts)

\[
\begin{array}{ccccc}
\text{CH}_2 & \text{O} & \text{O} & \text{O} \\
\text{R-C-R} & \text{R-C-R} & \text{R-C-F} & \text{R-C-H}
\end{array}
\]

2) Name the general class of organic molecules that each of these molecules belong to, and draw the Lewis structure including lone pairs for the following molecules. (10.5pts)

\[
\begin{array}{ccc}
\text{CH}_3\text{CONH}_2 & \text{CH}_3\text{CN} & \text{CH}_3\text{NCO}
\end{array}
\]
3) Circle the stronger base in the following pairs, and in a sentence explain your choice. (10pts)

(a) 

(b) 

(c) 

CH₃CH₂-CN

(d) 

(e) 

H₂N-
4) Name the following compounds in IUPAC acceptable terms. (12pts)
5) Explain why in both pairs, the left hand molecule is more reactive toward nucleophilic attack. (10pts)

\[
\begin{align*}
\text{CH}_3 & \text{C} & \text{CCl}_3 \\
\text{CH}_3 & \text{C} & \text{CH}_3
\end{align*}
\]

\[
\begin{align*}
\text{Ph} & \text{C} & \text{Ph} \\
\text{Ph} & \text{C} & \text{Ph}
\end{align*}
\]
6) Compound A is an illegal drug which creates states of entactogenesis and empathogenesis in users. Side effects have been shown to include lowered brain serotonin levels, which results in long term depression and memory degradation. The enantiomer shown is far more active than its mirror image.

(i) Indicate the chiral atom in A, and assign either R or S (2pts)

(ii) what functional group is attached to the left hand side of the aromatic ring in A? (2pts)

(iii) What reagents are required to afford D → C? (3pts)

(iv) What reagents are required to afford C → B? (3pts)

(v) What reagents are required to afford B → A? (3pts)

(vi) Draw the mechanism for any ONE of the above reactions (5pts)
7) Give the products formed in five of the following reactions. (15pts)

(a) \[
\begin{align*}
\text{H}_3\text{C} & - \text{C} - \text{CH}_3 \\
1) & \text{PhMgBr} \\
2) & \text{H}_3\text{O}^+
\end{align*}
\]

(b) \[
\begin{align*}
\text{O} & \\
\text{Tos} & \\
\text{KCN} & \rightarrow \text{A} \\
\text{LiAlH}_4, \text{H}_2\text{O} & \\
\text{excess} & \text{Ph} - \text{C} - \text{Cl}
\end{align*}
\]

(c) \[
\text{excess} \text{Ph} - \text{C} - \text{Cl}
\]

(d) \[
\text{excess CH}_3\text{CH}_2\text{CH}_2\text{-Br}
\]

(e) \[
1) \text{excess CH}_3\text{-Br} \\
2) \text{Ag}_2\text{O}, \text{H}_2\text{O}, \text{heat}
\]

(f) \[
\begin{align*}
\text{O} & \\
\text{Ph} - \text{C} - \text{CH}_3 \\
1) & \text{Ph}_3\text{P}, \text{CH}_3\text{CH}_2\text{-Br} \\
2) & \text{BuLi} \\
3) & \text{warm}
\end{align*}
\]
8) Give reagents for the following transformations, bearing in mind the incompatibility of some of the functional groups. (9pts)

\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O}
\end{align*}
\quad \rightarrow \quad
\begin{align*}
\text{O} & \quad \text{OH} \\
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O}
\end{align*}
\]

\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O}
\end{align*}
\quad \rightarrow \quad
\begin{align*}
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{OH} \\
\text{O} & \quad \text{O}
\end{align*}
\]

\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{O}
\end{align*}
\quad \rightarrow \quad
\begin{align*}
\text{OH} & \quad \text{OH} \\
\text{OH} & \quad \text{O}
\end{align*}
\]

9) Write both mechanisms for the acid and base catalyzed hydration of propanone (acetone) (8.5pts)
*Bonus questions* (up to 3pts)
Write the mechanism for the reaction of aniline with nitrous acid to generate a diazonium salt.

Or
Write the (correct) mechanism for the Canizarro reaction.
1) Name the general class of organic molecules that each of these molecules belong to, and circle the most reactive molecule with respect to undergoing nucleophilic attack. (7pts)

![Molecules diagram]

2) Name the general class of organic molecules that each of these molecules belong to, and draw the Lewis structure including lone pairs for the following molecules. (10.5pts)

![Molecules diagram]
3) Circle the stronger base in the following pairs, and in a sentence explain your choice. (10pts)

(a) 

(b) 

(c) 

(d) 

(e) 

The L.p. on N in pyrrole is involved in the TT system. Therefore protonation would destroy aromaticity. The pyridine N does not use its L.p. in the TT system, & is less available for protonation.

The L.p. on oxazole is stabilized by overlap with the aromatic TT system and is less available for donation.

The C=C is double, sp character and hence less tightly & is more available.

The oxide N L.p. is delocalized & is less available for protonation.

The N's on both involved in the 6r aromatic system. The L.H.S. has a N with a L.p. not involved in the TT bonding and this is the most available for donation.
4) Name the following compounds in IUPAC acceptable terms. (12pts)

2,6-dimethylcyclohexanone

N-methyl-3-pentanamine

2-methylhexan-3-one

3,5 dichloro pentanal
5) Explain why in both pairs, the left hand molecule is more reactive toward nucleophilic attack. (10pts)

The LHS molecule has an electron withdrawing group which pulls e\(^{-}\) density away from the carbonyl carbon, making it more \(S\text{+ve}\), and more reactive towards nucleophiles.

The LHS molecule is less sterically hindered and therefore approaching nucleophiles can attack the carbonyl carbon more easily.
6) Compound A is an illegal drug which creates states of entactogenesis and empathogenesis in users. Side effects have been shown to include lowered brain serotonin levels, which results in long term depression and memory degradation. The enantiomer shown is far more active than its mirror image.

![Chemical structures](image)

(i) Indicate the chiral atom in A, and assign either R or S (2pts)

(ii) What functional group is attached to the left hand side of the aromatic ring in A? (2pts)

(iii) What reagents are required to afford D → C? (3pts)

(iv) What reagents are required to afford C → B? (3pts)

(v) What reagents are required to afford B → A? (3pts)

(vi) Draw the mechanism for any ONE of the above reactions (5pts)
7) Give the products formed in five of the following reactions. (15pts)

(a) \[ \text{H}_2\text{C} - \text{C} - \text{CH}_3 \]
   \[ \xrightarrow{1) \text{PhMgBr}} \xrightarrow{2) \text{H}_3\text{O}^+} \]
   \[ \text{O} - \text{H} \]
   \[ \text{CH}_3 - \text{C} - \text{CH}_3 \]

(b) \[ \text{KCN} \rightarrow \text{A} \rightarrow \text{LiAlH}_4, \text{H}_2\text{O} \]

(c) \[ \text{excess Ph-C-Cl} \]

(d) \[ \text{excess CH}_3\text{CH}_2\text{CH}_2\text{-Br} \]

(e) \[ \xrightarrow{1) \text{excess CH}_3\text{-Br}} \xrightarrow{2) \text{Ag}_2\text{O, H}_2\text{O, heat}} \]

(f) \[ \text{Ph-C-CH}_3 \]
   \[ \xrightarrow{1) \text{Ph}_3\text{P, CH}_3\text{CH}_2\text{-Br}} \]
   \[ 2) \text{BuLi} \]
   \[ 3) \text{warm} \]
8) Give reagents for the following transformations, bearing in mind the incompatibility of some of the functional groups. (9pts)

\[
\text{HOOC} - \text{CH}_2 - \text{COOH} \quad \xrightarrow{1) \text{NaBH}_4\text{, 2)} \text{H}_2\text{O}^+} \quad \text{HOOC} - \text{CH}_2 - \text{CH}_2 - \text{COOH}
\]

\[
\text{HOOC} - \text{CH}_2 - \text{CH}_2 - \text{C} = \text{C} - \text{OH} \quad \xrightarrow{1) \text{Ag}_2\text{O, 2)} \text{KMnO}_4 \text{ or KIO}_4} \quad \text{HOOC} - \text{CH}_2 - \text{CH}_2 - \text{COOH}
\]

\[
\text{HOOC} - \text{CH}_2 - \text{COOH} \quad \xrightarrow{1) \text{H}_2\text{O}^+\text{, 2)} \text{NaBH}_4\text{, 3)} \text{H}_2\text{O}^+} \quad \text{HOOC} - \text{CH}_2 - \text{CH}_2 - \text{OH}
\]

9) Write both mechanisms for the **acid** and **base** catalyzed hydration of propanone (acetone) (8.5pts)
*Bonus questions* (up to 3pts)
Write the mechanism for the reaction of aniline with nitrous acid to generate a diazonium salt.

Or
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